California WaterFix Hearing
Exhibit No. SWRCB-96

Suisun Marsh
Habitat Management, Preservation, and Restoration Plan

Final
Environmental Impact Statement/ Environmental Impact Report

Volume Ia: Main Report, Executive Summary and Chapters 1–5

U.S. Department of the Interior
Bureau of Reclamation

U.S. Fish and Wildlife Service

California Department of Fish and Game

November 2011

Mission Statements

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

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

The Mission of the Department of Fish and Game is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public.

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November 2011

Contents

Tables

On Page

Figures

Follows Page

Acronyms and Abbreviations

µS/cm	microSiemens per centimeter
2-D	two-dimensional
AB	Assembly Bill
AB32	Assembly Bill 32
ABAG	Association of Bay Area Governments
ACHP	Advisory Council on Historic Preservation
ADAM	Aerometric Data Analysis and Management System
af	acre-feet
AFB	Air Force Base
APE	area of potential effects
ARB	California Air Resources Board
BAAQMD	Bay Area Air Quality Management District
BAOS	Bay Area 2005 Ozone Strategy
BASH	bird airstrike hazard
Basin Plans	water quality control plans
Bay-Delta	San Francisco Bay/Sacramento–San Joaquin River Delta
BCDC	San Francisco Bay Conservation and Development Commission
BDCP	Bay-Delta Conservation Plan
BMPs	best management practices
BOD	biochemical oxygen demand
BOs	Biological Opinions
CAA	federal Clean Air Act
CAAA	Clean Air Act Amendments of 1990
CAAQS	state ambient air quality standards
CalEPA	California Environmental Protection Agency
CALFED	CALFED Bay-Delta Program
CalOSHA	California Division of Occupational Safety and Health
Caltrans	California Department of Transportation
CAP	Bay Area 2000 Clean Air Plan and Triennial Assessment
CAP	Solano County Climate Action Plan
CBDA	California Bay-Delta Authority
CCAA	California Clean Air Act of 1988
CCF	Clifton Court Forebay
CCMP	Comprehensive Conservation and Management Plan
CCMP	Comprehensive Conservation and Management Plan
CCR	California clapper rail

CDF	California State Department of Forestry and Fire Protection
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGS	California Geological Survey
CH_4	methane
CHP	California Highway Patrol
CHRIS	California Historical Resources Information System
CNDDB	California Natural Diversity Database
CNEL	community noise equivalent level
CNG	compressed natural gas
CNPS	California Native Plant Society
CO	carbon monoxide
CO_2	carbon dioxide
Corps	U.S. Army Corps of Engineers
CPM	Certified Property Manager
CPUC	California Public Utilities Commission
CRHR	California Register of Historical Resources
CSLC	California State Lands Commission
CUPA	Certified Unified Program Agencies
CVP	Central Valley Project
CWA	federal Clean Water Act
CWC	California Water Code
CZMA	Coastal Zone Management Act
D-####	water right Decision ####
dB	Decibel
dBA	A-weighted decibel
Delta	Sacramento–San Joaquin River Delta
DFG	California Department of Fish and Game
DO	dissolved oxygen
DOI	Department of the Interior
DRERIP	Delta Regional Ecosystem Restoration Implementation Plan
DRMS	Delta Risk Management Strategy
DSL	Digital Subscriber Lines
DWR	California Department of Water Resources
E/I	export/inflow ratio
EC	electrical conductivity
EC	salinity
EFH	Essential Fish Habitat
EGP	Ecosystem Goals Project

EHW	extreme high water
EIS/EIR	Environmental Impact Statement/ Environmental Impact Report
EMS	emergency medical service
EPA	U.S. Environmental Protection Agency
ERP	Ecosystem Restoration Program
ERPP	Ecosystem Restoration Program Plan
ESA	federal Endangered Species Act
FAA	Federal Aviation Administration
FPD	Suisun Fire Protection District
fps	feet per second
FR	Federal Register
FSSD	Fairfield-Suisun Sewer District
FTA	Federal Transit Administration
FWCA	Fish and Wildlife Coordination Act
General Construction Permit	NPDES General Permit for Stormwater Discharges Associated with Construction Activity
GHG	greenhouse gases
GIS	geographic information systems
GPS	global positioning system
GWh	gigawatt hours
GYS	Goodyear Slough
HDPE	high-density polyethylene
Hp	Horsepower
I-680	Interstate 680
I-80	Interstate 80
IPCC	Intergovernmental Panel on Climate Change
IRWMP	Integrated Regional Water Management Plan
ITAs	Indian Trust Assets
ITP	incidental take permits
ITS	incidental take statement
JUFI	Joint-Use Facility Improvements
km	Kilometers
L_{dn}	day-night level
L_{eq}	equivalent sound level
L_{max}	maximum sound level
L_{min}	minimum sound level
LNG	liquefied natural gas
LNG	liquefied natural gas
LOS	level of service

LTMS	Long-Term Management Strategy
LUFT	leaking fuel tank
L_{xx}	percentile-exceeded sound level
maf	million acre-feet
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Act
MBTA	Migratory Bird Treaty Act
MCE	maximum credible earthquake
mcf	million cubic feet
MeHg	methyl-mercury
mg/L	milligrams per liter
MHHW	average of the highest tide mean higher high water
MHW	average high tide mean high water
MHW	mean high water
MIDS	Morrow Island Distribution System
MLHW	mean lower high water
MLLW	average lower low tide elevation
MLW	average of the low tide elevations
mm	millimeters
MOA	memorandum of agreement
MOU	memorandum of understanding
MOV	motorized valve
mph	miles per hour
MPWD	Maine Prairie Water District
MRZ	Mineral Resource Zone
mS/cm	milliSiemens per centimeter
MSCP	Multi-Species Conservation Plan
MSCS	Multi-Species Conservation Strategy
msl	feet above mean sea level
MTC	Metropolitan Transportation Commission
MTL	average (mean) tide elevation
MVEBs	motor vehicle emissions budgets
MW	Megawatts
N_2O	nitrous oxide
NAAQS	national ambient air quality standards
NAHC	Native American Heritage Commission
NEPA	National Environmental Policy Act
ng/l	nanograms per liter
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOA	Notice of Availability

NOAA	National Oceanic and Atmospheric Administration
NOC	Notice of Completion
NOD	Notice of Determination
NO_X	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NPMS	national pipeline mapping system
NRCS	U.S. Department of Agriculture's Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWIC	Northwest Information Center
O_3	ozone
OAP	2001 Revised San Francisco Bay Area Ozone Attainment Plan for the 1-Hour National Ozone Standard
OES	Office of Emergency Services
OPR	Office of Planning and Research
OPS	Office of Pipeline Safety
OSHA	Occupational Safety and Health Administration
PAI	Preservation Agreement Implementation
PEIS/EIR	CALFED Programmatic Environmental Impact Statement/Environmental Impact Report
PG&E	The Pacific Gas and Electric Company
PM2.5 and PM10	particulate matter 2.5 microns or less and 10 microns or less in diameter
Porter-Cologne Act	Porter-Cologne Water Quality Control Act
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
PPV	peak particle velocity
PRBO	Point Reyes Bird Observatory
PRC	California Public Resources Code
psu	parts sea salt
RACMs	reasonably available control measures
RD	Reclamation District
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RGP	Regional General Permit
RMP	risk management plan
ROD	Record of Decision
ROG	reactive organic gases
RRDS	Roaring River Distribution System
RWQCB	Regional Water Quality Control Board
SCGP	Solano County General Plan
SCMAD	Solano County Mosquito Abatement District
SCWA	Solano County Water Agency

SEMSC	Solano Emergency Medical Services Cooperative
SEW	Suisun Ecological Workgroup
SFEI	San Francisco Estuary Institute
SFEP	San Francisco Estuary Project
SHPO	State Historic Preservation Officer
SID	Irrigation District
SIP	state implementation plan
SLRSP	Sea Level Rise Strategic Program
SMARA	Surface Mining and Reclamation Act of 1975
SMHM	salt marsh harvest mouse
SMLIT	Suisun Marsh Levee Investigation Team
SMP	Suisun Marsh Plan
SMPA	Suisun Marsh Preservation Agreement
SMPP	Suisun Marsh Protection Plan
SMSCG	Suisun Marsh Salinity Control Gates
SO_2	sulfur dioxide
SOCCR	State of the Carbon Cycle Report
SRCD	Suisun Resource Conservation District
SS	suspended sediment
State Water Board	State Water Resources Control Board
SWP	State Water Project
SWPPP	stormwater pollution prevention plan
TACs	toxic air contaminants
TDS	total dissolved solids
Tg	million tons
TMDL	total maximum daily load
TNM	Traffic Noise Model
TOC	total organic carbon
USDOT	U.S. Department of Transportation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOCs	volatile organic compounds
VOCs	volatile organic carbons
VSFCD	Vallejo Sanitation and Flood Control District
Williamson Act	California Land Conservation Act of 1965
WQCP	Water Board Bay-Delta Water Control Plan
WQCP	Water Quality Control Plan
WQCPs or Basin Plans	Water Quality Control Plans
X2	salinity gradient
YSAQMD	Yolo-Solano County Air Quality Management District

Executive Summary

Introduction

The Suisun Marsh Habitat Management, Preservation, and Restoration Plan, referred to from here on as the Suisun Marsh Plan (SMP), is being pursued by the Suisun Principal Agencies (or Principals), a group of agencies with primary responsibility for Suisun Marsh management, and is intended to balance the benefits of tidal wetland restoration with other habitat uses in the Marsh by evaluating alternatives that provide a politically acceptable change in Marsh-wide land uses, such as salt marsh harvest mouse habitat, managed wetlands, public use, and upland habitat. It relies on the incorporation of existing science and information developed through adaptive management. The Principals are U.S. Fish and Wildlife Service (USFWS), U.S. Department of the Interior, Bureau of Reclamation (Reclamation), California Department of Fish and Game (DFG), California Department of Water Resources (DWR), National Marine Fisheries Service (NMFS), Suisun Resource Conservation District (SRCD), and CALFED Bay-Delta Program (CALFED). The Principals have consulted with other participating agencies, such as the U.S. Army Corps of Engineers (Corps), San Francisco Bay Conservation and Development Commission (BCDC) the Regional Water Quality Control Board (RWQCB) and the State Water Resources Control Board (State Water Board), in developing this plan.

Each Principal Agency will use this Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) to adopt particular actions described in the document and will contribute to the overall implementation of the SMP. For purposes of this document, Reclamation and USFWS are the joint National Environmental Policy Act (NEPA) lead agencies, and DFG is the California Environmental Quality Act (CEQA) lead agency. This Executive Summary summarizes the Proposed Project/Preferred Alternative and alternatives, the SMP implementation strategy, environmental commitments, and impacts and mitigation measures. It is based largely on the information provided in Chapters 1 and 2 of the SMP EIS/EIR.

Suisun Marsh Regulatory and Management Background

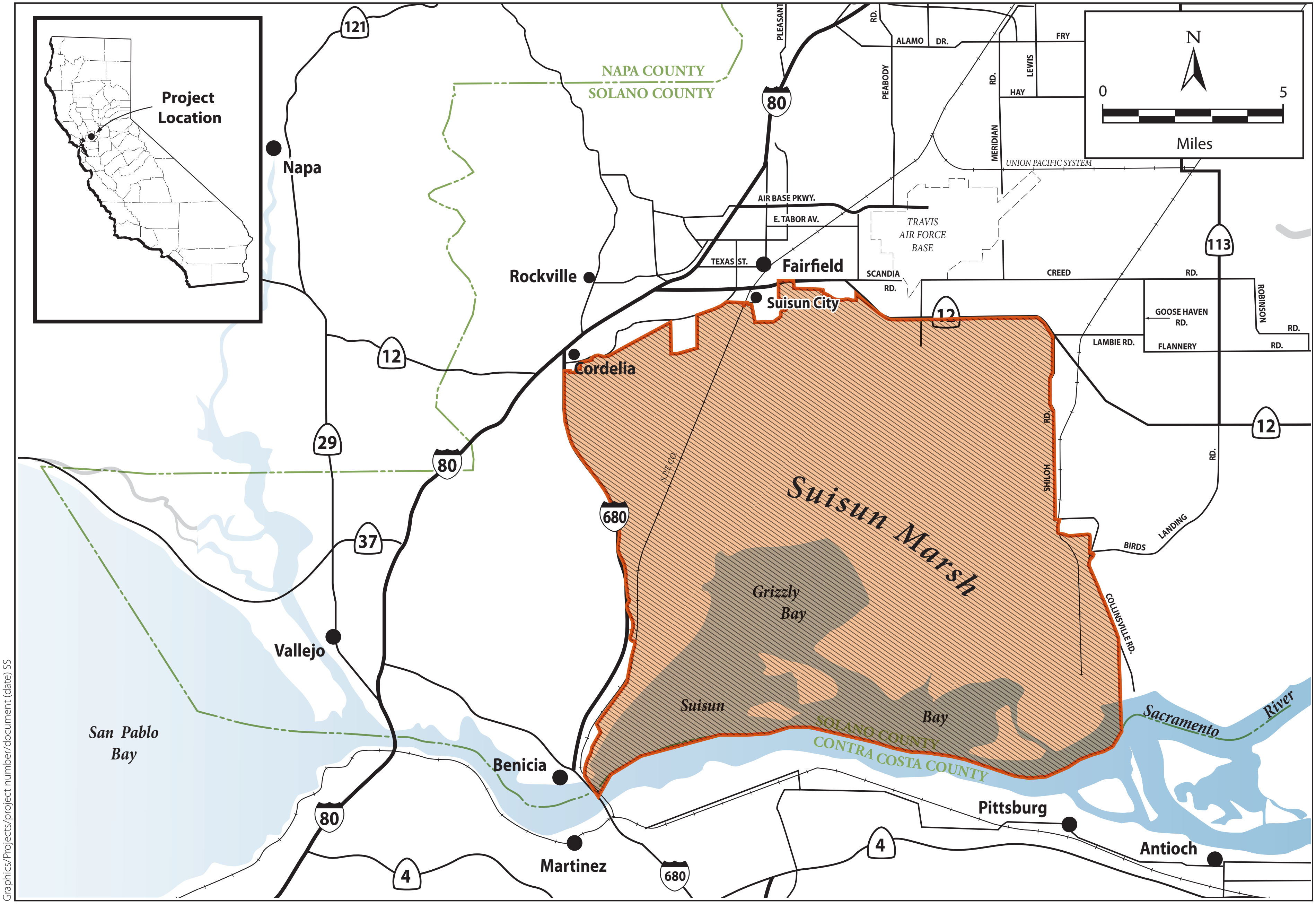
Suisun Marsh is the largest contiguous brackish water marsh remaining on the west coast of North America and is a critical part of the San Francisco

Bay/Sacramento–San Joaquin River Delta (Bay-Delta) estuary ecosystem. It is home to public waterfowl hunting areas and 158 private duck clubs. The Marsh encompasses more than 10% of California's remaining natural wetlands and serves as the resting and feeding ground for thousands of birds migrating on the Pacific Flyway and resident waterfowl. In addition, the Marsh provides important habitat for more than 221 bird species, 45 mammalian species, 16 different reptile and amphibian species, and more than 40 fish species. Suisun Marsh supports the state's commercial salmon fishery by providing important tidal rearing areas for juvenile fish. Approximately 200 miles of levees in the Marsh contribute to managing salinity in the Sacramento–San Joaquin River Delta (Delta). The Marsh's large open space and proximity to urban areas make it ideally suited for wildlife viewing, hiking, canoeing, and other recreation opportunities. Figure ES-1 shows the location of Suisun Marsh.

The values of the Marsh have been recognized, and several agencies have been involved in its protection since the mid-1970s. In 1974 the Nejedly-Bagley-Z'Berg Suisun Marsh Preservation Act was enacted by the California Legislature to protect the Marsh from urban development. In 1976, the BCDC developed the Suisun Marsh Protection Plan (SMPP), which defined and limited development within the primary and secondary management area for the "future of the wildlife values or the area as threatened by potential residential, commercial, and industrial development." The SMPP states that its focus is on maintaining waterfowl habitat, but it also addresses the importance of tidal wetlands. The SMPP calls for the preservation of Suisun Marsh; preservation of waterfowl habitat; improvement to water distribution and levee systems; and encouraging agriculture that is consistent with wildlife and waterfowl, such as grazing. In 1977, the California Legislature implemented the Suisun Marsh Preservation Act of 1977, which calls for the implementation of the SMPP and designates BCDC as the state agency with jurisdiction over the Marsh; it calls for the SRCD to have the primary local responsibility for water management on privately owned lands in the Marsh.

In 1987, Reclamation, DWR, DFG, and SRCD signed the Suisun Marsh Preservation Agreement (SMPA), which contains provisions for Reclamation and DWR to mitigate the adverse effects on Suisun Marsh channel water salinity from the State Water Project (SWP) and Central Valley Project (CVP) operations and other upstream diversions. It required Reclamation and DWR to meet salinity standards as specified in the then-current State Water Board D-1485, set a timeline for implementing the Plan of Protection for the Suisun Marsh, and delineated monitoring and mitigation requirements.

In 2000, the CALFED Record of Decision (ROD) was signed, which included the Ecosystem Restoration Program (ERP) calling for the restoration of 5,000 to 7,000 acres of tidal wetlands and the enhancement of 40,000 to 50,000 acres of managed wetlands (CALFED Bay-Delta Program 2000a). In 2001, the Principal Agencies directed the formation of a charter group to develop a plan for Suisun Marsh that would balance the needs of CALFED, the SMPA, and other plans by protecting and enhancing existing land uses, existing waterfowl and wildlife values including those associated with the Pacific Flyway, endangered species,



Graphics/Projects/project number/document (date) SS

Figure ES-1
Project Location

and state and federal water project supply quality. In addition to the Principal Agencies, the charter group includes other regulatory agencies such as the Corps, BCDC, and the State and Regional Water Boards.

This EIS/EIR describes three alternative 30-year plans and their potential impacts. The adopted alternative will become the SMP. Each Principal Agency's action related to the SMP is shown in Table ES-1. It is important to note that Principal Agencies and other agencies may choose to implement additional restoration and other activities beyond what is described in this SMP.

Table ES-1. Principal Agencies' Actions Related to the Suisun Marsh Plan

Agency	Suisun Marsh Habitat Management, Preservation, and Restoration Plan Action
Reclamation	Implementation of Managed Wetland Activities Implementation of PAI Fund[1]
USFWS	Implementation of Restoration Issuance of Biological Opinion
DFG	Implementation of Restoration Implementation of Managed Wetland Activities Issuance of Incidental Take Permit for non–Fully Protected Species Implementation of PAI Fund
NMFS	Issuance of Biological Opinion; Issuance of Essential Fish Habitat Conservation Recommendations
DWR	Implementation of Restoration Implementation of Managed Wetland Activities Implementation of PAI Fund
SRCD	Implementation of Managed Wetland Activities Implementation of PAI Fund
CALFED	Provide Guidance for Restoration through the Science Program

Reclamation = U.S. Department of the Interior, Bureau of Reclamation.
PAI = Preservation Agreement Implementation.
USFWS = U.S. Fish and Wildlife Service.
DFG = California Department of Fish and Game.
NMFS = National Marine Fisheries Service.
DWR = California Department of Water Resources.
SRCD = Suisun Resource Conservation District.
CALFED = CALFED Bay-Delta Program.

[1] The PAI Fund is included in the Revised SMPA and is proposed to fund certain maintenance activities to support mitigation obligations for the CVP and SWP operations, and is described in Chapter 2.

The Need, Purpose, and Objectives of the Suisun Marsh Plan

Need for the Suisun Marsh Plan

The SMP is a comprehensive plan designed to address the various conflicts regarding use of Marsh resources, with the focus on achieving an acceptable multi-stakeholder approach to the restoration of tidal wetlands and the management of managed wetlands and their functions. As such, the SMP is intended to be a flexible, science-based, management plan for Suisun Marsh, consistent with the revised SMPA and CALFED. It also is intended to set the regulatory foundation for future actions. The need for the action is based on the following major Marsh resources and functions.

Habitats and Ecological Processes

The conversion of tidal wetlands as a result of diking resulted in a loss of habitat for many species, including those now listed as threatened or endangered. Development in areas surrounding the Marsh has resulted in introduction and spread of nonnative species, fish entrainment issues, and degradation of water quality. Additionally, there have been water quality effects from drainage operations in managed wetlands. While taking appropriate steps to restore the ecological values of historical tidal wetland habitat, efforts will be made to improve management of managed wetlands and to lessen adverse effects from development, nonnative species, and detrimental land use practices in the secondary management areas and adjacent metropolitan areas.

Public and Private Land Use

Managed wetlands, tidal wetlands, and uplands, whether publicly or privately owned, provide important wetlands for migratory waterfowl and other resident and migratory wetland-dependent species and opportunities for hunting, fishing, bird watching, and other recreational activities. There is a need to maintain these opportunities as well as improve public stewardship of the Marsh to ensure that the implementation of restoration and managed wetland activities is understood and valued for both public and private land uses.

Levee System Integrity

Of the more than 200 miles of exterior levees in Suisun Marsh, only about 20 miles along Suisun, Grizzly, and Honker Bays (authorized through AB 360) receive public funding. Additionally, as restoration actions are implemented, some interior levees will be converted to exterior levees and will require reinforcement and more maintenance, and in some instances significant upgrades. Because of current restrictions preventing dredging from sloughs and constraints on importing materials, landowners in the Marsh have maintained their exterior levees using primarily material from ditch cleaning or pond bottom grading for more than a decade, a practice that increases subsidence and potentially weakens the existing levee foundations. These factors combined have exhausted the supply of levee maintenance material in the managed wetlands and have forced maintenance to be deferred on some exterior levees, increasing the risk of catastrophic flooding.

Water Quality

Multiple factors contribute to the water quality in Suisun Marsh, including upstream diversion, reduced Delta outflow, state and federal water project operations and diversions, drainage practices in managed wetlands, minimal tidal exchange in dead-end sloughs, urban runoff, erosion, agricultural runoff, discharge from the Fairfield Suisun Sewer District treatment plant to Boynton Slough, and remnant contaminants such as mercury. Improvement of water quality and management practices will benefit the ecological processes for all habitats, including managed and tidal wetlands.

Plan Objectives/Purpose

The SMP is intended to address the full range of issues in the Marsh, as described in the Need for Action section above. As such, the SMP purposes/objectives are divided by topic but are linked geographically, ecologically, and socially. The plan purposes/objectives are:

- **Habitats and Ecological Processes—**implement the CALFED Ecosystem Restoration Program Plan (ERPP) restoration target for the Suisun Marsh ecoregion of 5,000 to 7,000 acres of tidal marsh and protection and enhancement of 40,000 to 50,000 acres of managed wetlands;
- **Public and Private Land Use—**maintain the heritage of waterfowl hunting and other recreational opportunities and increase the surrounding communities' awareness of the ecological values of Suisun Marsh;
- **Levee System Integrity—**maintain and improve the Suisun Marsh levee system integrity to protect property, infrastructure, and wildlife habitats from catastrophic flooding; and
- **Water Quality—**protect and, where possible, improve water quality for beneficial uses in Suisun Marsh, including estuarine, spawning, and migrating habitat uses for fish species as well as recreational uses and associated wildlife habitat.

The SMP requires that these interrelated and interdependent purposes/objectives be implemented to some extent through all SMP actions. For example, the levee system integrity purpose/objective would ensure that managed wetlands are protected from catastrophic flooding, thus contributing to meeting the portion of the habitats and ecological processes purpose/objective that addresses protection of managed wetlands. Similarly, the restoration of certain properties may help protect and/or improve water quality, and achieving the habitats and ecological processes purpose/objective also would help to achieve the private and public land use purpose/objective. Recognizing these relationships, the SMP is proposed to contribute to meeting each of them in parallel over the 30-year planning period.

Overview of Plan Elements

The SMP is a comprehensive plan designed to address the various conflicts regarding use of Marsh resources, with the focus on achieving an acceptable multi-stakeholder approach to the restoration of tidal wetlands and the management of managed wetlands and their functions. The SMP addresses habitats and ecological process, public and private land use, levee system integrity, and water quality through restoration and managed wetland activities. The plan is intended to guide near-term and future actions related to restoration of tidal wetlands and managed wetland activities. Specific actions that would be implemented in the near term under the SMP include revising the SMPA to implement the PAI Fund and implementation of increased frequency of current and new managed wetland activities.

Alternatives

Three alternatives were evaluated in the EIS/EIR, varying in the number of acres restored and the number of acres subject to managed wetland activities.
Table ES-2 summarizes these differences.

Table ES-2. Differences in Amount of Tidal Wetlands Restored and Remaining Acres Subject to Managed Wetland Activities among the Alternatives (in acres)

Alternative	Tidal Restoration Target (acres)	Managed Wetlands Subject to Managed Wetland Activities (acres)
No Action Alternative	700	52,112
Alternative A, Proposed Project	5,000–7,000	44,000–46,000
Alternative B	2,000–4,000	46,000–48,000
Alternative C	7,000–9,000	42,000–44,000

The lead agencies have identified Alternative A as the Preferred Alternative because of its consistency with the restoration and enhancement goals of the ERPP, its ability to contribute to recovery of listed species, and acceptability by landowners in the Marsh.

The total amount of existing managed wetlands and uplands that could be affected by tidal restoration and managed wetland activities is 52,112 acres. The Marsh has been divided into four regions for purposes of this analysis (Figure ES-2). The tidal wetland restoration acreages for each alternative are described by region to achieve the total CALFED goal as described above and contribute to the USFWS tidal wetlands restoration goals. The USFWS *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* (http://www.fws.gov/sacramento/ea/news_releases/2010_News_Releases/tidal_marsh_recovery.htm) was used as a template in determining the goal of the percentage of restoration acreage per region (U.S. Fish and Wildlife Service 2010). Table ES-3 shows the total acreage that is potentially restorable in each region under the SMP, and how much of each region would be restored under each alternative. The SMP includes the continued implementation of and increased frequency of some managed wetland activities and the implementation of new managed wetland activities on the balance of 52,112 acres that is not restored.

Table ES-3. Total Restorable Acres per Region and Percentage That Will Be Restored under Each Alternative

Alternative/Region	SMP Target for Tidal Wetland Restoration*	Percentage of Existing Managed Wetlands That Will Be Restored to Tidal Wetland under the SMP
Alternative A, Proposed Project	**5,000–7,000**	
Region 1	1,000–1,500	8.4%–12.6%
Region 2	920–1,380	12.6%–18.9%
Region 3	360–540	12.1%–18.1%
Region 4	1,720–2,580	6.0%–9.0%
Alternative B	**2,000–4,000**	
Region 1	500–1,000	4.2%–8.4%
Region 2	460–920	6.3%–12.6%
Region 3	180–360	6.0%–12.1%
Region 4	860–1,720	3.0%–6.0%
Alternative C	**7,000–9,000**	
Region 1	1,500–2,250	12.6%–18.9%
Region 2	1,380–2,070	18.9%–28.5%
Region 3	540–810	18.1%–27.3%
Region 4	2,580–3,870	9.0%–13.5%

USFWS = U.S. Fish and Wildlife Service.

SMP = Suisun Marsh Habitat Management, Preservation, and Restoration Plan.

* The targets were developed for each region based on the different habitat conditions within each region to provide the range of environmental gradients necessary to contribute to the recovery of listed species. These targets complement and are consistent with the Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. The Adaptive Management Plan will track these targets to ensure restoration benefits for listed species.

Note: Adjustments to the Adaptive Management Plan may result in changes to the targets in each region.

Of the restored areas, a certain portion is expected to become tidal aquatic habitat. The percent cover of tidal aquatic habitat within tidal wetlands areas (Rush Ranch, Lower Joice Island, and Hill Slough) in Suisun Marsh was estimated based on existing tidal wetlands, the Integrated Regional Wetland Monitoring Pilot Project (BREACH), and GIS and site visits. The analysis demonstrated that tidal aquatic habitat accounts for an average of approximately 5 to 15% of the total area of established tidal wetlands. Assuming this relationship holds true for future restored tidal wetlands, Table ES-4 shows the increase of tidal aquatic habitat that would be expected to result when each action alternative is fully implemented and sites develop into fully functioning tidal marshes. The increase in acreage of tidal aquatic habitat shown does not limit the amount of restoration that could occur.

Table ES-4. Increase of Tidal Aquatic Habitat in Suisun Marsh Resulting from Each Alternative

Alternative	Tidal Wetlands Restored	Tidal Aquatic Habitat Increase
Alternative A, Proposed Project	5,000–7,000	250–1050 acres
Alternative B	2,000–4,000	100–600 acres
Alternative C	7,000–9,000	350–1,350 acres

Over the 30-year SMP implementation period, it is expected that the exact habitat amount provided by restored areas will depend on the existing elevation of the site, sedimentation rates and accretion, and sea level rise. The amount of subtidal aquatic habitat is expected to decrease gradually as sediment accretes and emergent tidal vegetation is established at each restoration site. As this happens, the site will be restored to a tidal wetland. However, the rate of accretion and the rate of sea level rise will dictate the end result, and the actual timeframe for such progression depends on the site-specific conditions, but significant geomorphic changes are decadal. Locations with large subsidence and low sediment concentrations may never return to emergent marsh and instead remain as open water. Adaptive management also will be used to improve restoration designs to achieve desired results.

Suisun Marsh Plan Implementation Strategy

The SMP is predicated on the assumption that each Principal Agency will implement or approve activities in the Marsh consistent with the SMP and its own mission and jurisdictional authority. The primary components of the strategy are to:

- implement the environmental commitments and mitigation measures in this EIS/EIR and other required state and federal permit measures to ensure that resources are protected and that restoration and managed wetland goals are met simultaneously,

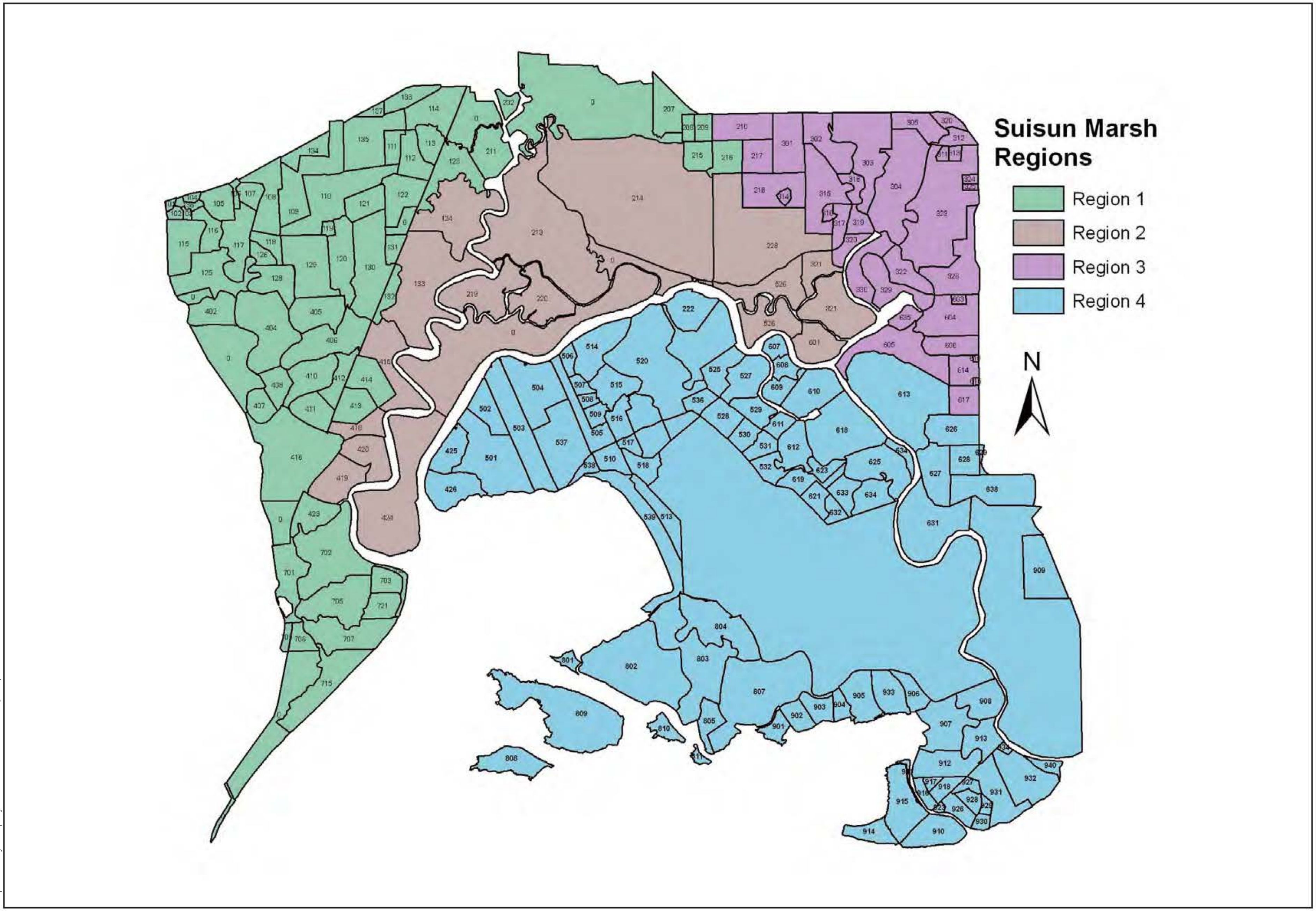


Figure ES-2
Suisun Marsh Regions

- implement adaptive management to ensure impacts described in this EIS/EIR are not exceeded and to improve the ecological effectiveness of restoration over the period of implementation of the SMP, and
- prepare annual reports on the status of SMP restoration and managed wetland activities.

To ensure that the restoration and managed wetland goals both are achieved within the 30-year time frame, the Charter Agencies have developed a strategy to implement the SMP. The SMP would contribute to recovery of many species in the Marsh, and for this EIS/EIR, implementation of the entirety of the Proposed Project, including both the restoration activities and managed wetland activities, is an integral part of the analysis. Based on the analysis in this EIS/EIR, implementation of the Proposed Project and environmental commitments would provide sufficient tidal restoration and resource protection of fish and wildlife resources to both offset potential impacts on those resources and contribute to recovery of listed species. As such, both restoration and managed wetland activities would proceed simultaneously, and implementation will be planned to carefully monitor and mitigate the effects of SMP activities. SRCD, DFG, Reclamation, and DWR would implement the Managed Wetland Activities. Any of the Principals could implement restoration.

The managed wetland activities would be implemented only if at least one third of the total restoration activities would be implemented in each of the 10-year increments. Therefore, it is expected that under the Proposed Project, for example, 1,600–2,300 acres in the Marsh would be restored by year 10, an additional 1,600–2,300 acres would be restored by year 20, and the full 5,000–7,000 acres would be restored by year 30. This would ensure that all actions would be implemented in a timeframe similar to that of the impacts and that restoration efforts would contribute toward recovery throughout the plan implementation period. If these 10-year incremental SMP restoration goals are met, both the managed wetland activities and tidal restoration would continue to ensure that the SMP goals would be met. Options for addressing conditions in which these incremental goals are not met are described below. Under this strategy, the restoration and managed wetland goals would be achieved concurrently. How the restoration acres would be applied for purposes of other regulatory permitting requirements (i.e., recovery vs. mitigation) would be specified through each permit as applicable.

To track the progress of restoration and managed wetland activities, the SMPA agencies (Reclamation, SRCD, DWR, and DFG) would submit implementation status reports annually to DFG, NMFS, and USFWS and other regulatory agencies that would describe the implemented restoration and managed wetland activities. Additional activities, including monitoring, application of adaptive management, results of adaptive management, and any activities that are being planned, would be submitted no less frequently than every other year.

Anticipated Near-Term Restoration Actions

The Hill Slough parcel in the Marsh is currently owned by the Principals and would likely be restored upon implementation of the SMP. The parcel comprises approximately 950 acres and would contribute to the total restoration acres for whichever alternative is selected. Although many of the potential impacts of restoration of this site are included in this EIS/EIR, a separate notice of determination and/or record of decision will be made if and when a decision to restore this area is made.

Impacts and Mitigation Measures

For the most part, the SMP components would be implemented in a way that helps mitigate impacts before or as they occur. However, four significant and unavoidable impacts were identified related to disturbance to cultural resources. Table ES-5, at the end of this summary, summarizes the impacts identified in the EIS/EIR.

Environmental Commitments

As part of the plan implementation, individual project proponents will incorporate certain environmental commitments and BMPs into specific projects to avoid or minimize potential impacts as applicable. Project proponents and the appropriate agencies also will coordinate planning, engineering, and design phases of the project. The environmental commitments are divided between Restoration Activities and Managed Wetland Activities. For restoration activities, project proponents are defined as any state, federal or local agency, landowner, or implementing body of a restoration action. For managed wetland activities, the SMPA Agencies (SRCD, DFG, DWR, and/or Reclamation) are the project proponents and will be responsible for implementing the environmental commitments, depending on the activity.

Restoration Activities

- implementation of BMPs, avoidance and minimization measures, and BO terms and conditions;
- implementation of stormwater pollution prevention plan and erosion and sediment control plan;
- compliance with Solano County's noise ordinance;
- implementation of traffic and navigation control plan and emergency access plan;
- implementation of Mosquito Abatement BMPs;

- implementation of hazardous materials management plan;
- implementation of air quality BMPs;
- cultural resources Native American graves protection;
- environmental awareness worker training;
- construction period restrictions;
- special-status wildlife protection through surveys, buffers, and monitoring;
- implementation of construction period restrictions; and
- nonnative plant control.

Managed Wetland Activities

- continuation of existing BMPs and BO terms and conditions,
- construction period restrictions,
- dredging practices to minimize impacts on the aquatic environment,
- implementation of hazardous materials management plan,
- cultural resources Native American graves protection, and
- environmental awareness worker training.

Public Involvement and Next Steps

Development of the SMP has been a multi-agency, collaborative process in an effort to design a plan to balance the various resources in the Marsh. Throughout the process, Principal Agencies (DFG, Reclamation, USFWS, NMFS, SRCD, DWR, and CALFED) have cooperated to develop the various components of the plan. Additionally, landowners in the Marsh and other agencies that have a jurisdictional or other stake in the outcome of the SMP have been engaged. These agencies include the Corps, BCDC, State Water Board, RWQCB, and Solano County.

Reclamation and FWS jointly filed an NOI on November 10, 2003, and DFG filed an NOP on November 7, 2003. Both the NOI and the NOP invited the public and agencies to provide comments during the scoping period. Three scoping meetings were held, one each on November 25, 2003 in Fairfield, CA; December 4, 2003 in Benicia, California; and December 10, 2003 in Fairfield, California. The November 25 meeting was during business hours, while the other two began at 6 p.m. In total, over 150 people attended these meetings. The scoping report provides additional information about the scoping procedures and outcomes. All of these issues and concerns were considered in the development of the plan, alternatives, and/or analysis of resource impacts.

This Public Draft EIS/EIR was available for review and comment for 60 days (October 29, 2010 through December 28, 2010) following filing of the Notice of Availability (NOA) of the EIS with the EPA and the Notice of Completion (NOC) of the EIR with the California State Clearinghouse.

This Final EIS/EIR includes responses to public and agency comments (Chapter 14) and changes in the text. All of the comments received are also included in Chapter 14 of this Final EIS/EIR. A total of 17 comment letters were received. Alternative A was identified as the Preferred Alternative and DFG, USFWS, and Reclamation will issue a Notice of Determination (NOD)/Record of Decision (ROD), respectively, for the decision regarding which alternative will become the SMP to be implemented.

Expected Outcomes

Besides the NEPA and CEQA compliance efforts for the SMP, the Principals expect to obtain other environmental permits as outlined in Table ES-1. Together with the completion of the CEQA and NEPA process, these permits will allow Principal and other agencies to implement restoration in the Marsh and allow the SMPA agencies to implement managed wetland activities.

Table ES-5. Summary of Impacts and Mitigation Measures

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
WATER SUPPLY AND MANAGEMENT				
Restoration Impacts				
WTR-1: Reduction in Water Availability for Riparian Water Diversions to Managed Wetlands Upstream or Downstream of Restoration Areas	A, B, C	Less than significant	None required	–
WTR-2: Increased Tidal Velocities from Breaching of Managed Wetlands Levees	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
WTR-3: Improved Water Supply as a Result of Improved Flooding and Draining of Managed Wetlands	A, B, C	Beneficial	–	–
WTR-4: Increased Tidal Flows and Improved Water Supply as a Result of Dredging	A, B, C	Beneficial	–	–
WATER QUALITY				
Restoration Impacts				
WQ-1: Increased Salinity in Suisun Marsh Channels from Increased Tidal Flows from Suisun Bay (Grizzly Bay) as a Result of Restoration	A, B, C	Less than significant	None required	–
WQ-2: Changes to Salinity of Water Available for Managed Wetlands from October to May	A, B, C	Less than significant	None required	–
WQ-3: Increased Salinity at Delta Diversions and Exports	A, B, C	Less than significant	None required	–
WQ-4: Possible Changes to Methylmercury Production and Export as a Result of Tidal Restoration	A, B, C	Less than significant	None required	–
WQ-5: Improved Dissolved Oxygen Concentrations in Tidal Channels from Reduced Drainage of High Sulfide Water from Managed Wetlands	A, B, C	Beneficial	None required	–
WQ-6: Temporary Changes in Water Quality during Construction Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
Managed Wetland Activities Impacts				
WQ-7: Temporary Degradation of Water Quality during Implementation of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WQ-8: Temporary Degradation of Water Quality during Dredging, Including Possible Increases in Mercury Concentrations	A, B, C	Less than significant	None required	–
GEOLOGY AND GROUNDWATER				
Restoration Impacts				
GEO-1: Potential to Create Unstable Cut or Fill Slopes	A, B, C	Less than significant	None required	–
GEO-2: Potential for Accelerated Soil Erosion	A, B, C	Beneficial or Less than significant	None required	–
GEO-3: Potential Loss of Topsoil Resources	A, B, C	Less than significant	None required	–
GEO-4: Reduction in Availability of Non-Fuel Mineral Resources	A, B, C	Less than significant	None required	–
GEO-5: Reduction in Availability of Natural Gas Resources	A, B, C	Less than significant	None required	–
GW-6: Potential for Altered Salinity in Shallow Suisun Marsh Groundwater	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
GEO-1: Potential to Create Unstable Cut or Fill Slopes	A, B, C	Less than significant	None required	–
GEO-2: Potential for Accelerated Soil Erosion	A, B, C	Beneficial or Less than significant	None required	–
GEO-5: Reduction in Availability of Natural Gas Resources	A, B, C	No impact	–	–
GEO-7: Potential for Damage to Structures as a Result of Surface Fault Rupture, Groundshaking and/or Seismically Induced Ground Failure (Liquefaction)	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
GEO-8: Potential for Damage to Structures as a Result of Landslides, Including Seismically Induced Landslides	A, B, C	Less than significant	None required	–
FLOOD CONTROL AND LEVEE STABILITY				
Restoration Impacts				
FC-1: Increased Potential for Catastrophic Levee Failure and Flooding Resulting from Restoration Activities That Expose Interior Levees to Tidal Action	A, B, C	Less than significant	None required	–
FC-2: Changes in Flood Stage and Flow Capacity in Suisun Marsh Channels as a Result of Increased Tidal Prism and Flood Storage Capacity	A, B, C	Beneficial	–	–
FC-3: Temporary Decrease in Levee Stability Resulting from Construction Activities	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
FC-4: Reduction in Potential for Catastrophic Levee Failure and Flooding Resulting from Improvements in Exterior Levee Maintenance	A, B, C	Beneficial	–	–
SEDIMENT TRANSPORT				
Restoration Impacts				
ST-1: Increased Scour in Bays or Channels Upstream and Downstream of Habitat Restoration Areas	A, B, C	Less than significant	None required	–
ST-2: Deposition of Sediment in the Restored Tidal Wetlands	A, B, C	Beneficial or Less than significant	None required	–
ST-3: Changes in Regional Sedimentation and Scour Patterns in Suisun Marsh	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
ST-4: Increase in Erosion Adjacent to Dredging Sites	A, B, C	Less than significant	None required	–
ST-5: Increase in Deposition at Dredging Sites	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
TRANSPORTATION AND NAVIGATION				
Restoration Impacts				
TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Patterns of Vehicular Circulation during Construction Activities	A, B, C	Less than significant	None required	–
TN-2: Temporary Increases in Road Hazards during Construction Activities	A, B, C	Less than significant	None required	–
TN-3: Damage to Roadway Surfaces from Construction Activities	A, B, C	Less than significant	None required	–
TN-4: Impacts to Air Traffic Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
TN-5: Impacts on Land Use Attributable to Restoration Activities within Travis Air Force Base Zone	A, B, C	Less than significant	None required	–
TN-6: Temporary Reduction in Boat Access during Construction Activities	A, B, C	Less than significant	None required	–
TN-7: Decrease in Rail Line Integrity and Disruption to Rail Service	A, B, C	Less than significant	None required	–
TN-8: Short-Term Reduction in Navigable Areas Resulting from Increased Velocities after Restoration Activities	A, B, C	Less than significant	None required	–
TN-9: Temporary Reduction in Boat Access during Dredging Activities	A, B, C	Less than significant	None required	–
TN-10: Increases in Navigable Areas of Suisun Marsh	A, B, C	Beneficial	–	–
TN-11: Operations and Maintenance Increase in Traffic	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Patterns of Vehicular Circulation during Construction Activities	A, B, C	Less than significant	None required	–
TN-2: Temporary Increases in Road Hazards during Construction Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
TN-3: Damage to Roadway Surfaces from Construction Activities	A, B, C	Less than significant	None required	–
TN-4: Impacts to Air Traffic Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
TN-5: Impacts on Land Use Attributable to Restoration Activities within Travis Air Force Base Zone	A, B, C	Less than significant	None required	–
TN-6: Temporary Reduction in Boat Access during Construction Activities	A, B, C	Less than significant	None required	–
TN-7: Decrease in Rail Line Integrity and Disruption to Rail Service	A, B, C	Less than significant	None required	–
TN-9: Temporary Reduction in Boat Access during Dredging Activities	A, B, C	Less than significant	None required	–
TN-11: Operations and Maintenance Increase in Traffic	A, B, C	Less than significant	None required	–
AIR QUALITY				
AQ-1: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Restoration	A, B, C	Significant	AQ-MM-1: Limit Construction Activity during Restoration AQ-MM-2: Reduce Construction NO_X Emissions AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures	Less than significant
AQ-2: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Current Management Activities	A, B, C	Significant	AQ-MM-2: Reduce Construction NO_X Emissions AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures	Less than significant
AQ-3: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with New Management Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
AQ-4: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Restoration and Management Activities Combined	A, B, C	Significant	AQ-MM-1: Limit Construction Activity during Restoration AQ-MM-2: Reduce Construction NO_X Emissions AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures AQ-MM-4: Limit Construction Activity during Restoration and Management	Less than significant
AQ-5: Construction-Related Diesel Health Risk Associated with Restoration	A, B, C	Less than significant	None required	–
AQ-6: Construction-Related Diesel Health Risk Associated with Current Management Activities	A, B, C	Less than significant	None required	–
AQ-7: Construction-Related Diesel Health Risk Associated with New Management Activities	A, B, C	Less than significant	None required	–
AQ-8: Construction-Related Diesel Health Risk Associated with Restoration and Management Activity Combined	A, B, C	Less than significant	None required	–
AQ-9: Increase in Construction Emissions in Excess of Federal *de Minimis* Thresholds	A, B, C	Less than significant	None required	–
AQ-10: Increase in Construction-Related Odor	A, B, C	Less than significant	None required	–
NOISE				
Restoration Impacts				
NZ-1: Temporary Increases in Ambient Noise during Construction Activities Associated with Restoration	A, B, C	Less than significant	None required	–
NZ-2: Temporary Exposure of Sensitive Land Uses to Groundborne Vibration or Noise from Construction Activities	A, B, C	Less than significant	None required	–
NZ-3: Permanent Increases in Ambient Noise	A, B, C	Less than significant	None required	–
NZ-4: Exposure of Noise-Sensitive Land Uses to Noise from Material Hauling Operations	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
Managed Wetland Activities Impacts				
NZ-2: Temporary Exposure of Sensitive Land Uses to Groundborne Vibration or Noise from Construction Activities	A, B, C	Less than significant	None required	–
NZ-3: Permanent Increases in Ambient Noise	A, B, C	Less than significant	None required	–
NZ-4: Exposure of Noise-Sensitive Land Uses to Noise from Material Hauling Operations	A, B, C	Less than significant	None required	–
NZ-5: Temporary Increases in Ambient Noise during Construction Activities Associated with Management Activities	A, B, C	Less than significant	None required	–
NZ-6: Exposure of Noise-Sensitive Land Uses to Noise from Portable Pump Operations	A, B, C	Significant	NZ-MM-1: Limit Noise from Pump Operations	Less than significant
CLIMATE CHANGE				
CC-1: Construction-Related Changes in Greenhouse Gas Emissions	A, B, C	Less than significant	None required	–
CC-2: Permanent Changes in Greenhouse Gas Sources and Sinks	A, B, C	Beneficial	None required	–
CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated With Sea Level Rise	No Action Alternative	–	–	
CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated With Sea Level Rise	A, B, C	Beneficial	None required	–
FISH				
Restoration Impacts				
FISH-1: Construction-Related Temporary Impairment of Fish Survival, Growth, and Reproduction by Accidental Spills or Runoff of Contaminants (Heavy Metals)	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
FISH-2: Construction-Related Temporary Reduction of Special-Status Fish Rearing Habitat Quality or Quantity through Increased Input and Mobilization of Sediment	A, B, C	Less than significant	None required	–
FISH-3: Short-Term Impairment of Delta Smelt Passage and Reduced Availability of Spawning and Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-4: Short-Term Impairment of Chinook Salmon Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-5: Short-Term Impairment of Steelhead Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-6: Short-Term Impairment of Green Sturgeon Passage and Reduced Availability of Holding and Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-7: Short-Term Impairment of Sacramento Splittail Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Velocity Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-8: Short-Term Impairment of Longfin Smelt Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Velocity Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-9: Temporary Reduction of Delta Smelt Habitat Quantity or Quality through Removal and Destruction of Cover Attributable to Restoration Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
FISH-10: Temporary Reduction of Chinook Salmon Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-11: Temporary Reduction of Steelhead Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-12: Temporary Reduction of Green Sturgeon Habitat Quantity or Quality as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-13: Temporary Reduction of Sacramento Splittail Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-14: Temporary Reduction of Longfin Smelt Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-15: Improved Fish Habitat Due to Increased Dissolved Oxygen Concentrations in Tidal Channels Attributable to Restoration Activities	A, B, C	Beneficial	None required	–
FISH-16: Salinity–Related Reduction of Delta Smelt Survival, Growth, Movement, or Reproduction Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-17: Salinity–Related Reduction of Chinook Salmon Survival, Growth, or Movement as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-18: Salinity–Related Reduction of Steelhead Survival, Growth, or Movement as a Result of Restoration Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
FISH-19: Salinity–Related Reduction of Green Sturgeon Survival, Growth, or Movement as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-20: Salinity–Related Reduction of Sacramento Splittail Survival, Growth, Movement, or Reproduction as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-21: Salinity–Related Reduction of Longfin Smelt Survival, Growth, Movement, or Reproduction as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-22: Disturbance, Injury, or Mortality of Individual Fish Resulting from Work Adjacent to Bodies of Water	A, B, C	Less than significant	None required	–
FISH-23: Change in Fish Species Composition Attributable to Changes in Salinity or Water Quality from Managed or Natural Wetland Modifications	A, B, C	Less than significant	None required	–
FISH-24: Change in Benthic Macroinvertebrate Composition Attributable to Changes in Channel Morphology and Hydraulics as a Result of Tidal Restoration	A, B, C	Less than significant	None required	–
FISH-25: Change in Primary Productivity as a Result of Tidal Restoration	A, B, C	Beneficial	–	–
Managed Wetland Activities Impacts				
FISH-26: Construction-Related Temporary Impairment of Fish Survival, Growth, and Reproduction by Accidental Spills or Runoff of Contaminants (Heavy Metals)	A, B, C	Less than significant	None required	–
FISH-27: Construction-Related Temporary Reduction of Fish Rearing Habitat Quality or Quantity through Increased Input and Mobilization of Sediment	A, B, C	Less than significant	None required	–
FISH-28: Construction-Related Mortality of Fish from Stranding	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
FISH-29: Temporary Reduction of Delta Smelt, Chinook Salmon and Steelhead Habitat Quantity or Quality Attributable to Management Activities	A, B, C	Less than significant	None required	–
FISH-30: Temporary Reduction of Green Sturgeon Habitat Quantity or Quality as a Result of Management Activities	A, B, C	Less than significant	None required	–
FISH-31: Temporary Reduction of Sacramento Splittail Habitat Quantity or Quality as a Result of Management Activities	A, B, C	Less than significant	None required	–
FISH-32: Temporary Reduction of Longfin Smelt Habitat Quantity or Quality as a Result of Management Activities	A, B, C	Less than significant	None required	–
FISH-33: Reduction in Benthic Macroinvertebrate Abundance as a Result of Dredging	A, B, C	Less than significant	None required	–
FISH-34: Disturbance, Injury, or Mortality of Delta Smelt Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-35: Disturbance, Injury, or Mortality of Chinook Salmon Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-36: Disturbance, Injury, or Mortality of Steelhead Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-37: Disturbance, Injury, or Mortality of Green Sturgeon Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-38: Disturbance, Injury, or Mortality of Sacramento Splittail Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-39: Disturbance, Injury, or Mortality of Longfin Smelt Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-40: Reduction of Fish Habitat Quantity or Quality Resulting from Installation of New Riprap on Levees	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
VEGETATION AND WETLANDS				
Restoration Impacts				
VEG-1: Short-Term Loss or Degradation of Tidal Wetlands and Tidal Perennial Aquatic Communities in Slough Channels Downstream of Restoration Sites as a Result of Increased Scour	A, B, C	Less than significant	None required	–
VEG-2: Loss or Degradation of Tidal Wetlands Adjacent to Restoration Sites as a Result of Levee Breaching/Grading	A, B, C	Less than significant	None required	–
VEG-3: Loss of Managed Wetlands as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
VEG-4: Loss of Upland Plant Communities and Associated Seasonal Wetland Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
VEG-5: Spread of Noxious Weeds as a Result of Restoration Construction	A, B, C	Less than significant	None required	–
VEG-6: Loss of Special-Status Plants or Suitable Habitat as Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
VEG-7: Degradation of Native Plant Species and Spread of Invasive Plant Species as a Result of Increased Public Access	A, B, C	Less than significant	None required	–
VEG-8: Loss or Degradation of Tidal Native Plant Species and Spread of Invasive Plant Species as a Result of Tidal Muting	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
VEG-9: Loss of Special-Status Plants or Suitable Habitat as Result of Exterior Levee Activities	A, B, C	Less than significant	None required	–
VEG-10: Loss or Degradation of Wetland Communities and Special-Status Plant Species in Slough Channels as a Result of Channel Dredging	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
VEG-1: Loss or Degradation of Rare Natural Communities and Special-Status Plant Species as a Result of New Fish Screen Facilities	A, B, C	Less than significant	None required	–
VEG-12: Loss or Disturbance of Managed Wetlands as a Result of Activities within Managed Wetlands	A, B, C	Less than significant	None required	–
VEG-13: Loss or Disturbance of Tidal Wetlands or Other Waters of the United States and Special-Status Plant Species as a Result of Placement of New Riprap and Alternative Bank Protection Methods	A, B, C	No impact	–	–
VEG-14: Loss or Disturbance of Wetlands and Special-Status Plant Species as a Result of DWR/Reclamation Facility Maintenance Activities	A, B, C	Less than significant	None required	–
VEG-15: Introduction or Spread of Noxious Weeds as Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILDLIFE				
Restoration Impacts				
WILD-1: Loss or Disturbance of Salt Marsh Harvest Mouse Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-2: Loss or Disturbance of California Clapper Rail Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-3: Loss or Disturbance of California Black Rail Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-4: Loss or Disturbance of Suisun Shrew Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-5: Loss or Disturbance of California Least Tern Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
WILD-6: Loss of Suisun Song Sparrow and Salt Marsh Common Yellowthroat Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-7: Loss or Disturbance of Raptor Nest Sites or Foraging Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-8: Loss or Disturbance of Western Pond Turtle as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-9: Loss or Disturbance of Tricolored Blackbird as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-10: Effects on Southern Resident Killer Whales as a Result of Changes in Salmon Populations	A, B, C	Less than significant	None required	–
WILD-11: Loss or Disturbance of Waterfowl and Shorebird Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
WILD-12: Loss or Disturbance of Salt Marsh Harvest Mouse Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-13: Loss or Disturbance of California Clapper Rail Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-14: Loss or Disturbance of California Black Rail Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-15: Loss or Disturbance of Suisun Shrew Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
WILD-16: Loss or Disturbance of California Least Tern Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-17: Loss or Disturbance of Suisun Song Sparrow and Salt Marsh Common Yellowthroat Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-18: Loss or Disturbance of Raptor Nest Sites or Foraging Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-19: Loss or Disturbance of Western Pond Turtle as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-20: Loss or Disturbance of Tricolored Blackbird as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-21: Effects on Southern Resident Killer Whales as a Result of Changes in Salmon Populations as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-22: Changes in Waterfowl Nesting and Wintering Habitat as a Result of Marsh Management Activities	A, B, C	Beneficial	–	–
WILD-23: Changes in Shorebird Nesting and Wintering Habitat as a Result of Marsh Management Activities	A, B, C	Beneficial	–	–
LAND AND WATER USE				
Restoration Impacts				
LU-1: Alteration of Existing Land Use Patterns	A, B, C	Less than significant	None required	–
LU-2: Conflict with Existing Land Use Plans, Policies, and Regulations	A, B, C	No impact	–	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
LU-3: Conflict with Any Applicable Habitat Conservation Plan or Natural Community Conservation Plan	A, B, C	No impact	–	–
Managed Wetland Activities Impacts				
LU-1: Alteration of Existing Land Use Patterns	A, B, C	Less than significant	None required	–
LU-2: Conflict with Existing Land Use Plans, Policies, and Regulations	A, B, C	No impact	–	–
LU-3: Conflict with Any Applicable Habitat Conservation Plan or Natural Community Conservation Plan	A, B, C	No impact	–	–
SOCIAL AND ECONOMIC CONDITIONS				
Restoration Impacts				
SOC-1: Change in Employment and Income Resulting from Construction, Restoration, and Other Expenditures	A, B, C	Beneficial	–	–
SOC-2: Changes in Employment and Income Resulting from Changes in Managed Wetland–Related Recreation Opportunities and Use	A, B, C	Beneficial	–	–
SOC-3: Changes in Property Tax Revenues as a Result of Purchasing and Restoring Private Lands	A, B, C	Less than significant	–	–
Managed Wetland Activities Impacts				
SOC-1: Change in Employment and Income Resulting from Construction Restoration, and Other Expenditures	A, B, C	Beneficial	–	–
SOC-2: Changes in Employment and Income Resulting from Changes in Managed Wetland–Related Recreation Opportunities and Use	A, B, C	Beneficial	–	–
SOC-4: Changes in Employment and Income Resulting from Increased Expenditures for Wetland Management Activities	A, B, C	Less than significant	–	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
UTILITIES AND PUBLIC SERVICES				
Restoration Impacts				
UTL-1: Damage to Pipelines and/or Disruption of Electrical, Gas, or Other Energy Services during Construction or Restoration Activities	A, B, C	Significant	UTL-MM-1: Relocate Overhead Powerlines or other Utilities that Could be Affected by Construction UTL-MM-2: Avoid Ground-Disturbing Activities within Pipeline Right-of-Way	Less than significant
UTL-2: Damage to Utility Facilities or Disruption to Service as a Result of Restoration	A, B, C	Significant	UTL-MM-3: Relocate or Upgrade Utility Facilities that Could be Damaged by Inundation UTL-MM-4: Test and Repair or Replace Pipelines that Have the Potential for Failure	Less than significant
UTL-3: Reduction in Capacity of Local Solid Waste Landfills	A, B, C	Less than significant	None required	–
UTL-4: Increase in Emergency Service Response Times	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
UTL-3: Reduction in Capacity of Local Solid Waste Landfills	A, B, C	Less than significant	None required	–
UTL-4: Increase in Emergency Service Response Times	A, B, C	Less than significant	None required	–
UTL-5: Damage to Pipelines and/or Disruption of Electrical, Gas, or Other Energy Services during Dredging	A, B, C	Significant	UTL-MM-2: Avoid Ground-Disturbing Activities within Pipeline Right-of-Way	Less than significant
POWER PRODUCTION AND ENERGY				
Restoration Impacts				
POW-1: Substantial Temporary Increase in Energy Use during Construction and Restoration Activities	A, B, C	Less than significant	None required.	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
Managed Wetland Activities Impacts				
POW-2: Substantial Temporary Increase in Energy Use during Managed Wetland Activities	A, B, C	Less than significant	None required.	–
VISUAL/AESTHETIC RESOURCES				
Restoration Impacts				
VIS-1: Temporary Changes in Views Caused by Construction Activities	A, B, C	Less than significant	None required	–
VIS-2: Temporary Changes in Views Caused by Habitat Reestablishment Period	A, B, C	Less than significant	None required	–
VIS-3: Changes in Views to and from Suisun Marsh	A, B, C	Less than significant	None required	–
VIS-4: Damage to Scenic Resources along Scenic Highway	A, B, C	No impact	–	–
VIS-5: Create a New Source of Light and Glare That Affects Views in the Area	A, B, C	Less than significant	None required	–
VIS-6: Conflict with Policies or Goals Related to Visual Resources	A, B, C	No impact	–	–
Managed Wetland Activities Impacts				
VIS-1: Temporary Changes in Views Caused by Construction Activities	A, B, C	Less than significant	None required	–
VIS-3: Changes in Views to and from Suisun Marsh	A, B, C	Less than significant	None required	–
VIS-4: Damage to Scenic Resources along Scenic Highway	A, B, C	No impact	–	–
VIS-5: Create a New Source of Light and Glare That Affects Views in the Area	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
VIS-6: Conflict with Policies or Goals Related to Visual Resources	A, B, C	No impact	–	–
CULTURAL RESOURCES				
Restoration Impacts				
CUL-1: Damage to Montezuma Slough Rural Historic Landscape and Mein's Landing as a Result of Ground-Disturbing Activities along Montezuma Slough	A, B, C	Significant	CUL-MM-1: Document and Evaluate the Montezuma Slough Rural Historic Landscape, Assess Impacts, and Implement Mitigation Measures to Lessen Impacts	Significant and unavoidable
CUL-2: Damage to or Destruction of Other Known Cultural Resources as a Result of Ground-Disturbing Activities in Lowland and Marsh Areas	A, B, C	Significant	CUL-MM-2: Evaluate Previously Recorded Cultural Resources and Fence NRHP- and CRHR-Eligible Resources prior to Ground-Disturbing Activities	Less than significant
CUL-3: Damage to Known Cultural Resources as a Result of Inundation	A, B, C	Significant	CUL-MM-3: Protect Known Cultural Resources from Damage Incurred by Inundation through Plan Design (Avoidance) CUL-MM-4: Resolve Adverse Effects prior to Construction	Significant and unavoidable
CUL-4: Inadvertent Damage to or Destruction of As-Yet-Unidentified Cultural Resources as a Result of Ground-Disturbing Activities in Restoration Areas	A, B, C	Significant	CUL-MM-5: Conduct Cultural Resource Inventories and Evaluations and Resolve Any Adverse Effects	Significant and unavoidable
CUL-5: Damage to or Destruction of Human Remains as a Result of Ground-Disturbing Activities	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
CUL-6: Damage to or Destruction of Shipwrecks or Other Submerged Resources as a Result of Channel Dredging	A, B, C	Significant	CUL-MM-6: Stop Ground-Disturbing Activities, Evaluate the Significance of the Discovery, and Implement Mitigation Measures as Appropriate	Less than significant

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
CUL-7: Damage to or Destruction of Known Cultural Resources Resulting from Managed Wetland Activities	A, B, C	Significant	CUL-MM-7: Complete NHPA Section 106 Consultation and Prepare and Implement Context Study; Evaluate Previously Recorded Cultural Resources and Fence NRHP- and CRHR-Eligible Cultural Resources prior to Ground-Disturbing Activities	Less than significant
CUL-8: Damage to or Destruction of As-Yet-Unidentified Cultural Resources in Uninspected Areas as a Result of Other Ground-Disturbing Managed Wetland Activities	A, B, C	Significant	CUL-MM-8: Complete NHPA Section 106 Consultation and Prepare and Implement Context Study; Conduct Cultural Resources Inventories and Evaluations and Resolve Any Adverse Effects	Significant and unavoidable
PUBLIC HEALTH AND ENVIRONMENTAL HAZARDS				
Restoration Impacts				
HAZ-1: Increased Risk of Mosquito-Borne Diseases	A, B, C	Less than significant	None required	–
HAZ-2: Exposure to or Release of Hazardous Materials during Construction	A, B, C	Less than significant	None required	–
HAZ-3: Release of Hazardous Materials into Surrounding Water Bodies during Construction	A, B, C	Less than significant	None required	–
HAZ-4: In-Channel Construction-Related Increase in Emergency Response Times	A, B, C	Less than significant	None required	–
HAZ-5: Increased Human and Environmental Exposure to Mercury	A, B, C	Less than significant	None required	–
HAZ-6: Reduction in Potential for Catastrophic Flooding	A, B, C	Beneficial	–	–
HAZ-7: Increased Human and Environmental Exposure to Natural Gas and Petroleum	A, B, C	Significant	UTL-MM-2: Avoid Ground-Disturbing Activities within Pipeline Right-of-Way UTL-MM-3: Relocate or Upgrade Utility Facilities That Could Be Damaged by Inundation UTL-MM-4: Test and Repair or Replace Pipelines That Have the Potential for Failure	Less than significant

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
Managed Wetland Activities Impacts				
HAZ-2: Exposure to or Release of Hazardous Materials during Construction	A, B, C	Less than significant	None required	–
HAZ-4: In-Channel Construction-Related Increase in Emergency Response Times	A, B, C	Less than significant	None required	–
HAZ-5: Increased Human and Environmental Exposure to Mercury	A, B, C	Less than significant	None required	–
HAZ-6: Reduction in Potential for Catastrophic Flooding	A, B, C	Beneficial	–	–
ENVIRONMENTAL JUSTICE				
Restoration Impact				
EJ-1: Disproportionate Impact of Management of Suisun Marsh on Minority and/or Low-Income Communities	A, B, C	No impact	–	–
Managed Wetland Activities Impact				
EJ-1: Disproportionate Impact of Management of Suisun Marsh on Minority and/or Low-Income Communities	A, B, C	No impact	–	–
INDIAN TRUST ASSETS				
No Impacts				

Chapter 1
Introduction, Purpose, and Need

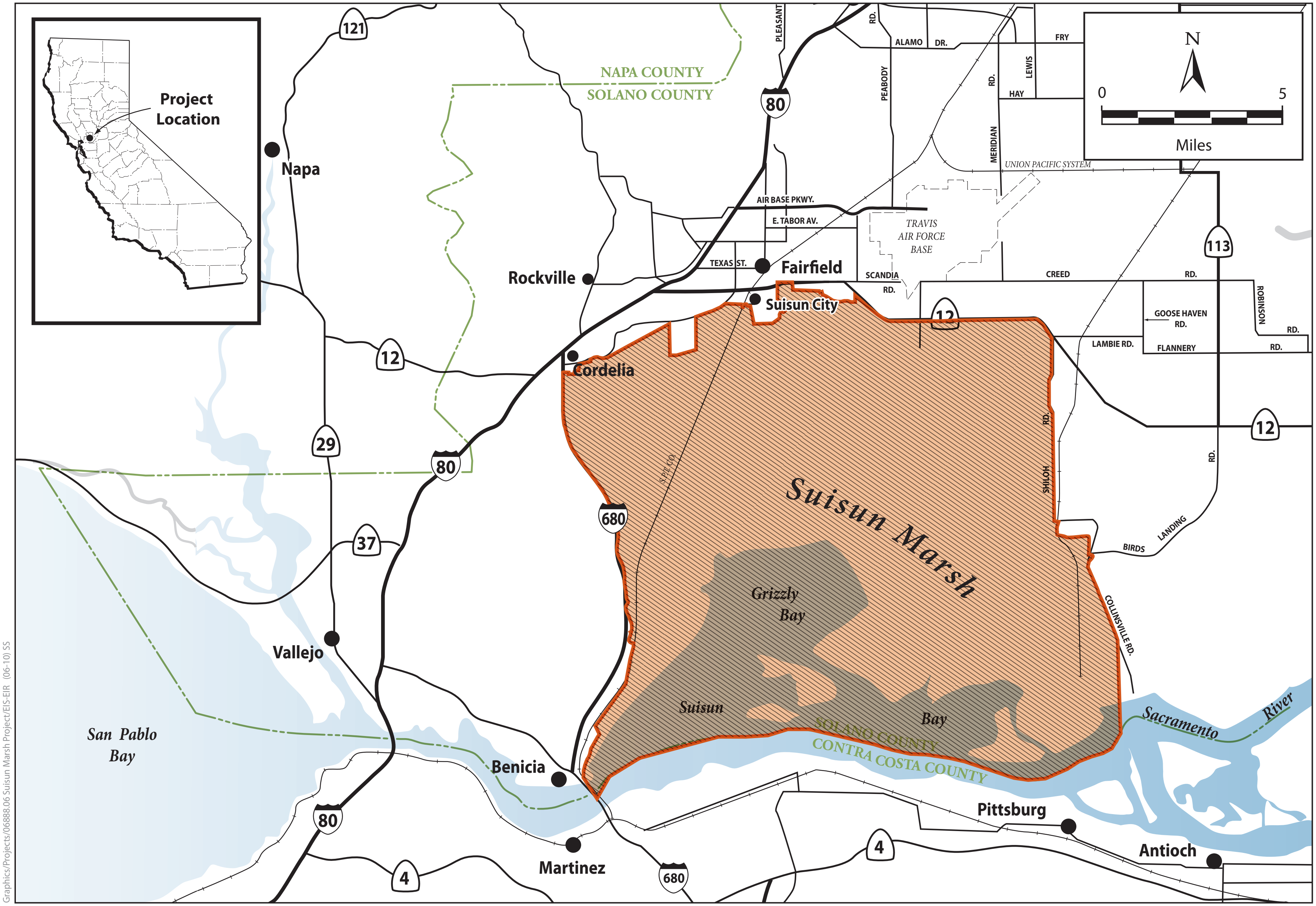
Introduction

Suisun Marsh is the largest contiguous brackish water marsh remaining on the west coast of North America and is a critical part of the San Francisco Bay/Sacramento–San Joaquin River Delta (Bay-Delta) estuary ecosystem. The Marsh encompasses more than 10 percent of California's remaining natural wetlands and serves as the resting and feeding grounds for thousands of birds migrating on the Pacific Flyway and resident waterfowl. In addition, the Marsh provides important habitat for more than 221 bird species, 45 mammalian species, 16 different reptile and amphibian species, and more than 40 fish species. Suisun Marsh supports the state's commercial salmon fishery by providing important tidal rearing areas for juvenile fish. Approximately 200 miles of levees in the Marsh contribute to managing salinity in the Sacramento–San Joaquin River Delta (Delta). It is home to public waterfowl hunting areas and 158 private duck clubs. The Marsh's large open space and proximity to urban areas make it ideally suited for wildlife viewing, hiking, canoeing, and other recreation opportunities. Figure 1-1 shows the location of Suisun Marsh.

The values of the Marsh have been recognized as important, and several agencies have been involved in its protection, since the mid-1970s. In 1974 the Nejedly-Bagley-Z'Berg Suisun Marsh Preservation Act was enacted by the California Legislature to protect the Marsh from urban development. It required the California Department of Fish and Game (DFG) and the San Francisco Bay Conservation and Development Commission (BCDC) to develop a plan for the Marsh and called for various restrictions on development in the Marsh boundaries. In 1976, the BCDC developed the Suisun Marsh Protection Plan (SMPP), which defined and limited development within the primary and secondary management area for the "future of the wildlife values or the area as threatened by potential residential, commercial, and industrial development." The primary management area consists of tidal marshes, seasonal marshes, managed wetlands, and lowland grasslands within the Marsh. The secondary management area comprises upland grasslands and agricultural lands, which provide significant buffer habitat to the Marsh (Solano County 2008). Figure 1-2 shows the primary and secondary management zones in the Marsh. The SMPP objectives are "to preserve and enhance the quality and diversity of the Suisun Marsh aquatic and wildlife habitats and to assure retention of upland areas adjacent to the Marsh in uses compatible with its protection." The SMPP calls for the preservation of Suisun Marsh; preservation of waterfowl habitat; improvement of water distribution and levee systems; and encouraging agriculture that is consistent with wildlife and waterfowl, such as grazing. In 1977, the California Legislature implemented Assembly Bill (AB) 1717, the Suisun Marsh Preservation Act of 1977, which replaced the 1974 Suisun Marsh Preservation Act and calls for the implementation of the SMPP; designates BCDC as the state agency with jurisdiction over the Marsh; and calls for Suisun Resource Conservation District (SRCD) to have the primary local responsibility for water management on privately owned lands in the Marsh. In 1984, the California Department of Water Resources (DWR) with cooperation from SRCD, DFG, and U.S. Department of the Interior, Bureau of Reclamation (Reclamation), published the Plan of Protection for Suisun Marsh, in response to State Water Resources Control Board (State Water Board) Water Rights Decision 1485 (D-1485), Order 7 (California Department of Water Resources 1984). The Plan of Protection was a proposal for staged implementation of a combination of activities, including monitoring, a wetlands management program for landowners, physical facilities, and supplemental releases of State Water Project (SWP) and Central Valley Project (CVP) reservoirs. With this staged implementation approach, each action would be evaluated to determine whether subsequent actions were needed. The Initial Facilities and the Suisun Marsh Salinity Control Gates (SMSCG) were constructed and continue to be operated.

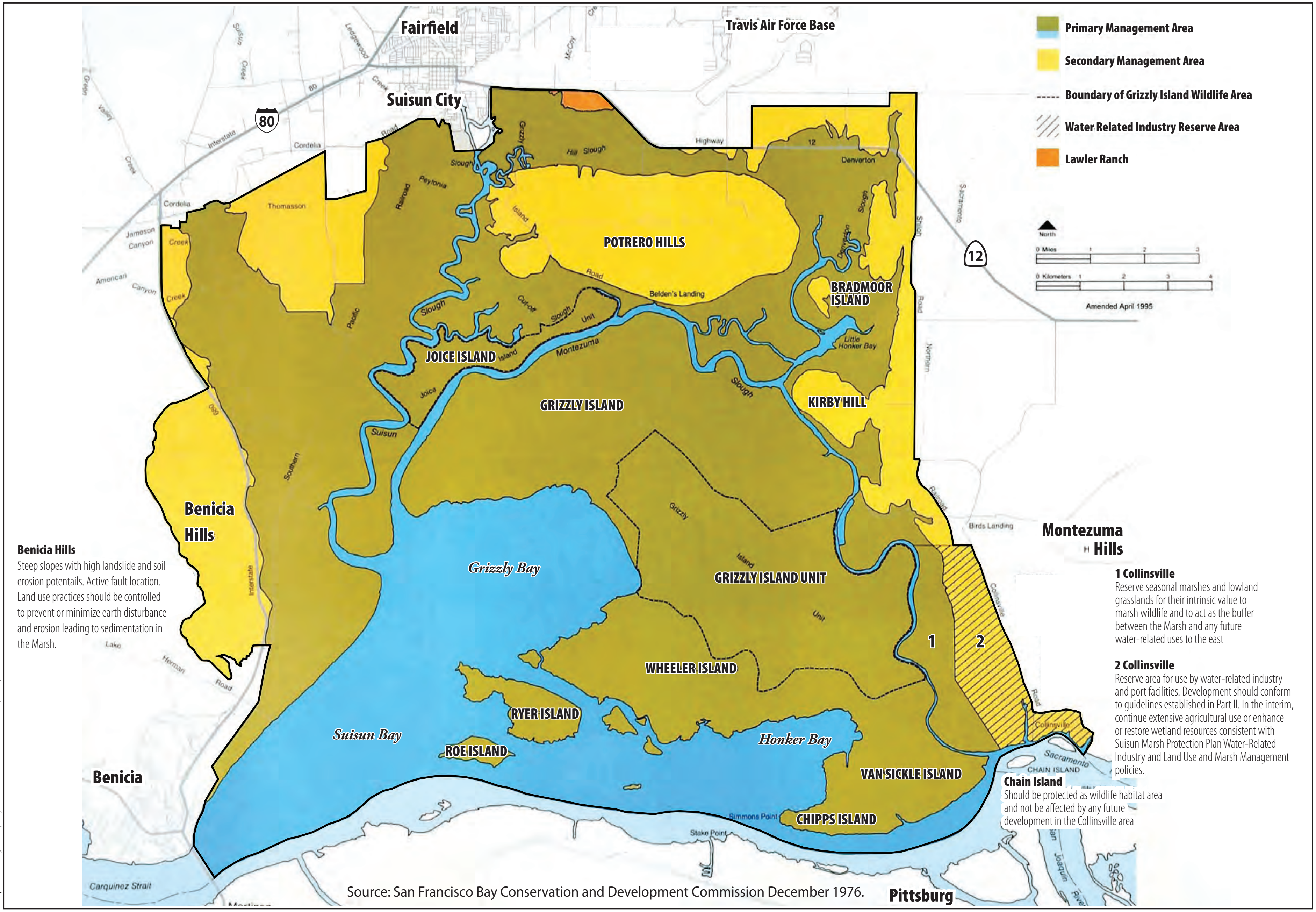
In 1987, Reclamation, DWR, DFG, and SRCD signed the Suisun Marsh Preservation Agreement (SMPA), which contains provisions for Reclamation and DWR to mitigate the adverse effects on Suisun Marsh channel water salinity from the SWP and CVP operations and other upstream diversions. It required Reclamation and DWR to meet salinity standards as specified in the then-current State Water Board D-1485, set a timeline for implementing the Plan of Protection for the Suisun Marsh, and delineated monitoring and mitigation requirements. Additional detail about the SMPA and how it relates to the Suisun Marsh Habitat Management, Preservation and Restoration Plan (SMP) is discussed later in this chapter.

In 2000, the CALFED Bay-Delta Program (CALFED) Record of Decision (ROD) was signed, which established the Ecosystem Restoration Program (ERP) calling for the restoration of 5,000 to 7,000 acres of tidal wetlands and the protection and enhancement of 40,000 to 50,000 acres of managed wetlands for Stage 1 implementation (CALFED Bay-Delta Program 2000a). In 2001, the CALFED agencies were directed to work with key entities involved with Suisun Marsh to form a charter group to develop a plan for Suisun Marsh that would balance the needs of CALFED, the SMPA, and other plans by protecting and enhancing existing land uses and existing waterfowl and wildlife values, including those associated with the Pacific Flyway, endangered species, and state and federal water project supply quality. The charter group includes all of the local, state, and federal agencies that have jurisdiction or interest in the Marsh. However, the SMP has been developed by a subset of the charter group, the Principal Agencies.



ICF INTERNATIONAL

Figure 1-1
Project Location



Graphics/Projects/project number/document (date) SS

ICF INTERNATIONAL

Figure 1-2
Suisun Marsh Protection Plan Map

The Principal Agencies are the U.S. Fish and Wildlife Service (USFWS); Reclamation; National Marine Fisheries Service (NMFS); DFG; DWR; SRCD, representing the interests of private landowners; and the California Bay-Delta Authority (CBDA). The Principal Agencies have consulted with other participating charter agencies, such as the U.S. Army Corps of Engineers (Corps), BCDC, and the State Water Board, in developing the SMP.

CBDA was created in 2003 as the governing entity for implementation of CALFED by the California Bay-Delta Authority Act. The Sacramento–San Joaquin Delta Reform Act of 2009 (Act) created the Delta Stewardship Council (Council), disbanded the CBDA, and transferred CBDA's CALFED responsibilities to the Council. The Act also created a Delta Conservancy, which is tasked with implementing ecosystem restoration and other actions in the Delta and Suisun Marsh. CBDA participated as a Principal Agency in the development of the SMP through the public draft. The future relationship between the Principal Agencies and the Council or Delta Conservancy is under development.

Each Principal Agency will use this Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) to adopt particular actions described in the document related to their jurisdiction and will contribute to the overall implementation of the SMP. Overall, the SMP is intended to balance the benefits of tidal wetland restoration with other habitat uses, including managed wetlands, in the Marsh by providing a plan for an acceptable change in Marsh-wide land uses. This EIS/EIR describes three alternative 30-year plans, and the adopted alternative will become the SMP. For purposes of this document, Reclamation and USFWS are the joint National Environmental Policy Act (NEPA) lead agencies, and DFG is the California Environmental Quality Act (CEQA) lead agency. Each Principal Agency's action related to the SMP is shown in Table 1-1. It is important to note that Principal Agencies and other agencies or organizations may choose to implement additional restoration and other activities beyond what is described in this SMP. The SMP provides a mechanism to accomplish restoration through use of this EIS/EIR and associated permits when applicable.

Table 1-1. Principal Agencies' Regulatory Actions Related to the Suisun Marsh Plan

	USFWS	Reclamation	DFG	DWR	SRCD	NMFS	CALFED/ CBDA
Restoration	NEPA Lead Programmatic BO	N/A	CEQA Lead	CEQA Responsible	CEQA Responsible	Programmatic BO EFH Conservation Recommendations	Science Integration
Managed Wetland Activities	BO	NEPA Lead	CEQA Responsible CESA Permit Streambed Alteration Agreement	CEQA Responsible	CEQA Responsible	BO EFH Conservation Recommendations	N/A
Preservation Agreement Implementation Fund	BO	NEPA Lead	CEQA Lead	CEQA Responsible	CEQA Responsible	BO EFH Conservation Recommendations	N/A

BO = biological opinion.
CALFED = CALFED Bay-Delta Program.
CBDA = California Bay-Delta Authority.
CESA = California Endangered Species Act.
DFG = California Department of Fish and Game.
DWR = California Department of Water Resources.
N/A = not applicable.
NMFS = National Marine Fisheries Service.
PAI = Preservation Agreement Implementation.
Reclamation = U.S. Department of the Interior, Bureau of Reclamation.
SRCD = Suisun Resource Conservation District.
USFWS = U.S. Fish and Wildlife Service.

Scope and Intent of This Environmental Impact Statement/Environmental Impact Report

This document is a joint EIS/EIR that satisfies the requirements of NEPA and CEQA. NEPA and CEQA require that, prior to project approval, the potential environmental impacts are disclosed and mitigation measures or alternatives are recommended to mitigate certain types of impacts related to the proposed project. This EIS/EIR will provide the necessary information for Reclamation and USFWS to approve and implement the SMP in compliance with NEPA, and DFG to approve and implement the SMP in compliance with CEQA. It is also expected to be used by other federal agencies, considered cooperating agencies under NEPA, and will be used by state and local agencies, considered responsible agencies under CEQA, to make approvals of the SMP in compliance with NEPA and CEQA, as required. As specific actions are proposed as part of implementation of the SMP, the implementing and/or approving federal, state, and local agencies will be required to ensure that the impacts of those actions are evaluated per the requirements of NEPA and/or CEQA. These future phases of NEPA and CEQA compliance may rely solely on the SMP EIS/EIR or may require additional NEPA and/or CEQA compliance, possibly including the preparation of a supplemental EIS or EIR. State CEQA Guidelines Sections 15162 through 15164 describes the circumstances under which an agency would be required to prepare a subsequent EIR, or a supplement or addendum to the EIR. Likewise, the Council on Environmental Quality's (CEQ's) NEPA Regulations (40 Code of Federal Regulations [CFR] 15029[c][1]) describe when a federal agency would be required to prepare a supplement to the EIS. Although CEQA contains more specificity on when a subsequent or supplement to the EIR is required than NEPA contains for supplements to the EIS, these conditions are generally the same for CEQA and NEPA.

The decision to prepare additional CEQA and/or NEPA compliance documents would be made on a case-by-case basis. It may be likely that during implementation of the SMP, many activities will not require additional CEQA and/or NEPA documentation beyond the SMP EIS/EIR. Additionally, not all future SMP activities will involve agencies subject to both CEQA and NEPA, and future activities therefore may require additional documentation subject to either CEQA or NEPA, but not both. The specific CEQA and/or NEPA documentation, if any, for implementation of the SMP would be determined by several factors, including the extent to which impacts and feasible mitigation and alternatives were evaluated in this EIS/EIR relative to the specificity of the proposed project, special circumstances or changes in circumstances such as the listing of a species under the federal Endangered Species Act (ESA) or California Endangered Species Act (CESA), and activities outside the scope of this EIS/EIR.

Under NEPA and CEQ's NEPA regulations (40 CFR 1500 *et seq.*), federal agencies are required to evaluate the environmental effects of an action, including feasible alternatives, and identify mitigation measures to minimize adverse effects when they propose to carry out, approve, or fund a project that may have a significant effect on the environment.

Three action alternatives for the SMP were selected to be analyzed in this EIS/EIR based on a rigorous alternatives screening and selection process (refer to Chapter 2, "Alternatives Development and Screening"). These alternatives vary in the number of acres that would be restored to tidal wetlands and managed wetlands enhanced. The CALFED Preferred Program Alternative provides the foundation of this acreage range (CALFED Bay-Delta Program 2000c: 149).

The following sections describe the SMP's relationship to CALFED and other ongoing regional programs, purpose and objectives of the SMP, need for the SMP, and background discussion supporting the purpose of and need for the plan. NEPA requires identification of the SMP purpose of and need for the plan, and CEQA requires identification of the objectives. The plan purpose/objectives and need are key criteria used in developing a reasonable range of plan alternatives.

NEPA Cooperating Agencies

NEPA requires that the lead agencies coordinate with federal, state, local, or tribal agencies that have a jurisdiction or special expertise related to the project. For the SMP, NMFS and the Corps are NEPA cooperating agencies. NMFS has participated as a Principal Agency throughout the development of the plan. This participation has included input from NMFS regarding the project description and the scope and content of the analysis. The Corps also has been a cooperating agency through participation in Charter Group meetings, regulatory workgroup meetings, and other meetings intended to solicit input from them regarding wetland resource issues and permitting approaches.

CEQA Responsible and Trustee Agencies

This EIS/EIR will be used by CEQA lead, responsible, and trustee agencies to determine the effects of the proposed plan. Responsible agencies are those that have a responsibility for carrying out or approving the plan. These agencies will rely on the lead agency’s environmental document in acting on the aspect of the plan that requires each agency’s approval but must prepare and issue its own findings regarding the project (State CEQA Guidelines Section 15096). As such, each agency’s use of this document is limited to actions taken under its jurisdiction as described below. Trustee agencies are those that have jurisdiction over certain resources held in trust for the people of California but do not necessarily have legal authority over approving or carrying out the project. For the SMP, DFG serves as lead, responsible, and trustee agency. Responsible and trustee agencies for the SMP are shown in Table 1-2.

Table 1-2. Responsible and Trustee Agencies

Agency	Jurisdiction
Lead	
California Department of Fish and Game	Largest landowner in the Marsh; conservation, protection, and management of wildlife, native plants, and habitat necessary to maintain biologically sustainable populations; habitat restoration
Trustee	
State Lands Commission	State-owned “sovereign” lands
California Department of Fish and Game	Impacts on fish and wildlife of the state, rare and endangered native plants, wildlife areas, and ecological reserves
Responsible	
California Department of Fish and Game	Streambed alteration and impacts on state-listed species
Office of Historic Preservation	Historic and cultural resources
California Department of Water Resources	Delta Levees Program; SMPA funding; water management facilities
Suisun Resource Conservation District	Managed wetland management
California Air Resources Board	Air quality
Regional Water Quality Control Board (#5)	Pollutant discharges to water bodies
Bay Conservation and Development Commission	Dredging; any development activity that occurs below the 10-foot contour level
Solano County	Construction

SMPA = Suisun Marsh Preservation Agreement.

Need for Action

The SMP is a comprehensive plan designed to address the various conflicts regarding use of Marsh resources, with the focus on achieving an acceptable multi-stakeholder approach to the restoration of tidal wetlands and the management of managed wetlands and their functions. As such, the SMP is intended to be a flexible, science-based, management plan for Suisun Marsh, consistent with the revised SMPA and CALFED. It also is intended to set the regulatory foundation for future actions. The need for the action is based on the following major Marsh resources and functions. Each Principal Agency has particular roles in implementation of the SMP as described in Table 1-1.

Habitats and Ecological Processes

The conversion of tidal wetlands as a result of diking resulted in a loss of habitat for many species, including those now listed as threatened or endangered. Development in areas surrounding the Marsh has resulted in introduction and spread of nonnative species, fish entrainment issues, and degradation of water quality. Additionally, there have been water quality effects from drainage operations in managed wetlands. While taking appropriate steps to restore the ecological values of historical tidal wetland habitat, efforts will be made to improve management of managed wetlands and to lessen adverse effects from development, nonnative species, and detrimental land use practices in the secondary management areas and adjacent metropolitan areas.

Public and Private Land Use

Managed wetlands, tidal wetlands, and uplands, whether publicly or privately owned, provide important wetlands for migratory waterfowl and other resident and migratory wetland-dependent species and opportunities for hunting, fishing, bird watching, and other recreational activities. There is a need to maintain these opportunities as well as improve public stewardship of the Marsh to ensure that the implementation of restoration and managed wetland activities is understood and valued for both public and private land uses.

Levee System Integrity

Of the more than 200 miles of exterior levees in Suisun Marsh, only about 20 miles along Suisun, Grizzly, and Honker Bays (authorized through AB 360) receive public funding. Additionally, as restoration actions are implemented, some interior levees will be converted to exterior levees and will require reinforcement and more maintenance, and in some instances significant upgrades. Because of current restrictions preventing dredging from sloughs and constraints on importing materials, landowners in the Marsh have maintained their exterior levees using primarily material from ditch cleaning or pond bottom grading for more than a decade, a practice that increases subsidence and potentially weakens the existing levee foundations. These factors combined have exhausted the supply of levee maintenance material in the managed wetlands and have forced maintenance to be deferred on some exterior levees, increasing the risk of catastrophic flooding.

Water Quality

Multiple factors contribute to the water quality in Suisun Marsh, including upstream diversion, reduced Delta outflow, state and federal water project operations and diversions, drainage practices in managed wetlands, minimal tidal exchange in dead-end sloughs, urban runoff, erosion, agricultural runoff, discharge from the Fairfield Suisun Sewer District treatment plant to Boynton Slough, and remnant contaminants such as mercury. Improvement of water quality and management practices will benefit the ecological processes for all habitats, including managed and tidal wetlands.

More detail on the need for the SMP is provided below.

Plan Purposes/Objectives

The SMP is intended to address the full range of issues in the Marsh, as described in the Need for Action section above. As such, the SMP purposes/objectives are divided by topic but are linked geographically, ecologically, and socially. The plan purposes/objectives are:

- **Habitats and Ecological Processes—**implement the CALFED Ecosystem Restoration Program Plan (ERPP) restoration target for the Suisun Marsh ecoregion of 5,000 to 7,000 acres of tidal marsh and protection and enhancement of 40,000 to 50,000 acres of managed wetlands;
- **Public and Private Land Use—**maintain the heritage of waterfowl hunting and other recreational opportunities and increase the surrounding communities' awareness of the ecological values of Suisun Marsh;
- **Levee System Integrity—**maintain and improve the Suisun Marsh levee system integrity to protect property, infrastructure, and wildlife habitats from catastrophic flooding; and
- **Water Quality—**protect and, where possible, improve water quality for beneficial uses in Suisun Marsh, including estuarine, spawning, and migrating habitat uses for fish species as well as recreational uses and associated wildlife habitat.

The SMP requires that these interrelated and interdependent purposes/objectives be implemented to some extent through all SMP actions. For example, the levee system integrity purpose/objective would ensure that managed wetlands are protected from catastrophic flooding, thus contributing to meeting the portion of the habitats and ecological processes purpose/objective that addresses protection of managed wetlands. Similarly, the restoration of certain properties may help protect and/or improve water quality, and achieving the habitats and ecological processes purpose/objective also would help to achieve the private and public land use purpose/objective. Recognizing these relationships, the SMP is proposed to contribute to meeting each of them in parallel over the 30-year planning period.

Suisun Marsh Regions

For purposes of this analysis, the Marsh has been divided into four regions. This division allows for a more specific characterization of potential actions and their impacts, and also provides direction related to the massing of restoration in any given area of the Marsh. Areas within each region are hydrologically and geographically linked as described below. Chapter 2 describes how restoration would be accomplished in each region and the Resource Management Associates (RMA) model used for determining water quality and tidal hydraulic impacts was based on these regions as described in Sections 5.1 and 5.2. The four regions are shown in Figure 1-3 and are described below.

Region 1

Region 1 consists of the western and northwestern portions of Suisun Marsh, primarily west of or adjacent to the Union Pacific Railroad. Managed wetland units diverting from, and draining into, medium to small tidal sloughs characterize this area of the Marsh. Some of these tidal sloughs are influenced significantly by freshwater inflow from the Green Valley, Suisun, and Ledgewood Creeks. Additionally, there are several dead-end sloughs in this region of the Marsh in which complete tidal exchange is minimal. The Fairfield Suisun Sewer District treatment plant discharges wastewater (a freshwater source) primarily into Boynton Slough and some managed wetlands in this region.

Region 2

Region 2 is the central portion of the Marsh, fronting Suisun and Cutoff Sloughs and a small portion of Montezuma Slough. This region of the Marsh is characterized as managed wetland areas that flood off of a mix of small to large tidal sloughs and drain primarily into Suisun Slough, the second largest tidal slough in the Marsh, or Montezuma Slough. Suisun Slough is similar to Montezuma, a large, highly energetic channel terminating at Grizzly Bay running north into the interior heart of the Marsh. Rush Ranch, the largest remnant tidal wetland in the Marsh, and Upper and Lower Joice Islands also are included in this region. The Fairfield Suisun Sewer District treatment plant discharges wastewater (a freshwater source) primarily into Boynton Slough, which is on the northern boundary of Region 2.

Region 3

The northeastern portion of Suisun Marsh is characterized by Little Honker Bay and minor sloughs such as Nurse, Denverton, and Luco Sloughs. Managed

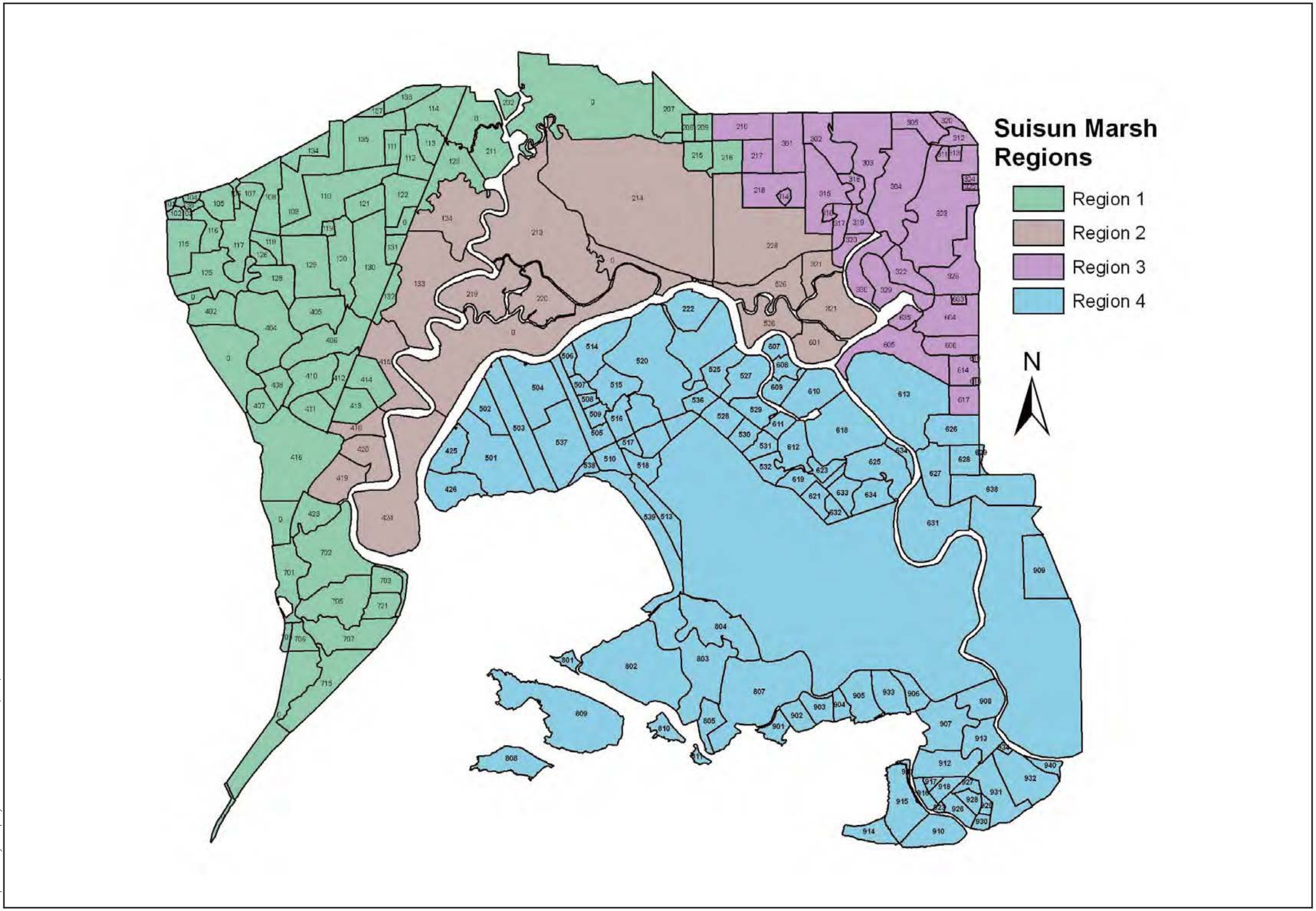


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Figure 1-3
Suisun Marsh Regions

wetland units flood and drain primarily into fairly large to medium-sized tidal sloughs and Little Honker Bay in this area of the Marsh.

Region 4

This is the central and southern portion of Suisun Marsh and represents the largest geographic region of the Marsh. This area includes Grizzly Island (which includes Van Sickle, Hammond, Simmons, and Wheeler Islands), Chipps Island, Ryer, Roe, and several smaller islands in Suisun Bay. Montezuma Slough, the Sacramento and San Joaquin Rivers, and Grizzly, Suisun, and Honker Bays hydrologically dominate this area. All of these channels and bays are highly energetic with enormous daily movements of water driven by tides, Delta outflow, wind, and the SMSCG. This region of the Marsh has had significant investment in fish screen facilities over the last 15 years, and more than 19,958 acres of managed wetlands have access to water that is screened. Some properties that have access to screened water cannot meet all of their needs with available screened water, but this is the primary water source. Screened water is depended upon in the spring when diversion restrictions are in place (i.e., diversion reductions or mandatory closures).

The presence of numerous fish-screened facilities, including the Roaring River Distribution System (RRDS), has supported historical management strategies of these managed wetlands. The other regions of the Marsh without fish screens have had to modify managed wetland strategies to accommodate restrictions to protect fish at unscreened diversions. Almost all of these wetland areas obtain their water from Montezuma Slough and drain to the bays if physically possible. If not, the wetland areas drain directly into the large tidal sloughs.

Plan Background

As briefly described above, Suisun Marsh has a long and complex management history involving multiple stakeholders. The following sections highlight major components of this history and the various ecological, recreational, and other resources in the Marsh related to the need for and purposes/objectives of the SMP.

History of Suisun Marsh Management

The historical management of the Marsh includes changed regulatory and institutional conditions, construction of new facilities and changes to existing facilities, and legislative changes; several important changes are listed in Table 1-3 below. Chapter 10, “Compliance with Applicable Laws, Policies, and Plans and Regulatory Framework,” contains a more detailed discussion of each of these actions.

Table 1-3. Changes in Management of Suisun Marsh

Action	Year	Description
4-Agency Memorandum of Agreement	1970	Called for studies necessary to obtain a thorough understanding of the requirements of fish and wildlife resources and evaluate alternative means of providing substitute freshwater supplies that would enable protection and enhancement of Suisun Marsh waterfowl habitat.
The Nejedly-Bagley-Z'Berg Suisun Marsh Preservation Act	1974	Required the BCDC and DFG to develop a plan for the protection of the Marsh and provides various restrictions on development within Marsh boundaries.
Suisun Marsh Protection Plan, The Suisun Marsh Preservation Act of 1977 (AB 1717)	1976, 1977	Adopted the Suisun Marsh Protection Plan, which defines and limits development in primary and secondary management areas (Figure 1-2), designates the BCDC as the state agency with regulatory jurisdiction of the Marsh, and calls for the SRCD to have responsibility for water management in the Marsh.
State Water Resources Control Board Water Rights Decision 1485	1978	Set water quality standards and required DWR and Reclamation to develop and fully implement a plan to meet the standards for the Marsh.
Plan of Protection for Suisun Marsh	1984	Prepared by DWR and Reclamation in response to D-1485. Included construction of large facilities and distribution systems in six phases to meet salinity standards. Two of the six phases were completed, including the Initial Facilities, establishment of water quality monitoring stations, and the Suisun Marsh Salinity Control Gates.
SMPA	1987	A contractual agreement among DWR, Reclamation, DFG, and SRCD. Requires DWR and Reclamation to meet salinity standards, sets a timeline for implementing the Plan of Protection for Suisun Marsh, and delineates monitoring and mitigation requirements.
Bay-Delta Accord	1994	State and federal agencies, working with agricultural, environmental, and urban stakeholders, reached agreement on water quality standards and related provisions that would remain in effect for 3 years.
State Water Board Water Quality Control Plan	1995–1998	Modified Delta Flow Standards. Modeling analysis by the Suisun Marsh Planning Program showed that Suisun Marsh standards would be met most of the time at all Suisun Marsh compliance stations. Some standard exceedances would be expected in the western Marsh that participants to the SMPA agreed could be mitigated by implementing the PAI fund and actions for more active water control by landowners.
Suisun Ecological Workgroup	1995	The 1995 Water Quality Control Plan recommended that DWR convene the multi-agency SEW to evaluate the beneficial uses and establish water quality objectives in the Marsh. The State Water Board asked for specific measures to implement the narrative objectives for the Marsh in the 1995 WQCP.
Environmental Coordination Advisory Team	1998	ECAT was convened to ensure compliance with conditions, mitigation, and monitoring responsibilities specified in the SMPA as well as biological opinions. ECAT includes staff from Reclamation, DFG Grizzly Island Wildlife Area, DFG Central Valley Bay-Delta Branch, SRCD, and DWR. The USFWS, NMFS, and Corps staffs have participated in an advisory role.
State Water Board Water Right Decision 1641	1999	Increased outflow and set salinity requirements for the Bay-Delta, which provided indirect benefits to Suisun Marsh. State Water Board relieved Reclamation and DWR of responsibility in meeting numerical salinity objectives at S-35 and S-97 in the western Marsh.

Action	Year	Description
CALFED Suisun Marsh Charter	2000	Intended to develop a plan for the management of the various resources in the Marsh in compliance with the many regulatory requirements already in place.
Revised SMPA	2005	Actions included an agreement to meet channel water salinity standards in D-1641, convert S-35 and S-97 from compliance stations to monitoring stations, implement a Water Manager Program, provide portable drainage pumps, realign and stabilize Roaring River Distribution System turnouts, and establish a Drought Response Fund.

AB = Assembly Bill.
BCDC = San Francisco Bay Conservation and Development Commission.
Corps = U.S. Army Corps of Engineers.
D-1485 = State Water Board water right Decision 1485.
D-1641 = State Water Board water right Decision 1641
DFG = California Department of Fish and Game.
DWR = California Department of Water Resources.
ECAT = Environmental Coordination and Advisory Team.
NMFS = National Marine Fisheries Service.
Reclamation = U.S. Department of the Interior, Bureau of Reclamation.
SEW = Suisun Ecological Workgroup.
SMPA = Suisun Marsh Preservation Agreement.
SRCD = Suisun Resource Conservation District.
State Water Board = State Water Resources Control Board.
USFWS = U.S. Fish and Wildlife Service.
1995 WQCP = 1995 Water Quality Control Plan for the San Francisco Bay/San Joaquin Delta Estuary.

Habitat Management

Since the mid-1990s, ecological goals and the focus of Suisun Marsh land use by some public agencies have transitioned from species- to habitat-based conservation goals, including increased interest in restoring more tidal wetlands in Suisun Marsh and other parts of the estuary. Historically, Suisun Marsh contained more than 60,000 acres of brackish tidal wetlands. Waterfowl hunting began in the 1850s. Construction of levees began around 1865, initially to enable livestock grazing but later for farming. Today approximately 7,672 acres of tidal wetlands remain, and property is held by both private and public entities as shown in Figure 1-4. The changes in land use resulted in a loss of habitat for tidal marsh–dependent species and fragmentation of the remaining tidal wetlands.

Suisun Marsh plays an important role in providing suitable habitat for the first waterfowl arriving from the north and resident waterfowl, and at times is the only habitat available until the Sacramento–San Joaquin Valley and Delta agricultural fields are flooded. Managed wetlands also provide habitat for many species of shorebirds and other birds. For example, more than 20 species of shorebirds occur in Suisun Marsh along with many species of hawks, owls, and songbirds. Some of the mammal species that occur in Suisun Marsh are river otter, tule elk, and salt marsh harvest mouse.

Current land use in the Marsh is a mixture of privately and state-managed lands, with approximately 52,112 acres of diked baylands managed mainly as wetlands. State and private landowners collaborate to achieve a wide degree of management goals, including those to protect tidal wetlands, managed wetlands, grazing, and recreational use, and to provide flood protection and mosquito control.

Tidal Wetlands

Tidal wetlands are composed of vegetated marsh plains and intertidal and subtidal channels that provide important habitat for a variety of endangered and sensitive species. Vegetated tidal marsh plains are typically at elevations between local mean high water and slightly above mean higher high water. Marsh channels, both the deeper "subtidal" channels and the shallower "intertidal" channels, provide important aquatic habitat for fish species such as delta smelt, longfin smelt, Sacramento splittail, and salmonids. The channel edges of tidal wetlands, which provide exposed beds and banks at lower tide stages, provide foraging habitat for California clapper rail along with many other bird species. The tidal marsh plains provide habitat for native plant species such as soft bird's-beak and Suisun thistle and breeding, forage, and roosting habitats for passerine birds such as Suisun song sparrow and tri-colored blackbirds.

There are currently approximately 7,700 acres of tidal wetland in Suisun Marsh, which include areas that are remnant historical tidal wetlands and restored tidal wetlands.

Diked Managed Wetlands

Suisun Marsh has approximately 52,112 acres of diked managed wetlands and uplands. These lands are managed primarily for wintering waterfowl but also provide important habitat for many resident and migratory species such as the salt marsh harvest mouse, tule elk, and Pacific Flyway birds. Most diked wetlands are managed as seasonal wetlands with a small amount managed as perennial wetlands. The diked managed wetlands are divided between private and public ownership. Approximately 37,500 acres (158 parcels) are privately owned and managed, and about 15,300 acres are owned and managed by DFG. Management for waterfowl typically is targeted at providing quality habitat for dabbling ducks and geese, including northern pintail, mallard, American wigeon, green-winged teal, and other dabblers. In dry years, the Marsh supports more than one-quarter of the central California wintering waterfowl population. This makes the waterfowl habitat in the Marsh critical to the survival of the Pacific Flyway wintering birds, particularly during drought conditions.

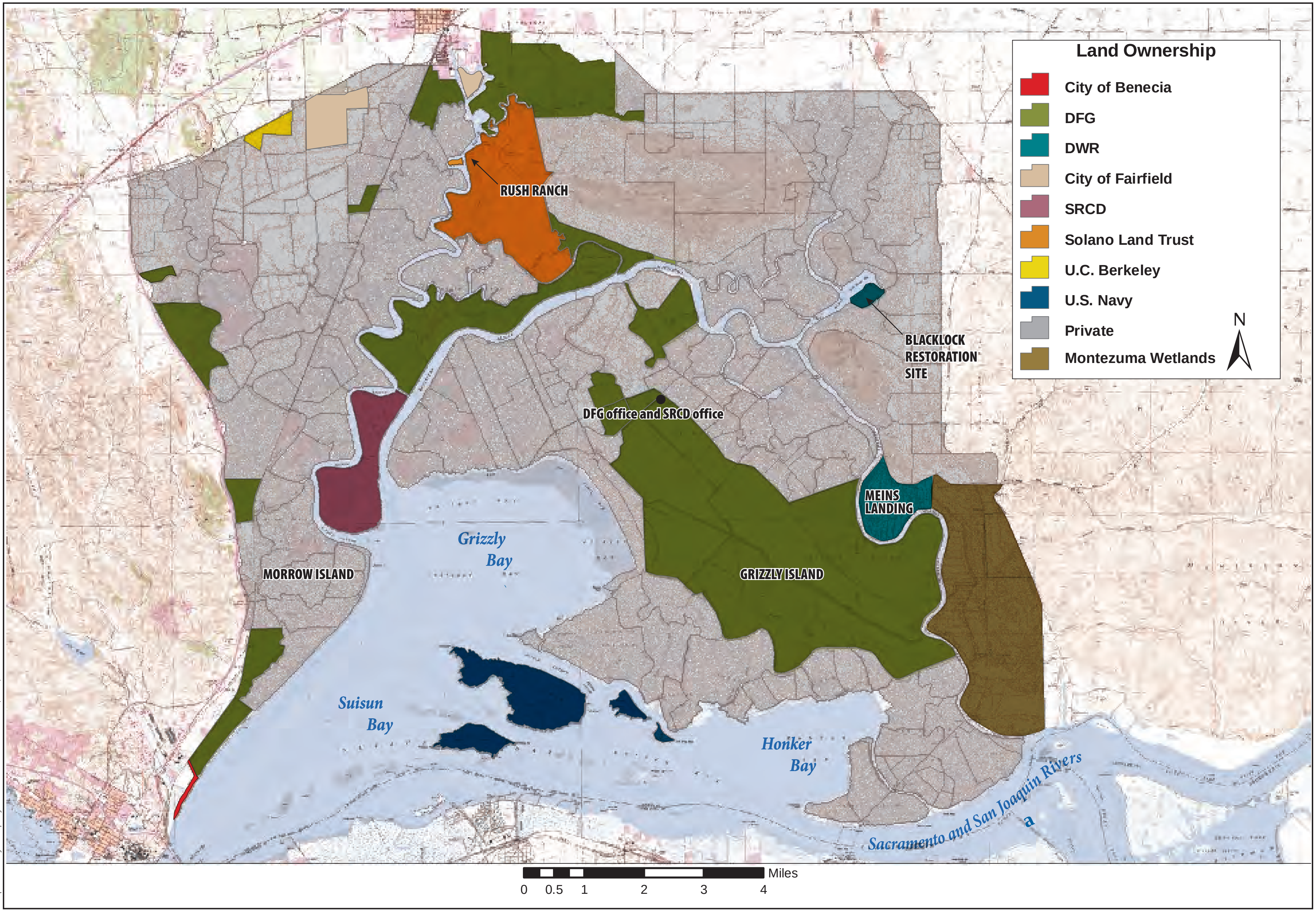

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Figure 1-4
Suisun Marsh Land Ownership

Other Habitats

Other habitat types are vernal pool, upland, tidal bays and sloughs, and riparian. In general, these habitats have been disturbed by the historical and current land management practices, including grazing; channelization and levee maintenance; managed wetland activities; and invasive species and have been affected by urbanization of the surrounding areas. Nonetheless, these historical and current land uses are consistent with applicable plans and policies and have prevented development of the Marsh.

Public and Private Land Use

As described above, there are currently 158 private duck clubs and more than 15,000 acres of public lands managed for duck hunting and other recreational activities. The full capacity to support non-consumptive recreational activities such as bird watching, walking, and wildlife viewing has not been achieved.

Levee System Integrity

The Marsh relies on levees to protect diked managed wetlands, roads, and other infrastructure from flooding. The following sections describe the current state of levees, levee maintenance funding, and the infrastructure they protect.

Levees and Levee Maintenance

As described above, there are approximately 200 miles of levees in Suisun Marsh maintained primarily by private landowners. Approximately 50 percent of these landowners have formed a Reclamation District (RD), a type of special-purpose district that is responsible for reclaiming and/or maintaining land threatened by permanent or temporary flooding, to address flood control. The State of California passed legislation (Water Code 5000 *et seq*.) allowing Reclamation Districts to form as a way to pay the costs associated with “reclaiming” the land.

In Suisun Marsh, RDs typically comprise a group of private landowners with the primary local responsibility for maintenance and repair of exterior levees, water control structures (pipes, fish screens, and pumps), water conveyance facilities, and access roads. These maintenance and repair activities are funded by the RD through the collection of fees or assessments of participating landowners. Today 13 RDs in Suisun Marsh perform activities in conformance with their original articles of incorporation and the Water Code (Figure 1-5). Landowners not members of an RD maintain their levees independently.

Approximately 10 percent (20 miles) of the 200-mile exterior levee system is included in some type of publically funded levee maintenance program, which provides an extremely variable and limited funding source for levee maintenance. Currently, four miles of levee are within the legal boundary of the Delta and thus eligible to participate in the Delta Levee Maintenance Subventions Program. An additional 12 miles of levee from Van Sickle Island to Montezuma Slough are eligible to participate in the Special Projects portion of the Delta Levee Program. Therefore, more than 180 miles of exterior levees have no financial assistance for exterior levee maintenance. With such a small fraction of the Suisun Marsh levees in a DWR financing program, private landowners and DFG are solely responsible for levee maintenance and emergency repairs unless the state and federal governments intervene as they did following the flooding in 1998, and to a lesser extent in 2006. Additionally, maintenance of levees by private landowners and DFG is constrained by the difficulty in obtaining permits for dredging and importation of materials. Landowners maintaining levees in the Marsh have relied solely on limited materials from within diked managed wetlands or minimal dredging during the flood years (1998 and 2006) when emergency permits were granted. This lack of access to soils for levee maintenance makes it increasingly difficult for landowners to protect against catastrophic levee failure in the Marsh.

Diked Wetland Management and Resource Protection

Most of the levees protect the diked managed wetlands and allow for wetlands management and flood protection of clubhouses in the duck clubs. These levees make active wetland management possible by allowing control of diked wetland hydrology. Exterior levees in the Marsh protect managed wetlands. Managed wetland levee integrity is important to maintain habitats that support waterfowl and other wildlife species that depend on these areas and special-status terrestrial species that use them for at least a part of their life cycle. Failure of levees results in deep flooding of managed wetlands and typically results in the elimination or considerable reduction of suitable habitat for resident and migratory wildlife species. In most cases, levee failures are repaired to allow continued diked wetland management. A small number of properties have reverted to permanent tidal action resulting from unrepaired levee failures.

Infrastructure Protection

Many of the Marsh levees serve as important local transportation corridors and protect private and public infrastructure in addition to providing ecological and aesthetic value. Significant examples of public infrastructure, protected by locally funded levee maintenance programs, are the Union Pacific Railroad, Amtrak Capitol Corridor, the petroleum product pipeline to Travis Air Force Base, other petroleum pipelines, State Route (SR) 12, Solano County roads, natural gas production wells and transmission lines, electrical transmission lines, and more than $120 million invested by DWR and Reclamation in Suisun Marsh water conveyance facilities. Although very rural, the DFG Grizzly Island Wildlife Area Complex (comprising more than 15,000 acres of publicly owned

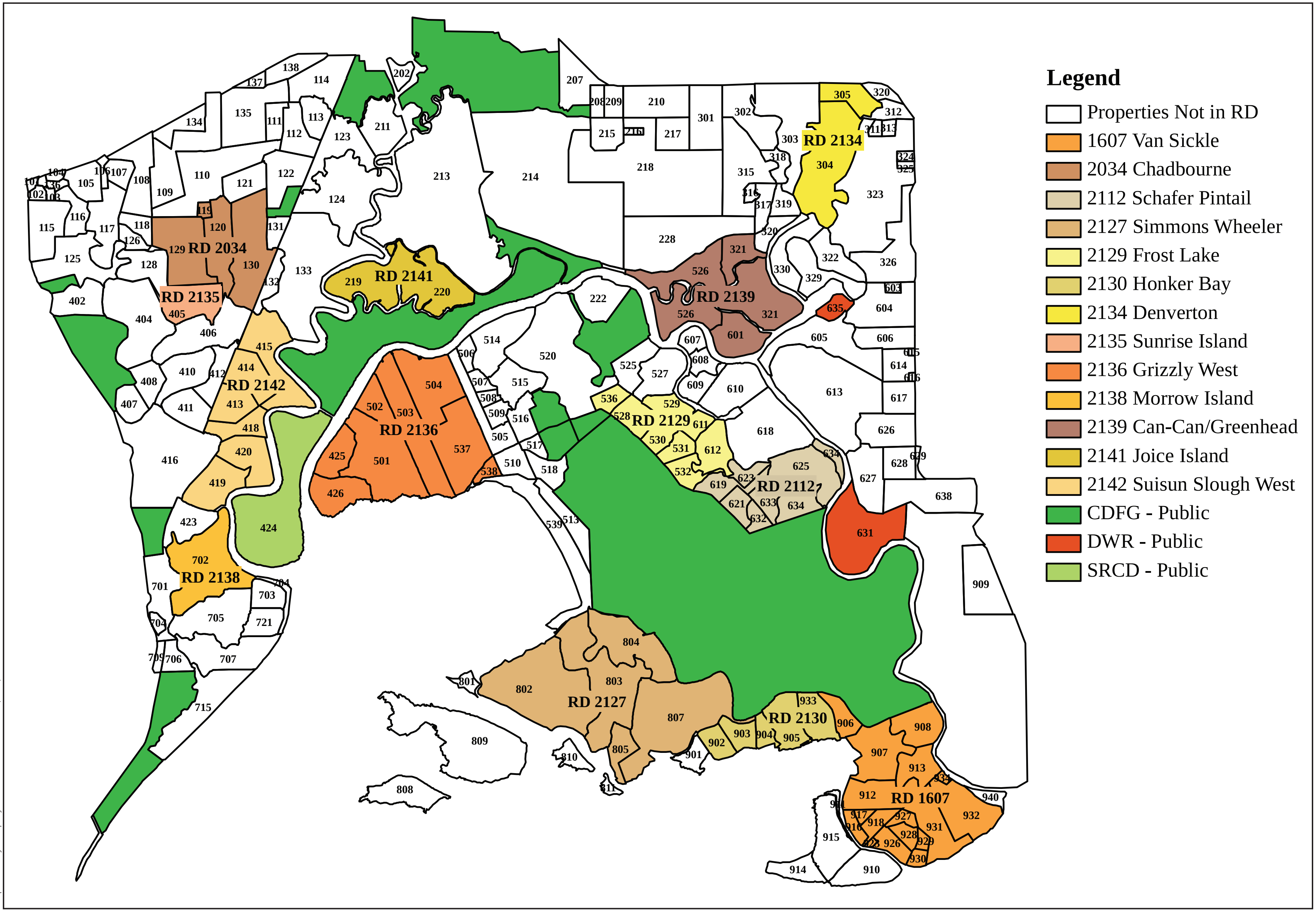

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Figure 1-5
Suisun Marsh Reclamation Districts

lands), includes local residents, families, homes, and private structures protected by this levee system.

Water Quality and Salinity Management

Salinity is the major water quality variable for Suisun Marsh because it affects the ability of managed wetlands to produce the vegetation and other habitat conditions necessary to support waterfowl. Salinity in the Marsh is controlled primarily by salinity in Suisun Bay. The applied salinity, as well as the drainage practices and leaching operations, controls the soil salinity, which in turn may limit or control the vegetation that is considered ideal for ducks and waterfowl in the managed seasonal wetlands (California Department of Water Resources 2000). Suisun Bay salinity is affected by CVP and SWP operations.

Salinity of water diverted for waterfowl habitat in the managed wetlands of the Marsh and Delta water management for agriculture, water supply diversions, and exports became linked in the 1978 State Water Resources Control Board Bay-Delta Water Quality Control Plan (WQCP) and D-1485 Suisun Marsh salinity standards (objectives). The State Water Board required a plan of protection for Marsh water quality conditions. Initial facilities (Figure 1-6), including improved RRDS facilities to supply approximately 5,000 acres on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly Islands with lower salinity water from Montezuma Slough, and the Morrow Island Distribution System (MIDS) and Goodyear Slough outfall to improve water supply for the southwestern Marsh, were constructed in 1979 and 1980; the Plan of Protection for Suisun Marsh was approved in 1984. The SMSCG on Montezuma Slough near Collinsville began operating in October 1988. The gates control salinity by allowing tidal flow from the Sacramento River into Montezuma Slough during ebb (outgoing) tides but restricting the tidal flow from Montezuma Slough during flood (incoming) tides. The gates cause a net inflow (about 2,500 cubic feet per second [cfs]) of low-salinity Sacramento River water into Montezuma Slough. Operation of the SMSCG lowers salinity in some Marsh channels, primarily those in the eastern Marsh, and results in a net movement of water from east to west. The SMSCG generally are operated from October through May to meet the Suisun Marsh salinity standards (objectives). The salinity monitoring stations are shown in Figure 1-7. In addition to these facilities, the Cygnus and Lower Joice units, original SMPA facilities, were completed to allow more rapid filling and enable proper management of wetlands, thus contributing to salinity management.

Besides salinity for managed wetlands, drinking water, and agricultural water, other water quality issues include low dissolved oxygen (DO), elevated temperature, ammonia, suspended sediments (SS) and mercury, especially as they relate to fish and other aquatic species habitat conditions.

Relationship of the Suisun Management Plan to Other Regulations and Ongoing Plans and Studies

The Delta, including Suisun Marsh, is the focus of many ongoing plans and studies intended to manage the various Delta resources. The following sections describe some of these plans and studies and their relationship to the SMP.

Relationship to the CALFED Bay-Delta Program

CALFED was a cooperative effort of 25 state and federal agencies with regulatory and management responsibilities in the Bay-Delta to develop and implement a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system. The collaborative planning process identified comprehensive approaches to the problems of ecosystem quality, water delivery reliability, water quality, and Delta levee integrity.

In July 2000, the CALFED agencies released the final Programmatic Environmental Impact Statement/Environmental Impact Report (PEIS/EIR) (CALFED Bay-Delta Program 2000b), which analyzed a range of alternatives to solve Bay-Delta system problems. In August 2000, the CALFED agencies adopted a preferred alternative that included measures to reduce potential conflict between stakeholders, restore Bay-Delta ecosystem functions, support levee integrity, and provide an adequate water supply for all beneficial uses of water (CALFED Bay-Delta Program 2000a).

The Preferred Program Alternative described in the CALFED ROD is a long-term plan that includes a variety of different potential actions to be implemented over the next 30 years by numerous public and private entities to improve the health of the Bay-Delta estuary. Suisun Marsh is addressed in the Levee System Integrity Program and the ERPP:

- Restore 5,000 to 7,000 acres of saline emergent wetland and assist in protecting and enhancing 40,000 to 50,000 acres of degraded seasonal wetlands. (CALFED Ecosystem Restoration Program Plan Volume II: Ecological Management Zone Visions [CALFED Bay-Delta Program 2000c: 149]).

Specific actions described in the CALFED ROD relative to Suisun Marsh include:

- Evaluate and, where appropriate, rehabilitate Suisun Marsh levees. (CALFED Bay-Delta Program 2000a: 20).
- Restore habitat in the Delta, San Pablo Bay, Suisun Bay, Suisun Marsh, and Yolo Bypass, including tidal wetlands and riparian habitat. In addition, 8,000 to 12,000 acres of wildlife-friendly agricultural lands will be established in cooperation with local participants (CALFED Bay-Delta Program 2000a: 39).

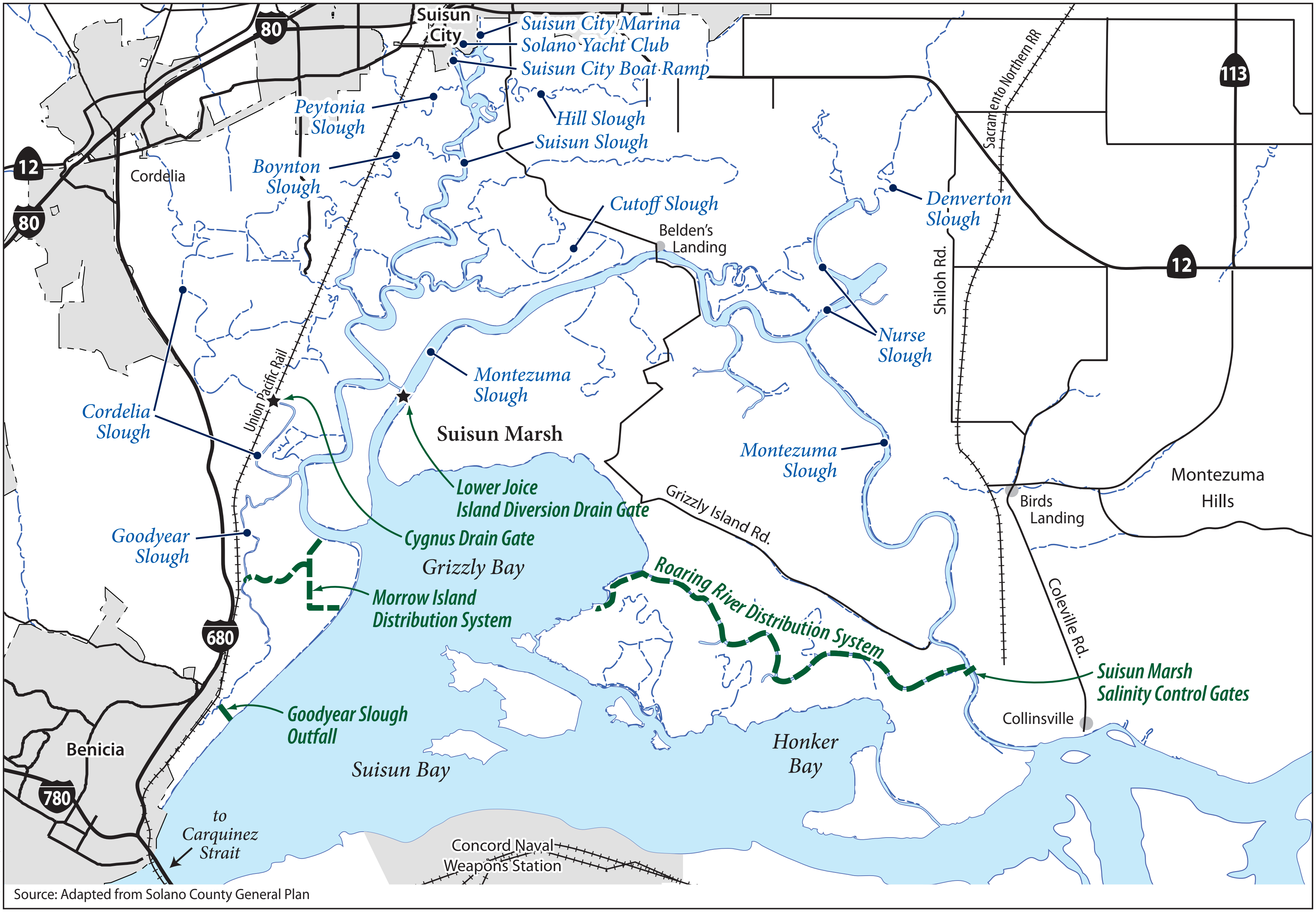

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Figure 1-6
DWR and Reclamation Salinity Control Facilities In Suisun Marsh

Source: Department of Water Resources, Environmental Services Office, Suisun Marsh Program website.

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Figure 1-7
Map of Suisun Marsh Monitoring and Compliance Stations

The CALFED ROD also notes that actions implemented under the CALFED Program needed to be based on sound science and include science-based adaptive management (CALFED Bay-Delta Program 2000a: 37). The Principal Agencies created a Science Integration Strategy to assure that the SMP was developed using these principles. The Science Integration Strategy includes employing a Science Advisor to assist in the development of conceptual models for key ecosystem functions and habitats and a Scientific and Technical Advisory Panel (STAP) and other peer review methods to provide independent review of the technical basis of the SMP. Additionally, Conceptual Models for Marsh habitats and processes have been developed and will serve as living documents that will guide restoration activities as new information is developed and incorporated into the models. The models can be viewed at <http://www.dfg.ca.gov/delta/SuisunMarsh>.

The SMP also meets the policy commitments described in the CALFED ROD that each project implementing the CALFED Program would be subject to the appropriate type of environmental analysis and will evaluate and use the appropriate programmatic mitigation strategies described in the CALFED PEIS/EIR and the CALFED ROD. (CALFED Bay-Delta Program 2000a: 29–30, 32–35, and Appendix A.) This SMP EIS/EIR focuses on a more specific plan and geographic area. The SMP is intended to implement specific ERP goals of CALFED, including restoration in Suisun Marsh. As such, the CALFED PEIS/EIR was used to guide development of SMP alternatives. This EIS/EIR stands alone with an independently developed analysis of the impacts of the SMP, including direct, indirect, and cumulative impacts, and avoidance/mitigation measures.

In 2003, the California Bay-Delta Authority Act created the CBDA and also designated Implementing Agencies responsible for conducting actions necessary to implement various program elements of the CALFED Program. The ERP Implementing Agencies were DFG, USFWS, and NMFS. The ERP Implementing Agencies have a framework through which they implement the ERP. Management-level representatives of the agencies, called ERP Implementing Agency Managers (ERPIAMs), meet regularly to discuss ERP priorities in light of annual findings related to program milestones, develop annual program plans and proposal solicitation packages reflecting those priorities, select which grant proposals to fund, and consider amendments to ongoing ERP-funded projects. This existing framework will be used as ERP implementation continues in the Delta Ecological Management Zone (EMZ) and in the other ERP focus areas.

In November 2009, California legislation disbanded the CBDA as the governing body for CALFED. This role has been assumed by the new Council along with the additional charge to develop and implement a plan to address water supply and ecosystem issues in the Delta. The Council and the Delta Plan are described below.

Relationship to the Delta Regional Ecosystem Restoration Implementation Plan

The Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) is one of four regional plans intended to guide the implementation of the CALFED ERP element. DRERIP concluded at the end of 2008 with completion of a broad suite of conceptual models and restoration action evaluation tools all founded within the adaptive management framework described in the CALFED ROD; it did not progress to the stage of developing an implementation plan. The DRERIP refined the planning foundation specific to the Delta with some applicability to Suisun Marsh. DRERIP developed a suite of conceptual models collating the latest science on ecosystems, processes, stressors, and species related to protecting and enhancing ecosystem function and protecting and recovering natural estuarine communities and native estuarine species. Some of these conceptual models used information developed for the Suisun Marsh conceptual models and are applicable to the Marsh. DRERIP also developed methods for using the conceptual models to conduct technical evaluations of proposed ecosystem enhancement and restoration actions and developed guidelines for how to write a restoration action in a manner well suited to effective technical evaluation. These tools are directly applicable to the SMP. The SMP and DRERIP are linked through some of the scientific conceptual models being developed for each. They would be linked hydrodynamically by tidal wetland restoration and they are linked ecologically through the movement of many fish and wildlife species.

Relationship to the Delta Vision Process

Delta Vision identified strategies for managing the Delta, including Suisun Bay and Marsh, as a sustainable ecosystem that would continue to support environmental and water supply reliability functions that are critical to the people of California. It evaluated the existing and proposed land and water uses, ecosystem functions and processes, and management practices in the Delta-Suisun region. (Delta Vision 2008.)

The Delta Vision Task Force has recommended natural values and functions, services, and management practices that should be considered priorities for future management as part of a sustainable Delta-Suisun region. Its October 2008 Strategic Plan identified and evaluated alternatives in the use of land and water resources, services to be provided in the Delta-Suisun region, governance, funding mechanisms, and ecosystem management practices. The ERP Stage 2 conservation strategy is recommended as the "single blueprint" for ecosystem restoration in the Delta EMZ under the new Delta Plan, which is the next step in the Delta Vision process, as described below.

This EIS/EIR has been developed in coordination with the recommendations of the Delta Vision Process. As a member of the Delta Vision Stakeholder Coordination Group, the SRCD has participated actively in the Delta Vision

Process and informed the Stakeholder Coordination Group, Blue Ribbon Task Force Committee, and staff of the SMP EIR/EIS development and Plan elements. Throughout this 2-year process, SRCD shared SMP goals and objectives and made several public presentations to the Coordination Group and Blue Ribbon Task Force Committee, with the support of other SMP Principal members.

Delta Stewardship Council and Delta Plan

In late 2009, a new Delta governance package was passed by the Legislature that establishes a Council, a Delta Conservancy, a Delta Science Program, and a "revamped" Delta Protection Commission. The precise relationship between the ERP and this new governance structure has yet to be determined. However, the ERP Implementing Agencies (ERPIA) intend to use the current project identification and selection process framework as ERP implementation continues in the Delta EMZ and in the other ERP focus areas. To the extent that ERPIAMs-identified priorities and funding recommendations involve actions in the Delta EMZ, it is expected that ERPIAs will annually present their annual work plan to the Council to demonstrate consistency with any future comprehensive Delta Plan and the preceding years activities. The Council then would determine whether it is consistent with the Delta Plan.

The Sacramento–San Joaquin Delta Reform Act of 2009 (Act) created the Council, disbanded the CBDA, and transferred CBDA's CALFED responsibilities to the Council. Additionally, the Council is charged with developing a Delta Plan. The Act also creates the Delta Conservancy, which is charged with implementing efforts that advance both environmental protection and the economic well-being of Delta residents. By 2012 the Conservancy board is to adopt a strategic plan that "shall be consistent with the Delta Plan,…the Suisun Marsh Preservation Act of 1977…, and the Habitat Management, Preservation and Restoration Plan for the Suisun Marsh."

Relationship to the Suisun Marsh Preservation Agreement

As described above, the SMPA is a contractual agreement among DFG, DWR, Reclamation, and SRCD intended to mitigate the salinity impacts in the Marsh related to SWP and CVP operations, and other upstream diversions. The SMPA was first signed in 1987 and since then has called for the development of many of the salinity control and monitoring facilities in the Marsh. In 2005, the SMPA was revised to replace the construction of additional large-scale salinity management facilities, as outlined in the 1984 Plan of Protection, with landowner-based management activities. As part of the revised SMPA, DWR and Reclamation would provide funding through the PAI Fund, which is an element of the SMP (described in detail in Chapter 2). Essentially, the PAI Fund is a mechanism that allows DWR and Reclamation to cost-share for certain managed wetland activities that assist landowners in meeting the desired flood and drain cycles to accommodate higher salinities applied to the managed wetlands and maintain existing habitat conditions.

The salinity management facilities and ongoing maintenance by landowners in the Marsh, including those that could be funded with the PAI Fund under the SMP, have been subject to Clean Water Act (CWA) Section 404 permitting through the Corps, and associated federal ESA compliance and consultation. As part of this 1981 ESA consultation with USFWS, the SMPA agencies have mitigated impacts for the implementation of the Plan of Protection and potential salt marsh harvest mouse habitat through the establishment of conservation and restoration areas, including the Blacklock parcel. In a letter sent to the SMPA agencies in 2007, the USFWS acknowledged that the completion of the restoration at Blacklock satisfied the goal of the original conservation measures for ongoing impacts on the salt marsh harvest mouse and also provided benefits to other tidal marsh–dependent species. Therefore, with completion of the Blacklock restoration project the total of 2,500 acres of Conservation Areas achieved the goal of preferred salt marsh harvest mouse habitat and mitigated the current ongoing impacts related to the managed wetland activities, including those that would be continued under the SMP (U.S. Fish and Wildlife Service 2007).

Relationship to the Regional General Permit 3

As described above, the SMPA agencies have been subject to CWA Section 404 permit requirements. Currently, many of the ongoing maintenance activities implemented in the Marsh are permitted through Corps 404 Regional General Permit (RGP) 3. RGP 3 is used by DFG and other landowners (as represented by SRCD) to complete work necessary to maintain and operate managed wetlands. The SMP includes the continuation of these activities, plus an increase in frequency of these activities. Additionally, the SMP includes activities that occur in the Marsh but were not included in RGP 3 (such as those activities currently conducted by DWR and Reclamation) and some activities that are new to the Marsh. These specific activities are described in Chapter 2, Table 2-5.

Relationship to the Bay-Delta Conservation Plan

The Bay-Delta Conservation Plan (BDCP) is a conservation plan being prepared to meet the requirements of the ESA, CESA, and the State of California's Natural Communities Conservation Planning Act (NCCPA). DWR (and potentially state and federal water contractors) intends to apply for ESA and CESA incidental take permits (ITP) for water operations and management activities in the Delta. These incidental take authorizations would allow the incidental take of threatened and endangered species resulting from covered activities and conservation measures that will be identified through the planning process, including those associated with water operations of the SWP as operated by DWR, and certain

Mirant Delta LLC (Mirant Delta) power plants. Additionally, if feasible, the BDCP will be used as the basis for ESA compliance by Reclamation, including compliance with Section 7 of ESA in coordination with USFWS and NMFS for operation of the CVP. Ultimately, the BDCP is intended to secure authorizations that would allow projects that restore and protect water supplies, water quality, and ecosystem health to proceed within a stable regulatory framework.

Although the geographic scope is more specific to Suisun Marsh, the SMP shares the BDCP objective of protection and restoration of habitat that supports many species covered by the BDCP. The BDCP covered activities include SWP and CVP facility operations. However, potential BDCP conservation actions are not confined to the legal Delta and specifically include Suisun Marsh for potential restoration actions. In addition, the two plans cannot be implemented as mutually exclusive activities. Suisun Marsh is inextricably linked to the greater Delta in terms of hydrodynamics, habitat continuity and quantity, and water quality. Current and future actions in Suisun Marsh have the potential to affect BDCP objectives. The reverse is also true.

The BDCP team tentatively has identified Suisun Marsh as having “high opportunity/low constraints” for such restoration relative to most other areas throughout the Delta. Attributes that suggest high opportunity include the fact that a great deal of planning, regulatory compliance, monitoring, and stakeholder collaboration has been performed pursuant to the SMP and this EIS/EIR. Availability of public lands (plus a general willingness of private landowners to participate) and multiple salinity gradients that can support habitat diversity and critical ecological processes also were identified as favorable attributes of Suisun Marsh.

Restoration and enhancement of terrestrial and riparian natural communities, enhancement and adaptive management of aquatic habitats, and other BDCP conservation objectives potentially can be leveraged to implement actions that also benefit Suisun Marsh. For example, restoration specified in the SMP potentially could benefit from a source of implementation funding. Such cost-sharing could be mutually beneficial to the SMP and BDCP objectives. Potential also exists to implement restoration beyond the SMP (using BDCP resources) should actions of such magnitude be deemed warranted by and agreeable to BDCP participants.

Relationship to the Regional Water Quality Control Board Delta Strategic Plan

The Delta Strategic Plan (DSP) is a workplan to direct staff of the State Water Board, Central Valley Regional Water Quality Control Board (RWQCB), and San Francisco Bay RWQCB of the actions the Water Boards will complete to protect beneficial uses of water in the Bay-Delta and provides timelines and resource needs for implementing the actions. Workplan activities cover a range of actions that: (1) implement the State Water Boards’ core water quality responsibilities; (2) continue meeting prior State Water Board commitments; (3) are responsive to priorities identified by the Governor and the Delta Vision Blue Ribbon Task Force; and (4) build on existing processes, such as the BDCP. Overall, the workplan identifies a range of actions that constitute a reasonable sharing of responsibility to protect the Bay-Delta and the public trust, while still protecting diverse public interests.

One of the workplan elements is to review and implement Suisun Marsh objectives and take other appropriate actions. This effort will be coordinated with development of the SMP as a means of leveraging its water quality control planning functions and to ensure that linkages with other water quality control planning efforts, including BDCP, will be identified and considered. Water supply and beneficial use protection will need to be balanced in water quality control planning and implementation, and therefore in development of the SMP.

The goal is to take actions within the State Water Board's scope to appropriately manage, preserve, and restore habitat in Suisun Marsh to protect the public trust, fish and wildlife, and other beneficial uses of water in the Marsh and the Bay-Delta. The objectives of this project are to: support an interagency effort to develop the SMP; determine what, if any, changes may be needed to the Bay-Delta Plan Suisun Marsh water quality objectives and their implementation to protect the public trust and fish and wildlife beneficial uses; regulate, manage, and study pollutants in the Marsh; address development around the Marsh to minimize impacts on beneficial uses; and encourage development of a watershed management plan for the entire watershed in Solano County that is tributary to the Marsh.

This project will be coordinated closely with the SMP planning process, BDCP, Delta Vision, CALFED, and other processes as appropriate.

Relationship to the San Francisco Bay Long-Term Management Strategy

The San Francisco Bay Long-Term Management Strategy (LTMS) is a plan to maximize the efficiency of disposing of materials dredged from the San Francisco Bay region. Its goal is to ensure that dredging occurs in areas necessary to maintain navigation and that dredged sediments are applied to a beneficial use, such as levee maintenance or tidal marsh restoration. Sediment contaminant testing and water quality monitoring guidelines are included. Additionally, it was intended to streamline the permitting process for such activities. Suisun Marsh is in the San Francisco Bay LTMS region.

Relationship to the Delta Risk Management Strategy

The Delta Risk Management Strategy (DRMS) evaluated the sustainability of the Delta and Suisun Marsh and assessed major risks to the Delta and Marsh resources from floods, seepage, subsidence, and earthquakes. The DRMS area included Suisun Marsh east of the Benicia-Martinez Bridge on Interstate 680 and the Delta (California Department of Water Resources 2008). DRMS also evaluated the consequences and developed recommendations to manage the risk. In addition, DRMS provided the majority of information needed to evaluate the potential impacts on water supplies derived from the Delta based on 50-, 100-, and 200-year projections for each of the following possible impacts: subsidence, earthquakes, floods, climate change, and sea level rise, or a combination of the above, as required under AB 1200 (California Water Code [CWC] Section 139.2 *et seq*.). The SMP EIS/EIR has considered elements of DRMS that pertain to the SMP.

San Francisco Bay Ecosystems Goals Project

The San Francisco Bay Ecosystem Goals Project (Goals Project) completed in 2000 was a 5-year collaborative effort sponsored by a group of agencies that included the U.S. Environmental Protection Agency (EPA), DFG, and the RWQCB, in addition to numerous other public and private entities. The Goals Project was developed as a way to implement the provisions of the San Francisco Estuary Project's 1993 Comprehensive Conservation and Management Plan (CCMP).

The purpose of the Goals Project was to provide guidance to public and private stakeholders interested in restoring and enhancing the wetlands and related habitats of the San Francisco Bay estuary system. It is an informational document that recommends the types, extent, and distribution of habitats needed to sustain diverse and healthy ecosystems in the San Francisco Bay estuary system. Recommendations are presented by region, subregion, and segment. Regionwide goals include restoration of large patches of tidal marsh connected by corridors to enable the movement of small mammals and marsh-dependent birds; restoration of large complexes of salt ponds for the management of shorebirds; and expansion of large areas of managed marsh. The SMP area is located within the Goals Project's Suisun Marsh east and the Suisun Marsh west subregions. The Draft Report of the Subtidal Habitat Goals Project was released in June 2010 and the Final Report is due out in November 2010.

Goals Project recommendations specific to Suisun Marsh are listed below.

- An overall goal for this subregion is to restore tidal marsh on the northern and southern sides of Suisun Bay, Grizzly Bay, and Honker Bay and to restore and enhance managed marsh, riparian forest, grassland, and other habitats (Goals Project 1999: 94).
- A continuous band of restored tidal marsh, from the confluence of Montezuma Slough and the Sacramento/San Joaquin Rivers to the Marsh's western edge, should extend in an arc around the northern edge of the Marsh and should blend naturally with the adjacent grasslands to provide maximum diversity of the upland ecotone, especially for plant communities (Goals Project 1999: 94).

- A broad band of tidal marsh also should be restored along the southern edge of Suisun Marsh and around Honker Bay, in large part to improve fish habitat (Goals Project 1999: 94).
- On the majority of lands within Suisun Marsh, the longstanding practice of managing diked wetlands primarily for waterfowl should continue; these brackish marshes should be enhanced, through protective management practices, to increase their waterfowl carrying capacity (Goals Project 1999: 96).
- On the periphery of the Marsh, moist grasslands with vernal pools should be enhanced, as should riparian vegetation along the tributary streams (Goals Project 1999: 96).
- Between 17,000 and 22,000 acres of tidal marsh should be restored and 32,000 to 37,000 acres of diked, managed wetlands should be maintained (Goals Project 1999: 96).

Relationship to National Marine Fisheries Service and U.S. Fish and Wildlife Service Recovery Plans

NMFS and USFWS have written various recovery plans for threatened and endangered fish, birds, and mammals and for special habitat, such as vernal pool. The goals of all of the recovery plans are for habitat protection and increased numbers of special-status species so they can be delisted.

NMFS is responsible for anadromous fish and has written various recovery plans for threatened and endangered fish. NMFS has released a draft recovery plan (2009) for Chinook salmon (spring- and winter-run) and Central Valley steelhead. The plan states that successful recovery of these species includes increased abundance, increased population growth rate, increased population spatial structure, and greater genetic/life history diversity (National Marine Fisheries Service 2009). Two of the recovery plan goals are to:

- address threats to habitat quality and quantity; and
- provide sufficient habitat (type, amount, and quality) for long-term population maintenance.

A central California coast steelhead recovery plan and a green sturgeon recovery plan also are being written, but the publication dates are unknown.

USFWS has recovery plans for Delta fish species, salt marsh harvest mouse, California clapper rail, California least tern, tidal marshes, and vernal pools. These plans all call for recovery and delisting of special-status species.

The Recovery Plan for the Sacramento–San Joaquin Delta fishes (U.S. Fish and Wildlife Service 1996) covers all native fish species present in Suisun Marsh, such as delta smelt, green sturgeon, longfin smelt, Sacramento splittail, and all runs of Chinook salmon. The recovery objective is to delist delta smelt and restore populations of other fish species. Actions required to increase numbers of fish include enhancing and restoring aquatic and wetland habitat in the Sacramento–San Joaquin River estuary. The Recovery Plan focuses on Suisun Bay and Suisun Marsh as habitat for delta smelt, longfin smelt, green sturgeon, and Sacramento splittail.

The recovery plan for salt marsh harvest mouse and California clapper rail (U.S. Fish and Wildlife Service 1984) is currently being updated. The Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California, which will replace the existing recovery plan, emphasizes reestablishment of diverse wetland habitats within the Bay-Delta region, including the range of habitats that would have persisted under natural conditions (U.S. Fish and Wildlife Service 2010).

Part of the recovery plan includes protecting and enhancing existing marsh habitat, restoring former habitat to tidal wetlands, and conducting additional research on habitat requirements and population trends, which includes areas in Suisun Marsh—Joice Island North, Joice Island South, and Suisun Slough North. Another part of the recovery plan is to protect essential mouse and rail habitat in Suisun Marsh, including: identifying areas of essential mouse and rail habitat; securing and managing essential mouse and rail habitat; and developing and implementing management plans for salt marsh harvest mouse and California clapper rail habitat in Suisun Marsh.

The California least tern recovery plan also calls for complete recovery of the species so it can be taken off the endangered list. Actions for recovery include preserving and managing nesting areas of existing colonies, developing and implementing least tern management plans/programs in existing use areas, and preserving and managing nesting areas for currently insecure colonies. At the time the recovery plan was written, no colonies were found in Suisun Marsh, so the plan area is not identified in the recovery plan. However, surveys conducted in 2006 identified a nesting colony on a sandy dredge disposal island in Montezuma Wetlands (Marschalek 2007).

The vernal pool recovery plan promotes natural ecosystem processes and functions by protecting and conserving intact vernal pools and vernal pool complexes within the recovery planning area to maintain viable populations of listed species and species of concern and prevent additional threats from emerging over time. Contra Costa goldfields and alkali milk vetch have been identified in Suisun Marsh (U.S. Fish and Wildlife Service 2005). Detailed information regarding vernal pool habitat is discussed in Section 6.2, Vegetation and Wetlands.

Relationship to Central Valley Habitat Joint Venture 2006 Management Plan

The Central Valley Joint Venture (CVJV) is one of 17 Joint Venture partnerships in the United States, established under the North American Waterfowl Management Plan and funded under the annual Interior Appropriations Act. The CVJV brings together conservation organizations, public agencies, private landowners, and other partners interested in the conservation of bird habitat in California's Central Valley.

The Suisun Marsh is one of nine wetland basins addressed in the 2006 Central Valley Habitat Joint Ventures 2006 Implementation Plan. The plan included specific conservation measures to ensure adequate habitat characteristics and acreages to support the plan's goals for resident and wintering waterfowl, shorebirds, and other waterbirds in the Suisun Marsh. These measures include annual enhancement of 2,686 acres/year of existing seasonal wetlands. The SMP, through managed wetland activities, would contribute to this enhancement.

Scoping and Issues of Known Controversy

Scoping meetings were held November 25, 2003, at the Solano County Mosquito Abatement District in Fairfield, California; December 4, 2003, in the Dona Benicia room of the Benicia Public Library in Benicia, California; and December 10, 2003, in the Peña Adobe Room of the Solano County Office of Education in Fairfield, California.

NEPA requires that project proponents identify issues of known controversy that have been raised in the scoping process and throughout the development of the SMP. Reclamation, USFWS, DFG, and other Principal Agencies considered these concerns in the development of the SMP. All significant environmental impacts resulting from constructing and operating the SMP will be mitigated to a less-than-significant level. The following sections outline those issues that have been identified by agencies and the public relative to the SMP and each of these issues is addressed in this EIS/EIR.

Ecological Processes

Concerns have been raised about the potential goals of the SMP's proposed tidal marsh restoration and the potential economic costs of these restoration activities. Specifically, there are concerns about the potential final conditions of restored tidal marshes, the level of effort necessary to achieve these restored conditions, and whether the planning process ensures that ecological/habitat conditions are being improved. In addition, the public requested that the potential effects of sea level rise on each of the SMP's alternatives be addressed.

The economic costs of the SMP's alternatives, including the tidal marsh restoration component of these alternatives, are addressed in Section 7.3, Social and Economic Conditions, of this document. Effects of global warming, including a potential rise in sea levels, on the SMP's project components and goals are addressed in Section 5.9, Climate Change.

Property Acquisition

Concerns about property acquisition during implementation of the SMP have been expressed. As described in Chapter 2, the SMP will not include the acquisition of properties from unwilling sellers. Instead, implementing agencies would purchase land only from willing sellers whose land is considered appropriate for tidal restoration or other actions described in the plan. The SMP is a 30-year plan that is not intended to forcefully change the land use in the Marsh, but rather modify the dynamics of the marsh habitat over time.

Changes in Habitats and Land Uses

There is a concern about how changes in land uses would affect habitats in the Marsh. Issues include the regulation and maintenance of fish screens, salt marsh harvest mouse populations and restoration, and the tidal marsh habitat restoration efforts and subsequent effects, including those on adjacent landowners in the Marsh. Overall, the SMP is intended to balance the benefits of tidal wetland restoration with other habitat uses in the Marsh by evaluating alternatives that provide for a politically acceptable change in Marsh-wide land uses, such as salt marsh harvest mouse habitat, managed wetlands, public use, and upland habitat. The multiple uses of the Marsh are all being considered as an important part of the plan, as demonstrated by the four equal purposes/objectives. A key component of the SMP is the implementation of managed wetland activities. The implementing agencies are committed, as described throughout this EIS/EIR, to ensuring that as managed wetland is converted to tidal wetland, remaining managed wetlands are enhanced.

Maintenance of Managed Wetland Functions

Many landowners in the Marsh voiced concern that restoration actions could affect their ability to manage their clubs to maintain current levels of hunting opportunities. Landowner concerns include loss of waterfowl habitat, reducing wintering waterfowl numbers in the Marsh, redistribution of waterfowl occurrence, impacts of increased salinity from tidal restoration and a reduction in managed wetlands diversity, wetlands seed production, and the decreased life expectancy of managed wetlands infrastructure. As such, this could result in an increased cost of maintenance. Additionally, there are concerns about the potential impacts on adjacent managed wetlands from muted tide stage from tidal restoration resulting in decreased managed wetland drainage capacity. Each of these potential impacts is addressed in this EIS/EIR.

Levee System Integrity

There are concerns about the levee system integrity in the Marsh, given the existing and potential restrictions on levee maintenance activities, funding shortages, and potential changes in levee uses (e.g., levee function changes from an interior levee to an exterior levee) as a result of the SMP. It was suggested that dredging is a critical activity for the maintenance of levees and overall habitat quality. Permitting delays affect the ability of property owners to implement necessary levee maintenance activities in a timely manner. Parties responsible for the costs associated with levee maintenance should be identified and supported through a levee management emergency fund. Riprap was suggested as an effective way to protect levees from the erosion resulting from boat traffic. A component of the SMP is to provide levee system integrity as integral to the continuation of managed wetlands and the success of created tidal wetlands.

Nonnative Species

The public recommended that the eradication of nonnative species, such as *Lepidium*, *Phragmites*, and feral pigs, should be addressed in the SMP EIS/EIR. Other concerns were related to the SMP's ability to prevent the establishment of new nonnative species and to reduce the impact of established nonnative species. Another concern was to protect existing special-status species from harmful chemicals and other methods of weed control to reduce nonnative vegetation abundance. Acceptable methods to control nonnative species should be discussed and should include the burning of invasive plant species. Monitoring should be implemented to ensure these actions are benefiting the Marsh as a whole.

Water and Sediment Quality

Property owners adjacent to the Marsh have expressed concerns about the existing water quality conditions in the Marsh and the water quality effects of the SMP. The poor water quality of some small dead-end sloughs is referred to as *black water* and is a serious concern that needs to be addressed. Air quality issues associated with the poor water quality in these sloughs were also a concern. Questions were raised on the potential water quality effects of tidal restoration, levee removal, and water supply activities, such as Delta export pumping or increased freshwater inputs to the Marsh. It is believed that tidal restoration, with an eventual increase in flows resulting from tidal action, will help address at least some of these water quality concerns.

Public Use and Waterfowl Hunting

Local development surrounding and upstream of the Marsh was a primary concern of Marsh property owners. Urban runoff from these developments is believed to result in the transport of pollutants, such as oil/grease, fertilizers, and sediments, to the Marsh. Specific developments that were of particular concern were the Potrero Hills landfill and the proposed Benicia Intermodal Transportation Station.

Subsequent potential effects of implementation of the SMP on existing landowners and public use and access in the Marsh were also concerns. Marsh property owners questioned whether they would be required to sell their lands against their will. Upland game hunting, recreational fishing, mitigation of impacts on hunting/fishing/waterfowl habitat, and public access to private lands under mandate were additional issues raised during scoping.

Long-Term Funding, Plan Implementation, and Regulatory Reliability and Efficiency

Conflicts, a lack of cooperation, and other delays by regulatory agencies involved in the Marsh are a concern for landowners in the Marsh. The role of each agency and number of agencies involved in the management of the Marsh and activities therein (as proposed in the SMP and historically) are not well known by Marsh landowners and should be explained in the EIS/EIR. It was suggested that the SMP define the circumstances under which regulatory gridlock would constitute a regulatory taking of private land. The implications of the SMP implementation and/or increased agency involvement on private landowners in the Marsh should be addressed. It also was recommended that certain existing regulatory restrictions concerning California clapper rail protection and dredging be reevaluated. In addition, it was requested that Solano County and the City of Fairfield be involved in the SMP implementation process.

Consensus among regulatory agencies and landowners and funding for landowners are seen as critical elements to effectively implementing the SMP. It was recommended that to support the many public benefits derived from the private and public lands of the Marsh, mandated actions must be affordable to landowners and should be funded by the public. The public recommended that the SMP not impose additional restrictions on landowners or lengthen the amount of time required for landowners to obtain a permit for levee repair activities. It was suggested that restrictions regarding pumping, flooding, and draining Marsh areas be reevaluated to consider the freshwater supply needs of landowners.

Organization of This Document

This EIS/EIR is organized in the following chapters:

- Chapter 1, “Introduction”—This chapter introduces the Principal Agencies, CEQA and NEPA lead agencies, describes the purpose of and need for the plan, and presents background information needed to understand the plan purpose and need.
- Chapter 2, “Habitat Management, Preservation, and Restoration Plan”—This chapter presents a description of the plan elements, a summary of the alternatives screening process, and plan alternatives evaluated in this EIS/EIR.
- Chapter 3, “Overview of Impact Analysis Approach”—This chapter describes the various methods used in this EIS/EIR to assess environmental impacts as a result of the alternatives.
- Chapter 4, “Summary Comparison of Environmental Consequences”—This chapter summarizes the environmental impacts arising from each alternative and presents a comprehensive view of their similarities and differences.
- Chapter 5, “Physical Environment”—This chapter describes the affected environments and impacts of each alternative on water supply, hydrology, and Delta water management; water quality; geology, seismicity, and soils; flood control and levee stability; sediment transport; groundwater resources; transportation and navigation; air quality; noise; and climate change.
- Chapter 6, “Biological Environment”—This chapter describes the affected environment and impacts on fisheries, vegetation and wetlands, and wildlife as a result of the proposed alternatives.
- Chapter 7, “Land and Water Use, Social Issues, and Economics”—This chapter describes the affected environments and impacts on land and water use; social issues and economics; utilities and public services; recreation resources; power production and energy; visual and aesthetic resources; cultural resources; public health and environmental hazards; environmental justice; and Indian Trust Assets as a result of each alternative.
- Chapter 8, “Compliance with Applicable Laws, Policies, Plans, and Regulatory Framework”—This chapter lists and describes the regulations and constraints affecting the proposed plan.
- Chapter 9, “Growth-Inducing Impacts”—This chapter describes the potential for the plan and its alternatives to promote growth in the Suisun Marsh region and throughout California.
- Chapter 10, “Cumulative Impacts”—This chapter discusses potential and existing projects that, together with the SMP, may compound the impact on similar resources.
- Chapter 11, “Public and Agency Involvement”—This chapter describes the participation of the public and state, federal, and local agencies in

determining the alternatives issues that needed to be addressed in this EIS/EIR.

- Chapter 12, “List of Preparers”—This chapter lists the contributors to this document, including those who wrote and reviewed sections and composed graphics.
- Chapter 13, “References”—This chapter contains references for the information cited in this EIS/EIR.
- Chapter 14, “Response to Comments”—This chapter contains the public comments received on the draft EIS/EIR and responses to those comments.

Chapter 2
Habitat Management, Preservation, and Restoration Plan

Introduction

The Suisun Marsh Principal Agencies have agreed to jointly prepare the SMP to protect and enhance Suisun Marsh and existing managed wetland values, tidal habitats, endangered species, water quality, and levee integrity in Suisun Marsh. Overall, the SMP is intended to meet the purposes/objectives of and need for the plan as described in Chapter 1 and is consistent with CALFED, SMPA, applicable species recovery plans, and other interagency goals. As described in Chapter 1, Reclamation, USFWS, and DFG have agreed to act jointly as the NEPA and CEQA lead agencies, and Principal Agencies and other agencies also may use this document to comply with CEQA and/or NEPA as they implement specific restoration and managed wetland activities in the Marsh. Additionally, the SMP may offer guidance to other programs such as the BDCP by providing a framework for restoration or other activities in the Marsh.

Several regulations, as described in Chapter 1, are in place to protect water quality, fish, terrestrial animals and plants, and other important resources. The SMP would not conflict with these regulations.

Overview of Plan Elements

The SMP is a comprehensive plan designed to address the various conflicts regarding use of Marsh resources, with the focus on achieving an acceptable multi-stakeholder approach to the restoration of tidal wetlands and the management of managed wetlands and their functions. The SMP addresses habitats and ecological process, public and private land use, levee system integrity, and water quality through restoration and managed wetland activities. The plan is intended to guide near-term and future actions related to restoration of tidal wetlands and managed wetland activities. Specific actions that would be implemented in the near term under the SMP include revising the SMPA to implement the PAI Fund and implementation of increased frequency of current and new managed wetland activities.

California Environmental Quality Act/ National Environmental Policy Act Requirements

CEQA and NEPA require consideration of a range of alternatives to a proposed project that would attain most of the basic project objectives, while avoiding or substantially lessening project impacts, and fulfill the project purpose and need. A range of reasonable alternatives is analyzed to sharply define the issues and provide a clear basis for choice among the options. The CEQA/NEPA analysis also must include an analysis of the no project or no action alternative.

CEQA requires that the lead agency consider alternatives that would avoid or reduce one or more of the significant impacts identified for the project in an EIR. The State CEQA Guidelines state that the range of alternatives required to be evaluated in an EIR is governed by the "rule of reason"; the EIR needs to describe and evaluate only those alternatives necessary to permit a reasonable choice and to foster informed decision-making and informed public participation (Section 15126.6[f]). Consideration of alternatives focuses on those that can either eliminate significant adverse environmental impacts or reduce them to less-than-significant levels; alternatives considered in this context may include those that are more costly and those that could impede to some degree the attainment of all the project objectives (Section 15126.6[b]). CEQA does not require the alternatives to be evaluated in the same level of detail as the proposed project.

CEQ regulations for implementing NEPA (40 CFR 1502.14) require all reasonable alternatives to be evaluated objectively in an EIS, so that each alternative is evaluated at an equal level of detail. Alternatives that cannot reasonably meet the purpose and need do not require detailed analysis. An EIS must briefly describe alternatives to the proposed action where unresolved resource conflicts exist. NEPA does not require alternatives to offer some environmental benefit over the proposed action; however, neither does it discourage consideration of alternatives with lesser effects. NEPA requires that alternatives be evaluated at a comparable level of detail (40 CFR 1502.14[b]).

Terminology Used in This Document

NEPA and CEQA are similar in that both laws require the preparation of an environmental study to evaluate the environmental effects of proposed governmental activities. However, there are several differences between the two regarding terminology, procedures, environmental document content, and substantive mandates to protect the environment. For this environmental evaluation, the more rigorous of the two laws was applied in cases in which NEPA and CEQA differ. Additional detail regarding these differences is provided in Chapter 3.

Many concepts are common to NEPA and CEQA; however, the laws sometimes use differing terminology for these common concepts. Table 2-1 below compares the terminology of NEPA and CEQA. For this EIS/EIR, the terms used will be defined as necessary throughout the document.

Table 2-1. NEPA/CEQA Terminology

NEPA Term	Correlating CEQA Term
Lead Agency	Lead Agency
Cooperating Agency	Responsible Agency
Environmental Impact Statement	Environmental Impact Report
Record of Decision	Findings
Preferred Alternative	Proposed Project
Project Purpose	Project Objectives
No Action Alternative	No Project Alternative
Affected Environment	Environmental Setting

Alternatives Development Process

The restoration and enhancement goals of the ERPP called for 5,000 to 7,000 acres of tidal restoration and protection, and enhancement of 44,000 to 46,000 acres of managed wetlands in the Marsh. The SMP alternatives development process was founded on the basic assumption that the SMP would assist in meeting this CALFED objective. The mechanisms to accomplish this objective were the subject of much of the alternatives development process. During the scoping process, the Principal Agencies developed general goals to help the public identify potential actions that could be included in the plan.

- **Goal 1: Ecological Processes**—Rehabilitate natural processes where feasible in Suisun Marsh to support more fully, with minimal human intervention, natural aquatic and associated terrestrial biotic communities and habitats, in ways that favor native species of those communities, with a particular interest in waterfowl and sensitive species.
- **Goal 2: Habitats**—Protect, restore, and enhance habitat types where feasible in Suisun Marsh for ecological and public values, such as supporting species and biotic communities, ecological processes, recreation, scientific research, and aesthetics.
- **Goal 3: Levee System Integrity**—Provide long-term protection for multiple Suisun Marsh resources by maintaining and improving the integrity of the Suisun Marsh levee system.

- **Goal 4: Nonnative Invasive Species**—Prevent the establishment of additional nonnative species and reduce the negative ecological and economic impact of established nonnative species in Suisun Marsh.
- **Goal 5: Water and Sediment Quality**—Improve and/or maintain water and sediment quality conditions to provide good water quality for all beneficial uses and fully support healthy and diverse aquatic ecosystems in Suisun Marsh and eliminate, to the extent possible, toxic impacts on aquatic organisms, wildlife, and people.
- **Goal 6: Public Use/Waterfowl Hunting**—Maintain the heritage of waterfowl hunting and increase the surrounding communities' awareness of the ecological values of Suisun Marsh.
- **Goal 7: Long-Term Funding, Plan Implementation, Regulatory Feasibility, and Efficiency**—Develop and implement a plan that: (1) addresses long-term funding; (2) creates an efficient and reliable regulatory climate; (3) promotes effective management practices; and (4) improves coordination of activities among agencies with interests in and/or adjacent to Suisun Marsh.

These goals then were refined into the following plan purposes/objectives, which together are consistent with restoration and enhancement goals of the ERPP relative to the Marsh:

- Habitats and Ecological Processes
- Public and Private Land Use
- Levee System Integrity
- Water Quality

These purposes/objectives are described in detail in Chapter 1.

Next, several documents were reviewed for potential design and implementation actions to include in the SMP. These documents included:

- Suisun Marsh Protection Plan (San Francisco Bay Conservation and Development Commission 1976)
- Baylands Ecosystem Habitat Goals Report (GOALS Report) (Goals Project 1999)
- CALFED ROD (CALFED Bay-Delta Program 2000a)
- CALFED ERP Documents (CALFED Bay-Delta Program 2000c)
- Implementation Strategy of the San Francisco Bay Joint Venture (San Francisco Bay Habitat Joint Venture 2008)
- Central Valley Joint Venture Plan (Central Valley Joint Venture 2006)
- Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan (U.S. Fish and Wildlife Service 1984)

- North American Waterfowl Management Plan (U.S. Fish and Wildlife Service 1986)
- Restoration Plan for the Anadromous Fish Restoration Program, January 2001 (U.S. Fish and Wildlife Service 2001)
- Restoration Plan for the Sacramento/San Joaquin Native Fishes, November 1996 (U.S. Fish and Wildlife Service 1996b)
- Suisun Ecological Workgroup Report (Suisun Ecological Workgroup 2001)
- Suisun Marsh Preservation Agreement and Revised Suisun Marsh Preservation Agreement (Suisun Marsh Preservation Agreement 1987, 2005)
- Solano County General Plan (Solano County 2008)
- Solano Multispecies Habitat Conservation Plan (HCP) (Solano County Water Agency 2009)
- Solano County Mosquito Prevention Criteria (Solano County Mosquito Abatement District 1978)
- Solano County Policies and Regulations Governing Suisun Marsh (Solano County 1982)
- Suisun Marsh Management Plans (Suisun Resource Conservation District 2009)
- Recovery Plan for Vernal Pool Ecosystems of California and Oregon (U.S. Fish and Wildlife Service 2005, 2008)
- Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California (U.S. Fish and Wildlife Service 2010)
- California Least Tern Breeding Survey, 2006 Season (Marschalek 2007).

Based on these documents, a restoration approach was developed that is analyzed in this EIS/EIR for the restoration element. This restoration element is described below and is intended to contribute to meeting each of the project purposes/objectives.

Several ranges of restoration acreage for the SMP were considered during the screening process, ranging from none up to 35,000 acres restored in the Marsh. Three alternatives of differing restoration ranges, including the Proposed Project/Preferred Alternative, have been carried forward for detailed evaluation in this EIS/EIR. The amount of restoration included in the Proposed Project/Preferred Alternative was based on the CALFED ERPP restoration target for the Suisun Marsh ecoregion, which identified a tidal wetland restoration goal of 5,000 to 7,000 acres and a managed wetland protection and enhancement goal of 44,000 to 46,000 acres. The acreage ranges of tidal restoration per region were based on the draft Tidal Marsh Recovery Plan (U.S. Fish and Wildlife Service 2010). Additional alternatives were developed and screened based on other plans and documents that address restoration in the Marsh. Although some of these other plans such as the GOALS Report recommend restoration of up to 35,000 acres, restoration of more than 9,000 acres was determined to result in the inability of the plan to meet the water quality, land use, and some habitat purposes/objectives of the SMP. With more than 9,000 acres restored over the 30-year plan, it was determined based on modeling that salinity at the south Delta export facilities would be substantially affected, the plan would be unacceptable to landowners, and it would be more difficult to maintain duck populations necessary for heritage hunting in the Marsh and protect species, such as the millions of migratory birds that depend on the managed wetland habitats. Similarly, restoration of fewer than 2,000 acres was not expected to meet any of the plan objectives because without substantial restoration, improvements in tidal wetland habitats and water quality would not occur, and managed wetland operations may be difficult to permit. Therefore, three alternatives encompassing a range of 2,000 to 9,000 acres of restored tidal wetlands are evaluated in this EIS/EIR, including the Proposed Project/Preferred Alternative of 5,000 to 7,000 acres.

To develop the management activities component of the SMP, the Principals evaluated the current activities conducted in the Marsh, how they are conducted, their effectiveness, and what additional activities would be needed to meet the SMP objectives. It was determined that for the most part, the current suite of activities is sufficient to meet the SMP objectives, but that frequency of these activities would need to be increased to meet the purpose/objective for managed wetland enhancement. Additionally, SRCD identified the need for a comprehensive dredging program to provide source material for exterior levee maintenance on managed wetlands, as well as other activities that have been implemented in the Marsh but were not a component of the current management regime. Working with the Principal Agencies and other regulatory agencies, SRCD developed a preferred dredging program based on the Proposed Project restoration component that minimizes the effects of dredging on habitats and species. This dredging program, along with the increased frequency of current activities, was grouped with the proposed restoration alternative. As such, the alternatives evaluated in the SMP include both a restoration and a management activities component with varying degrees of restoration and dredging.

Each alternative also may contribute to the achievement of goals outside the scope of the SMP (e.g., GOALS Report, USFWS and NMFS Recovery Plans, BDCP), and the selection of any alternative does not preclude future tidal wetlands restoration projects beyond the acreage evaluated in the SMP. There are 52,112 acres available that could be affected by tidal wetland restoration and managed wetland activities. For each action alternative, as tidal wetland restoration increases, the acreage subject to managed wetland activities decreases, unless existing upland areas can be purchased from willing sellers and restored to wetlands. Similarly, if the alternative has less tidal restoration, opportunities for managed wetland activities increase. Additionally, Principal Agencies and other agencies may implement restoration and managed wetland activities beyond what is described in this SMP.

Identification of a Proposed Project/ Preferred Alternative

CEQA's directives are written with the premise that the lead agency is reacting to a proposal or request for a discretionary action and conducting an environmental review of a "proposed project" (see for example, State CEQA Guidelines Sections 15124(a), (b); 15126(a); 15126.2(a); and 15126.6). Therefore, compliance with CEQA, in preparing an EIR, typically relates to analysis of the proposed project and alternatives (based on the proposed project's objectives). NEPA directs that the lead agency's environmental analysis in an EIS evaluate all reasonable alternatives (see 40 CFR 1502.14). NEPA also is written with the premise that there can be a "proposed action" if there is a non-federal applicant (see 40 CFR 1502.14[b]) and requires that lead agencies identify the preferred alternative if one exists at the time of the Draft EIS.

Alternative A was indentified in the Draft EIS/EIR as the Proposed Project/Preferred Alternative, from here on referred to as the Proposed Project, because of its consistency with restoration and enhancement goals of the ERPP, its ability to contribute to recovery of listed species, and acceptability by landowners in the Marsh. Details of Alternative A: Proposed Project, and alternatives are provided below.

Review of Project Alternatives

As described above, three alternatives, including the Proposed Project, were carried forward for evaluation in this EIS/EIR in addition to the No Action Alternative. The following section describes the differences in the action alternatives. The actions needed to accomplish the restoration and enhancement acreage targets are the same for each of the alternatives and are described below. As such, the difference between the Proposed Project and alternatives is the number of acres restored and enhanced. Table 2-2 summarizes these differences.

Alternative A: Proposed Project

Alternative A: Proposed Project includes the following components relative to tidal wetland restoration and managed wetland activities:

- restoring 5,000 to 7,000 acres in the Marsh to fully functioning, self-sustaining tidal wetland and protecting and enhancing existing tidal wetland acreage; and
- enhancing the remaining 44,000 to 46,000 acres of managed wetlands levee stability and flood and drain capabilities.

Alternative B

Alternative B would restore less tidal wetland than Alternative A and includes the following actions:

- restoring 2,000 to 4,000 acres of marsh to fully functioning, self-sustaining tidal wetlands and protecting and enhancing existing tidal wetland acreage; and
- enhancing the remaining 46,000 to 48,000 acres of managed wetlands levee stability and flood and drain capabilities.

Alternative C

Alternative C would restore more tidal wetland than Alternative A and includes the following actions:

- restoring 7,000 to 9,000 acres of the Marsh to fully functioning, self-sustaining tidal wetlands and protecting and enhancing existing tidal wetlands acreage; and
- enhancing the remaining 42,000 to 44,000 acres of managed wetlands levee stability and flood and drain capabilities.

Table 2-2. Differences in Amount of Tidal Wetlands Restored and Remaining Acres Subject to Managed Wetland Activities among the Alternatives (in acres)

Alternative	Tidal Restoration Target (acres)	Managed Wetlands Subject to Managed Wetland Activities (acres)
No Action Alternative	700	52,112
Alternative A, Proposed Project	5,000–7,000	44,000–46,000
Alternative B	2,000–4,000	46,000–48,000
Alternative C	7,000–9,000	42,000–44,000

No Action Alternative

A no action alternative is required pursuant to NEPA, and a no project alternative is required for CEQA. For the SMP, it will be referred to as the No Action Alternative. The No Action Alternative is described relative to each of the project purposes/objectives. The No Action Alternative is what is assumed to be the conditions should the SMP not be implemented.

Habitats and Ecological Processes

Under the No Action Alternative, the amount of restoration in the Marsh likely would be limited. Although the CALFED ERPP calls for tidal wetland restoration in the Marsh and other current planning efforts include restoration in the Marsh, it is not certain that substantial additional restoration would occur under the No Action Alternative. Implementation of tidal marsh restoration may be accomplished through other programs, such as through CALFED Proposition 204 or BDCP, or through mitigation obligations. There is a wide range of potential outcomes in the Marsh and there are currently no adopted plans for restoration. The potential for other plans to be implemented is outside the scope of the No Action description and analysis (although these plans are evaluated as part of the cumulative analysis). As such, the amount of restoration assumed to occur in the Marsh absent the SMP reflects conditions without a comprehensive restoration plan and provides a point of comparison for the SMP decision-makers and the public. Proposition 204 has funded approximately $1 million to acquire properties in the western and northern Marsh, with exact properties determined by willing sellers. Approximately 250 to 500 acres could be purchased, with the ultimate goal of restoration (although funding is not included for restoration). Additionally, DFG owns Hill Slough West, which is approximately 200 acres and would be restored with or without the SMP. Therefore, it is assumed for purposes of this No Action evaluation, approximately 700 acres could be restored absent the SMP. Additionally, any levee breaches that occur in inaccessible areas may not be repaired, and passive restoration would occur in those areas. Additional restoration would be difficult to achieve because of the absence of a framework to protect existing managed wetlands.

Habitat types and values for sensitive species, including Multi-Species Conservation Strategy (MSCS) species, could change substantially if operations and maintenance of managed wetlands are limited as a result of permitting difficulties. This would result in substantially reduced flood and drain operations, waterfowl habitat, hunting opportunities, and activities to maintain levees, resulting in an increased risk of levee failure. If some landowners in the Marsh were able to secure individual permits, diversion restrictions would continue to be enforced, and programs to encourage landowners to manage properties to protect habitat values for listed species would continue to be implemented. Additionally, programs to control managed wetland vegetation would continue. Installation of new water diversions would continue to be minimized, and fish screens would continue to be installed on existing diversions where feasible. Existing programs to control nonnative species and protect sensitive wetlands from the adverse effects of grazing would continue to be implemented. The extent to which regulatory mechanisms would limit managed wetland operations and maintenance is speculative, but it is assumed that absent the SMP, there would be substantial changes in management of the Marsh.

Additionally, without the SMP, including the CEQA and NEPA compliance for managed wetland activities and the PAI Fund (described below under the Action Alternatives), the impacts on landowners as a result of CVP and SWP operations would be only partially mitigated and would result in delayed implementation of actions to provide equivalent or better protection of Suisun Marsh resources and would likely require the reopening of negotiations among the SMPA agencies. Existing DWR/Reclamation mitigation facilities and salinity stations would be repaired and maintained, but at a much slower rate due to obtaining permits, completing project specific CEQA/NEPA review, and compliance with mitigation measures imposed as a result.

Given the difficulty in securing permits to dredge and with continued difficulties in importing materials for levee repair, combined with a lack of a reliable funding source for levee repairs, it is likely that the No Action Alternative would result in degradation of managed wetland habitat. This degradation would result from the continued use of materials taken from within managed wetland areas to maintain levees, which would reduce drainage efficiencies and increase subsidence. Additionally, absent the SMP or other levee programs in Suisun Marsh, it is possible that naturally breached levees would not be repaired, resulting in a loss of managed wetland habitat. This loss of managed wetlands would result in an increase in tidal wetland habitat and local, and potentially regional, changes in salinity that may adversely affect drinking water quality, depending on the extent and location of the loss. However, because of the subsided conditions of many of the managed wetland properties in the Marsh, natural breaching may result in a majority of shallow-water or subtidal habitat, with limited tidal wetland areas around the edges of the flooded area.

Public and Private Land Use

Under the No Action Alternative, public and private land use, especially hunting, could be negatively affected if mechanisms for levee maintenance and flood and drain operations for managed wetlands are not improved, as described above. Additionally, natural breaches may lead to increased navigable waters, which would increase the area available to the public for recreational use. However, there would be no changes in types of recreational activities available, and there would be no deliberate expansion of opportunities such as hunting, fishing, and bird watching available in the Marsh.

Levee System Integrity

Under the No Action Alternative, levee system integrity throughout the Marsh likely would decrease. Currently, there is no reliable mechanism or funding for obtaining and using materials to maintain levees. It is expected that the current dredging restriction in the Marsh would remain in place, and minimal, if any, dredging would occur because of the difficulty in obtaining permits for dredging in tidal sloughs. Other means for obtaining materials (pond-bottom scraping) may not be permitted absent the SMP. Riprap and alternative bank protection measures would continue to be implemented, if permitted. However, in the event of a levee failure, it is not certain that levees would be repaired. Sea level rise and climate change–induced storm intensity and frequency would increase pressures on the levee system.

Water Quality

Under the No Action Alternative, water management for maintaining the channel salinity within the Marsh to meet existing WQCP salinity objectives would continue, including regulation of Delta outflow and operation of the SMSCG. Natural, uncontrolled levee breaches could occur and, if not repaired, could result in changes in salinity regimes in the Marsh, and potentially the Delta, depending on the extent and location of the breaches. Delayed maintenance of existing DWR/Reclamation facilities and salinity stations due to obtaining environmental clearance for such work could increase the risk of facilities functioning properly, resulting in inadequate water quality being provided to wetland habitats. Resource managers and regulators may need to adapt to the changes by implementing different management practices and regulatory actions (e.g., the State Water Board could modify water quality standards), although some uncontrolled breaches may result in unmanageable salinity changes.

Under the No Action Alternative, the annual discharge of seasonally high levels of biochemical oxygen demand (BOD) with reduced DO concentrations, and somewhat higher methylmercury in some channels and sloughs would improve because of restrictions on managed wetland operations resulting from permitting difficulty that could restrict flood and drain operations. Additionally, if natural levee breaches restore tidal action to managed wetlands, there could be a reduced extent of managed wetland areas contributing to the BOD/DO depletion problem, which also could result in improved water quality within tidal waterways in Suisun. Total methylmercury loadings to the environment also may decrease, to the extent that the restored tidal areas produce less methylmercury.

The effects of the No Action Alternative on fish, wildlife, recreational opportunities, levee stability, water quality, and other important resources are discussed later in this EIS/EIR in the analysis of specific resource areas.

Proposed Project and Alternatives

As described above, all action alternatives of the SMP, including the Proposed Project, include the same basic components, which provide a framework for how restoration and managed wetland activities would be implemented. The alternatives differ in the amount of acreage of restored tidal wetlands and remaining managed wetlands subject to managed wetland activities. These differences result in variations on how other SMP components such as levee integrity, water quality, and recreation are affected and managed. The components of the action alternatives are described below. Following this discussion of SMP components is a description of how the alternatives specifically differ. The analysis of action alternatives in this EIS/EIR focuses on the potential environmental effects, including benefits, of implementing the following actions to meet each alternative range.

The Proposed Project, described below, includes the following elements:

- restoration of tidal wetlands;
- increased frequency of currently implemented activities in managed wetlands;
- new managed wetlands activities, including dredging, placement of new riprap, and installation of new fish screens;
- environmental commitments;
- implementation of the SMPA PAI Fund; and
- adaptive management.

Restoration of Tidal Wetlands

Restoration of tidal wetlands would help to achieve the restoration goals established for the Marsh by the CALFED ERPP, San Francisco Bay Area Wetlands Ecosystem Goals Project, and USFWS's Draft Tidal Recovery Plan for the Suisun Marsh Ecoregion. Restoration of tidal wetlands in the Marsh would contribute to the recovery of special-status wildlife species, including small mammals (salt marsh harvest mouse, Suisun shrew), birds (California clapper rail, California black rail, Suisun song sparrow, salt marsh common yellowthroat), fish (salmonids, Delta smelt, longfin smelt, Sacramento splittail, green sturgeon), and plants (soft bird's-beak, Suisun thistle, Delta tule pea). Tidal wetland restoration also will be designed to accommodate sea level rise more easily than managed wetlands because the gradual elevations within tidal wetlands will not require the same level of levee maintenance and will provide an area for sediment accretion.

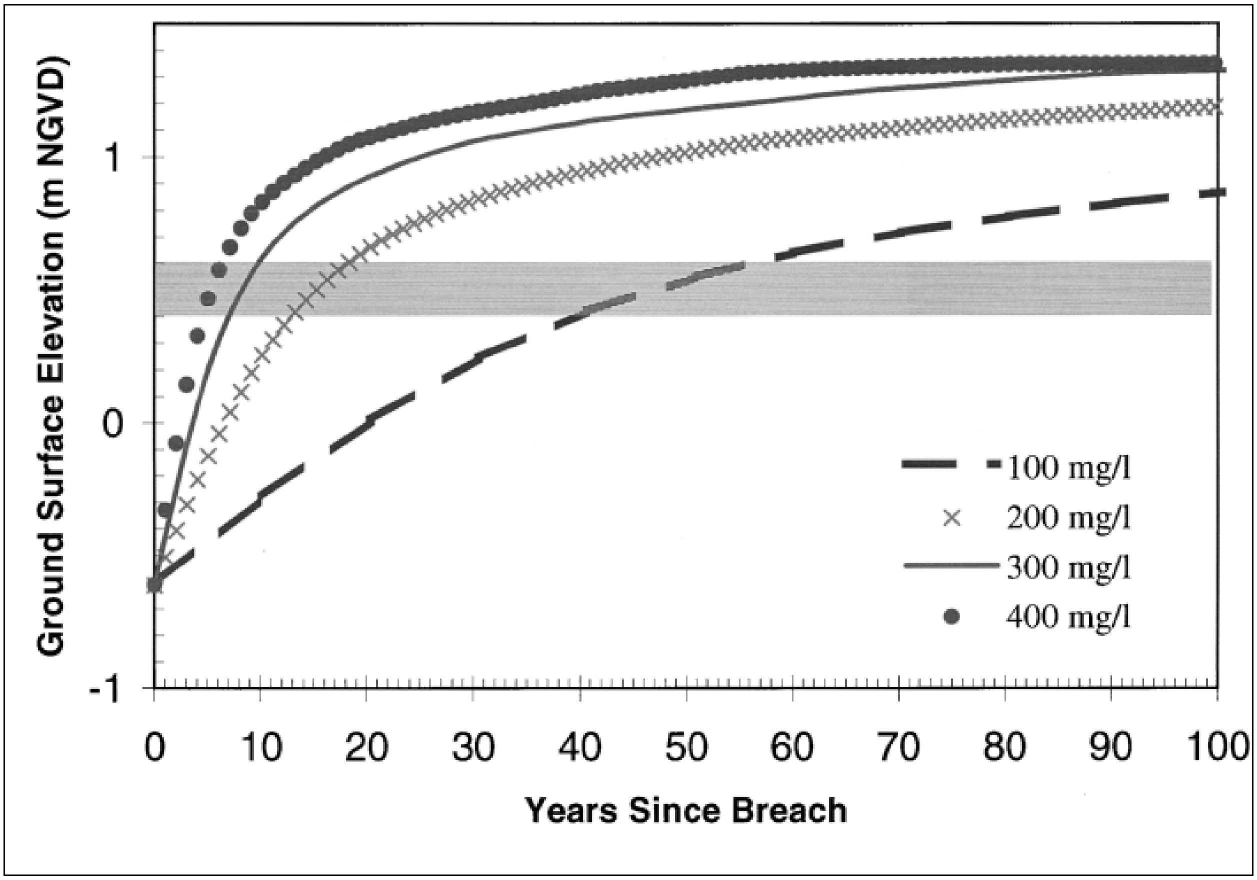
Tidal wetlands are composed of vegetated marsh plains and intertidal and subtidal channels, all of which provide habitat to support the various life history stages of native fish and wildlife species. There are approximately 7,672 acres of tidal wetlands currently in Suisun Marsh. Vegetated tidal wetland plains provide habitat for native plant species such as soft bird's-beak and Suisun thistle and nesting and foraging habitat for bird species such as California clapper rail, California black rail, Suisun song sparrow, salt marsh common yellowthroat, and some waterfowl species. Tidal marsh plains also contribute terrestrial and benthic invertebrates to the aquatic food web. Smaller fish will use the marsh plain when it is flooded by the higher tides. Tidal marsh pannes, sometimes found within the marsh plains, provide habitat for invertebrates that, in turn, support aquatic and avian communities, and they provide roosting habitat for shorebirds and waterfowl. Channels can provide habitat for native fish species such as the delta smelt, longfin smelt, Sacramento splittail, green sturgeon, and outmigrating salmonids. Channels also support phytoplankton production; phytoplankton is a food source for aquatic species and supports benthic invertebrate production, providing a food source for fish, bird, and marine mammal species. The mudflat edges of tidal wetlands, found within channels at low tide and along open water marsh edges, provide habitat for numerous invertebrates and foraging habitat for shorebirds at low tide. Wetlands also provide critical habitat components for species generally considered strictly terrestrial, such as passerine birds (song sparrows) and raptors (short-eared owls and harriers) that feed and/or breed in wetlands and spend some time in adjacent upland habitats. Tidal wetlands along the marsh perimeter allow ecological connectivity to adjacent habitats, thereby supporting a broader range of wildlife species.

The strong salinity gradients in Suisun, both east-west along the main axis of the estuary and north-south from the main Suisun Bay channel to the upper reaches of the tides, provide widely differing tidal marsh conditions. Fresher wetlands will occur in the southeast of Suisun Marsh, with greater abundance of the taller tules and bulrushes. Marshes along the west side of Suisun would be far more saline, exhibiting far fewer tules and bulrushes and greater amounts of shorter salt-tolerant wetland plants. Between these two end points will be a broad variety of brackish marsh, with the plant communities reflecting the localized salinity regime.

The geographic position of tidal marshes within Suisun exerts additional factors in defining their ecological functions. Proximity to the main Suisun Bay channel connecting the Delta to San Francisco Bay affects population abundances of numerous aquatic species. Proximity to this main channel and also to the large shallow embayments in southern Suisun also provides a significant sediment supply for marsh accretion; areas removed from these sediment sources would take far longer for natural accretion. Proximity to the edge of Suisun links sites to adjacent uplands and in some locations to local streams, each of which has a large effect on species that could use a restored marsh; sites around the edge of Suisun may have the potential for sea level rise resiliency, if they are able to flood adjacent uplands over time and allow marsh landward expansion. In summary, location within Suisun Marsh is a critical factor in directing the ecological functions that a particular restoration site could provide.

Strategically restoring tidal wetlands gradually would provide a range of the above habitat values depending on the initial site conditions (mainly elevation), the local and regional physical evolution drivers, and location in Suisun. The ecosystem functions a restored site provides will change over time, with benefits to particular species increasing or decreasing with site evolution. Initially subsided sites may provide primarily subtidal aquatic habitat until the surface has accreted enough sediment for vegetation colonization; that process could take many years to decades (Figure 2-1) in the more subsided areas that are away from adequate sediment supply, and some locations could remain as open water indefinitely. Subtidal aquatic habitats provide many benefits to numerous species. Diving and dabbling ducks would have significant foraging habitat, the extent of which varies with the tidal cycle and thus water depth. Submerged and floating aquatic vegetation would provide significant food resources for birds and fish. Phytoplankton and zooplankton production in the water column would support the food web. These areas may provide spawning substrate for some resident fish species.

Figure 2-1. Approximate Timelines of Accretion as a Function of Sediment Supply



Source: Williams and Orr 2002.

Note: This plot is for the lower, saline region of the San Francisco Estuary. Applies to sites sheltered from wind-wave action. The shaded bar identifies the approximate Spartina colonization elevation. Prediction is based on tides at the San Francisco Presidio, no sea level rise, and 550 kg/m^3 dry density of inorganics typical for San Francisco Bay. Spartina is not found within the marsh; therefore, this is used as an example to depict the relationship between breaching of levees and colonization elevation.

Restoration of tidal wetlands would be implemented over the 30-year SMP timeframe, and benefits from individual projects would change as elevations rise, vegetation becomes established, and vegetation communities shift over time from low marsh to high marsh conditions. All restored areas are most likely to provide different types and magnitude of benefits at any given period after restoration and at different geographic locations, as local and regional conditions will determine the salinity regime, plant communities, and rate of sedimentation. Existing elevation data (LIDAR) can be used to screen potential properties considered for acquisition and restoration, followed by a more detailed topographic survey. Also, the Charter acquisition considerations (Table 2-3) will be used to screen potential sites. In the interim, a range of subtidal habitat–ecosystem functions will be provided.

The specific actions that would be implemented as part of the tidal restoration component of the SMP are listed below.

Selecting Restoration Sites

Lands suitable for restoration of tidal wetlands would be acquired only from willing sellers. As opportunities present themselves, several factors would be considered for each site, as shown in Table 2-3. One overarching goal of restoration is to create a diverse mosaic of interconnected habitat types.

Table 2-3. Tidal Wetland Restoration Land Acquisition Considerations

Site Characteristic	Considerations
Species and Habitats	• Historical geographic ranges and current populations of species • Abundance of nonnative invasive species • Ability to support multiple habitat types following restoration • Inclusion in any recovery plans • Presence of listed species • Connectivity to adjacent existing tidal wetlands • Absence of existing or proposed industrial facilities in vicinity • Presence of upland transition
Waterfowl	• Existing suitability for supporting waterfowl populations • Suitability for supporting waterfowl populations when restored
Recreation	• Potential for recreationally important wildlife distributions and habitat use in surrounding areas • Potential for, and extent of, public access • Potential for disturbance to private property
Site Elevation	• Amount of imported fill material and grading required • Degree of subsidence and the ability to reverse subsidence through natural sedimentation and vegetation colonization/expansion (peat accumulation and sediment trapping) to promote functional, self-sustaining tidal wetlands plain elevations with natural upland transitions
Water Quality	• Potential for brackish water intrusion into the Delta • Potential for black water (low dissolved oxygen) conditions • Potential for adverse or beneficial effects on Delta, Suisun, and local salinity
Levees	• Currents, winds, adjacent properties, extant channel networks, topography, etc., in selecting the location and size of levee breaches • The extent to which the land requires flood protection levees to protect adjacent landowners • Potential flood liability when tidal action is restored

Site Characteristic	Considerations
Estimated Costs	• Costs of acquisition and restoration • Interim management costs • Long-term operations and maintenance (O&M) needs • Cost of upgrading interior levees to exterior levees • Cost of maintaining and/or rehabilitating exterior levees • Costs of maintaining levee access for construction/maintenance
Landscape Position	• Potential for site to accommodate sea level rise • Adjacent land uses • Presence of infrastructure such as transmission lines, rail lines, roads, etc. • Position relative to other planned or implemented restoration sites
Cultural Resource Potential	• Presence or absence of known cultural resources • Location of potential restoration areas with respect to areas sensitive for the presence of buried and surface-manifested cultural resources

The total amount of existing managed wetlands and uplands that could be affected by tidal restoration and managed wetland activities is 52,112 acres. As described above, based on hydrology and facilities, the Marsh has been divided into four regions for purposes of this analysis. The tidal wetland restoration acreages for each alternative are divided by region to achieve the total CALFED goal as described above and contribute to the USFWS tidal wetlands restoration goals. The USFWS *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California*[1] was used as a template in determining the goal of the percentage of restoration acreage per region (U.S. Fish and Wildlife Service 2010). Table 2-4 shows the goals of how much of each region would be restored under each alternative. The SMP includes the continued implementation of and increased frequency of some managed wetland activities and the implementation of new managed wetland activities on the balance of 52,112 acres that is not restored. Restoration sites would be selected based on their ability to contribute to the restoration goals for each region shown in Table 2-4 as well as the considerations described in Table 2-3.

[1] <http://www.fws.gov/sacramento/ea/news_releases/2010_News_Releases/tidal_marsh_recovery.htm>.

Table 2-4. Total Acres per Region and Percentage That Will Be Restored under Each Alternative

Alternative/Region	SMP Target for Tidal Wetland Restoration*	Percentage of Existing Managed Wetlands That Will Be Restored to Tidal Wetland under the SMP
Alternative A, Proposed Project	**5,000–7,000**	
Region 1	1,000–1,500	8.4%–12.6%
Region 2	920–1,380	12.6%–18.9%
Region 3	360–540	12.1%–18.1%
Region 4	1,720–2,580	6.0%–9.0%
Alternative B	**2,000–4,000**	
Region 1	500–1,000	4.2%–8.4%
Region 2	460–920	6.3%–12.6%
Region 3	180–360	6.0%–12.1%
Region 4	860–1,720	3.0%–6.0%
Alternative C	**7,000–9,000**	
Region 1	1,500–2,250	12.6%–18.9%
Region 2	1,380–2,070	18.9%–28.5%
Region 3	540–810	18.1%–27.3%
Region 4	2,580–3,870	9.0%–13.5%

USFWS = U.S. Fish and Wildlife Service.

SMP = Suisun Marsh Habitat Management, Preservation, and Restoration Plan.

* The targets were developed for each region based on the different habitat conditions within each region to provide the range of environmental gradients necessary to contribute to the recovery of listed species. These targets complement and are consistent with the Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. The Adaptive Management Plan will track these targets to ensure restoration benefits for listed species.

Note: Adjustments to the Adaptive Management Plan may result in changes to the targets in each region.

Site Preparation

Once a site has been acquired from a willing seller, the project proponent would undertake several land management activities necessary to prepare the site for restoration. These land management activities would need to occur from the time of acquisition until the time of restoration, which could last anywhere from 1 to 5 or more years.

Each restoration site would be designed to accomplish specific environmental goals by restoring historical conditions. To accomplish this, sites would need to be graded and prepared to re-create flows and hydraulic conditions. As such, ditches previously used for managed wetland flood and drain practices may be filled in with dirt, brush boxes, or other material. Depending on the timing of this activity, material removed from levees, either as breaches or grade-downs, or from grading the restoration site could be used to fill adjacent ditches. In addition to or in lieu of filling in ditches, specific restoration designs may include placement of hay bales, brush boxes, or other slow-degrading material adjacent to levee breaches that block water access to ditches and direct tidal energy into the restoration area. Additionally, restoration preparation may include digging starter channels to increase tidal water connectivity.

Moist soil management likely would be implemented during the growing season to promote the natural production of desired wetland plant species. Depending on site elevations and local salinity regime, these pre-breach managed plant communities may persist following restoration of tidal action, or they may be sacrificial. Establishment of vegetation communities prior to inundation is expected to contribute suitable habitat immediately for some species, to discourage establishment of nonnative species upon inundation, to provide for early subsidence reversal, and to help capture suspended sediment once the site is restored to tidal action. Establishment of these vegetation communities is likely to increase the rate at which the tidal wetland matures, and could occur on the levees or in other areas of the restoration site.

Maintenance of levees and water control structures also may be required during the period prior to restoration of tidal action. Maintenance activities would follow the methods and approaches employed for the diked, managed wetlands. The extent of maintenance required would depend upon conditions at the time of acquisition and changes in those conditions that occur over time. However, structures peculiar to managed wetlands, including duck blinds and derelict pipelines, likely would be removed. Support apparatus for water control structures often require levee excavation and pile, culvert, flashboard riser, and gate removal. The removal of water control structures would depend on the moist soil management regime prior to breaching, but their eventual removal is expected at all sites.

Selecting Breach Location(s) at Restoration Site

Restoration would be accomplished by breaching and/or lowering existing exterior levees to restore tidal inundation. Depending on site-specific goals, levee modifications would be made in various ways by manipulating the opening width, depth, and/or slope angle. Breach edges may require scour protection with rock, geotextiles, or piles. Alternatively, long reaches of levee may be graded down to lower elevations—most likely between mean sea level and mean higher-high water (MHHW). Material would be used to create topographic variability and encourage diverse plant communities and shallow tidal habitat. Breach location, number, and size would be chosen based on two considerations. The first consideration is to maximize the ecological benefits of the restoration. Considerations would include ability to reconnect existing tidal channel networks from the site's history as a tidal marsh if those channels remain, providing suitable connectivity to the tidal source waterways, orientation relative to winds and currents to promote natural sedimentation and access to aquatic organisms, and constructability. The second consideration is to minimize upstream tidal muting, tidal elevation changes, slough channel scour, and hydraulic changes, and restoration projects would be designed to ensure that changes in tidal flows remain below about 1 foot per second (fps). In general breaches on larger channels or multiple breaches would reduce the effects of the increased tidal flows on tidal elevations and velocities. If feasible based on site-specific conditions, breach locations would be located in areas that have minimal or no existing tidal wetlands on channel berms or in locations where the tidal wetland habitat value is lowest (e.g., riprap levee sections).

As part of each site-specific restoration action, project proponents will use an accurate tidal hydraulics and salinity model (e.g., the RMA Bay-Delta model or other appropriate model) to simulate the proposed action to ensure the impacts on scour, sedimentation, salinity, and other hydraulic processes do not exceed those described in this EIS/EIR. This information will be used to adjust designs of restoration projects and other activities to minimize adverse impacts on tidal elevations and velocities, or other site-specific characteristics, in the restoration site and/or in Marsh channels adjacent to restoration projects; minimize salinity effects at upstream Delta locations; and potentially create benefits related to scour and sedimentation.

Upgrading or Constructing New Exterior Levees

To protect adjacent properties from an increased risk of flooding, existing interior levees may be upgraded or new exterior levees would be constructed prior to breaching the levee. These new or upgraded levees would include brush boxes or other biotechnical wave dissipaters to protect the levee from wind and wave erosion.

Habitat levees that include benches or berms also may be constructed, which would provide similar wind and wave-action protection and opportunities for high marsh/upland transition habitat. The construction of habitat levees would depend on cost and availability of fill. Habitat levees are low, wide, gently sloping vegetated levees, which may be overtopped during storm surges with nominal eroding or destabilizing. Habitat levees are designed to allow intermittent flooding; minimize dispersal and denning of terrestrial predators; reestablish facsimiles of marsh topographic gradients; accommodate natural patterns of debris deposition and shoreline disturbance; and provide wave energy buffers (Interagency Ecological Program 2007).

Habitat levees may be planted and seeded with native marsh species and/or allowed to colonize naturally with native and naturalized species. This habitat would promote intertidal zones and mudflats that support various species that rely on a gradually transitioning marsh plain. Habitat levee design and locations would vary by site but are expected to include the widening of existing interior levees by 15 to 30 feet with a gradual slope or the construction of new interior levees or islands. Specifically, these benches or berms would be designed to create mid- and high-marsh habitat for dependent species and will be guided at least partially by information obtained through the adaptive management process.

It is expected that benches or berms that support habitat for these species would benefit many other species.

Habitat levees would be constructed from resources available at the time of construction and may include channel dredged material collected in bays and sloughs in the plan area, dredged material from outside the plan area, or material excavated within the tidal restoration area or other areas of the Marsh.

Increased and New Managed Wetland Activities

The managed wetlands of Suisun Marsh are managed specifically for duck hunting activities but also provide important habitat for a variety of resident and migratory waterfowl and shorebirds and other native and special-status species, and protection of these areas is a goal of many agencies and programs, including the Central Valley Joint Venture program and CALFED. These wetlands, which are managed for a diversity of wetland vegetation and other wetland wildlife food plants, are important as feeding and roosting areas for species such as geese, mallards, pintails, wigeons, and gadwalls. Managed wetlands also provide breeding habitat for shorebirds, which nest in a wide range of habitats from unvegetated wetland flats to uplands. Spring drawdowns practiced by Suisun Marsh wetland managers in conjunction with adjacent uplands provide foraging opportunities for migrating shorebirds.

Managed wetlands provide valuable habitat for a variety of non-waterfowl birds, mammals, reptiles, and amphibians. Birds such as Suisun song sparrow, salt marsh common yellowthroat, shorebirds, and ring-necked pheasant forage and nest in the managed wetlands. Managed wetlands support mammals such as salt marsh harvest mouse, northern river otter, coyote, raccoon, striped skunk, black-tailed jackrabbit, common muskrat, and tule elk, as well as native reptiles and amphibians (e.g., western pond turtle, gopher snake).

Managed wetlands face challenges and constraints such as aging water management facilities, threatened and endangered species regulations, subsidence, mosquito abatement regulations, and water quality issues, including salinity. Additionally, the aging levee system, which is difficult to maintain because of a lack of appropriate levee source materials and regulatory constraints, compromises the managed wetland system.

The intended outcomes of the managed wetlands activities described below are to maintain and improve habitat conditions and minimize or avoid adverse effects of wetland operations. For managed wetlands, the optimum flood and drain cycle is 30 days. The activities described below provide a suite of tools that can be used to maintain and improve levee stability and the 30-day flood and drain cycle. As described above and in Chapter 1, the restoration and enhancement goals of the ERPP include protecting and enhancing 40,000 to 50,000 acres of managed wetlands. The SMP assumes that managed wetlands are enhanced by improving levees and the flood and drain cycle because it allows managed wetlands to be managed as effectively as possible.

The ability for managed wetlands to improve habitat is also dependent on the availability of lower salinity water. DWR/Reclamation facilities and salinity stations are used to reduce water salinity and to distribute less saline water to managed wetlands. These facilities and stations must be maintained in order to work as intended.

Most of the managed wetland activities described below are already occurring in the Marsh. Some of the current activities would be modified, and new activities would be conducted. Many of the current activities would qualify for the SMPA PAI Fund, which is described below. Under the SMP, many of these activities would increase in frequency, primarily because of an increase in funding provided by the PAI Fund.

Increased Frequency of Currently Implemented Managed Wetland Activities

DFG, DWR, and landowners (as represented by SRCD) currently maintain their facilities and/or properties in the Marsh by implementing the actions listed below. Additionally, Reclamation contributes funding to DWR to implement operations and maintenance of facilities that mitigate the effects of the CVP/SWP, including RRDS, MIDS, Goodyear Slough Outfall, salinity stations, and other facilities and/or properties. The list below is a comprehensive description of most of the activities conducted by these agencies and landowners in the Marsh, although the activities each implements depend on their individual facilities, properties, and other factors. Some of these actions are expected to increase in frequency under the SMP because of the increase in effort to support the managed wetland targets as well as the PAI Fund (described below), and to ensure continuing functionality of state/federal facilities. The current level of activity combined with the increased frequency of currently implemented activities and proposed new activities makes up the total work needed to support managed wetland operations. Increasing the current level of work and implementing the new activities would help SRCD and DFG meet the SMP managed wetland goals related to levees and flood and drain cycles. This EIS/EIR describes the impact resulting from the work above the existing baseline condition. The baseline for each activity and the proposed change in each activity are shown in Table 2-5. The analysis of impacts on resources is based on the change for each activity. All activities would be implemented by DFG, landowners (as represented by SRCD), and/or DWR except as noted. A full description of each activity is provided following Table 2-5.

Table 2-5. Baseline and Proposed Change in Currently Implemented Managed Wetland Activities

Managed Wetland Activities	Annual Baseline Activities (Average, Low–High)	Current Corps Permitted Annual Limits	Anticipated Change from Baseline with SMP Implementation
Repair existing interior levees	29,228 cy, 9,697–54,040	443,000 cy	Slight increase (10% or less of annual baseline)

Managed Wetland Activities	Annual Baseline Activities (Average, Low–High)	Current Corps Permitted Annual Limits	Anticipated Change from Baseline with SMP Implementation
Repair existing exterior levees	43,902 cy, 28,622–87,232	443,000 cy	Decrease
Core existing interior levees	6,380 cy, 2,022–15,108	No limit	No change
Grade pond bottoms for water circulation	147,377 cy, 79,750–228,546	1,772,000 cy	Decrease
Create pond bottom spreader V-ditches	40,403 linear feet, 14,500–72,300	1,438,000 linear feet	No change
Repair existing interior water control structures	24, 10–37	No limit	No change
Replace pipe for existing interior water control structures or install new interior water control structures	20, 14–38	No limit	Slight increase (10% or less of annual baseline)
Install new blinds and relocate, replace, or remove existing blinds	38, 23–51	5 per ownership annually	No change
Disc managed wetlands	2,552 acres, 1,837–3,100	No limit	No change
Install drain pumps and platforms	1, 0–2	No limit	No change
Replace riprap on interior levees	50 cy, 0–300	Obtained as needed	No change
Replace riprap on exterior levees	2,435 cy, 292–7,406	Limited to replacement of existing riprap	No change
Repair exterior water control structures (gates, couplers, and risers)	17, 8–28	No limit	No change
Install or replace pipe for existing exterior flood or dual-purpose gate	11, 1–23	50 annually Marsh-wide	No change
Install, repair, or re-install water control bulkheads	11, 3–21	No limit	No change
Remove floating debris from pipes, trash racks, and other structures	20 cy, 10–50	Obtained as needed	No change
Install alternative bank protection such as brush boxes, biotechnical wave dissipaters, and vegetation on exterior and interior levees	450 ft, 300–600	Obtained as needed	No change
Construct cofferdams in managed wetlands	1 unit, 0–2	Obtained as needed	No change
Repair and maintain Suisun Marsh salinity control gate	1, 0–2	Obtained as needed	No change

Managed Wetland Activities	Annual Baseline Activities (Average, Low–High)	Current Corps Permitted Annual Limits	Anticipated Change from Baseline with SMP Implementation
Clean roaring river distribution system fish screen	Oct daily Nov–Sept weekly	No limit	No change
Install new fish screen facilities	2 units, 0–5	Obtained as needed	No change
Salinity monitoring station repair and replacement	2 stations, 0–18	Obtained as needed	No change
Relocate, install, or remove salinity station	1 station, 0–5	Obtained as needed	No change
Construct new interior ditches; clear existing interior ditches	49,456 cy, 9,724–69,022	443,000 cy	Slight increase (10% or less of annual baseline)

cy = cubic yards.

Repairing Existing Interior and Exterior Levees

This action involves the improvement or repair of levees by using spoils from other permitted activities such as clearing interior ditches, constructing new interior ditches, or grading pond bottoms. Vegetation growth on levees can require mowing to maintain condition and to assess repair needs. The spoils would be placed on the crown of the levee with an excavator, dozer, or box scraper. On rare occasions, exterior levee integrity is compromised, (from rodent holes, storm damage, or unanticipated overtopping of the levee crown), allowing uncontrollable tidal flows to enter the managed wetland which can cause levee breaches. If the exterior levee breach can be repaired utilizing on site material consistent with existing permit terms and conditions, the levee integrity is restored on the next appropriate low tide cycle. See managed wetlands environmental commitments for additional discussion of this activity. Aggregate base rock may be placed on the crown of levees to prevent road surface degradation. Work generally would occur in late summer, and approximately 500 linear feet of levee can be repaired per day.

Coring Existing Interior Levees

The coring of levees is intended to stop the flow of water through rodent holes and cracks in levees. To core a levee, typically a 2-foot-wide trench (depending on the width of the excavator bucket) is excavated in the levee crown using a long-reach excavator or backhoe, and the material is placed on the crown of the levee adjacent to the excavation site. The trench then is backfilled immediately using the same material that was excavated. The material is compacted during the backfilling process to seal the levee. If a rodent hole is identified, its entire length may need to be excavated to stop the flow of water and prevent future burrowing by small mammals. Coring of levees generally is performed between July and September, and approximately 700 feet can be completed in 1 day.

Grading Pond Bottoms for Water Circulation

To improve water circulation by re-contouring low areas and raising pond bottoms and provide material for levee maintenance, material is graded from high-ground areas or pond bottoms. The raising of low pond bottom areas improves circulation and drainage in the managed wetlands. Grading also can include the creation or maintenance of swales, typically 2 feet deep with gradual slopes. This work is completed with a box scraper pulled by a low–ground pressure dozer or tractor. Work generally is done June through August. Approximately 700 cubic yards (cy) can be graded per day.

Creating Pond Bottom Spreader V-Ditches

V-ditches are 18-by-18-inch or 24-by-24-inch ditches created by pulling a V-ditch plow behind a tractor. These V-ditches facilitate circulation and drainage of low areas and sinks. Occasionally, a ditch may be constructed in high areas to improve drainage by connecting an isolated wet area to other draining wet areas. Typically, these ditches silt in quickly and last only 1 to 2 years after creation. These ditches normally are created after the ponds have drained for the season, generally June through August, and 2,000 feet can be constructed per day. Spoil materials typically remain on the sides of the V-ditches, although they may be spread back into the pond bottom to further improve the low areas, or they can be flattened adjacent to the V-ditch.

Repairing Existing Interior Water Control Structures

This repair involves the replacement of component parts of pipes through interior levees (gates, stubs, or couplers) but not replacement of the pipe itself. Work is done by hand (uncoupling the old structure and re-coupling the new structure), and generally a ground crew removes the damaged structure and installs the new structure on the end on the existing pipe. This work typically is completed in the summer, when the managed wetlands are dry.

Replacing Pipe for Existing Water Control Structures or Installing New Interior Water Control Structures

This activity includes the replacement of a pipe for an existing interior water control structure or the installation of a pipe for a new interior water control structure. If a new structure is being installed, the new structure is assembled on the crown of the levee, a trench is excavated laterally through the levee, the new pipe is placed in the trench, the trench is backfilled, and the fill is compacted. If a pipe is being replaced, the trench is excavated at the site of the old pipe and that pipe is removed. Similar to installing new pipe, the replacement pipe is placed in the trench and backfilled. However, when feasible, new drainage pipes would be placed where they can be consolidated or drain into an existing ditch. Occasionally, an interior ditch cannot be drained sufficiently for pipe replacement. In these instances sheetpiles may be used to retain the water temporarily until the pipe is replaced.

Many water control structures have walkways that run from the levee to the end of the pipe. These walkways include pilings, walkway boards, and handrails. These structures strengthen the gate by providing a grounded structure for frame attachment, and they provide a means by which wetland managers can access the gate for operation. Any necessary repair to these structures typically is done during pipe replacement. However, some repairs may need to be done more frequently, especially replacement of walkway boards or handrails.

This work typically is completed in the summer when the managed wetlands are dry.

Installing New Blinds and Relocating, Replacing, or Removing Existing Blinds

Duck blinds are plastic, fiberglass, or metal structures (3’ x 4’ x 8’) placed in the ground to conceal the hunter. When an in-ground blind is replaced, the old blind is excavated from the ground, and a new blind is placed in the void, which can be as deep as 4 feet. This work is completed with a dozer and/or excavator. The blind is placed and secured with vertical timbers and cross timbers that are pushed into the ground adjacent to the blind. Then material from the pond bottom is graded to conceal the sides of the blind.

Discing Managed Wetlands

Discing is done on the landside of levees in the spring or late summer to clear problematic vegetation, reduce the production of vector mosquitoes, break up the soil for seedbed preparation, smooth excavated material, fill cracks in soil, or create fire breaks. A disc is pulled behind a tractor or dozer. Depending upon the wetland management and vegetation objectives, discing can occur annually in upland areas to promote annual grasses and cereal grain production and once every two to five years in wetland areas to set back plant succession. Discing is voluntarily limited to one-fifth of a property area per year (Suisun Resource Conservation District 1998).

Installing Drain Pumps and Platforms

Drain pumps are installed on wooden platforms built to support them. The pump and platform are installed on the inland side of the exterior levee. Occasionally, the pump discharge pipe will be set high in the profile of the exterior levee so that the pipe does not limit levee access but allows discharge at high tidal levels.

Replacing Riprap on Interior Levees

Riprap is replaced on interior levees in the minimum amount necessary for bank stabilization and in areas around water control structures where water flow and eddies erode the ditch bank and interior levee toe. Riprap will be placed on interior levee banks only in those areas with existing riprap. Riprap is placed on the interior levees using a long-reach excavator that is located on the levee crown. Approximately 300 feet of riprap can be placed per day. Riprap generally is replaced during July through September.

Replacing Riprap on Exterior Levees

Riprap is replaced on the tidal side of exterior levees in the minimum amount necessary for bank stabilization. Riprap will be placed on exterior levee banks only in those areas with existing riprap. Those areas that receive direct wave impacts historically have been fortified with riprap and require periodic maintenance. Riprap is placed on the tidal side of exterior levees using a long-reach excavator that is located on the levee crown, or by barge with a dragline or clamshell dredge. The barge method is used less frequently as it requires greater channel widths and depths and is more expensive. Riprap generally is replaced during July through September.

Coring Existing Exterior Levees

This activity is the same as described for interior levees.

Repairing Exterior Water Control Structures (Gates, Couplers, and Risers)

Repairing exterior water control structures involves the replacement of components of pipes through exterior levees (gates, stubs, or couplers) but does not involve the replacement of the pipe itself. All work is completed at low tide to allow access to the pipe and typically does not involve any excavation of sediments from the exterior slough. The repairs are generally done during July through September. In-water work is done by hand (uncoupling the old structure and re-coupling the new structure), and generally a ground crew lifts the damaged structure out of the water and lowers the new structure into place.

Installing or Replacing Pipe for Existing Exterior Flood or Dual-Purpose Gates

This activity is the replacement of an exterior water control structure (pipe, gates, stubs, and couplers) that is used to either flood or drain managed wetlands. There are no restrictions on the size of a draingate. For floodgates and dual-purpose gates (flood and drain) that divert water from tidal sloughs, however, the overall capacity of the diversion for that parcel may not be enlarged. In the past, water control structures typically were constructed of corrugated metal pipe. Because of the corrosive environment of the Marsh, these pipes often begin leaking and fail in 8 to 15 years. If an exterior pipe leaks, habitat management and maintenance activities would be compromised as a result of uncontrollable flooding of the managed wetland. Therefore, metal pipes typically are replaced with high-density polyethylene (HDPE) pipes.

When a pipe is replaced, a new pipe and appurtenant structures are assembled on the crown of the levee with the appropriate control structure components attached to each end of the pipe. A trench is excavated in the exterior levee over the old pipe, and the pipe is removed. All replacement activity is completed in one low tide. Replacement pipes typically are placed in the same location as the existing structure, the trench is backfilled, and the backfilled material is compacted. Either a dozer or an excavator is used to excavate the trench, and generally an excavator is used to install the replacement pipe. The backfill material is compacted with a dozer and/or excavator. Replacement of the pipes takes approximately 4 days and generally would be done March through September. The first day is mobilization of equipment and materials, the second day is assembly and preparation for installation, the third day is installation, and the fourth day is demobilization and site clean-up.

If a new drainpipe is required, it would be installed at a location where discharge channels already exist or exterior levees have minimal vegetation. The new structure is assembled on the crown of the levee, usually with a flap gate or screw flap on the outside and flashboard riser or screw gate on the inside. Installing a new drainpipe requires the same types of equipment and takes the same amount of time as replacing an old drainpipe.

Installing, Repairing, or Re-Installing Water Control Bulkheads

Bulkheads are built to stabilize and strengthen levees exposed to highly energetic water flows or wave energy. These structures typically are installed near water control structures and prevent the erosion of soils at the toe of the levee and ditch banks. Exterior work is done at low tide and does not involve any excavation of sediments from the exterior slough. In-water work is done by hand (unbolting the old boards and/or bolting a new structure together), and generally a ground crew lifts the old boards out of the water and lowers the new boards into place. A new bulkhead may be constructed to strengthen newly excavated sections of levee, and to help avoid additional turbidity after installation of exterior water controls by containing loose soils that otherwise may fall into the exterior slough. Bulkheads can be constructed from wood or vinyl or metal sheetpile. This activity generally would be implemented in the summer months.

Removal of Floating Debris from Pipes, Trash Racks, and Other Structures

Floating vegetative debris and other debris, such as wood and trash, often accumulates in front of pipes, trash racks, and other structures. This debris typically is removed using a long-reach excavator. Material is disposed of outside of the Suisun Marsh. Work is done annually, generally during the summer months.

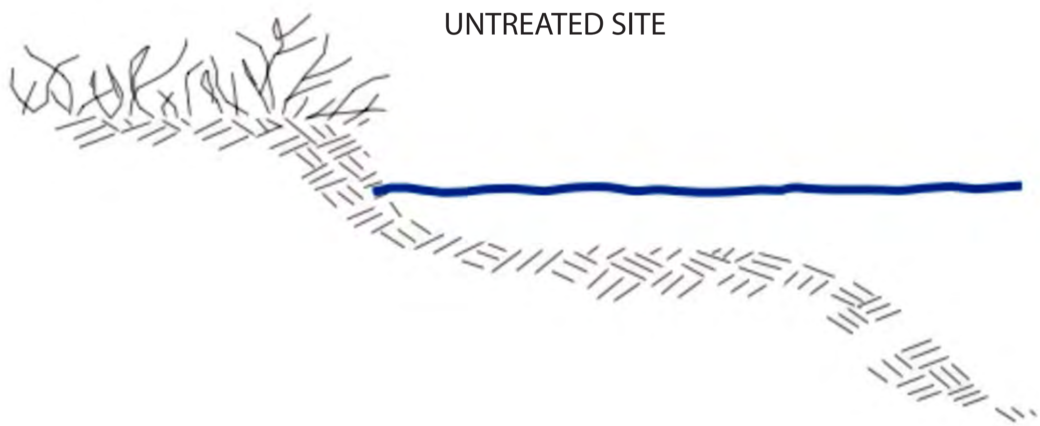
Installing Alternative Bank Protection such as Brush Boxes, Biotechnical Wave Dissipaters, and Vegetation on Exterior and Interior Levees

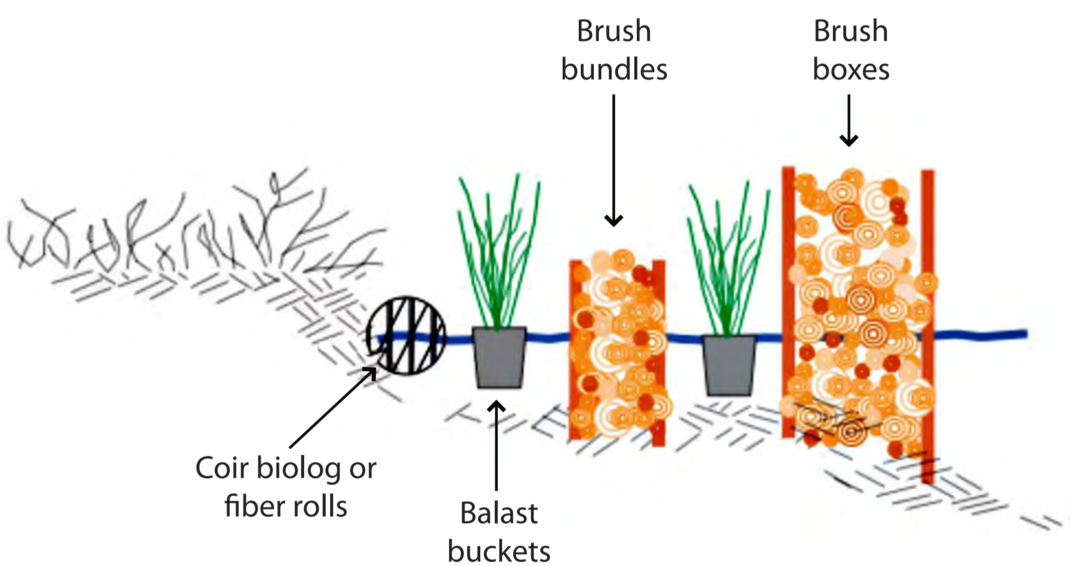
As described above, vegetation applications, including brush boxes, may be appropriate and effective mechanisms for controlling erosion of levees. Pursuant to previous BOs from NMFS and the USFWS, SRCD was required to employ levee maintenance methods that do not use riprap. Brush boxes use natural materials and native plants for capturing sediment to stabilize and protect exterior levees while also providing fish habitat (Figure 2-2). The installations generally are done during July through September.

Brush boxes, brush bundles, and ballast buckets are placed below the mean high water mark and anchored with tree stakes. Brush boxes and brush bundles are generally dead branches that are staked into the ground or wrapped in coconut fiber (Figure 2-2). Ballast buckets are organic, biodegradable buckets planted with native wetland species such as tule, three-corner bulrush, and Baltic rush. As the technology is developed further, alternative materials or installation methods may be used. The installation of brush boxes and ballast buckets does not involve any in-water work because all work is done at low tide. This work is done entirely by hand, reducing the sedimentation that can occur with mechanical work. After the build-up of sediment and the growth of native plants over time, the exterior levee would be stabilized and protected from further erosion, and habitat would be established for fish and the macroinvertebrates on which they feed.

Integrated vegetation solutions are desirable to provide low maintenance “living” bank protection and wave-energy dissipation. Applications of these solutions are limited by the local channel velocities and depth, wind fetch, and exposure to wake. If the tidal hydraulic regime is suitable for the establishment of vegetation capable of resisting high channel velocities and wave energy, vegetation will be incorporated into the erosion protection design. This would reduce the future

DESIGN FOR LOW BANK, MODERATE SLOPE





Composite Brush Works/Ballast Buckets

Composite protection and habitat enhancement techniques include brush boxes to serve as breakwaters, coir-wrapped brush bundles to capture sediment, and ballast-bucket plantings for habitat establishment.

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Figure 2-2
Composite Brush Works/Ballast Buckets

maintenance costs of erosion protection. The following criteria would be considered in determining the appropriateness of vegetation, either by itself or in combination with riprap, at each site.

- When channel velocities are low enough to prevent loss, vegetation solutions can be installed to halt erosion processes along levee slopes and natural channel bank sections.
- If channel depth on the face of the levee slope is less than 3 feet below mean tide level (MTL), i.e., mid tide level, and the levee slope is less than 3:1 (H:V), vegetation solutions can be installed to halt erosion processes along levee slopes and natural channel bank sections.
- If levee slopes can provide suitable foundations, brush boxes can be installed at various elevations to create a "benched" sequence up the slope and reduce or stop erosion in areas where scallop failures have occurred.
- If shallow water, shallow slopes, benches, or shoal exists, vegetation can be installed to greatly reduce wake energy and provide a low-maintenance erosion-reduction measure.
- If fetch length is less than 1,000 feet in the direction of the predominant southeast to southwest winds during high-water conditions (e.g., winter storms, spring tides) or prevailing winds during all other times (typically from the west), vegetation solutions should be applied to the upper slope of the levee to dissipate wind-driven waves and reduce erosion potential.

Constructing Cofferdams in Managed Wetlands

Cofferdams are temporary earthen structures used to cross interior ditches or prevent interior water from flowing into construction sites, in support of other permitted construction activities (e.g., exterior pipe replacement) and required best management practices (BMPs). Cofferdams are temporary in nature and are constructed from material from the levee toe, pond-bottom grading, or other excavated areas in the managed wetlands. The volume of material used to transverse the ditch is limited to that required to stop the flow of water and provide adequate width to support equipment access to both sides of the ditch. During installation, a long-reach excavator or dozer places or pushes material from the adjacent levee crown or field area into the ditch. Upon completion of the associated work activities, the cofferdam or crossing is excavated and removed from the ditch and the ditch is restored to its original width and depth. Upon removal of the cofferdam, all material is placed on the crown and backslope of the exterior levee or is spread out over the adjacent interior ditch bank or levee. An alternative to cofferdams is a sheetpile that can be driven into the levee with a long-reach excavator and removed upon completion of construction. Sheetpiles could be used instead of or in conjunction with cofferdams. This activity generally would be implemented in the summer months.

Suisun Marsh Salinity Control Gate Repair and Maintenance

Flashboards are installed and removed on an annual basis by means of either a land-based crane on the banks of Montezuma Slough or a barge crane. Repairs and maintenance include servicing, replacing, and installing sections and pieces of the radial gates or boat locks that are connected to or associated with the entire facility. Most work is done above water from a boat or the superstructure while sections are hoisted out of the water. This activity is conducted by DWR.

Roaring River Distribution System Fish Screen Cleaning

The fish screens are cleaned by successively lifting each of the stationary vertical screen panels out of the water and pressure washing the silt and vegetation accumulation off of the screens. During the flood-up season (generally August through October), this activity can be conducted up to once a day. During the rest of the year, this activity is conducted less frequently on an as-needed basis. This activity is conducted by DWR.

Installing New Fish Screen Facilities

Fish screens are installed at managed wetland water intakes (flood pipes) to prevent fish from swimming or being drawn into managed wetlands. The installation of fish screens was permitted in the 1995 RGP (diversions are screened.)

Wetland impacts from screening diversions to protect fish would not exceed 1,000 square feet per year or a total of 30,000 square feet over the 30-year plan period. All Suisun Marsh screens would be designed to comply with USFWS delta smelt approach velocities of 0.2 foot per second (fps), which are well below required approach velocities for salmon.

There are many different designs for fish screens in the Delta and Suisun Marsh. Site-specific considerations, such as acreage served, diversion volume, and channel and diversion point configuration, will dictate screen design. The stainless steel conical 8-foot, 10-foot, and 12-foot fish screens have proven most efficient design for small diversions screened in Suisun Marsh. These screens were designed to be removable from the crown of the exterior levee with a standard boom truck or excavator. This aspect of the design allows normal maintenance to be conducted in the dry, and the screens can be removed from the tidal slough and placed on a storage platform for inspection and maintenance. Normal maintenance includes power washing the screens, replacing cathodic protection (zinc or magnesium anodes), replacing cleaning brushes, and general inspecting.

Typically, fish screens are installed at an existing diversion structure; therefore, there is an existing channel or basin in the tidal area and a supply ditch in the managed wetland. However, consolidation of unscreened diversions may require a new diversion location to serve multiple wetland units at one location. The fish screen platform is supported by four pilings that are pushed into the bay mud at the toe of the exterior levee. The conical fish screen support platform and diversion pipe are placed on top of these support pilings and installed through the exterior levee. These construction methods are similar to exterior pipe replacement and bulkhead repair or installation. All other work activities for screen installation are completed at the toe of the exterior levee on the landside of the levee. These activities include water control installation, storage platform construction, and control center platform installation. This activity generally would be implemented in the summer months.

Salinity Monitoring Station Maintenance, Repair, and Replacement

Infrequent major maintenance activities do not include work done in the water. This includes repairs to walkways, equipment housing, or other wood, plastic, or metal structures. This also includes installation, removal, replacement, repair, or modification of monitoring instrumentation within the equipment housing. These activities are done twice per year.

Weekly maintenance activities include collecting data from the electronic equipment at the site and the calibration and cleaning of the probes. With the exception of lowering the probes in the water, these activities are done above the water or adjacent to the water on the levee bank.

Activities to be conducted periodically in the water by hand include cleaning or replacing the probe mounting equipment, resetting the water stage gage, cleaning probe pipes, and replacing the dimple collar to suppress wave action. On the remaining stations with stilling wells, clearing accumulated sediment from the stilling well is done by flushing the stilling well with water pumped from the adjacent area.

Stilling well replacement and walkway/platform piling replacement involves removal by tractors and trucks operated from the existing roadway/levee and excavators or cranes operated from the roadway/levee or barge. Work generally is scheduled during the dry months of summer and fall. This activity is performed by DWR about once every 5 to 10 years at a site.

DWR gradually is moving away from the use of stilling wells and moving toward using pressure transducers to measure water surface elevation. Pressure transducers (as well as the other transducers in the bundle) are suspended in the water above the bottom. This activity is conducted by DWR.

Salinity Station Relocation, Installation, and Removal

Salinity stations may need to be relocated, installed, or removed because of regulatory requirements, physical constraints, the need to obtain more reliable data, the data no longer being required, or other reasons. Maintenance equipment may include trucks, bucket excavators, small cranes, boats, barges, and other equipment as required. Work generally is scheduled during the dry months, June through September.

When a salinity station is removed, it is done by hand when feasible. Otherwise, tractors and trucks operate from the existing roadway/levee and excavators or cranes operate from the roadway/levee or from barges. All components of the station will be removed. This includes the stilling well culvert, and pilings supporting the walkway will be removed from the levee slope/river bottom. Materials from the removed station are disposed of at an approved off-site location. The total disturbance would not exceed 400 square feet. The removal of a monitoring station usually takes about 8 hours over the course of approximately 3 days.

New monitoring stations are installed on a levee when possible or in water when location on a levee is not feasible. A new station may include installation of salinity measurement equipment with equipment housing. Stations that cannot be located on the levee also will require a platform to support the equipment housing, a walkway to access the platform, and pilings to support the platform and walkway. Stilling wells may be installed. Alternatively, pressure transducer equipment will be attached to structures in the water, such as pilings, to enable measurements to be taken in the water column without requiring disturbance of the substrate during installation or maintenance. The footprint for the walkway (actual fill) is less than 2 cubic feet. Installation of a monitoring station usually takes approximately 4 days, involves the use of a truck to haul equipment, and may require an excavator and small boat to install the stilling basin. The total disturbance would not exceed 50 square feet. This activity is conducted by DWR.

Modification of Currently Implemented Activities

Only three activities currently implemented would be modified under the SMP. The activities themselves—clearing existing interior ditches, constructing new interior ditches, and repairing existing exterior levees—would not change, but how the activities are administered would change. These activities would be implemented by DFG, landowners (as represented by SRCD), and/or DWR. This includes RRDS, MIDS, Goodyear Slough Outfall, and other facilities and/or properties.

Clearing Existing Interior Ditches

This action is the removal of accumulated silt, emergent vegetation, and aquatic vegetation from interior ditches with an excavator to eliminate water-flow restrictions. Approximately 900 linear feet of ditch can be cleared in 1 day. The RRDS includes a square-shaped 40-acre intake area that receives water from the water control structures behind the fish screen and allows sediment to settle out of the water prior to it flowing into the RRDS ditch. Although this area is not linear like a ditch, it is similar to ditches due to being an area with open water, boarded by levees, which may have emergent vegetation growth due to excess silt accumulation. Removal generally would be done during the months of June through September. A long-reach excavator, harvester, or other drag methods may be used to remove the material.

The material would be spread evenly on adjacent land. However, spoils also may be sidecast and left adjacent to the ditch for up to 1 year, then must be used for an authorized activity (levee maintenance or grading) or removed to an area outside Corps jurisdiction (crown of a levee). In this case, spoils are moved using a dozer or box scraper. Currently, sidecast materials may be left in place to dry for only a month. SRCD, DFG, DWR, and Reclamation propose that this period is extended to a year to ensure that all materials are dried before put to beneficial use.

Constructing New Interior Ditches

This action is the removal of pond bottom material with an excavator to create a new interior ditch for improved water circulation. Approximately 600 linear feet of ditch can be constructed in 1 day, and work generally would be conducted during the months of June through August. A long-reach excavator may be used to remove the silt and spread materials evenly on adjacent land. However, spoils may be sidecast and left adjacent to the ditch for up to 1 year; then they must be used for an authorized activity (levee maintenance or grading) or removed to an area outside Corps jurisdiction (crown of a levee). Spoils are moved using a dozer or box scraper.

Similar to clearing existing ditches, sidecast materials currently may be left in place to dry for only a month. SRCD, DFG, DWR, and Reclamation propose this period be extended to a year to ensure that all materials are dried before put to beneficial use.

Repairing Existing Exterior Levees

The most common practices for repairing exterior existing levees in Suisun Marsh involve the removal of accumulated silt and vegetation from water circulation ditches in managed wetlands and placement of spoil material on the crown of adjacent levees to raise the crown to its original or design height, and/or improvement of interior side slopes. Materials may be imported from an upland source within or outside the Marsh for beneficial uses of dredged materials or from the LTMS. A potential additional material source, dredging from tidal sloughs, is described below under New Activities.

Repair of existing levees typically occurs from June through September. Approximately 800 linear feet can be completed in 1 day.

It is unlikely that a significant amount of levee repair material would be lost to the outboard side of an exterior levee below the mean high water line. Any material that might trickle down the outside slope of the levee from the crown probably would not affect vegetated areas and may cause only slight and very temporary turbidity.

This activity currently is limited based on acreage of each parcel protected by the exterior levee. The proposed change is to limit work based on actual lineal footage of each ownership. This change is proposed because some small-acreage properties may have significant lengths of exterior levee (e.g., a long, narrow parcel), and a large acreage property may have minimal or no exterior levees but be protected by the small property exterior levee. This administrative change would provide landowners with a more appropriate limit for maintenance of exterior levees. Placement of up to 1.5 cy of levee material per linear foot on average for annual work activities would occur. One levee segment may require no work in a given year, and a different levee segment may require 3.0 cy per linear foot because of flood damage. This would average out over the individual property's total levee system. This slight change in how permitted volumes are calculated is not expected to change the overall patterns of activities conducted in the Marsh. However, the frequency of work is expected to increase to meet the enhancement objective.

New Activities

New activities are activities that have not been implemented in the Marsh, or that have not been implemented in so long that they are not considered part of the existing baseline condition. These new activities would be implemented by DFG, landowners (as represented by SRCD), and/or DWR. This includes RRDS, MIDS, Goodyear Slough Outfall, and other facilities and/or properties. These new activities are described below.

Dredging from Tidal Sloughs as Source Material for Exterior Levee Maintenance and to Remove Sediment around Fish Screens and Other Areas

A dredging program would be implemented to provide materials for deferred and anticipated levee maintenance needs. A total of 3 million cy of materials would be dredged from major and minor tidal sloughs and bays over the 30-year SMP implementation period. However, over time, as tidal restoration occurs, the number of exterior levees in the Marsh may decrease, thus reducing the amount of dredging required to maintain Marsh levees. This may occur under all three alternatives, with Alternative B having only a slight reduction, Alternative A having a moderate reduction, and Alternative C having a substantial reduction. Based on the tidal restoration proposed in each alternative, it is expected that dredging needed for Alternative A (Proposed Project) could be reduced by 15% (total of 85,000 cy annually), Alternative B could be reduced by 9% (total of 91,000 cy annually), and Alternative C could be reduced by 20% (total of 80,000 cy annually). These reductions in dredging would occur over time and would be concurrent with the implementation of the restoration. This activity would be performed during the dredging windows of August through November.

Up to approximately 100,000 cy of material would be dredged annually. However, as described above, as tidal restoration occurs, the number of exterior levees in the Marsh may decrease, thus reducing the amount of dredging required to maintain Marsh levees. The annual allotment would be divided between state and private property, depending on need, and limited to 2.1 cy per linear foot of channel, based on the linear extent of exterior levees on each property or the length of dredger cut. This limitation would be provided as a general guideline; however, flexibility would be necessary in case of special conditions, such as catastrophic levee failure. The proposed volume may be reduced, in any given year, if supplemental material is available through beneficial reuse of suitable dredged materials (i.e., LTMS or other operations).

Some exterior levee segments have vegetation growth on the levee toe that extends out into the bay and/or slough. Repair of levee segments with this vegetation would be avoided if the tidal berm is more than 50 feet wide. Dredging could be done within dredger cuts, which transect wide berms, and salinity stations located on the edge of such berms. Dredging from the center channel will be done to avoid emergent vegetation and other areas with vegetation will be avoided. The approximate cubic yards and acreage of other habitat types per region proposed for dredging per year is shown in Tables 2-6 and 2-7. Minor sloughs include all sloughs except Montezuma and Suisun. Dredger cuts are small, linear channel areas isolated by or transecting a vegetated berm. These are channels which were created immediately adjacent to the toe of the exterior levees during original levee construction or are channels that run from water control structures to bays or sloughs that were previously created to facilitate water drainage.

Table 2-6. Proposed Dredging Volume of 100,000 Cubic Yards Distributed per Habitat Classification and Plan Region

Feature	Region 1 Volume (cy)	Region 2 Volume (cy)	Region 3 Volume (cy)	Region 4 Volume (cy)	Montezuma Slough Volume (cy)	Total Volume (cy)
Bays	0	0	100	4,000	0	4,100
Major Sloughs	2,100	10,700	0	0	16,000	28,800
Minor Sloughs	21,600	8,900	3,000	2,400	0	35,900
Dredger Cuts	6,300	2,700	4,500	10,500	7,200	31,200
Total	**30,000**	**22,300**	**7,600**	**16,900**	**23,200**	**100,000**

Table 2-7. Annual Acreage of Dredging per Habitat (acres)

Feature	Region 1	Region 2	Region 3	Region 4	Montezuma Slough	Total Acres
Bays	0	0	0.02	0.79	0	0.81
Major Sloughs	0.42	2.12	0	0	3.16	5.7
Minor Sloughs	4.28	1.76	0.61	0.48	0	7.13
Dredger Cuts	1.25	0.54	0.89	2.08	1.43	6.19
Total	**5.95**	**4.42**	**1.52**	**3.35**	**4.59**	**19.83**

Dredging activities would be tracked by SRCD using GIS to ensure that it does not occur more than once every 3 years in any location, and would not remove material deeper than 4 feet per dredging cycle. The actual dredging locations would be based on needed levee improvements, but would be limited by region, annual limits, habitat types, and frequency in any one location as described above.

A clamshell dredge or long-reach excavator could be used to dredge in the Marsh. The long-reach excavator could dredge from the levee crown or from a barge. Clamshell dredging could take place either from a barge within the slough channel or from the top of a levee, depending on restrictions caused by vegetation on channel banks or the width of a channel. Barge clamshell dredges are not self-propelling and therefore would need a small tugboat to maneuver within the channel. From a barge, the operation would begin when the bucket assembly, attached by a boom (up to 100 feet), is lowered into the channel to collect sediments. It would scoop up to 5 cy of consolidated bay mud and deposit it on the landside of the levee or crown adjacent to the channel. In limited instances, materials may be used for exterior levee maintenance in areas not adjacent to the dredged material source. The clamshell dredge or long-reach excavator may sit atop the levee and scoop up to 5 cy of consolidated bay mud from the channel bottom, using the same method as from a barge, and deposit the dredged material on the landside backslope, crown , or the levee slope on the bay/slough side if it is devoid of vegetation.

Once material is placed, an excavator bucket would be used to compact the material against the levee to make it as smooth as possible. After 2–3 months of drying time, the material would be disced and graded to integrate the new materials with the existing levee. Minimal materials enter the interior managed wetland or bay/slough because the materials are deliberately placed and kept on the crown and slopes of the levee.

Dredging could occur in the center of slough channels, adjacent to water control structures or culverts, in salinity station locations, in the location of the Suisun Marsh Salinity Control Gates, adjacent to fish screen structures, and in historical dredger cuts. Some exterior levee segments have vegetation growth on the levee toe that extends out into the bay and/or slough. Repair of levee segments with this vegetation would be avoided by not dredging adjacent to tidal berms more than 50 feet wide, dredging from the center channel to avoid emergent vegetation often found along levee slopes, and avoiding other areas with vegetation. Dredging in human-made dredger cuts, which are linked directly to the water control infrastructure of the managed wetlands, fish screens, and in transect wide berms would improve drainage issues that have resulted from siltation. Siltation in some instances has restricted flap gates from opening, dammed water in the drainage channel, and clogged trash racks. This reduces the management capabilities and habitat quality on managed wetland units and reduces the effectiveness of state/federal facilities.

Similarly, some of the 16 fish screen structures and the RRDS fish screen experience significant siltation problems. Silt is deposited around these screens, which impedes the operation of the screen and screen-cleaning brushes. Every few years a relatively small amount of material would be removed from the fish screen basins (about 20 to 100 cy each) by dredging. (This amount is included in the total 3 million cy proposed for dredging in the Marsh.) Alternative measures (trying to move silt by hand) have been ineffective. Dredging around fish screens would be done during low tide to minimize in-water work and minimize turbidity. As the tide returns, the fish screen would be opened to allow turbidity to be drawn into the managed wetland. Dredge spoils would be placed on the crown or landside slope of the exterior levee adjacent to the fish screen. In instances where material cannot be used adjacent to the dredging site, the material may be used on other levees within Suisun Marsh, following the same environmental commitments as identified in the plan.

Placing New Riprap in Areas That Were Not Previously Riprapped

The levee system in Suisun Marsh is continually under the pressure of tidal stage, wind fetch, eroding currents, and boat-wake damage. With sea level rise and climate change these pressures are expected to increase. Over time, protective vegetated berms and levee toes erode and expose the levee foundation to the erosive forces of wind, water, and logs. Many of the areas that require riprap have been treated, and their continued maintenance is described above. This activity addresses those areas that currently do not have riprap but that may be determined in the future to require such treatment.

This new activity would place up to 6,000 linear feet of new riprap over the 30-year plan period on the side slopes of interior water conveyance ditches and up to 2,000 linear feet of new riprap on the side slopes of exterior levees on newly exposed areas not previously riprapped. (This is in addition to the replacement of riprap described above.) No more than 200 linear feet of new riprap would be placed annually. Riprap is placed on the levee using a long-reach excavator or a clamshell or dragline dredge. Placement of riprap would be done from June through September. Riprap materials are transported to the site with a 10-wheel dump truck with a capacity of 16 cy or by barge with a 400 cy capacity. For interior levees, this activity is needed occasionally where the velocity of water flowing through an exterior water control structure causes scouring eddies and bank erosion of inter-levee toes.

New riprap would be placed only when it has been determined that the specific conditions of each site would not support other types of erosion control. Riprap would be applied only under the following circumstances:

- Levees exposed to channel velocities that are too high to support vegetation. Depending on soil type, it may be possible for levee material to withstand short durations that exceed 6 fps.
- Channel depth on the face of the levee slope is deeper than 3 feet below MTL and the levee slope is steeper than 3:1 (H:V); riprap would be applied to reduce erosion potential without consideration for incorporation of vegetation.
- Levee face typically is exposed to vessel wakes year-round and not located in a 5-mph zone; riprap would be applied in area where erosion persists.
- Fetch length exceeds 1,000 feet in the direction of the predominant southwest to southeast winds during high water conditions (e.g., winter storms, spring tides) or prevailing winds during all other times (typically from the west); riprap would be applied to the upper slope of the levee to dissipate wind-driven waves and reduce erosion potential.

Where new riprap is placed, integrative vegetation also would be applied where it is biologically appropriate.

If new riprap is placed on either interior or exterior levees, BMPs would be implemented to reduce the environmental effect as described below in the Environmental Commitments section.

Constructing New Interior Levees for Improved Water Control and Habitat Management within the Managed Wetland Units

Interior levees are embankments that allow management of water inside exterior levees on the managed wetlands. The interior levees are not exposed to tidal action. The purpose of interior levees is to isolate specific areas within the managed wetland to allow independent water control or different water elevations in those areas. The crown width of these levees is normally 10 feet or less, with a crown height of 3 feet above pond bottom, 1 foot of freeboard, and a side slope of 2:1 on both sides.

Interior levees can be constructed in numerous ways: (1) by excavating a new or existing water conveyance ditch and stacking the excavated material to create an interior levee, (2) recontouring a ponded area and pushing up material with a dozer, (3) placing material with a box scraper to create a levee from high ground or pond bottom areas, or (4) importing materials and placing with an excavator or dozer. Interior levees generally would be constructed during the summer months when managed wetlands are dry. Approximately 400 feet of levee can be constructed per day.

Preservation Agreement Implementation Fund

The SMPA PAI Fund is proposed to fund certain permitted activities to support mitigation obligations for the CVP and SWP operations. It is funded by DWR and Reclamation as part of the CVP and SWP mitigation for impacts on the Marsh, as described in the Revised SMPA. The PAI Fund would not include activities beyond what is described above for managed wetland activities, but rather would provide a funding mechanism for landowners to perform needed improvements more frequently for improved water management capabilities to fulfill Reclamation and DWR mitigation obligations. As described below, the PAI Fund applies only to specific work activities.

The PAI Fund would be part of a mitigation strategy for the effects of the CVP and SWP operations on water quality in the Marsh. The PAI Fund would contribute to the funding of some activities needed to improve managed wetland facility operations by establishing a single cost-share funding mechanism that combines the three formerly proposed SMPA Amendment 3 actions into the PAI Fund. The type of improvement determines which cost-share program would apply. These activities would remain as distinct elements under the new PAI Fund, consistent with the objectives and guidelines of each program, cost-share requirements, and regulatory permitting compliance requirements.

The Joint-Use Facility Improvements (JUFI) program would provide funds on a 75/25 cost-share basis for infrastructure improvement to increase efficient and cooperative use of joint-use water delivery systems to managed wetlands. Joint-use facility structures may include but are not limited to interior levees, water conveyance ditches, water control structures, and permanent pumps. Funded activities include construction of new facilities and improvements to existing facilities.

The PAI Fund includes two programs: the 75/25 cost-share program and a 50/50 cost-share program. The 75/25 cost-share program would provide funds for infrastructure improvements that are necessary for the property to meet the 30-day flood and drain cycle objective for managed wetlands. Reimbursement of approved expenditures is limited to the purchase and installation of new, larger, lowered, or relocated discharge facilities to enable the individual owners to meet the 30-day flood and drain cycle. Funds made available by this program would not be used for regular maintenance or for fish screen construction.

The 50/50 cost-share program would provide funds for management and infrastructure improvements that are necessary to improve leaching and drainage efficiency of individual clubs. Eligible activities are cleaning, widening, deepening, and creating new primary and secondary ditches; adding v-ditches or drainage swales; raising elevations of pond bottom sinks; installing or improving interior water control structures; coring interior levees; offsetting electrical and fuel costs for portable and stationary pumps during spring leaching periods only; and offsetting fish screen electrical costs.

These funds, totaling $3.7 million, could be used for improvements as shown in Table 2-8 below.

Table 2-8. Improvements Funded by Preservation Agreement Implementation Fund

Activity Name	Applicable Fund
Clear existing interior ditches	JUFI, PAI Fund 50/50
Construct new interior ditches	JUFI, PAI Fund 50/50
Repair existing interior levees	JUFI
Core existing levees	JUFI, PAI Fund 50/50
Grade pond bottoms for water circulation and raising pond bottom sinks	JUFI, PAI Fund 50/50
Maintain pond bottom spreader V-ditches and swale	JUFI, PAI Fund 50/50
Repair existing interior water control structures	JUFI, PAI Fund 75/25, PAI Fund 50/50
Replace pipe for existing water control structures or installation of new interior water control structures	JUFI, PAI Fund 75/25, PAI Fund 50/50
Install drain pumps and platforms	JUFI, PAI Fund 75/25
Repair exterior water control structures (gates, couplers, and risers)	PAI Fund 75/25
Replace pipe for existing exterior flood or dual-purpose gate	PAI Fund 75/25
Install, repair, or reinstall water control bulkheads	PAI Fund 75/25

Protection of Other Habitat Types

The SMP is not specifically intended to restore, protect, or enhance habitats besides existing managed wetlands and properties acquired for tidal wetland restoration. However, the Principal Agencies recognize the importance of other habitats in the Marsh. As such, when properties are restored, the specific project proponent will protect sensitive habitats that may be located within the bounds of that property. In these instances, the following actions will be implemented as appropriate and feasible.

- Protect and enhance existing tidal wetlands, vernal pool, riparian, and aquatic habitat functions and values by installing fencing to enable improved grazing management.
- Maintain trees, including nonnative eucalyptus, wherever feasible, which provide limited roosting and nesting habitat for raptors, herons, egrets, and other native species in the Marsh.
- Modify and/or set back existing levees to expand the floodplain and restore natural riparian processes.
- Remove and/or modify barriers to upstream fish movement/migration within the project area.
- Plant native riparian trees and shrubs to increase habitat diversity and structure.
- Identify sources of low-DO water in sloughs and bays, and where feasible, implement strategies for increasing DO concentrations in receiving waters.
- Increase natural connectivity between the shallow high productivity marsh plain habitat and adjacent nutrient-rich channels and sloughs.

Of the restored areas, a certain portion is expected to become tidal aquatic habitat. The percent cover of tidal aquatic habitat within tidal wetlands areas (Rush Ranch, Lower Joice Island, and Hill Slough) in Suisun Marsh was estimated based on existing tidal wetlands, the Integrated Regional Wetland Monitoring Pilot Project (BREACH), and GIS and site visits. The analysis demonstrated that tidal aquatic habitat accounts for an average of approximately 5 to 15% of the total area of established tidal wetlands. Assuming this relationship holds true for future restored tidal wetlands, Table 2-9 shows the increase of tidal aquatic habitat that would be expected to result when each action alternative is fully implemented and sites develop into fully functioning tidal marshes. The increase in acreage of tidal aquatic habitat shown does not limit the amount of restoration that could occur.

Table 2-9. Increase of Tidal Aquatic Habitat in Suisun Marsh Resulting from Each Alternative

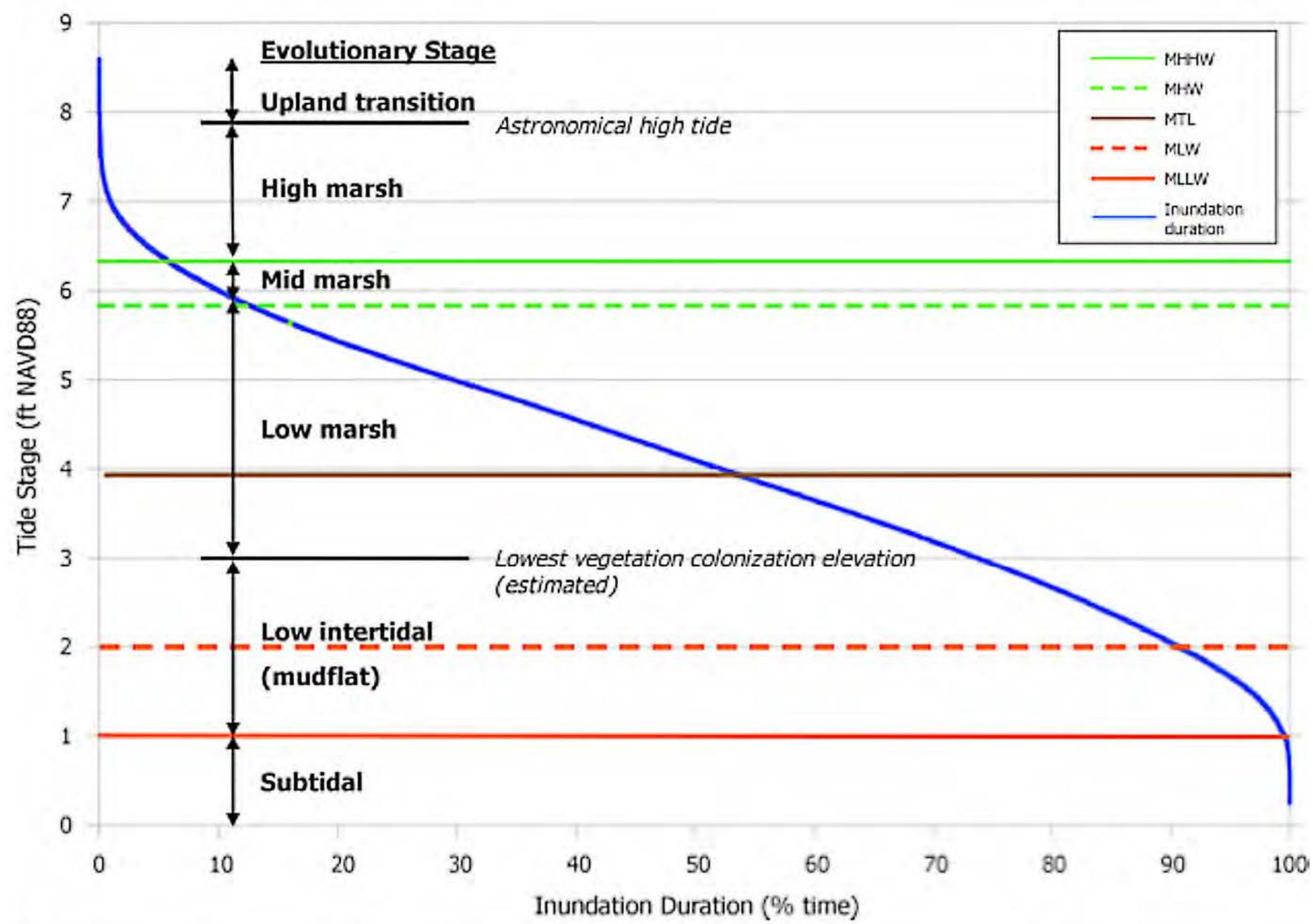
Alternative	Tidal Wetlands Restored	Tidal Aquatic Habitat Increase
Alternative A, Proposed Project	5,000–7,000	250–1050 acres
Alternative B	2,000–4,000	100–600 acres
Alternative C	7,000–9,000	350–1,350 acres

Over the 30-year SMP implementation period, it is expected that the exact habitat amount provided by restored areas will depend on the existing elevation of the site, sedimentation rates and accretion, and sea level rise. The amount of subtidal aquatic habitat is expected to decrease gradually as sediment accretes and emergent tidal vegetation is established at each restoration site. As this happens, the site will be restored to a tidal wetland. However, the rate of accretion and the rate of sea level rise will dictate the end result, and the actual timeframe for such progression depends on the site-specific conditions, but significant geomorphic changes are decadal (Figures 2-1 and 2-3). Locations with large subsidence and low sediment concentrations may never return to emergent marsh and instead remain as open water. Adaptive management also will be used to improve restoration designs to achieve desired results.

CEQA Environmentally Superior and NEPA Environmentally Preferred Alternative

According to Section 15126.6(e)(2) of the State CEQA Guidelines, if the environmentally superior alternative is the no action alternative, the EIR also must identify an environmentally superior alternative among the other alternatives. In the case of the SMP, the No Action Alternative is not environmentally superior to any of the action alternatives, and an environmentally superior action alternative need not be identified.

NEPA requires the identification of an environmentally preferred alternative. In the case of the SMP, each alternative, including the Proposed Project, has many environmental tradeoffs. For example, Alternative C includes the greatest amount of restoration, which is environmentally preferred for species that use tidal habitats. However, it also results in the greatest loss of managed wetlands, making it the least environmentally preferred for species that use these habitats. Likewise, Alternative B offers the greatest benefits for managed wetland species and the least benefits for tidal species. Alternative A, the Proposed Project, represents the mid-range of restoration intended to achieve substantial improvements in tidal wetlands in the Marsh while protecting and enhancing managed wetlands.



Source: Siegel, 2009

Graphics/Projects/project number/document (date) SS

ICF INTERNATIONAL

Figure 2-3
Inundation Regime, Marsh Elevation, and Restoration Evolution Trajectories

Suisun Marsh Plan Implementation Strategy

The SMP is predicated on the assumption that each Principal Agency will implement or approve activities in the Marsh consistent with the SMP and its own mission and jurisdictional authority. The primary components of the strategy are to:

- implement the environmental commitments and mitigation measures in this EIS/EIR and other required state and federal permit measures to ensure that resources are protected and that restoration and managed wetland goals are met simultaneously,
- implement adaptive management to ensure impacts described in this EIS/EIR are not exceeded and to improve the ecological effectiveness of restoration over the period of implementation of the SMP, and
- prepare annual reports on the status of SMP restoration and managed wetland activities.

Meeting Restoration and Managed Wetland Goals Simultaneously

The SMP would contribute to recovery of many species in the Marsh, and for this EIS/EIR, implementation of the entirety of the Proposed Project, including both the restoration activities and managed wetland activities, is an integral part of the analysis. Based on the analysis in this EIS/EIR, implementation of the Proposed Project and environmental commitments would provide sufficient tidal restoration and resource protection of fish and wildlife resources to both offset potential impacts on those resources and contribute to recovery of listed species. As such, both restoration and managed wetland activities would proceed simultaneously, and implementation will be planned to carefully monitor and mitigate the effects of SMP activities.

The managed wetland activities would be implemented only if at least one third of the total restoration activities would be implemented in each of the 10-year increments. Therefore, it is expected that under the Proposed Project, for example, 1,600–2,300 acres in the Marsh would be restored by year 10, an additional 1,600–2,300 acres would be restored by year 20, and the full 5,000–7,000 acres would be restored by year 30. This would ensure that all actions would be implemented in a timeframe similar to that of the impacts and that restoration efforts would contribute toward recovery throughout the plan implementation period. If these 10-year incremental SMP restoration goals are met, both the managed wetland activities and tidal restoration would continue to ensure that the SMP goals would be met. Options for addressing conditions in which these incremental goals are not met are described below. Under this strategy, the restoration and managed wetland goals would be achieved concurrently. How the restoration acres would be applied for purposes of other regulatory permitting requirements (i.e., recovery vs. mitigation) would be specified through each permit as applicable.

Applying Adaptive Management

Many questions remain as to how proposed actions may result in changes in habitat functions and values. To ensure that impacts do not exceed those described in this EIS/EIR and to improve the ecological effectiveness of restoration projects as they are implemented, an Adaptive Management Plan (AMP) will be implemented as a crucial component of the SMP.

Adaptive management of the SMP will consist of an iterative process of:

1. implementing actions that apply the understandings and test hypotheses contained in the conceptual models;
2. collecting science-based field data at implementation areas and in any needed other locations that specifically evaluate the hypotheses being tested;
3. interpreting these data;
4. reevaluating goals and objectives, as appropriate, updating conceptual models and hypotheses, and adjusting subsequent implementation actions; and
5. reviewing the progress of restoration and managed wetland enhancement to determine if changes in the adaptive management plan are necessary.

This process allows for implementing tidal marsh restoration in the face of uncertainty, with an aim to reducing uncertainty over time through system monitoring. In this way, decision making simultaneously meets resource objectives and accrues information needed to improve future management. The information produced through adaptive management of the SMP will permit changes to be made that will assist in the design of future steps. Adaptive management will assist project proponents in understanding the restored system and will aid in their ability to explain their management actions to Suisun Marsh neighbors and the general public. As such, the AMP is an important component of the implementation strategy and will be used throughout the 30-year implementation period. Adaptive management of implementing the SMP will be conducted consistent with available funding.

Reporting

To track the progress of restoration and managed wetland activities, the SMPA agencies (Reclamation, SRCD, DWR, and DFG) would submit implementation status reports annually to DFG, NMFS, and USFWS and other regulatory agencies that would describe the implemented restoration and managed wetland activities. Additional activities, including monitoring, application of adaptive management, results of adaptive management, and any activities that are being planned, would be submitted no less frequently than every other year.

The SMPA agencies will report the status of restoration and managed wetlands in each report. Additional information will be included in the SMP Biological Assessments and Biological Opinions. In general, reports will include the following information:

- the location, extent, and timing of land acquisition for tidal restoration;
- the location, extent, and timing of restoration planning, protection, enhancement, restoration, or creation of tidal wetlands;
- status of restoration planning for acquired properties;
- descriptions of conservation agreements, lands acquired in fee title, interagency memorandums of agreement, or any other agreements entered into for the purposes of protecting, enhancing, or restoring tidal or managed wetlands;
- descriptions of the previous year's managed wetland activities, including a description of how actual impacts compare to impacts analyzed in this EIS/EIR (this information can be used to determine if additional CEQA or NEPA documentation is required for future discretionary actions);
- descriptions of monitoring results, including any actions that will be implemented as a result of this information; and
- a summary of how implemented activities compare to SMP goals in terms of habitat types, managed wetland operations, acreage goals, and species composition.

If any report indicates that restoration or managed wetland targets are not being met or have the potential not to be met, the SMPA agencies along with NMFS and USFWS will convene to determine how to proceed to get plan implementation on track. The mutually agreeable plan of action may include a range of potential solutions, including:

- changes to the manner in which the SMP is implemented,
- temporarily or permanently adjusting certain SMP provisions through an amendment or other process, or
- slowing or stopping aspects of the managed wetland activities permit issuance until restoration catches up with impacts.

Project-Specific Implementation

The SMP likely would rely on several restoration actions to meet the restoration goals. Some sites have been identified as available for restoration (e.g., Meins Landing, Hill Slough), and other properties that have the characteristics desired for restoration are anticipated to become available for purchase (see Table 2-2).

The SMP attempts to describe a typical restoration action in an effort to fully describe the potential impacts of the restoration element of the SMP because this EIS/EIR is intended to provide as much environmental analysis as possible with the limited site-specific information relative to the 30-year plan implementation. In some site-specific instances, the project proponent will be able to rely solely on this EIS/EIR for CEQA and/or NEPA compliance, and under other circumstances, this EIS/EIR may be tiered from or supplemented to disclose all potential environmental impacts. The approach for each restoration action will be determined by the specific lead agencies and will be based on this EIS/EIR, project-specific design components, consideration of any new information (including that obtained through implementation of the AMP), or other factors.

The managed wetland activities would be implemented by the SMPA Agencies, including SRCD, which represents private landowners and reclamation districts in the Marsh, as described for each activity, and this EIS/EIR discloses all of the resulting potential impacts. As such, additional CEQA and/or NEPA documentation is not expected to be required over the 30-year plan implementation period for the management activities.

Plan Response to Predicted Sea Level Rise

This EIS/EIR evaluates the long-term alternatives for the SMP over a 30-year planning horizon, including consideration of global climate change and relative sea level rise on habitat distributions, ability to support target ecological functions, and flood hazards. Relative sea level rise—or the rate of sea level rise expected to be observed locally—is a product of global sea level rise, tectonic land movements, and local subsidence and sedimentation. The rate of global sea level rise is expected to continue along a global warming–induced trajectory, and model-based predictions of sea level rise range from low estimates of 0.18 to 0.38 meter and high estimates of 0.26 to 0.59 meter by the end of the 21st century (Intergovernmental Panel on Climate Change 2007). A regional study estimates that the sea level will increase in California between 12 and 17 inches (0.3 to 0.4 meter) by 2050 and between 20 and 55 inches (0.5 to 1.4 meters) by 2099 (San Francisco Bay Conservation and Development Commission 2009). More recent Ocean Protection Council (OPC) estimates are also consistent with these estimates (Vermeer and Rahmstorf 2009). Although significant uncertainty exists regarding these rates, ongoing research regarding the primary factors affecting global and regional sea level rise continues to narrow the uncertainties and refine future estimates.

Looking forward, if sea level rise matches the mid-range of the Intergovernmental Panel on Climate Change (IPCC) (2007) predictions and sediment availability to the Marsh remains the same, sustainable vegetated tidal marshes are expected to develop in the tidally restored ponds within the plan's 30-year planning horizon. If higher rates of sea level rise prevail, tidally restored areas within the SMP area may persist as intertidal unvegetated mudflats or shallow–open water habitat for prolonged periods. Many tidally restored wetlands still would be expected to accrete sediment and eventually support vegetated tidal marsh, except at a slower rate, though some restorations in Suisun could remain unvegetated well into the foreseeable future.

Higher than anticipated sea level–rise rates that result in delayed or arrested marsh establishment could hinder the progression toward tidal wetlands, resulting in a mix of habitats, including managed wetlands, tidal wetlands, open water, and subtidal aquatic habitats. Sea level rise represents only one of many uncertainties that could affect the ultimate habitat mix.

A number of features can be built into the restoration efforts to support achieving long-term ecological functions. Providing for the tidal wetland to advance "upslope" can be achieved through constructing a gradually sloping wetland/upland transition zone at interior sites and selecting restoration sites at the wetland-upland edge of Suisun that provide an elevation gradient over which tidal wetland could shift upslope as sea level rises. Promoting early emergent vegetation can help to capture sediment for marsh accretion, and it can enhance the accumulation of organic matter in the developing wetland sediments. This could be accomplished by managing lands prior to restoring tidal action to promote wetland plant biomass accumulation that reverses subsidence.

The potential for sea level rise is acknowledged in the site selection considerations and therefore will be a recurring consideration based on best available science for each restoration project. Administration of this criterion will recognize the dynamic nature of the land/water interactions, including subsidence, sediment accretion potential, and biomass accumulation potential. This will enable project designs to be based on habitat trajectory (as opposed to current or static conditions) over the 30-year planning horizon. This approach will help minimize "sunk cost" of habitat and facility investments as well as help ensure that the targeted habitat type occurs as planned. In addition to site selection and project design considerations, the AMP provides a framework for adapting to sea level rise.

Managed wetland operations and levee maintenance would be adjusted over time with sea level rise. Flood protection levees would be designed to accommodate future sea level rise, either with higher crown elevations at the time of initial construction or with the flexibility to add levee height in the future. Ongoing levee maintenance would maintain levee crown elevations as needed to provide continued flood protection with sea level rise. In general, raising levee crown heights requires widening the levee footprint in order to maintain levee stability. Managed wetlands also will be more difficult to drain by gravity at low tide, thereby reducing water management ability, which can be offset mainly through increased use of pumps for managed wetland drainage, with some clubs continuing to be gravity-drained but with greater management options to take best advantage of every low tide.

Environmental Commitments

As part of the plan implementation, individual project proponents will incorporate certain environmental commitments and BMPs into specific projects to avoid or minimize potential impacts as applicable. Project proponents and the appropriate agencies also will coordinate planning, engineering, and design phases of the project. The environmental commitments are divided between Restoration Activities and Managed Wetland Activities. For restoration activities, project proponents are defined as any state, federal or local agency, landowner, or implementing body of a restoration action. For managed wetland activities, the SMPA Agencies (SRCD, DFG, DWR, and/or Reclamation) are the project proponents and will be responsible for implementing the environmental commitments, depending on the activity (Table 1-1).

Restoration Environmental Commitments

The following BMPs and environmental commitments will be implemented during restoration activities. The environmental commitments discussed below apply to the activities described in the Restore Tidal Wetlands section above.

Standard Design Features and Construction Practices

USFWS, Reclamation, and DFG, as lead agencies for the SMP, determined the following design features and construction practices to be potentially feasible and implementable measures to reduce or mitigate certain short-term, construction-related effects. These measures would be implemented at a site-specific level, as appropriate, depending on the location of construction, potential effects of the specific project, and surrounding land uses. The identified measures are:

- Stopping work immediately if a conflict with a utility facility occurs and contacting the affected utility to (1) notify it of the conflict, (2) aid in coordinating repairs to the utility, and (3) coordinate to avoid additional conflicts in the field.
- Constructing structures in accordance with California Building Code and County General Plan Standards to resist seismic effects and to meet the implementation standards outlined in the Solano County General Plan.
- Ensuring that changes within the Suisun Marsh channels will not significantly affect navigation and emergency access by having Rio Vista and Vallejo Coast Guard Stations review plans to assess safety issues associated with changes when there is potential for in-channel work to affect access.
- Implementing BMPs to minimize any disease-carrying mosquitoes and threats to public health if it is found that project components pose a threat to public health.

- Controlling construction equipment access and placement of fill to maintain acceptable loading based on the shear strength of the foundation material.
- Minimizing degradation of wetland habitats where feasible, i.e., work will be conducted from levee crown.
- Implementing BMPs and measures to minimize water quality impacts such as temporary turbidity increases. See Erosion and Sediment Control Plan below.
- Inspecting all equipment for oil and fuel leaks every day prior to use. Equipment with oil or fuel leaks will not be used within 100 feet of wetlands.
- Requiring the construction contractor to remove all trash and construction debris after construction and to implement a revegetation plan for temporarily disturbed vegetation in the construction zones.
- Maintaining waste facilities. Waste facilities include concrete wash-out facilities, chemical toilets, and hydraulic fluid containers. Waste will be removed to a proper disposal site.

Access Point/Staging Areas

Project proponents will establish staging areas for equipment storage and maintenance, construction materials, fuels, lubricants, solvents, and other possible contaminants in coordination with resource agencies. Practices and procedures for construction activities along city and county streets will be consistent with the policies of the affected local jurisdiction.

Staging areas will have a stabilized entrance and exit and will be located at least 100 feet from bodies of water unless site-specific circumstances do not allow such a setback, in which case the maximum setback possible will be used. If an off-road site is chosen, qualified biological and cultural resources personnel will survey the selected site to verify that no sensitive resources would be disturbed by staging activities. If sensitive resources are found, an appropriate buffer zone will be staked and flagged to avoid impacts. If impacts on sensitive resources cannot be avoided, the site will not be used. An alternate site will be selected.

Where possible, no equipment refueling or fuel storage will take place within 100 feet of a body of water. Vehicle traffic will be confined to existing roads and the proposed access route. Ingress and egress points will be clearly identified in the field using orange construction fence. Work will not be conducted outside the designated work area.

Erosion and Sediment Control Plan

For projects that could result in substantial erosion, project proponents will prepare and implement an erosion and sediment control plan to control short-term and long-term erosion and sedimentation effects and to restore soils and vegetation in areas affected by construction activities. The plan will include all the necessary local jurisdiction requirements regarding erosion control and will implement BMPs for erosion and sediment control as required.

An erosion control plan will be developed to ensure that during rain events construction activities do not increase the levels of erosion and sedimentation. This plan will include the use of erosion control materials (baffles, fiber rolls, or hay bales; temporary containment berms) and erosion control measures such as straw application or hydroseeding with native grasses on disturbed slopes, and floating sediment booms and/or curtains to minimize any impacts that may occur from increased mobilization of sediments.

Stormwater Pollution Prevention Plan

For projects that involve grading or disturbance of more than 1 acre, a stormwater pollution prevention plan (SWPPP) will be developed by a qualified engineer or erosion control specialist and implemented prior to construction. The objectives of the SWPPP would be to (1) identify pollutant sources associated with construction activity and project operations that may affect the quality of stormwater and (2) identify, construct, and implement stormwater pollution prevention measures to reduce pollutants in stormwater discharges during and after construction. The project proponents and/or their contractor(s) will develop and implement a spill prevention and control plan as part of the SWPPP to minimize effects from spills of hazardous, toxic, or petroleum substances during construction of the project. Implementation of this measure would comply with state and federal water quality regulations. The SWPPP will be kept on site during construction activity and during operation of the project and will be made available upon request to representatives of the RWQCB. The SWPPP will include but is not limited to:

- a description of potential pollutants to stormwater from erosion,
- management of dredged sediments and hazardous materials present on site during construction (including vehicle and equipment fuels),
- details of how the sediment and erosion control practices comply with state and federal water quality regulations, and
- a description of potential pollutants to stormwater resulting from operation of the project.

Noise Compliance

The project proponents and/or their contractors will comply with local noise regulations when construction activities occur near residences by limiting construction to the hours specified by Solano County. It is assumed that construction activities would occur during normal working hours, between

7:00 a.m. and 6:00 p.m., Monday through Friday, and between 8:00 a.m. and 5:00 p.m., Saturday and Sunday.

Additionally, when it is determined through site-specific analysis that construction has the potential to occur near residences, noise-reduction practices listed below will be implemented.

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 to 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 redirected roadways away from sensitive receptors.

Traffic and Navigation Control Plan and Emergency Access Plan

For projects that would substantially affect traffic or navigation patterns, or could result in hazardous road or waterway conditions, the project proponents, in coordination with affected jurisdictions, will develop and implement a traffic and navigation control plan, which will include an emergency access plan to reduce construction-related effects on the local roadway and waterway systems and to avoid hazardous traffic and circulation patterns during the construction period. All construction activities will follow the standard construction specifications and procedures of the appropriate jurisdictions, and will avoid major construction activities on days known or expected to have a significant increase in traffic as a result of events in the Marsh.

The traffic and navigation control plan will include an emergency access plan that provides for access into and adjacent to the construction zone for emergency vehicles. The emergency access plan, which requires coordination with emergency service providers such as the Coast Guard before construction, would require effective traffic and navigation direction, substantially reducing the potential for disruptions to response routes.

The traffic and navigation control plan will include but not be limited to the following actions, depending on site-specific conditions:

- coordinating with the affected jurisdictions on construction hours of operation;
- following guidelines of the local jurisdiction for road closures caused by construction activities;
- installing traffic control devices as specified in the California Department of Transportation's (Caltrans's) *Manual of Traffic Controls for Construction and Maintenance Works Zones* (2004);
- notifying the public of road closures in the immediate vicinity of the open trenches in the construction zone and of temporary closures of recreation trails;
- posting signs that conform to the California Uniform State Waterway Marking System upstream and downstream of the dredge areas to warn boaters of work;
- providing access to driveways and private roads outside the immediate construction zone;
- coordinating with Solano County to monitor and repair road damage to levee roads and any other roads damaged during construction to the extent allowed by law, depending on the specific project proponent. An MOU may be implemented for specific restoration projects and could include the following as suggested by Solano County:
    - The restoration project will be responsible for the cost of maintaining, repairing, paving and/or reconstructing roads affected during construction, operation, and maintenance of the restoration project.
    - Repairs will be implemented to comply with the current County Road Improvement Standards, except that repairs to damaged paved sections may be made within 5 inches of asphalt concrete at the discretion of the County, while repairs to damaged gravel sections of road will replace the preexisting depth of aggregate base but not less than 12 inches in depth;
- coordinating with the Union Pacific Railroad prior to beginning any work within the right-of-way of a rail line to ensure that the integrity of the rail line is maintained and to minimize disruptions to service; and
- coordinating with emergency service providers before construction to develop an emergency access plan for emergency vehicles into and adjacent to the construction zone; the emergency access plan would require effective traffic direction, substantially reducing the potential for disruptions to response routes.

Recreation Best Management Practices

The project proponents will implement measures related to recreation and recreation facilities to decrease impacts.

- Avoid nesting habitats and other sensitive areas, such as important roosting and foraging sites during critical nesting periods.

Temporary impacts on boating access may be minimized by:

- not allowing construction to occur during major summer holiday periods;
- maintaining boat access to prime areas;
- providing public information regarding alternate access;
- posting warning signs and buoys in channels, upstream of and downstream of all construction equipment, sites, and activities, during construction;
- posting signs describing alternate boating routes in convenient locations when boating access is restricted; and
- minimizing water-level fluctuation during construction.

Mosquito Abatement Best Management Practices

As described in Section 7.8, Public Health and Environmental Hazards, the Solano County Mosquito Abatement District (SCMAD) is concerned that tidal restoration has the potential to increase mosquito production in the Marsh. However, tidal restoration would be designed to minimize such effects. To further reduce the potential for this effect to occur, SCMAD has recommended several measures to reduce the potential for the production and subsequent spread of diseases carried by mosquitoes. Specific project proponents would develop site-specific plans to address mosquito production for each restoration activity based on the following recommendations, which would be implemented prior to removal or breaching of any levee or water control structure:

1. Develop a management program consistent with Marsh-wide management actions for the control of mosquitoes.
2. If necessary, obtain an engineering survey to locate depressions that would retain tidal water and design site restoration to promote water drainage.

Hazardous Materials Management Plan

A hazardous materials spill plan will be developed prior to construction of each action. The plan will describe the actions that will be taken in the event of a spill. The plan also will incorporate preventive measures to be implemented (such as vehicle and equipment staging, cleaning, maintenance, and refueling) and contaminant (including fuel) management and storage. In the event of a contaminant spill, work at the site immediately will cease until the contractor has contained and mitigated the spill. The contractor will immediately prevent further contamination, notify appropriate authorities, and mitigate damage as appropriate. Adequate spill containment materials, such as oil diapers and hydrocarbon cleanup kits, will be available on site at all times. Containers for storage, transportation, and disposal of contaminated absorbent materials will be provided on the project site.

The project proponents and their contractors will not use any hazardous material in excess of reportable quantities, as specified in Title 40 CFR Part 355, Subpart J, Section 355.50, unless approved in advance by the Office of Emergency Services (OES), and will provide to the OES in the annual compliance report a list of hazardous materials contained at a project site in reportable quantities. The reporting of Hazardous Materials in excess of reportable quantities of Title 40 CFR Part 355 is required annually to Solano County Environmental Health Services Division as the Solano County Certified Unified Program Agency (CUPA).

For large-scale projects, the project proponents will prepare a risk management plan (RMP). The RMP will be submitted to EPA and will reflect the comments of the Solano County CUPA. An RMP addresses acutely hazardous materials such as chlorine gas, ammonia gas, hydrogen chloride, flammable gases. This document is required to be submitted to both the EPA and Solano County Environmental Health Services Division as the CUPA. The plan will describe procedures, protective equipment requirements, and training and contain a checklist. At least 60 days prior to the start of construction, or a lesser period of time as mutually agreed upon, the project proponents will provide the final RMP and the safety plan to the Certified Property Manager (CPM).

Air Quality Best Management Practices

The following control practices will be used to offset any air quality issues that may arise (Bay Area Air Quality Management District 1999).

Basic Control Measures

The following controls will be implemented at all construction sites.

- Treat all graded surfaces to prevent nuisances from dust or spillage on roads or adjacent properties.

Enhanced Control Measures

The following measures will be implemented at construction sites greater than 4 acres in area.

- Hydroseed with native or non-invasive species appropriate to that specific location or apply (nontoxic) soil stabilizers to inactive construction areas (i.e., previously graded areas inactive for 10 days or more).
- Limit traffic speeds on unpaved roads to 15 mph.

- Install sandbags or other erosion control measures to prevent silt runoff to public roadways.
- Replant vegetation with native or non-invasive species appropriate to that specific location in disturbed areas as quickly as possible.

Additional Air Quality Best Management Practices

In addition to the above BMPs, the following measures will be required in order to further reduce construction emissions:

- maintain properly tuned engines;
- minimize the idling time of diesel-powered construction equipment to 2 minutes;
- use alternative-powered (e.g., hybrid, compressed natural gas, biodiesel, electric) construction equipment;
- use add-on control devices such as diesel oxidation catalysts or particulate filters; and
- require all contractors to use equipment that meets California Air Resources Board's (ARB's) most recent certification standard for off-road heavy-duty diesel engines.

Visual/Aesthetic Best Management Practices

For projects that have the potential to affect views or create a new source of light or glare, project proponents will identify sensitive view receptors for site-specific analysis and ensure that contractors minimize fugitive light from portable sources used for nighttime operations. Also, a visual barrier will be installed to prevent light spill from truck headlights in areas with sensitive view receptors.

Inadvertent Discovery of Cultural Resources

Federal and state laws and regulations outline the courses of action required in the event of inadvertent discoveries of cultural resources, including human remains. Section 106 of the National Historic Preservation Act (NHPA) allows for federal agencies to plan for post-Section 106 review, or inadvertent, discoveries of cultural resources prior to authorization of a federal action or undertaking (36 CFR 800.13[a]). One avenue for planning is through a programmatic agreement (PA) (see 36 CFR 800.13[a][2]). Such PAs must define the parties responsible for action in the event of cultural resource discoveries, communication protocols, response times, and specific action items. The cultural resources analysis in this EIS/EIR identifies a PA as a critical element in mitigating significant effects on cultural resources; the PA will include provisions for inadvertent discoveries.

Federal and state laws and regulations impose additional requirements specific to the discovery of human remains and associated artifacts. On federal or tribal land, human remains discoveries are subject to the Native American Grave Protection and Repatriation Act (NAGPRA). Additionally, Reclamation has specific policies for the implementation of the NAGPRA provisions (Reclamation Directives and Standards LND 07-01). For human remains discoveries on non-federal land, the requirements of the California Public Resources Code and Health and Safety Code apply, as described below. In the event that human remains are discovered inadvertently during ground-disturbing activities, the lead state or federal agency will implement the following measures. These measures also will be discussed, with explicit treatment of roles and responsibilities under the various applicable regulations, in the PA referenced previously.

- The contractor immediately will cease work within 100 feet of the find. All construction personnel will leave the area. Vehicles and equipment will be left in place until a qualified archaeologist identifies a safe path out of the area. The on-site supervisor will flag or otherwise mark the location of the find and keep all traffic away from the resource. The on-site supervisor immediately will notify the lead state or federal agency of the find.
- The lead federal agency is responsible for compliance with NAGPRA (43 CFR 10) if inadvertent discovery of Native American remains occurs on federal lands. The lead federal agency is responsible for compliance with state laws relating to the disposition of Native American burials (Public Resources Code [PRC] 5097 and California Health and Safety Code 7050.5[b]) for human remains discoveries on non-federal lands.
- If human remains of Native American origin are discovered during ground-disturbing activities on non-federal land, the lead state or federal agency must comply with state laws relating to the disposition of Native American burials, which fall within the jurisdiction of the Native American Heritage Commission (NAHC) (PRC 5097). If human remains are discovered or recognized in any location other than a dedicated cemetery, the lead state or federal agency will not allow further excavation or disturbance of the site or any nearby area reasonably suspected to overlie adjacent human remains until:
    - the Solano County coroner has been informed and has determined that no investigation of the cause of death is required; and
    - if the remains are of Native American origin,
        - the descendants of the deceased Native Americans have made a recommendation to the landowner or the person responsible for the excavation work for means of treating or disposing of, with appropriate dignity, the human remains and any associated grave goods as provided in PRC 5097.98; or
        - the NAHC was unable to identify a descendant or the descendant failed to make a recommendation within 48 hours after being notified by the NAHC.

Biological Resources Best Management Practices

The following section outlines the potential BMPs that would be implemented to avoid or minimize impacts on biological resources. The BMPs that are implemented for each specific project will depend on the project location, potential to adversely affect biological resources, and guidance and requirements set forth by resource agencies through informal and formal consultations. Environmental commitments, including an erosion and sediment control plan, SWPPP, hazardous materials management plan, spoils disposal plan, and environmental training content will be provided to NMFS, USFWS, and DFG 30 days prior to construction activities commencing at a restoration site. Any adverse effects on special-status species, critical habitat, or essential fish habitat (EFH) attributable to construction activities may require implementation of additional avoidance or mitigation measures. NMFS, USFWS, and DFG will be consulted, and additional avoidance and mitigation measures may be implemented on a site-specific basis.

General Best Management Practices

- No firearms (except for federal, state, or local law enforcement officers and security personnel) will be permitted at the project site to avoid harassment, killing, or injuring of wildlife.
- No pets will be permitted at the project site to avoid harassment, killing, or injuring of wildlife.
- Native vegetation trimmed or removed on the project site will be stockpiled during work. After construction activities, removal of temporary mats and construction-related materials, and application of native seed mix have been completed, stockpiled native vegetation will be reapplied over temporarily disturbed wetlands to provide temporary soil protection and as a seed source.
- Where vegetation removal is required, work will be conducted using hand-held tools to enable wildlife to escape. If any areas with pickleweed or vegetation within 50 feet of the edge of pickleweed need to be cleared for project activities, vegetation shall be removed only with non-mechanized hand tools (i.e., trowel, hoe, rake, and shovel). No motorized equipment, including weed whackers and lawn mowers, shall be used to remove this vegetation. Vegetation shall be removed under the supervision of a qualified biologist approved by DFG and USFWS. If a mouse of any species is observed within the areas being removed of vegetation, DFG and USFWS shall be notified. Vegetation removal may begin when no mice are observed and shall start at the edge farthest from the salt marsh or the poorest habitat and work its way toward the salt marsh or the better salt marsh habitat.
- Removal of vegetation in wetland habitat will be conducted with a qualified biological monitor present. This monitor will watch for special-status wildlife species and temporarily stop work if special-status species are encountered. Wildlife will be allowed to escape before work is resumed. Monitors with the appropriate qualifications to handle special-status species

will be allowed to move special-status species to safe locations as permitted by their authorizations.

- Temporarily affected wetlands will be restored by removing construction-related debris, and trash. Affected areas will be seeded with a seed mix of local native wetland species.

Worker Training

Project proponents will provide training to field management and construction personnel on the importance of protecting environmental resources. Communication efforts and training will be done during preconstruction meetings so that construction personnel are aware of their responsibilities and the importance of compliance.

Construction personnel will be educated on the types of sensitive resources located in the project area and the measures required to avoid impacts on these resources. Materials covered in the training program will include environmental rules and regulations for the specific project and requirements for limiting activities to the construction right-of-way and avoiding demarcated sensitive resources areas. Training seminars will educate construction supervisors and managers on:

- the need for resource avoidance and protection,
- construction drawing format and interpretation,
- staking methods to protect resources,
- the construction process,
- roles and responsibilities,
- project management structure and contacts,
- environmental commitments, and
- emergency procedures.

If new construction personnel are added to the project, the contractor will ensure that the personnel receive the mandatory training before starting work. A representative will be appointed during the employee education program to be the contact for any employee or contractor who might inadvertently kill or injure a listed species or who finds a dead, injured, or entrapped individual. The representative's name and telephone number will be provided to the USFWS before the initiation of ground disturbance.

Special-Status Plant Species Protection

A complete botanical survey of restoration areas will be completed using the USFWS's *Guidelines for Conducting and Reporting Botanical Inventories for*

Federally Listed, Proposed and Candidate Plants (September 23, 1996) (U.S. Fish and Wildlife Service 1996a) and DFG's *Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities* (November 24, 2009) (California Department of Fish and Game 2009).

- Special-status plant surveys required for project-specific permit compliance will be conducted within 1 year prior to initiating construction. The purpose of these surveys will be to verify that the locations of special-status plants identified in previous surveys are extant, identify any new special-status plant occurrences, and cover any portions of the project area not previously identified. The extent of mitigation of direct loss of or indirect impacts on special-status plants will be based on these survey results.
- Locations of special-status plants in proposed construction areas will be recorded using a global positioning system (GPS) unit and flagged.
- If initial screening by a qualified biologist identifies the potential for special-status plant species to be directly or indirectly affected by a specific project, the biologist will establish an adequate buffer area to exclude activities that would directly remove or alter the habitat of an identified special-status plant population or result in indirect adverse effects on the species.
- Access may be restricted around restoration sites where necessary to protect special-status plant populations though appropriate management plans and the design of the tidal marsh restoration. This may include signage, buffers, seasonal restrictions and design or no access depending on the sensitive species in question.
- The project proponents will oversee installation of a temporary, plastic mesh–type construction fence (Tensor Polygrid or equivalent) at least 1.2 meters (4 feet) tall around any established buffer areas to prevent encroachment by construction vehicles and personnel. A qualified biologist will determine the exact location of the fencing. The fencing will be strung tightly on posts set at maximum intervals of 3 meters (10 feet) and will be checked and maintained weekly until all construction is complete. The buffer zone established by the fencing will be marked by a sign stating:

  > This is habitat of *[the special-status species being protected]*, a *[identify the species' status]* plant species, and must not be disturbed. This species is protected by *[the Endangered Species Act of 1973, as amended/California Endangered Species Act/California Native Plant Protection Act]*. Violators are subject to prosecution, fines, and imprisonment.

- No construction activity, including grading, will be allowed until this condition is satisfied.
- No grading, clearing, storage of equipment or machinery, or other disturbance or activity will occur until all temporary construction fencing has been inspected and approved by the qualified biologist.
- Where feasible, for stump-sprouting vegetation, construction will limit removal of woody vegetation by trimming vegetation to approximately 1 foot above ground level.

Protection of Special-Status Wildlife Species

If individuals of listed wildlife species may be present and subject to potential injury or mortality from construction activities, a qualified biologist will conduct a preconstruction survey. Minimum qualifications for the qualified biologist will be a 4-year college degree in biology or related field and 2 years of professional experience in the application of standard survey, capture, and handling methods for the species of concern. However, in the case of fully protected species, no capture or handling will be done. Fully protected wildlife species are listed in Section 6.3, Wildlife. Any special-status mammal, bird or other species observed during surveys will be reported to DFG so the observations can be added to the California Natural Diversity Database (CNDDB).

Mammals

Only two special-status mammal species occur in the Marsh, salt marsh harvest mouse and Suisun shrew. Suisun shrews use habitat similar to salt marsh harvest mouse, so any measures implemented to protect salt marsh harvest mouse would apply to shrews. The following measures will be implemented:

- A USFWS-approved biologist, with previous salt marsh harvest mouse monitoring and surveying experience, will identify suitable salt marsh habitat for the mouse prior to project initiation.
- Disturbance to wetland vegetation will be avoided to the extent feasible in order to reduce potential impacts on salt marsh harvest mouse habitat. If wetland vegetation cannot be avoided, it will be removed by hand. The USFWS-approved biologist will be on site to monitor all wetland vegetation removal activities.
- The upper 6 inches of soil excavated within salt marsh harvest mouse habitat will be stockpiled separately and replaced on top of the backfilled material.
- Vegetation will be removed by hand using hand tools.
- In construction and staging areas where habitat is to be disturbed, vegetation must be cleared to bare ground or stubble no higher than 1 inch.
- Work will be scheduled to avoid extreme high tides (6.5 feet or above, as measured at the Golden Gate Bridge) when there is potential for salt marsh harvest mouse to move to higher, drier grounds. All equipment will be staged on existing roadways away from the project site when not in use.
- To prevent salt marsh harvest mouse from moving through the project site during construction, temporary exclusion fencing will be placed around a defined work area before construction activities start and immediately after vegetation removal. The fence should be made of a material that does not allow salt marsh harvest mouse to pass through or over, and the bottom should be buried to a depth of 2 inches so that mice cannot crawl under the fence. Any supports for the salt marsh harvest mouse exclusion fencing must be placed on the inside of the project area.
- Prior to the start of daily construction activities during initial ground disturbance, the USFWS-approved biological monitor will inspect the salt

marsh harvest mouse–proof boundary fence to ensure that it has no holes or rips and the base is still buried. The fenced area also will be inspected to ensure that no mice are trapped in it. Any mice found along and outside the fence will be closely monitored until they move away from the construction area.

- If a salt marsh harvest mouse is discovered, construction activities will cease in the immediate vicinity of the individual until DFG and USFWS are contacted and the individual has been allowed to leave the construction area.
- A DFG- and USFWS-approved biologist with previous salt marsh harvest mouse experience will be on site during construction activities occurring in wetlands. The biologist will document compliance with the project permit conditions and avoidance and conservation measures. The biologist has the authority to stop project activities if any of the requirements associated with these measures is not being fulfilled. If the biologist has requested work stoppage because of take of any of the listed species, the USFWS and DFG will be notified within 1 day by email or telephone.

Birds

The project proponents will perform preconstruction surveys to determine whether nesting birds, including migratory birds, raptors, and special-status bird species, are present within or immediately adjacent to the project sites and associated staging and storage areas if activities would occur during active nesting periods. Bird species using the managed wetland habitat include waterfowl, shorebirds, Suisun song sparrow, Suisun common yellowthroat, and several other resident and migratory songbirds.

- The project proponents will remove all woody and herbaceous vegetation from construction areas (earthwork areas) during the nonbreeding season (September 1–February 1) to minimize effects on nesting birds.
- During the breeding season, all vegetation subject to impact will be maintained to a height of approximately 6 inches to minimize the potential for nesting.
- If construction occurs during the breeding season and not all affected vegetation has been removed, a qualified biologist will survey the construction area for active nests and young migratory birds immediately before construction.
- If active nests or migratory birds are found within the boundaries of the construction area, the project proponents will develop appropriate measures and coordinate with DFG to determine an acceptable buffer width.
- Inactive migratory bird nests (excluding raptors) located outside of the construction areas will be preserved. If an inactive migratory bird nest is located in the area of effect, it will be removed before the start of the breeding season (approximately February 1).
- Impacts on great blue heron rookeries will be avoided; mature trees will not be removed and nearby work will occur outside the nesting season.

Raptors

- Preconstruction surveys will be performed before and during the raptor nesting season (bimonthly, i.e., two times per month) to identify existing nests that may be used during the nesting season.
- Raptors may nest from later winter through mid-summer; therefore, multiple nesting season surveys will performed.
- DFG will be notified of all raptor nests located during the preconstruction surveys. If a raptor nest is located within the recommended buffer, the project proponents will coordinate with DFG to determine an acceptable buffer width.
- If an active raptor nest is found outside the construction areas, a buffer zone will be created around the nest tree. For special-status species a larger buffer will be required (e.g., 0.5-mile Swainson's hawk buffer). The project proponents will coordinate with DFG prior to project implementation to determine the species-specific buffer widths.

California Clapper Rail and California Black Rail

If construction activities are necessary during the breeding season, preconstruction surveys for California clapper rail and black rail will be conducted at and adjacent to areas of potential tidal and managed wetlands habitats for California clapper rail and black rail. The surveys will focus on potential habitat that may be disturbed by construction activities during the breeding season to ensure that these species are not nesting in these locations. Survey methods will follow the protocols used by DFG during previous rail surveys in Suisun Marsh (California Department of Fish and Game 2007). The specific project proponent will implement the following survey protocols:

- Surveys should be initiated sometime between January 15 and February 1. A minimum of four surveys should be conducted. The survey dates should be spaced at least 2 to 3 weeks apart and should cover the time period from the date of the first survey through the end of March or mid-April. This will allow the surveys to encompass the time period when the highest frequency of calls is likely to occur.
- Listening stations will be established at 150-meter intervals along road, trails, and levees that will be affected by plan implementation.
- California clapper rail and California black rail vocalization recordings will be played at each station.
- For California clapper rails, each listening station will be occupied for a period of 10 minutes, followed by 1 minute of playing California clapper rail vocalization recordings, then followed by an additional minute of listening.
- For black rails, each listening station will be occupied for 1 minute of passive listening, 1 minute of "grr" calls followed by 30 seconds of "ki-ki-krrr" calls, then followed by another 3.5 minutes or passive listening.
- Sunrise surveys will begin 60 minutes before sunrise and conclude 75 minutes after sunrise (or until presence is detected).

- Sunset surveys will begin 75 minutes before sunset and conclude 60 minutes after sunset (or until presence is detected).
- Surveys will not be conducted when tides are greater than 4.5 National Geodetic Vertical Datum (NGVD) or when sloughs and marshes are more than bankfull.
- California clapper rail and California black rail vocalizations will be recorded. A GPS receiver will be used to identify call location and distance. The call type, location, distance, and time will be recorded on a data sheet.

If California clapper rail or black rail is present in the immediate construction area, the following measures will apply during construction activities.

- To avoid the loss of individual California clapper rails or black rails, activities within or adjacent to California clapper rail or black rail habitat will not occur within 2 hours before or after extreme high tides (6.5 feet or above, as measured at the Golden Gate Bridge), when the marsh plain is inundated, because protective cover for California clapper rails is limited and activities could prevent them from reaching available cover.
- To avoid the loss of individual California clapper rails or black rails, activities within or adjacent to tidal marsh areas will be avoided during the California clapper rail breeding season from February 1 through August 31 each year unless surveys are conducted to determine California clapper rail locations and California clapper rail and black rail territories can be avoided. Figure 2-5 shows the areas of known clapper rail breeding habitat.
- If breeding California clapper rails or black rails are determined to be present, activities will not occur within 700 feet of an identified calling center. If the intervening distance across a major slough channel or across a substantial barrier between the California clapper rail calling center and any activity area is greater than 200 feet, it may proceed at that location within the breeding season.
- *Exception:* Only inspection, maintenance, research, or monitoring activities may be performed during the California clapper rail or black rail breeding season in areas within or adjacent to California clapper rail breeding habitat with approval of the USFWS and DFG under the supervision of a qualified biologist.

California Least Tern

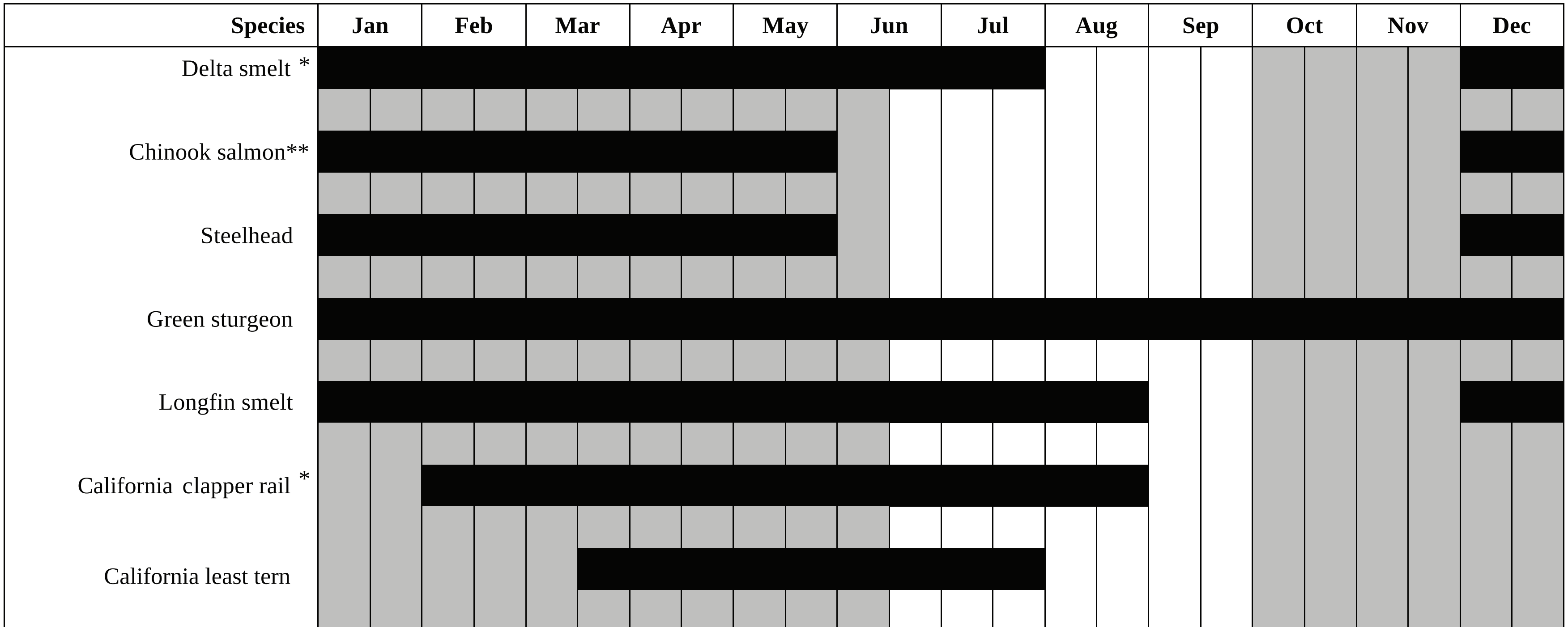
- No activities will be performed within 300 feet of an active least tern nest during the least tern breeding season, April 15 to August 15 (or as determined through surveys).
- *Exception:* Only inspection, maintenance, research, or monitoring activities may be performed during the least tern breeding season in areas within or adjacent to least tern breeding habitat with approval of the USFWS and DFG under the supervision of a qualified biologist.

Biological Monitoring

- The project proponents will provide a biologist/environmental monitor who will be responsible for monitoring implementation of the conditions in the state and federal permits (federal Clean Water Act [CWA] Section 401, 402, and 404; ESA Section 7; Fish and Game Code Section 1602 and/or 2050; project plans [SWPPP]; and EIS/EIR mitigation measures).
- The biologist/environmental monitor will determine the location of environmentally sensitive areas adjacent to each construction site based on mapping of existing land cover types and special-status plant species. If such maps are not available, the biologist/environmental monitor will map and quantify the land cover types and special-status plant populations in the proposed project footprint prior to construction.
- To avoid construction-phase disturbance to sensitive habitats immediately adjacent to the project area, the monitor will identify the boundaries of sensitive habitats and add at least a 100-foot buffer, where feasible, using orange construction barrier fencing. The fencing will be mapped on the project designs. Erosion-control fencing also will be placed at the edges of construction where the construction activities are upslope of wetlands and channels to prevent washing sediment off site. The sensitive habitat and erosion-control fencing will be installed before any construction activities begin and will be maintained throughout the construction period.
- The biologist/environmental monitor will ensure the avoidance of all sensitive habitat areas outside direct project footprints, including patches of tidal wetland along channel banks, during dredging operations, to the extent practical.
- Plants for revegetation will primarily come from natural recruitment. Plants imported to the restoration areas will come from local stock, and to the extent possible, local nurseries. Only native plants will be used for restoration efforts.

Construction Period Restrictions

Timing of restoration construction activities will depend on the type of activity, presence or absence of sensitive resources, tides, and/or water management in wetlands. In general, landside work will occur between July and September. In-water activities will be conducted during the months of August through November (Figure 2-4). Working outside this window would require additional approvals from the resource agencies. Other timing restrictions may be necessary during the hunting season, such as limiting work to days other than Saturday, Sunday, and Wednesday.



Notes:

* Delta smelt and California clapper rail are present year-round in the marsh. Black represents periods of species sensitivity to construction activities.

** Chinook salmon includes spring-, winter-, fall-, and late fall–run species.

- Species presence and/or period of sensitivity
- Permissible time period for construction
- No construction activities can occur

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Figure 2-4
Work Activity Windows for Sensitive Species

Nonnative Plant Control

The project proponents will include the following measures in the project construction specifications to minimize the potential for the introduction of new noxious weeds and the spread of weeds previously documented in the project area.

- Use certified, weed-free, imported erosion control materials (or rice straw in upland areas).
- Coordinate with the county agricultural commissioner and land management agencies to ensure that the appropriate BMPs are implemented.
- Educate construction supervisors and managers on weed identification and the importance of controlling and preventing the spread of noxious weeds.
- Clean equipment at designated wash stations after leaving noxious weed infestation areas.
- Treat isolated infestations of noxious weeds identified in the project area with approved eradication methods at an appropriate time to prevent further formation of seed, and destroy viable plant parts and seed.
- Minimize surface disturbance to the greatest extent possible.
- Use certified weed-free native mixes for any restoration planting or seeding as may be necessary, as provided in the revegetation plan developed in cooperation with DFG. Mulch with certified weed-free mulch. Rice straw may be used to mulch upland areas.
- Use native, noninvasive species or nonpersistent hybrids in erosion control plantings to stabilize site conditions and prevent invasive species from colonizing.

Cultural Resources

- If any previously unknown historic or archeological artifacts are discovered while accomplishing the authorized work, the landowner must stop work immediately and notify the Corps. The activity is not authorized until the requirements of Section 106 of the NHPA have been satisfied.
- Work is not authorized within 100 feet of archeological site CAL-SOL-13.

Managed Wetland Activities Environmental Commitments

Continuation of Existing Best Management Practices and Biological Opinion Terms and Conditions

The SMPA agencies and private landowners have been maintaining property and/or facilities in the Marsh for more than three decades in compliance with existing BOs from USFWS and NMFS. Implementation of the SMP will include continuation of monitoring, fish screening, and other ongoing requirements and programs.

Implementation of the SMP will include submitting BAs to USFWS and NMFS. Terms and conditions of the revised BOs will be followed. Any adverse effects on special-status species, critical habitat, or EFH will be addressed by the project proponent, and any additional measures will be followed in compliance with CESA, ESA and EFH authorizations. Many of these requirements are described in the applicable existing conditions sections of the resource analysis sections.

Standard Design Features and Construction Practices

- When possible, drain pipes should be relocated to drain into larger receiving sloughs with good tidal circulation to avoid and minimize the degradation of water quality in receiving waters.
- All new and/or replacement drain pipes will be located on the largest possible sloughs, or sloughs with the highest levels of tidal circulation possible, to minimize or lessen the possibility of degraded water quality conditions.
- Management options, including vegetation management and diversion timing and location, will be pursued to avoid and minimize occurrence of low dissolved oxygen (DO) water conditions in managed wetlands.
- New exterior drain structures will be installed where the discharge channel already exists. The new drain will not be placed on emergent vegetation. The pipe will be installed at low tide. No in-water work is authorized.
- Landowners importing any material besides rock material from outside the Suisun Marsh must contact the RWQCB before importation. Landowners must obtain the RWQCB's concurrence that the imported material is acceptable before use.
- Material excavated from existing spreader ditches and creation of new spreader ditches may be sidecast adjacent to the ditch. No excavated material will be more than 12 inches high.
- Exterior pipes will be placed below the depth of emergent vegetation.

- Pipe replacement as well as repair, replacement, or installation of exterior water control structures will not change the existing use or diversion capacity.
- All pipes will be pre-assembled before installation to minimize work time.
- All material shall remain on the crown or interior side of the levee during the repair of exterior existing levees, the coring of existing exterior levees, and the installation of drain pumps and platforms.
- All bulkheads will be in place prior to backfilling the bulkhead during installation, repair, or re-installation of water control structures.
- Installation of drain pumps and platforms will be done entirely within the managed wetland; although discharge pipes will comply with permit terms and conditions for exterior discharge pipe installation.
- All work to be performed on the exterior side of levees shall commence and be completed within a 6-hour period, from 3 hours prior to low tide to 3 hours after low tide.
- Construction equipment used for projects will be checked each day prior to work and, if necessary, action will be taken to prevent fluid leaks. If leaks occur during work, the Corps, its permittee, or the contractor will contain the spill and remove the affected soils.
- All contractors must have a supply of erosion and pollution control materials on site to facilitate a quick response to unanticipated storm events or emergencies.
- No in-water work will occur during the repair of existing exterior levees; the coring of existing levees; pipe replacement at the exterior flood or dual-purpose gate; pipe replacement at the existing exterior drain gate; installation, repair, or re-installation of water control bulkheads; installation of drain pumps and platforms; or installation of new exterior drain structures.
- Emergent vegetation will not be disturbed during the following activities: repair of existing exterior levees, replacement of existing riprap on exterior levee, or installation of the new exterior drain structure.
- No fresh concrete, cement, silts, clay, soil, or other materials will be discharged to Marsh waters.

Reporting Requirements

Proposed work reports must be submitted to the Corps, NMFS, State Lands Commission, and RWQCB by the first day of each month. When the first day falls on a weekend, the report would be due the following Monday.

The SRCD shall prepare an annual report that summarizes the amounts and locations of activities performed. This report shall be submitted to the Corps, U.S. Environmental Protection Agency, NMFS, USFWS, State Lands Commission, and the RWQCB. This report must include an estimate regarding temporarily affected wetlands and describe any additional minimization methods (i.e., replacing a metal pipe with HDPE pipe to lessen future maintenance needs).

The Corps and applicant shall provide a written annual report to NMFS by December 31 of each year. The report shall be submitted to the NMFS Santa Rosa Area Office, Attention: Supervisor of Protected Resources Division, 777 Sonoma Avenue, Room 325, Santa Rosa, California 95404-6528. The report shall contain, at a minimum, the following information:

i. **Project-related activities**—The report shall include the type, size, and location of specific actions (on exterior pipe replacement and installation and rip rap placement) undertaken; dates when specific actions began and were completed; a description of BMPs implemented to minimize project effects; photographs taken before, during, and after the activity from photo reference points; and a discussion of specific project performance or efficacy.

ii. **Unanticipated project effects**—The report shall include a discussion of any unanticipated project effects or unanticipated levels of project effects on salmonids, green sturgeon, and/or critical habitat and a description of any and all measures taken to minimize those unanticipated effects as well as a statement regarding whether the unanticipated effects had any effect on ESA-listed fish or critical habitat.

iii. **Gate closures and diversion curtailment**—The report shall summarize compliance monitoring for gate closures and diversion curtailments.

iv. **Observations of salmonids and green sturgeon**—The report shall document observations of any salmonids or green sturgeon occurring within the action area during project actions.

A summary of the results of water quality monitoring or evaluation of the wetland management operational modifications used is no longer required. This information was previously provided by SRCD and DFG in 2008, 2009, and 2010 to NMFS.

Riprap

Riprap replacement may occur on the slopes of interior ditches where rock has been washed away and on exterior levees where rock has been washed away or subsided.

- Riprap will not be placed directly on emergent vegetation (e.g., tules, *Scirpus* spp.).
- Emergent vegetation will not be uprooted during the placement of riprap, nor will it be displaced by riprap.
- Riprap placed on the exterior side of the levee will commence and be complete within a six-hour period, from three hours prior to low tide to three hours following low tide.

Dredging Practices

Dredging has the potential to result in adverse environmental effects if it leads to the release of fine-grained sediments or increasing turbidity, or if it remobilizes contaminated materials. The following preliminary environmental commitments will be implemented as part of the proposed dredging program to avoid and/or minimize effects on aquatic resources in Suisun Marsh.

- All construction facilities and working platforms required for dredging operations will maintain an operating environment free of fuel spills.
- Runoff generated on the job site will be controlled.
- Dredging activities will occur only between August 1 and November 30.
- Removal of emergent vegetation will be avoided where feasible, although areas of vegetation may need to be disturbed during construction to provide site access, adequate volume of material for construction, and proper water flow at the site.
- Dredging will be avoided within 200 feet of storm drain outfall and urban discharge locations, unless suitable preconstruction contaminant testing is conducted (coordination and consulting with the DMMO relative to evaluation and placement of the materials).
- A berm will be constructed on the channel-side of the levee crown to prevent runoff into adjacent aquatic habitats.
- Releases of discharge water from managed wetlands will be limited following dredged material placement.
- The extent of dredging disturbance will be limited based upon slough channel habitat classification and plan region as identified in Table 2-6.
- Alternate boating routes will be identified if dredging impedes navigation.

Biological Resources Best Management Practices

Below are environmental commitments for special-status plants, birds, and fish. Any suspected take of listed species will be reported immediately to DFG and the SRCD, who will immediately contact USFWS or NMFS. Any carcasses of listed fish will be frozen in a whirl-pak bag and retained until instructions are received from the applicable agency.

Biological Monitoring

The project proponents will monitor implementation of environmental commitments pertaining to dredging, riprap placement, or work on the water side of exterior levees that removes vegetation and will provide a biologist/environmental monitor who will be responsible for monitoring implementation of the conditions of any state and federal permits (CWA

Sections 401, 402, and 404; ESA Section 7; Fish and Game Code Section 1602 and/or 2050; project plans [SWPPP]; and EIS/EIR mitigation measures).

Plants

An on-site field inspection for special-status plants will be conducted by a USFWS-approved biologist for managed wetlands activities on the water side of exterior levees. This includes all water control structure replacement and rip rap placement, except when a headwall is present; installation of exterior water control structures; alternative bank protection placement; and dredging and other facility maintenance activities that remove vegetation. Special-status plants include:

- soft bird's beak (*Cordylanthus mollis* ssp. *mollis*),
- salt marsh bird's beak (*C. maritimus* ssp. *maritimus*)
- hispid bird's beak (*C. mollis* ssp. *hispidus*)
- Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*)
- Mason's lilaeopisis (*Lilaeopsis masonii*)
- Suisun thistle (*Cirsium hydrophilum* var. *hyrdophilum*)
- Suisun Marsh aster (*Aster lentus*)
- alkali milk-vetch (*Astragalus tener*)
- heartscale (*Atriplex cordulata*)
- brittlescale (*Atriplex depressa*)
- valley spearscale (*Atriplex joaquiniana*)

If a special-status plant is found during a survey, it should be avoided, and a map showing the location of the plant should be provided to DFG, the Corps, and USFWS no later than 7 calendar days after the survey is completed. If a special-status plant cannot be avoided during the proposed work and it is not listed as threatened or endangered, the plant will be carefully transplanted to the nearest suitable habitat provided this action and the proposed transplantation site are determined by DFG to be adequate to offset any impact. If approved by DFG, a qualified representative of SRCD or DFG may conduct the transplantation. If DFG does not determine that transplantation will offset the impact, a restoration plan will be prepared and implemented, after DFG approval, that will be able to ensure that impacts on the plant population are offset. This determination by DFG will include an assessment of species distribution, the abundance in the Marsh, and the level of proposed impact.

If a federally listed threatened or endangered plant is found that cannot be avoided during the proposed work, the qualified representative of SRCD or DFG will notify the Corps immediately so it can consult with the USFWS. If determined necessary by USFWS and if a federally listed plant cannot be avoided during the proposed work, the plant will be carefully transplanted to the nearest suitable habitat provided this action and the proposed transplantation site is determined by USFWS to be adequate to offset any impact. If approved by USFWS, a qualified representative of SRCD or DFG may conduct the transplantation. If USFWS does not determine that transplantation will offset the impact, a restoration plan will be prepared and implemented, after USFWS approval, that will be able to ensure that impacts on the plant population are offset. This determination by USFWS will include an assessment of species distribution, abundance in the Marsh, and the level of proposed impact.

Birds

- Work may not be conducted in California clapper rail habitat between February 1 and August 31 unless surveys indicate that CCR is not present. Figure 2-5 depicts the areas of habitat to be avoided during this time.
- Impacts on great blue heron and egret rookeries will be avoided and minimized by removing mature trees only outside the nesting season and maintaining a 500-foot buffer between roost sites and managed wetland activities during the nesting season.
- Managed wetland activities in the vicinity of active raptor nests will not be implemented during breeding season.

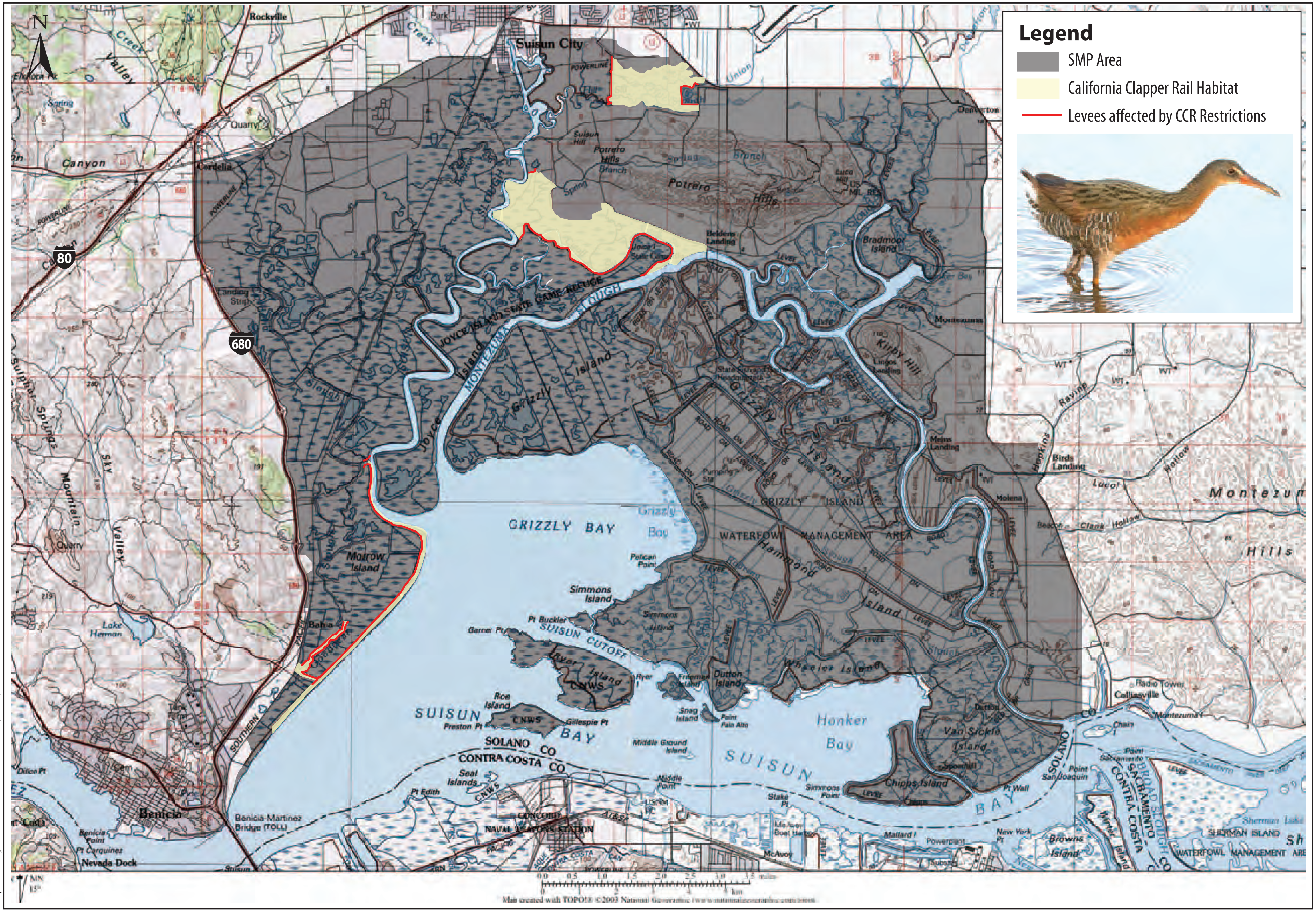
Fish

- To minimize entrainment losses of fish throughout the Marsh, water control structures will be consolidated and/or equipped with state-of-the-art fish screens when practicable and as funding allows. Intakes that present the highest risk of entrainment to salmonid smolts should be given the highest priority, including intakes located on Montezuma, Suisun, and Cordelia Sloughs.
- Any new or enlarged exterior water control structures will be screened in accordance with DFG's criteria unless DFG and the Corps determine that the structure would not adversely affect any listed species and the Corps obtains concurrence for any federally listed species with that determination from NMFS or USFWS as applicable.
- Water control structures may be installed or replaced only during low tides (within a 6-hour period, from 3 hours prior to low tide to 3 hours following low tide) when there is the least chance of affecting fish.
- SRCD and DFG will continue to identify and prioritize placement of water control structures that require fish screens in consultation with the Corps, NMFS, and the USFWS. The SRCD and DFG will seek funding to install screens at the highest-priority sites.
- Water control structures will be operated to minimize impacts on listed fish, taking into consideration seasonal timing and water quality.

- All in-water work will be done by hand and during low tide (within a 6-hour period, from 3 hours prior to low tide to 3 hours following low tide) as part of the following activities: repair, replacement, or installation of exterior water control structures; pipe replacement at the exterior flood or dual-purpose gate; pipe replacement at the existing exterior drain gate; and installation of the new exterior drain structure.
- All levee repairs and pipe replacements will be restricted to the dry season and not done in the rain.
- Repairs of existing exterior levees, to stop the flow of tidal waters entering into the managed wetlands, shall be completed within 7 days of the breach for coverage under the RGP.
- Fish screens will be installed on any new or enlarged water control structures.
- No more than 1,000 square feet of wetlands throughout the Marsh per year shall be filled during installation of fish screens.
- A biologist or on-site monitor shall evaluate each site during project implementation of exterior pipe replacement or riprap placement to document project actions for the purpose of identifying any condition that could adversely affect salmonids, green sturgeon, or their habitat. Whenever conditions are identified that could adversely affect salmonids, green sturgeon, or their habitat in a manner not described in the opinion, the Corps, its permittee, or the contractor shall immediately notify a NMFS biologist.
- If the Corps, its permittee, or the contractor identifies a project-related condition that could adversely affect salmonids, green sturgeon, or their habitat in a manner not anticipated, the Corps, its permittee, or the contractor will be responsible for rectifying such changes in a timely manner.
- If the managed wetlands are subject to uncontrolled tidal flow, dewatering of the managed wetland area will be conducted through the use of existing gravity tidal drainage gates as much as possible. DFG will be consulted to determine if fish salvage efforts are needed prior to completely dewatering of the site.

Water Diversion Restrictions

- SRCD shall notify DFG, NMFS, and the Corps of the starting and closing dates of duck hunting season annually at least 1 month prior to the start of the season. Landowners diverting water from sloughs designated by NMFS (i.e., Montezuma Slough and its tributaries lower Nurse Slough [from the confluence with Denverton Slough to Montezuma], Denverton Slough; Cuttoff Slough [including Spring Branch Slough, first and second Mallard Branch Slough]; Suisun Slough, [from downstream of the confluence with Boynton Slough to Grizzly Bay; and Chipps Island]) shall use no more than 25% of the water control structure's diversion capacity from November 1 to the last day of duck hunting season. These landowners are prohibited from diverting water from designated sloughs from February 21 to March 31. The



Graphics/Projects/06888.06 Suisun Marsh (10-10) SS

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Figure 2-5
California Clapper Rail Habitat in Suisun Marsh

purpose of these diversion restrictions is to protect migrating salmonids and longfin smelt. The following table describes the diversion restrictions.

Table 2-10. Inches of Water Discharged through Pipe for Salmonid Restriction

Diameter of Pipe (inches)	25% Open (inches)
12	3
18	4
24	6
30	7
36	9
48	12

- Landowners diverting water from sloughs designated by NMFS (i.e., Montezuma Slough and its tributaries lower Nurse Slough [from the confluence with Denverton Slough to Montezuma], Denverton Slough; Cuttoff Slough [including Spring Branch Slough, first and second Mallard Branch Slough]; Suisun Slough, [from downstream of the confluence with Boynton Slough to Grizzly Bay; and Chipps Island]) shall use only 35% of the water control structure's intake capacity between April 1 and May 31. If, during this time, two out of the three DFG 20-millimeter trawl surveys sites (sites 606, 609, and 610) predict delta smelt densities greater than 20 delta smelt individuals per 10,000 cubic meters over a 2-week sampling period, all diversions from these sloughs shall use only 20% of the water control structure's intake capacity. Survey trawls shall take place at least once every 14 days between April 1 and May 31. The table below determines delta smelt diversion restrictions.

Table 2-11. Inches of Water Discharging through Pipe for Delta Smelt Restriction

Diameter of Pipe (inches)	20% Open (inches)	35% Open (inches)
12	3	5
18	4	7
24	5	8.5
30	6	10.5
36	7	13
48	8	17

- While diversion restrictions are in place, SRCD and DFG shall monitor gate closures. If an open gate is observed, they shall immediately contact the landowner, and the gates shall be brought into compliance.

Construction Period Restrictions

Timing of construction activities will depend on the type of activity, presence or absence of sensitive resources, tides, and/or water management in wetlands. In general, in-water work will occur between August 1 and November 30, which avoids most of the special-status fish species. Additionally, most of the managed wetland activities are expected to be implemented from June to September when the wetlands are dry enough to conduct these activities (Figure 2-4). Activities may be conducted during other times of the year, depending on the potentially affected species for each site-specific case. Activities occurring during the hunting season will not occur on Saturday, Sunday, or Wednesday when such activities have a reasonable possibility of disrupting access to hunting or represent a safety concern. Furthermore, construction will not occur during major summer holiday periods and adequate warnings signs, postings, and/or notices will be provided upstream and downstream of all construction equipment, sites, and activities to warn recreational boaters. Finally, signs describing alternate boating routes will be posted when construction activities limit and/or restrict boating access.

Hazardous Materials Management Plan

A hazardous spill plan will be developed for the managed wetland activities. The plan will describe the actions that will be taken in the event of a spill. The plan also will incorporate preventive measures to be implemented (such as measures pertaining to vehicle and equipment staging, cleaning, maintenance, and refueling) as well as contaminant management and storage (e.g., fuel). In the event of a contaminant spill, work at the site will cease until the contractor has contained and mitigated the spill. The contractor will immediately prevent further contamination, notify appropriate authorities, and mitigate damage as appropriate. Adequate spill containment materials, such as oil diapers and hydrocarbon cleanup kits, will be available on site at all times.

Cultural Resources

- If any previously unknown historic or archeological artifacts are discovered while accomplishing the authorized work, the landowner must stop work immediately and notify the Corps. The activity is not authorized until the requirements of Section 106 of the NHPA have been satisfied.
- Work is not authorized within 100 feet of archeological site CAL-SOL-13.

Chapter 3
Guide to Impact Analysis

Guide to Impact Analysis

This chapter is included to help readers understand how the impact analyses are presented in resource Chapters 5, 6, and 7. Information on the environmental consequences of the alternatives presented in this document was prepared by a team of resource specialists using and building upon a series of technical reports, including the Bay-Delta and Suisun Marsh ecological processes and species conceptual models. Chapter 4 summarizes the environmental consequences as a result of the SMP, and compares the various alternatives in terms of environmental impacts and outcomes. Chapters 8 and 9 discuss growth-inducing and cumulative impacts, respectively, as a result of implementing the proposed project. Resources evaluated in this EIS/EIR have been grouped into three main categories:

- physical environment;
- biological environment; and
- land and water use, social issues, and economics.

This EIS/EIR evaluates a range of alternatives that vary in both the acres of tidal wetlands restored and the remaining acres of managed wetlands that would be enhanced. The possible effects of each of these alternatives on each resource area are examined in each section.

Impact Analysis Organization

The impact analysis for each resource is divided into several parts, including a summary, a description of the affected environment/existing conditions, and discussions of environmental consequence. Separate chapters discuss and analyze growth-inducing and cumulative impacts. Each of these divisions is explained more fully below.

Introduction

The introduction provides an overview of the primary concerns, impacts, and mitigation measures of each section. It also summarizes methods used in the resource analysis.

Summary of Impacts

A summary of impacts on each resource is presented in table format at the beginning of each resource section. These tables show the impact, applicable alternatives, any applicable mitigation, and the final level of significance. This information is also provided in Table 4-1.

Affected Environment

The Affected Environment section provides a historical perspective and a detailed description of the current conditions for each resource. This information is obtained from published environmental documentation, books, web sites, research and journal articles, and personal communications with experts in their fields.

Regulatory Setting

This section lists and describes laws, regulations, and policies that affect the resource or the assessment of impacts on the resource. Often, as in water quality and biological resources, the regulatory framework is the basis for the conclusion of the level of significance, and therefore plays a crucial role in impact assessment. Laws, regulations, and policies that apply to more than one resource topic are also listed in Chapter 10, "Compliance with Applicable Laws, Policies, and Plans and Regulatory Framework." More detailed regulatory framework that is unique to a resource section will be found in the specific section.

Environmental Impacts

Assessment Methods

Descriptions of assessment methods are resource-specific and provide the approach used to identify and assess the environmental impacts for the resource category. Analytical models used in the evaluation also are identified.

Significance Criteria

This section describes thresholds of significance used for that particular resource. While CEQA requires that a determination of significant impacts be stated in an EIR, NEPA does not. Under NEPA, significance is used to determine whether an EIS or some other level of documentation is required, and once a decision to prepare an EIS is made, the magnitude of the impact is evaluated and no further judgment of significance is required. As such, the significance criteria and associated significance conclusions are for purposes of CEQA compliance. Significance criteria also provide a tool to predict whether it is likely that the impacts identified as potentially significant can be avoided, reduced, or mitigated to a less-than-significant level.

No Action Alternative

This section presents the environmental impacts of the No Action Alternative. The No Action Alternative represents the likely future conditions without implementation of the SMP. The No Action alternative is compared to the same baseline (existing conditions) as the action alternatives.

Action Alternatives

It is required by both CEQA and NEPA that a reasonable range of alternatives to the project be identified. Alternatives are developed to show the difference in environmental consequences among varying approaches to a project. Alternatives are feasible and satisfy the objectives and needs of the proposed project. They may identify activities, operations, or construction methods that could lessen adverse impacts on the environment while accomplishing the same objectives and goals. This EIS/EIR fully analyzes all alternatives identified in Chapter 2.

Growth-Inducing Impacts

Growth-inducing impacts are those that “foster economic or population growth” or that “remove obstacles to growth” (State CEQA Guidelines section 15126.2[d]). Chapter 8 discusses the growth-inducing impacts that may result from implementation of the SMP. Specifically, the potential for this plan to promote growth in the Suisun Marsh area is analyzed. Chapter 8 provides a full discussion of growth-inducing impacts as a result of the SMP alternatives.

Cumulative Impacts

Cumulative environmental impacts must be addressed in EISs and EIRs under both NEPA and CEQA. NEPA defines cumulative impacts as those impacts that result from the

> incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency… or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

The definition of cumulative impacts under CEQA is similar:

> Cumulative impacts refer to two or more individual impacts that, when considered together, are considerable or that compound or increase other environmental impacts. The cumulative impact of several projects is the change in the environment that results from the incremental impact of the project when added to other, closely related past, present, or reasonably foreseeable, probable future projects.

The analysis of cumulative impacts in this document is a separate chapter (Chapter 9) and considers long-term environmental impacts of this project, including those that would be less than significant, together with similar impacts of other projects for each resource.

In general, the analysis of cumulative impacts is qualitative. Impacts were identified based on: (1) information extracted from existing environmental documents or studies for the resource categories potentially affected by each project, (2) investigation of other state and federal agencies' and privately funded project plans in the Suisun Marsh area over the next 30 years, and (3) knowledge of expected effects of similar projects in the study area.

Mitigation Measures

Mitigation measures are intended to avoid, reduce, or compensate for adverse impacts on a resource and can include actions such as implementation of plans to minimize impacts. For each impact identified as significant, a mitigation measure to reduce that impact to a less-than-significant level is described. However, some significant unavoidable impacts remain related to disturbance of cultural resources.

Chapter 4
Summary of Environmental Consequences

Introduction

This chapter summarizes the impacts identified as a result of constructing and operating the Proposed Project and alternatives. Full discussion of impacts on resources may be found in the specific resource sections in Chapters 5, 6, 7, and discussion of growth-inducing and cumulative impacts may be found in Chapters 9 and 10, respectively. This chapter also articulates the relationship between short-term uses and long-term productivity, irreversible and irretrievable commitment of resources, significant unavoidable impacts, estimated land use changes as a result of the plan, and presents a summary of how each alternative meets each plan objective.

Impacts

Impacts resulting from implementation of the SMP are determined by comparing the Proposed Project and alternatives to the existing conditions. When an impact meets or exceeds the thresholds of significance, it is determined to be a significant impact. All applicable mitigation is proposed to reduce the magnitude of that impact. Table 4-1, at the end of this chapter, summarizes the impacts resulting from each alternative, as well as mitigation measures proposed for adoption and the final level of significance. In some cases, a significant impact cannot be mitigated to a less-than-significant level.

Significant and Unavoidable Impacts

Four significant, unavoidable impacts have been identified related to cultural resources impacts: damage to Montezuma Slough Rural Historic Landscape as a result of ground disturbance, damage to known cultural resources as a result of inundation, inadvertent damage to as-yet-unidentified cultural resources as a result of ground disturbance in restoration areas, and damage to or destruction of such resources as a result of ground disturbance in managed wetland areas.

The four significant and unavoidable cultural resources impacts are described in Section 7.7, Cultural Resources. These impacts would transpire under any of the action alternatives and to a lesser degree the No Action alternative. The impacts have been determined to be significant and unavoidable because the cultural resources—both known and as-yet-unidentified—involved have not been formally evaluated for significance under federal, state, or local cultural resources regulations. Additionally, the proposed mitigation measures would not necessarily reduce the identified impacts to a less-than-significant level: the complete destruction of archaeological sites, for instance, cannot be fully mitigated due to the non-renewable nature of the resource.

Summary of Each Alternative's Ability to Meet the Plan Objectives

The Proposed Project is designed to meet the purposes/objectives as described in Chapter 1. Alternatives B and C meet at least most of the purposes/objectives. However, one may do so better or in ways different from others. This section provides an overview of how each alternative, including the Proposed Project, specifically meets each of the separate purposes/objectives.

No Action Alternative

The No Action Alternative does not meet most of the plan purposes/objectives. Absent the SMP and local and regulatory agency support, no major restoration would occur in the Marsh and managed wetland activities would be substantially limited or suspended. As a result, levee integrity would continue to degrade and recreational opportunities would decrease. As a result of suspended maintenance and resulting operations of duck clubs in the Marsh, efficiency of flooding and draining managed wetlands would not be maximized or improved. The absence of draining low DO water from some managed wetlands into sloughs has the potential to improve water quality in some areas under certain conditions. However, overall, there would be little if any improvement in habitats for waterfowl, fish, shorebirds, or other species because managed wetlands could not be operated to their full potential, and there would still be limited tidal marsh habitat available for terrestrial and aquatic species. It is assumed that habitats, levees, public and private land use, and water quality would continue to degrade absent the SMP.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Alternative A is the Proposed Project because it is viewed by the lead agencies as the alternative that best meets most of the plan purposes/objectives as described below.

Habitats/Ecological Processes

Alternative A allows for a significant amount of tidal wetland restoration, which is also determined to be an acceptable range for the current landowners in the Marsh and is consistent with restoration and enhancement goals of the ERPP. As a trade-off for implementing this restoration, the remaining managed wetlands/duck clubs would be allowed to continue managed wetland activities, leading to better habitats for waterfowl, shorebirds, and other species that depend or rely on managed wetlands. Restoration of tidal wetlands is assumed to provide habitats for several special-status aquatic and terrestrial species and improve the overall ecosystem functions in the Marsh.

Public and Private Land Use

Improvements in managed wetlands along with increasing the area of navigable waters in the Marsh through restoration are assumed to improve public and private land use opportunities, including fishing, bird watching, and other activities such as non-consumptive recreation. The conversion of privately managed wetlands to public tidal wetlands will provide increased public hunting opportunities.

Levee System Integrity

Through the implementation of managed wetland activities, landowners in the Marsh would be better equipped to maintain and improve levees to protect against catastrophic flood events. Additionally, restoration would include improvements to interior levees that would need to function as exterior levees, allowing the opportunity to ensure that these levees adequately protect managed wetlands, provide habitat, and incorporate erosion control that is environmentally sensitive and is not likely to need replacement.

Water Quality

Water quality constituents of concern in the Marsh are salinity, DO, mercury, suspended sediment, and other parameters regulated by the State Water Board. Restoration would result in a reduction in total acres of managed wetlands, decreasing managed wetland discharges. For those properties that cause DO sags and other water quality problems, restoration has the potential to improve water quality. Additionally, managed wetland activities are intended to improve flood and drain operations, potentially improving discharge water quality. The water quality improvement would depend on the actual sites restored and the managed wetlands that improve their flood and drain capabilities using the managed wetland activities.

Alternative B: Restore 2,000–4,000 Acres

Alternative B is similar to Alternative A, but differs in the extent to which it meets each plan purpose/objective because of the difference in acres of restoration and areas subject to managed wetland activities. Alternative B would restore fewer acres, leaving more area subject to managed wetland activities.

Habitats/Ecological Processes

Alternative B includes less restoration than Alternative A. As a trade-off for implementing this restoration, the remaining managed wetlands/duck clubs would be enhanced to improve management capabilities, leading to better habitats for waterfowl, shorebirds, and other species that depend or rely on managed wetlands. Compared to both existing conditions and Alternative A, there would be more managed wetland activities and more of the resultant improvements in habitats for reliant species. Restoration of tidal wetlands is assumed to provide habitats for several special-status aquatic and terrestrial species. Although this would be an improvement compared to existing conditions, this would be approximately 2,000 fewer acres of tidal wetlands in the Marsh compared to Alternative A, and this alternative would not fully achieve the desired results related to ecological processes.

Public and Private Land Use

Improvements in managed wetlands along with increasing the area of navigable waters in the Marsh through restoration are assumed to improve public and private land use opportunities, including fishing, hunting, bird watching, and activities. Alternative B would be an improvement of these opportunities compared to existing conditions, but compared to Alternative A, there would be more hunting, bird watching, and other land-based recreational opportunities and less fishing, as there would be less navigable water and public access.

Levee System Integrity

Through the implementation of managed wetland activities, landowners in the Marsh would be better equipped to maintain and improve levees to protect against catastrophic flood events compared to the existing condition. Compared to Alternative A, there would be less restoration, and therefore more levees requiring maintenance would remain intact. As such, this component of the SMP would require more resources to maintain the same level of integrity.

Water Quality

Water quality constituents of concern in the Marsh are salinity, DO, mercury, suspended sediment, and other parameters regulated by the State Water Board. Compared to the No Action Alternative, restoration would result in a reduction in total acres of managed wetlands, reducing managed wetland discharges, which can cause low DO and other water quality issues in some locations under certain circumstances. As such, water quality would be improved compared to the existing conditions. Compared to Alternative A, Alternative B would result in the preservation of more managed wetlands, and therefore improvements in water quality would be less.

Alternative C: Restore 7,000–9,000 Acres

Alternative C is similar to Alternative A, but differs in the extent to which it meets each plan purpose/objective because of the difference in acres of restoration and areas subject to managed wetland activities. Alternative C would restore more acres, leaving less area subject to managed wetland activities.

Habitats/Ecological Processes

Alternative C includes more restoration than Alternative A. As this alternative calls for up to 9,000 acres of tidal marsh restored over the 30-year SMP implementation period, it would result in the most benefits to species and processes related to tidal wetlands compared to the other alternatives. However, as a trade-off for implementing this restoration, almost 20% of the existing managed wetlands would be converted, which could result in substantial changes to habitats and processes related to managed wetlands. Similar to Alternatives A and B, the remaining managed wetlands/duck clubs would be subject to managed wetland activities, leading to higher quality habitats for waterfowl, shorebirds, and other species that depend or rely on managed wetlands. It may be difficult to meet the goals related to habitats and ecological processes for species that depend on or use managed wetlands under this Alternative, especially for species that do not use tidal wetland habitats.

Public and Private Land Use

Improvements in managed wetlands along with increasing the area of navigable waters in the Marsh through restoration are assumed to improve public and private land use opportunities, including fishing, bird watching, and non-consumptive recreational activities. Alternative C would be an improvement of these opportunities compared to existing conditions, but compared to Alternative A, there would be less hunting, bird watching, and other land-based recreational opportunities, and more fishing as there would be more navigable water and public access.

Levee System Integrity

Through the implementation of managed wetland activities, landowners in the Marsh would be better equipped to maintain and improve levees to protect against catastrophic flood events. Compared to Alternative A, there would be more restoration, and therefore fewer levees requiring maintenance would remain intact. As such, this component of the SMP would require fewer resources to maintain the same level of integrity.

Water Quality

Restoration would result in a reduction in total acres of managed wetlands, reducing managed wetland discharges, which can cause low DO and other water quality issues in some locations under certain circumstances. As such, water quality would be improved compared to the existing conditions. Compared to Alternative A, Alternative C would result in the preservation of fewer managed wetlands, and therefore potentially greater improvements in water quality.

Table 4-1. Summary of Impacts and Mitigation Measures

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
WATER SUPPLY AND MANAGEMENT				
Restoration Impacts				
WTR-1: Reduction in Water Availability for Riparian Water Diversions to Managed Wetlands Upstream or Downstream of Restoration Areas	A, B, C	Less than significant	None required	–
WTR-2: Increased Tidal Velocities from Breaching of Managed Wetlands Levees	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
WTR-3: Improved Water Supply as a Result of Improved Flooding and Draining of Managed Wetlands	A, B, C	Beneficial	–	–
WTR-4: Increased Tidal Flows and Improved Water Supply as a Result of Dredging	A, B, C	Beneficial	–	–
WATER QUALITY				
Restoration Impacts				
WQ-1: Increased Salinity in Suisun Marsh Channels from Increased Tidal Flows from Suisun Bay (Grizzly Bay) as a Result of Restoration	A, B, C	Less than significant	None required	–
WQ-2: Changes to Salinity of Water Available for Managed Wetlands from October to May	A, B, C	Less than significant	None required	–
WQ-3: Increased Salinity at Delta Diversions and Exports	A, B, C	Less than significant	None required	–
WQ-4: Possible Changes to Methylmercury Production and Export as a Result of Tidal Restoration	A, B, C	Less than significant	None required	–
WQ-5: Improved Dissolved Oxygen Concentrations in Tidal Channels from Reduced Drainage of High Sulfide Water from Managed Wetlands	A, B, C	Beneficial	None required	–
WQ-6: Temporary Changes in Water Quality during Construction Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
Managed Wetland Activities Impacts				
WQ-7: Temporary Degradation of Water Quality during Implementation of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WQ-8: Temporary Degradation of Water Quality during Dredging, Including Possible Increases in Mercury Concentrations	A, B, C	Less than significant	None required	–
GEOLOGY AND GROUNDWATER				
Restoration Impacts				
GEO-1: Potential to Create Unstable Cut or Fill Slopes	A, B, C	Less than significant	None required	–
GEO-2: Potential for Accelerated Soil Erosion	A, B, C	Beneficial or Less than significant	None required	–
GEO-3: Potential Loss of Topsoil Resources	A, B, C	Less than significant	None required	–
GEO-4: Reduction in Availability of Non-Fuel Mineral Resources	A, B, C	Less than significant	None required	–
GEO-5: Reduction in Availability of Natural Gas Resources	A, B, C	Less than significant	None required	–
GW-6: Potential for Altered Salinity in Shallow Suisun Marsh Groundwater	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
GEO-1: Potential to Create Unstable Cut or Fill Slopes	A, B, C	Less than significant	None required	–
GEO-2: Potential for Accelerated Soil Erosion	A, B, C	Beneficial or Less than significant	None required	–
GEO-5: Reduction in Availability of Natural Gas Resources	A, B, C	No impact	–	–
GEO-7: Potential for Damage to Structures as a Result of Surface Fault Rupture, Groundshaking and/or Seismically Induced Ground Failure (Liquefaction)	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
GEO-8: Potential for Damage to Structures as a Result of Landslides, Including Seismically Induced Landslides	A, B, C	Less than significant	None required	–
FLOOD CONTROL AND LEVEE STABILITY				
Restoration Impacts				
FC-1: Increased Potential for Catastrophic Levee Failure and Flooding Resulting from Restoration Activities That Expose Interior Levees to Tidal Action	A, B, C	Less than significant	None required	–
FC-2: Changes in Flood Stage and Flow Capacity in Suisun Marsh Channels as a Result of Increased Tidal Prism and Flood Storage Capacity	A, B, C	Beneficial	–	–
FC-3: Temporary Decrease in Levee Stability Resulting from Construction Activities	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
FC-4: Reduction in Potential for Catastrophic Levee Failure and Flooding Resulting from Improvements in Exterior Levee Maintenance	A, B, C	Beneficial	–	–
SEDIMENT TRANSPORT				
Restoration Impacts				
ST-1: Increased Scour in Bays or Channels Upstream and Downstream of Habitat Restoration Areas	A, B, C	Less than significant	None required	–
ST-2: Deposition of Sediment in the Restored Tidal Wetlands	A, B, C	Beneficial or Less than significant	None required	–
ST-3: Changes in Regional Sedimentation and Scour Patterns in Suisun Marsh	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
ST-4: Increase in Erosion Adjacent to Dredging Sites	A, B, C	Less than significant	None required	–
ST-5: Increase in Deposition at Dredging Sites	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
TRANSPORTATION AND NAVIGATION				
Restoration Impacts				
TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Patterns of Vehicular Circulation during Construction Activities	A, B, C	Less than significant	None required	–
TN-2: Temporary Increases in Road Hazards during Construction Activities	A, B, C	Less than significant	None required	–
TN-3: Damage to Roadway Surfaces from Construction Activities	A, B, C	Less than significant	None required	–
TN-4: Impacts to Air Traffic Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
TN-5: Impacts on Land Use Attributable to Restoration Activities within Travis Air Force Base Zone	A, B, C	Less than significant	None required	–
TN-6: Temporary Reduction in Boat Access during Construction Activities	A, B, C	Less than significant	None required	–
TN-7: Decrease in Rail Line Integrity and Disruption to Rail Service	A, B, C	Less than significant	None required	–
TN-8: Short-Term Reduction in Navigable Areas Resulting from Increased Velocities after Restoration Activities	A, B, C	Less than significant	None required	–
TN-9: Temporary Reduction in Boat Access during Dredging Activities	A, B, C	Less than significant	None required	–
TN-10: Increases in Navigable Areas of Suisun Marsh	A, B, C	Beneficial	–	–
TN-11: Operations and Maintenance Increase in Traffic	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Patterns of Vehicular Circulation during Construction Activities	A, B, C	Less than significant	None required	–
TN-2: Temporary Increases in Road Hazards during Construction Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
TN-3: Damage to Roadway Surfaces from Construction Activities	A, B, C	Less than significant	None required	–
TN-4: Impacts to Air Traffic Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
TN-5: Impacts on Land Use Attributable to Restoration Activities within Travis Air Force Base Zone	A, B, C	Less than significant	None required	–
TN-6: Temporary Reduction in Boat Access during Construction Activities	A, B, C	Less than significant	None required	–
TN-7: Decrease in Rail Line Integrity and Disruption to Rail Service	A, B, C	Less than significant	None required	–
TN-9: Temporary Reduction in Boat Access during Dredging Activities	A, B, C	Less than significant	None required	–
TN-11: Operations and Maintenance Increase in Traffic	A, B, C	Less than significant	None required	–
AIR QUALITY				
AQ-1: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Restoration	A, B, C	Significant	AQ-MM-1: Limit Construction Activity during Restoration AQ-MM-2: Reduce Construction NO_X Emissions AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures	Less than significant
AQ-2: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Current Management Activities	A, B, C	Significant	AQ-MM-2: Reduce Construction NO_X Emissions AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures	Less than significant
AQ-3: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with New Management Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
AQ-4: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Restoration and Management Activities Combined	A, B, C	Significant	AQ-MM-1: Limit Construction Activity during Restoration AQ-MM-2: Reduce Construction NO_X Emissions AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures AQ-MM-4: Limit Construction Activity during Restoration and Management	Less than significant
AQ-5: Construction-Related Diesel Health Risk Associated with Restoration	A, B, C	Less than significant	None required	–
AQ-6: Construction-Related Diesel Health Risk Associated with Current Management Activities	A, B, C	Less than significant	None required	–
AQ-7: Construction-Related Diesel Health Risk Associated with New Management Activities	A, B, C	Less than significant	None required	–
AQ-8: Construction-Related Diesel Health Risk Associated with Restoration and Management Activity Combined	A, B, C	Less than significant	None required	–
AQ-9: Increase in Construction Emissions in Excess of Federal *de Minimis* Thresholds	A, B, C	Less than significant	None required	–
AQ-10: Increase in Construction-Related Odor	A, B, C	Less than significant	None required	–
NOISE				
Restoration Impacts				
NZ-1: Temporary Increases in Ambient Noise during Construction Activities Associated with Restoration	A, B, C	Less than significant	None required	–
NZ-2: Temporary Exposure of Sensitive Land Uses to Groundborne Vibration or Noise from Construction Activities	A, B, C	Less than significant	None required	–
NZ-3: Permanent Increases in Ambient Noise	A, B, C	Less than significant	None required	–
NZ-4: Exposure of Noise-Sensitive Land Uses to Noise from Material Hauling Operations	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
Managed Wetland Activities Impacts				
NZ-2: Temporary Exposure of Sensitive Land Uses to Groundborne Vibration or Noise from Construction Activities	A, B, C	Less than significant	None required	–
NZ-3: Permanent Increases in Ambient Noise	A, B, C	Less than significant	None required	–
NZ-4: Exposure of Noise-Sensitive Land Uses to Noise from Material Hauling Operations	A, B, C	Less than significant	None required	–
NZ-5: Temporary Increases in Ambient Noise during Construction Activities Associated with Management Activities	A, B, C	Less than significant	None required	–
NZ-6: Exposure of Noise-Sensitive Land Uses to Noise from Portable Pump Operations	A, B, C	Significant	NZ-MM-1: Limit Noise from Pump Operations	Less than significant
CLIMATE CHANGE				
CC-1: Construction-Related Changes in Greenhouse Gas Emissions	A, B, C	Less than significant	None required	–
CC-2: Permanent Changes in Greenhouse Gas Sources and Sinks	A, B, C	Beneficial	None required	–
CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated With Sea Level Rise	No Action Alternative	–	–	
CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated With Sea Level Rise	A, B, C	Beneficial	None required	–
FISH				
Restoration Impacts				
FISH-1: Construction-Related Temporary Impairment of Fish Survival, Growth, and Reproduction by Accidental Spills or Runoff of Contaminants (Heavy Metals)	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
FISH-2: Construction-Related Temporary Reduction of Special-Status Fish Rearing Habitat Quality or Quantity through Increased Input and Mobilization of Sediment	A, B, C	Less than significant	None required	–
FISH-3: Short-Term Impairment of Delta Smelt Passage and Reduced Availability of Spawning and Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-4: Short-Term Impairment of Chinook Salmon Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-5: Short-Term Impairment of Steelhead Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-6: Short-Term Impairment of Green Sturgeon Passage and Reduced Availability of Holding and Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-7: Short-Term Impairment of Sacramento Splittail Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Velocity Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-8: Short-Term Impairment of Longfin Smelt Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Velocity Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-9: Temporary Reduction of Delta Smelt Habitat Quantity or Quality through Removal and Destruction of Cover Attributable to Restoration Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
FISH-10: Temporary Reduction of Chinook Salmon Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-11: Temporary Reduction of Steelhead Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-12: Temporary Reduction of Green Sturgeon Habitat Quantity or Quality as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-13: Temporary Reduction of Sacramento Splittail Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-14: Temporary Reduction of Longfin Smelt Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-15: Improved Fish Habitat Due to Increased Dissolved Oxygen Concentrations in Tidal Channels Attributable to Restoration Activities	A, B, C	Beneficial	None required	–
FISH-16: Salinity–Related Reduction of Delta Smelt Survival, Growth, Movement, or Reproduction Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-17: Salinity–Related Reduction of Chinook Salmon Survival, Growth, or Movement as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-18: Salinity–Related Reduction of Steelhead Survival, Growth, or Movement as a Result of Restoration Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
FISH-19: Salinity–Related Reduction of Green Sturgeon Survival, Growth, or Movement as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-20: Salinity–Related Reduction of Sacramento Splittail Survival, Growth, Movement, or Reproduction as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-21: Salinity–Related Reduction of Longfin Smelt Survival, Growth, Movement, or Reproduction as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-22: Disturbance, Injury, or Mortality of Individual Fish Resulting from Work Adjacent to Bodies of Water	A, B, C	Less than significant	None required	–
FISH-23: Change in Fish Species Composition Attributable to Changes in Salinity or Water Quality from Managed or Natural Wetland Modifications	A, B, C	Less than significant	None required	–
FISH-24: Change in Benthic Macroinvertebrate Composition Attributable to Changes in Channel Morphology and Hydraulics as a Result of Tidal Restoration	A, B, C	Less than significant	None required	–
FISH-25: Change in Primary Productivity as a Result of Tidal Restoration	A, B, C	Beneficial	–	–
Managed Wetland Activities Impacts				
FISH-26: Construction-Related Temporary Impairment of Fish Survival, Growth, and Reproduction by Accidental Spills or Runoff of Contaminants (Heavy Metals)	A, B, C	Less than significant	None required	–
FISH-27: Construction-Related Temporary Reduction of Fish Rearing Habitat Quality or Quantity through Increased Input and Mobilization of Sediment	A, B, C	Less than significant	None required	–
FISH-28: Construction-Related Mortality of Fish from Stranding	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
FISH-29: Temporary Reduction of Delta Smelt, Chinook Salmon and Steelhead Habitat Quantity or Quality Attributable to Management Activities	A, B, C	Less than significant	None required	–
FISH-30: Temporary Reduction of Green Sturgeon Habitat Quantity or Quality as a Result of Management Activities	A, B, C	Less than significant	None required	–
FISH-31: Temporary Reduction of Sacramento Splittail Habitat Quantity or Quality as a Result of Management Activities	A, B, C	Less than significant	None required	–
FISH-32: Temporary Reduction of Longfin Smelt Habitat Quantity or Quality as a Result of Management Activities	A, B, C	Less than significant	None required	–
FISH-33: Reduction in Benthic Macroinvertebrate Abundance as a Result of Dredging	A, B, C	Less than significant	None required	–
FISH-34: Disturbance, Injury, or Mortality of Delta Smelt Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-35: Disturbance, Injury, or Mortality of Chinook Salmon Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-36: Disturbance, Injury, or Mortality of Steelhead Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-37: Disturbance, Injury, or Mortality of Green Sturgeon Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-38: Disturbance, Injury, or Mortality of Sacramento Splittail Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-39: Disturbance, Injury, or Mortality of Longfin Smelt Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-40: Reduction of Fish Habitat Quantity or Quality Resulting from Installation of New Riprap on Levees	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
VEGETATION AND WETLANDS				
Restoration Impacts				
VEG-1: Short-Term Loss or Degradation of Tidal Wetlands and Tidal Perennial Aquatic Communities in Slough Channels Downstream of Restoration Sites as a Result of Increased Scour	A, B, C	Less than significant	None required	–
VEG-2: Loss or Degradation of Tidal Wetlands Adjacent to Restoration Sites as a Result of Levee Breaching/Grading	A, B, C	Less than significant	None required	–
VEG-3: Loss of Managed Wetlands as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
VEG-4: Loss of Upland Plant Communities and Associated Seasonal Wetland Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
VEG-5: Spread of Noxious Weeds as a Result of Restoration Construction	A, B, C	Less than significant	None required	–
VEG-6: Loss of Special-Status Plants or Suitable Habitat as Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
VEG-7: Degradation of Native Plant Species and Spread of Invasive Plant Species as a Result of Increased Public Access	A, B, C	Less than significant	None required	–
VEG-8: Loss or Degradation of Tidal Native Plant Species and Spread of Invasive Plant Species as a Result of Tidal Muting	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
VEG-9: Loss of Special-Status Plants or Suitable Habitat as Result of Exterior Levee Activities	A, B, C	Less than significant	None required	–
VEG-10: Loss or Degradation of Wetland Communities and Special-Status Plant Species in Slough Channels as a Result of Channel Dredging	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
VEG-1: Loss or Degradation of Rare Natural Communities and Special-Status Plant Species as a Result of New Fish Screen Facilities	A, B, C	Less than significant	None required	–
VEG-12: Loss or Disturbance of Managed Wetlands as a Result of Activities within Managed Wetlands	A, B, C	Less than significant	None required	–
VEG-13: Loss or Disturbance of Tidal Wetlands or Other Waters of the United States and Special-Status Plant Species as a Result of Placement of New Riprap and Alternative Bank Protection Methods	A, B, C	No impact	–	–
VEG-14: Loss or Disturbance of Wetlands and Special-Status Plant Species as a Result of DWR/Reclamation Facility Maintenance Activities	A, B, C	Less than significant	None required	–
VEG-15: Introduction or Spread of Noxious Weeds as Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILDLIFE				
Restoration Impacts				
WILD-1: Loss or Disturbance of Salt Marsh Harvest Mouse Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-2: Loss or Disturbance of California Clapper Rail Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-3: Loss or Disturbance of California Black Rail Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-4: Loss or Disturbance of Suisun Shrew Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-5: Loss or Disturbance of California Least Tern Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
WILD-6: Loss of Suisun Song Sparrow and Salt Marsh Common Yellowthroat Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-7: Loss or Disturbance of Raptor Nest Sites or Foraging Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-8: Loss or Disturbance of Western Pond Turtle as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-9: Loss or Disturbance of Tricolored Blackbird as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-10: Effects on Southern Resident Killer Whales as a Result of Changes in Salmon Populations	A, B, C	Less than significant	None required	–
WILD-11: Loss or Disturbance of Waterfowl and Shorebird Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
WILD-12: Loss or Disturbance of Salt Marsh Harvest Mouse Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-13: Loss or Disturbance of California Clapper Rail Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-14: Loss or Disturbance of California Black Rail Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-15: Loss or Disturbance of Suisun Shrew Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
WILD-16: Loss or Disturbance of California Least Tern Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-17: Loss or Disturbance of Suisun Song Sparrow and Salt Marsh Common Yellowthroat Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-18: Loss or Disturbance of Raptor Nest Sites or Foraging Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-19: Loss or Disturbance of Western Pond Turtle as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-20: Loss or Disturbance of Tricolored Blackbird as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-21: Effects on Southern Resident Killer Whales as a Result of Changes in Salmon Populations as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-22: Changes in Waterfowl Nesting and Wintering Habitat as a Result of Marsh Management Activities	A, B, C	Beneficial	–	–
WILD-23: Changes in Shorebird Nesting and Wintering Habitat as a Result of Marsh Management Activities	A, B, C	Beneficial	–	–
LAND AND WATER USE				
Restoration Impacts				
LU-1: Alteration of Existing Land Use Patterns	A, B, C	Less than significant	None required	–
LU-2: Conflict with Existing Land Use Plans, Policies, and Regulations	A, B, C	No impact	–	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
LU-3: Conflict with Any Applicable Habitat Conservation Plan or Natural Community Conservation Plan	A, B, C	No impact	–	–
Managed Wetland Activities Impacts				
LU-1: Alteration of Existing Land Use Patterns	A, B, C	Less than significant	None required	–
LU-2: Conflict with Existing Land Use Plans, Policies, and Regulations	A, B, C	No impact	–	–
LU-3: Conflict with Any Applicable Habitat Conservation Plan or Natural Community Conservation Plan	A, B, C	No impact	–	–
SOCIAL AND ECONOMIC CONDITIONS				
Restoration Impacts				
SOC-1: Change in Employment and Income Resulting from Construction, Restoration, and Other Expenditures	A, B, C	Beneficial	–	–
SOC-2: Changes in Employment and Income Resulting from Changes in Managed Wetland–Related Recreation Opportunities and Use	A, B, C	Beneficial	–	–
SOC-3: Changes in Property Tax Revenues as a Result of Purchasing and Restoring Private Lands	A, B, C	Less than significant	–	–
Managed Wetland Activities Impacts				
SOC-1: Change in Employment and Income Resulting from Construction Restoration, and Other Expenditures	A, B, C	Beneficial	–	–
SOC-2: Changes in Employment and Income Resulting from Changes in Managed Wetland–Related Recreation Opportunities and Use	A, B, C	Beneficial	–	–
SOC-4: Changes in Employment and Income Resulting from Increased Expenditures for Wetland Management Activities	A, B, C	Less than significant	–	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
UTILITIES AND PUBLIC SERVICES				
Restoration Impacts				
UTL-1: Damage to Pipelines and/or Disruption of Electrical, Gas, or Other Energy Services during Construction or Restoration Activities	A, B, C	Significant	UTL-MM-1: Relocate Overhead Powerlines or other Utilities that Could be Affected by Construction UTL-MM-2: Avoid Ground-Disturbing Activities within Pipeline Right-of-Way	Less than significant
UTL-2: Damage to Utility Facilities or Disruption to Service as a Result of Restoration	A, B, C	Significant	UTL-MM-3: Relocate or Upgrade Utility Facilities that Could be Damaged by Inundation UTL-MM-4: Test and Repair or Replace Pipelines that Have the Potential for Failure	Less than significant
UTL-3: Reduction in Capacity of Local Solid Waste Landfills	A, B, C	Less than significant	None required	–
UTL-4: Increase in Emergency Service Response Times	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
UTL-3: Reduction in Capacity of Local Solid Waste Landfills	A, B, C	Less than significant	None required	–
UTL-4: Increase in Emergency Service Response Times	A, B, C	Less than significant	None required	–
UTL-5: Damage to Pipelines and/or Disruption of Electrical, Gas, or Other Energy Services during Dredging	A, B, C	Significant	UTL-MM-2: Avoid Ground-Disturbing Activities within Pipeline Right-of-Way	Less than significant
POWER PRODUCTION AND ENERGY				
Restoration Impacts				
POW-1: Substantial Temporary Increase in Energy Use during Construction and Restoration Activities	A, B, C	Less than significant	None required.	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
Managed Wetland Activities Impacts				
POW-2: Substantial Temporary Increase in Energy Use during Managed Wetland Activities	A, B, C	Less than significant	None required.	–
VISUAL/AESTHETIC RESOURCES				
Restoration Impacts				
VIS-1: Temporary Changes in Views Caused by Construction Activities	A, B, C	Less than significant	None required	–
VIS-2: Temporary Changes in Views Caused by Habitat Reestablishment Period	A, B, C	Less than significant	None required	–
VIS-3: Changes in Views to and from Suisun Marsh	A, B, C	Less than significant	None required	–
VIS-4: Damage to Scenic Resources along Scenic Highway	A, B, C	No impact	–	–
VIS-5: Create a New Source of Light and Glare That Affects Views in the Area	A, B, C	Less than significant	None required	–
VIS-6: Conflict with Policies or Goals Related to Visual Resources	A, B, C	No impact	–	–
Managed Wetland Activities Impacts				
VIS-1: Temporary Changes in Views Caused by Construction Activities	A, B, C	Less than significant	None required	–
VIS-3: Changes in Views to and from Suisun Marsh	A, B, C	Less than significant	None required	–
VIS-4: Damage to Scenic Resources along Scenic Highway	A, B, C	No impact	–	–
VIS-5: Create a New Source of Light and Glare That Affects Views in the Area	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
VIS-6: Conflict with Policies or Goals Related to Visual Resources	A, B, C	No impact	–	–
CULTURAL RESOURCES				
Restoration Impacts				
CUL-1: Damage to Montezuma Slough Rural Historic Landscape and Mein's Landing as a Result of Ground-Disturbing Activities along Montezuma Slough	A, B, C	Significant	CUL-MM-1: Document and Evaluate the Montezuma Slough Rural Historic Landscape, Assess Impacts, and Implement Mitigation Measures to Lessen Impacts	Significant and unavoidable
CUL-2: Damage to or Destruction of Other Known Cultural Resources as a Result of Ground-Disturbing Activities in Lowland and Marsh Areas	A, B, C	Significant	CUL-MM-2: Evaluate Previously Recorded Cultural Resources and Fence NRHP- and CRHR-Eligible Resources prior to Ground-Disturbing Activities	Less than significant
CUL-3: Damage to Known Cultural Resources as a Result of Inundation	A, B, C	Significant	CUL-MM-3: Protect Known Cultural Resources from Damage Incurred by Inundation through Plan Design (Avoidance) CUL-MM-4: Resolve Adverse Effects prior to Construction	Significant and unavoidable
CUL-4: Inadvertent Damage to or Destruction of As-Yet-Unidentified Cultural Resources as a Result of Ground-Disturbing Activities in Restoration Areas	A, B, C	Significant	CUL-MM-5: Conduct Cultural Resource Inventories and Evaluations and Resolve Any Adverse Effects	Significant and unavoidable
CUL-5: Damage to or Destruction of Human Remains as a Result of Ground-Disturbing Activities	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
CUL-6: Damage to or Destruction of Shipwrecks or Other Submerged Resources as a Result of Channel Dredging	A, B, C	Significant	CUL-MM-6: Stop Ground-Disturbing Activities, Evaluate the Significance of the Discovery, and Implement Mitigation Measures as Appropriate	Less than significant

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
CUL-7: Damage to or Destruction of Known Cultural Resources Resulting from Managed Wetland Activities	A, B, C	Significant	CUL-MM-7: Complete NHPA Section 106 Consultation and Prepare and Implement Context Study; Evaluate Previously Recorded Cultural Resources and Fence NRHP- and CRHR-Eligible Cultural Resources prior to Ground-Disturbing Activities	Less than significant
CUL-8: Damage to or Destruction of As-Yet-Unidentified Cultural Resources in Uninspected Areas as a Result of Other Ground-Disturbing Managed Wetland Activities	A, B, C	Significant	CUL-MM-8: Complete NHPA Section 106 Consultation and Prepare and Implement Context Study; Conduct Cultural Resources Inventories and Evaluations and Resolve Any Adverse Effects	Significant and unavoidable
PUBLIC HEALTH AND ENVIRONMENTAL HAZARDS				
Restoration Impacts				
HAZ-1: Increased Risk of Mosquito-Borne Diseases	A, B, C	Less than significant	None required	–
HAZ-2: Exposure to or Release of Hazardous Materials during Construction	A, B, C	Less than significant	None required	–
HAZ-3: Release of Hazardous Materials into Surrounding Water Bodies during Construction	A, B, C	Less than significant	None required	–
HAZ-4: In-Channel Construction-Related Increase in Emergency Response Times	A, B, C	Less than significant	None required	–
HAZ-5: Increased Human and Environmental Exposure to Mercury	A, B, C	Less than significant	None required	–
HAZ-6: Reduction in Potential for Catastrophic Flooding	A, B, C	Beneficial	–	–
HAZ-7: Increased Human and Environmental Exposure to Natural Gas and Petroleum	A, B, C	Significant	UTL-MM-2: Avoid Ground-Disturbing Activities within Pipeline Right-of-Way UTL-MM-3: Relocate or Upgrade Utility Facilities That Could Be Damaged by Inundation UTL-MM-4: Test and Repair or Replace Pipelines That Have the Potential for Failure	Less than significant

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
Managed Wetland Activities Impacts				
HAZ-2: Exposure to or Release of Hazardous Materials during Construction	A, B, C	Less than significant	None required	–
HAZ-4: In-Channel Construction-Related Increase in Emergency Response Times	A, B, C	Less than significant	None required	–
HAZ-5: Increased Human and Environmental Exposure to Mercury	A, B, C	Less than significant	None required	–
HAZ-6: Reduction in Potential for Catastrophic Flooding	A, B, C	Beneficial	–	–
ENVIRONMENTAL JUSTICE				
Restoration Impact				
EJ-1: Disproportionate Impact of Management of Suisun Marsh on Minority and/or Low-Income Communities	A, B, C	No impact	–	–
Managed Wetland Activities Impact				
EJ-1: Disproportionate Impact of Management of Suisun Marsh on Minority and/or Low-Income Communities	A, B, C	No impact	–	–
INDIAN TRUST ASSETS				
No Impacts				

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, Hydrology, and Delta Water Management";
- Section 5.2, "Water Quality";
- Section 5.3, "Geology and Groundwater";
- Section 5.4, "Flood Control and Levee Stability";
- Section 5.5, "Sediment Transport";
- Section 5.6, "Transportation and Navigation";
- Section 5.7, "Air Quality";
- Section 5.8, "Noise"; and
- Section 5.9; "Climate Change."

Section 5.1
Water Supply, Hydrology, and Delta Water Management

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on water supply, hydrology, and Delta water management.

Delta water management for agriculture, water supply diversions, and exports and the salinity of water diverted for waterfowl habitat in the managed wetlands of the Marsh officially became linked in the 1978 State Water Board Delta Water Control Plan and the water right decision (D-1485) Suisun Marsh salinity standards (objectives). D-1485 required DWR and Reclamation to prepare a plan to protect the beneficial use of water for fish and wildlife and meet salinity standards for the Marsh. Initial facilities included improved RRDS facilities to supply approximately 5,000 acres on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly Islands with lower salinity water from Montezuma Slough, and the MIDS and Goodyear Slough outfall to improve supply of lower salinity water for the southwestern Marsh. These initial facilities were constructed in 1979 and 1980; the required Suisun Marsh Plan of Protection was prepared and approved in 1984. This section describes the impacts of the SMP alternatives on water supply in Suisun Marsh. The impacts on hydrodynamics (water flows and tidal elevations) also are described in this section; water quality effects (i.e., salinity and contaminants) are described in the next section (Section 5.2).

SWP and CVP projects affect Suisun Marsh salinity by regulating Delta outflow through upstream reservoir storage and releases and Delta exports. D-1485 (since 1978) and the currently applicable D-1641 (since 1995) require DWR and Reclamation to meet various Delta outflow and salinity objectives in the Delta and in the Marsh. These objectives limit the allowable exports during some periods of relatively low Delta inflows. The State Water Board suggested in D-1485 that "Full protection of Suisun Marsh now could be accomplished only by requiring up to 2 million acre-feet (maf) of freshwater outflow in dry and critical years in addition to that required to meet other standards." This was strong motivation for DWR and Reclamation to prepare a plan of protection for Suisun Marsh that would use other facilities or management actions to provide appropriate salinity in the Marsh. The SMSCG on Montezuma Slough near Collinsville, which began operating in October 1988, were constructed by DWR and Reclamation to improve the salinity in the Marsh channels without requiring the additional Delta outflow that the State Water Board had anticipated.

Summary of Impacts

Table 5.1-1 summarizes impacts from implementing the SMP alternatives on water supply, hydrology, and Delta water management. There are no significant impacts on water supply or Delta water management from implementing the SMP alternatives.

Table 5.1-1. Summary of Water Supply, Hydrology, and Delta Water Management Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
WTR-1: Reduction in Water Availability for Riparian Water Diversions to Managed Wetlands Upstream or Downstream of Restoration Areas	A, B, C	Less than significant	None required	–
WTR-2: Increased Tidal Velocities from Breaching of Managed Wetlands Levees	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
WTR-3: Improved Water Supply as a Result of Improved Flooding and Draining of Managed Wetlands	A, B, C	Beneficial	–	–
WTR-4: Increased Tidal Flows and Improved Water Supply as a Result of Dredging	A, B, C	Beneficial	–	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section to describe the conceptual linkage between Marsh management alternatives and Delta water management:

- *Comprehensive Review of Suisun Marsh Monitoring Data 1985–1995* (California Department of Water Resources 2001).
- *Suisun Marsh Ecological Workgroup Final Report* (California Department of Water Resources 2001).

- *Conceptual Model for Managed Wetlands in Suisun Marsh* (California Department of Fish and Game 2007).
- RMA modeling of the Marsh and tidal restoration alternatives (Appendix A, "Numerical Modeling in Support of Suisun Marsh PEIR/EIS Technical Memorandum, March 2008").
- *Draft Suisun Marsh Tidal Marsh and Aquatic Habitats Conceptual Model* (Conceptual Model 2010).
- *Design Guidelines for Tidal Wetland Restoration in San Francisco Bay* (PWA and Phyllis Faber 2004).

Regulatory Setting

Tidal hydraulic conditions and potential impacts are of concern to several federal and state agencies. Actual regulations, however, are limited and indirect.

Several federal agencies such as National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), and the Corps participate in the monitoring and analysis of tidal conditions in the San Francisco Estuary. FEMA regulates (i.e., evaluates) the 100-year flood frequency tidal elevation, which is determined to be about 7 feet above mean sea level (msl) (National Geodetic Vertical Datum [NGVD] 1929 datum) or 10 feet NAVD 1988 datum.

Several state agencies such as the State Water Board, DWR, and DFG have interests, jurisdictions, and regulatory authority within the Marsh, as generally described in Chapter 1. No specific regulations, however, govern tidal elevations, tidal flows, or tidal velocities in the Marsh channels. Several local agencies such as Solano County have interests, jurisdictions, and regulatory authority within the Marsh. The following sections describe the regulations applicable to water supply and Delta water management, including tidal hydraulic processes.

Federal

Many federal regulations intended to protect sensitive species are in place that affect water supply operations in Suisun Marsh and throughout the Delta. In the Marsh, NMFS and USFWS have implemented some restrictions on the unscreened diversions for the protection of winter-run Chinook salmon and delta smelt, respectively. The winter-run restriction applies from November–January for unscreened diversions, and limits each diversion to 25% of each diversion's capacity. Diversions are also not allowed from February 21 to March 31 on diversions without fish screens. The delta smelt restriction applies in April and May when unscreened diversions are restricted to 20% or 35% of each diversion's capacity, depending upon the presence of delta smelt in the Marsh. These protective measures require more skillful water management to provide sufficient soil leaching, soil moisture, and water depth in ponded areas during the winter and spring months. In addition to the Suisun Marsh specific water supply restrictions, the 2008 USFWS and 2009 NMFS BOs for the Coordinated Operation of the CVP and SWP (Operations BOs) dictate some water supply operations in the Marsh (operation of the SMSCG).

State

The State Water Resource Control Board Water Right Decisions and Water Quality Control Plans (WQCPs or Basin Plans) provide the framework for water supply in the Delta and for salinity standards for the water applied to managed wetlands in the Marsh.

The 1978 Bay-Delta WQCP and D-1485 in 1978 introduced the initial salinity objectives in the Marsh to protect the beneficial uses of water for fish and wildlife in the Marsh. The State Water Board directed DWR and Reclamation to prepare a plan of protection for Suisun Marsh. This provision initiated the development of facilities and management assistance within the Marsh. The 1995 Bay-Delta WQCP (State Water Resources Control Board 1995) and D-1641 (State Water Resources Control Board 1999) generally renewed the salinity objectives and management guidelines to protect the beneficial uses of water for fish and wildlife in the Marsh.

State permits and authorizations from DFG intended to protect state listed species including longfin smelt, delta smelt and Chinook salmon, are in place that affect water supply operations in Suisun Marsh and throughout the Delta.

Local

The SRCD has the primary local responsibility for water management practices on privately owned lands within the primary management area of the Suisun Marsh and provides local jurisdiction for the assistance with the management of water diversions and drainage facility operations. The Marsh water rights are riparian or pre-1914; the general requirements for reasonable beneficial uses apply.

Existing Conditions

Tidal Hydraulics of Suisun Bay and Suisun Marsh

Rainfall and Watershed Runoff

The largest gaged creek inflows enter from Suisun Creek to Chadbourne Slough and Green Valley Creek to Cordelia Slough in the northwest Marsh. Runoff from these 30– and 50–square mile watersheds is usually of short duration (1–5 days) with peak daily flows of about 800 cubic feet per second (cfs) to 1,350 cfs for an inch of runoff. Base flow is on the order of 3–5 cfs. Ledgewood Creek flows into Peytonia Slough with a similar runoff assumed (no gage). The Fairfield and Suisun wastewater treatment plant discharges about 20 cfs into Boynton Slough and has a (new) second discharge location into Peytonia Slough just north of Cordelia Road. Development on the periphery of the Marsh also contributes to runoff. Rainfall generally is retained in the managed wetlands and reduces the salinity until discharged with the normal managed wetlands discharges.

Tidal Elevations

Figure 5.1-1 shows the measured tidal elevations for July 2002 at Martinez, located at the downstream end of Suisun Bay. The tides are semi-diurnal (two tide cycles each lunar day of 24.86 hours) with unequal tide elevations on most days.

Table 5.1-2 gives the tidal range for the Port Chicago NOAA tide gage located upstream of Martinez. Using the 1929 NGVD datum (msl), the average (mean) tide elevation (MTL) is about 1.1 feet msl. The 1929 NGVD datum is used for most USGS 1:24000 quad sheets and was the datum for the RMA Bay-Delta model used for analysis of tidal effects. The average high tide or mean high water (MHW) elevation is about 3 feet, and the average of the highest tide or mean higher high water (MHHW) each day is about 3.5 feet. The average of the low tide elevations or mean low water (MLW) is about –0.7 foot, and the average (mean) lower low tide elevation (MLLW) is about –1.5 feet. The average tidal range therefore is defined as the difference between MHW and MLW, which is about 3.7 feet. But as Figure 5.1-1 indicates, the tidal range during a day can be higher or lower, depending on the 14.8-day cycle of spring (highest tidal range) and neap (lowest tidal range) tides. Spring tides can vary by 6 feet, from –1.5 feet to 4.5 feet msl.

Table 5.1-2. Tidal Elevation Statistics in Suisun Bay (Port Chicago NOAA Tidal Gage)

Tidal Elevation	1929 NGVD Datum	MLLW Datum	1988 NAVD Datum
Mean Higher High Water	3.45	4.91	6.13
Mean High Water Elevation	2.95	4.41	5.63
Mean Tide Elevation	1.12	2.58	3.8
Average Low Tide Elevation	-0.72	0.74	1.96
Average Lower Low Tide Elevation	-1.46	0.0	1.22

Figure 5.1-2 shows the measured monthly range of tidal elevations at Martinez for water years 1976–1991. The minimum tide elevation within each month varies somewhat from about –2.5 feet to about –2.0 feet msl. The 10% tidal

elevation (exposed to air for 10% of the month) varies from about –1.5 feet to –1.0 foot msl. The 30% tidal elevation (exposed 30% of the month) varies from about 0.0 feet to 0.5 foot msl. The 50% tidal elevation (median, exposed 50% of the month) varies from about 0.75 foot to 1.25 feet msl. The 70% tidal elevation (exposed 70% of the month) varies from about 1.75 feet to 2.25 feet msl. The 90% tidal elevation (exposed 90% of the month) varies from about 2.75 feet to 3.25 feet msl. The maximum monthly tidal elevation varies from about 4 feet to 5 feet msl. The MHW and MHHW correspond to the lower and upper range of the 90% monthly tidal elevation. The MLW and MLLW correspond to the upper and lower range of the 10% monthly tidal elevation. MTL corresponds to the 50% (median) tidal elevation.

Tidal Volumes

The ocean tides provide the water movement and water exchange within the Marsh. Water flows into the Marsh channels during flood (rising elevation) tides and fills the Marsh to the high tide elevation. Water flows out of the Marsh channels during ebb tides (declining elevation), draining the Marsh to the low tide elevation. Each channel will convey the water needed to fill or drain the upstream tidal volume, sometimes called the tidal prism. This is the volume between the MHW and the MLW elevations. If the Marsh had vertical walls, this volume would be the upstream surface area times the average tidal range of 3.7 feet (MHW – MLW). The highest tide each day has a larger tidal prism, defined as the difference in volume between MHHW and MLLW, a tidal range of almost 5 feet. The tidal prism upstream of a station can be measured with a tidal flow gage or simulated with a tidal hydraulic model.

Table 5.1-3 gives the surface area for tidal channels and tidal wetlands within the existing Marsh, estimated from the RMA tidal hydraulic model, which is based on existing bathymetric survey data. The area and volume estimates from the DWR tidal model of the Delta (DSM2) are given for comparison; the RMA model has a more detailed bathymetry for the Marsh channels. The volume of the Marsh channels and sloughs below MLLW (i.e., subtidal) is about 36,000 acre-feet (af). The volume of Marsh channels and tidal wetlands at MHHW is about 58,000 af. The intertidal volume is therefore about 22,000 af. The existing intertidal volume of the Marsh is about 40% of the total volume at MHHW, and the existing subtidal Marsh volume is about 60% of the total volume at MHHW. Most of the subtidal volume is in Montezuma Slough, Suisun Slough, and a few other large tidal sloughs. The average tidal volume (tidal prism) between MHW (55,500 af) and MLW (38,000 af) is about 17,500 af. The tidal exchange is therefore a large fraction (30%) of the Marsh MHHW water volume.

The surface area of the Marsh open to tidal action is about 3,700 acres at MLLW (elevation –1.4 feet msl) and about 5,800 acres at MHHW (elevation 3.4 feet msl). The intertidal area within the Marsh is about 2,100 acres. Because the area is 3,700 acres with a volume of 36,000 af at MLLW, the average depth of these subtidal channels and sloughs is about 10 feet. Zone 1 and Zone 4 are representative areas of managed wetlands that might be converted to tidal

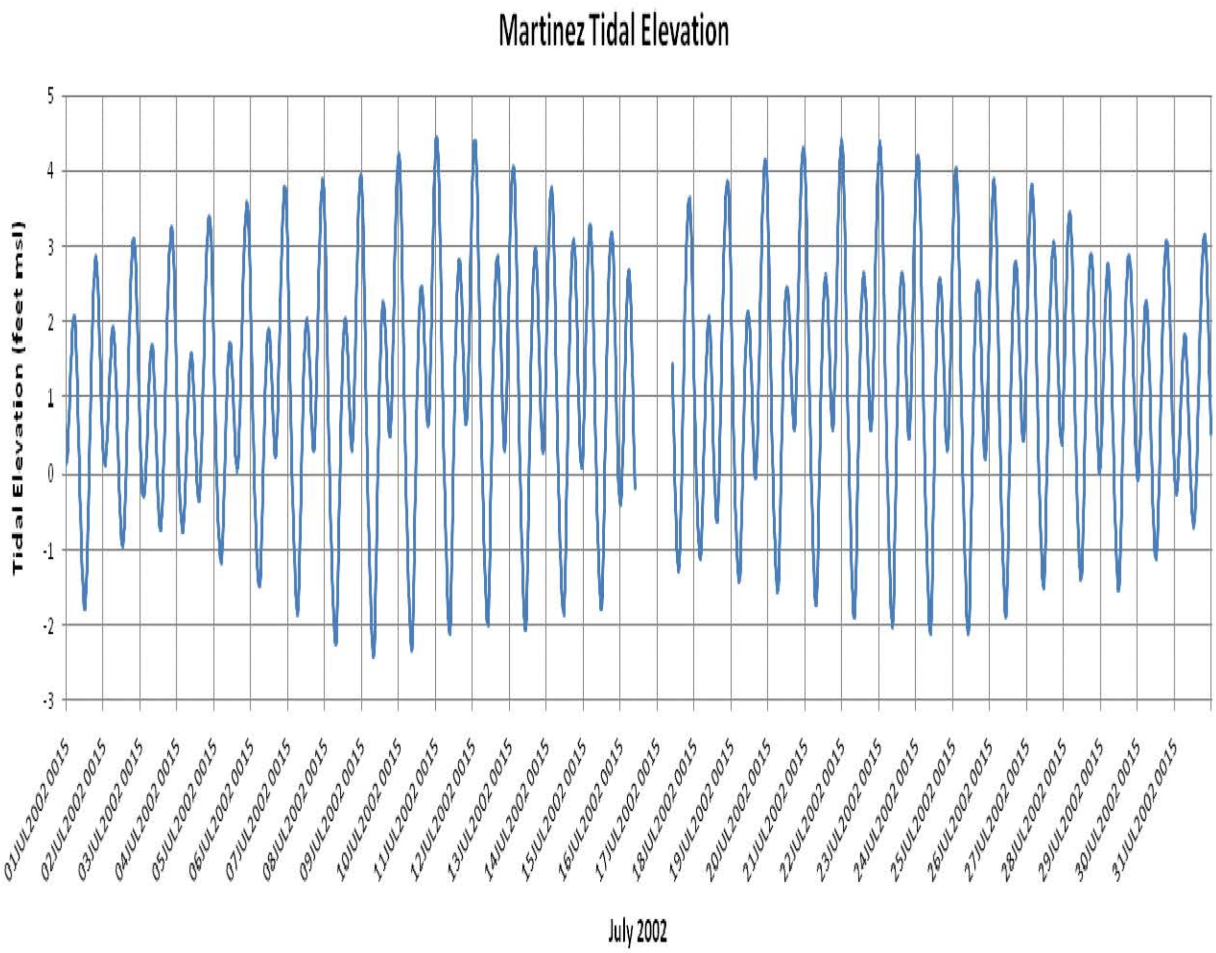

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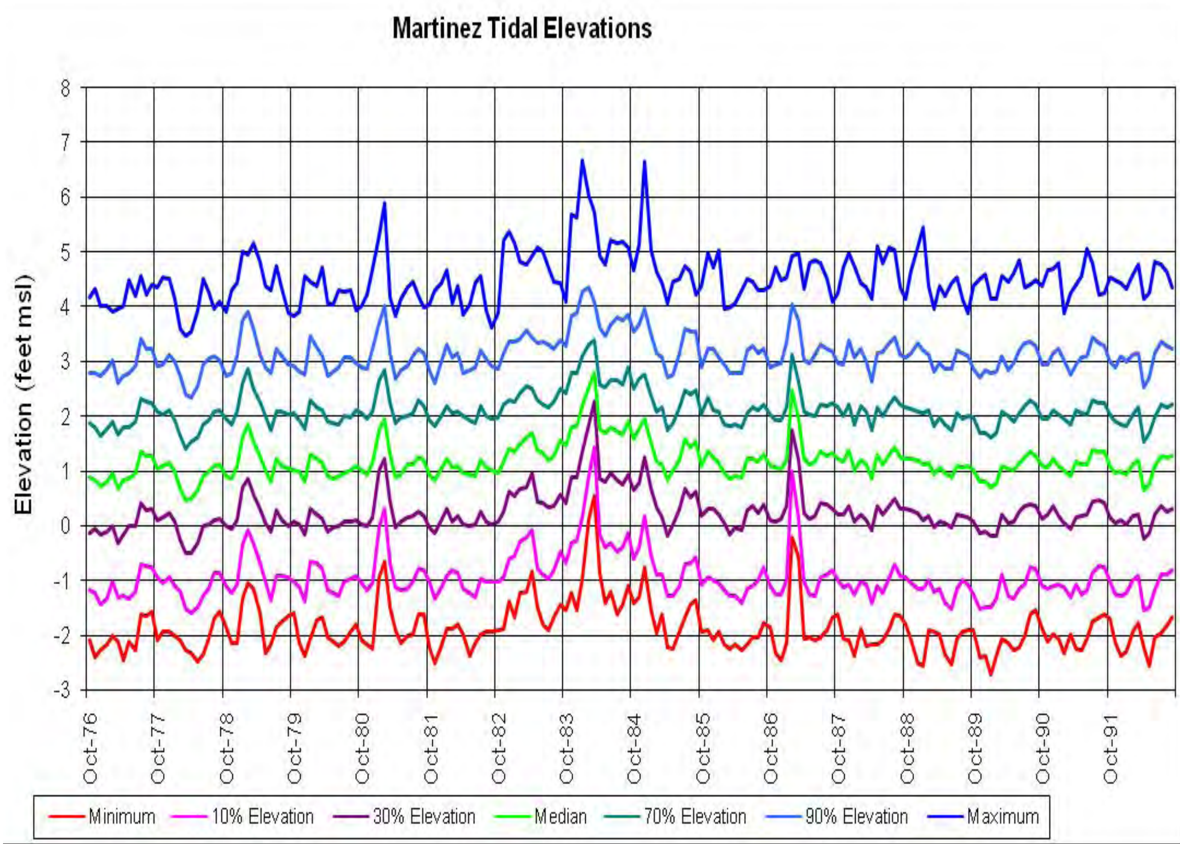
Figure 5.1-1
Measured Tidal Elevations at Martinez in July of 2002



Note: Highest tides correspond to major outflow periods in 1983 and 1984.

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Figure 5.1-2
Measured Monthly Distribution of Tidal Elevations at Martinez for Water Years 1976–1991

wetlands, as described in the Assessment Methods section and in Appendix A. The Zone 1 and Zone 4 areas and volumes are shown here to demonstrate that the intertidal and subtidal distribution of tidal marsh would be similar to the existing area and volume distribution of tidal channels within the Marsh.

Table 5.1-3. Summary of Suisun Marsh Tidal Geometry

Elevation (feet msl)	Tidal Range	Baseline Area (acre)	Baseline Volume (acre-feet)	DSM2 Area (acre)	DSM2 Volume (acre-feet)	Zone 1 Area (acre)	Zone 1 Volume (acre-feet)	Zone 4 Area (acre)	Zone 4 Volume (acre-feet)
5		7,326	68,485	3,804	54,128	1,949	14,502	3,302	27,174
4		6,531	61,481			1,951	12,553	3,310	23,869
3.4	MHHW	5,793	57,787			1,966	11,378	3,319	21,880
3	MHW	5,350	55,560	3,708	46,615	1,976	10,589	3,325	20,551
2		4,682	50,607			1,985	8,610	3,337	17,220
1	MTL	4,378	46,085			1,989	6,626	3,339	13,881
0		4,094	41,829	3,513	35,751	1,991	4,638	3,340	10,542
-1	MLW	3,797	37,870			1,540	2,939	3,105	7,265
-1.4	MLLW	3,700	36,367			1,328	2,350	2,988	6,054
-2		3,455	34,210	3,288	28,946	835	1,601	2,598	4,302
-3		2,909	30,975			383	880	1,402	2,133
-4		2,618	28,202			146	568	477	1,022
-5		2,405	25,678	2,364	20,199	114	455	138	624

Tidal Channels

Tidal channels perform two fundamental functions in the Marsh plain. First, tidal channels are the conduits through which water, sediment, nutrients, and aquatic organisms circulate into, around, and out of the Marsh. This transport function directly controls most of the physical conditions in a tidal marsh to which plants and wildlife are subject. Channels also provide habitat for a wide variety of fish and wildlife species. Vegetation along the channels provides edge habitat for birds and other wildlife species. Channels may provide shallow-water habitat for dabbling and diving ducks and other waterfowl. Channels provide forage and rearing habitat and movement corridors for a wide variety of fish species. Most tidal channels in Suisun Marsh are bordered by levees that protect managed wetlands. These levees are often a mix of dredged sediment and artificial materials such as riprap and often have fringing vegetation. Channel sediments are primarily mud (silt- and clay-size particles).

Montezuma Slough is the major tidal channel within the Marsh. The length of Montezuma Slough is about 32 km from the mouth at Suisun Bay (western end) to the head near Collinsville (western end). The major tributary channel to Montezuma Slough is Nurse Slough. Nurse Slough joins Montezuma Slough near the middle and extends about 5 km north along the east edge of Potrero Hills. Little Honker Bay is located on Nurse Slough adjacent to the Blacklock tidal wetlands, north of Kirby Hills. Denverton Slough extends north from Little Honker Bay.

Suisun Slough is the second major tidal channel within the Marsh. It has a length of about 21 km from the mouth at Suisun Bay (southern end) to Suisun City (northern end). Cordelia Slough joins Suisun Slough from the west, about 3 km upstream from the mouth of Suisun Slough. Cordelia Slough extends about 12 km along the northwest edge of the Marsh. Cordelia Slough crosses under the Southern Pacific Railroad and connects with Chadbourne Slough and several other small channels. Goodyear Slough joins Cordelia Slough near its mouth.

Hunter Cut connects Montezuma Slough and Suisun Slough about 7.5 km north of the mouth of Suisun Slough. Several small tidal sloughs branch from Suisun Slough. Wells Slough connects with Chadbourne Slough. Cutoff Slough connects Suisun Slough and Montezuma Slough about 15 km upstream from the mouth of Suisun Slough. Sheldrake Slough joins Suisun Slough from the west. Boynton Slough joins Suisun Slough from the west, and receives the freshwater discharge (of about 20 cfs) from the Fairfield–Suisun City wastewater treatment plant. Hill Slough joins Suisun Slough from the east and extends to the north of Potrero Hills. Peytonia Slough joins Suisun Slough just south of Suisun City.

Several other channels (historical tidal sloughs) have been isolated from tidal influence by the levees around the managed wetlands. The largest of these are Roaring River, Grizzly Slough, Frost Slough, Island Slough, and upper Tree Slough, which once were connected to Montezuma Slough, and Volanti Slough, which once connected with Suisun Slough.

Tidal Wetlands

Most of the historical tidal wetlands in the Marsh were separated from tidal flows with levees and converted (i.e., drained) for agricultural use. Later, these areas were converted to managed wetlands for waterfowl hunting and are regularly flooded in the late fall and early winter. Several of the major areas still open to tidal flows in the Marsh are ecological preserves. A total of 7,672 acres of tidal wetlands remains. Rush Ranch tidal wetlands are located north of Cutoff Slough. Hill Slough tidal wetlands are near the northern end of Suisun Slough, flowing to the north of Potrero Hills. Peytonia Slough Ecological Reserve is located at the northern end of Suisun Slough. Blacklock is a recently (2006) restored 70-acre tidal wetlands on Nurse Slough (little Honker Bay). Figure 5.1-3 shows the locations of these major existing tidal wetlands within the Marsh.

There are tidal wetlands along the Marsh sloughs and channels called fringe wetlands. These fringe wetlands are located along the levee bank or berm adjacent to the levee. The wetland usually extends about 5–10 feet from the levee, representing just an acre per mile. The total area of these intertidal bands

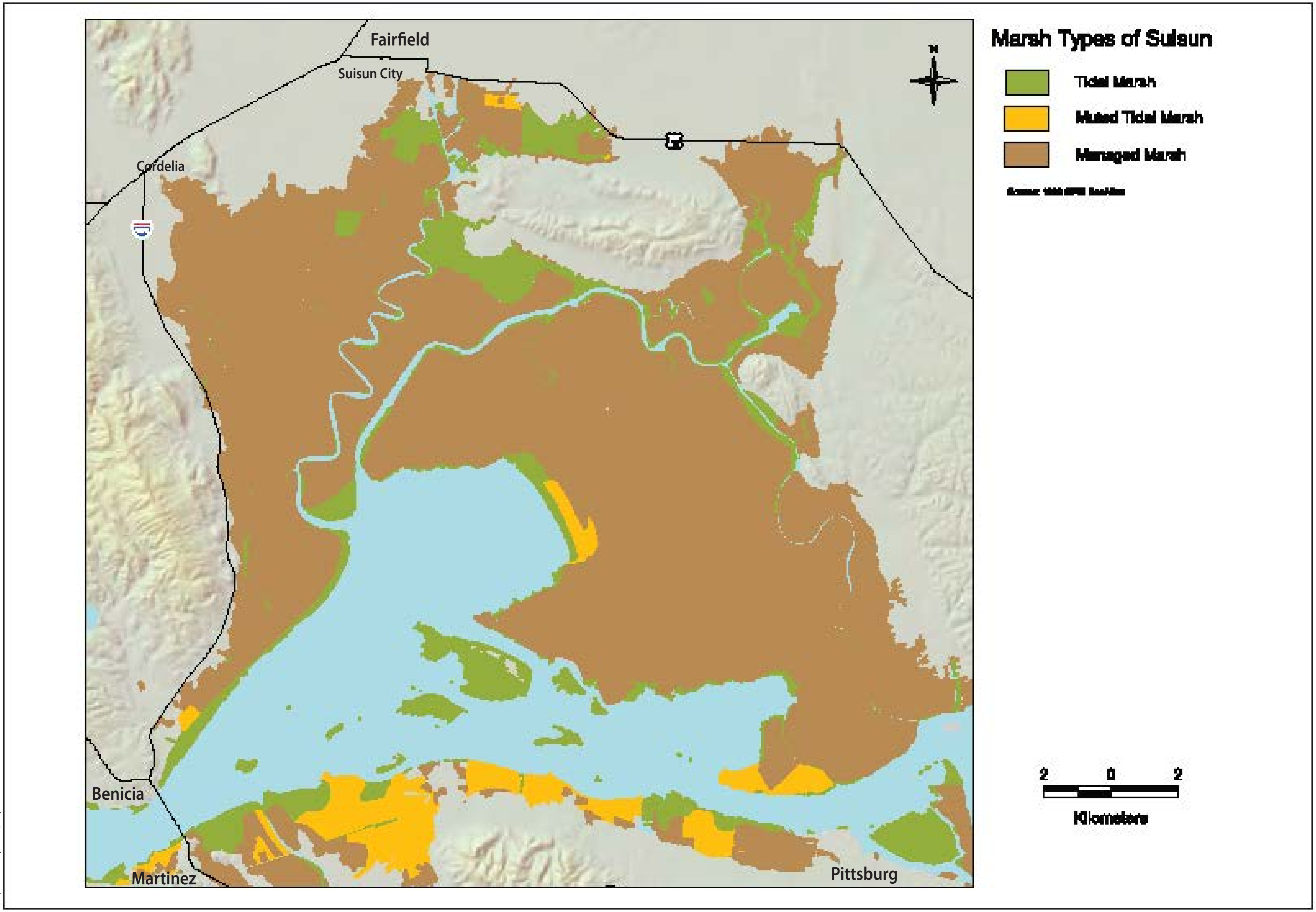

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Figure 5.1-3
Marsh Types in Suisun Marsh

along the channel banks is estimated to be 1,500 acres, which is the majority of the existing intertidal area in the Marsh.

Tidal marsh vegetation may be restricted to particular tidal inundation bands. For example, channels with bottom elevations below the MLLW are almost always inundated. This portion of the tidal marsh channels is called subtidal or shallow-water habitat. Bulrushes, cattails, tules, and other emergent vegetation can grow in the subtidal zone with elevations of less than –1.5 feet msl (MLLW). Some emergent vegetation can grow in the shallow habitat below MLLW, but most emergent vegetation is located above MLLW.

In the San Francisco Bay area, intertidal marsh vegetation is generally confined to above MTL, with mud-flats below this elevation. Low marsh in San Francisco Bay generally is defined as elevations of 1 foot msl to 3 feet msl (MTL to MHW). Dominant low marsh vegetation in Suisun Marsh includes bulrushes, tules, and cattails. The middle marsh is defined as a narrow band between elevation 3.0 feet and 3.5 feet (MHW to MHHW). This zone typically is dominated by saltgrass and pickleweed. The high marsh is defined as 3.5 to 5 feet msl (MHHW to spring-tide high water).

Managed Wetlands

About 52,112 acres in the Marsh are diked with low levees and managed as waterfowl habitat, but most are privately owned waterfowl hunting clubs. These managed wetlands are separated from the tidal sloughs by exterior levees, and water exchange is controlled by gated culverts. Waterfowl club managers control the timing and duration of flooding to promote growth of waterfowl food plants within the confines of existing regulatory constraints. Water levels are manipulated to optimize wetland plant diversity while preventing salt accumulation in the managed wetland soils. This is achieved by using the existing managed wetland topographical variation and contouring and ditching low areas to ensure adequate drainage to avoid trapping water in sinks and elevating salinities as a result of evaporation of remaining water.

Flooding and draining of these managed wetlands depends on the tidal elevation and location in the Marsh. Water is flooded onto the managed wetlands during periods of high tide when the channel elevation is higher than the flooded elevation. The managed wetlands cannot be flooded higher than MHHW unless a pump is used. Drainage without a pump cannot lower the water elevation below MLLW. Therefore, the land elevations of most of the managed wetlands are intertidal. Some of the lands are below MLLW and must be drained with ditches and pumps. Some subtidal areas in the managed wetlands that cannot be drained are managed as permanent ponds, with circulation, which provides habitat for resident and migratory waterfowl and wildlife.

Tidal Flows in Suisun Marsh

Tidal flow propagates into Suisun Marsh through western Grizzly Bay and creates large tidal exchanges at the mouth of Montezuma Slough (peak flow of about 50,000 cfs) and Suisun Slough (peak flow of about 15,000 cfs). The tides in the eastern Marsh are significantly less energetic, and peak tidal flows in the eastern end of Montezuma Slough are about 10,000 cfs. Tidal exchange occurs from both ends of Montezuma Slough, although the tidal flows are smaller (averaging about 5,000 cfs) at the upstream end (head) near Collinsville.

Tidal Flows in Suisun Slough

The mouth of Suisun Slough is the most downstream (western) channel in the Marsh. Suisun Slough supplies tidal flows to Cordelia Slough, Goodyear Slough, Wells-Chadbourne Slough, Cutoff Slough, Boynton Slough, Peytonia Slough, and Hill Slough.

Figure 5.1-4 shows the simulated tidal stage and tidal flow at the mouth of Suisun Slough (Godfather gage) and above Hunter Cut for July 2002. The tidal elevation in Suisun Slough is nearly identical to the tidal elevation at Martinez. The tidal elevation has a slight gradient in Suisun Slough, with a positive (downstream) elevation difference of about 0.5–1.0 foot during ebb tide, and a negative (upstream) elevation difference of about 0.5–1.0 foot during flood tide. At slack tide the water elevations are about equal throughout the Marsh channels. Figure 5.1-4 also shows the simulated tidal flows at the mouth of Suisun Slough for July 2002. Tidal flows are greatest at the beginning of ebb tide, when water begins to drain from the largest water surface area. The ebb-tide (i.e., downstream) flow decreases as the tidal elevation declines. Ebb tide flows are greatest during spring-tide periods when the higher high tide is followed by the lower low tide. The flood-tide (i.e., upstream) flows are more uniform throughout the month.

These tidal elevation changes and corresponding tidal flows can be summarized by calculating the cumulative tidal volumes during each ebb or flood tide. Figure 5.1-5 shows the simulated tidal volumes in Suisun Slough for July 2002. The tidal exchange occurs about twice each day as the tidal elevations rise and fall twice each day. The flood-tide volumes are fairly uniform, while the ebb tide volumes are more variable, ranging from less than 2,000 af to more than 5,000 af during the month. The average tidal volume at the mouth of Suisun Slough is about 3,000 af during each flood and ebb tide. Because a considerable tidal flow moves up Montezuma Slough to Hunter Cut and across to Suisun Slough, the tidal volume in Suisun Slough above Hunter Cut is greater than at the mouth of Suisun Slough. The tidal volume above Hunter Cut averages about 4,000 af during each ebb and flood tide.

Figure 5.1-5 also shows the tidal volumes for the mouth of Cordelia Slough, located about 1.5 miles upstream from the mouth of Suisun Slough and for the mouth of Hill Slough, located about 13.5 miles upstream from the mouth of Suisun Slough. The average tidal volume for Cordelia Slough is about 1,000 af. This includes tidal exchange into Goodyear Slough and portions of Chadbourne

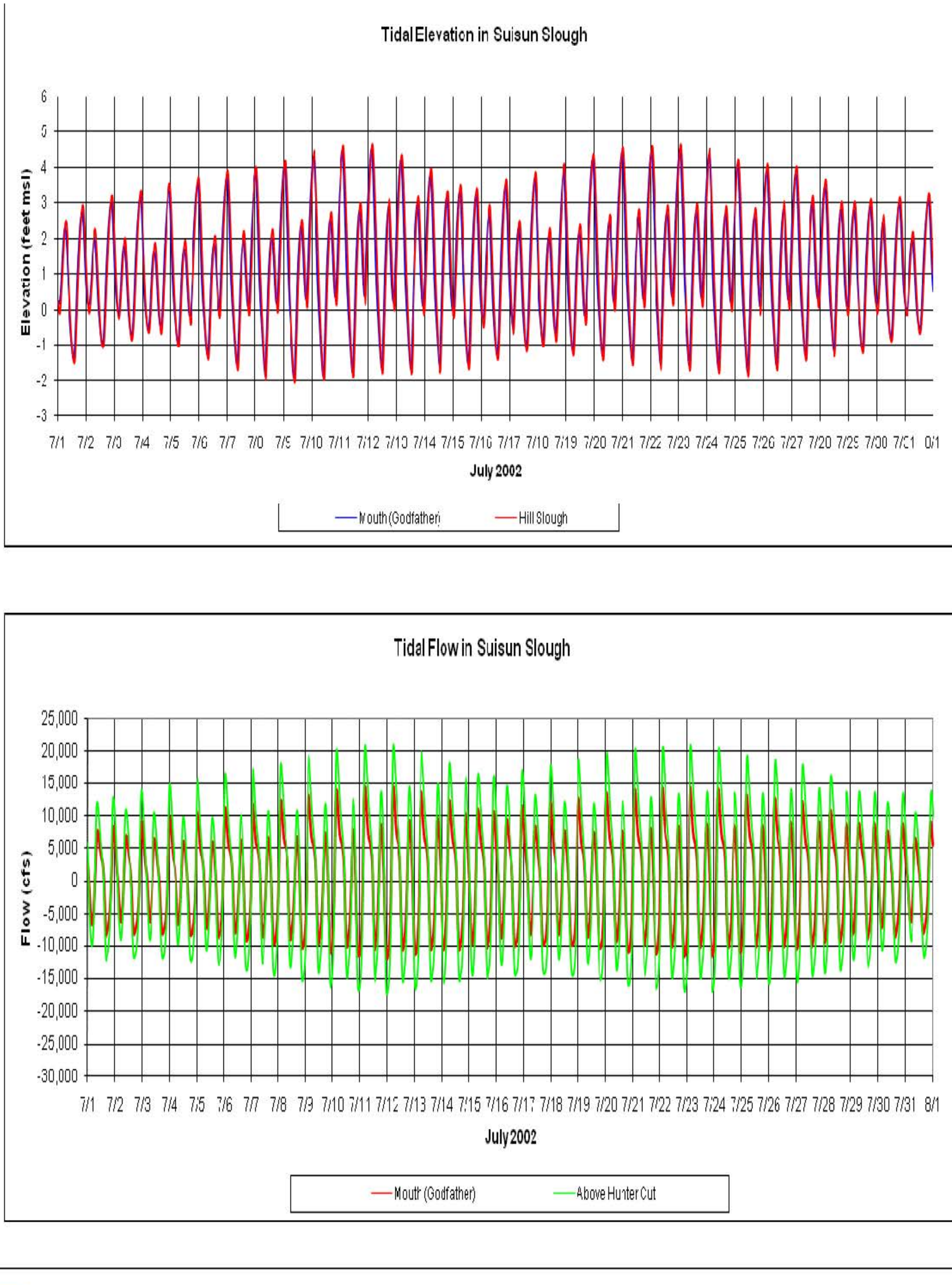

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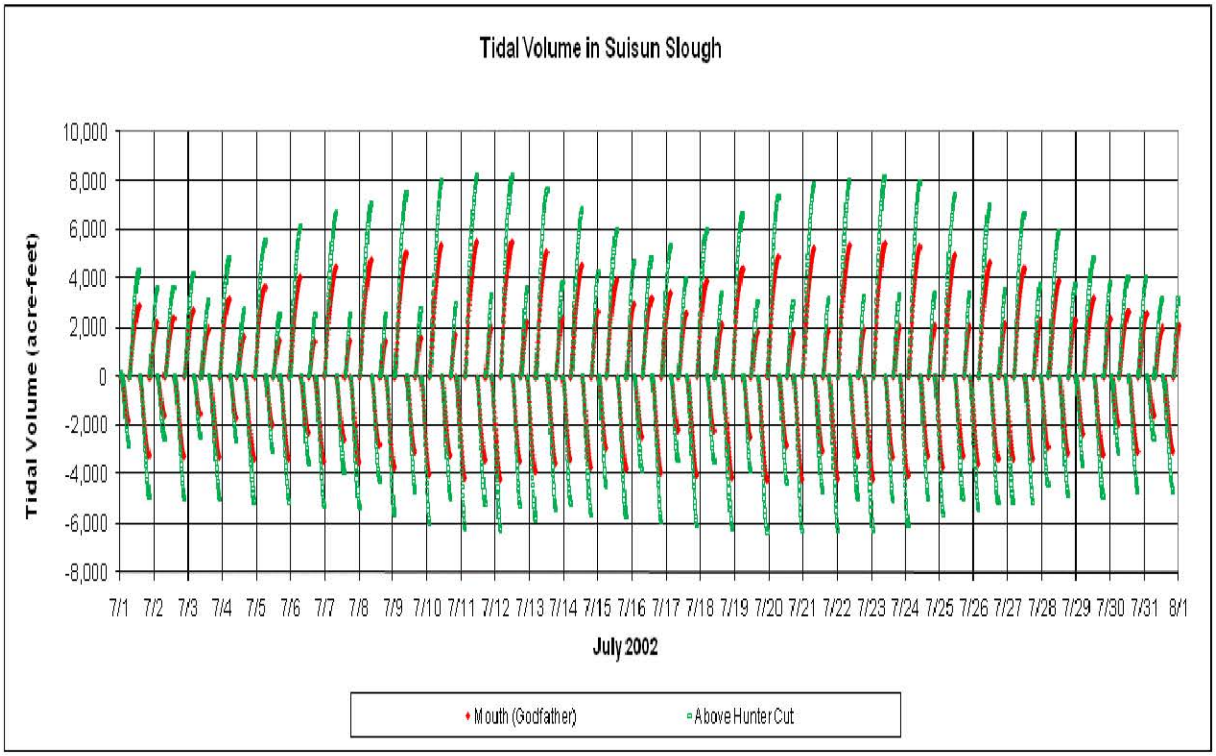
Figure 5.1-4
Tidal Elevations and Tidal Flows in Suisun Slough for July 2002



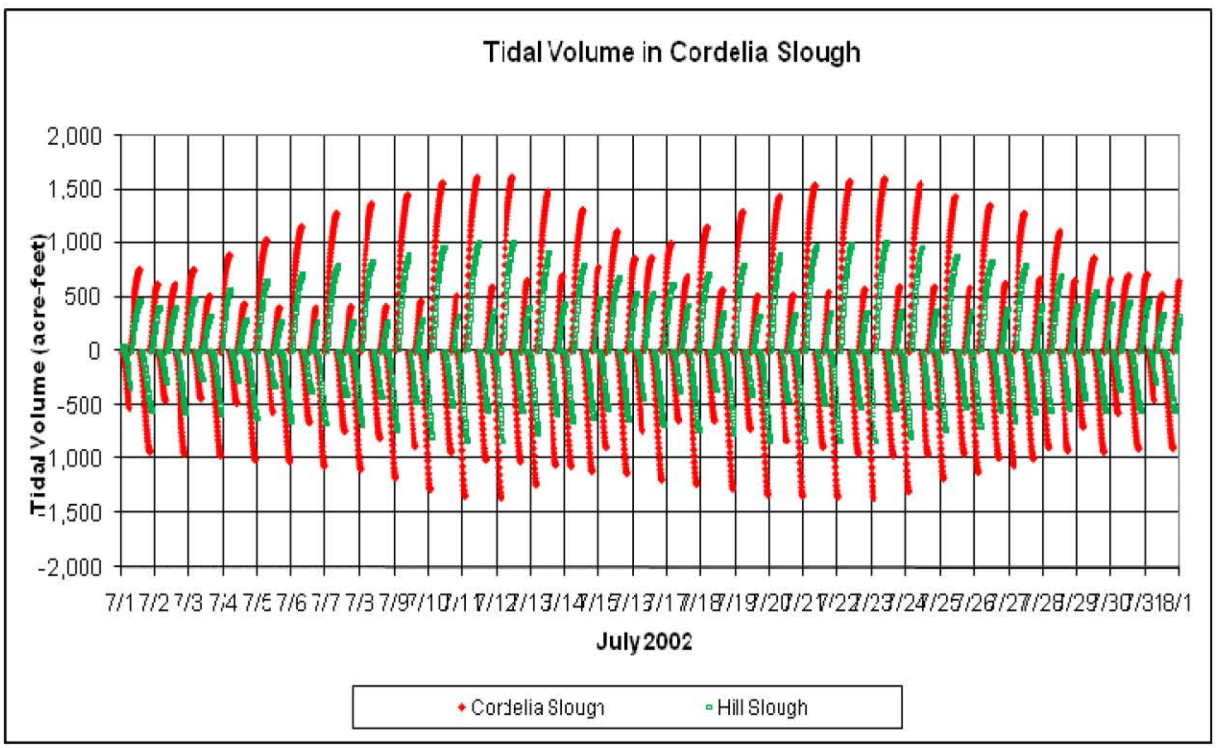


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Figure 5.1-5
Simulated Tidal Volumes in Suisun Slough and Tributary Sloughs in July 2002

Slough on the northeast side of the Southern Pacific Railroad. The average tidal volume at the mouth of Hill Slough is about 500 af.

Other tributary channels to Suisun Slough have similar tidal volumes corresponding to the upstream intertidal area and volume. Some of these tributary sloughs include tidal wetlands, but most of these tidal flows fill and drain the tidal slough channels and the fringe wetlands located along the margins of these tidal channels. Table 5.1-3 provides a summary of the subtidal and intertidal area and volume in each of these Suisun Slough tributaries. The average tidal volume is also given for reference.

Tidal Flows in Montezuma Slough

The downstream end of Montezuma Slough is just upstream (east) of the mouth of Suisun Slough. Almost all of the tidal exchange into Suisun Marsh comes from this northern end of Suisun Bay (Grizzly Bay). A small amount of tidal exchange enters the upstream end of Montezuma Slough. The tidal exchange at the upstream end of Montezuma Slough near Collinsville is nearly balanced without much net flow downstream in Montezuma Slough. For July 2002 conditions, the simulated net flow was –56 cfs (upstream toward Collinsville).

Figure 5.1-6 shows the simulated tidal elevation and tidal flows at the head of Montezuma Slough and upstream of Hunter Cut in Montezuma Slough. The simulated peak ebb tidal flows in Montezuma Slough upstream of Hunter Cut ranged from less than 30,000 cfs during neap tide to more than 45,000 cfs during spring tides. The simulated peak flood tidal flows upstream of Hunter Cut ranged from about 20,000 cfs to 30,000 cfs. The simulated tidal flows at the upstream end of Montezuma Slough (head) were about 7,500 cfs to 10,000 cfs. Careful examination of Figure 5.1-6b indicates that the tidal flow at the head of Montezuma begins entering the Marsh from the Sacramento River as high tide approaches (because of the net Delta outflow). This tidal flow into the Marsh continues for the first half of ebb tide, but then the flow direction reverses and water moves upstream (east) toward Collinsville in the second half of the ebb tide. This suggests that the two ends of Montezuma Slough act as separate tidal sloughs, with a null-zone (i.e., no net flow) located somewhere upstream of Nurse Slough (near Meins Landing).

Figure 5.1-7 shows the simulated tidal volumes at the two ends of Montezuma Slough. Because a major portion of the Montezuma Slough flow connects with Suisun Marsh through Hunter Cut, the tidal volumes upstream of Hunter Cut are also shown in Figure 5.1-7. The average tidal volume at the mouth of Montezuma Slough is about 11,000 af. The average tidal volume above Hunter Cut is about 7,500 af. The average tidal volume in Hunter Cut is about 3,500 af. The average tidal flow at the head of Montezuma Slough near Collinsville is about 2,300 af.

Figure 5.1-7 also shows the simulated tidal volumes in Montezuma Slough at Belden’s Landing and in Nurse Slough, which is the major tributary to Montezuma Slough. The average tidal volume in Nurse Slough is about 2,500 af. The average tidal volume at Belden’s Landing is about 5,700 af. Because the flows at Belden's Landing and at the head of Montezuma Slough are in the same direction, the majority of the Nurse Slough tidal volume enters from downstream in Montezuma Slough.

In summary, the simulated tidal flows entering the Marsh channels during each flood tide and leaving the Marsh channels during each ebb tide are a total of about 16,500 af. This is very close to the average tidal volume of 17,500 af estimated from the tidal marsh geometry. This difference is largely attributable to the tidal flow locations being slightly upstream from the mouth of Suisun Slough and Montezuma Slough. As already described, the subtidal volume of 38,000 af (MLW) is about twice the intertidal exchange volume. About one-third of the maximum Marsh volume is replaced during each tidal cycle.

Montezuma Slough Salinity Control Gate Operations

The SMSCG were constructed in 1987 and began operating in 1988 to reduce salinity in the Marsh channels during the salinity control season of October through May, when D-1485 objectives were specified. The relatively complex tidal flows in and out of the head of Montezuma Slough near Collinsville require that the gates be operated in real-time with monitoring of the tidal elevations and flows. Operation of the gates generally involves closing the gates whenever tidal flows would be upstream from Montezuma Slough to the Sacramento River. The gates remain open when tidal flows move into Montezuma Slough to provide the maximum inflow of fresh water to Montezuma Slough. Operations are regulated by the Operations BOs.

The summary of simulated tidal volume at the head of Montezuma Slough can be used to describe the basic SMSCG operations on tidal flows. The average tidal volume for both ebb and flood tides is about 2,300 af during each tidal period (two each day). Therefore, by blocking the upstream tidal volume, a net inflow of about 4,600 af/day of low salinity Sacramento River water will be "pumped" into the upper end of Montezuma Slough. However, the tidal range in Montezuma and Nurse Sloughs will remain about the same, so the flood tide volume entering from the mouth of Montezuma Slough (estimated as 11,000 af) will remain the same, but the ebb tide volume will be increased to 13,200 af). Gate operations will create a net downstream flow in Montezuma Slough of about 2,300 af during each tidal cycle. Because this is about 20% of the flood tide volume entering from the mouth of Montezuma Slough, the salinity gradient within Montezuma Slough will be shifted downstream. The salinity effects of this tidal pumping produced by the SMSCG operations will be more fully described in Section 5.2, Water Quality.

Tidal Velocities in Suisun Marsh

Tidal velocities in the Marsh channels and sloughs are controlled by the tidal flows and the cross sections in the Marsh channels and sloughs. Figure 5.1-8 shows the simulated tidal velocities in several of the major sloughs for July 2002. The peak velocities are generally less than 2–3 feet per second (fps). The natural processes of scouring and deposition produce channel sections that are in equilibrium with these processes and the upstream tidal area (volume). Velocities of more than 3 fps are likely to scour mud and sand bottoms.

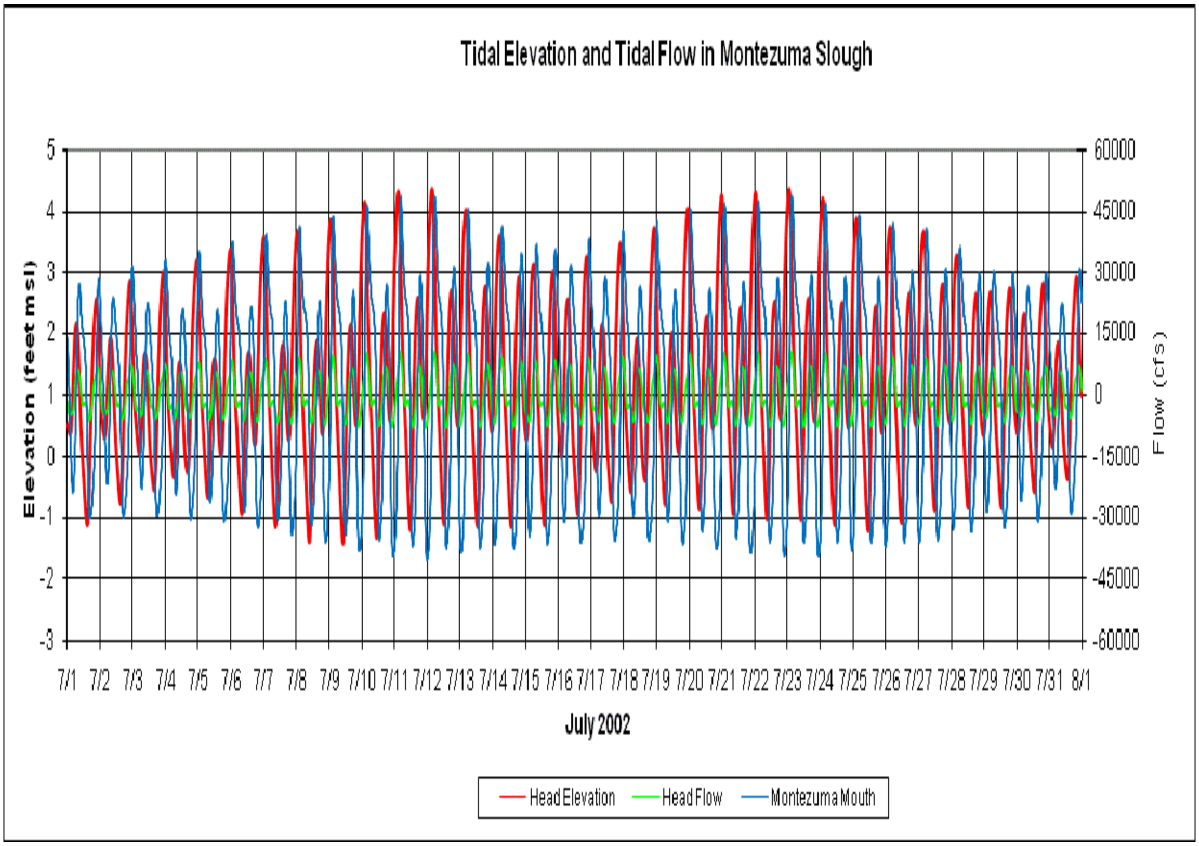

Figure 5.1-6a. Simulated Tidal Elevations and Tidal Flows at the Mouth and Head of Montezuma Slough for July 2002

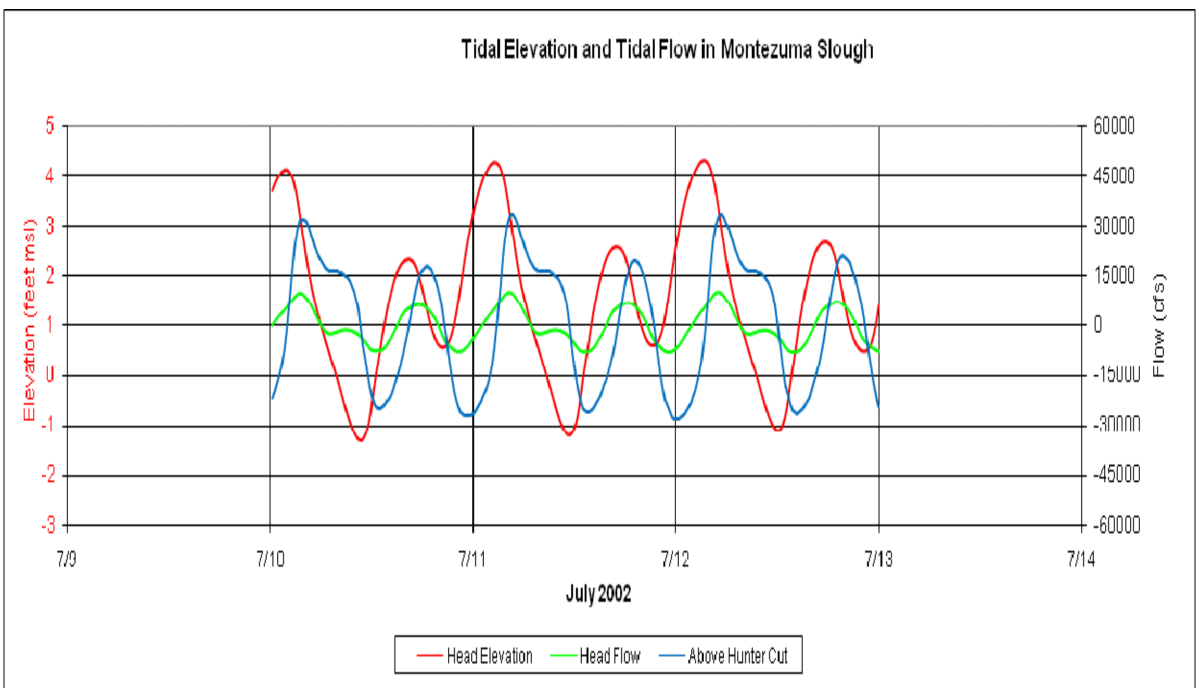

Figure 5.1-6b. Detail of Tidal Simulation for July 10–12, 2002

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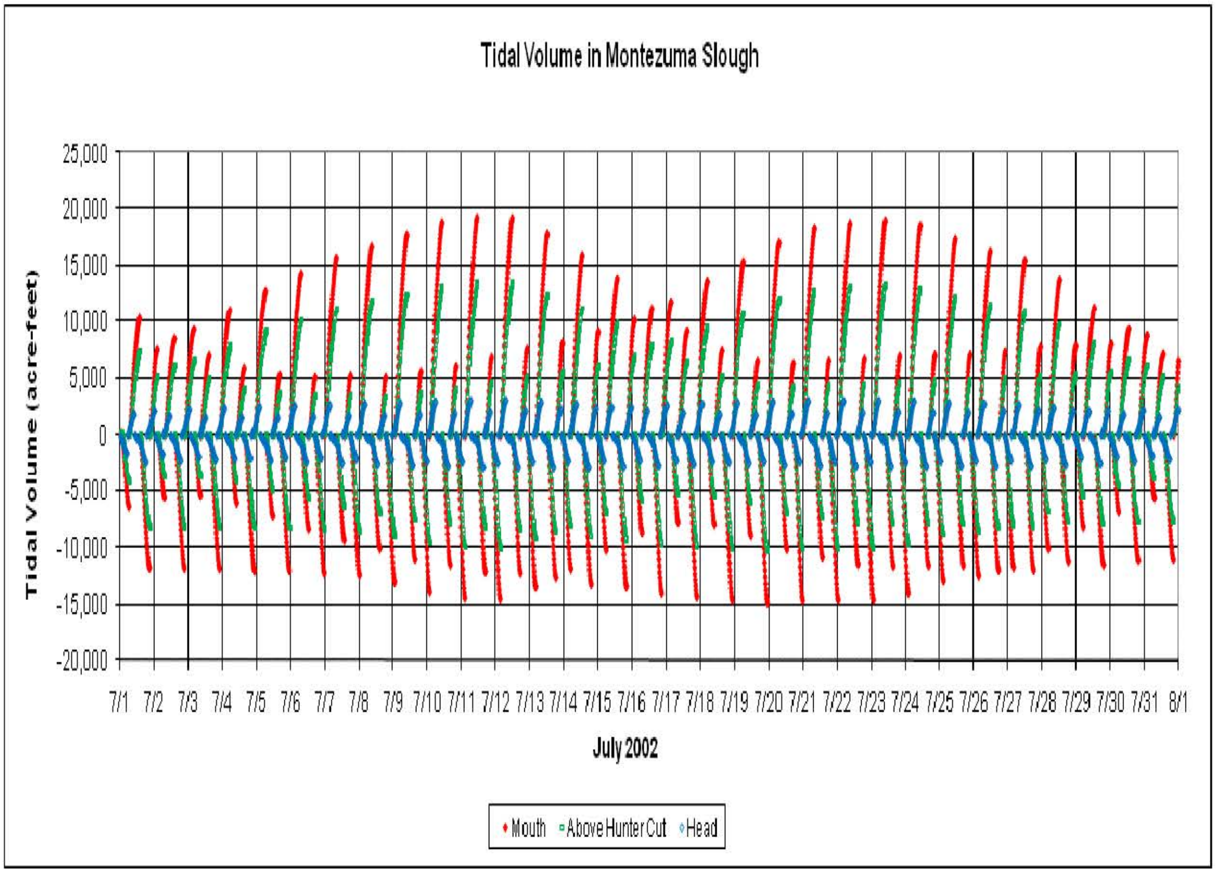
Figure 5.1-6



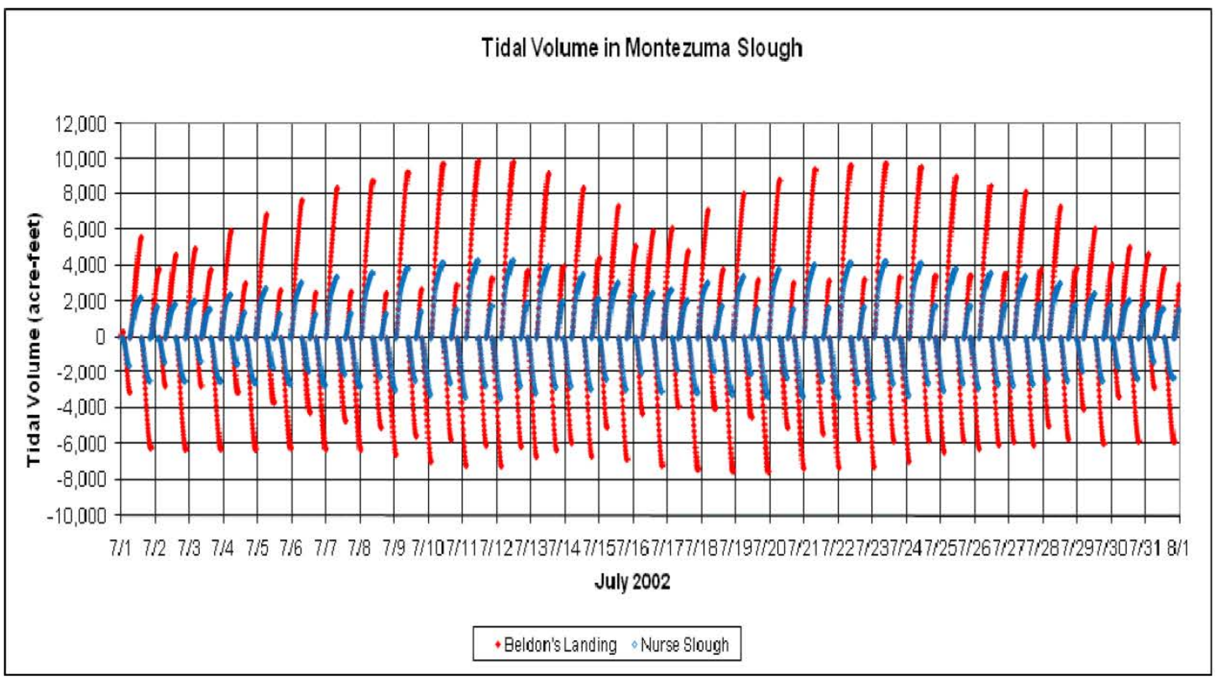


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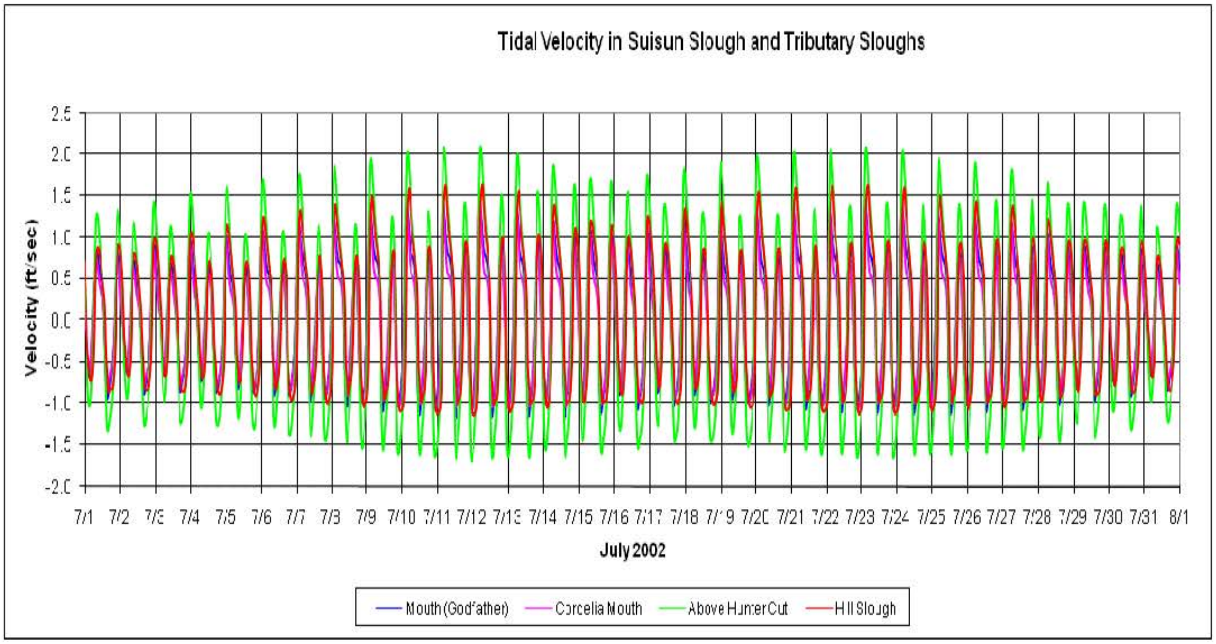
Figure 5.1-7
Simulated Tidal Volumes in Montezuma Slough and Nurse Slough for July 2002



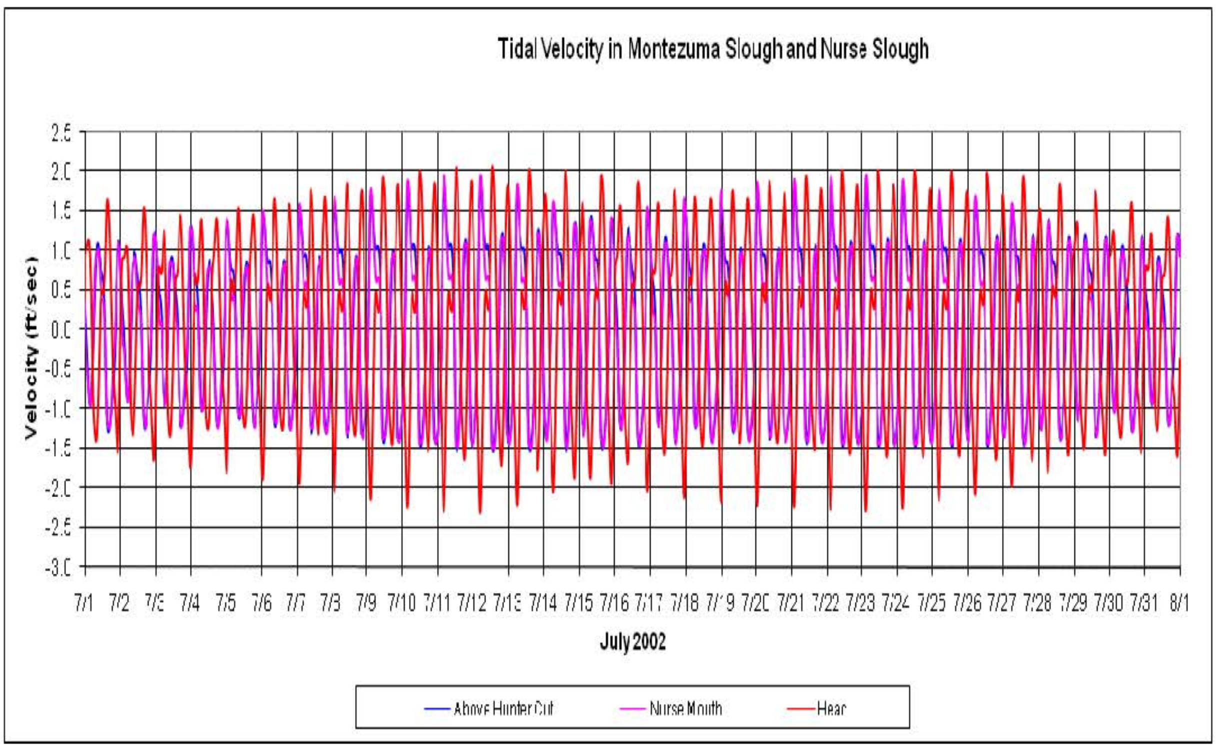


Figure 5.1-8
Simulated Tidal Velocities in Marsh Channels (Sloughs) for July 2002

Cohesive clay sediment may be less susceptible to scour. Velocities in some connecting channels, such as Hunters Cut, may be higher because of the tidal elevations differences between the channels. Higher velocities also may be expected in levee breaches and main channels of restored tidal wetlands.

Water Supply in Suisun Marsh and Delta

Recent Historical Delta Outflow

Table 5.1-4 gives the monthly historical Delta outflow in 1968–2007. The last column gives the annual total water volume in thousands of acre-feet (taf). The table is arranged by water years because the flooding in the Marsh managed wetlands for waterfowl habitat begins in October. This period corresponds to the historical record when Marsh salinity and Delta water management have been considered linked. These historical Delta outflows were regulated by D-1485 outflow and salinity objectives in the Delta and in the Marsh from 1978 to 1994, and by D-1641 objectives that include similar salinity objectives in the Delta and in the Marsh, revised Delta outflow requirements for the location from the Golden Gate Bridge of the 2 parts per thousand (ppt) salinity gradient (X2), and new limits on the export/inflow ratio (E/I) from 1995 to 2007.

The historical Delta outflow is important for this environmental evaluation of potential impacts from implementing the plan because it controls Marsh salinity and the subsequent beneficial uses for fish and wildlife in the managed wetlands. Table 5.1-5 gives the general relationship between Delta outflow and salinity near the downstream (western) end of the Marsh (Fleet) and at the upstream (eastern) end of the Marsh (Collinsville). See Figure 1-6 for map of Marsh. Also shown is the relationship between Delta outflow and the X2 location. The range of regulated Delta outflow ranges from about 3,000 cfs to about 12,000 cfs. Over this range of outflow, the EC at Fleet varies from 25,000 microSiemens per centimeter (µS/cm) to about 11,000 µS/cm. The corresponding range of EC at Collinsville varies from about 12,000 µS/cm to about 1,500 µS/cm. The X2 location varies from about 91 km (near Emmaton) to 75 km (near Chipps Island or Mallard Slough). These outflow-EC relationships will be described more fully in Section 5.2, Water Quality.

Table 5.1-4. Historical Monthly Average Delta Outflow (cfs) for Water Years 1968–2007 (Source: DWR DAYFLOW database)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (taf)
1968	16,719	16,202	20,498	24,257	52,061	40,314	9,932	6,737	3,666	3,684	5,264	6,004	**12,348**
1969	5,453	11,120	25,682	123,140	159,046	93,506	69,375	64,564	46,596	13,143	12,458	20,188	**38,377**
1970	19,484	19,964	46,190	193,121	111,326	55,986	11,027	10,761	6,214	5,256	7,947	14,587	**30,094**
1971	13,423	26,117	85,369	64,190	34,196	32,049	36,972	26,406	21,218	11,654	12,988	19,660	**23,217**
1972	13,957	13,743	23,967	21,339	21,968	18,127	7,542	5,140	2,891	6,211	6,487	10,476	**9,181**
1973	11,935	25,944	27,133	101,686	102,165	76,907	22,191	11,699	7,212	4,599	5,963	11,153	**24,384**
1974	14,071	59,945	76,406	138,699	59,178	77,575	109,547	25,544	16,943	9,366	12,784	20,981	**37,423**
1975	18,529	23,991	28,018	17,489	57,330	66,834	34,519	28,796	22,508	11,129	9,523	13,419	**19,891**
1976	16,901	17,921	19,954	9,310	7,471	7,788	8,729	3,937	3,775	4,186	4,394	3,583	**6,541**
1977	3,611	3,643	4,213	4,363	4,878	3,007	2,977	3,909	2,383	3,049	2,383	2,717	**2,477**
1978	2,046	4,003	8,570	66,157	56,159	85,619	61,170	40,759	8,945	3,854	5,814	11,718	**21,313**
1979	9,600	10,928	8,780	30,522	46,341	38,087	14,485	13,435	5,316	5,264	3,357	4,972	**11,403**
1980	7,799	12,172	19,029	118,220	121,655	99,152	28,628	20,804	14,790	11,065	4,122	9,803	**28,117**
1981	7,321	6,662	12,487	18,325	21,171	26,483	11,648	9,143	4,596	5,306	3,148	4,696	**7,873**
1982	5,214	36,001	86,287	97,674	92,555	80,088	142,192	57,782	28,123	16,741	13,309	25,802	**40,910**
1983	22,975	39,152	88,908	89,762	175,756	266,623	118,100	98,659	70,929	43,759	24,484	31,442	**64,266**
1984	32,283	74,137	154,587	100,906	41,515	34,916	14,637	11,093	7,925	10,127	8,179	13,586	**30,600**
1985	11,899	25,953	31,066	15,120	15,590	10,410	6,846	7,291	5,113	4,835	2,248	3,175	**8,406**
1986	3,366	6,890	9,430	15,209	205,414	169,447	46,539	15,810	9,223	7,293	5,054	10,726	**29,647**
1987	10,608	7,732	8,986	10,818	16,859	22,916	6,212	4,845	3,382	3,724	2,772	1,737	**6,047**
1988	3,761	4,291	9,454	19,591	3,039	4,481	11,417	4,659	3,082	3,732	2,305	2,251	**4,377**
1989	3,142	6,619	7,231	3,604	6,379	38,928	11,687	7,379	6,156	6,163	4,469	6,446	**6,554**
1990	4,887	5,478	4,399	9,886	6,788	3,813	5,923	7,700	4,846	3,966	4,461	2,450	**3,895**
1991	3,405	4,495	6,383	3,973	7,361	24,579	3,701	3,862	4,002	3,318	2,558	3,761	**4,315**
1992	3,909	3,909	7,623	6,413	28,759	13,283	6,258	3,255	3,426	2,983	2,824	3,366	**5,141**
1993	4,350	4,126	11,603	57,886	55,022	63,969	44,296	25,188	27,078	9,450	9,422	5,306	**19,047**
1994	5,118	7,381	12,361	10,787	20,557	10,595	8,150	7,941	3,782	4,495	3,335	5,506	**5,978**

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (taf)
1995	3,217	5,356	9,629	107,487	72,836	200,645	90,837	98,047	46,754	26,789	10,876	19,629	**41,801**
1996	11,371	8,383	27,709	32,144	126,912	89,148	42,032	46,021	15,270	9,156	9,592	7,293	**25,486**
1997	4,742	10,035	84,538	262,325	118,694	33,699	14,142	12,257	8,199	9,286	8,639	3,914	**34,299**
1998	4,826	10,153	15,351	71,545	230,854	104,441	88,395	67,612	71,736	30,856	19,893	20,060	**43,487**
1999	12,280	20,636	47,241	38,021	98,804	69,106	35,509	22,138	13,664	10,463	5,930	4,784	**22,542**
2000	4,258	6,803	10,467	21,541	94,092	87,828	27,233	22,057	8,823	9,123	6,024	4,622	**18,156**
2001	5,724	4,742	5,996	15,211	19,567	23,404	12,158	9,612	7,404	4,645	3,153	4,123	**6,944**
2002	4,259	8,205	24,733	38,734	12,029	16,964	11,892	13,483	7,374	5,662	3,768	4,108	**9,164**
2003	4,184	7,331	28,885	51,440	29,622	15,761	22,029	41,877	11,719	9,631	6,874	3,447	**14,050**
2004	4,288	6,626	23,820	32,104	68,091	56,256	21,948	12,354	5,651	7,317	5,204	4,676	**14,922**
2005	8,508	6,708	12,449	33,589	24,922	38,546	29,876	50,929	27,838	9,378	5,586	6,897	**15,404**
2006	4,764	5,249	47,943	156,265	55,278	124,121	183,031	82,004	37,105	12,044	8,914	8,610	**43,806**
2007	3,948	5,182	9,238	8,316	21,337	14,039	11,235	9,313	7,793	5,354	3,724	4,616	**6,216**
Minimum	2,046	3,643	4,213	3,604	3,039	3,007	2,977	3,255	2,383	2,983	2,248	1,737	**2,477**
Average	8,803	14,598	29,815	56,029	62,589	58,486	36,125	25,370	15,336	9,201	7,006	9,157	**19,952**
Maximum	32,283	74,137	154,587	262,325	230,854	266,623	183,031	98,659	71,736	43,759	24,484	31,442	**64,266**

Table 5.1-5. Relationship between Delta Outflow and Salinity (EC) at the Downstream (Fleet) and Upstream (Collinsville) Ends of Suisun Marsh

Effective Delta Outflow (cfs)	EC at Fleet (µS/cm)	EC at Collinsville (µS/cm)	Location of X2 (km from GG)
3,000	25,000	12,000	90.7
4,000	23,000	9,500	87.3
5,000	21,000	7,500	84.7
6,000	19,500	6,000	82.6
7,000	18,000	5,000	80.8
8,000	16,500	4,000	79.2
9,000	15,000	3,000	77.8
10,000	13,500	2,250	76.6
11,000	12,000	1,750	75.5
12,000	11,000	1,500	74.5

µS/cm = microSiemens per centimeter.
cfs = cubic feet per second.
GG = Golden Gate Bridge.
km = kilometers.

Salinity, controlled by Delta outflow, is also important for aquatic habitat conditions that influence the distribution and abundance of fish species and other aquatic organisms. These potential impacts will be discussed in Section 5.2, Water Quality, and Section 6.1, Fish.

Historical Central Valley Project and State Water Project Exports

Table 5.1-6 gives the monthly historical CVP exports during 1968–2007. This period corresponds to the historical record when Marsh salinity and Delta water management have been considered linked. These historical CVP exports include the period prior to the SWP exports and San Luis Reservoir operations, which began in 1969. Before the San Luis Reservoir was completed, the CVP exports were used directly for water deliveries along the Delta-Mendota Canal. The CVP exports have been less seasonal since San Luis Reservoir operations began. The CVP pumping plant has a maximum diversion of about 4,600 cfs, and has been regulated by D-1485 objectives from 1978 to 1994, and by D-1641 objectives from 1995 to 2007.

Table 5.1-7 gives the monthly historical SWP exports during 1968–2007. This period corresponds to the historical record when Marsh salinity and Delta water management have been considered linked. The SWP exports generally increased with higher water demands through the 1970s and 1980s. Water demands have been relatively constant and SWP exports have varied with water availability since 1995. The SWP pumping plant had a maximum capacity of about 6,000 cfs until 1988, when four pumps were added to provide a maximum pumping capacity of 10,300 cfs, but the pumping is limited to 6,680 cfs by existing regulatory requirements. The SWP exports were regulated by D-1485 objectives from 1978 to 1994, and by D-1641 objectives from 1995 to 2007.

The historical exports indicate the magnitude of Delta water management that is controlled by CVP and SWP operations. Although the Delta outflow requirements may limit Delta exports, these outflow requirements are conditions on the water rights permits to protect salinity for other beneficial uses.

Table 5.1-6. Historical Monthly Average Central Valley Project Exports (cfs) for Water Years 1968–2007
(Source: DWR DAYFLOW database)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (taf)
1968	1,586	964	428	638	1,721	3,282	3,771	4,165	4,200	4,738	3,902	3,597	**1,997**
1969	3,785	2,298	1,105	2,883	2,998	2,206	1,886	2,187	1,890	2,703	4,366	2,244	**1,844**
1970	1,629	366	0	412	1,481	1,757	3,644	3,562	4,230	4,447	3,559	2,281	**1,653**
1971	2,046	470	8	24	2,312	3,805	3,339	3,609	4,440	4,563	4,372	2,779	**1,918**
1972	2,858	2,322	1,943	1,034	3,253	3,904	3,527	4,065	3,319	4,228	4,391	3,937	**2,346**
1973	3,368	0	0	1,472	631	641	2,473	4,477	4,591	4,640	4,489	3,806	**1,855**
1974	3,342	2,993	1,551	1,235	3,474	4,237	2,564	4,380	4,396	4,498	4,520	3,320	**2,444**
1975	3,440	0	10	2,687	4,189	3,760	4,213	3,949	3,996	4,612	4,490	3,637	**2,349**
1976	3,604	3,833	3,881	4,055	4,584	4,563	4,399	4,540	3,735	3,459	4,564	4,539	**3,008**
1977	3,170	2,518	1,569	3,630	2,250	2,028	1,002	1,657	310	354	1,094	1,641	**1,281**
1978	488	1,638	2,168	3,871	4,065	3,985	2,741	2,066	4,133	4,505	4,166	3,781	**2,264**
1979	2,952	3,206	3,178	2,699	1,227	1,986	3,182	2,991	2,987	4,549	4,558	4,382	**2,296**
1980	3,910	1,031	0	0	2,754	3,236	3,837	2,915	2,863	4,569	4,541	3,509	**2,006**
1981	3,566	3,852	3,788	4,083	3,656	1,942	3,684	3,136	3,458	4,351	4,110	3,314	**2,590**
1982	2,111	1,435	785	1,804	3,788	4,123	3,452	2,984	2,935	2,911	4,349	2,065	**1,971**
1983	2,239	3,337	3,139	3,864	3,947	3,934	3,662	2,823	2,975	3,971	4,266	3,345	**2,502**
1984	2,081	954	1,604	1,373	3,811	4,283	3,961	2,990	2,985	4,676	4,378	3,118	**2,190**
1985	3,614	3,893	3,956	3,859	4,039	3,949	3,900	2,991	3,000	4,573	4,376	4,096	**2,790**
1986	3,927	3,719	3,871	3,881	3,940	2,435	2,783	2,998	2,993	4,450	4,385	4,010	**2,618**
1987	4,000	3,693	4,010	4,004	4,030	2,379	4,339	2,998	2,998	4,435	4,565	4,284	**2,758**
1988	3,998	3,931	4,034	4,063	4,098	4,083	4,083	2,971	2,993	4,479	4,531	4,592	**2,895**
1989	3,547	3,602	4,166	4,183	4,097	4,112	3,987	2,999	2,996	4,739	4,704	4,422	**2,870**
1990	4,217	4,165	4,113	4,137	4,095	4,109	4,253	2,770	2,987	3,661	3,033	3,195	**2,697**
1991	1,107	1,588	2,277	1,883	2,606	3,722	2,882	1,277	894	1,633	1,659	1,852	**1,408**
1992	1,730	2,009	1,855	3,196	2,463	4,094	1,718	846	790	897	989	1,594	**1,342**
1993	967	1,278	1,219	4,006	4,026	4,082	2,882	1,524	1,990	4,303	4,362	4,379	**2,108**

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	**Annual (taf)**
1994	4,311	4,240	4,144	2,277	3,870	2,268	1,562	1,123	1,328	2,512	2,440	3,541	**2,023**
1995	2,480	2,488	3,534	4,141	4,218	2,372	3,326	2,985	4,067	4,463	4,386	4,387	**2,581**
1996	4,334	4,223	4,273	4,272	3,589	739	2,395	2,074	4,416	4,449	4,379	4,295	**2,626**
1997	4,196	4,123	4,083	2,022	557	4,344	2,719	1,744	4,439	4,396	4,429	4,322	**2,510**
1998	4,281	4,201	4,075	3,952	2,956	2,062	1,446	2,320	2,862	4,060	4,371	4,357	**2,474**
1999	4,162	2,136	33	2,978	4,317	4,108	1,710	1,703	3,336	4,426	4,391	4,279	**2,262**
2000	4,249	4,195	2,544	3,205	4,108	3,380	2,207	1,263	3,045	4,319	4,386	4,250	**2,487**
2001	4,208	4,061	3,910	2,737	3,519	1,883	2,177	857	2,997	4,135	4,130	4,081	**2,332**
2002	3,625	3,756	3,677	4,145	3,604	4,182	2,145	857	2,535	4,355	4,337	4,279	**2,505**
2003	4,088	3,671	3,333	4,262	4,274	4,355	1,899	1,465	4,413	4,200	4,308	4,267	**2,685**
2004	4,303	4,324	4,150	4,358	3,968	4,141	1,956	961	3,632	4,374	4,430	4,393	**2,722**
2005	4,350	4,293	3,794	4,217	3,889	3,377	2,121	1,071	4,167	4,374	4,408	4,362	**2,679**
2006	4,342	4,287	4,275	3,918	4,321	3,262	816	1,803	3,363	4,406	4,401	4,378	**2,628**
2007	4,316	4,034	4,140	4,353	4,368	4,023	2,728	843	2,478	4,390	4,429	4,334	**2,679**
Minimum	488	0	0	0	557	641	816	843	310	354	989	1,594	**1,281**
Average	3,263	2,828	2,616	2,995	3,377	3,278	2,884	2,473	3,154	3,995	4,049	3,681	**2,330**
Maximum	4,350	4,324	4,275	4,358	4,584	4,563	4,399	4,540	4,591	4,739	4,704	4,592	**3,008**

Table 5.1-7. Historical Monthly Average State Water Project Exports (cfs) for Water Years 1968–2007 (Source: DWR DAYFLOW database)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (taf)
1968	138	76	167	439	47	1,153	1,479	1,287	284	206	772	1,820	**476**
1969	2,314	2,631	2,572	2,805	1,648	1,143	1,253	975	491	526	556	177	**1,032**
1970	273	628	727	655	385	436	880	283	570	568	834	647	**416**
1971	423	1,482	1,844	1,780	777	846	1,023	843	1,186	1,781	2,148	1,000	**917**
1972	836	640	401	515	407	2,634	2,668	2,216	1,802	665	2,364	2,879	**1,091**
1973	2,915	3,472	3,383	1,428	483	575	795	1,833	2,570	2,820	3,067	1,794	**1,526**
1974	2,479	1,825	1,732	682	1,923	1,972	1,561	2,635	4,545	5,994	4,761	1,620	**1,921**
1975	1,057	1,877	2,744	2,717	2,445	2,245	1,993	1,521	357	398	4,326	4,024	**1,550**
1976	3,870	4,116	3,896	4,139	3,067	3,713	570	869	335	574	2,176	3,689	**1,878**
1977	1,313	1,564	1,090	3,300	1,971	1,722	280	1,310	385	510	425	167	**847**
1978	168	890	3,552	5,937	6,209	1,823	574	1,017	3,491	3,511	4,194	3,657	**2,100**
1979	2,105	2,278	2,785	1,339	1,659	2,294	2,611	3,098	3,166	4,687	5,713	4,795	**2,211**
1980	3,690	4,715	5,894	6,310	3,376	1,069	1,492	1,688	3,012	2,252	4,605	4,092	**2,555**
1981	3,010	2,487	2,901	4,095	3,509	2,813	4,304	1,131	336	2,457	5,002	3,311	**2,132**
1982	3,680	3,197	4,343	3,355	5,614	6,247	6,108	2,970	955	1,057	3,673	3,166	**2,668**
1983	2,973	2,667	5,229	6,175	6,208	1,352	112	404	1,974	1,174	2,833	764	**1,912**
1984	344	732	484	302	1,889	2,586	3,675	2,860	3,078	4,653	4,981	2,258	**1,685**
1985	1,859	4,000	4,452	1,898	3,478	4,561	3,361	3,094	3,402	4,734	5,584	4,485	**2,710**
1986	3,604	3,485	5,881	5,044	2,061	706	1,863	3,183	3,061	4,019	5,423	6,338	**2,705**
1987	3,451	3,020	3,102	2,127	2,707	3,089	2,578	2,184	2,055	4,377	5,075	4,615	**2,319**
1988	1,756	1,377	4,827	6,227	5,802	4,234	4,362	3,184	2,785	3,370	4,123	3,385	**2,747**
1989	1,924	2,339	2,871	5,875	3,968	6,024	6,408	3,121	2,153	4,634	6,452	6,171	**3,136**
1990	6,149	6,060	6,184	6,347	6,315	6,363	5,289	500	385	2,434	3,502	2,577	**3,138**
1991	2,295	2,122	2,780	2,884	1,794	5,933	4,560	1,368	985	870	2,081	2,287	**1,812**
1992	3,447	1,036	1,190	3,088	3,530	6,269	1,246	815	1,107	533	1,580	2,793	**1,612**
1993	765	1,050	2,742	7,564	5,205	1,864	2,745	1,777	2,124	4,305	6,313	6,452	**2,583**

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual (taf)
1994	6,455	2,595	6,288	3,496	1,912	1,921	336	707	499	1,721	3,523	3,695	**2,013**
1995	2,779	3,586	3,903	7,508	4,573	533	147	1,279	3,428	5,976	4,823	2,887	**2,500**
1996	2,947	1,235	113	5,707	2,976	2,735	1,801	2,617	5,118	6,085	6,255	5,870	**2,633**
1997	5,514	5,834	3,576	629	1,706	2,577	1,809	1,357	2,688	5,320	4,466	5,797	**2,496**
1998	4,323	4,916	6,838	3,195	234	0	17	909	2,189	3,575	4,431	4,476	**2,134**
1999	4,824	2,191	2,072	1,426	938	2,948	3,105	1,640	1,124	6,277	6,686	6,956	**2,439**
2000	4,986	5,185	3,778	6,454	7,391	5,554	3,048	1,713	4,382	5,852	6,287	6,504	**3,692**
2001	5,050	5,316	4,791	3,929	4,734	5,880	1,724	594	269	3,688	4,077	3,606	**2,635**
2002	983	3,246	6,119	6,466	4,976	3,896	2,114	677	2,265	6,241	6,844	4,199	**2,900**
2003	1,754	3,139	4,165	5,771	6,385	6,216	2,578	983	5,965	6,705	7,004	6,783	**3,458**
2004	2,862	3,828	4,278	6,830	6,408	6,888	2,143	753	1,697	6,342	6,651	5,015	**3,251**
2005	2,843	3,825	4,226	7,801	4,938	3,616	3,868	1,914	5,600	7,162	7,147	7,149	**3,625**
2006	6,303	5,277	6,559	3,184	4,901	2,662	2,713	2,061	3,663	6,862	7,133	7,126	**3,527**
2007	6,024	5,382	6,586	3,454	2,474	3,022	2,088	534	457	6,589	6,765	5,341	**2,954**
Minimum	138	76	113	302	47	0	17	283	269	206	425	167	**416**
Average	2,862	2,883	3,527	3,822	3,276	3,053	2,282	1,598	2,149	3,538	4,366	3,859	**2,248**
Maximum	6,455	6,060	6,838	7,801	7,391	6,888	6,408	3,184	5,965	7,162	7,147	7,149	**3,692**

Managed Wetlands Water Supply

The water supply for the managed wetlands within the Marsh is through riparian and appropriative water rights. Water supply is for waterfowl habitat flooding operations and soil leaching for vegetation management. The majority of diversions occur in October and November at the beginning of the waterfowl habitat flooding period.

The SRCD estimates that the total flooded wetland acreage is about 40,000 acres, and the flooded depth averages about 1 foot. Therefore, the total diversions in October are likely about 40,000 acre-feet. This water is circulated throughout the managed wetlands and then drained back into the slough channels. The water used for soil leaching for salt control and evapotranspiration of the drained wetlands/vegetation in the summer is harder to estimate, but will not exceed seasonal evaporation (about 2 feet). Some of this water is supplied by rainfall, so the total water diversions are likely between 100,000 and 150,000 acre-feet. More details of the managed wetlands water management are provided in the Conceptual Model for Managed Wetlands in Suisun Marsh (California Department of Fish and Game 2007).

Environmental Consequences

Assessment Methods

Timing of availability of the water supply for the managed wetlands in the Marsh is directly related to tidal hydraulics because most water is diverted by gravity to the managed wetlands. These flooding operations rely on adequate tidal water elevations to divert water from the channels. The RMA hydrodynamic model has been used as the primary tool for identifying and evaluating potential tidal hydraulic changes from the SMP alternatives. The tidal hydraulic changes have been evaluated with comparative simulations of tidal hydraulics in 2002 and 2003, which were selected as the evaluation period for RMA modeling because these were recent years with relatively low Delta outflow, so the salinity conditions in the Marsh were relatively high (typical of low-outflow years). An alternative may change tidal flows and tidal elevations in the Marsh by increasing the amount of tidal wetlands that exchange water with the channels of Suisun Marsh during the tidal cycle. Changes in tidal elevations and tidal flows, both upstream and downstream of connections with new tidal wetlands, are somewhat difficult to anticipate; mathematical modeling is the most accurate method for simulating these effects. Two possible distributions of new tidal wetlands within the Marsh have been simulated to estimate the likely general effects from substantial new tidal wetlands (about 7,500 acres in each representative simulation). These simulations assumed all the tidal wetland restoration occurred at one time and looked at the immediate effect on tidal elevations of the total restoration. The simulations did not consider how sea level rise may interact with the tidal restoration actions when predicting tidal elevation changes. The simulations also did not look at tidal elevation changes from tidal restoration actions after the change to determine if the potential tidal elevation changes would continue over any part of the SMP planning horizon.

Based on the variables in the simulation, tidal restoration of existing managed wetlands would increase the tidal flow in the Marsh channels between Suisun Bay and the breached levee connections to the tidal wetlands. Tidal flows upstream from the new levee breaches would not be reduced if the tidal channel is large enough to convey the increased tidal flows. Table 5.1-3 shows the increased tidal areas and tidal volumes that would be added to the existing Marsh channels and tidal wetlands if about 2,000 acres of managed wetlands ("Zone 1" example in the southwest corner of Suisun Slough and Suisun Bay) were restored to tidal action with levee breaches. The additional subtidal volume would be about 2,350 af, and the additional tidal volume between MLLW and MHHW (about 5 feet difference) would be about 9,000 af. A slightly larger restoration of about 3,350 acres ("Zone 4" example in the northeast corner on Montezuma Slough) would add a subtidal volume of about 6,000 af and increase the tidal volume by about 16,000 af between MLLW and MHHW. Therefore, about 25% of the example tidal restoration volumes would be subtidal (below MLLW) and about 75% would be intertidal (i.e., above MLLW). The estimated channel volumes from the DSM2 tidal hydraulic model geometry are similar to those of the revised geometry used in the RMA model. The existing RMA model geometry has about 20% more volume at MLLW and MHHW. The RMA model geometry is assumed to be more accurate. More discussion of the effects of simulated tidal restoration on the Marsh channel tidal hydraulics and water quality (salinity) can be found in Appendix A, "Numerical Modeling in Support of Suisun Marsh EIR/EIS."

Changes in tidal hydraulics in Suisun Marsh also can influence the tidal flows and velocities upstream in the Delta channels. This change in tidal exchange can influence salinity intrusion (i.e., tidal mixing) upstream in the Delta and at the water supply diversions and export pumping locations. These salinity effects will be described and evaluated in the Section 5.2, Water Quality.

Potential effects of Delta water management (CVP and SWP operations) on the salinity of Suisun Marsh water diversions are adequately protected under existing conditions by the Delta outflow constraints and water quality objectives included in the water rights decisions (D-1485 and D-1641) that regulate the CVP and SWP exports and other permitted diversions from the Delta. These established standards in conjunction with the Revised SMPA and the PAI Fund are assumed to offset or prevent any potential salinity impacts on the water supply used for beneficial use of fish and wildlife in the managed wetlands within the Marsh. Likewise, because of the protection provided by established water quality objectives, potential impacts of tidal restoration on salinity that would limit the availability or impair the beneficial uses of upstream municipal water supplies are assumed to be negligible.

The nearest municipal water supply diversions are the City of Antioch and the CCWD intake at Mallard Slough, across from Chipps Island. However, because these water diversions are operated only when salinity is below specific thresholds during periods of high Delta outflows, no impacts on these diversions from Suisun Marsh water management or restoration programs are anticipated.

Significance Criteria

Significance criteria have been developed for one possible impact from new tidal wetland restoration in the Marsh related to water supply.

The possible impact is a reduction in the water availability for the water supply of the managed wetlands. The primary water supply for managed wetlands comes from riparian diversions. A reduction in the amount of water available for riparian diversion as the water supply to the managed wetlands caused by tidal wetlands restoration is considered significant.

The primary issues with water availability for the water supply to managed wetlands are amount of water and timing of water available. The restoration of tidal wetlands is not a consumptive use of water and therefore does not have a significant impact on the amount of water available. The restoration of tidal wetlands could affect the timing of available water related to the riparian water supply by alteration of tidal elevations or velocities.

The normal tidal range within the Marsh is about 5 feet. The RMA tidal hydraulic modeling (Appendix A) indicates that reductions in the MHHW elevations and increases in the MLLW elevations are possible at locations adjacent to substantial acreage of tidal wetlands restoration. These possible changes in tidal elevation range (difference between MHHW and MLLW) would result from additional tidal flows and volumes moving into and out of the restored wetlands. The operation of the managed wetland water supply depends on filling the wetlands during high tides. Changes to tidal elevations could affect the timing of water availability for riparian water diversion to managed wetlands.

Increases in the maximum channel tidal velocities could also affect the timing of water availability for riparian water diversion to managed wetlands. Tidal velocities in the Marsh channels and sloughs are generally moderate, with maximum velocities of between 1 fps and 2 fps, depending on the size of the channel cross section and the upstream tidal volume (upstream area). An increase in average channel velocity to more than 2 fps or an increase of more than 1 fps in an existing channel could affect the timing water availability for diversion.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, some restoration of tidal marsh and natural levee breaching would occur. Changes in tidal hydraulic conditions of water elevation fluctuations or velocity fluctuations in the Suisun Marsh channels may occur, depending on the location of the restoration and natural breaching. Changes in tidal conditions upstream in the Delta channels would not be anticipated. The risk of levee failure would remain at existing levels or increase as maintenance of exterior levees continues to be deferred. Following a levee breach, the tidal flows would be changed both upstream and downstream of the breach. After the levee breach is repaired, the tidal conditions would return to the baseline tidal flows and velocities. The likelihood of levee failure under existing conditions is generally known from the historical frequency of levee breaches, and is expected to increase under the No Action Alternative as a result of deferred maintenance and the effects of sea level rise. The primary change in water supply in the Marsh under the No Action Alternatives would result from a regulatory constraint on operations of managed wetlands as a result of limited restoration. Absent the SMP, it is anticipated that NMFS and FWS BOs for the operations of the managed wetlands would not allow continued operations of the same magnitude as current conditions. This could limit the available water supply through restrictions on flood and drain practices. However, Delta water management would continue under D-1641 outflow requirements, export limits, water quality objectives, and other restrictions related to the CVP/SWP Long Term Operations BOs.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Proposed tidal restoration of 5,000 to 7,000 acres throughout the Marsh over the 30-year period may cause tidal hydraulic changes in some of the existing channels. As part of the site-specific assessment, the initial tidal restoration design would be compared to the existing conditions with modeling studies to determine the extent of any hydraulic effects. Reduction of impacts generally will involve tidal restoration design changes (i.e., number of breaches, locations, lengths, and depths) or modifications in the existing channels (e.g., placement of riprap or local dredging). After restoration to tidal wetlands, the existing channels may experience some hydraulic adjustments (i.e., widening in response to higher tidal flows and velocities). However, the hydraulic modeling of the Marsh used fixed channel geometry and therefore represents the first year of tidal marsh restoration, without any substantial hydraulic adjustments.

Restoration Impacts

Impact WTR-1: Reduction in Water Availability for Riparian Water Diversions to Managed Wetlands Upstream or Downstream of Restoration Areas

The impact would be due to a change in timing of water availability for water supply to the managed wetlands due to changes in tidal elevations. Tidal flows into restored tidal wetlands may affect the tidal range in the sloughs adjacent to the restored tidal wetlands. The reduction in tidal range upstream would be caused by the diversion of the flood-tide channel flow into the tidal wetlands, and the drainage from the tidal wetlands during ebb-tide would reduce the drainage of the slough upstream from the restored wetlands. The diversion of a portion of the tidal flows would cause a greater dissipation of the tidal energy through the breach and within the new tidal wetlands area. A similar reduction in the tidal range downstream from the tidal wetlands breach could be caused by increased drainage from the slough and restored wetlands at low tide. Modeling results (see Appendix A, "Numerical Modeling in Support of Suisun Marsh EIR/EIS") and field measurements in sloughs with temporary breaches in managed wetlands levees have demonstrated this effect.

The changes in tidal elevation could affect the timing of water available to the riparian diversions. While the total amount of water available for diversion would not change, changes in tidal elevation would have a small effect on the timing of water availability due to the intertidal location of most manage wetlands in the Marsh. For one season or a portion of one season, the timing of water availability may experience a small change on a diurnal basis due to reduced tidal elevation differences. This change of timing would not significantly affect the beneficial use of the water for fish and wildlife in the managed wetlands and would not affect the amount of water supply available during the diversion periods.

The current operations of some of the managed wetlands could be effected for limited periods of time by reduced tidal elevation differences due to infrastructure limitations, but the amount of water available in tidal sloughs to divert would not be changed.

As described in Chapter 2, breaches will be designed to ensure that tidal flows remain below about 2 fps to prevent tidal muting (i.e., reduced tidal range) that is caused by the increased water surface gradient during peak tidal flows in channels with relatively high velocities.

Conclusion: Less than significant No mitigation required.

Impact WTR-2: Increased Tidal Velocities from Breaching of Managed Wetlands Levees

Tidal velocities in the Marsh channels and sloughs are generally moderate, with maximum velocities of between 1 fps and 2 fps, depending on the size of the channel cross section and the upstream tidal volume (upstream area). These maximum tidal velocities occur regularly (four times each day). An increase in average channel velocity to more than 2 fps or an increase of more than 1 fps in an existing channel is considered a significant change in tidal velocities and may result in local sediment scour or vegetation disruption. As described in Chapter 2, restoration designs will incorporate breach locations to minimize upstream tidal muting, tidal elevation changes, channel scour, and hydraulic changes. This can be accomplished by locating breaches on larger channels or allowing more openings to reduce the effects of the increased tidal flows on tidal elevations and velocities.

Breaches will be designed to ensure that tidal flows remain below 3 fps to prevent tidal muting or scouring that is caused by the increased water surface gradient during peak tidal flows in channels with relatively high velocities.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities

Impact WTR-3: Improved Water Supply as a Result of Improved Flooding and Draining of Managed Wetlands

The increased frequency of managed wetland activities has the potential to improve the ability to flood and drain managed wetlands. Activities that involve improving diversion such as installation and replacement of water control structures, and DWR/Reclamation activities such as maintenance of RRDS, would improve managed wetland water supply for those managed wetlands that implemented these activities. This would be a beneficial water supply impact for individual managed wetlands.

Conclusion: Beneficial.

Impact WTR-4: Increased Tidal Flows and Improved Water Supply as a Result of Dredging

Dredging is proposed to obtain source materials for levee maintenance throughout the Marsh. This includes dredging around water control structures and fish screens. Therefore, dredging would improve the ability of managed wetlands to obtain water supplies for flooding operations. Additional water management facilities and improved maintenance procedures would benefit the water management operations within the Marsh. Dredging channels for levee maintenance materials also would have an indirect effect of improving tidal circulation in dredged channels by increasing the total channel volume.

Conclusion: Beneficial.

Alternative B: Restore 2,000–4,000 Acres

Impacts for Alternative B would be similar to those described for Alternative A. Alternative B involves less tidal restoration, so any minor changes in timing of water availability for water supply would be of less magnitude and would occur in fewer areas of the Marsh.

Alternative C: Restore 7,000–9,000 Acres

Impacts for Alternative C would be similar to those described for Alternative A. Alternative C involves more tidal restoration, and therefore localized changes in timing of water available for diversions may occur more frequently throughout the Marsh, however any impacts to water supply from these minor timing changes would be less than significant.

Section 5.2
Water Quality

Introduction

This section describes the existing environmental conditions and possible beneficial and deleterious impacts on water quality that may result from implementing SMP alternatives.

The Affected Environment subsection below establishes the existing environmental context against which potential impacts may be considered. The Impact Analysis subsection specifically identifies potential impacts, their causes and estimated extents, and mitigation measures to reduce impacts to less-than-significant levels, where appropriate.

Salinity is the best understood and most managed water quality parameter in the Marsh. Delta water management for agriculture and water supply diversions and exports and the salinity of water diverted for waterfowl habitat in the managed wetlands of the Marsh became linked in the State Water Board's 1978 *Water Quality Control Plan for the Sacramento–San Joaquin Delta and Suisun Marsh* (1978 WQCP) and D-1485 Suisun Marsh salinity standards (objectives). The State Water Board required a plan of protection for Marsh water quality conditions. Initial facilities, including an improved RRDS to better supply approximately 5,000 acres on Simmons, Hammond, Van Sickle, Wheeler, and Grizzly Islands with lower salinity water from Montezuma Slough and the MIDS and Goodyear Slough outfall to improve water supply for the southwestern Marsh, were constructed in 1979 and 1980. The Plan of Protection for Suisun Marsh was approved in 1984.

Delta outflow is the primary factor governing salinity in the Marsh. Sloughs in the Marsh are used to flood and drain managed wetlands in support of habitat for resident and migratory wildlife and waterfowl hunting. Increased salinity in water used in managed wetlands inhibits wetland diversity and food-plant productivity intended to attract waterfowl species. Therefore, in addition to other critical water quality parameters, this section explores existing salinity conditions and the possible changes to salinity within the Marsh that may result from the SMP or its alternatives. In addition to salinity in the Marsh, the SMP and alternatives have the potential to affect salinity as distant as the south Delta CVP and SWP export facilities. Modeling of salinity impacts is described in great detail in Appendix A. Overall, minimal salinity effects are expected to occur.

The majority of impacts on water quality can be grouped as conventional pollutants or chemical contaminants. Besides potential adverse changes in salinity levels, other conventional water quality pollutants include low dissolved oxygen (DO), elevated water temperature, and increased levels of suspended sediment (SS). Chemical contamination includes elevated levels of mercury, especially in fish and other aquatic species. (Impacts on fish are discussed in Section 6.1.) In the context of the SMP, the primary anticipated sources of water quality pollution are annual discharges from existing managed wetlands and temporary construction activities during tidal wetlands restoration. However, this analysis assesses only the change in restoration and managed wetland activities associated with the SMP alternatives.

Summary of Impacts

Table 5.2-1 summarizes water quality impacts from implementing SMP alternatives. There are currently chronic significant, albeit temporary and localized, impacts on water quality from annual discharges of poor-quality (e.g., low-DO, high sulfur compound–containing) water from some managed wetlands. These impacts are expected to be reduced under the No Action Alternative and with implementation of the three project alternatives. No significant impacts on water quality solely from implementing any of the SMP action alternatives are anticipated.

Table 5.2-1. Summary of Water Quality Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
WQ-1: Increased Salinity in Suisun Marsh Channels from Increased Tidal Flows from Suisun Bay (Grizzly Bay) as a Result of Restoration	A, B, C	Less than significant	None required	–
WQ-2: Changes to Salinity of Water Available for Managed Wetlands from October to May	A, B, C	Less than significant	None required	–
WQ-3: Increased Salinity at Delta Diversions and Exports	A, B, C	Less than significant	None required	–
WQ-4: Possible Changes to Methylmercury Production and Export as a Result of Tidal Restoration	A, B, C	Less than significant	None required	–
WQ-5: Improved Dissolved Oxygen Concentrations in Tidal Channels from Reduced Drainage of High Sulfide Water from Managed Wetlands	A, B, C	Beneficial	None required	–
WQ-6: Temporary Changes in Water Quality during Construction Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Managed Wetland Activities Impacts				
WQ-7: Temporary Degradation of Water Quality during Implementation of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WQ-8: Temporary Degradation of Water Quality during Dredging, Including Possible Increases in Mercury Concentrations	A, B, C	Less than significant	None required	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- California Department of Water Resources. 1998. Suisun Marsh Preservation Agreement Amendment Three Actions as a means to provide equivalent or better protection than channel water salinity standards at Suisun Marsh Stations S-35 and S-97. Suisun Marsh Branch, Environmental Services Office.
- California Department of Water Resources. 2000. *Comprehensive Review of Suisun Marsh Monitoring Data 1985–1995*.
- California Department of Water Resources. 2001. *Final Report of the Suisun Marsh Ecological Workgroup Chapter 6 Hydrology and Water Quality Sub-Committee*. Prepared for the State Water Board.
- DWR and Reclamation electrical conductivity (EC) monitoring records. Available from IEP and CDEC.
- NMFS Biological Opinion and Essential Fish Habitat Consultation for the 2006 Regional General Permit 3 Extension (National Marine Fisheries Service 2006).
- Resource Management Associates (RMA) (2008) Bay-Delta and Suisun Marsh 2-D Model Calibration and Comparison of Tidal Marsh Restoration (Appendix A).
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- Wesley A. Heim, Dr. Kenneth Coale, and Mark Stephenson. 2003. *Methyl and Total Mercury Spatial and Temporal Trends in Surficial Sediments of the San Francisco Bay-Delta, CALFED Bay-Delta Mercury Project Final Report*. October. Moss Landing Marine Lab.
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Regulatory Setting

Implementation of Federal Water Quality Law

The Clean Water Act is the Nation's water quality law, administered by the EPA, with regulatory assistance from the Corps. It generally applies to all navigable waters of the United States. As intended, many day-to-day administrative and regulatory requirements of this act are administered by local, state, and Indian Tribe organizations—for example, in California by the State Water Board and RWQCBs.

The nine RWQCBs designate official beneficial uses of water (e.g., various uses of water to maintain aquatic and wildlife habitats) for all California water bodies, establish water quality objectives (allowable limits) on pollutants intended to protect designated beneficial uses, and develop effective implementation and enforcement plans. The region-specific planning information necessary to manage the State's water quality is contained in regional Water Quality Control Plans (Basin Plans), developed and revised periodically by the RWQCBs. Additional plans and policies are prepared as necessary. In particular, the RWQCBs are required by the Clean Water Act to identify impaired water body segments, those waters chronically failing to meet water quality objectives, and to develop total maximum daily loads (TMDLs) (the amounts of pollution that can be safely tolerated while still achieving objectives) for every pollutant-impaired water body segment combination identified.

Three of the state water quality agencies have direct jurisdiction over parts of the Delta: the State Water Board, the San Francisco Bay RWQCB, and the Central Valley RWQCB. The San Francisco Bay RWQCB, through its regional Basin Plan, has general water quality jurisdiction over the Marsh, Suisun Bay, and, of course, the San Francisco Bay estuary. Beneficial uses for the Suisun Marsh and associated sloughs include estuarine, spawning, and migrating habitat uses for fish species, recreational uses (contact and non-contact) and wildlife habitat uses. Mercury, specifically methylmercury (MeHg), in Suisun Bay is one example of a pollutant–water body combination that has an EPA-approved TMDL requiring regulatory action by the San Francisco Bay RWQCB. Meanwhile, because of the complex, sensitive, and multi-jurisdictional issues involved in one of California's most important watershed areas, the State Water Board Division of Water Rights Bay-Delta Program has for many years developed specific water quality standards for the Delta, including the Suisun Bay area, through various water rights decisions and regional water quality control plans.

State Water Quality Objectives

Salinity

The State Water Board established salinity standards for the protection of Suisun Marsh fish and wildlife starting with its 1978 regional water quality plan (1978 WQCP) and accompanying water rights decision (D-1485). The interim salinity standard was a maximum EC of 12.5 milliSiemens per centimeter (mS/cm) from October to May of all water-year types and locations. These interim salinity standards were to remain in place for 5 years until the Suisun Marsh Plan of Protection was developed, some initial facilities were constructed, and salinity monitoring stations were established.

At the end of the 5-year period, the D-1485 salinity objectives were implemented at eight locations (shown in Figure 1-6) for all water-year types. Maximum salinity (as EC) levels varied from 8 to 19 mS/cm depending on month (October to March) and Delta outflow (19 mS/cm in October, 15.5 mS/cm in November and December, 12.5 mS/cm in January, 8 mS/cm in February and March, and 11 mS/cm in April and May). The State Water Board also required a minimum Delta outflow of 10,000 cfs from February to May in wet-water years. Flow requirements were included in the standards, in part, to help meet salinity requirements. Objectives were not established for summer months because only limited use of water for pond circulation and irrigation of some wetland vegetation occurs from June to September in any particular year.

The revised 1995 WQCP retained the D-1485 monthly standards for Marsh monitoring sites. Salinity objectives at monitoring sites S-35 (Goodyear Slough) and S-97 (Cordelia Slough) had not been implemented because the State Water Board extended the effective date of compliance at these locations by specific orders (October 30, 1997; August 14, 1998; April 30, 1999; and November 1, 1999). Monthly salinity objectives were implemented at three eastern Marsh locations: Collinsville, Montezuma Slough at National Steel, and Montezuma Slough near Belden's Landing. The Revised SMPA includes the same salinity objectives, and the State Water Board will continue to waive requirements at S-35 and S-97 if equivalent or better protection of the Marsh can be shown through the implementation of the Revised SMPA and the PAI Fund. Instead of numeric standards, a narrative standard was applied. There was disagreement among the many parties with interests in the Marsh as to the efficacy of a narrative standard. The USFWS testimony differed from that of the SMPA agencies. The USFWS expressed concern over the proposed operations of the SMSCG and the efficacy of the D-1641 narrative standard.

In May 1995, the State Water Board asked DWR to convene the Suisun Ecological Workgroup (SEW), with the primary purpose of determining the appropriate measures and objectives to protect and maintain the beneficial uses of the Suisun Marsh to address the need for a salinity standard for the Marsh based on the varied resources existing there. This process required the review of the numeric and narrative salinity standards for the Marsh. The SEW individual workgroups came up with disparate recommendations based on the resources they were examining; namely, brackish marsh vegetation, aquatic habitat, wildlife, and waterfowl. These subgroups were unable to reconcile their differences, and their final report went forward to the State Water Board with a chapter devoted to each resource group and resource-specific recommendations.

The narrative standard calls for maintaining healthy tidal marsh within Suisun Marsh. If the narrative standard is retained, the question of the health of these areas can be answered by the triennial vegetative survey conducted by DWR in cooperation with DFG as part of the SMPA Suisun Monitoring Agreement, which is a "companion" agreement to the SMPA. The survey is designed to detect changes in the vegetative makeup of the Marsh and can distinguish between wetland types. The brackish tidal wetlands are included in that survey, and it therefore can serve as a measure of compliance with the narrative standard. In addition, one of the SMP goals is to increase the amount of tidal marsh while concurrently enhancing existing managed marsh. Therefore, tidal marsh restoration and programs to enhance endangered plant species habitat will provide additional protection and contribute to the recovery of these species.

The 1995 WQCP included a new salinity objective in Suisun Bay known as X2, which allowed the State Water Board to help regulate salinity by controlling flow. X2 is the 2 parts per thousand isohaline point, defined as the location of the 2 parts per thousand salinity contour (isohaline), 1 meter off the bottom of the estuary, as measured in kilometers (km) upstream from the Golden Gate. (The 1995 WQCP used an EC value of 2.64 mS/cm to represent the X2 point.) Biologists determined that regulating the location of X2 in the months of February to June downstream of Collinsville in Honker Bay or Suisun Bay proved beneficial to fish species there, and this may benefit fish in Marsh channels, as well. Figure 5.2-1 shows the location of all water quality compliance and monitoring stations established in the 1995 WQCP and subsequently in D-1641).

Dissolved Oxygen

The minute-by-minute concentration of DO throughout the water column is critical for the immediate survival and long-term viability of fish and other aquatic species. The San Francisco Bay RWQCB Basin Plan DO objective for the Suisun Marsh is 7 milligrams per liter of water (mg/l) or more of DO (or at least 80% of maximum saturation within the water column of DO). Deleterious effects on aquatic organisms may occur at low DO concentrations below 5 mg/l. Therefore, as required by water quality law, the DO objective includes a buffer to ensure that oxygen concentrations stay at acceptable levels for the most vulnerable beneficial uses of water (e.g., maintenance of aquatic habitat for the most sensitive aquatic species). Because the oxygen saturation concentration is temperature-dependent, this minimum DO objective is intended to be particularly protective during warm water temperatures. The warmer water becomes, the less DO it can retain. The oxygen saturation point is about 9.2 mg/l in 20 degrees Celsius (°C) (68 degrees Fahrenheit [°F]) water but only about 8.4 mg/l in 25°C (77°F) water. As a result, temperature-sensitive species, such as salmon, become oxygen-deprived more easily in higher water temperatures.

DO levels increase in water through gradual gas exchange with the atmosphere at the surface of a body of water; turbulent action (e.g., spray and foaming); the release of oxygen throughout the water column by aquatic plants, particularly algae (during daylight hours); and other chemical and physical pathways. Oxygen is removed from water by those same aquatic plants (at night) and by aerobic bacteria, common to most water bodies, at any time. Excessive aquatic bacterial activity (i.e., mass digestion of over-ample food supplies resulting in too-rapid bacteria population increases)—as can occur when water bodies receive excessive amounts of dead organic material—often can result in sudden, catastrophic declines in DO levels. Fish kills can occur in waterways lacking significant flows and, as a result, adequate flushing and mixture.

The analytical process for quantifying the uptake of DO by biological organisms in water is called biochemical oxygen demand (BOD). It involves monitoring DO concentrations in water samples over a set period of time in strictly controlled laboratory conditions (e.g., at a particular temperature). Like DO, BOD is measured in milligrams of oxygen per liter of water. The higher the BOD, the greater the bacterial demand for oxygen and the greater the potential impact on multi-cellular, water-breathing aquatic organisms (e.g., fish, insects, amphibians). Relatively high BOD is required to reduce oxygen concentrations below 5 mg/l. However, this easily can occur under the right conditions in artificially impounded water bodies subject to high organic loads (e.g., from dead or decaying vegetation, the influx of animals wastes, contamination by fertilizers and other organic materials). Moderate BOD commonly reduces DO levels to as low as 7 mg/l.

Another factor related to BOD and DO can be an excess of algae or other aquatic plants. Plants both increase (through photosynthesis in daylight) and decrease (from respiration at night) DO concentrations. Under healthy environmental conditions, the results of these two activities are balanced and DO levels remain adequate both day and night. But under adverse conditions (e.g., long periods of sunlight, warm water temperatures, together with high nutrient loads), algae and other aquatic (often nonnative) plants can proliferate, reach excessive levels, and seriously deplete DO levels. Nighttime demands on oxygen in water from algae blooms can rapidly reduce DO concentrations to near zero, killing water-breathing organisms before oxygen levels have time to recover during daylight hours. And when weather conditions change rapidly (e.g., cloudiness increases, temperatures fall significantly) or herbicides (or herbicidal pollutants) are discharged, large-scale algae die-offs in impounded, slow-moving water bodies can fuel excessive BOD, again seriously reducing DO levels.

The factors discussed above are pertinent to considerations of Suisun Marsh because under certain conditions, managed wetlands contribute to the problems discussed; less so for tidally influenced wetland, where on the average regular flushing generally helps ensure adequate oxygen levels and fewer incidences of algal blooms or excessive BOD.

Temperature

The temperature quality objectives, developed by the State Water Board for estuaries, are (a) any increase in surface water temperature must be less than 4°F (outside a mixing zone) and (b) a change in 25% of the cross section of a river must be less than 1°F. These limits were intended to help control major thermal power-plant cooling discharges. No monthly temperature standards apply.

Suspended Sediment

The San Francisco Bay RWQCB Basin Plan includes objectives for turbidity and SS concentrations. Generally a discharge or dredging activity should not increase the turbidity by more than 10% in water where natural turbidity is greater than 50 nephelometric turbidity units (NTUs).

Mercury

Current Pertinent Mercury Regulatory Guidelines

Both the San Francisco Bay and the Central Valley RWQCB staffs have prepared or are preparing TMDL plans for better control of total mercury and methylmercury in San Francisco Bay and Delta waters. The current (as of October 2010) draft Central Valley RWQCB Delta TMDL recommends a maximum of 0.24 part of methylmercury per one million parts of fish tissue (ppm) in 350 millimeter (mm) (14-inch) largemouth bass, to protect humans who may consume these sports fish. For its draft TMDL effort, Central Valley RWQCB staff has estimated methylmercury values in both water and fish tissue that should be protective of human consumers, as well as fish and wildlife.

The San Francisco Bay TMDL for mercury has a median goal for total mercury in SS of 0.2 ppm, about half the current median level. Discussed in the San Francisco Bay mercury TMDL documents are control measures to reduce mercury input to the bay from upstream (e.g., the Delta, Suisun Bay) and from wastewater treatment facilities. However, because of the large remnant load of existing mercury already present in bay sediments (a legacy of historical mining upstream), these control measures probably will not significantly lower total mercury levels in suspended bay sediment. The bay mercury TMDL also set target criteria of 0.03 ppm methylmercury in small prey fish (<75 mm) that may be eaten by waterfowl and shore birds, and 0.2 ppm methylmercury in large sport fish. Methylmercury levels in about half the fish sampled as part of the San Francisco Bay Regional Water Quality Monitoring Plan (RMP) (conducted by the San Francisco Estuary Institute) are currently above, and therefore violate, these criteria.

The San Francisco Bay RWQCB is currently developing a TMDL to address multiple pollutants, including mercury, in the Suisun Marsh.

Other Water Quality Parameters

The San Francisco Bay RWQCB Basin Plan includes other water quality objectives intended to protect fish and wildlife, recreation and drinking water beneficial uses against various chemical pollutants. One compound of potential concern is ammonia.

Ammonia, a nitrogen-containing compound, commonly exists in water in two forms—the more toxic un-ionized (un-dissociated) “free ammonia” (NH_3), and the much less toxic, ionized (charged) ammonium compound (NH_4^+). The ratio in water of free ammonia to ammonium ions (which together compose total ammonia) increases with increased pH and temperature—i.e., proportionally more toxic NH_3 makes up total ammonia under warmer and more alkaline conditions.

As stated, free or un-ionized ammonia is the form most hazardous to fish and other aquatic organisms. The LC_{50}—the lethal concentration at which 50% of test animals die within a standard length of time (e.g., 96 hours)—of un-ionized ammonia for salmonids species in fresh water can range from 0.2 to 0.7 milligrams of ammonia per liter. Free ammonia therefore is categorized as *highly* toxic by the EPA, and the RWQCB Basin Plan establishes a region-wide water quality objective of 0.025 mg/l as N (annual median).

Ammonia compounds often exist naturally in wetlands as part of a complex nitrogen cycle of physical, chemical, and biological activities. Their production may be related to the natural breakdown of dead vegetation, waste excretions from resident fish and animals, atmospheric deposition of nitrogen, and waste treatment and other discharges. Fortunately, free ammonia is rapidly diluted and degrades to less toxic forms readily in the aquatic environment. Nonetheless, nitrogen-containing materials, including the byproducts of ammonia, from natural and artificial fertilizers and from sewage are often a major biostimulatory (though not necessarily toxic) factor in many California watersheds, fueling the excessive growth of algae and other aquatic plants. Ammonia therefore could be of hypothetical localized concern in the Marsh during temporary dredging operations or more permanently in the vicinity of the treated wastewater discharge into Boynton Slough.

For this document, the assessment of potential impacts from ammonia relies on a qualitative evaluation of likely effects of the alternatives. Experience shows (e.g., DFG Napa–Sonoma Marsh restoration project) that the transformation of previously ponded wetlands into healthy salt marsh habitat should reduce, and certainly not increase, conditions that encourage free ammonia production. Denser populations of salt marsh plants would help remove nitrogen compounds from the water column and sediments. Also, daily tidal flows would help dilute, degrade, and transport away ammonia compounds and by-products. Therefore, any impact from ammonia from restoration activities is expected to be minimal at most and most likely insignificant.

Local

Solano County and local municipalities do not specifically regulate water quality in the managed or tidal wetland areas in Suisun Marsh. The Fairfield-Suisun Sewer District has a National Pollutant Discharge Elimination System (NPDES) permit (a Clean Water Act-based point source pollution permit issued by the RWQCB) which controls its discharge of treated wastewater to the Marsh. The District discharges about 20 cfs of effluent to Boynton Slough. Depending on or despite the level of treatment, such discharges can, over time or during emergency overflow events, be sources of nutrients and other pollutants, including mercury.

Relationship between Delta Outflow and X2 (Salinity Gradient)

Table 5.1-5 shows the basic relationships between effective Delta outflow and the EC values at Fleet and at Collinsville, as well as the estimated X2 locations. The historic Delta outflow values were used to calculate the end of month X2 locations for 1968 to 2007. Over the 40-year period, X2 values averaged 74 km upstream of the Golden Gate, ranging from a minimum 41 to a maximum 98 km. For comparison, Martinez is located at about 54 km, both the downstream (mouth) of Suisun Slough and Port Chicago at about 64 km, and the upstream end of Montezuma Slough at Collinsville at about 81 kilometers upstream from the Golden Gate, the mouth of the San Francisco Bay Estuary.

As discussed above, the X2 isohaline objective currently corresponds to an average electrical conductivity value of 2.64 mS/cm. This objective helps maintain the X2 point downstream of Collinsville from February through June in all years (except in May and June of years where the Sacramento River Index is less than 8.1 maf). This suggests that salinity at the upstream end of the Marsh near Collinsville would be relatively low. The X2 location is, by design, required to be downstream of Chipps Island (now Mallard Slough) at kilometer 75 for several days each month, depending on the previous month's runoff. This generally provides fairly low salinity (less than 5 mS/cm) at the downstream end of Montezuma Slough and Suisun Slough. The X2 salinity objective is intended to provide protection for managed brackish-water wetlands from excessive Suisun Bay salinity in winter and spring months, when water is pumped from Marsh sloughs to help leach salts from soils in managed wetlands.

Calculations using an X2 regression equation (San Francisco Estuary Project 1993) show that an outflow of about 7,000 cfs would maintain average salinity (as EC) at about the 2.64 mS/cm standard near Collinsville, at the upstream entrance to the Marsh and at the upstream end of Montezuma Slough. Such salinity would generally be satisfactory for those Grizzly Island diversions near the SMSCG.

Relationship between Delta Outflow and Suisun Marsh Salinity

The outflow of fresh water from the upstream Delta controls the Suisun Bay salinity gradient and corresponding Suisun Marsh channel salinity conditions. Salinity levels at both the mouth of Suisun Slough and the mouth of Montezuma Slough are very similar to salinity measured in Suisun Bay at Port Chicago (opposite Roe Island). Similarly, salinity in the upstream portion of Montezuma Slough is similar to salinity at Collinsville. The SMSCG reduce salinity in Montezuma Slough, with the most noticeable effects seen at the National Steel and Belden's Landing stations. The impacts on salinity of the SMSCG are less at Hunter Cut and smaller still in Suisun Slough and the tributary sloughs. Minimal impacts from the SMSCG occur in western areas of the Marsh (Cordelia Slough and Goodyear Slough).

Local runoff from Green Valley Creek and Suisun Creek potentially could lower salinity in Cordelia Slough and Suisun Slough after storm events. However, the greatest local runoff often accompanies large flows from the Delta, so salinity-lowering impacts from local runoff in general may be relatively unimportant as salinity throughout the Marsh will already be relatively low when local runoff stands to make the greatest contribution. The 20 cfs discharge of treated wastewater effluent from the Fairfield-Suisun wastewater treatment plant to Boynton Slough provides an additional source of relatively non-salty water year-round that slightly reduces salinity in the upstream end of Suisun Slough.

One source of quantitative data is daily estimates of Delta outflow calculated using the DWR DAYFLOW database. Calculations were based on measured inflows, measured exports, and estimated channel depletions (diversions for agriculture minus drainage and runoff pumped from the Delta islands). Although daily variations in Delta outflow can be large, the average salinity at any particular station in the Estuary responds slowly, with a definite time-lag response. CCWD staff (Denton and Sullivan 1993) calculated the effective outflow based on the sequence of daily Delta outflow values. The equation used is similar to the X2 equation and results in a “moving average” of outflow. CCWD staff also found that salinity (measured as EC or concentration of chloride) at each Estuary station could be estimated from the effective outflow with a negative exponential equation. Based on these calculations, the daily average salinity (as EC) at Martinez, Port Chicago, and Collinsville can be estimated accurately from the daily effective outflow, providing a descriptive procedure for evaluating the range of seasonal salinity in the Marsh as a function of the seasonal Delta outflow conditions.

Measured Suisun Marsh Salinity (Electrical Conductivity)

Figure 5.2-2 illustrates daily Delta outflow, estimated effective outflow, and salinity (as EC) for Suisun Bay stations in 2002 and 2003. The salinity gradient in Suisun Bay can be identified from these data. During periods of high outflow, Suisun Bay salinity is reduced and the salinity gradient is smaller. During periods of low Delta outflow, the salinity (as EC) at Martinez increases to about 30 mS/cm, and the salinity upstream increases proportionally.

Modeled Delta outflow estimates are lower than daily (sampled) Delta outflow measurements when actual Delta outflow is increasing, and effective outflow estimates are higher than daily outflow readings when Delta outflow is decreasing. The effective Delta outflow model is similar to a 14-day moving average of Delta outflow. The minimum effective outflow was less than 5,000 cfs in the fall of both 2002 and 2003. The SMSCG were operated during the October–December period in both years. Delta outflow increased sufficiently in December 2002 to reduce the Marsh channel salinity to meet the salinity objective from January through May 2003, so the SMSCG were not operated after December 2002. As the effective outflow increases, the salinity at all Suisun Bay stations and in the Marsh decreases. As the effective outflow declines, the salinity at all Suisun Bay stations and in the Marsh increases.

Figure 5.2-3 compares estimated salinity against actual measured salinity (as EC) for various Suisun Bay locations. Salinity data from Martinez (generally the highest) and Collinsville (the lowest) define the full range of salinity values in the Suisun Bay area. The top chart portrays measured (actual) salinity during 2002 and 2003 at Collinsville, the SMSCG, and Martinez, and estimated salinity (using CCWD equations) for Collinsville and Martinez. Delta outflow is also portrayed (blue line). As shown, estimated and actual salinity values coincide reasonably well.

The bottom chart plots actual and estimated salinity (as EC) at each Suisun Bay station against effective (modeled) Delta outflow. Collinsville salinity (as EC) declines rapidly as effective outflow increases. This model suggests that Delta outflow is a major factor controlling salinity in Suisun Bay and adjacent Suisun Marsh channels.

The top graph in Figure 5.2-4 compares actual salinity (as EC) measured at several locations along Montezuma Slough in 2002 and 2003. Note a roughly inverse relationship between measured salinity and modeled outflow for all sites (except, naturally, at the SMSCG).The bottom chart illustrates data for the same parameters and time period at Suisun Slough sample sites (fleet data are provided for comparison in both the upper and lower chart). Once again, salinity and flow appear to be inversely related. This suggests that flow is a key impact on salinity levels throughout the Marsh.

Hill Slough salinity was probably lower than the other Suisun Slough stations because of the 25 cfs of low salinity treated wastewater from the Fairfield-Suisun treatment plant discharged into Boynton Slough near the upstream end of Suisun Slough. Tidal mixing distributes this non-saline water throughout the upper end of Suisun Slough (including Peytonia, Boynton, and Hill Sloughs).

Based on current measurements and modeling, Delta outflow is postulated to be the major factor controlling salinity in the Marsh. Dilution of the western sloughs (e.g., Cordelia and Chadbourne Sloughs) occurs after major local storm runoff events. Salinity at the upper end of Suisun Slough is diluted by the Fairfield-Suisun treated wastewater of about 25 cfs. Each year’s data reveals a different seasonal salinity regime, controlled by the seasonal pattern of effective outflow.

Suisun Marsh Salinity Control Gates

The SMSCG near Collinsville began operating in October 1988. The gates control salinity by allowing tidal flow from the Sacramento River into Montezuma Slough during ebb (outgoing) tides but restricting the tidal flow from Montezuma Slough during flood (incoming) tides. The SMSCG cause a net inflow (about 2,500 cfs) of low-salinity Sacramento River water into Montezuma Slough. Operation of the SMSCG lowers salinity in some Marsh channels, primarily those in the eastern Marsh, and results in a net movement of water from east to west. The SMSCG generally are operated from October through May to meet the Suisun Marsh salinity standards (objectives). They generally are not operated when salinity becomes lower than the monthly salinity objectives because of high Delta outflow. The operation of the SMSCG may increase the salinity in Honker Bay and the Delta slightly because the forced diversion into Montezuma Slough reduces the net outflow past Chipps Island and may allow slightly higher seawater intrusion from tidal mixing.

The SMSCG normally are operated from October through May by DWR to help meet D-1641 Suisun Marsh salinity standards for that critical period. The SMSCG have been operated in September occasionally to help reduce Marsh channel salinity prior to initial flooding of managed wetlands in October. Flooding managed wetlands with low-salinity water in late September or early October helps prevent the buildup of salt in flooded (and later dried) temporary pond sediments and improves food plant production for preferred waterfowl species during non-flooded periods later in the year.

Restrictions on unscreened diversions to managed wetlands are intended for the protection of delta smelt and winter-run Chinook salmon, but make it more difficult to manage soil leaching cycles efficiently. It therefore is important to managed wetlands that the intake of salt be reduced to the extent possible during the initial flooding.

Figure 5.2-4 suggests that the SMSCG operation in October of 2002 and 2003 reduced Montezuma Slough salinity somewhat in both years. Hunter Cut, Belden's Landing, and National Steel salinity levels dropped noticeably following SMSCG operations. The Collinsville salinity readings remained relatively constant during the period of SMSCG operations, probably because the effective Delta outflow remained relatively low during that period. Higher Delta outflow in December summarily reduced the Collinsville salinity as well as salinity at the other Suisun Bay stations.

The total number of days the SMSCG are operated varies from year to year. From 1988 to 2004 the SMSCG were operated between 60 and 120 days from October to December. With time and operational experience, achieving salinity standards requires fewer days of SMSCG operation. In 2006 and 2007, the SMSCG were operated periodically between 10 and 20 days annually. This level of operation should continue in the future, except perhaps during the most extreme hydrologic conditions.

Dissolved Oxygen and Temperature

As described above, oxygen concentrations in water and water temperature are somewhat related. Higher water temperatures generally result in lower DO concentrations because the maximum amount of oxygen that can be held dissolved in water (the saturation level) decreases with increased water temperature. This is one reason that unusually warm water temperatures negatively affect some aquatic animals. In Suisun Marsh, low DO levels and warm water conditions may result when discharges of long-impounded water from managed wetlands temporarily overwhelm receiving water in the tidal sloughs. This can occur throughout the Marsh but has been associated most with small dead-end sloughs in Region 1. In compliance with the previous ESA/Essential Fish Habitat (EFH) consultation terms and conditions, managed wetland managers have implemented the following actions:

- eliminate as much drainage discharge to Boynton and Peytonia Sloughs as deemed possible and relocate drainage to Suisun Slough;
- discourage growth of and mow broad-leaved vegetation prior to flood-up to reduce BOD while ponds are inundated;
- increase circulation in managed wetlands to reduce BOD and total organic levels in drainage water (i.e., help prevent incidences of "black water"); and
- implement rapid flooding and drainage to increase water aeration.

These measures are only partially effective in controlling DO and in some cases they could exacerbate the impacts if all the discharges from landowners occur over the same short period of time.

SRCD monitored Peytonia, Boynton, Suisun, Cordelia, Chadbourne, and Goodyear Sloughs in 2006 and 2007 for temperature and DO conditions (Suisun Resource Conservation District and California Department of Fish and Game 2009). DO concentrations in discharge water were consistently less than 5 mg/l, whereas DO levels in receiving (slough channel) waters were generally higher than that level. (Boynton Slough DO concentrations were generally lower than measurements at other ambient stations. The Fairfield-Suisun wastewater discharge may be a factor in the low Boynton Slough DO measurements, although the discharge satisfies the ambient monitoring DO requirements specified by the San Francisco Bay RWQCB. UC Davis researchers also have monitored selected areas in the Marsh. Preliminary results suggest that DO levels have improved in many small tidal sloughs with previous problems.

Suspended Sediment and Contaminants

SS concentrations have been measured at several locations throughout Suisun Marsh. Ruhl and Schoellhamer (2004) measured SS concentrations at a shallow-water site (Honker Bay) and a deep-water channel (Mallard Island) from December 1996 through July 1997. They found similar temporal trends caused by tidal velocities and storm events at both the shallow-water and deep-channel sites. In December, SS was relatively low (25–50 mg/l) at both sites but increased following the first-flush winter storm event to 100–150 mg/l in Honker Bay and 50–100 mg/l at Mallard Island.

The Blacklock Restoration Project is located on Nurse Slough adjacent to Little Honker Bay and provides an example of background SS levels. DWR measured SS concentrations at two locations in Nurse Slough from December 2004 to April 2006 as part of background monitoring for the restoration plan (see Figure 5.2-5). Average SS concentration was about 100 mg/l. Concentrations were lowest (about 50 mg/l) in fall 2005. It appears that Suisun Bay and the Marsh channels have a reasonably high and relatively constant SS concentration of about 50–100 mg/l.

SS binds metals and other potentially toxic chemicals and pollutants, including mercury. However, as discussed elsewhere in this section, clear, predictable relationships among the various forms of mercury, appearing in different media (e.g., water, sediment, living tissue), often are lacking or at least are not well understood. At present, there are no firm grounds to assume that temporary changes to SS levels during habitat restoration will result in higher (or lower) levels of organic mercury, the form of most concern, in resident fish and other species.

Mercury and Methylmercury

The concentration of total mercury in sediments at various levels sampled throughout San Francisco Bay averages about 0.4 ppm (Conaway et al. 2007). However, total mercury levels in deeper bay sediments (which are probably more representative of older, pre-mining and pre-industrial, natural background conditions) average only about 0.05 ppm (almost 10 times less). The higher total mercury levels in shallow, more recent bay sediment layers probably originated with upstream mining (i.e., historical use of elemental mercury in gold processing) and from industrial activities surrounding the Bay-Delta. In comparison, Sacramento River sediment averages about 0.1 ppm in total mercury (one-fourth that of the Bay concentration). The gradual influx of this relatively cleaner sediment into the Bay-Delta therefore may contribute to a long-term overall reduction in the average total mercury load in San Francisco Bay estuary sediments.

As previously discussed, methylmercury concentrations in sediment normally are not correlated with total sediment mercury levels, being linked instead to amounts of sulfate and organic materials in sediment. For example, methylmercury sediment concentrations are generally less than 1% of total mercury levels, but were found as high as 5% in wetlands sediment with relatively high organic peat content near Franks Tract (Choe et al. 2004).

The concentration of SS in Suisun Bay and the Marsh channels is often relatively high (e.g., 50–100 mg/l), and similar concentrations have been measured in Little Honker Bay near the Blacklock tidal wetlands restoration. Mercury is strongly adsorbed onto sediment particles, so inorganic mercury historically entered Suisun Marsh channels from Suisun Bay through tidal transport, creating legacy total mercury sediment concentrations similar in magnitude to those in upper-level San Francisco Bay sediments (i.e., 0.4 ppm).[1]

[1] Slotten et al. (2002) sampled surficial sediments (top 1 cm) throughout Suisun Marsh and the Delta and analyzed the samples for total mercury. Mercury concentrations in Suisun Marsh generally ranged from 0.20 to 0.33 ppm (dry weight). Heim et al. (2003) collected sediment from Suisun Bay and Grizzly Bay and found total mercury concentrations averaging 0.3 ppm (dry wt) with some sites above 0.5 ppm (dry wt). Hornberger et al. (1999) found that the mercury concentration in surficial sediment from Grizzly Bay was about 0.3 ppm. However, the concentration increased to 0.95 ppm at a depth of 30 cm. The mercury-enriched zone persisted to about 80 cm before declining to a background concentration of 0.05 to 0.08 ppm. The higher mercury concentrations in sediments 30–80 cm deep were attributed to hydraulic mining debris.

Slotten et al. (2002) found that flooded tracts characterized by dense submergent and/or emergent aquatic vegetation and highly organic sediments had greater levels of methylmercury in sediment than adjacent non-wetland control sites. These sites generated all of the most elevated sediment methylmercury samples, with vegetated wetlands tracts exhibiting up to 10 times greater methylmercury concentrations than adjacent control sediments. In Suisun Bay, sediment samples were collected from the Ryer Island tidal marsh and the adjacent Grizzly Bay. Methylmercury concentrations on Ryer Island were 2.15 nanograms of methylmercury per gram of sediment (ng/g) compared to 0.30 ng/g in the adjacent channel. (A nanogram is 1/1000 of a microgram [µg].) 2 nanograms are equivalent to about 2 parts of methylmercury per 1 billion parts of sediment, or about 0.5% of the total mercury content of 0.4 ppm. Methylmercury concentrations are generally less than 1% of total mercury in Bay-Delta sediment. The local production of methylmercury by sulfate-reducing bacteria, which may be controlled by the organic content of the sediment, is likely the most important factor for methylmercury concentration. The methylmercury moves into the pore water and is transported to the water column. Benthos (invertebrates, clams) may ingest mercury from the sediments. Phytoplankton and zooplankton incorporate mercury from the water. Fish are exposed to water (very low concentrations) and to the phytoplankton and zooplankton and benthos that they eat.

Mercury concentrations[2] in bivalve organisms (e.g., mussels, clams) range from about 0.5 to 2.5 ppm (dry weight). This is somewhat higher than mercury concentrations found in game fish tissue in the estuary. The national human health criterion for mercury in fish tissue is 0.3 ppm, as established by the EPA (U.S. Environmental Protection Agency 2001). The San Francisco Bay RWQCB mercury TMDL has established a fish tissue methylmercury objective of 0.2 ppm for game fish. The mercury objective for small fish used as prey (forage) by waterfowl, shore birds, and other wildlife is 0.03 ppm. Many of the small fish in the Bay-Delta have average mercury concentration of about 0.025 to 0.075 ppm (Greenfield et al. 2006).

Environmental Consequences

Assessment Methods

Dissolved Oxygen

Changes in levels of DO in Marsh channels are related primarily to annual discharges of poor-quality water from adjacent managed wetlands. Hunting club management procedures create yearly low DO conditions in impounded seasonal waterfowl ponds. When these waters are discharged into sloughs with minimal tidal flushing, the quality of water in the sloughs can decrease significantly, at

[2] Tissue samples are frequently measured in the laboratory for total mercury, as most mercury in animal tissue is methylmercury.

least temporarily. Discharges into the Marsh from adjacent developed and agricultural areas likely contribute to the problem. Tidal restoration of portions of the Marsh would result in fewer poor-quality (e.g., low-DO) conditions. Because the level of improvement to DO concentration levels in Marsh sloughs from tidal restoration cannot be quantified precisely, impacts are described qualitatively.

Total Organic Carbon

There is no evidence to suggest that tidal wetlands will produce larger volumes of vegetation and export more total organic carbon (TOC) than managed seasonal wetlands. There are few measurements of TOC export from managed wetlands, and the contribution of TOC from tidal wetlands has not been measured reliably. Therefore, these impacts are evaluated qualitatively.

Suspended Sediment

The level of SS in Suisun Bay and Marsh sloughs is closely related to measurements of turbidity. Many contaminants are found to be strongly adsorbed (i.e., bound) to sediment particles. The San Francisco Bay Basin Plan SS objectives (turbidity) require the effects of discharge or dredging to be no more than a 10% increase in background levels. Evaluating turbidity in a hydraulically complicated, tidally influenced bay-marsh system is difficult, at best. Impacts of upstream flow, storm and wind events, and existing narrow channels can be difficult to separate from any short-term restoration/construction activities. As there are no measurements of SS or turbidity concentrations in the yearly managed-wetland discharges, the effects of tidal restoration and dredging will be discussed qualitatively.

Methylmercury

The possibility of either increasing or decreasing the amount of methylmercury exported into the bay by restoring tidal wetlands (as compared to maintaining existing managed wetlands) is possible but not yet scientifically proven. Most area experts suspect that low-lying, continuously wet tidal wetlands generally produce and export smaller quantities of methylmercury than do managed wetlands. However, there are no comprehensive studies comparing methylmercury production and export between tidal and seasonal wetlands.

Salinity

Salinity is an important water quality parameter for Suisun Marsh because the presence of salt negatively affects the ability of wetland managers to encourage the growth of vegetation that supports preferred waterfowl species. Salinity in the Marsh is controlled primarily by salinity in Suisun Bay. The salinity of water applied annually to managed wetlands, as well as yearly management (e.g., drainage, leaching) practices, controls the cumulative buildup of salt in managed wetlands soils, which in turn affects vegetation for preferred duck and waterfowl species.

An RMA hydrodynamic and water quality model of San Francisco Bay and the Delta was manipulated to identify and evaluate potential salinity impacts from SMP alternatives. The model evaluated 2 restoration scenarios (Set 1 and Set 2) as shown in Figure 5.2-6, which were intended to capture the range of salinity effects based on different restoration configurations. Details are provided in Appendix A.

The model was used to test the hypothesis that introduced tidal flow to Marsh areas bordering the bay might increase salinity in the Delta and Marsh channels used as a source for seasonal-pond flood-up and at water supply diversion locations. Likely changes to salinity as the result of tidal restoration are described in Appendix A. The RMA model was used to simulate tidal conditions and salinity in the Marsh and Delta for 2002 and 2003 because actual outflow in those years was generally low and those years therefore represent a worst-case (i.e., relatively high fall salinity) scenario.

Using the 2002–2003 low-flow period, comparisons of simulated salinity levels and actual measured salinity values at 14 key monitoring sites suggest that salinity levels in the western portion of Suisun Marsh will not be significantly affected by any of the tidal restoration scenarios (see Appendix A).

Significance Criteria for Water Quality Assessment

Dissolved Oxygen

The San Francisco Bay RWQCB Basin Plan water quality objectives for DO are 7 mg/l for Estuary waters above the Carquinez Bridge, and a 3-month median level of at least 80% of the DO saturation point. A significant deleterious impact on some sensitive species may occur when oxygen concentrations fall below that number (<7 mg/l), or from any reduction in DO levels of more than 20% below the oxygen saturation level. DO levels below the legal water quality objective (7 mg/l) have been observed in virtually all sloughs of the Marsh including Grizzly Bay.

Turbidity

The RWQCB Basin Plan turbidity objectives prohibit more than a 10% increase in turbidity attributable to waste discharge in waters where natural turbidity is above 50 NTU. Turbidity is often directly related to the level of SS. An increase in SS (turbidity) from dredging or tidal restoration of more than 10% of the average background concentration is considered significant. A 10% increase may be difficult to detect because the measured turbidity variations in Suisun Bay and Marsh channels are relatively large during the daily tidal cycles and within the monthly spring-neap tidal cycle.

Mercury

Accurate determination of quantitative significance thresholds for judging potential impacts from methylmercury production and export is difficult because of the complicated nature of mercury chemistry in the environment and indefinite relationships among mercury levels in various media (sediment, water, and animal tissue). Water quality objectives (San Francisco Bay RWQCB Basin Plan) for mercury in Suisun Bay and Marsh saline and brackish waters are in units of total, not methyl-, mercury per water volume: 2.1 μg/l (1-hour average). (For fresh water [salinity <1,000 ppm], the 1-hour average is 2.4 μg/l.) As stated elsewhere, the statistical relationships between total mercury in water and methylmercury in water and living animals are often poor and non-predictive. Yet any impact on natural resources is related to the level of methylmercury in resident animals. Nonetheless, these total mercury objectives, developed by the EPA, are intended to be conservatively protective against bioaccumulation of methylmercury in the food chain and apparently are the only mercury-related water quality objectives that apply to the Suisun area.

No methylmercury water quality objectives and no methylmercury TMDL as yet applies specifically to Suisun Bay or Marsh waters. A methylmercury TMDL for the upstream, primarily freshwater Delta adopted in April 2010 by the Central Valley RWQCB includes target numbers of 0.03 mg/kg (<5 cm), 0.08 (trophic level 3), and 0.24 mg/kg (trophic level 4) for fish tissue, and a corresponding concentration of 0.06 ng/l for ambient fresh waters, all intended to protect human health and wildlife.

For downstream waters a San Francisco Bay mercury TMDL includes target values for protection of (a) human health of 0.2 mg/kg (wet weight) in sport fish and (b) wildlife of 0.03 mg/kg (wet weight) in fish 3 to 5 cm in length (i.e., prey items for many larger fish and for birds). That same TMDL includes target numbers for total mercury in SS (0.2 ppm, dry weight). Again, total mercury levels in sediments do not necessarily accurately predict methylmercury levels in resident animals.

As there are no applicable methylmercury water quality objectives for the Suisun Bay area, determinations of mercury-related significance must be predominantly qualitative. Impacts were considered significant if an alternative would:

- violate any applicable water quality standards or waste discharge requirements,
- degrade surface water and/or groundwater quality, or

- discharge contaminants into the waters of the United States.

Salinity

Any increase in salinity exceeding State Water Board Delta salinity standards is a significant impact. For purposes of this analysis, however, those increases that do not exceed objectives, but are nonetheless greater than 10% of the applicable monthly salinity objective, are also considered significant.[3] Salinity changes that are less than 10% of the maximum monthly criteria are similar to natural variability and are not likely to cause significant harm to natural habitat or species.

For Suisun Marsh objectives, the lowest salinity (as EC) objective is 8 mS/cm in February and March, so the most restrictive guideline would be an increase of more than 0.8 mS/cm in February or March. For the upper Delta water supply intakes, the salinity objective is 1 mS/cm, so the 10% guideline would be a change in salinity of more than 0.1 mS/cm. This guideline is intended to protect the water quality for managed wetland habitat, as well as the salinity at Delta drinking water intakes and agricultural diversions.

Environmental Impacts

No Action Alternative

The existing management of salinity conditions with the operation of the SMSCG would continue as it has since 1988 to lower salinity during the fall and winter period when water is applied to the managed wetlands. Actual operations of the SMSCG would depend on environmental conditions and regulatory constraints by BOs for the Continued Operation of the CVP and SWP (U.S. Fish and Wildlife Service 2008; National Marine Fisheries Service 2009) and other application permits. Uncontrolled levee breaches could occur and, if not repaired, could result in small changes in salinity regimes in the Marsh and, potentially, the Delta. The extent of this change would be based on the size and location of the breaches and whether they are repaired. However, without adequate supplies of levee materials to maintain levees at current standards as well as address sea level rise, the potential for levee failure and resultant changes in water quality will increase over time.

[3] A 10% change in the baseline salinity value would not be considered significant in an estuarine tidal slough or channel unless the baseline salinity was approaching the maximum monthly objective. A 10% (or 5% or 20%) change in baseline salinity has been considered significant in some previous salinity impact analyses. However, if the baseline monthly salinity is relatively low, the significance criteria will be relatively small. A small change in salinity is not likely to cause concern. On the other hand, salinity that increases by a substantial fraction of the monthly salinity objective is potentially harmful.

The No Action Alternative also assumes that absent the SMP, it would be difficult for managed wetland operations to continue as a result of an inability to secure the necessary environmental permits. As such, it is expected that most, if not all, managed wetland flood and drain activities would cease, and the current water quality degradation from managed wetland operations likewise would be reduced. This would result in an improvement in many water quality parameters, including DO, BOD, sulfide, and methylmercury.

Cattle grazing, common on grasslands in Potrero Hills and other surrounding uplands, contributes to (a) increased sediment in adjacent sloughs, (b) degradation or elimination of riparian habitat, (c) trampling of tidal wetland vegetation along sloughs, and (d) introduction of excessive nutrients. Agricultural drainwater from the northwestern and northeastern Marsh contaminates creeks and sloughs in the northwestern and northeastern Marsh with pesticides, herbicides, and fertilizers. Permitted discharges of stormwater and treated wastewater, plus the occasional pollutant spill, also would continue to contribute proportionately and seasonally to Marsh water degradation.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact WQ-1: Increased Salinity in Suisun Marsh Channels from Increased Tidal Flows from Suisun Bay (Grizzly Bay) as a Result of Restoration

Increased tidal flows in Marsh channels from restoration would not significantly increase salinity in channels connecting Suisun Bay with restored tidal wetlands. Seasonal magnitude of salinity in the Marsh would continue to be governed primarily by Delta outflow and operation of the SMSCG. Therefore, changes to salinity are expected to be insignificant.

Additional tidal wetland within the Marsh would increase the tidal flows throughout the Marsh channels and could increase the salinity in the channels between Suisun Bay and the new tidal wetlands. The magnitude of the salinity effects would depend on the location (and breach connection) of the new tidal wetlands and the size (acreage) of the new tidal wetlands. Restoration with tidal connection to Suisun Bay or Honker Bay may have the largest salinity effects. The effects would be greatest during period of low Delta outflow when the Suisun Bay salinity is highest and the salinity gradients within Suisun Bay and along Montezuma Slough are strongest. However, the seasonal magnitude of the salinity in the Marsh would continue to be governed by Delta outflow and operation of the SMSCG.

Modeling by RMA suggests that maximum changes in monthly average salinity in the Marsh would be less than 10% (Appendix A). Figures 5.2-7 to 5.2-13 show simulated salinity in selected Marsh channels for baseline conditions and for simulated tidal restoration conditions (with about 7,500 acres of new tidal restoration) for years 2002 and 2003. Salinity changes in the Marsh sloughs would depend on the additional tidal restoration upstream and downstream from the stations, as well as the location within the Marsh. For example, Goodyear Slough and Cordelia Slough salinity probably would not change with additional tidal wetland restoration in the Marsh because salinity in the western Marsh is strongly controlled by Delta outflow and the corresponding Suisun Bay salinity. The results from this modeling generally indicated the following changes in salinity:

- Mouth of Suisun Slough—No change.
- Montezuma Slough at Hunter's Cut—The simulated restoration cases did not change the EC at Hunter's Cut by more than 1 mS/cm (Figure 5.2-7). No significant change.
- Montezuma Slough at Belden's Landing—The simulated restoration cases did not change the EC at Belden's Landing by more than 1 mS/cm (Figure 5.2-8). No significant change.
- Montezuma Slough at National Steel—Estimated reduction in salinity by about 1 mS/cm (Figure 5.2-9). No significant change.
- Suisun Slough at Volanti—Estimated increase in salinity by about 1 mS/cm (Figure 5.2-10). No significant change.
- Hill Slough—Estimated increase in salinity by about 1 mS/cm (Figure 5.2-11). No significant change.
- Cordelia Slough—The simulated restoration cases had little effect on the simulated EC in Cordelia Slough (Figure 5.2-12). No significant change.
- Goodyear Slough at Morrow—The simulated restoration cases had little effect on the simulated EC in Goodyear Slough (Figure 5.2-13). No significant change.

Models suggest that monthly salinity changes would likely be less than about 5 to 10% of the baseline monthly salinity value, and hence would be less than the significance criteria (10% of salinity objective from October to May). For maximum seasonal salinity values in October (about 15–20 mS/cm) any increase in salinity caused by tidal wetland restoration above the maximum monthly objective (19 mS/cm) would be significant. Any change of more than 10% (1.9 mS/cm) also would be considered significant. Simulated changes in the Marsh locations are much less than these values. Salinity changes in the Marsh channels therefore would be less than significant.

Conclusion: Less than significant. No mitigation required.

Impact WQ-2: Changes to Salinity of Water Available for Managed Wetlands from October to May

As described under Impact WQ-1, models predict that salinity changes at Suisun Marsh monitoring locations, including the eastern channels, would be much less than the maximum allowed by monthly objectives. Also, any change in salinity would be substantially less than 10% of the objectives at those locations. Additionally, the seasonal salinity pattern (determined primarily by Delta outflow) would remain similar, and any potential change to salinity should not reduce the value of Marsh channel water for managed wetlands flood and drain operations.

Conclusion: Less than significant. No mitigation required.

Impact WQ-3: Increased Salinity at Delta Diversions and Exports

Models indicate that any increases in salinity in channels and sloughs upstream can be eliminated by physically connecting tidal wetlands to existing Marsh channels, rather than directly to Suisun Bay. Using this design, any upstream salinity impacts from tidal restoration would be less than significant. Figures 5.2-14 and 5.2-15 indicate that even the largest increase in upstream salinity would be much less than 10% of the average baseline salinity, with no month increasing by more than 10% of any pertinent salinity objective.

Conclusion: Less than significant. No mitigation required.

Impact WQ-4: Possible Changes to Methylmercury Production and Export as a Result of Tidal Restoration

Many, if not most, northern California environmental mercury experts suspect that tidal wetland habitat produces and exports less methylmercury than managed wetlands. Unfortunately, authoritative studies comparing methylmercury production and export among the tidal and non-tidal wetlands are lacking. There is no evidence to conclude that tidal restoration in the Marsh would lead to increased problems with methylmercury for fish and wildlife (and consumers). One preliminary, unpublished account focusing on water entering and leaving the newly tidal Blacklock area suggests an overall reduction in the export of methylmercury in water. This result must also remain preliminary and unsubstantiated. However, ultimately it is not the amount of inorganic or even organic mercury in sediment or in water that is most critical, but the amount of organic mercury that appears in representative, resident organisms and that enters the food chain. As yet there are insufficient data to conclude that those amounts would increase with tidal restoration.

It is reasonable to assume that tidal wetland restoration in Suisun Marsh will not result in increased methylmercury compared to the baseline export of mercury (total or methyl-) in sediment or soils from managed wetlands to tidal sloughs during flood and drain activities. In cooperation with regional monitoring and research efforts, sediment and fish monitoring will be conducted at several restoration sites. Ongoing information can be used adaptively to correct long-term construction and management plans and activities associated with restoration.

Some experts suspect an actual benefit of less methylmercury being exported by tidal marshes than from existing habitat may occur.

Conclusion: Less than Significant. No mitigation required.

Impact WQ-5: Improved Dissolved Oxygen Concentrations in Tidal Channels from Reduced Drainage of High Sulfide Water from Managed Wetlands

As a result of the conversion of managed wetland to tidal wetland, there is the potential of increasing DO and reducing sulfide concentrations in Marsh channels, thereby improving overall water quality conditions. The extent to which this happens depends on the location of restoration sites. Sites with little or no previous DO problems probably would not see a noticeable benefit. Managed wetlands with low-DO events that are restored to tidal influence should see the greatest improvement in water quality. Tidal restoration therefore is expected to have a beneficial impact on water quality because it would increase levels of DO and improve overall water quality in Marsh channels.

Conclusion: Beneficial.

Impact WQ-6: Temporary Changes in Water Quality during Construction Activities

Remobilization of sediments into the water column caused by restoration activities such as levee breaching can lead to temporary, localized increases in SS and DO. However, construction activities would be spread throughout the Marsh and over the 30-year implementation period.

Additionally, as described in Chapter 2 in the Environmental Commitment section, Erosion and Sediment Control Plan and Stormwater Pollution Prevention Plan, SS will be minimized during project activities. Because of the short duration, limited extent of local construction activities, implementation of the appropriate best management practices, and environmental commitments to minimize and control erosion, these temporary water quality impacts would be less than significant.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact WQ-7: Temporary Degradation of Water Quality during Implementation of Managed Wetland Activities

Increased frequency of managed wetland activities and new activities occurring on the waterside of levees could result in temporary and localized impacts on water quality. These activities would occur in small, distinct, localized areas throughout the Marsh and be minimized through the implementation of standard BMPs, as described in Chapter 2.

Conclusion: Less than significant. No mitigation required.

Impact WQ-8: Temporary Degradation of Water Quality during Dredging, Including Possible Increases in Mercury Concentrations

Project dredging would result in a temporary degradation of water quality as a result of disturbing channel-bottom sediments. Water quality parameters that might be affected would include levels of SS, ammonia, and possibly mercury (in SS). But the form of mercury in the SS probably would be predominantly inorganic, with minor or no additional impacts on aquatic life expected. Temporary changes in turbidity would be minimal and localized, and because the minimum SS concentrations in the Marsh are relatively high, the effects of dredging in Marsh channels would not likely change the already relatively turbid conditions. The localized and temporary impacts would be similar to increased levels of SS caused by spring tides and major runoff events. These effects on SS concentrations in the tidal channels of the Marsh are expected to be less than 10% of the background (e.g., about 50 mg/l).

While levels of inorganic mercury may increase temporarily, there currently exists no reasonable evidence to assume a significant increase in methylmercury concentrations in Marsh or Bay organisms as a result of these temporary dredging activities.

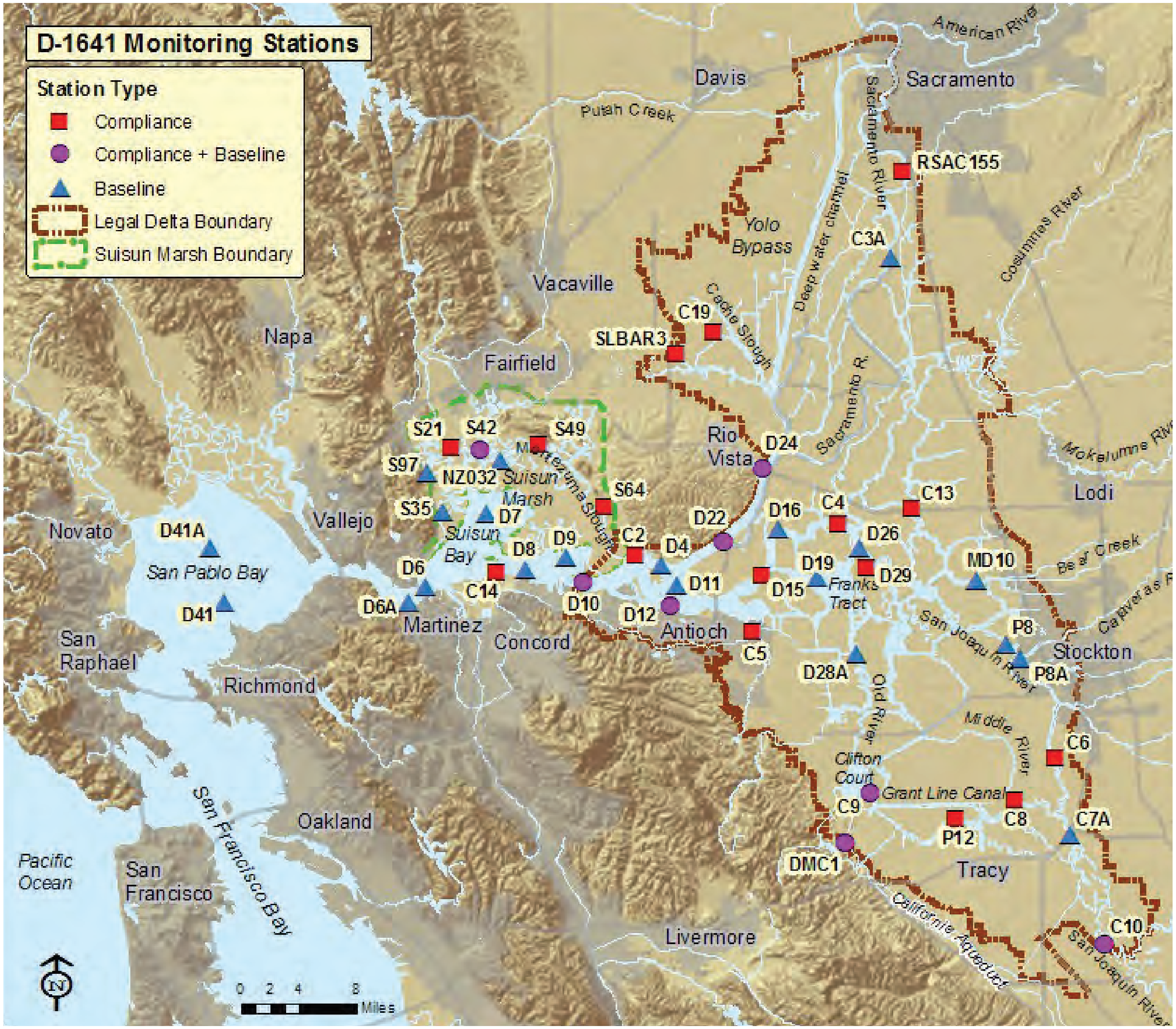
Conclusion: Less than significant. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres

Impacts of Alternative B are similar to those described for Alternative A. Under Alternative B, less tidal restoration would occur, so the magnitude of any adverse or beneficial impacts described for restoration under Alternative A would be less for Alternative B, and the impacts of managed wetland activities would increase compared to Alternative A. The significance of adverse impacts would be the same as under Alternative A.

Alternative C: Restore 7,000–9,000 Acres

Impacts for Alternative C are similar to those described for Alternative A. Under Alternative C, more tidal restoration would occur, so the magnitude of any adverse and beneficial impacts described for restoration under Alternative A would increase under Alternative C, and impacts related to managed wetland activities would decrease compared to Alternative A. The significance of adverse impacts would be the same as under Alternative A.



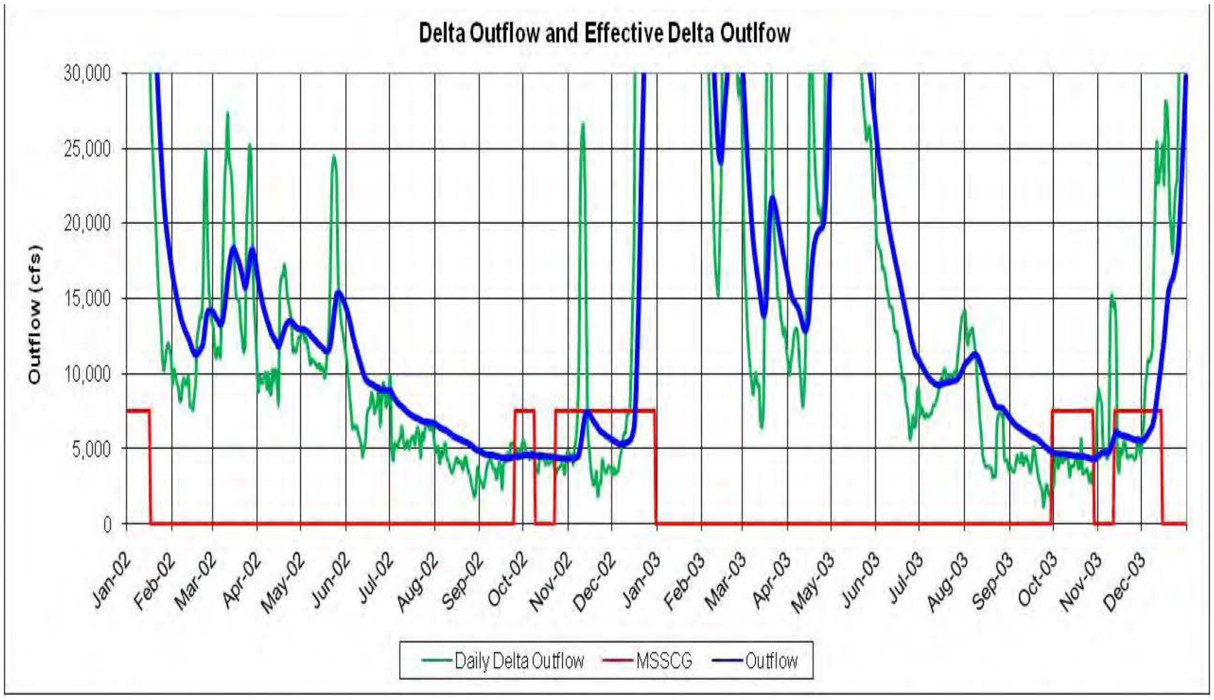
Location	Station
Martinez	D6
Port Chicago	C14
Chipps Island	D10
Collinsville	C2
Jersey Point	D15
Clifton Court Forebay (SWPExports)	C9
Delta Mendota Canal (CVP Exports)	DMC1

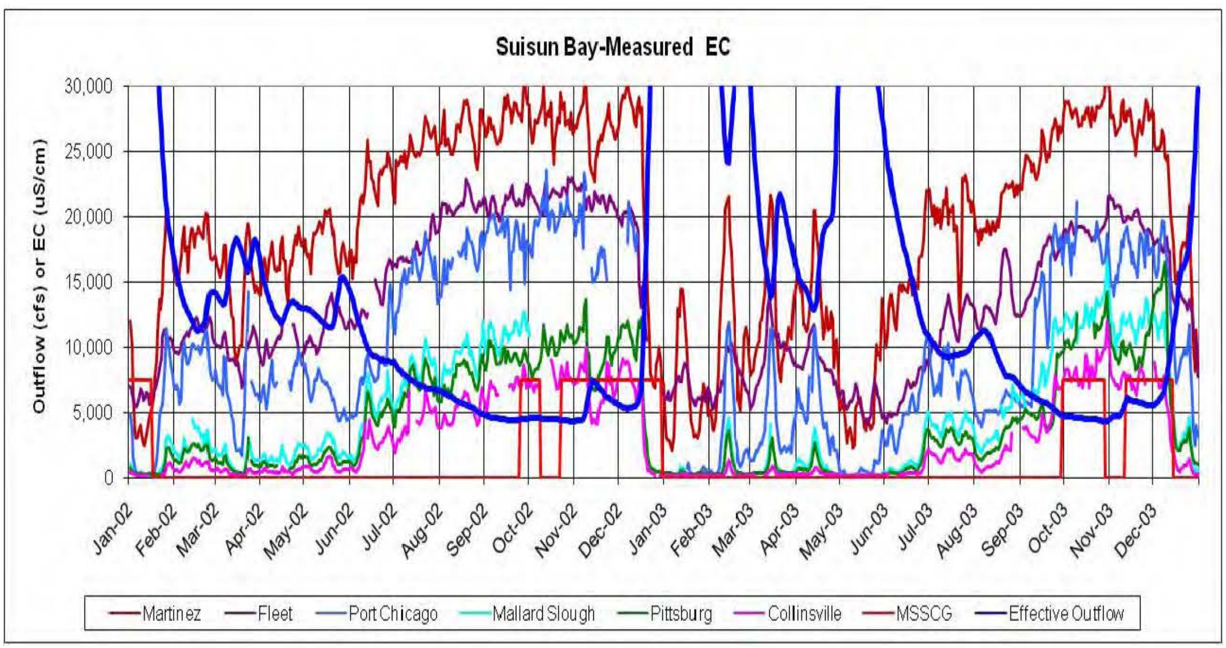
Source: Source: Department of Water Resources, Bay Delta and Tributaries (BDAT) website.

Graphics/Projects/project number/document (date) SS

ICF INTERNATIONAL

Figure 5.2-1
Map of Water Right Decision1641 Monitoring Stations

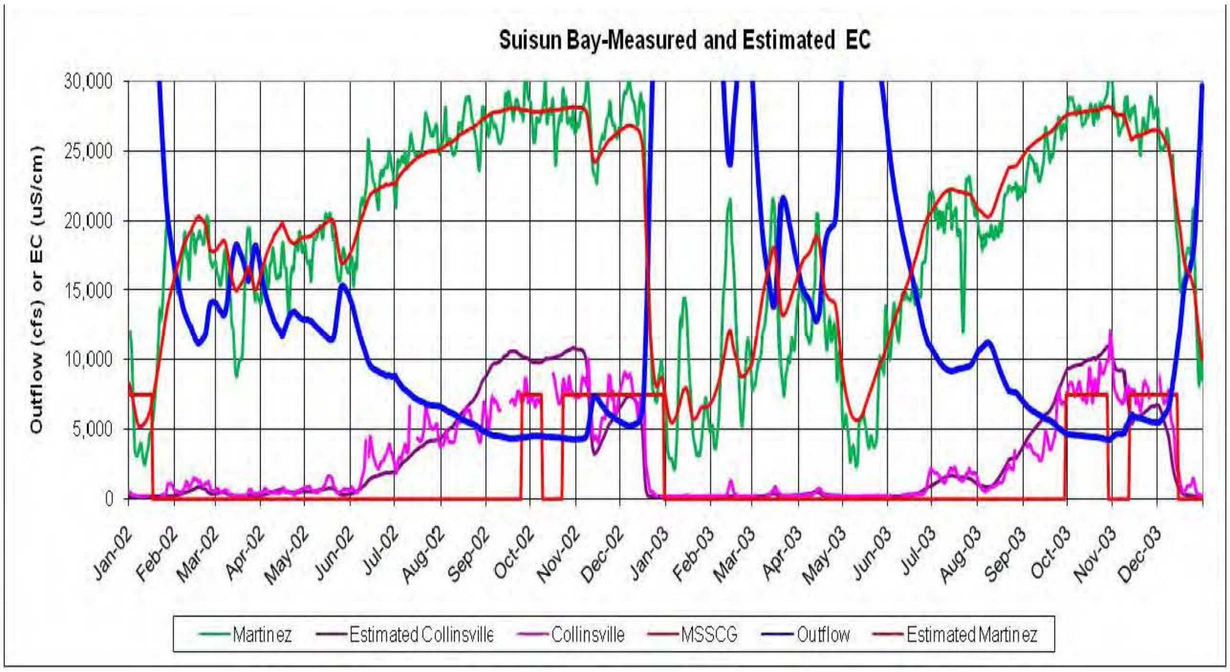


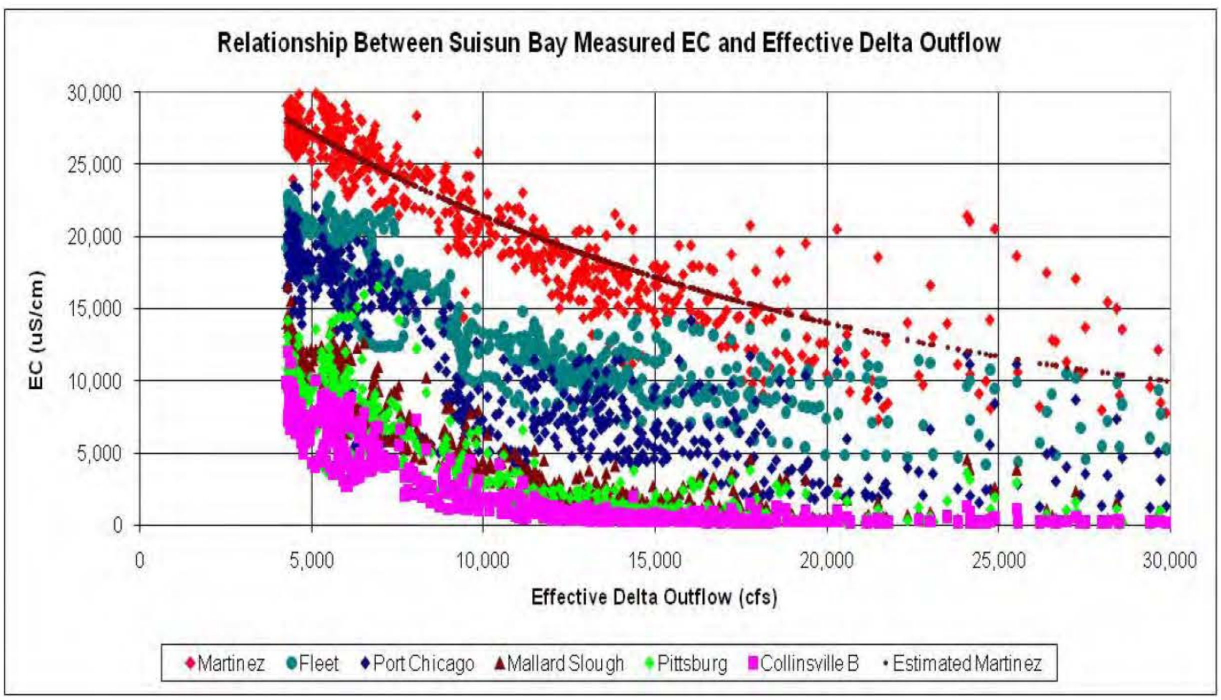


Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

ICF INTERNATIONAL

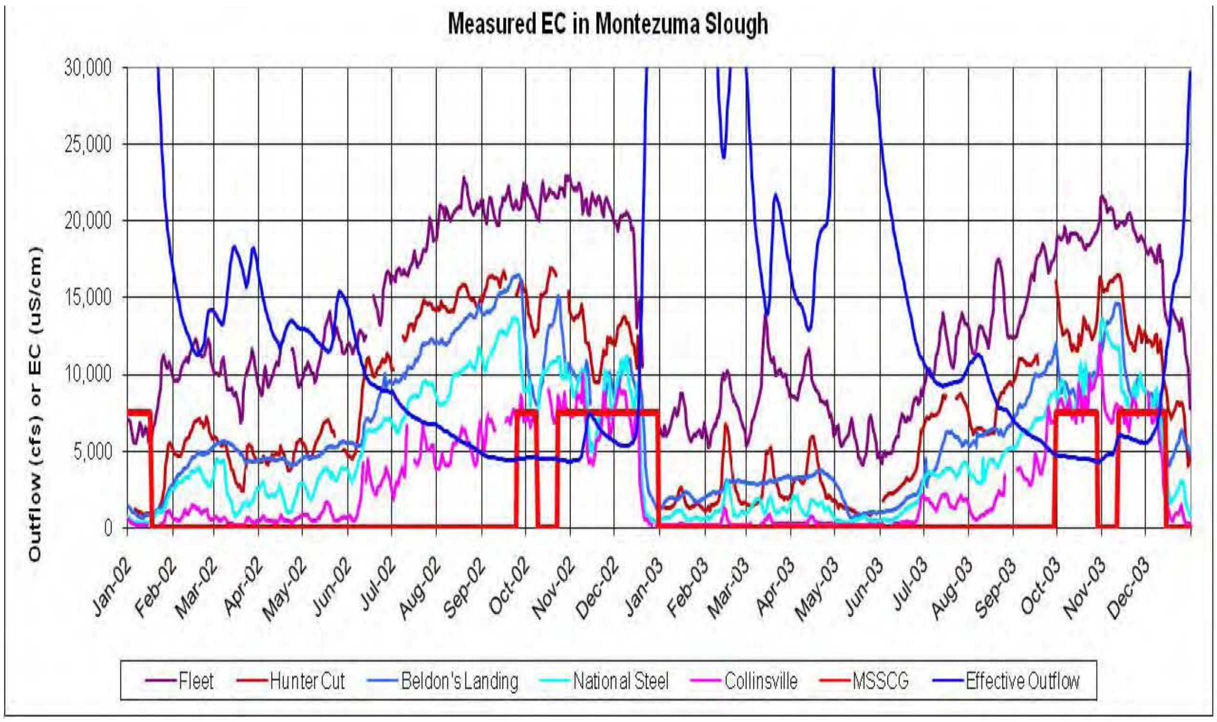
Figure 5.2-2
Daily Delta Outflow, Effective (G-model) Delta Outflow,MSSCG Operations and Measured Daily Average EC in Suisun Bay for 2002 and 2003

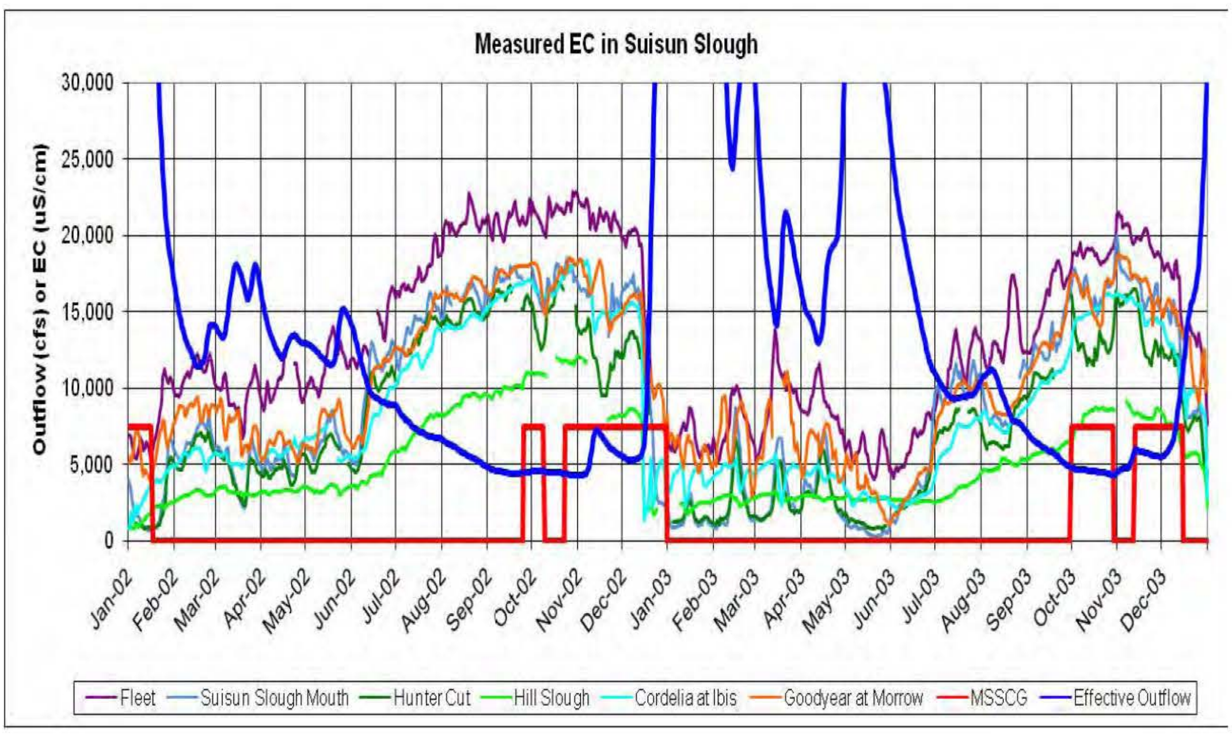




Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

Figure 5.2-3
Measured EC at Martinez and Collinsville with Relationship between Suisun Bay EC and Effective (G-model) Delta Outflow in 2002 and 2003

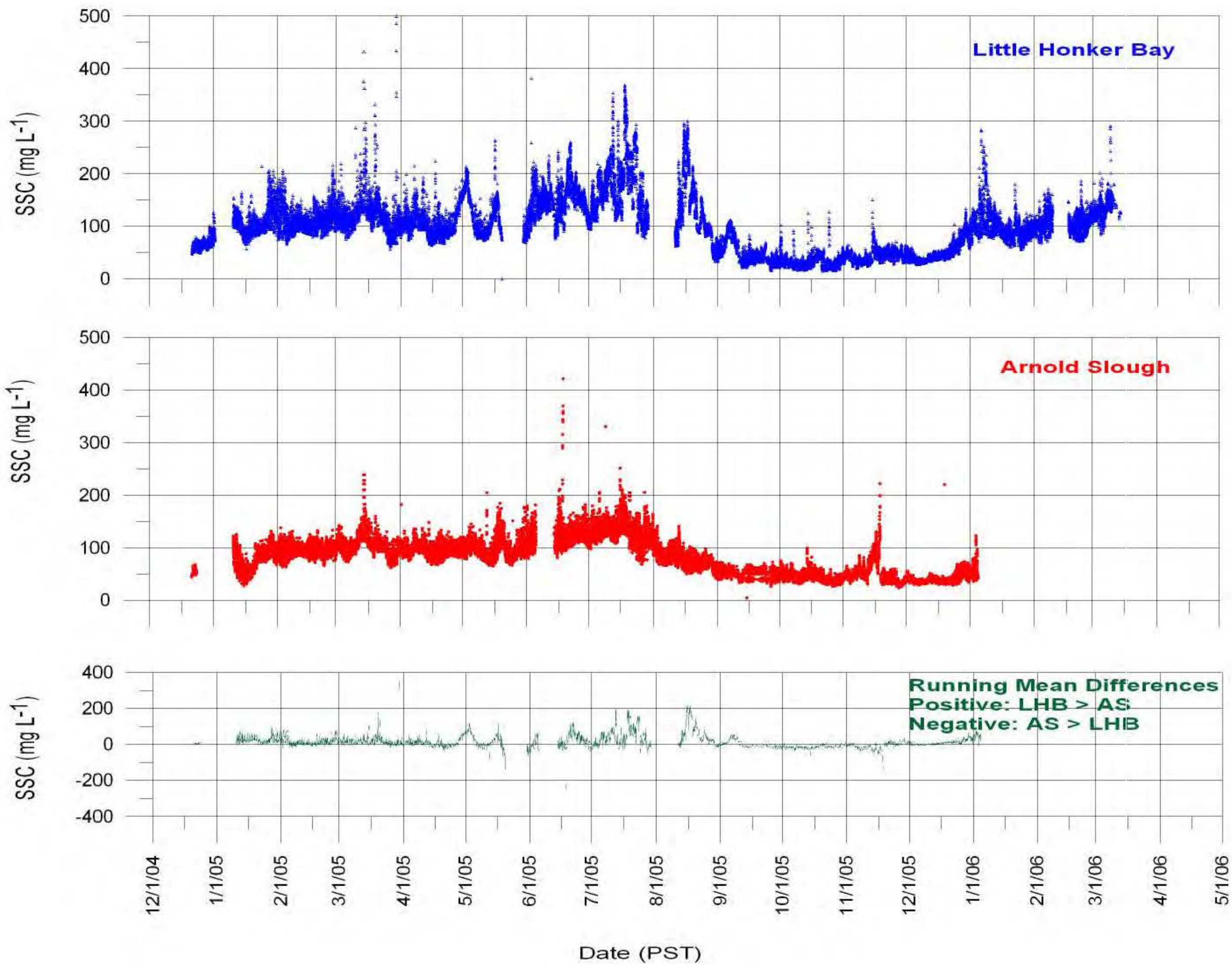




Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

ICF INTERNATIONAL

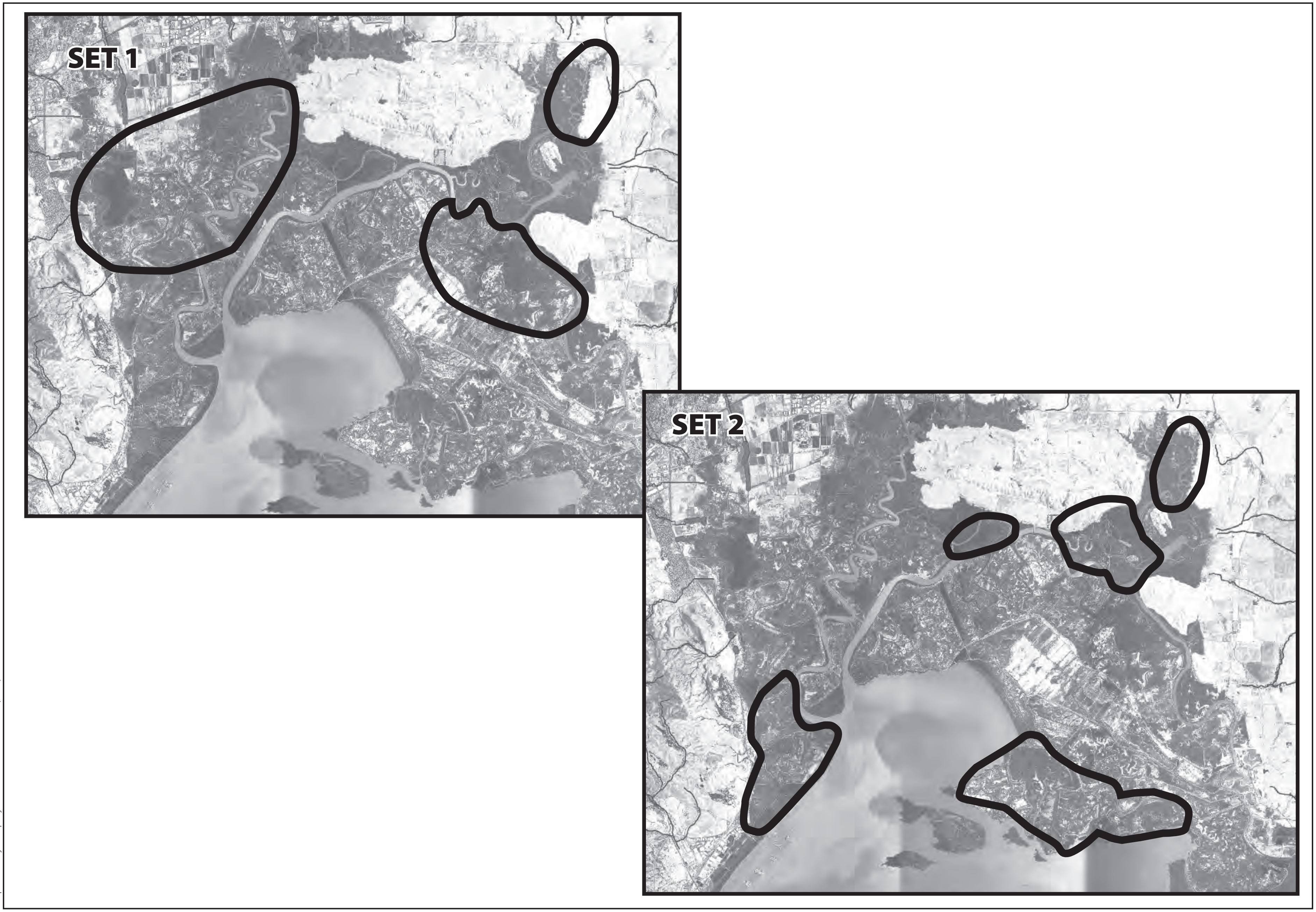
Figure 5.2-4
Measured EC at Montezuma Slough and Suisun Slough Stations in 2002 and 2003



Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

ICF INTERNATIONAL

Figure 5.2-5
Measured Suspended Sediment Concentration (SSC) in Little Honker Bay and Arnold Slough Adjacent to the Blacklock Tidal Restoration Site for 2005



Graphics/Projects/project number/document (date) SS

ICF INTERNATIONAL

Figure 5.2-6
Approximate Congurations of Modeled Restoration Areas

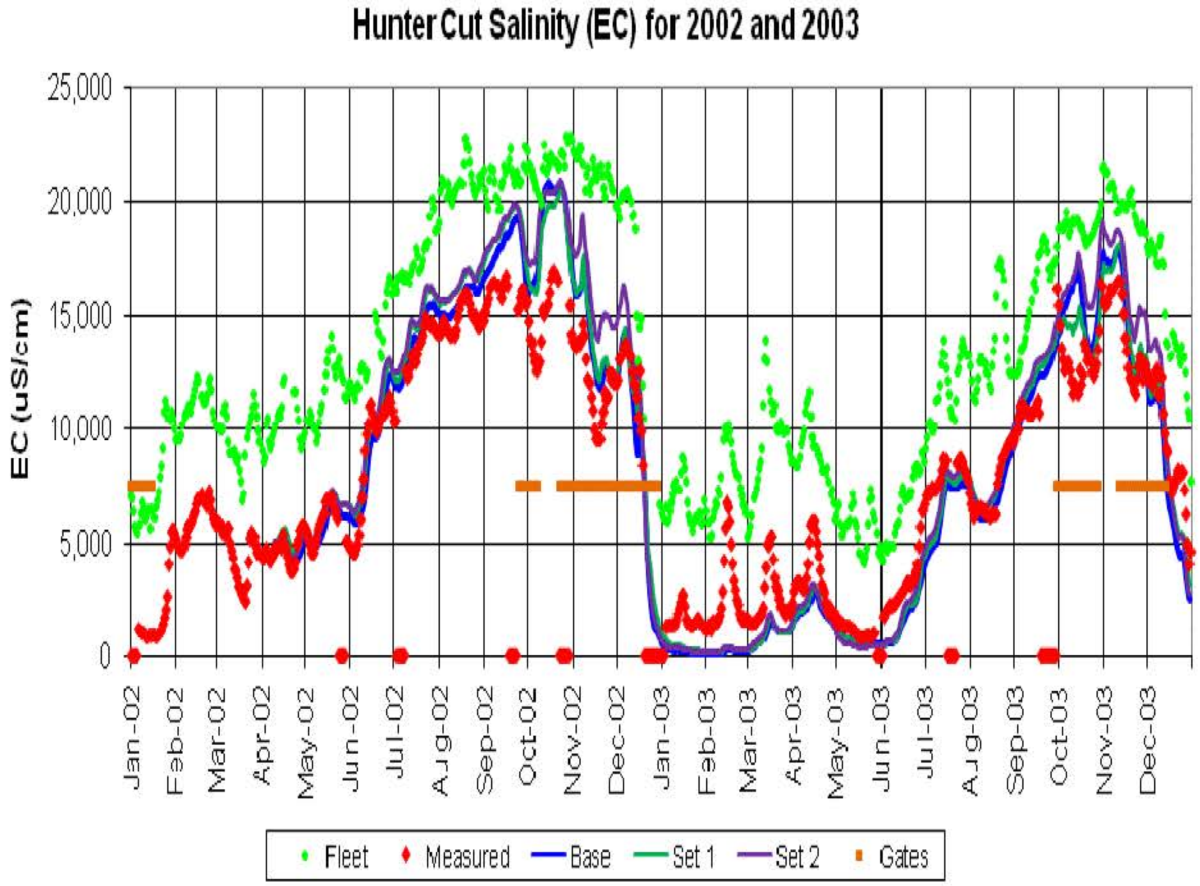
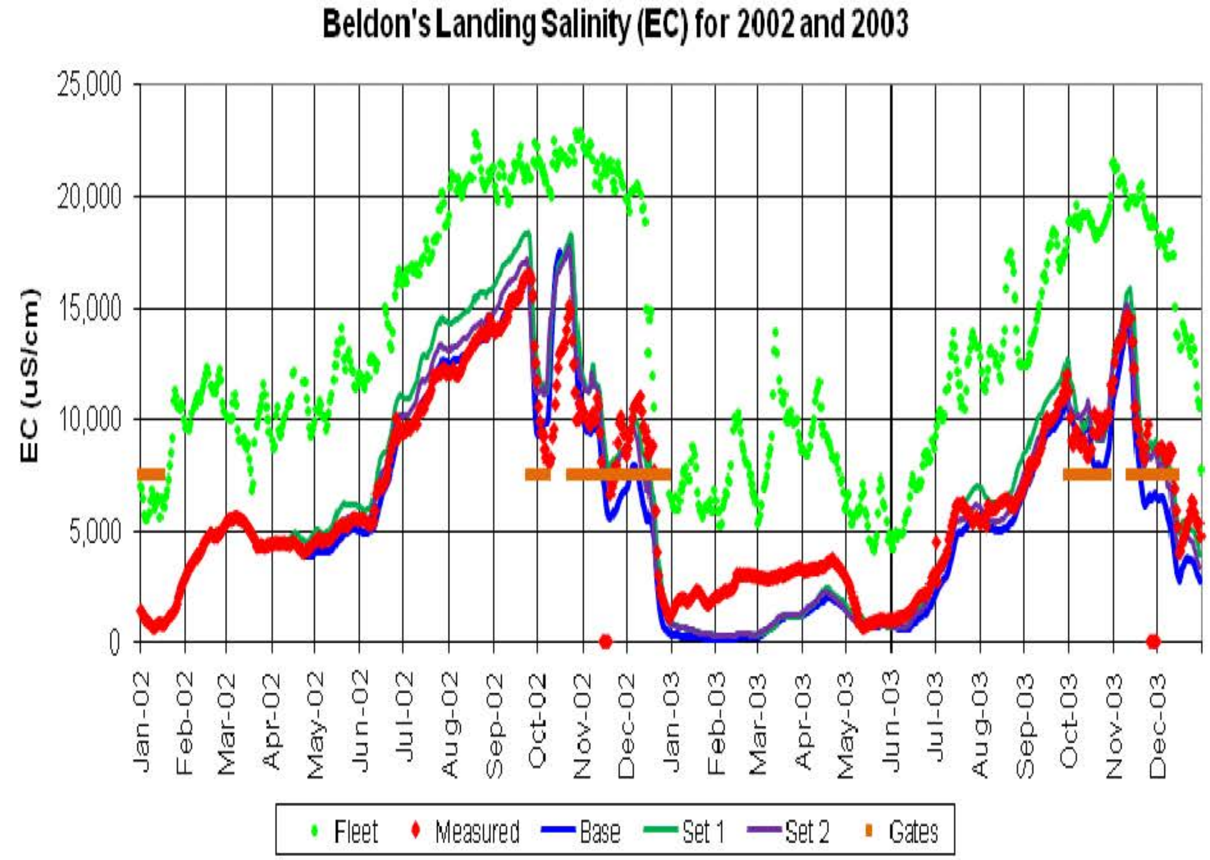


Figure 5.2-7
Measured EC and Simulated EC in Montezuma Slough at Hunter Cut (2 Miles Upstream from the Mouth) for 2002 and 2003



Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

Figure 5.2-8
Measured EC and Simulated EC in Montezuma Slough at Beldon's Landing for 2002 and 2003

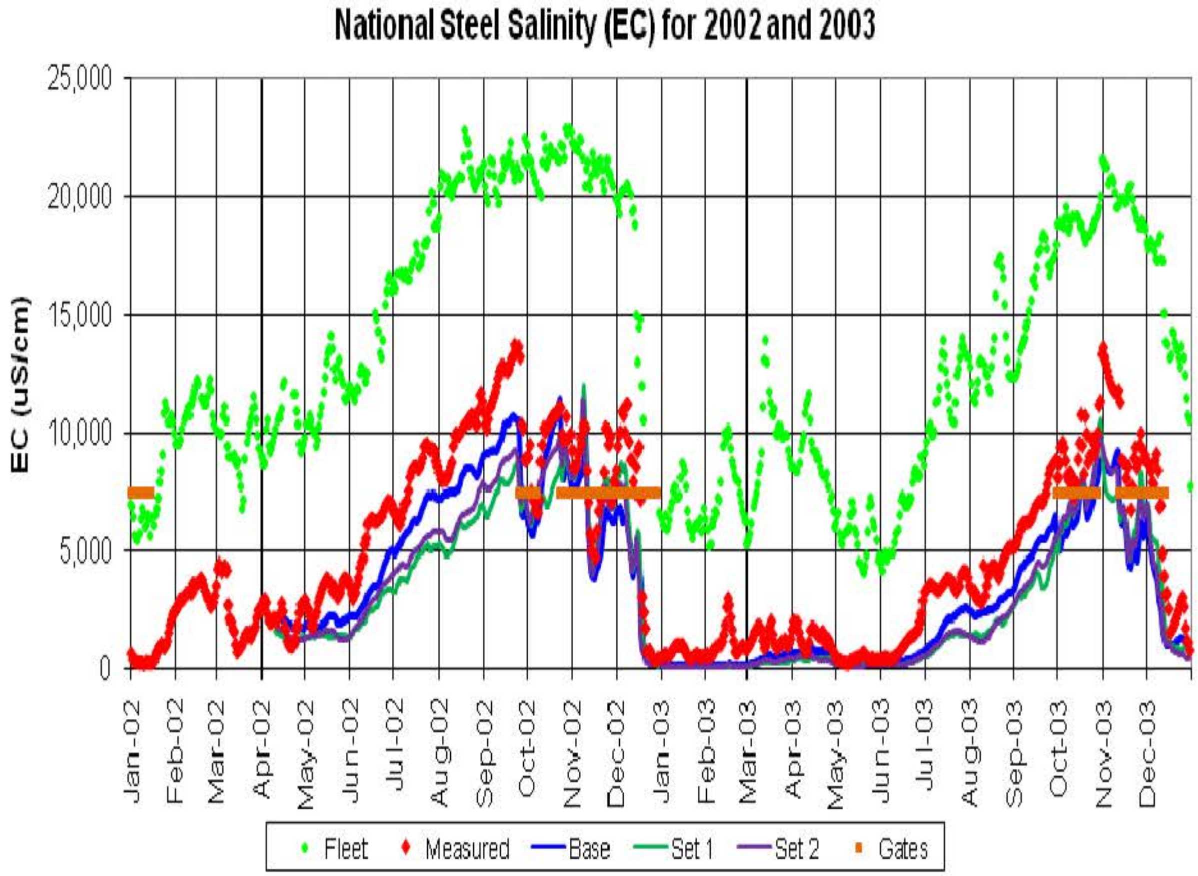


Figure 5.2-9
Measured EC and Simulated EC in Montezuma Slough at National Steel for 2002 and 2003

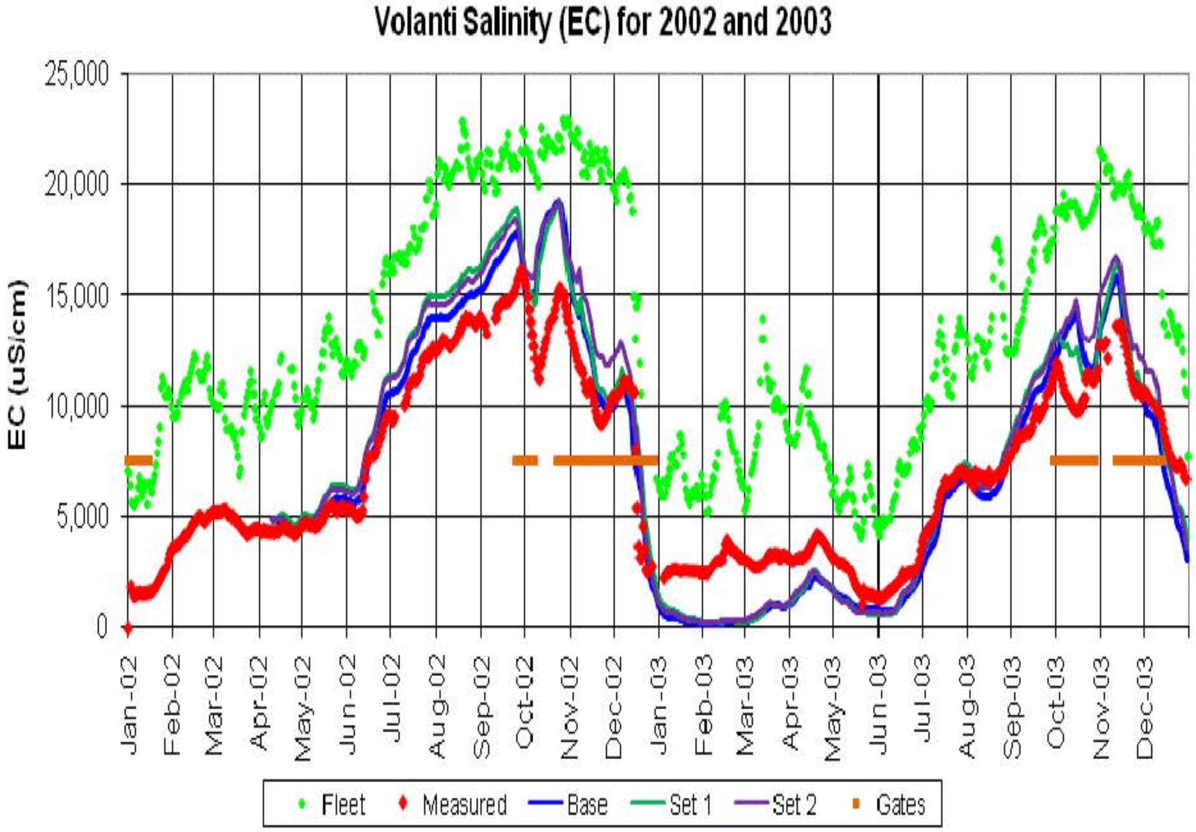
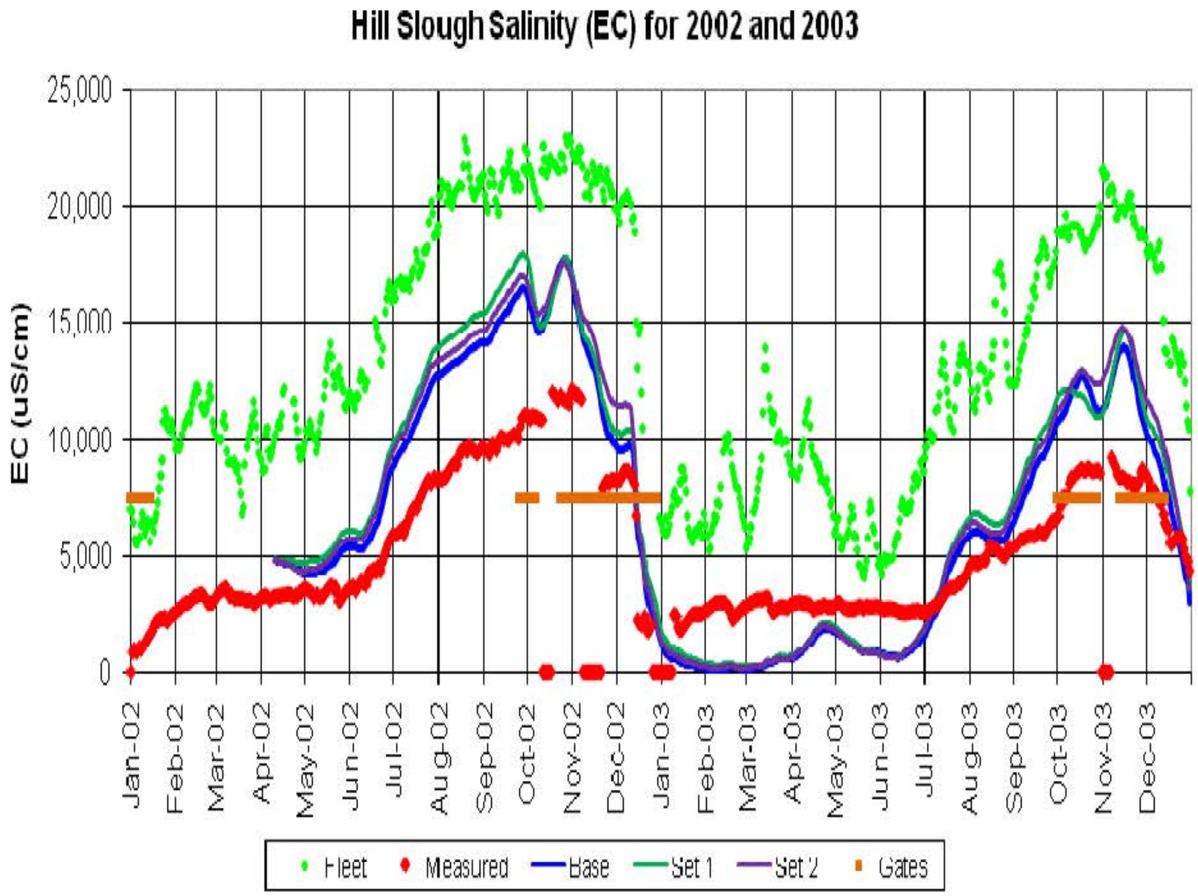


Figure 5.2-10
Measured EC and Simulated EC in Suisun Slough at Volanti for 2002 and 2003



Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

ICF INTERNATIONAL

Figure 5.2-11
Measured EC and Simulated EC in Hill Slough for 2002 and 2003

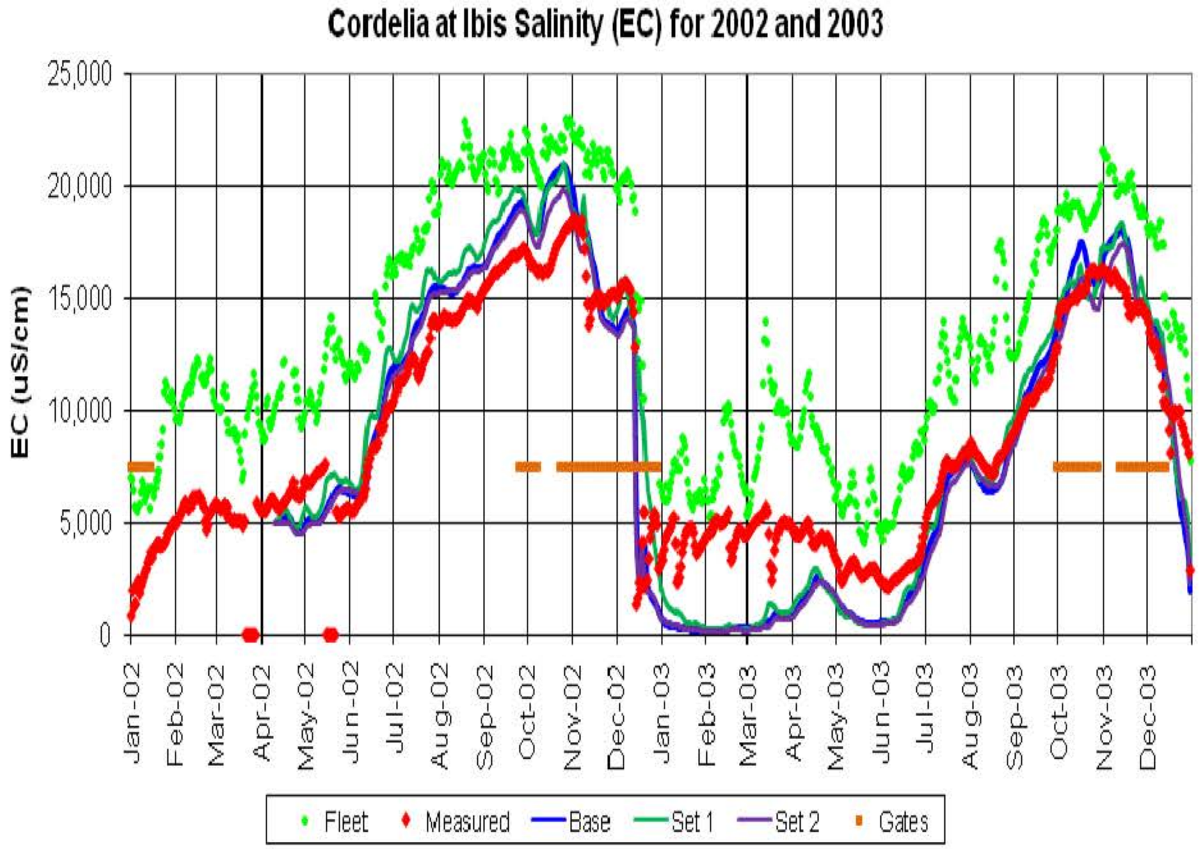
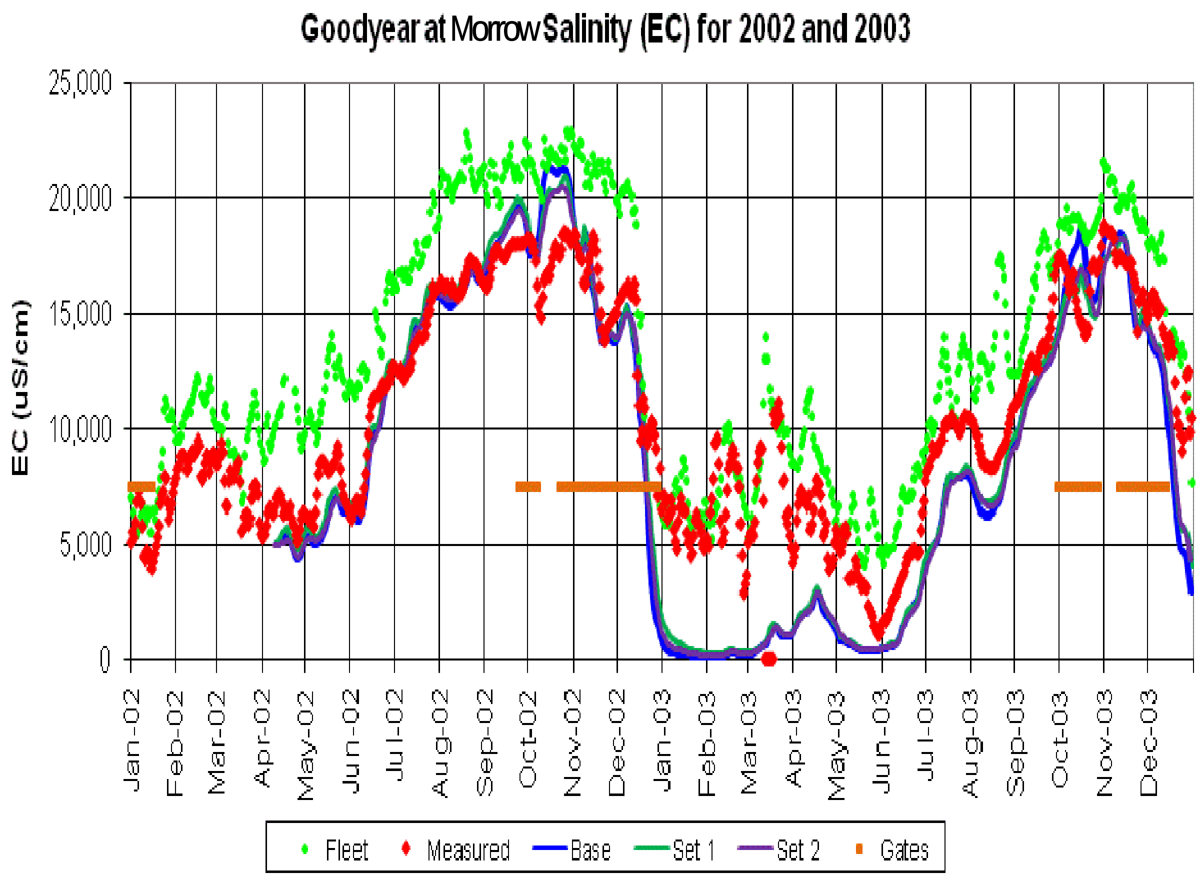
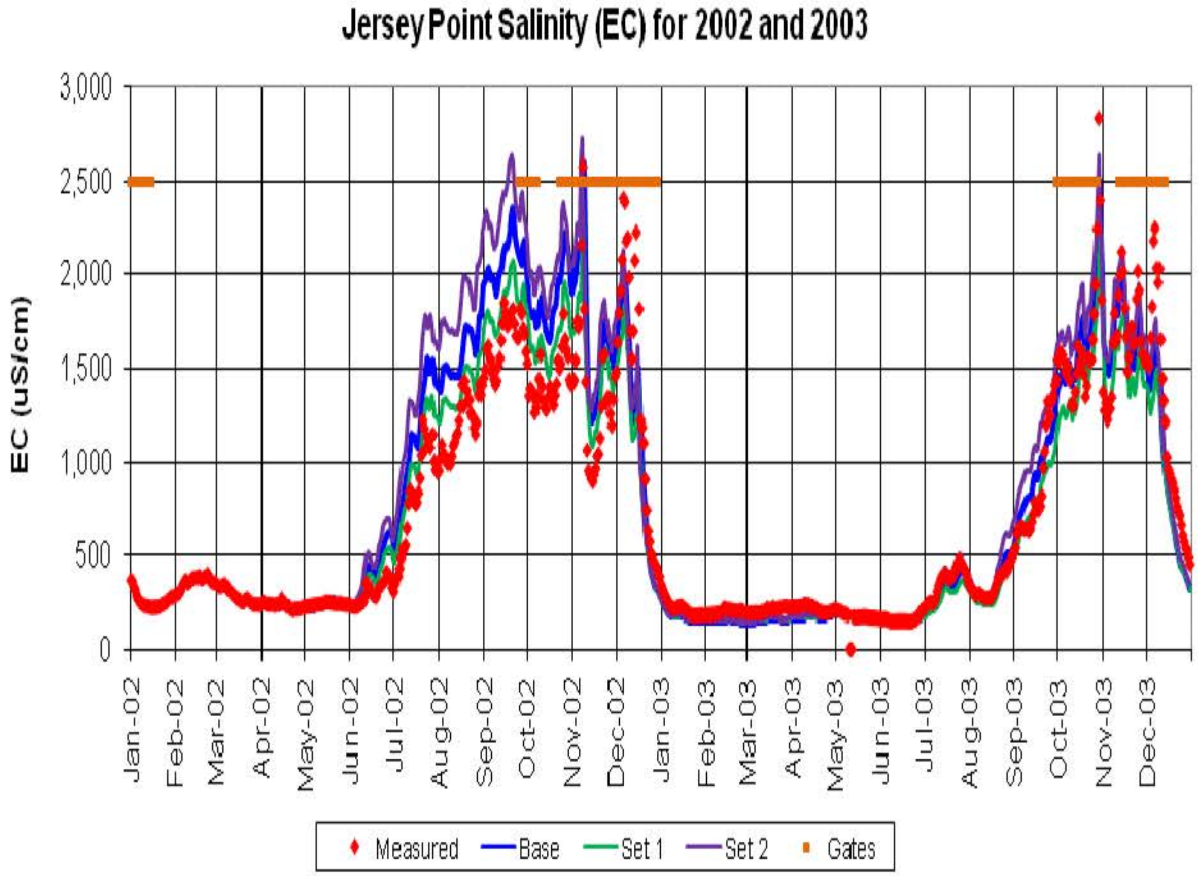


Figure 5.2-12
Measured EC and Simulated EC in Cordelia Slough at Ibis for 2002 and 2003



ICF INTERNATIONAL

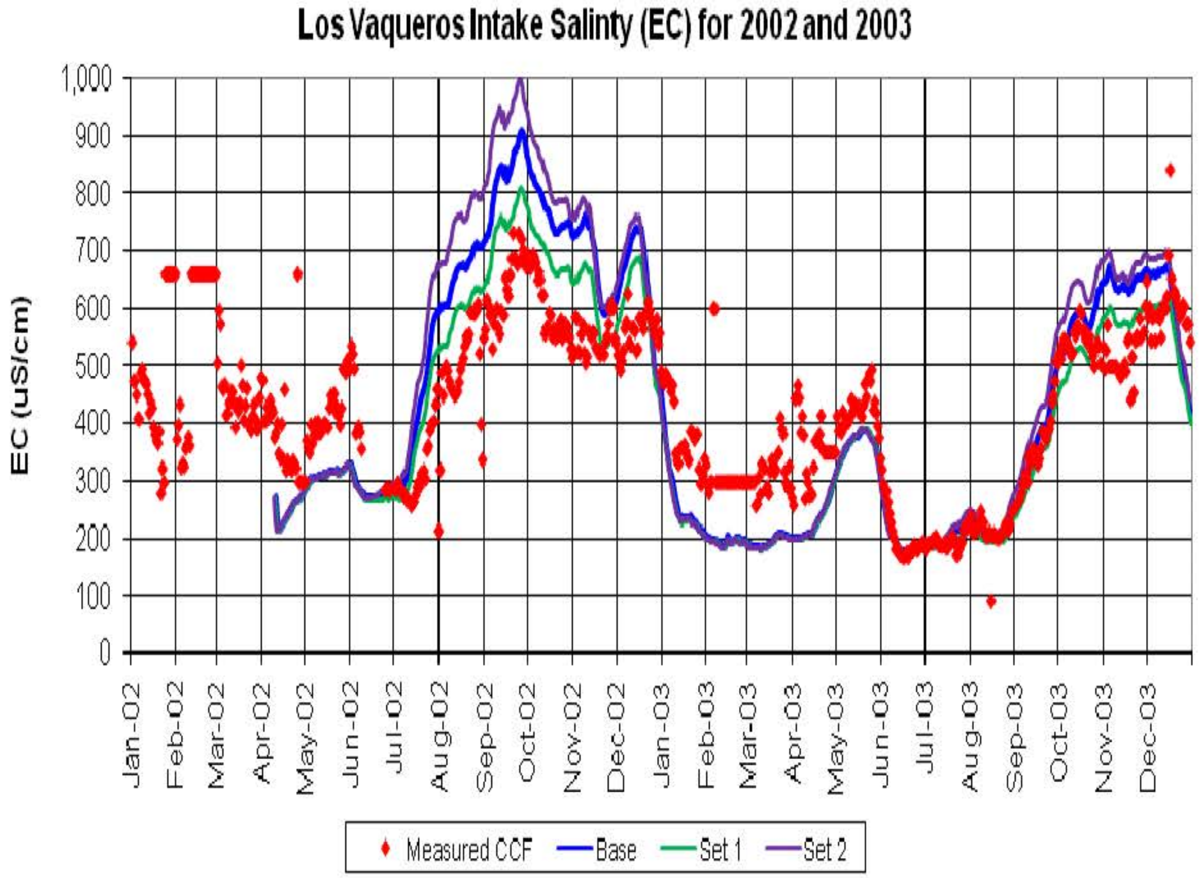
Figure 5.2-13
Measured EC and Simulated EC in Goodyear Slough at Morrow for 2002 and 2003



Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

ICF INTERNATIONAL

Figure 5.2-14
Measured EC and Simulated EC at Jersey Point for 2002 and 2003



Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

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Figure 5.2-15
Measured EC (at CCF) and Simulated EC in Old River at CCWD Los Vaqueros Reservoir Intake for 2002 and 2003

Section 5.3
Geology and Groundwater

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on geology and groundwater resources.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts. The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 5.3-1 summarizes impacts on geology, seismicity, soils, mineral resources, and groundwater from implementing the SMP alternatives. There would be no significant impacts on geology, seismicity, soils, mineral resources, and groundwater from implementing the SMP alternatives.

Table 5.3-1. Summary of Impacts on Geology, Seismicity, Soils, Mineral Resources, and Groundwater

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
GEO-1: Potential to Create Unstable Cut or Fill Slopes	A, B, C	Less than significant	None required	–
GEO-2: Potential for Accelerated Soil Erosion	A, B, C	Beneficial or Less than significant	None required	–
GEO-3: Potential Loss of Topsoil Resources	A, B, C	Less than significant	None required	–
GEO-4: Reduction in Availability of Non-Fuel Mineral Resources	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
GEO-5: Reduction in Availability of Natural Gas Resources	A, B, C	Less than significant	None required	–
GW-6: Potential for Altered Salinity in Shallow Suisun Marsh Groundwater	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
GEO-1: Potential to Create Unstable Cut or Fill Slopes	A, B, C	Less than significant	None required	–
GEO-2: Potential for Accelerated Soil Erosion	A, B, C	Less than significant	None required	–
GEO-5: Reduction in Availability of Natural Gas Resources	A, B, C	No impact	–	–
GEO-7: Potential for Damage to Structures as a Result of Surface Fault Rupture, Groundshaking and/or Seismically Induced Ground Failure (Liquefaction)	A, B, C	Less than significant	None required	–
GEO-8: Potential for Damage to Structures as a Result of Landslides, Including Seismically Induced Landslides	A, B, C	Less than significant	None required	–

Affected Environment

Sources of Information

Background information in this section was derived from sources in the published geologic literature. No new fieldwork or other research was conducted for the preparation of this EIS/EIR. Specific reference information is given in the text. Key sources used in compiling this section include:

- maps and reports published by the U.S. Geological Survey (USGS) and California Geological Survey (CGS);
- soil surveys by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) (formerly U.S. Soil Conservation Service);
- the Solano County General Plan (Solano County 2008) and background reports prepared for the recent General Plan update (EDAW/AECOM 2006a, 2006b);
- publications of the California Department of Conservation's Division of Oil, Gas, and Geothermal Energy;
- California Department of Water Resources' Bulletin 118 (*California's Groundwater*) (California Department of Water Resources 2003);

- the San Francisco Bay Conservation and Development Commission's *Suisun Marsh Protection Plan* (San Francisco Bay Conservation and Development Commission 1976);and
- the Solano County Water Agency's *Integrated Regional Water Management Plan and Strategic Plan* (Solano County Water Agency 2005).

Existing Conditions

Regional Geologic Setting

The plan area is located near the east flank of the Coast Ranges, in the east-central portion of California's Coast Ranges geomorphic province (e.g., Norris and Webb 1990).

The Coast Ranges province is characterized by echelon northwest-trending mountain ranges formed over the past 10 million years or less by active uplift related to complex tectonics of the San Andreas fault/plate boundary system (e.g., Norris and Webb 1990, Buising and Walker 1995, Atwater and Stock 1998). The Coast Ranges Province extends westward to the coastline and beyond, including the Farallon Islands offshore; on the east, it abuts the Great (Central) Valley province (Norris and Webb 1990). The eastern rangefront is defined by faults that have been interpreted as contractile features associated with shortening along an axis approximately normal to the rangefront (e.g., Sowers et al. 1992, Unruh et al. 1995; see also Jennings 1977 for regional mapping) but may also locally accommodate a right-lateral component of motion (e.g., Richesin 1996).

The eastern Coast Ranges are broadly antiformal. At the general latitude of the project area, they consist of a central "core" of Mesozoic units—including mafic and ultramafic rock allied with the Coast Range ophiolite, and lithologically diverse units of the Franciscan complex—flanked on the west by extensive exposures of Miocene volcanic rocks (Sonoma Volcanics) and on the east by an upward-younging sequence of marine and terrestrial sedimentary units that ranges in age from Cretaceous (Great Valley Group) to Neogene (Monterey Group, San Pablo Group, Sonoma Volcanics, and Huichica Formation). The area's larger drainages preserve several generations of alluvial fan and stream deposits ranging in age from Pleistocene to Holocene (Wagner and Bortugno 1982; Graymer et al. 2002).

Topography and Geology of Project Site

Suisun Bay occupies a topographic depression in the easternmost portion of the Coast Ranges. This low area is defined on its west side by uplift along the active Green Valley and Concord fault trends (Wagner and Bortugno 1982; Wagner et al. 1990; Hart and Bryant 1997; Graymer et al. 2002) and on the east by the

Pittsburg−Kirby Hills fault zone, which is likely allied to the Mt. Diablo thrust system to the south and may also be active, as discussed in more detail below (Unruh and Hector 1999). West of Suisun Bay the Coast Ranges rise steeply; east of Suisun Bay are the rolling Montezuma Hills, which consist of uplifted sedimentary strata of early Pleistocene age, with active (Holocene) alluvium in stream drainages that dissect the uplift. Low-lying flat areas of current and former marshland that border the Bay proper are underlain by Bay Mud deposits of Holocene age. To the north of Suisun Bay, the Potrero Hills, which form the topographically higher central portion of Grizzly Island, consist primarily of tightly folded and faulted marine sedimentary rocks of Eocene age, flanked by an apron of late Pleistocene alluvial fan deposits (Graymer et al. 2002).

Geologic Hazards

Primary Seismic Hazards—Surface Fault Rupture[1] and Groundshaking

The only faults known to be active in the immediate project vicinity are the Concord and Green Valley faults, which cross the project area at the westernmost end of Suisun Bay. Both of these structures are zoned by the State of California pursuant to the Alquist-Priolo Act and are recognized as Type B seismic sources by the Uniform and California Building Codes (International Conference of Building Officials 1997, 2001). The western edge of the project area, along the mapped traces of the Concord and Green Valley faults, is thus at some risk of surface fault rupture.

To date, the potential for Holocene activity on the Pittsburg−Kirby Hills fault zone has not been studied extensively, and this system is not zoned by the State of California or recognized by the Uniform Building Code. However, recent work suggests that it may be active. Peat layers of Holocene age thicken markedly toward the fault's surface trace, indicating active valley floor subsidence along this trend during Holocene time (Williams and Gabet 1997). A north-northwest trending alignment of earthquake foci along the west margin of the Montezuma Hills likely is associated with the Pittsburg−Kirby Hills system, and physical features suggestive of Holocene activity—such as well developed topographic lineaments and aligned drainages—coincide with the zone's mapped fault traces (Unruh and Hector 1999). In addition, the Pittsburg−Kirby Hills fault may be related to the Mt. Diablo Thrust system to the south (Unruh and Hector 2007), which is also increasingly thought to be Holocene-active (e.g., Sawyer 1999). With this in mind, there also may be some risk for surface fault rupture along the eastern margin of the project area, where the Pittsburg−Kirby Hills fault zone marks the edge of the Montezuma Hills uplift.

In addition to some level of localized surface fault rupture hazard, the entire project area is likely to experience strong groundshaking during the lifespan of

[1] *Surface fault rupture* is a rupture at the ground surface along an active fault, caused by earthquake or creep activity.

the project. Recent USGS studies estimate a 62% probability of at least one earthquake with a magnitude of 6.7 or greater occurring on one of the faults of the greater San Francisco Bay Area in the next 30 years, and a 10% probability of a magnitude 7.0 or greater event during the same timeframe (U.S. Geological Survey Working Group on California Earthquake Probabilities 2003). Table 5.3-2 summarizes current information on earthquake recurrence intervals and maximum credible earthquake (MCE) for key structures in and near the project area.

Table 5.3-2. Maximum Credible Earthquake and 30-Year Earthquake Probabilities for Principal Active Faults in Project Vicinity

Fault	Magnitude of MCE	30-Year Probability[a]
San Andreas	6.9–7.9[a]	All ruptures: 0.24 Magnitude≥6.7: 0.24 Magnitude≥7.0: 0.18 Magnitude≥7.5: 0.09
Hayward−Rodgers Creek	6.5–7.3[a]	All ruptures: 0.40 Magnitude≥6.7: 0.27 Magnitude≥7.0: 0.11 Magnitude≥7.5: 0.00
Green Valley−Concord	6.0–6.7[a]	All ruptures: 0.26 Magnitude≥6.7: 0.04 Magnitude≥7.0: 0.00 Magnitude≥7.5: 0.00
Calaveras	5.8–6.9[a]	All ruptures: 0.59 Magnitude≥6.7: 0.11 Magnitude≥7.0: 0.02 Magnitude≥7.5: 0.00
Greenville	6.2–6.9[a]	All ruptures: 0.08 Magnitude≥6.7: 0.03 Magnitude≥7.0: 0.01 Magnitude≥7.5: 0.00
Macaama (South)	6.9[b]	Not Provided
West Napa	6.5[b]	Not Provided
Pittsburg−Kirby Hills	>6[d]	Unknown
Cordelia	>6[c]	Unknown

Sources:
[a] U.S. Geological Survey Working Group on California Earthquake Probabilities 2003.
[b] International Conference of Building Officials 1997.
[c] Information compiled from multiple published sources, in Jones & Stokes (2005)
[d] Unruh and Hector 1999.

Secondary Seismic Hazards—Liquefaction and Ground Failure

The State of California maps areas subject to secondary seismic hazards pursuant to the Seismic Hazards Mapping Act of 1990. To date, this effort has focused on the Los Angeles Basin–Orange County region and the San Francisco Bay area, where dense populations are concentrated along active faults. State seismic hazards maps have not been issued for the Suisun Bay area, and no such mapping is planned in the immediate future (California Geological Survey 2004).

In general, however, liquefaction risks are greatest where the shallow substrate consists of loose or unconsolidated sands or silts that are saturated by groundwater; areas of Holocene Bay Mud substrate surrounding Suisun Bay are thus at high risk of liquefaction (Figure 5.3-1) (EDAW/AECOM 2006a, 2006b). Liquefaction risks are low in alluvial fan areas adjacent to the Montezuma and Potrero Hills and very low in the consolidated deposits interior to these uplifts (EDAW/AECOM 2006a, 2006b).

Landslides

The project area is located in flat marshland topography, and as such the majority of the project area is not subject to landslide hazard. However, U.S. Geological Survey landslide mapping, and landslide susceptibility maps in baseline reports prepared for the County's recent General Plan update, identify substantial landslide potential in some of Solano County's hillslope areas (Wentworth et al. 1997; EDAW/AECOM 2006b). Portions of the project area at the base of steep, landslide-prone uplifts are in potential landslide runout areas and subject to corollary risks. These portions include the strip along I-680 at the west edge of Suisun Marsh and alluvial/marshlands downslope from the western tip of the Potrero Hills (Figure 5.3-2).

Soils

Soils of Suisun Bay's bayland and marsh areas include the Joice muck, Tamba mucky clay, and Suisun peaty muck, with small enclaves of remaining active tidal marsh substrate. Areas of Reyes silty clay, and Valdez loams (Valdez silty clay loam, clay substratum; Valdez silt loam, drained) are also present (Bates 1977).

The Joice and Suisun series occur in nearly level areas of salt marsh or former salt marsh and are very poorly drained organic soils that formed from the accumulation of hydrophytic plant remains with an input of fine-grained mineral sediment (Bates 1977). A typical profile of the Joice muck consists of black, saline clayey muck to depths of more than 60 inches. Permeability is limited; surface water tends to pond, and erosion hazard is slight (Bates 1977). The

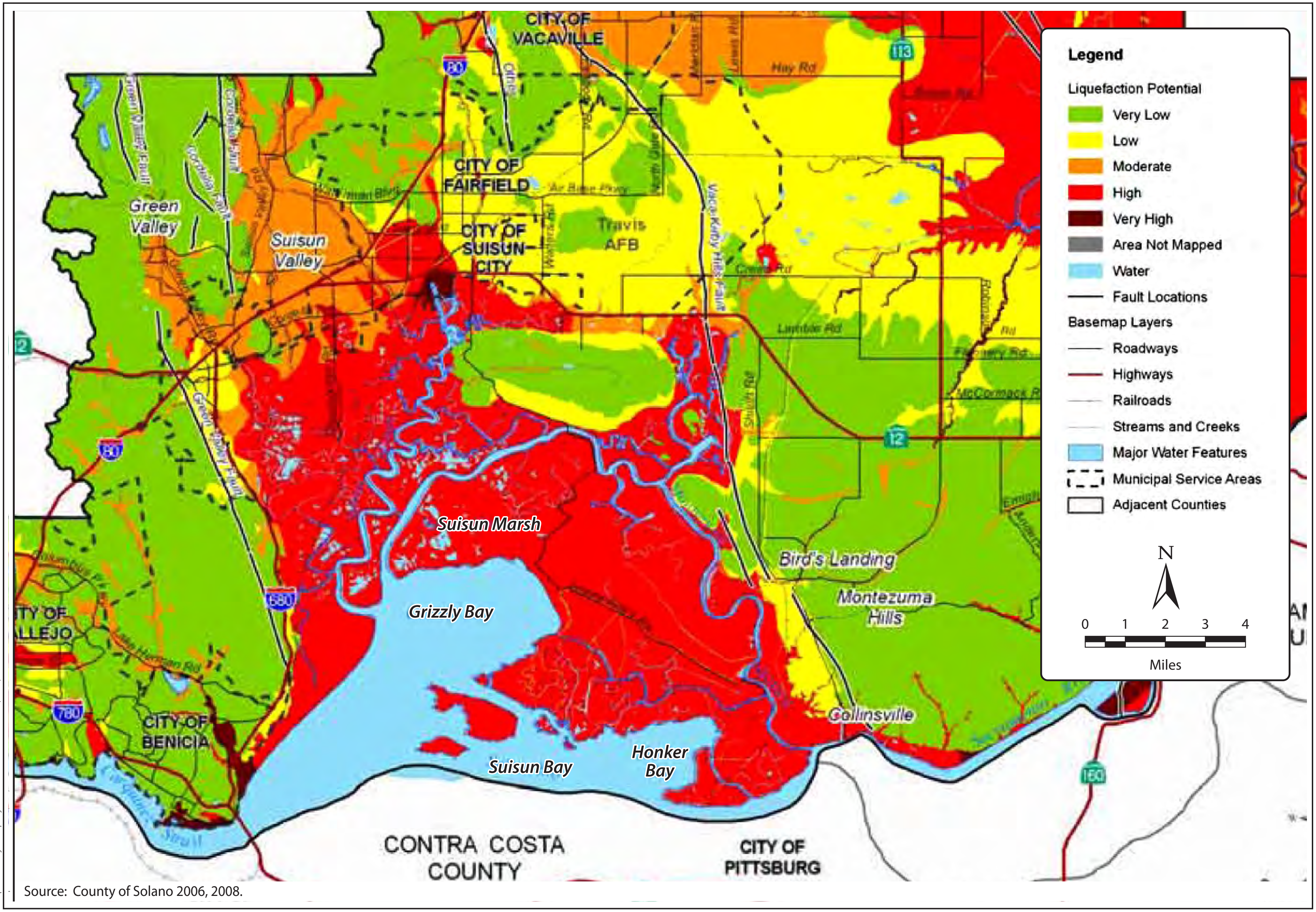

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Figure 5.3-1
Liquefaction Susceptibility

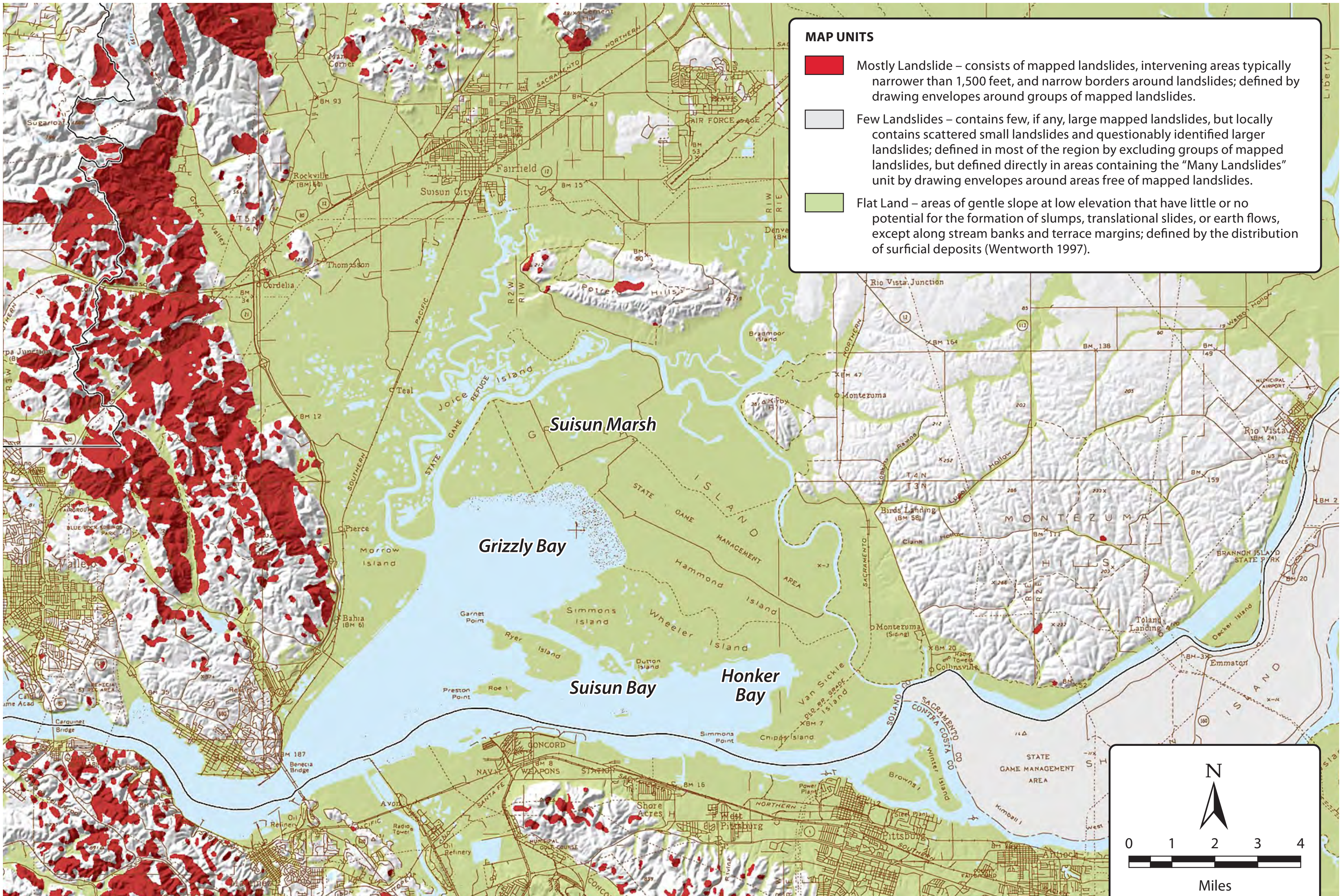

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Figure 5.3-2
Summary Distribution of Landslides and Earth Flows

Suisun peaty muck consists of more than 60 inches of dark-colored muck that contains dark reddish-brown plant fibers. Permeability is rapid, but under natural conditions the water table is shallow (10–20 inches below ground surface), so surface water tends to pond. Erosion is not a hazard in the Suisun peaty muck (Bates 1977).

The Tamba series also occurs in nearly level areas of current and former salt marsh and consists of very poorly drained organic-rich soils. Tamba series soils formed in alluvium derived from mixed sources and in hydrophytic plant remains. In a typical profile, the Tamba mucky clay consists of about 10 inches of light brownish-gray, grayish-brown, and yellowish-brown mottled mucky clay overlying about 30 inches of mottled gray and black mucky clay, which in turn overlies a substratum consisting of more than 30 inches of gray mucky clay. Permeability of the subsoil is moderate, and under natural conditions the water table (12–36 inches below ground surface) so surface water tends to pond. Erosion hazard is slight (Bates 1977).

Active tidal marsh is a very poorly drained, strongly saline land type restricted to areas between constructed levees and bodies of water. Tidal marsh substrate ranges from mud flats to a mixture of hydrophytic plant remains and alluvial sediment (Bates 1977).

The Reyes series occurs in nearly level areas of current and former salt marsh and consists of poorly drained soils that are very strongly acid and saline. Reyes soils formed in alluvium derived from mixed sources. A typical Reyes profile, like that of the Reyes silty clay, consists of about 7 inches of light gray, yellowish-red, and grayish-brown mottled silty clay overlying about 35 inches of mottled gray silty clay, which in turn overlies a substratum of gray silty clay. The substratum is moderately alkaline *in situ* but becomes strongly acid when exposed to the air and allowed to dry. The water table is 24–48 inches below ground surface under natural conditions. Permeability is slow, and surface water ponds on Reyes soils. Erosion is a slight hazard (Bates 1977).

The Valdez series consists of poorly drained soils that formed in nearly level areas on alluvial fans. Valdez soils are also present in some areas where dredge spoils have been disposed of. A typical Valdez profile includes about 12 inches of light-colored mottled silty clay loam, overlying about 20 inches of light-colored mottled and stratified silty clay loam and very fine sandy loam, which in turn overlies a subsoil consisting of more than 40 inches of slightly darker colored mottled and stratified silty clay loam, silt loam, and very fine sandy loam. The Valdez silty loam, drained, has a profile similar to this, except that the texture is silt loam throughout, and salinity is lower. Artificial drainage maintains the fluctuating water table at depths of more than 4 feet below ground surface. Permeability is moderately slow, runoff is slow, and erosion hazard is slight in the Valdez silt loam, drained. The Valdez silty clay loam, clay substratum is also similar to the typical Valdez profile but is underlain by a buried clay soil at a depth of 35–50 inches below ground surface. It is a moderately to strongly saline soil. Permeability is slow, runoff is slow, and erosion hazard is slight in the Valdez silty clay loam, clay substratum. The water table is 3–5 feet below ground surface in this unit (Bates 1977).

Land Subsidence

Portions of Suisun Marsh have undergone marked subsidence, although not near as much as the neighboring Delta area. This is believed to be the result of diking and removal from tidal inundation—where formerly saturated peaty soils allowed to dry out, plant material oxidizes, decays, and becomes more compact. Drying also allows the mineral soil matrix to compact, as pore space is no longer filled by water. Agricultural and managed wetland activities such as disking, which accelerates the drying and oxidation processes, likely have contributed to accelerated subsidence. The amount of subsidence in various parts of Suisun Marsh is believed to be controlled by the thickness of the soil column and the abundance and distribution of organic material (Siegel pers. comm.). In other parts of the Bay Area and in parts of the Central Valley, land subsidence has been caused by groundwater overdraft; the contribution of groundwater withdrawal, if any, to Suisun Marsh subsidence has not been evaluated (Siegel pers. comm.). Active tectonics also can result in subsidence but are not thought to have contributed to recent subsidence in Suisun Marsh (Siegel pers. comm.).

Natural Gas Reserves

Natural gas refers to hydrocarbons that occur naturally in a gas or vapor state at ordinary temperatures and pressures. Natural gas consists primarily of methane but also may contain a smaller percentage of ethane, propane, and other gaseous hydrocarbons. Impurities such as nitrogen, carbon dioxide, hydrogen sulfide, and water (brines) also may be present (Jackson 1997). Already an essential energy source for heating, electricity generation, and transportation, natural gas is expected to increase in importance in coming years, because it offers a “cleaner” alternative to other petroleum products and coal. However, world reserves of natural gas are limited and likely will be exhausted within the next 50 years (EDAW/AECOM 2006c).

Known for “dry” or nonassociated gas (i.e., natural gas produced without concurrent production of crude oil), the Sacramento Valley and Delta areas are home to some of California’s most important gas reserves. Figure 5.3-3 shows natural gas fields in Solano County. Although production rates have declined somewhat in recent years and are expected to continue on a downward trend, as of 2005 the county had about 900 active natural gas extraction wells. Most of these wells are located in proven fields, although gas field boundaries are expanding in some areas. (EDAW/AECOM 2006c.)

The Rio Vista field, east of Suisun Bay, has been the largest producer of dry gas in northern California and one of the largest gas producers in California for a number of years (e.g., California Department of Conservation, Division of Oil,

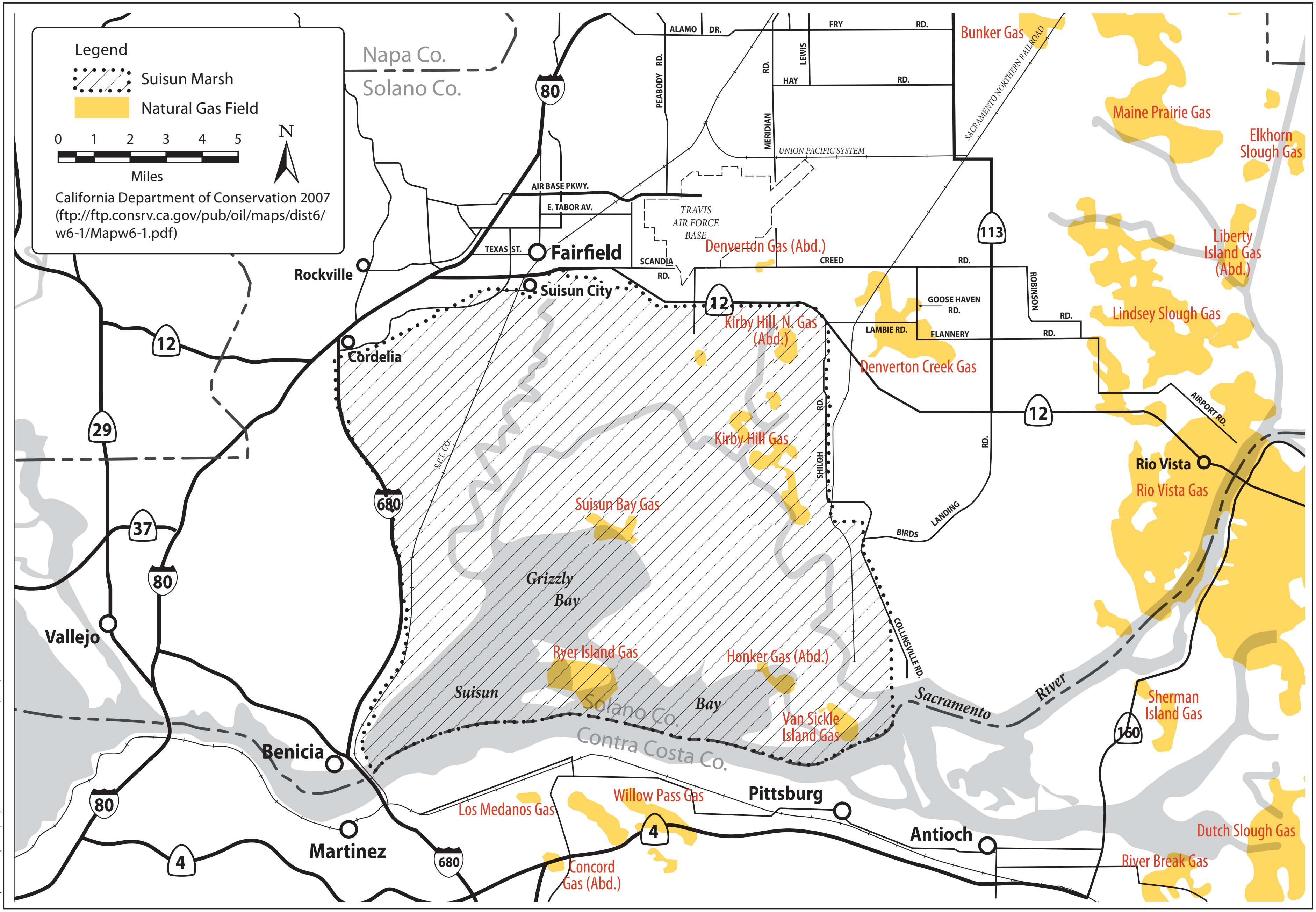

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Figure 5.3-3
Natural Gas Fields

Gas, and Geothermal Resources 2004, 2006). In the immediate project area, active gas fields include Ryer Island and Suisun Bay (California Department of Conservation, Division of Oil, Gas, and Geothermal Resources 2008). Nearby Kirby Hill is an important natural gas storage field (EDAW/AECOM 2006c).

Non-Fuel Mineral Resources

Solano County is rich in non-fuel mineral resources, including mercury, construction sand and gravel, stone products, clay, calcium, and sulfur (EDAW/AECOM 2006a). Figure 5.3-4 shows the location and distribution of known mineral resources in the county.

As shown in Figure 5.3-4, small areas zoned MRZ-2 and MRZ-3 for aggregate resources are located along the edge of the plan area, in and adjacent to the city of Vallejo. Portions of the Potrero Hills also are zoned MRZ-3 for sand and gravel resources. One operating quarry is located on the north flank of the Potrero Hills uplift, and other active sand, gravel, and stone quarries are located in and adjacent to the city of Benicia, along the west side of the plan area. Mercury also has been produced in this portion of the county (EDAW/AECOM 2006a).

Groundwater Resources

The project area overlies the Suisun-Fairfield Valley Groundwater Basin, which is the second-largest groundwater basin in Solano County, with an area of 133,600 acres. The Suisun-Fairfield basin is bounded on the north and west by foothills of the Coast Ranges uplift, on the south by marshlands bordering Suisun Bay, and on the east by the low bedrock ridges that crop out southeast from Vacaville to the Montezuma Hills (Thomasson et al. 1960; Solano County Water Agency 2005).

The Suisun-Fairfield Valley groundwater basin recharges by infiltration on the Suisun Valley floor and along stream channels and drains generally southward into Suisun Marsh, where groundwater provides freshwater mixing and flushing action (San Francisco Bay Conservation and Development Commission 1976). The most important water-bearing formations are the gravel and sand deposits within the older alluvium, which are up to 200 feet thick. These are underlain at depth by a thick sequence of non–water-bearing marine sedimentary deposits of Mesozoic-Paleogene age (Great Valley Complex) and by volcanic rocks associated with the Sonoma Volcanics of Miocene age.

Groundwater supplies municipal, agricultural, and rural residential uses in Solano County (Solano County Water Agency 2005). To date, however, groundwater use has not been accurately quantified, and the SCWA's Integrated Regional Water Management Plan (IRWMP) identifies the need for better understanding of groundwater supply and demand as a key issue for water management in the county (Solano County Water Agency 2005). Nonetheless, existing data suggest that the Suisun-Fairfield basin is not a significant source of supply because of low yields (average = 200 gallons per minute [gpm], maximum = 500 gpm) and poor water quality (total dissolved solids [TDS] averaging 410 mg/l and ranging as high as 740 mg/l) (Solano County Water Agency 2005; California Department of Water Resources 2003). However, several small communities and individual landowners on the periphery of the Marsh, as wells as a few parcels in the Primary Zone of the Marsh, use groundwater for their domestic water supply.

An existing well in the Grizzly Island Wildlife Area provides brackish water with a high mineral content. With the exception of the few landowners that use groundwater for domestic supplies, well water typically is used for lawn irrigation, and drinking water is imported.

Regulatory Setting

Federal

Geology, Geologic Resources, and Geologic Hazards—Clean Water Act, Section 402(p)

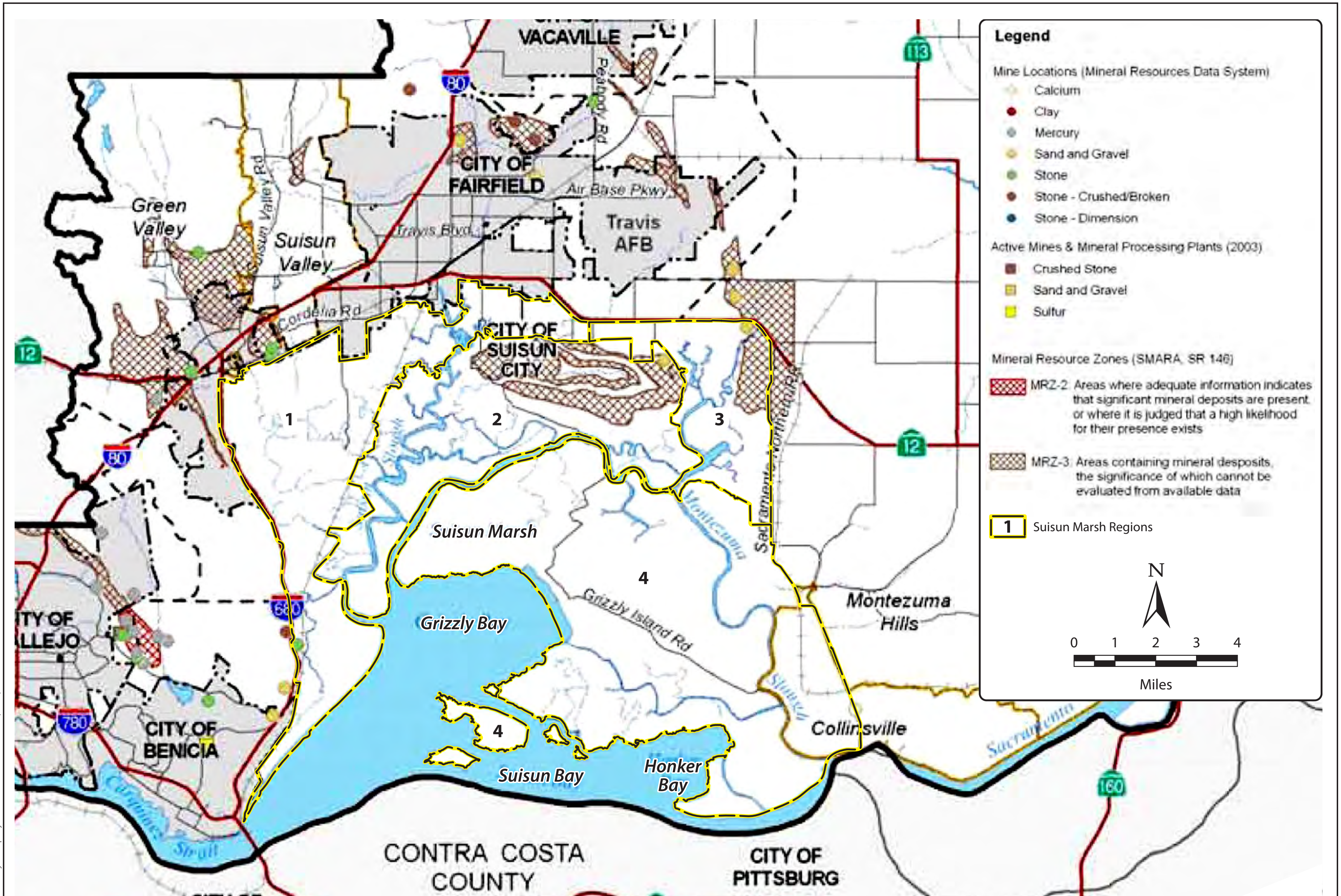
Amendments to the CWA in 1987 added Section 402(p), which created a framework for regulating municipal and industrial stormwater discharges under the NPDES program. In California, the State Water Board is responsible for implementing the NPDES program; pursuant to the state's Porter-Cologne Water Quality Control Act (Porter-Cologne Act) (see discussion in Water Quality section of this EIS/EIR), it delegates implementation responsibility to the state's nine RWQCBs.

Under the NPDES Phase II Rule, any construction project disturbing 1 acre or more must obtain coverage under the state's NPDES General Permit for Stormwater Discharges Associated with Construction Activity (General Construction Permit). The purpose of the Phase II rule is to avoid or mitigate the effects of construction activities, including earthwork, on surface waters. To this end, General Construction Permit applicants are required to file a Notice of Intent to Discharge Stormwater with the RWQCB that has jurisdiction over the construction area and to prepare a stormwater pollution prevention plan (SWPPP) stipulating BMPs that will be in place to avoid adverse effects on water quality.

Additional information on other aspects of the CWA is provided in the Water Quality section of this EIS/EIR.

Groundwater—Clean Water Act, Other Sections

As discussed in more detail in the Hydrology and Water Quality section, the CWA is the primary federal law that protects the quality of the nation's waters.



Source: Solano County General Planning Documents, 2006 and 2008.

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Figure 5.3-4
Mineral Resources

It operates on the principle that all discharges of pollutants into the nation's waters are unlawful unless specifically authorized by a permit; permit review is the CWA's primary regulatory tool.

Groundwater quality is indirectly protected by the permit review under CWA Section 402 (permits for discharge of stormwater from construction sites, discussed briefly in the preceding section), and to some extent by the Section 404 process (permits for discharge of dredged and fill materials to waters of the United States).

Broader protection is provided by Section 401, which stipulates that any project requiring a federal permit must be reviewed for its potential effects on water quality, and Section 303(d); under Section 303(d) and California's Porter-Cologne Act of 1969 (discussed below), the State of California is required to establish beneficial uses of state waters and to adopt water quality standards to protect those beneficial uses.

State

Geology, Geologic Hazards, and Geologic Resources

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources Code [PRC] Section 2621 et seq.), originally enacted in 1972 as the Alquist-Priolo Special Studies Zones Act and renamed in 1994, is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The Alquist-Priolo Act prohibits the location of most types of structures intended for human occupancy across the traces of active faults and strictly regulates construction in the corridors along active faults (earthquake fault zones). It also defines criteria for identifying active faults, giving legal weight to terms such as *active*, and establishes a process for reviewing building proposals in and adjacent to earthquake fault zones.

Under the Alquist-Priolo Act, faults are zoned and construction along or across them is strictly regulated if they are "sufficiently active" and "well-defined." A fault is considered sufficiently active if one or more of its segments or strands shows evidence of surface displacement during Holocene time (defined for purposes of the act as referring to approximately the last 11,000 years). A fault is considered well-defined if its trace can be clearly identified by a trained geologist at the ground surface or in the shallow subsurface, using standard professional techniques, criteria, and judgment (Hart and Bryant 1997).

Seismic Hazards Mapping Act

Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act of 1990 (PRC Sections 2690–2699.6) is intended to reduce damage resulting from earthquakes. While the Alquist-Priolo Act addresses surface fault rupture, the Seismic Hazards Mapping Act addresses other earthquake-related hazards, including strong groundshaking, liquefaction, and seismically induced landslides. Its provisions are similar in concept to those of the Alquist-Priolo Act: the state is charged with identifying and mapping areas at risk of strong groundshaking, liquefaction, landslides, and other corollary hazards, and cities and counties are required to regulate development within mapped seismic hazard zones.

Under the Seismic Hazards Mapping Act, permit review is the primary mechanism for local regulation of development. Specifically, cities and counties are prohibited from issuing development permits for sites within seismic hazard zones until appropriate site-specific geologic and/or geotechnical investigations have been carried out and measures to reduce potential damage have been incorporated into the development plans.

Surface Mining and Reclamation Act

The Surface Mining and Reclamation Act of 1975 (SMARA) (PRC Sections 2710–2719) is the principal legislation addressing mineral resources in California. SMARA was enacted in response to land use conflicts between urban growth and essential mineral production. Its stated purpose is to provide a comprehensive surface mining and reclamation policy that will encourage the production and conservation of mineral resources while ensuring that:

- adverse environmental effects of mining are prevented or minimized;
- mined lands are reclaimed and residual hazards to public health and safety are eliminated; and
- consideration is given to recreation, watershed, wildlife, aesthetic, and other related values.

SMARA governs the use and conservation of a wide variety of mineral resources, although some resources and activities are exempt from its provisions, including excavation and grading conducted for farming, construction, or recovery from flooding or other natural disaster.

SMARA provides for the evaluation of an area's mineral resources using a system of mineral resource zone (MRZ) classifications that reflect the known or inferred presence and significance of a given mineral resource. The MRZ classifications are based on available geologic information, including geologic mapping and other information on surface exposures, drilling records, and mine data; and socioeconomic factors such as market conditions and urban development patterns. The MRZ classifications are defined as follows.

- **MRZ-1**: Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
- **MRZ-2:** Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood for their presence exists.
- **MRZ-3:** Areas containing mineral deposits, the significance of which cannot be evaluated from available data.

- **MRZ-4:** Areas where available information is inadequate for assignment into any other MRZ.

The State of California is responsible for mineral resources zoning under SMARA, but SMARA implementation and enforcement authority rests with the local jurisdiction and is carried out through the county or city land use planning process and codes. Solano County's SMARA implementing regulations are contained in Chapter 29 of the County Code.

Marsh Development Permits

In the primary management area of Suisun Marsh, a new project involving grading would require a BCDC marsh development permit. Depending on the size of the project and the amount of work, the project could either require an administrative permit or a major permit (requiring a public hearing). Individual projects will be evaluated based on project activities and project proponents to determine the appropriate permitting mechanism. It is anticipated that restoration activities under the SMP would require a permit.

Groundwater

Porter-Cologne Water Quality Control Act of 1969

The Porter-Cologne Act, passed in 1969, dovetails with the CWA. Both laws are discussed in detail in the Hydrology and Water Quality section of this EIS/EIR. Briefly, the Porter-Cologne Act established the State Water Resources Control Board and divided the state into nine regions, each overseen by an RWQCB. The State Water Board has primary responsibility for the quality of the state's surface and groundwater supplies, but much of its daily implementation authority is delegated to the nine RWQCBs, which are responsible for implementing Sections 401 and 402 of the CWA. They also oversee implementation of CWA Section 303(d). In general, the State Water Board manages water rights and regulates statewide water quality, and the RWQCBs focus on water quality within their respective regions.

The Porter-Cologne Act requires the RWQCBs to develop water quality control plans (Basin Plans) that designate beneficial uses of California's major surface water bodies and groundwater basins and establish specific narrative and numerical water quality objectives for those waters. *Beneficial uses* represent the services and qualities of a water body—i.e., the reasons why the water body is considered valuable. *Water quality objectives* reflect the standards necessary to protect and support those beneficial uses. Basin Plan standards are implemented primarily by using the NPDES permitting system to regulate waste discharges so that water quality objectives are met. Under the Porter-Cologne Act, Basin Plans must be updated every 3 years.

The Suisun Marsh area is within the jurisdiction of the San Francisco Bay RWQCB, headquartered in Oakland.

Groundwater Management Act

California's Groundwater Management Act (California Water Code Sec. 10750–10756) gives existing local agencies expanded authority over the management of groundwater resources in basins recognized by DWR. Its intent is to promote the voluntary development of groundwater management plans in order to ensure stable groundwater supplies for the future. Under the act, a groundwater management plan is defined as providing for "planned use of the groundwater basin yield, storage space, transmission capability, and water in storage."

The act stipulates the technical components of a groundwater management plan as well as procedures for such a plan's adoption, including passage of a formal resolution of intent to adopt a groundwater management plan, and holding a public hearing on the proposed project. The act also requires agencies to adopt rules and regulations to implement an adopted plan and empowers agencies to raise funds to pay for the facilities needed to manage the basin, such as extraction wells, conveyance infrastructure, recharge facilities, and testing and treatment facilities.

Local

Grading

Solano County has adopted the 1997 Uniform Building Code and 2001 California Building Standards Code, including the optional appendices that regulate earthwork. The County's grading codes (also referred to as the Grading, Drainage, Land Leveling and Erosion Control Ordinance) are contained in Chapter 31 of the County Code, and do not apply to federal or state agencies. The County requires grading permits for most earthwork, with the exception of the following.

- Small excavations and fills (those with no more than 8,000 square feet disturbed, an excavated volume less than 150 cubic yards, a finished depth less than 4 feet, and slopes no steeper than 2:1).
- Landscaping of areas smaller than 10,000 square feet.
- Excavation for structures—such as pools, basements, and septic tanks—that are typically covered through other permit processes.
- Permitted land leveling for agricultural purposes.
- Agricultural activities on previously graded or leveled lands.
- Utility trenches, wells, and exploratory excavations by licensed personnel.
- Activities in disposal areas, landfills, quarries, stockpiles, and other operations where a County Use Permit has been granted
- Grading for fire roads and firebreaks.
- Grading by Solano County or Special Districts; grading for projects on state- or federally owned or operated lands.

- Grading within the Suisun Primary Marsh Area.

Mineral and Energy Resources

The Resources Element of the County General Plan (Solano County 2008) recognizes the economic importance of the county's mineral resources and contains policies (Policy RS.P-32) to ensure that

- areas with important mineral resources are zoned and developed in ways that maintain resource availability;
- mineral extraction activities are performed in a manner that is compatible with surrounding land uses;
- adverse environmental effects of extractive activities are avoided; and
- mined sites are properly restored following closure, consistent with SMARA requirements and surrounding land uses.

General Plan policies regarding natural gas resources differ somewhat from those for non-fuel mineral resources. The General Plan recognizes the past and current importance of natural gas in Solano County but also stresses that natural gas has a limited lifespan as an alternative to other fossil fuels. General Plan Policy RS.P-54 identifies the importance of "responsible extraction, storage, and transportation of natural gas resources" to "minimize the impact on the natural environment" (Solano County 2008).

Groundwater

The SCWA was established in 1951 to provide untreated water to water service agencies in Solano County from the federal Solano Project and the North Bay Aqueduct of the SWP. SCWA is responsible for delivering water to water service agencies and monitoring efforts to mitigate stormwater runoff. An IRWMP (Solano County Water Agency 2005) has been developed for the SCWA and its member cities and districts. The IRWMP proposes regionwide policies and projects to meet key strategic issues identified by stakeholder groups, including the management of the county's groundwater resources. The IRWMP identifies lack of knowledge about groundwater resources as a key management concern, limiting understanding of groundwater problems and opportunities in areas where insufficient monitoring has taken place (Solano County Water Agency 2005).

Environmental Consequences

Assessment Methods

Impacts related to geology, seismicity, soils, and mineral and groundwater resources were assessed qualitatively, based on published information and professional judgment, in light of the current standards of care for engineering geology, mineral resources management, and groundwater management. Analysis of geology-related impacts focused on the potential for increased risk of personal injury, loss of life, damage to property or facilities, and reduced availability of important mineral resources. Analysis of groundwater impacts focused on the potential for the project to deplete groundwater resources or degrade water quality in the groundwater basin.

Significance Criteria

Impacts would be significant and would require mitigation if the proposed action were to result in any of the following.

- Exposure of people, structures, or facilities to hazards involving:
  - rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map or based on other substantial evidence of active faulting;
  - strong seismic groundshaking;
  - seismically induced ground failure, including but not limited to liquefaction;
  - landslides, including seismically induced landslides; or
  - expansive soils, as defined in the current California Building Code.
- Creation of unstable cuts or fills.
- Substantial loss of topsoil resources; substantially accelerated soil erosion.
- Loss or substantial reduction in availability of a known mineral resource of regional or statewide value.
- Loss or substantial reduction in availability of a locally important mineral resource recovery site.
- Substantial depletion of groundwater supplies or interference with groundwater recharge.
- Long-term groundwater overdraft; appreciable land subsidence as a result of groundwater overdraft.
- Interference 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.
- Increased seepage losses from sloughs, canals, and streams.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, the SMP would not be implemented, and land use decision making would continue under current plans and practices. Limited marsh restoration and managed wetland enhancement are expected to occur through several separate projects unrelated to the SMP.

As there would be no change from baseline land use, current conditions, practices, and outcomes relative to geology, soils, natural gas, and non-fuel mineral resources would remain unchanged under the No Action alternative. However, the reduction in frequency of managed wetland activities would limit the potential for soil disturbance throughout the Marsh.

Depending on their location and extent, marsh restoration projects under the No Action Alternative might have some potential to affect the salinity of shallow groundwater, especially during dry periods when inland recharge is substantially diminished, but if this occurs, it would represent a return to a more natural hydrologic pattern and would be considered an overall benefit. Aquifer stratigraphy in Suisun Marsh is not well documented, so it is unclear whether shallow infiltration could affect the producing aquifer. However, because wells in Suisun Marsh are not used for potable, municipal, or agricultural supply, even if producing aquifers were affected, there would be little or no effect on the use of well water, particularly in light of the limited extent of restoration anticipated under the No Action Alternative.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact GEO-1: Potential to Create Unstable Cut or Fill Slopes

The proposed action would entail activities requiring fill placement and/or excavation, including but not necessarily limited to placement of locally obtained fill (dredge spoils) to raise levee crest elevations. Excavation associated with restoration would be limited to grading to create desired habitat features and removal of levee portions to inundate the restoration area. Fill would be applied mainly to improve both interior and exterior levees, but may also be used to create islands or other upland transition areas as part of restoration design. Excavation would be limited by both volume and geographic location, thus minimizing risks of soil instability. Additionally riprap and other bank protection would be implemented to protect newly created or modified slopes from excessive instability and erosion. As a result, project activities are not expected to create unstable cut or fill slopes, and would likely benefit slopes in both newly created tidal and existing managed wetlands.

Conclusion: Less than significant. No mitigation required.

Impact GEO-2: Potential for Accelerated Soil Erosion

Soils in Suisun Marsh are clay-rich and are not highly erodible, but ground-disturbing activities—such as earthwork to breach levees and fill placement to expand and maintain the levees that are not removed—nonetheless would have the potential to increase rates and extent of soil erosion. However, as described in Chapter 2, project proponents will implement an erosion and sediment control plan consistent with the current engineering standard of care and also will be required to implement a SWPPP for CWA compliance for activities that disturb an area of more than 1 acre. Additionally, restoration sites will be managed to establish vegetation before breaching, which would limit erosion. With these protective measures in place, impacts related to the potential for accelerated soil erosion would be substantially avoided or minimized, and are expected to be less than significant.

Restoring tidal action to portions of Suisun Marsh would increase the mobility of sediment in reconnected tidal channels and mudflat areas. This would entail some scour and localized sediment deposition. However, the cycle of tidally driven sediment erosion, transport, and redeposition would reflect the restoration of natural processes interrupted by the existing levee and dike system, so it is viewed as a benefit and does not require mitigation. Sediment transport is analyzed in more detail in Section 5.5, Sediment Transport.

Conclusion: Beneficial or less than significant. No mitigation required.

Impact GEO-3: Potential Loss of Topsoil Resources

Topsoil is the fertile, organic-rich upper portion of a soil profile; under natural conditions, it is present only where a soil profile has developed over time. Thus, some portions of the project area—active tidal channels and mudflats, where sediment is regularly remobilized by tidal currents—are unlikely to support topsoil.

Nonetheless, in areas where topsoil is present, construction of new project facilities would require removal of the existing topsoil layer. Other ground-disturbing activities—such as earthwork to breach levees and fill placement to expand and maintain the levees that are not removed—also would have some potential to result in removal and loss of topsoil resources where they are present. Ground disturbance would be confined to the minimum area necessary for project purposes, and, where feasible, topsoil would be sidecast and stockpiled for on-site reuse. The amount of topsoil lost as a result of project activities would be reduced to the extent feasible; in consideration of the comparatively small loss of topsoil and the overall project outcome of restoring, enhancing, and preserving marshland ecology (including an intact soil profile, where originally present) over a large area, impacts are evaluated as less than significant.

Conclusion: Less than significant. No mitigation required.

Impact GEO-4: Reduction in Availability of Non-Fuel Mineral Resources

Small areas zoned MRZ-2 and MRZ-3 for aggregate resources are located along the edge of the project area, in and adjacent to the city of Vallejo. Portions of the Potrero Hills also are zoned MRZ-3 for sand and gravel resources. One operating quarry is located on the north flank of the Potrero Hills uplift, and other active sand, gravel, and stone quarries are located in and adjacent to the city of Benicia, along the west side of the project area. Mercury also has been produced in this portion of the county (EDAW/AECOM 2006a).

To the extent that restored marsh habitat is viewed as incompatible with mineral resource extraction on nearby parcels, the proposed action could lead to long-term shifts in land use planning priorities, rendering extractive activities less feasible in the future. However, because the known mineral resources are not within the project area and are located only in limited areas on the periphery, it is not expected that restoration would result in changes in land uses related to mineral extraction.

Conclusion: Less than significant. No mitigation is required.

Impact GEO-5: Reduction in Availability of Natural Gas Resources

Several proved natural gas fields are located in or near the plan area, as shown in Figure 5.3-3 above. As discussed in the previous impact for non-fuel mineral resources, habitat restoration may be viewed as incompatible with continued, new, or renewed extraction of natural gas. To the extent that restored marsh habitat is viewed as incompatible with natural gas extraction, the proposed action could render natural gas extraction less feasible in the future. Regardless, restoration activities would occur only on lands purchased from willing sellers, and natural gas still would be extracted in other areas in and around the Marsh.

Conclusion: Less than significant. No mitigation required.

Impact GW-6: Potential for Altered Salinity in Shallow Suisun Marsh Groundwater

Restoring tidal connectivity and increasing the acreage of tidal wetland in Suisun Marsh would increase the area exposed to saline and brackish surface water. In normal years, groundwater moves from inland areas toward the marsh, where it provides freshwater flushing; thus, in most years, restoration likely would have little to no effect on groundwater salinity. In dry periods, when inland recharge is substantially diminished, there might be some potential for increased infiltration of saline waters into the shallow subsurface in Suisun Marsh. This would represent a return from the marsh's present condition to a more natural hydrologic pattern, representing an overall benefit. Aquifer stratigraphy in Suisun Marsh is not well documented, so it is unclear whether shallow infiltration could affect the producing aquifer. However, because wells in Suisun Marsh are not used for potable, municipal, or agricultural supply, even if producing aquifers were affected, there would be little or no effect on the use of well water.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact GEO-1: Potential to Create Unstable Cut or Fill Slopes

The proposed action would entail activities requiring fill placement and/or excavation, including but not necessarily limited to placement of locally obtained fill (dredge spoils) and raise levee crest elevations for purposes of managed wetland enhancement. Excavation for enhancement would be limited to the interior areas of managed wetlands and center channels of tidal sloughs. Fill would be applied mainly to improve both interior and exterior levees. Excavation would be limited by both volume and geographic location, thus minimizing risks of soil instability. Additionally riprap and other bank protection would be implemented to protect newly created or modified slopes from excessive instability and erosion. As a result, project activities are not expected to create unstable cut or fill slopes, and would likely benefit slopes in managed wetlands.

Conclusion: Less than significant. No mitigation required.

Impact GEO-2: Potential for Accelerated Soil Erosion

Soils in Suisun Marsh are clay-rich and are not highly erodible, but ground-disturbing activities would have the potential to increase rates and extent of soil erosion. However, managed wetland enhancement activities would not result in ground disturbance substantially above the currently implemented land management. Additionally, areas that may be disturbed within the managed wetlands are contained behind levees, water is not discharged until the wetlands are fully flooded, vegetation within the wetlands helps reduce suspended sediments, the low tide discharges are minimal compared to the total volume of the flooded managed wetland areas and area disturbed, and impacts related to the potential for accelerated soil erosion would be substantially avoided or minimized through BMPs required as part of the CWA permit conditions. As such, impacts are expected to be less than significant.

Conclusion: Less than significant. No mitigation required.

Impact GEO-5: Reduction in Availability of Natural Gas Resources

Several proved natural gas fields are located in or near the plan area, as shown in Figure 5.3-3 above. Enhancement activities would not change the current potential for natural gas extraction because there would be no changes in land use or other factors that would limit extraction potential.

Conclusion: No impact.

Impact GEO-7: Potential for Damage to Structures as a Result of Surface Fault Rupture, Groundshaking and/or Seismically Induced Ground Failure (Liquefaction)

The only three types of structures that would be constructed under the SMP are levees, duck blinds, and pump platforms. The principal concern related to surface fault rupture, groundshaking, and liquefaction would be the potential for structural damage, although injury and loss of life are also possible. As discussed in Geologic Hazards above, the westernmost end of the Suisun Marsh area is traversed by the active Concord and Green Valley faults, both of which are zoned by the State of California under the Alquist-Priolo Earthquake Fault Zoning Act. The eastern edge of the plan area also may be subject to surface fault rupture hazard along the Pittsburg−Kirby Hills fault zone, which is not zoned by the state but likely is also active. The area of Holocene Bay Mud substrate surrounding the Bay—which includes most of the area informally referred to as Suisun Marsh—is also at high risk of liquefaction in moderate and larger earthquakes. Both groundshaking and liquefaction have the potential to damage new project facilities.

If new levees, pump platforms, and duck blinds are constructed near the alignment of the active Concord or Green Valley fault, they could be at risk of damage as a result of surface fault rupture associated with this fault system. There also may be some potential for damage to pump station structures constructed along the Pittsburg−Kirby Hills fault zone.

Duck blinds would be small facilities, occupied only a few hours out of each hunting season month (October–November), and they likely would be exempt from the triggering criteria of the Alquist-Priolo Act, which applies to structures that have a human occupancy rate of more than 2,000 person-hours per year.

This slight increased risk of potential structural damage to new levees, duck blinds, and pump platforms would be in limited locations in the Marsh and would not be considered significant. Additionally, the placement of materials on levees would improve levee stability.

Conclusion: Less than significant. No mitigation required.

Impact GEO-8: Potential for Damage to Structures as a Result of Landslides, Including Seismically Induced Landslides

The project area is located in flat marshland topography, and as such the majority of the project area is not at risk of landslides. However, lands at the base of steep, slide-prone uplifts are in potential landslide runout areas; these include the strip along I-680 at the west edge of Suisun Marsh, and marshlands downslope from the western tip of the Potrero Hills. Any new project facilities constructed in such areas could be at risk of substantial damage with minor corollary risks to personal safety. However, few structures would be constructed in areas subject to damage from landslides, and because these structures generally are not occupied, there would not be a substantial change from current conditions with the implementation of Alternative A.

Conclusion: Less than significant. No mitigation is required.

Alternative B: Restore 2,000–4,000 Acres

Impacts under Alternative B would be very similar to those described for the proposed action, with the following principal differences.

- Alternative B would result in less extensive tidal restoration and could entail less major earthwork because less levee breaching would be required. However, the increased enhancement compared to Alternative A would result in more ground-disturbing activities in managed wetlands and dredging activities in channels. Additionally, there would be more levee improvements through increased enhancement. The level of significance of impacts described for Alternative A would be the same for Alternative B.
- Reduced tidal restoration likely also would decrease land use planning pressures identified as potentially unfavorable to mineral resources and natural gas extraction. This would be particularly true for mineral resources because of substantial reductions in proposed restoration in Regions 1, 2, and 4 (see Figure 5.3-4). The level of significance of impacts described for Alternative A would be the same for Alternative B.

Alternative C: Restore 7,000–9,000 Acres

Impacts under Alternative C would be broadly similar to those described for the proposed action, with the following principal differences.

- Alternative C would result in substantially more extensive tidal restoration than Alternative A, and would have greater potential for temporary soil instability due to levee breaching. Impacts related to ground disturbance, topsoil loss, and accelerated soil erosion in managed wetlands would be less than Alternative A, and still would be less than significant because the same environmental commitments and regulatory requirements identified for the proposed action (topsoil reuse, Erosion and Sediment Control Plan, SWPPP) would apply under Alternative C. The overall level of significance of impacts described for Alternative A would be the same for Alternative C.
- Increased extent of tidal restoration would increase land use planning pressures identified as potentially unfavorable to mineral resources and natural extraction (see Figure 5.3-4). The level of significance of impacts described for Alternative A would be the same for Alternative C.
- Increased extent of tidal restoration would increase the potential for impacts on shallow groundwater. However, impacts still are expected to be less than significant overall for the same reasons identified above for the proposed action.

Section 5.4
Flood Control and Levee Stability

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on flood control and levee stability.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting is intended to be directly or indirectly relevant to the subsequent discussion of impacts.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 5.4-1 summarizes impacts on flood control and levee stability from implementing the SMP alternatives. There would be no significant impacts on flood control and levee stability from implementing the SMP alternatives.

Table 5.4-1. Summary of Flood Control and Levee Stability Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
FC-1: Increased Potential for Catastrophic Levee Failure and Flooding Resulting from Restoration Activities That Expose Interior Levees to Tidal Action	A, B, C	Less than significant	None required	–
FC-2: Changes in Flood Stage and Flow Capacity in Suisun Marsh Channels as a Result of Increased Tidal Prism and Flood Storage Capacity	A, B, C	Beneficial	–	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
FC-3: Temporary Decrease in Levee Stability Resulting from Construction Activities	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
FC-4: Reduction in Potential for Catastrophic Levee Failure and Flooding Resulting from Improvements in Exterior Levee Maintenance	A, B, C	Beneficial	–	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- Suisun Marsh Charter Group Levee Conceptual Model—State of Knowledge, Draft Final (California Department of Water Resources 2005).
- Suisun Marsh Numerical Modeling, RMA (January 2008, PowerPoint).
- CALFED Suisun Marsh Levee Investigation Report (California Department of Water Resources 2000).
- DRMS Study Phase 1 Report (California Department of Water Resources 2007).
- Suisun Marsh Levee Evaluation (Ramlit and Associates 1983).

The Suisun Marsh is protected from tidal action and high water events by 200 miles of exterior levees. Several miles of interior levees are also maintained to separate land with differing uses and management practices. Exterior levees provide the Marsh with necessary flood protection and vehicle access. They also play a role in maintaining channels in the Marsh and thus have the potential to influence salinity in the Marsh and as far as the south Delta CVP and SWP diversions. Levees in the Marsh have not been constructed to an engineered standard nor have they been maintained to the standard of an urban or an agricultural levee.

The majority of Suisun Marsh, including wildlife habitat, is situated at or below mean tide elevation. Levees serve as the primary flood protection for Suisun Marsh lands, infrastructure, and natural resources. Exterior levees are used in conjunction with interior levees, ditches, and water control structures to retain, exclude, and direct water.

Where possible, levees were constructed on existing channel berms to take advantage of the existing natural topography throughout the Marsh. Levee configurations throughout the Marsh vary considerably in material composition, cross-sectional geometry, strength, and stability (California Department of Water Resources 2005).

Since the early 1800s levees were constructed primarily with dredged material removed from the adjacent channels. As levees have been maintained, some of the longstanding levees have increased in size as additional dredged material has been placed on the crown, seaward side, and landside. Due to regulatory constraints, options for maintaining Marsh levees are limited to the use of materials from within the managed wetlands or by very limited importation. Subsidence requires additional placement of material to raise and reinforce the levees.

Levee failures can result in flooding that can affect the regional salinity of the adjacent waterways, tidally restored sites, and managed wetlands. Historical flooding, including the flooding in 1998, prompted DWR to complete a levee breach analysis study to determine whether there was a correlation between levee failures in Suisun Marsh and salinity increases in the Delta. The study concluded that portions of the exterior levee system in Suisun Marsh may be important to controlling salinity. The August 1999 breach at the Sunrise Club on Chadbourne Slough (280 acres) is an example of a small breach (180 feet in width) that had localized impacts on salinity for adjacent landowners. Larger, region-wide breaches and flooding in the Marsh, as in 1998, can have water quality effects in the Delta that can affect SWP and CVP operations (California Department of Water Resources 1999, 2000, 2001).

While levee failure mechanisms are well understood, the mechanism causing a sudden failure is rarely able to be determined. Therefore, it is important to inspect levees and adequately maintain them to prevent failure. In Suisun Marsh, levee overtopping has been the historical failure mechanism (Chappell pers. comm.). (Overtopping is a systematic design failure which causes erosion that then breaches the levee as opposed to a breach caused by an internal structural failure of the levee.) As levees subside, the available freeboard (the distance between the high tide or flood elevation and the top of the levee) is reduced and the potential for overtopping is increased. Wave action and sea level rise also can reduce the effective freeboard. Over time, without maintenance all levees eventually will fail.

As described in Chapter 2, most if not all restoration activities will require some amount of levee improvements to ensure that adjacent properties are adequately protected from flooding. These upgrades will likely include levee raises and contouring, brush boxes, riprap, or other wave and wind protection.

Regulatory Setting

Federal

There are no federal mandates for flood control and levee stability in the Marsh.

State

There are no state mandates for flood control and levee stability in the Marsh.

Local

Suisun Resource Conservation District Levee Standards

In 1980, *SRCD's Management Program to Preserve, Protect, and Enhance the Plant and Wildlife Communities within the Primary Management Zone of the Suisun Marsh* was developed, and included minimum standards for levee design in the Marsh. These standards assume that the maximum water depth against an exterior levee is 7 feet above sea level and the maximum depth against an interior levee is 3 feet above sea level. The SRCD management program acknowledges that when these water elevation conditions are exceeded special design levee standards are required. Table 5.4-2 shows the applicable standards for typical exterior and interior levees.

Table 5.4-2. Applicable Standards for Typical Exterior and Interior Levees

Levee Type	Crown Width	Freeboard	Sideslopes
Exterior	12 feet	2 feet; 3 feet where wave action occurs	2:1
Interior	10 feet	1 foot minimum; if water depth is greater than 1 foot, freeboard should be equal to water depth and not exceed 3 feet	2:1

Suisun Marsh Levee Investigation Team

CALFED established the Suisun Marsh Levee Investigation Team (SMLIT) in 1998 to gather information on the costs and benefits of including Suisun Marsh levees in the CALFED Program, especially as they relate to CALFED Water Quality, Water Supply Reliability, and ERP goals. The SMLIT used computer models to evaluate hydrodynamics and salinity impacts of controlled and uncontrolled levee breaches in Suisun Marsh. The SMLIT final report was completed as the Suisun Marsh Charter process was initiated. The SMLIT agreed that implementation of their recommendations should be carried out within the context of the SMP. The SMLIT recommended:

- establishment of an interim plan that emphasizes development of an emergency response program,
- establishment of a base-level Marsh-wide maintenance program,
- establishment of a program for enhanced protection that is modeled on the current special flood control projects program and the special projects program,
- development of a criteria and evaluation methodology for acceptable parcel characteristics,
- establishment of an application of focused research toward an engineering strategy for levee breaching and maintenance,
- development of methods to obtain more accurate topographical data for Suisun Marsh for planning purposes,
- examination of sedimentation processes in the Marsh to explore possible means of creating sediment accretions throughout Suisun Marsh,
- inclusion of adaptive management techniques to pursue any tidal marsh conversion efforts,
- the addition of Suisun Marsh levees to the CALFED Levee Program Risk Assessment and Risk Management Strategy,
- funding for an emergency response element to address Suisun Marsh levees,
- structuring funding for improvements to Suisun Marsh levees to avoid competition with the already strained resources for the maintenance of levees currently included in the Delta Subventions Program,
- concurrent implementation of restoration and maintenance improvements, and
- focus first on lands in public ownership for habitat conversion opportunities.

Environmental Consequences

Assessment Methods

The RMA hydrodynamic and water quality model of the San Francisco Bay and the Delta (described in Appendix A) was used to predict changes in stage, velocity, and flow to compare alternative scenarios for Marsh restoration that impacts flood control and levee stability in Suisun Marsh.

Significance Criteria

Significance of impacts is determined by using significance criteria set forth in the State CEQA Guidelines and professional standards and practices. Impacts on flood risks are considered significant if implementation of an alternative would:

- significantly raise flood stage elevations along flood control levees;
- increase the frequency and duration of inundation on lands within the flood control area; 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 flood control levee.

Impacts on the levee system are considered significant if an alternative would substantially increase:

- seepage,
- levee settlement,
- wind erosion,
- scour,
- sediment deposition, or
- subsidence of land adjacent to levees.

In addition, an impact on the levee system is considered significant if an alternative would substantially decrease:

- levee stability;
- inspection, maintenance, or repair capabilities;
- current levee slope protection;
- emergency response capabilities;
- channel conveyance capacity; or
- ability of the levees to withstand seismic loading.

Environmental Impacts

No Action Alternative

The No Action Alternative would rely on the existing level of maintenance activities to inspect, assess, and maintain the exterior levee system. The inability to obtain permits for managed wetland activities, including levee maintenance, would further reduce the level of maintenance activities. Currently, maintenance efforts are not able to keep up with the current rate of levee degradation. Suisun

Marsh is already susceptible to flooding during major flood events, and continued wave erosion (fetch-generated and boat traffic) rates are putting several miles of exterior levees at risk for failure during less frequent flood events and potential "summer failure" (e.g., Jones Tract). If the No Action alternative is selected, the flood risk in Suisun Marsh would continue to increase as a result of deferred maintenance.

Alternative A: Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact FC-1: Increased Potential for Catastrophic Levee Failure and Flooding Resulting from Restoration Activities That Expose Interior Levees to Tidal Action

As a result of levee breaches and other actions that may be implemented as part of SMP tidal wetland restoration actions, interior levees may become exterior levees, thus increasing their exposure to tidal action for which they were not intended. To reduce the potential risk for failure of these levees, they would be improved to meet exterior levee standards. The Suisun Marsh exterior levee section standard requires a crown (top width) of 12 feet and 2:1 (H:V) side slopes. In addition, the levee must provide necessary freeboard above the 100-year flood. Necessary freeboard is described as 2 feet of freeboard under normal conditions and 3 feet of freeboard in wave-prone areas. The 100-year flood elevation is estimated at 10.0 feet NAVD 88. This datum should be compared against other tidal and survey datums in use in the Marsh prior to any levee evaluation. The 200 miles of exterior levee locations and any proposed "new" exterior levees associated with planned breaches will be evaluated to determine the proper freeboard requirement. Levee profile and crown surveys will be completed to determine compliance with the standard and identify areas needing improvements.

Additionally, benches, berms, and erosion protection such as brush boxes, vegetation, and riprap that would be included to establish a range of marsh habitats also would serve to protect the levee from wind and wave erosion. These improvements would be implemented prior to breaches that would expose them to tidal action to ensure that there is no point during which an unimproved interior levee is exposed to tidal action.

Conclusion: Less than significant. No mitigation required.

Impact FC-2: Changes in Flood Stage and Flow Capacity in Suisun Marsh Channels as a Result of Increased Tidal Prism and Flood Storage Capacity

The creation of additional tidal wetland habitat through breaching of existing exterior levees would increase the acreage of land available to draw tidal flows overland and increase flood storage capacity during storm events. This additional area would have varying effects on the adjacent waters that would supply flow to the tidal wetland areas. Preliminary hydraulic modeling suggests that the addition of tidal prism through the breaching of levees and restoration of tidal wetlands would reduce tidal stages in the adjacent channels and bays (Appendix A, "Numerical Modeling in Support of Suisun Marsh PEIR/EIS Technical Memorandum, March 2008"). The magnitude and extent of stage reduction would be dependent on the volume of additional tidal prism and the location within the Marsh.

This reduction in stage in channels adjacent to restoration areas likely would be a beneficial change relative to flooding, as the channels would have a greater carrying capacity during storm events, and levees within the restoration area would be improved to meet exterior levee standards, as described above.

Conclusion: Beneficial.

Impact FC-3: Temporary Decrease in Levee Stability Resulting from Construction Activities

During construction of new levee sections or rehabilitation of levees to bring them up to a minimum standard, the levee may be subject to ground shaking and increased ground pressures from heavy equipment or placement of fill. This additional loading may exceed the potential for the existing levee material or levee foundation material to support the levee section (i.e., shear strength) and may cause rapid settling or fracture of the levee section. As described in Chapter 2, specific project proponents will control construction equipment access and placement of fill to maintain acceptable loading based on the shear strength of the foundation material.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact FC-4: Reduction in Potential for Catastrophic Levee Failure and Flooding Resulting from Improvements in Exterior Levee Maintenance

The SMP includes a program to improve levee maintenance activities for exterior levees. This would be accomplished by increasing slope stability and reducing erosion, overtopping, and failure through placement of riprap or alternative bank protection measures, as well as modifying the heights of exterior levees, which would require dredging and importation of appropriate levee materials (e.g., mineral soils and clays). Depending on existing conditions, work may occur on the waterside slope, landside slope, or both. Improved levee stability would reduce the risk of catastrophic levee failure.

Conclusion: Beneficial.

Alternative B: Restore 2,000–4,000 Acres

Compared to Alternative A, this alternative includes more managed wetland activities that would accommodate the reduced restoration that leaves more exterior levees to be maintained. Less restoration also would lead to less need to bolster interior levees to meet exterior levee standards. Similarly, there would be fewer changes in tidal stage and muting. However, the level of significance for the impacts identified for Alternative A would be the same for Alternative B.

Alternative C: Restore 7,000–9,000 Acres

This alternative calls for more restoration than Alternative A, which reduces the need for some exterior levee maintenance, but the reduced application of managed wetland activities is not expected to change the overall flood protection improvements described in Alternative A. There would be more changes in tidal stage and muting; nonetheless, the level of significance for the impacts identified for Alternative A is the same for Alternative C.

Section 5.5
Sediment Transport

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on sediment transport.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 5.5-1 summarizes impacts on sediment transport from implementing the SMP alternatives. There would be no significant impacts on sediment transport from implementing the SMP alternatives.

Table 5.5-1. Summary of Sediment Transport Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
ST-1: Increased Scour in Bays or Channels Upstream and Downstream of Habitat Restoration Areas	A, B, C	Less than significant	None required	–
ST-2: Deposition of Sediment in the Restored Tidal Wetlands	A, B, C	Beneficial or Less than significant	None required	–
ST-3: Changes in Regional Sedimentation and Scour Patterns in Suisun Marsh	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Managed Wetland Activities Impacts				
ST-4: Increase in Erosion Adjacent to Dredging Sites	A, B, C	Less than significant	None required	–
ST-5: Increase in Deposition at Dredging Sites	A, B, C	Less than significant	None required	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- Draft Results for Discussion. RMA Suisun Marsh Models, January 2008 (PowerPoint) (RMA 2008).
- *Proposed Negative Declaration and Environmental Assessment/Initial Study for the Proposed Blacklock Restoration Project* (California Department of Fish and Game and Bureau of Reclamation 2006).
- *Conceptual Model Scalar Transport and Suisun Marsh Geometry: Implications of Tidal Marsh Restoration on Formerly Diked Wetlands. Suisun Marsh Planning* (California Department of Water Resources).

Suisun Marsh Sediment Supply

The Sacramento–San Joaquin River system in combination with the tidal influences of San Francisco Bay is the primary hydraulic and sediment transport source in Suisun Marsh. The Suisun Marsh sediment supply is influenced by the continuous input of SS from the Sacramento River, which can enter the Marsh through Montezuma Slough. However, tidal currents and wind-driven suspension of mudflats in Suisun Bay and the Marsh channels also provide a continuous source of suspended sediment. Local tributaries north of Suisun Marsh provide infrequent floodflows and sediment pulses that coincide with precipitation events in southern Solano County.

SS concentrations have been measured at several locations throughout Suisun Marsh. Ruhl and Schoellhamer (2004) measured SS concentrations at a shallow-water site (Honker Bay) and a deep-water channel (Mallard Island) from December 1996 through July 1997. They found similar temporal trends caused by tidal velocities and storm events at both the shallow-water and deep-channel sites. In December, SS was relatively low (25–50 mg/l) at both sites but increased following the first-flush winter storm event to 100–150 mg/l in Honker Bay and 50–100 mg/l at Mallard Island.

The Blacklock Restoration Project is located on Nurse Slough adjacent to Little Honker Bay and is a good example of how SS may be affected by restoration activities. DWR measured SS concentrations using optical backscatter sensors at two locations in Nurse Slough from December 2004 to April 2006 as part of background monitoring for the restoration plan. The SS data are displayed in Figure 5.2-5. The average SS concentration was about 100 mg/l. The SS concentrations were lowest, about 50 mg/l, in fall 2005. It appears that Suisun Bay and the Marsh channels have a reasonably high and relatively constant SS concentration of about 50 mg/l. This provides a large amount of particles for adsorbing metals and other potentially toxic chemicals and pollutants.

Suisun Marsh Sediment Transport

RMA has developed a two-dimensional (2-D) hydraulic model of San Francisco Bay and the Delta to assess the potential changes in Suisun Marsh hydrodynamics related to potential restoration scenarios (Appendix A). While this model does not calculate sediment transport or geomorphologic changes expected to occur in the channels and bays over time, it does provide changes in velocity that can be used to better understand how sediment may be mobilized and transported.

In general the Marsh channels could be considered to be in a state approaching equilibrium. Dredging of channels has been limited in scale over the last 10 to 15 years. Channels are accumulating sediment where channel velocities are low enough for sediment to settle out of the water column. Where channel velocities are higher, sediments are suspended and carried in the direction of flow until they settle out again. In addition, wind-driven wave action and boat wakes provide enough energy to re-suspend and mobilize sediment. Scour zones and depositional zones could be expected to remain the same into the future, unless the tidal prism (i.e., upstream tidal volume) or channel geometries in the Marsh are altered (i.e., restoration efforts change tidal prism, and dredging operations alter channel geometry).

Increasing tidal prism would involve breaching levees to provide additional tidal habitat directly connected to bays, sloughs, or channels in the Marsh. Sediment is expected to be carried through these breaches by tidal flows and deposited in the new tidal areas. These sediments would come from the available SS in the water column or from sediment that is mobilized by increased channel velocities or wave energy. Early predictions from the RMA 2-D model indicate that channel velocities will increase by 3 to 4 fps locally at levee breaches and sloughs that will convey increased tidal flows to the breach sites. The modeled velocity increases are localized and do not persist great distances upstream or downstream. Therefore, the sediment contributions from these increased velocities would be limited and may reach a new sedimentation equilibrium quickly. It would be expected that some channel or bank erosion would occur in the area of increased velocity if scour countermeasures or enlarged breach areas are not installed. Based on preliminary hydraulic modeling, it appears that tide-driven channel velocities will not increase enough to mobilize more sediment from the Marsh channels. Therefore, sediment supplies that are expected to deposit in the restoration areas will come from the existing sediment supply in the water column that results from wind/wave–driven re-suspending of sediments on nearby shallow mudflats or shallow water along the channel banks.

Environmental Consequences

Assessment Methods

Assessment of environmental impacts associated with sedimentation and scour has been accomplished through application of quantitative modeling (Appendix A). This modeling has been used to forecast the potential for, and patterns of, sedimentation and erosion in Suisun Marsh channels.

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 the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation off site or in areas not identified for deposition in the proposed restoration design.

Environmental Impacts

No Action Alternative

For the No Action Alternative, some restoration and natural levee breaching may occur. In these areas, existing sedimentation and/or scour rates could temporarily change. However, managed wetland activities would cease or decrease as a result of regulatory restrictions. Therefore, there would be no impacts.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact ST-1: Increased Scour in Bays or Channels Upstream and Downstream of Habitat Restoration Areas

As tidal restoration is implemented and areas are opened to tidal influences and floodflows, the adjacent waterways that supply the tidal water volume may experience increased velocities and have a greater potential to mobilize sediment. It is expected that each new levee breach would experience local scour as increased volumes of water pass through the opening on the tidal cycle and during flood events. Some adjacent channels would scour and increase their conveyance areas to supply additional tidal water volume to the new habitats. However, as part of the restoration design, breach locations would be selected to minimize scour and channel hydraulic changes. Also, as discussed in Chapter 2 under Environmental Commitments, site-specific hydraulic simulation modeling and scour analysis would occur. All final restoration designs would be simulated with the RMA model (or equivalent model) to verify that the effects of scour are minimized.

Conclusion: Less than significant. No mitigation required.

Impact ST-2: Deposition of Sediment in the Restored Tidal Wetlands

Breaching of levees and dikes would encourage natural deposition of sediment in the tidal wetland restoration areas. Removal of the levee or dike and restoring the tidal function to the managed wetland areas would create slow and shallow tidal flows. Under these conditions, SS from the water column typically will be deposited. The rate of deposition would depend on the residence time of tidal flow, depth of tidal flooding, and concentration and gradation of SS. Natural deposition within the tidal wetlands would restore a range of wetland elevations, providing the expected tidal habitat conditions.

Conclusion: Beneficial or less than significant. No mitigation required.

Impact ST-3: Changes in Regional Sedimentation and Scour Patterns in Suisun Marsh

The intent of the plan is to restore greater tidal function to Suisun Marsh. Breaching exterior levees and dikes that have allowed reclamation of historical marsh lands would return these lands to tidal marsh. The increased marsh area effectively would increase the tidal prism (i.e., the amount of water that can flood the marsh on the high tide). This increase in the tidal prism would increase local channel velocities and provide greater low-velocity tidal habitats in the restored wetland areas, which would change the overall sedimentation in Suisun Marsh.

Some channels may experience local scour attributable to increased velocity as more water travels to the restoration areas. In addition, the restoration areas would have greater capacity to trap or accept deposited sediments. Regionally, the channels in the Marsh would adjust to accommodate the higher restored tidal flow, but the channels would reach a new sedimentation equilibrium over time. Areas that typically are targeted for dredging likely would remain areas of deposition, so the local supply of sediments for levee maintenance and strengthening are not expected to be reduced.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact ST-4: Increase in Erosion Adjacent to Dredging Sites

Channel dredging would occur in center channels and would avoid emergent vegetation. As such, it is not expected to encroach on levee profiles or benches adjacent to levees. Although localized scour and deposition in the vicinity of dredging areas would be temporarily modified as dredged sites refill with sediment, it is not expected that channel erosion would be increased beyond what generally occurs in the dynamic (i.e., tidal) Marsh.

Conclusion: Less than significant. No mitigation required.

Impact ST-5: Increase in Deposition at Dredging Sites

Following dredging operations, the deeper channel sections would have the greatest potential for trapping deposited sediments, which may reduce depositional rates in adjacent channels or restored tidal habitat areas. As the entire sediment budget of the Marsh adjusts to restoration area sediment demands and changes in channel geometry attributable to restoration and dredging, sedimentation rates throughout the Marsh are expected to vary.

Conclusion: Less than significant. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres

Impacts for Alternative B would be the same as for Alternative A but to a lesser extent.

Alternative C: Restore 7,000–9,000 Acres

Impacts for Alternative C would be the same as for Alternative A but to a greater extent.

Section 5.6
Transportation and Navigation

Introduction

This section describes the existing transportation and navigation conditions and the consequences of implementing the SMP alternatives on transportation and navigation resources.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts. For example, the setting identifies transportation and navigation in the action area because the action could have an effect on transportation and navigation in the plan area.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 5.6-1 summarizes transportation and navigation impacts from implementing the SMP alternatives. There would be no significant impacts on transportation and navigation resources from implementing the SMP alternatives.

Table 5.6-1. Summary of Transportation and Navigation Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Patterns of Vehicular Circulation during Construction Activities	A, B, C	Less than significant	None required	–
TN-2: Temporary Increases in Road Hazards during Construction Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
TN-3: Damage to Roadway Surfaces from Construction Activities	A, B, C	Less than significant	None required	–
TN-4: Impacts to Air Traffic Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
TN-5: Impacts on Land Use Attributable to Restoration Activities within Travis Air Force Base Zone	A, B, C	Less than significant	None required	–
TN-6: Temporary Reduction in Boat Access during Construction Activities	A, B, C	Less than significant	None required	–
TN-7: Decrease in Rail Line Integrity and Disruption to Rail Service	A, B, C	Less than significant	None required	–
TN-8: Short-Term Reduction in Navigable Areas Resulting from Increased Velocities after Restoration Activities	A, B, C	Less than significant	None required	–
TN-9: Temporary Reduction in Boat Access during Dredging Activities	A, B, C	Less than significant	None required	–
TN-10: Increases in Navigable Areas of Suisun Marsh	A, B, C	Beneficial	–	–
TN-11: Operations and Maintenance Increase in Traffic	A, B, C	Less than significant	None required	–
Managed Wetland Activities				
TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Patterns of Vehicular Circulation during Construction Activities	A, B, C	Less than significant	None required	–
TN-2: Temporary Increases in Road Hazards during Construction Activities	A, B, C	Less than significant	None required	–
TN-3: Damage to Roadway Surfaces from Construction Activities	A, B, C	Less than significant	None required	–
TN-4: Impacts to Air Traffic Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
TN-5: Impacts on Land Use Attributable to Restoration Activities within Travis Air Force Base Zone	A, B, C	Less than significant	None required	–
TN-6: Temporary Reduction in Boat Access during Construction Activities	A, B, C	Less than significant	None required	–
TN-7: Decrease in Rail Line Integrity and Disruption to Rail Service	A, B, C	Less than significant	None required	–
TN-9: Temporary Reduction in Boat Access during Dredging Activities	A, B, C	Less than significant	None required	–
TN-11: Operations and Maintenance Increase in Traffic	A, B, C	Less than significant	None required	–

Affected Environment

Roadway Network

The primary regional roadways serving Suisun Marsh are located around the Marsh perimeter and include Interstate 80 (I-80) (Urban Interstate Freeway) and SR 12 (Rural Major Arterial) to the north, SR 4 to the south, and Interstate 680 (I-680) (Major Collector) to the west. I-80 connects Solano County to the San Francisco and Sacramento metropolitan areas. I-680 connects the county to the east Bay Area, and SR 12 and SR 4 act as major arterials connecting major urban areas (Figure 5.6-1).

Solano County maintains several roads in the interior Marsh that serve rural developments, managed wetlands and agricultural operations, and other uses in the Marsh. Table 5.6-2 lists these roads in relation to Suisun Bay. The Operations division of the Solano County Public Works Department surveys the roads every 2 weeks to assess public safety issues and need for any repairs. If major repairs are deemed necessary, a 5-year road improvement plan is implemented. The County also conducts annual surveys to measure major road damage and repair needs. The plan area can be accessed via some combination of the local roadways listed below. There are also many roads within the Marsh that are privately owned and maintained. The key local roadways in the Marsh are shown in Figure 5.6-2.

Table 5.6-2. Local Roads in Suisun Marsh

North of Suisun Bay *East of I-80/I-680 and South of SR 12*	**Northeast of Grizzly Bay**	**East of Montezuma Slough**
• O’Rher Road	• Van Sickle Road	• Lambie Road
• Cordelia Road	• Grizzly Island Road	• Flannery Road
• Chadbourne Road	• Redhouse Road	• Little Honker Road
• Thomasson Lane	• Potrero Hill Lane	• Olsen Road
• Ramsey Road	• Killdeer Road	• Birds Landing Road
• Goodyear Road	• Scally Road	• Montezuma Hills Road
• Jacksnipe Road	• Rio Vista Road	• Coleville Road
• Pierce Harbor Lane	• Nurse Slough Road	• Fire Truck Lane
• Morrow Lane	• Explosive Technology Road	
• Lake Herman Road		

Rail

The Union Pacific Railroad (UPRR) runs through the western portion of the Marsh and carries freight cars between Bay Area ports and the rest of the country (Figure 5.6-1). The Capitol Corridor (Amtrak) uses the UPRR line and has a station in Suisun City. This passenger line connects regionally and nationally (Solano County General Plan 2008, T-17). The California Northern Railroad runs a short line freight service. They lease 250 miles of Union Pacific Railroad tracks from Suisun City to Schellville and other areas (California Northern Railroad Company no date).

The Concord Naval Weapons Station is located along the southern perimeter of Suisun Bay, immediately south of Ryer Island and north of SR 4 (Figure 5.6-1). The station houses three commercial class 1 railroads (GlobalSecurity.org 2008).

Boats

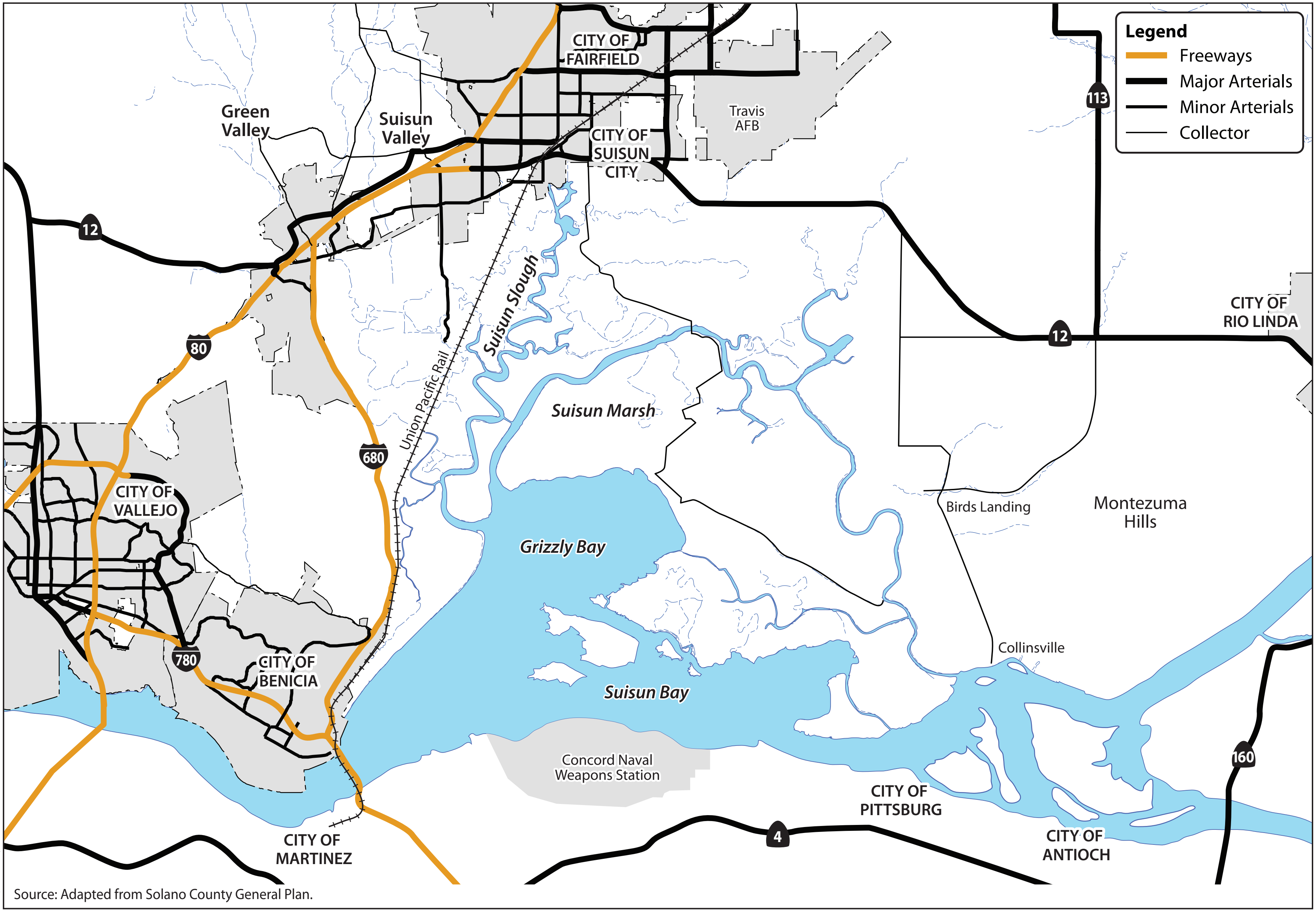
Suisun Bay is a major navigational and recreational water body and serves as the entrance to the Delta. Suisun Marsh is a 102,053-acre marsh with many navigable channels throughout. Figure 5.6-3 shows the major surface waters in and around the Marsh. Bays and minor and major sloughs comprise 26,980 acres of navigable channels (Table 6.2-2, “Suisun Marsh Acreage by Habitat Type and Region”). The two major channels are Montezuma and Suisun Sloughs. Suisun Slough runs from Grizzly Bay to the northern portion of the Marsh, and Montezuma Slough runs from the eastern side of Grizzly Bay to the western side, with several smaller channels diverging from it. Other navigable waterways are Cordelia, Denverton, Nurse, and Hill Sloughs.

Most of the Marsh is navigable by small boats, and some channels, such as Montezuma and Suisun Sloughs, are navigable by much larger boats. A major navigation channel is the Suisun Bay channel, which connects to the Carquinez Strait.

As described in the Recreation section, launching locations in the Marsh include Suisun City boat ramp, Suisun City Marina, and Solano Yacht Club, all located in Suisun Slough, Belden’s Landing located in Montezuma Slough, and McAvoy Yacht Harbor and Yacht Club, located on Suisun Bay at Bay Point. In addition, there are marinas on the Contra Costa shoreline near Pittsburg and Antioch that provide access to Suisun Bay. Most boating in the Marsh is recreational such as fishing, water and jet skiing, kayaking, and canoeing (See Section 7.4, Recreation). Most of the sloughs are narrow, and when tides recede, the sloughs become shallow, limiting some access.

Aviation Facilities

Travis Air Force Base (AFB) is located approximately 1 mile from the northern boundary of the SMP area (on the northeast side of SR 12). Travis AFB handles more cargo and passengers than any other military air terminal in the United States and is home to the 60^{th} Air Mobility Wing, the largest air mobility organization in the United States Air Force (Figure 5.6-1).



Source: Adapted from Solano County General Plan.

Graphics/Projects/06888.06/ 6-EIS-EIR (09-10)

ICF INTERNATIONAL

Figure 5.6-1
Major Highways, Rail Lines, and Aviation Facilities Surrounding Suisun Marsh

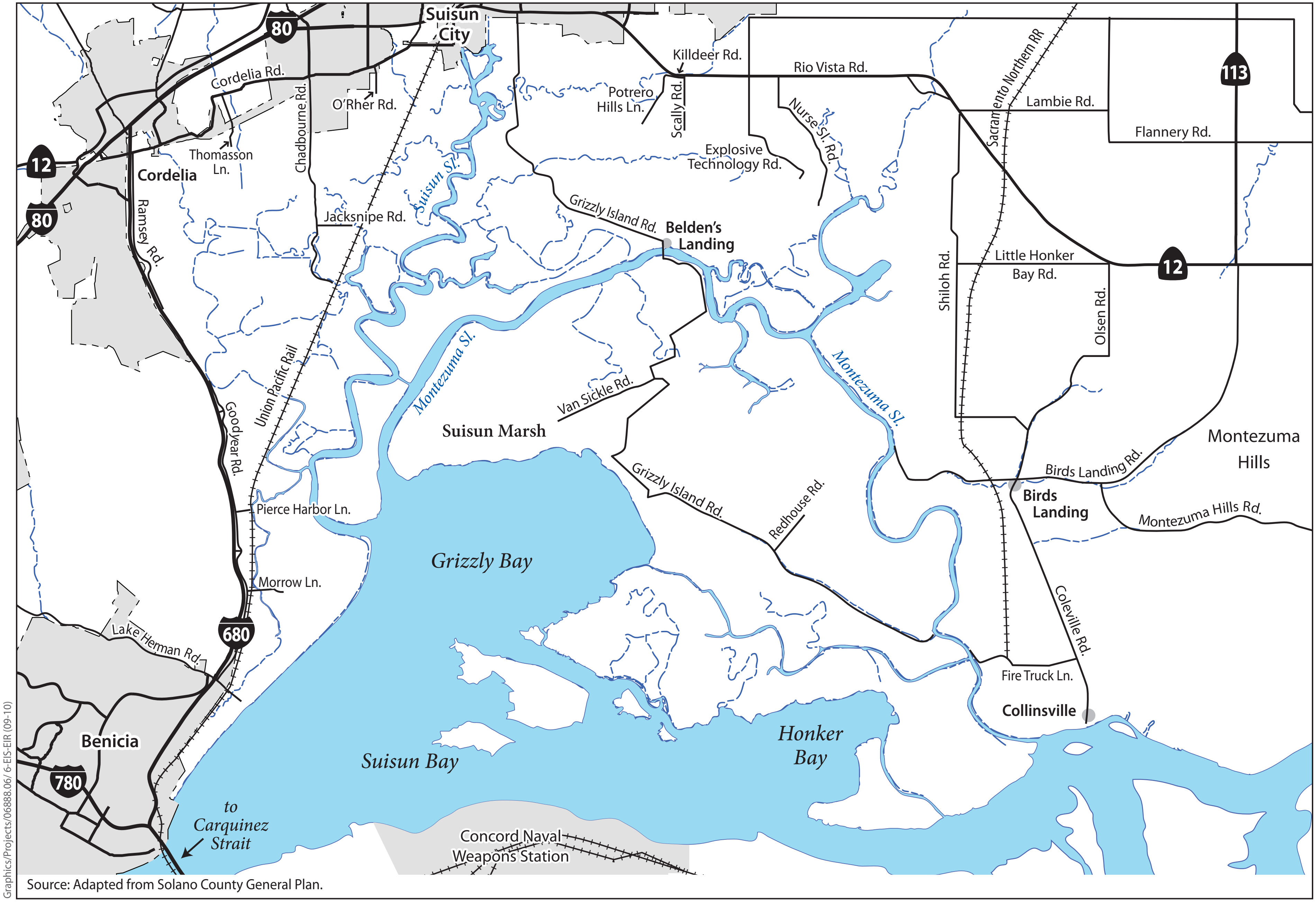
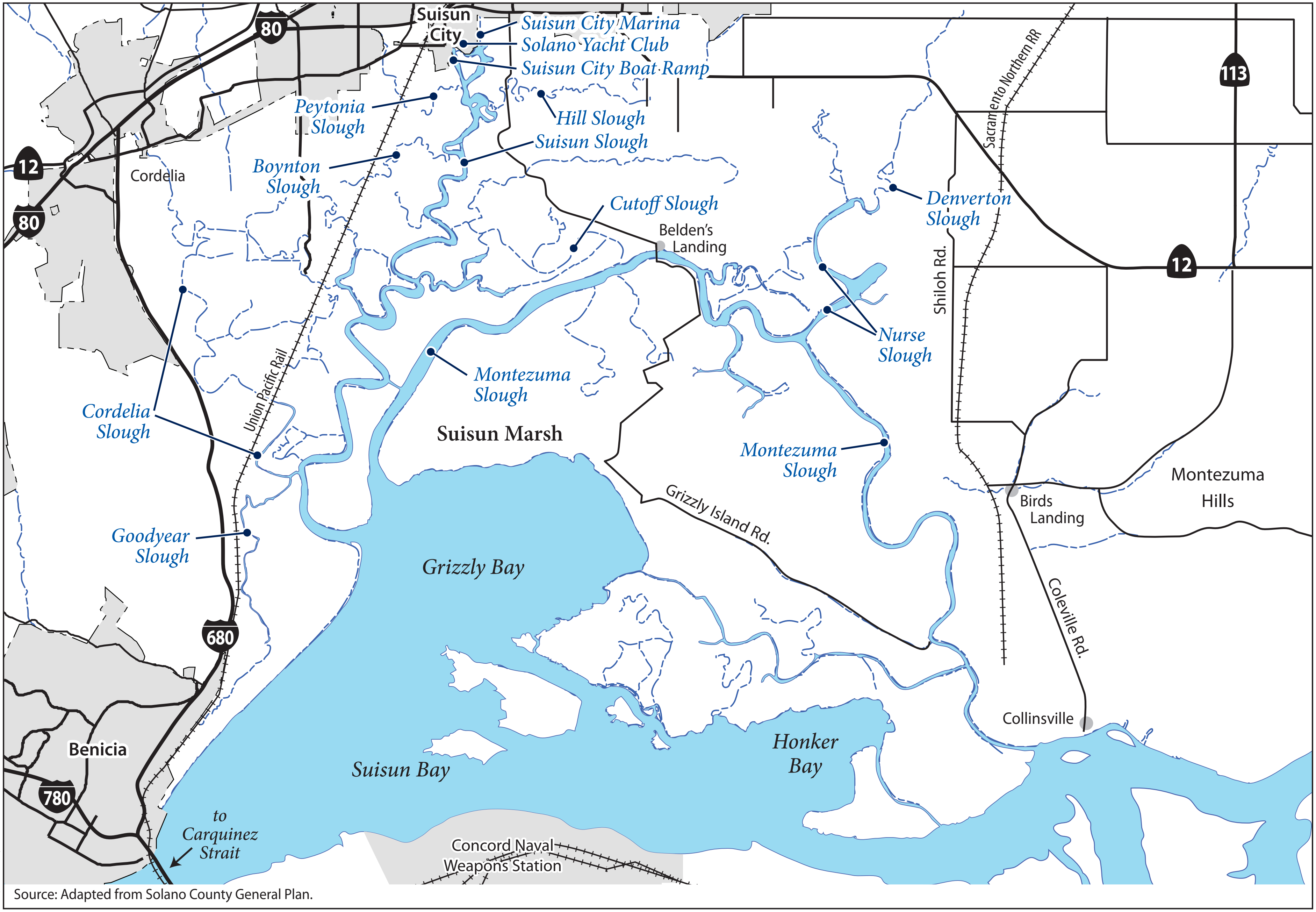


Figure 5.6-2
Local Roadways in and around Suisun Marsh



Source: Adapted from Solano County General Plan.

Graphics/Projects/06888.06/ 6-EIS-EIR (09-10)

ICF INTERNATIONAL

Figure 5.6-3
Surface Waters in and around Suisun Marsh

The Concord Naval Weapons Station, the location of which is described in the Rail section, above, currently has three commercial air terminals and three military air terminals (GlobalSecurity.org 2008).

Sources of Information

The following key sources of information were used in the preparation of this section:

- Solano County General Plan, Land Use and Circulation Element (Solano County Planning Department 1992), and
- City of Suisun City—Wal-Mart Walters Road West Project Draft EIR (Michael Brandman Associates 2008).

Regulatory Setting

Federal

Federal Aviation Administration

Standards for airport and air traffic safety and service are under the jurisdiction of the Federal Aviation Administration (FAA). The FAA's guidance regarding prevention of bird airstrike hazard (BASH) addresses land uses such as waste disposal operations, water management facilities, wetlands, dredge spoil contaminant areas, agricultural activities, golf courses, and landscaping near airports that could attract wildlife. BASH is addressed in Advisory Circular 150/5200-33B Hazardous Wildlife Attractants on or near Airports (Federal Aviation Administration 2007), which recommends setbacks from airport operations. Depending on the aircraft type (piston or turbine-powered) distances regulated by BASH range from 5,000 feet (0.93 mile) to 10,000 feet (1.86 miles) from air operations areas. For all airports, the FAA recommends a perimeter of 5 miles from air operations area for approaching and departing aircraft. The Advisory Circular also recommends that the FAA be given the opportunity to review proposed land uses and evaluate their effects on aviation safety. Based on its review, FAA may request implementation of appropriate management measures to reduce potential hazards to aircraft.

Local

Solano County Transportation Authority

The Solano County Transportation Authority sets forth various goals, objectives, and policies that would apply to projects in the county. Applicable goals, objectives, and policies from the Arterials, Highways, and Freeways Element of the Solano Comprehensive Transportation Plan, dated June 2005, that are applicable to the proposed project include:

- Objective A—Preserve the System: Preserve the physical and operational condition of existing roadway facilities as a means of protecting past transportation investments and maintaining an effective system.
- Policy 1: Encourage member jurisdictions and Caltrans to maintain level of service (LOS) E or better conditions during the a.m. and p.m. peak hours on roadways of countywide significance.

Solano County Airport Land Use Commission

The Solano County Airport Land Use Commission regulates land use around Travis AFB by recommending to cities that projects in their jurisdictions comply with the Travis AFB Land Use Compatibility Plan. The plan identifies land use compatibility policies applicable to future development near Travis AFB. The policies are designed to ensure that future land uses in the surrounding area will be compatible with potential aircraft activity at the base. In certain circumstances, local governments have the ability to override the decisions of the Airport Land Use Commission.

The Travis Air Force Base Land Use Compatibility Plan prohibits land uses that would create glare or distracting lights; sources of dust, steam, or smoke; sources of electrical interference with aircraft communications or navigation; or any land use (e.g., landfills) that may attract an increased number of birds. Land has been acquired to the north and east of Travis AFB and is reserved for open space or future base expansion. Areas surrounding Travis AFB are also designated as Zones A, B1, B2, C, and D (Figure 7.1-3). Compatibility Zone D, in which Suisun Marsh is located, includes all other locations beneath any of the Travis AFB airspace protection surfaces delineated in accordance with Federal Aviation Regulations Part 77. Limitations on the height of structures are the only compatibility factors within this zone.

Solano County General Plan

Cities and counties are responsible for planning, designing, constructing, operating, and maintaining local public roadways within their jurisdictions. The Solano County General Plan Circulation Element informs and describes the existing and future circulation conditions in unincorporated sections of Solano County (Solano County 2008).

According to the *Road Improvement Standards and Land Development Requirements*,

> the goal of Solano County is to maintain a Level of Service C on all roads and intersections. In addition to meeting the design widths and standards contained in this document, all projects shall be designed to maintain a Level of Service C, except where the existing level of service is already

below C, the project shall be designed such that there will be no decrease in the existing level of service.

Solano County will issue an encroachment permit whenever construction activities would be conducted within the public right-of-way. Encroachment permits are intended to safeguard the affected jurisdictions' properties, by providing either preventive measures to be implemented during project construction or corrective measures if damage occurs.

Any encroachment within the right-of-way of a state highway or route would be subject to Caltrans regulations, including issuance of an encroachment permit and the provision of temporary traffic control systems. Such a system could include traffic control warning signs, lights, and/or safety devices to ensure the safety of the traveling public.

Environmental Consequences

Assessment Methods

The impacts resulting from SMP alternatives have been assessed based on assumptions about construction-related traffic and navigational disruptions in the plan area. It is assumed that construction of the various SMP alternative components would occur over the 30-year SMP implementation period and would be intermittent. The types and numbers of equipment in use at one time cannot be determined at this time, but it is assumed that minimal overlap in major restoration or managed wetland activities would occur. However, specific projects may require further analysis to describe in more detail any potential impacts on traffic resulting from implementation of that specific project. The SMP alternatives are compared to the No Action Alternative, and that potential change in transportation and/or navigation is described. The significance of potential changes is determined based on the significance criteria described below. Mitigation measures are recommended, as necessary, to reduce significant transportation and navigation impacts.

While described as a planning tool, existing and potential LOS resulting from Plan implementation is not included because there would be no permanent impacts from roadway modifications and construction impacts would be minimal and short-term. Except for during construction activities, additional vehicle trips would be minimal and are not expected to change vehicle/capacity ratios noticeably.

Significance Criteria

For the purposes of this analysis, a significant traffic impact would occur if the implementation of an SMP alternative would:

- cause traffic operations on a roadway or at an intersection to degrade (e.g., because of increased traffic generated by construction vehicles and/or loss of a travel lane to accommodate the construction work zone);
- cause a substantial increase in traffic relative to the traffic volume of the local traffic network;
- result in lengthy delays for transit riders;
- result in an inadequate parking capacity;
- substantially impede access to local streets or adjacent uses, including emergency access;
- substantially increase hazards because of a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment);
- conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks); or
- cause temporary or permanent disruption of rail operations.

For the purposes of this analysis, a significant air traffic impact would occur if implementation of an SMP alternative would:

- result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that would result in substantial safety risks;
- conflict with the recommendations of the FAA's Advisory Circular 150/5200-33B (Federal Aviation Administration 2007) by creating bird habitat within 5,000 feet of airports serving piston-powered aircraft and/or 10,000 feet of airports serving turbine-powered aircraft; or
- conflict with designated land use zones within Travis AFB.

For the purposes of this analysis, a significant navigation impact would occur if implementation of an SMP alternative would:

- substantially impede or block navigational craft;
- create safety conflicts in Delta waterways; or
- reduce the navigable area of the Marsh.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, limited restoration activities would occur. Traffic generated by private property owners and recreational users would continue to circulate locally within the plan area and on roadways adjacent to the plan area similar to current conditions. Thus, it is not expected that impacts on LOS at major intersections and roadway segments adjacent to and within the plan area would occur.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Patterns of Vehicular Circulation during Construction Activities

Implementation of the proposed action could result in impacts associated with construction of the various SMP components that would require the use of construction equipment and potentially the importation of fill and other materials. Construction-related impacts could result from trips made by construction equipment and workers to and from a project site. Construction activities associated with implementing the SMP are the major impact mechanism for transportation effects, particularly construction equipment and the importation of soil, plantings, and other materials. During critical construction periods, public access would be restricted or controlled.

Material may be brought to a project area by barge and/or by truck. In addition, short-term construction traffic would consist of the transport of the work crew, and construction trucks delivering equipment and materials. Substantial amounts of fill hauled in to project areas by trucks, as well as other construction-related equipment and worker vehicles, could result in adverse impacts on transportation, including rail and public transit, depending on the number of trucks, total truck trips, and roadways used.

It is anticipated that the average restoration project would require up to 10 roundtrip truck trips and 10 worker trips a day for up to 30 days. The routes would be designed to ensure total loads and capacities are not exceeded. As shown in Figure 5.6-2, the primary roads that would be used for entry into the Marsh are Grizzly Island Road, Chadbourne Road, Shiloh Road, and Birds Landing Road. All of these roads dead-end in the Marsh, and there is no traffic beyond that generated by visitors to the Marsh. These roads are rural connector roads that operate at a high LOS, except during busy recreational events in the Marsh, such as opening day of duck hunting season. As described in Chapter 2, no major construction activities would occur on days known or expected to have a significant increase in traffic as a result of events in the Marsh. As such, the short-term addition of these additional trips is not expected to affect circulation on roads in the Marsh. Arterial roads and highways would not be affected by an additional 20 roundtrips per day of construction vehicles and worker trips.

Some smaller restoration activities would not generate traffic that would cause a substantial increase in the number of vehicles on the road or changes in circulation. However, for those projects that have the potential to result in significant traffic impacts, a traffic control plan, as described in the environmental commitments section of Chapter 2, will be implemented to ensure that impacts related to traffic during construction are minimal and less than significant.

Conclusion: Less than significant. No mitigation required.

Impact TN-2: Temporary Increases in Road Hazards during Construction Activities

The majority of the proposed project would be constructed away from existing major road networks and areas of residential or urban development. As such, the likelihood of accidents involving construction equipment resulting in potentially dangerous situations for the general public is low. The potential for hazards depends on the type of equipment and roadways used, as well as roadway conditions. Increased hazards would occur when roads are narrower or have other characteristics that make maneuvering difficult, equipment is larger and/or more difficult to maneuver, or roadways used include those that are used by the general public to access various areas of the Marsh. Restoration design planning will take into account access to the site, but potential road hazards may remain. As such, a traffic control plan will be implemented for each major site-specific action that has the potential to create a significant hazard to ensure that such risks are minimized or eliminated.

Conclusion: Less than significant. No mitigation required.

Impact TN-3: Damage to Roadway Surfaces from Construction Activities

Implementing the proposed project would require the transport of construction equipment and material, including but not limited to long-reach excavators, excavators, dozers, box scrapers, tractors, pipes, riprap, etc. Some roads within the Marsh may not be designed to accommodate such traffic, and therefore, there is potential for damage to roads by construction activities, construction vehicles, and transport of equipment. As described in the Environmental Commitments section of Chapter 2, the specific project proponent will conduct pre- and post-construction assessments of roadways to determine whether any roads are damaged during construction of the SMP alternatives. If damage is found, and is determined to be attributable to the SMP action, the damage will be repaired through an MOU with Solano County.

Conclusion: Less than significant. No mitigation required.

Impact TN-4: Impacts to Air Traffic Attributable to Restoration Activities

Implementation of the SMP alternatives include restoring tidal marsh habitat, which could result in more diversity of birds and other wildlife to the Suisun Marsh area than currently are present. The total acres of wetlands in the Marsh would be similar to existing conditions, but there would be shifts in the types of wetlands. In some instances, additional wetlands may be created on the periphery of tidal wetlands through inundation of upland areas. Compared to the existing tidal marsh and managed wetland acreage, the overall increase in acreage of these habitats would not significantly change wildlife or bird usage of the Marsh. Additionally, restoration and managed wetland activities would occur far enough away from the airport that bird activity would not affect air traffic patterns.

Conclusion: Less than significant. No mitigation required.

Impact TN-5: Impacts on Land Use Attributable to Restoration Activities within Travis Air Force Base Zone

As discussed above under Solano County Airport Land Use Commission, Suisun Marsh restoration would occur in Zone D under the Travis Air Force Base zoning areas. Zone D compatible land use is restricted only by the height of features that would be built. None of the proposed SMP activities are expected to result in major structures that would be considered tall enough to conflict with the Zone D land use.

Conclusion: Less than significant. No mitigation required.

Impact TN-6: Temporary Reduction in Boat Access during Construction Activities

Implementation of the SMP alternatives would include in-channel work related to restoration. In-channel work may require the reduction of some channel area available for boating and other navigation. It is expected that in-channel work related to levee breaching for restoration, specifically dredging or levee repair, would be conducted sporadically throughout the Marsh over the 30-year period, would be temporary, and would not result in permanent reductions in navigable areas. The only major navigational channel is located in Suisun Bay, and plan activities are not expected to affect this area.

Additionally, as described in the environmental commitments section of Chapter 2, specific project proponents would develop and implement a traffic and navigation control plan in coordination with affected jurisdictions and emergency service providers to reduce construction-related effects and hazards in the waterway during the construction period, including postings warning boaters of construction activities in compliance with the California Uniform State Waterway Marking System.

Conclusion: Less than significant. No mitigation required.

Impact TN-7: Decrease in Rail Line Integrity and Disruption to Rail Service

Restoration or other activities could affect the integrity of levees holding the rail line for the Union Pacific Railroad by causing increased inundation and erosion, depending on the specific location and type of SMP activities implemented. Breaches will be designed to avoid levees where rail lines sit. Restoration activities will be designed to protect rail lines. Work occurring within a particular right-of-way determined by the railroads may result in delays or other temporary disruptions to rail service, depending on the type of activities implemented. As described in the environmental commitments section of Chapter 2 under the Traffic and Navigation Control Plan, specific project proponents will coordinate with the Union Pacific Railroad prior to beginning any work within a right away of a rail line to ensure that the integrity of the rail line is maintained and to minimize disruptions to service.

Conclusion: Less than significant. No mitigation required.

Impact TN-8: Short-Term Reduction in Navigable Areas Resulting from Increased Velocities after Restoration Activities

Levee breaches associated with restoration activities could result in changes in velocities adjacent to the breach location (see Section 5.1, Water Supply, Hydrology, and Delta Water Management, and Section 5.5, Sedimentation Transport.) Increased velocities in these areas are expected to be temporary and localized to the immediate breach site location but could interfere with navigation by temporarily creating areas within the Marsh that are unsafe or not navigable. If such an impact occurs, it is expected to be temporary and minimal and would not interfere substantially with the ability of boats or other watercraft to maneuver through the Marsh area. Additionally, as described in Chapter 2, these areas will be marked to warn boaters of risks and direct them to a safe alternate route.

Conclusion: Less than significant. No mitigation required.

Impact TN-9: Temporary Reduction in Boat Access during Dredging Activities

Dredging from major and minor tidal sloughs and bays over the 30-year SMP implementation period, with the first 10 years as the most intensive period, could result in temporary reductions in boat access in isolated areas throughout the Marsh. Clamshell dredging could occur either from a barge within the channel or from the top of a levee, depending on restrictions caused by channel width or existing vegetation. From a barge, clamshell dredges would require a small tugboat to maneuver within the channel, resulting in a substantial area of the channel occupied by dredging equipment, depending on the width of the channel and the size of the barge. Dredging from the levee crown generally would require less channel space, but restrictions on boating in the immediate area still would be in place. Once dredging is complete, no further restrictions would be implemented. Dredging activities therefore would result in a temporary reduction in boat access, especially within the first 10 years of SMP implementation. Dredging would be temporary and spread throughout the Marsh area over the 30-year implementation period. It is not expected that a substantial number of individual projects or activities would be implemented at the same time, and therefore it is not expected that in-channel work would disrupt boat access in more than a minor area of the Marsh at any given time.

As described in the environmental commitments section of Chapter 2, specific project proponents would develop and implement a traffic and navigation control plan in coordination with affected jurisdictions and emergency service providers to reduce construction-related effects and hazards in the waterway during the construction period. The navigational signage environmental commitment described in Chapter 2 also would help to ensure that there are no substantial disruptions.

Conclusion: Less than significant. No mitigation required.

Impact TN-10: Increases in Navigable Areas of Suisun Marsh

Under the proposed project, the restoration of approximately 5,000 to 7,000 acres of tidal marsh would lead to an increase in the navigable areas of Suisun Marsh. The total increase in navigable areas depends on which areas are restored, beginning elevations, sedimentation rates, and sea-level rise. Some restored areas may begin with large navigable areas, but as sediment accumulates, water becomes shallow and the navigable area is reduced. Regardless, it is expected that there would be a net increase in navigable areas compared to existing conditions.

Conclusion: Beneficial.

Impact TN-11: Operations and Maintenance Increase in Traffic

Upon completion of construction of restoration, minimal traffic would be generated. There could be some monitoring efforts, but the associated increase is not expected to be noticeable. Additionally, it is not expected that the shift in habitat types would generate new trips.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact TN-1: Temporary Addition of Vehicles to Roadway System and Alteration of Patterns of Vehicular Circulation during Construction Activities

Impacts to the roadway system as a result of managed wetland activities would be similar to those described for restoration activities, but to a lesser extent. Most managed wetland activities would not generate traffic that would cause a substantial increase in the number of vehicles on the road or changes in circulation. A traffic control plan will be implemented to ensure that construction-related traffic impacts are minimal and less than significant.

Conclusion: Less than significant. No mitigation required.

Impact TN-2: Temporary Increases in Road Hazards during Construction Activities

Increases in road hazards as a result of managed wetland activities would be similar to those described for restoration activities, but to a lesser extent. In general, the increased frequency of current and the implementation of new managed wetland activities is not expected to require a substantial number of equipment pieces imported to the Marsh during any one period. Restoration actions have the highest potential to increase road hazards.

Conclusion: Less than significant. No mitigation required.

Impact TN-3: Damage to Roadway Surfaces from Construction Activities

This impact would be similar to that described for restoration activities. Certain marsh management activities would require the transport of construction equipment and material, including but not limited to long-reach excavators, tractors, pipes, riprap, etc. There is potential for damage to roads by construction activities, construction vehicles, and transport of equipment. As described in the Environmental Commitments section of Chapter 2, the specific project proponent will conduct pre- and post-construction assessments of roadways to determine whether any roads are damaged during construction of the managed wetland activities. If damage is found, and is determined to be attributable to the managed wetland activity, the damage will be repaired by the County through an MOU between the land owner conducting the managed wetland activity and Solano County.

Conclusion: Less than significant. No mitigation required.

Impact TN-4: Impacts to Air Traffic Attributable to Restoration Activities

This impact would be similar to that described for restoration activities. Enhancing managed wetlands could result in more diversity of birds and other wildlife to the Suisun Marsh area than currently are present. However, compared to the existing tidal marsh and managed wetland acreage, the overall increase in acreage of these habitats would not significantly change wildlife or bird usage of the Marsh. Additionally, managed wetland activities would occur far enough away from the airport that bird activity would not affect air traffic patterns.

Conclusion: Less than significant. No mitigation required.

Impact TN-5: Impacts on Land Use Attributable to Restoration Activities within Travis Air Force Base Zone

This impact would be the same as that described for restoration activities. Managed wetland activities would occur in Zone D under the Travis Air Force Base zoning areas. Zone D compatible land use is restricted only by the height of features that would be built. None of the proposed SMP activities are expected to result in major structures that would be considered tall enough to conflict with the Zone D land use.

Conclusion: Less than significant. No mitigation required.

Impact TN-6: Temporary Reduction in Boat Access during Construction Activities

This impact would be similar to that described for restoration activities. Implementation of the SMP alternatives would include in-channel work related to managed wetland activities, which may require the reduction of some channel area available for boating and other navigation. It is expected that in-channel work related to activities for managed wetland activities, specifically dredging or levee repair, would be conducted sporadically throughout the Marsh over the 30-year period, would be temporary, and would not result in permanent reductions in navigable areas. The only major navigational channel is located in Suisun Bay, and plan activities are not expected to affect this area.

Conclusion: Less than significant. No mitigation required.

Impact TN-7: Decrease in Rail Line Integrity and Disruption to Rail Service

This impact would be similar to that described for restoration activities. Activities associated with wetland management will not impact rail lines. As described in the environmental commitments section of Chapter 2 under the Traffic and Navigation Control Plan, specific project proponents will coordinate with the Union Pacific Railroad prior to beginning any work in the right of way of a rail line to ensure that the integrity of the rail line is maintained and to minimize disruptions to service.

Conclusion: Less than significant. No mitigation required.

Impact TN-9: Temporary Reduction in Boat Access during Dredging Activities

This impact would be the same as that described for restoration activities. Dredging from major and minor tidal sloughs and bays could result in temporary reductions in boat access in isolated areas throughout the Marsh, especially within the first 10 years of SMP implementation.

It is not expected that a substantial number of individual projects or activities would be implemented at the same time, and therefore it is not expected that in-channel work would disrupt boat access in more than a minor area of the Marsh at any given time. Additionally, as described in Chapter 2, alternate boating routes will be identified if dredging impedes navigation. Furthermore, the majority of the managed wetland activities would be conducted on private lands. Therefore, there would be no substantial disruption to boat access during dredging activities.

Conclusion: Less than significant. No mitigation required.

Impact TN-11: Operations and Maintenance Increase in Traffic

This impact would be similar to that described for restoration activities. Minimal traffic would be generated. There could be some increase in traffic during monitoring efforts, but the associated increase is not expected to be noticeable.

Conclusion: Less than significant. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres

Impacts for Alternative B are similar to those described for Alternative A. There would be less tidal restoration, and more managed wetland subject to managed wetland activities. The magnitude and types of impacts resulting from Alternative B would be similar to those described above for Alternative A, except that there would be fewer benefits related to navigation because less tidal restoration would occur. Additionally, there would be fewer large construction projects related to restoration and less potential to result in changes in circulation, increased hazards, or road damage. Compared to the No Action Alternative, Alternative B would result in less-than-significant impacts related to traffic circulation, increased traffic, road and air traffic hazards, and roadway damage and beneficial impacts related to increases in navigable areas.

Alternative C: Restore 7,000–9,000 Acres

Impacts for Alternative C are similar to those described for Alternative A. There would be more tidal restoration, and less managed wetland subject to managed wetland activities. The magnitude and types of impacts resulting from Alternative C would be similar to those described above for Alternative A, except that there would be additional benefits related to navigation as more tidal restoration would occur. Additionally, there would be more large construction projects related to restoration and more potential to result in changes in circulation, increased hazards, or road damage. Compared to the No Action Alternative, Alternative C would result in less-than-significant impacts related to traffic circulation, increased traffic, road and air traffic hazards, and roadway damage and beneficial impacts related to increases in navigable areas.

Section 5.7
Air Quality

Introduction

This section describes the existing conditions and the consequences of implementing the SMP alternatives on air quality.

Summary of Impacts

Table 5.7-1 summarizes impacts on air quality from implementing the SMP alternatives. There would be no significant impacts on air quality from implementing the SMP alternatives.

Table 5.7-1. Summary of Impacts on Air Quality

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
AQ-1: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Restoration	A, B, C	Significant	AQ-MM-1: Limit Construction Activity during Restoration AQ-MM-2: Reduce Construction NO_X Emissions AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures	Less than significant
AQ-2: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Current Management Activities	A, B, C	Significant	AQ-MM-2: Reduce Construction NO_X Emissions AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures	Less than significant
AQ-3: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with New Management Activities	A, B, C	Less than Significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
AQ-4: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Restoration and Management Activities Combined	A, B, C	Significant	AQ-MM-1: Limit Construction Activity during Restoration AQ-MM-2: Reduce Construction NO_X Emissions AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures AQ-MM-4: Limit Construction Activity during Restoration and Management	Less than significant
AQ-5: Construction-Related Diesel Health Risk Associated with Restoration	A, B, C	Less than significant	None required	–
AQ-6: Construction-Related Diesel Health Risk Associated with Current Management Activities	A, B, C	Less than significant	None required	–
AQ-7: Construction-Related Diesel Health Risk Associated with New Management Activities	A, B, C	Less than significant	None required	–
AQ-8: Construction-Related Diesel Health Risk Associated with Restoration and Management Activity Combined	A, B, C	Less than significant	None required	–
AQ-9: Increase in Construction Emissions in Excess of Federal *de Minimis* Thresholds	A, B, C	Less than significant	None required	–
AQ-10: Increase in Construction-Related Odor	A, B, C	Less than significant	None required	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section.

- Bay Area Air Quality Management District (BAAQMD) CEQA Guidelines (Bay Area Air Quality Management District 1999).
- BAAQMD Workshop Draft Options Report: CEQA Thresholds of Significance (Bay Area Air Quality Management District 2009).
- California Air Resources Board's (ARB's) *Proposed Amendments to the Area Designation Criteria and Area Designations for State Ambient Air Quality Standards and Maps of Area Designations for State and National Ambient Air Quality Standards* (California Air Resources Board 2006).

- ARB's Aerometric Data Analysis and Management System (ADAM) databases (California Air Resources Board 2009).
- EPA air data (U.S. Environmental Protection Agency 2009).
- SCAQMD Final Methodology to Calculate Particulate Matter (PM) 2.5 and PM2.5 Significance Thresholds, October 2006 (Santa Clara Air Quality Management District 2006).
- Starcrest Consulting Group, 2007, Puget Sound Maritime Air Emissions Inventory, prepared April 2007 (Starcrest Consulting Group 2007).
- 2008 Estimated annual Average Emissions-San Francisco Bay Area Air Basin (California Air Resources Board 2008a).
- Yolo-Solano County Air Quality Management District (YSAQMD), 2007, Handbook for Assessing and Mitigating Air Quality Impacts, adopted July 11, 2007 (Yolo-Solano County Air Quality Management District 2007).

Regional Climate and Meteorology

Cool rainy winters and warm dry summers characterize the climate of Solano County. Similar to the rest of the Bay Area, Solano County is classified as a Marine West Coast Climate type with Mediterranean characteristics. The average rainfall ranges from 17 to 20 inches per year. Winter temperatures are generally 40º to 60ºF, and summer temperatures are generally 55º to 80ºF. The prevailing wind direction is from the west. Typical wind speeds in the County are less than 5 miles per hour (mph) in the fall and winter and approximately 10 mph in the spring and summer.

The Carquinez Strait runs from Rodeo to Martinez. It is the only sea-level gap between San Francisco Bay and the Central Valley. The Carquinez Strait subregion includes the lowlands bordering the strait to the north and south, as well as the area adjoining Suisun Bay and the western part of the Delta as far east as Bethel Island. Further, the subregion extends from Rodeo in the southwest and Vallejo in the northwest to Fairfield in the northeast and Brentwood in the southeast.

Prevailing winds are from the west in the Carquinez Strait. During the summer and fall, high pressure offshore coupled with low pressure in the Central Valley causes marine air to flow eastward through the strait. The wind is strongest in the afternoon. Afternoon wind speeds of 15 to 20 mph are common throughout the strait region. Annual average wind speeds are 8 mph in Martinez, and 9 to 10 mph farther east. Sometimes atmospheric conditions cause air to flow from the east. East winds usually contain more pollutants than the cleaner marine air from the west. In summer and fall, this can cause elevated pollutant levels to move into the central Bay Area through the strait. These high-pressure periods are usually accompanied by low wind speeds, shallow mixing depths, higher temperatures, and little or no rainfall.

Summer mean maximum temperatures reach about 90°F in the subregion. Mean minimum temperatures in winter are in the high 30s (°F). Temperature extremes are especially pronounced in sheltered areas farther from the moderating effects of the strait itself (e.g., at Fairfield).

Many industrial facilities with significant air pollutant emissions (e.g., chemical plants and refineries) are located in the Carquinez Strait region. The pollution potential of this area is often moderated by high wind speeds. However, upsets at industrial facilities can lead to short-term pollution episodes, and emissions of unpleasant odors may occur at any time. Receptors downwind of these facilities could suffer more long-term exposure to air contaminants than individuals elsewhere. Consequently, it is important that local governments and other lead agencies maintain buffer zones around sources of air pollution sufficient to avoid adverse health and nuisance impacts on nearby receptors. Areas of the subregion that are traversed by major roadways (e.g., Interstate 80) also may be subject to higher local concentrations of carbon monoxide (CO), particulate matter, and certain toxic air contaminants (TACs) such as benzene.

Criteria Pollutants and Local Air Quality

Description of Pollutants

The federal and state governments have established ambient air quality standards for six criteria pollutants: ozone (O_3), CO, nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter, and lead (Table 5.7-2). O_3 and NO_2 generally are considered regional pollutants because these pollutants or their precursors affect air quality on a regional scale. Pollutants such as CO, SO_2, and lead are considered local pollutants that tend to accumulate in the air locally. Particulate matter is considered a local and regional pollutant. The pollutants of greatest concern in the plan area are CO, O_3, and inhalable particulate matter (PM2.5 and PM10 [particulate matter 2.5 microns or less and 10 microns or less in diameter, respectively]). Brief descriptions of these pollutants, as well as TACs, follow.

Table 5.7-2. Ambient Air Quality Standards Applicable in California

Pollutant	Symbol	Average Time	Standard (parts per million)		Standard (micrograms per cubic meter)		Violation Criteria	
			California	National	California	National	California	National
Ozone*	O_3	1 hour	0.09	NA	180	NA	If exceeded	NA
		8 hours	0.070	0.075	137	147	If exceeded	If fourth highest 8-hour concentration in a year, averaged over 3 years, is exceeded at each monitor within an area
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 arithmetic mean	0.030	0.053	57	100	If exceeded	If exceeded on more than 1 day per year
		1 hour	0.18	NA	339	NA	If exceeded	NA
Sulfur dioxide	SO_2	Annual arithmetic mean	NA	0.030	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	If exceeded	NA
Hydrogen sulfide	H_2S	1 hour	0.03	NA	42	NA	If equaled or exceeded	NA
Vinyl chloride	C_2H_3Cl	24 hours	0.01	NA	26	NA	If equaled or exceeded	NA
Inhalable particulate matter	PM10	Annual arithmetic mean	NA	NA	20	NA	NA	NA
		24 hours	NA	NA	50	150	If exceeded	If exceeded on more than 1 day per year
	PM2.5	Annual arithmetic mean	NA	NA	12	15	NA	If 3-year average from single or multiple community-oriented monitors is exceeded
		24 hours	NA	NA	NA	35	NA	If 3-year average of 98th percentile at each population-oriented monitor within an area is exceeded
Sulfate particles	SO_4	24 hours	NA	NA	25	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-day average	NA	NA	1.5	NA	If equaled or exceeded	NA
		Rolling 3-Month average	NA	NA	NA	0.15	If equaled or exceeded	Averaged over a rolling 3-month period

Notes: All standards are based on measurements at 25ºC and 1 atmosphere pressure. National standards shown are the primary (health effects) standards. NA = not applicable.

* The U.S. Environmental Protection Agency recently replaced the 1-hour ozone standard with an 8-hour standard of 0.08 part per million. EPA issued a final rule that revoked the 1-hour standard on June 15, 2005. However, the California 1-hour ozone standard will remain in effect.

Source: California Air Resources Board 2008b.

Ozone

O_3 is a respiratory irritant and an oxidant that increases susceptibility to respiratory infections, and can cause substantial damage to vegetation and other materials. O_3 is a severe eye, nose, and throat irritant. O_3 also attacks synthetic rubber, textiles, plants, and other materials and causes extensive damage to plants by leaf discoloration and cell damage. O_3 is not emitted directly into the air; it is formed by a photochemical reaction in the atmosphere. O_3 precursors—reactive organic gases (ROG) and oxides of nitrogen (NO_X)—react in the atmosphere in the presence of sunlight to form O_3. Because photochemical reaction rates depend on the intensity of ultraviolet light and air temperature, O_3 is primarily a summer problem. ROG and NO_X are emitted by mobile sources and stationary combustion equipment.

Carbon Monoxide

CO is essentially inert to plants and materials but can have significant impacts on human health. It combines readily with hemoglobin and thus reduces the amount of oxygen transported in the bloodstream. Effects on humans range from slight headaches to nausea to death. Motor vehicles are the dominant source of CO emissions in most areas. High CO levels develop primarily during winter when periods of light winds combine with the formation of ground-level temperature inversions, typically from evening through early morning. These conditions result in reduced dispersion of vehicle emissions. Motor vehicles also exhibit increased CO emission rates at low air temperatures.

Inhalable Particulate Matter

Particulates can damage human health and retard plant growth. Health concerns associated with suspended particulate matter focus on those particles small enough to reach the lungs when inhaled. Particulates also reduce visibility and corrode materials. Particulate emissions are generated by a wide variety of sources, including agricultural activities, industrial emissions, dust suspended by vehicle traffic and construction equipment, and secondary aerosols formed by reactions in the atmosphere. The federal and state standards for particulate matter apply to two classes of particulates: PM10 and PM2.5.

Toxic Air Contaminants

TACs are pollutants that may be expected to result in an increase in mortality or serious illness, or that may pose a present or potential hazard to human health. Health effects of TACs include cancer, birth defects, neurological damage, damage to the body's natural defense system, and diseases that lead to death. The ARB identifies diesel exhaust particulate matter as a TAC.

Federal and State Ambient Air Quality Standards

The State of California and the federal government each have established ambient air quality standards for air pollutants (see Table 5.7-2). For some pollutants, separate standards have been set for different periods, with most standards set to protect public health; however, for some pollutants, standards have been based on other values, such as protection of crops, protection of materials, or avoidance of nuisance conditions.

Monitoring Data and Attainment Status

The existing air quality conditions in the plan area can be characterized by monitoring data collected in the region. The nearest air quality monitoring station in the vicinity is located at 304 Tuolumne Street, Vallejo, CA 94590, which is located in an urbanized area upwind of the Marsh. Air quality monitoring data from the Vallejo monitoring station are summarized in Table 5.7-3. These data represent air quality monitoring data for the last 3 years for which complete data are available (2006 to 2008).

As indicated in Table 5.7-3, the station has experienced no violations of the state 1-hour O_3 standard, 12.6 violations of the state PM10 standard, three violations of the federal 8-hour O_3 standard, no violations of the federal and state CO standards, and 25.1 violations of the federal PM10 standard during the last 3 years for which complete data are available.

Table 5.7-3. Ambient Air Quality Monitoring Data Measured at the Vallejo 304 Tuolumne Street Monitoring Station

Pollutant Standards	2006	2007	2008
1-Hour Ozone			
Maximum 1-hour concentration (ppm)	0.080	0.078	0.109
1-hour California designation value	0.08	0.08	0.08
1-hour expected peak day concentration	0.083	0.077	0.083
Number of days standard exceeded[a]			
CAAQS 1-hour (>0.09 ppm)	0	0	0
8-Hour Ozone			
National maximum 8-hour concentration (ppm)	0.069	0.066	0.075
National second-highest 8-hour concentration (ppm)	0.064	0.056	0.072
State maximum 8-hour concentration (ppm)	0.070	0.067	0.075
State second-highest 8-hour concentration (ppm)	0.064	0.056	0.073
8-hour national designation value	0.057	0.054	0.060
8-hour California designation value	0.065	0.061	0.067
8-hour expected peak day concentration	0.066	0.061	0.067
Number of days standard exceeded[a]			
NAAQS 8-hour (>0.075 ppm)	0	0	0
CAAQS 8-hour (>0.070 ppm)	0	0	3

Pollutant Standards	2006	2007	2008
Carbon Monoxide (CO)			
National[b] maximum 8-hour concentration (ppm)	2.94	2.70	2.31
National[b] second-highest 8-hour concentration (ppm)	2.73	2.60	1.96
California[c] maximum 8-hour concentration (ppm)	2.94	2.70	2.31
California[c] second-highest 8-hour concentration (ppm)	2.73	2.60	1.96
Maximum 1-hour concentration (ppm)	3.7	3.3	2.7
Second-highest 1-hour concentration (ppm)	3.5	3.3	0.9
Number of days standard exceeded[a]			
NAAQS 8-hour (≥9 ppm)	0	0	0
CAAQS 8-hour (≥9.0 ppm)	0	0	0
NAAQS 1-hour (≥35 ppm)	0	0	0
CAAQS 1-hour (≥20 ppm)	0	0	0
Particulate Matter (PM10)[d]			
National[b] maximum 24-hour concentration (μg/m^3)	46.6	49.1	42.1
National[b] second-highest 24-hour concentration (μg/m^3)	43.9	47.3	31.4
State[c] maximum 24-hour concentration (μg/m^3)	50.1	52.4	43.6
State[c] second-highest 24-hour concentration (μg/m^3)	47.2	51.1	32.4
State annual average concentration (μg/m^3)[e]	19.8	19.0	–
National annual average concentration (μg/m^3)	19.1	18.2	16.0
Number of days standard exceeded[a]			
NAAQS 24-hour (>150 μg/m^3)[f]	0	0	–
CAAQS 24-hour (>50 μg/m^3)[f]	0	12.6	–
Particulate Matter (PM2.5)			
National[b] maximum 24-hour concentration (μg/m^3)	42.2	40.8	50.0
National[b] second-highest 24-hour concentration (μg/m^3)	40.5	40.0	47.0
State[c] maximum 24-hour concentration (μg/m^3)	44.0	41.5	51.2
State[c] second-highest 24-hour concentration (μg/m^3)	43.2	41.3	50.0
National annual designation value (μg/m^3)	10.2	9.8	9.8
National annual average concentration (μg/m^3)	9.8	9.8	9.9
State annual designation value (μg/m^3)	13	12	12
State annual average concentration (μg/m^3)[e]	12.4	12.0	–
Number of days standard exceeded[a]			
NAAQS 24-hour (>35 μg/m^3)	5.9	12.1	7.1

Sources: California Air Resources Board 2009; U.S. Environmental Protection Agency 2009.

Notes: CAAQS = California Ambient Air Quality Standards. NAAQS = National Ambient Air Quality Standards. – = insufficient data available to determine the value.

[a] An exceedance is not necessarily a violation.

[b] National statistics are based on standard conditions data. In addition, national statistics are based on samplers using federal reference or equivalent methods.

[c] State statistics are based on local conditions data, except in the South Coast Air Basin, for which statistics are based on standard conditions data. In addition, State statistics are based on California approved samplers.

[d] Measurements usually are collected every 6 days.

[e] State criteria for ensuring that data are sufficiently complete for calculating valid annual averages are more stringent than the national criteria.

[f] Mathematical estimate of how many days concentrations would have been measured as higher than the level of the standard had each day been monitored.

If monitored pollutant concentrations meet state or federal standards over a designated period of time, the area is classified as being in attainment for that pollutant. If concentrations violate the standards, the area is considered a nonattainment area for that pollutant. If data are insufficient to determine whether a pollutant is violating the standard, the area is designated as unclassified. The attainment status of Solano County is listed in Table 5.7-4.

Table 5.7-4. Federal and State Attainment Status for Solano County

	Solano County	
Pollutant	Federal	State
1-hour O_3	–[1]	Nonattainment
8-hour O_3	Marginal nonattainment	–
CO	Moderate (≤12.7 ppm) maintenance	Attainment
PM10	Unclassified/attainment	Nonattainment
PM2.5	Nonattainment (pending)	Nonattainment

[1] Previously in nonattainment area, no longer subject to the 1-hour standard as of June 15, 2005.

Sensitive Receptors

According to the YSAQMD, a sensitive receptor is generically defined as a location where human populations, especially children, seniors, or sick persons are found, and there is reasonable expectation of continuous human exposure according to the averaging period for the ambient air quality standards (e.g., 24-hour, 8-hour, 1-hour). Examples of sensitive receptors are residences, hospitals, and schools. Sensitive receptors in the plan area include scattered single-family residences and waterfowl hunting clubhouses.

Regulatory Setting

Federal

The federal Clean Air Act (CAA), promulgated in 1963 and amended twice thereafter (including the 1990 amendment), establishes the framework for modern air pollution control. This act directs the EPA to establish ambient air standards for six pollutants: O_3, CO, lead, NO_2, particulate matter, and SO_2. The standards are divided into primary and secondary standards; the former are set to protect human health within an adequate margin of safety and the latter to protect environmental values, such as plant and animal life.

The primary legislation that governs federal air quality regulations is the Clean Air Act Amendments of 1990 (CAAA). The CAAA delegates primary responsibility for clean air to the EPA. The EPA develops rules and regulations to preserve and improve air quality, as well as delegating specific responsibilities to state and local agencies.

Federal Conformity Requirements

The CAAA of 1990 requires that all federally funded projects come from a plan or program that conforms to the appropriate state implementation plan (SIP). Federal actions are subject to either the transportation conformity rule (40 CFR 51[T]), which applies to federal highway or transit projects, or the General Conformity Rule (40 CFR 51[W]), which applies to all other federal actions.

General Conformity Requirements

The purpose of the General Conformity Rule is to ensure that federal actions conform to applicable SIPs so that they do not interfere with strategies employed to attain the national ambient air quality standards (NAAQS). The rule applies to federal actions in areas designated as nonattainment areas for any of the six criteria pollutants and in some areas designated as maintenance areas. The rule applies to all federal actions except:

- programs specifically included in a transportation plan or program that is found to conform under the federal transportation conformity rule,
- projects with associated emissions below specified *de minimis* threshold levels, and
- certain other projects that are exempt or presumed to conform.

A general conformity determination would be required if a proposed action's total direct and indirect emissions fail to meet any of the following two conditions:

- emissions for each affected pollutant for which the region is classified as a maintenance or nonattainment area for the national standards are below the *de minimis* levels indicated in Tables 5.7-5 and 5.7-6. As described below, the *de minimis* thresholds applicable to this proposed action are:
  - NO_X: 100 tons/year
  - Volatile organic compounds (VOCs): 100 tons/year, and
  - CO: 100 tons/year.

If any of the two conditions above are not met, a general conformity determination must be performed to demonstrate that total direct and indirect emissions for each affected pollutant for which the region is classified as amaintenance or nonattainment area for the national standards would conform to the applicable SIP.

However, if the above two conditions are met, the requirements for general conformity do not apply because the proposed action is presumed to conform to the applicable SIP for each affected pollutant. As a result, no further analysis or determination would be required.

Table 5.7-5. Federal *de Minimis* Threshold Levels for Criteria Pollutants in Nonattainment Areas

Pollutant	Emission Rate (Tons per Year)
Ozone (ROG/VOC or NO_X)	
Serious nonattainment areas	50
Severe nonattainment areas	25
Extreme nonattainment areas	10
Other ozone nonattainment areas outside an ozone transport region[1]	100
Other ozone nonattainment areas inside an ozone transport region[1]	
ROG/VOC	50
NO_X	100
CO: All nonattainment areas	100
SO_2 or NO_2: All nonattainment areas	100
PM10	
Moderate nonattainment areas	100
Serious nonattainment areas	70
PM2.5	
Direct emissions	100
SO_2	100
NO_X (unless determined not to be a significant precursor)	100
ROG/VOC or ammonia (if determined to be significant precursors)	100
Pb: All nonattainment areas	25

Note: *de minimis* threshold levels for conformity applicability analysis.

[1] Ozone Transport Region is comprised of the States of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, the Consolidated Metropolitan Statistical Area that includes the District of Columbia and northern Virginia (Section 184 of the Clean Air Act).

Underlined text indicates pollutants for which the region is in non-attainment, and a conformity determination must be made.

Source: 40 CFR 51.853.

Table 5.7-6. Federal *de Minimis* Threshold Levels for Criteria Pollutants in Maintenance Areas

Pollutant	Emission Rate (Tons per Year)
Ozone (NO_X, SO_2 or NO_2)	
All maintenance areas	100
Ozone (ROG/VOC)	
Maintenance areas inside an ozone transport region[1]	50
Maintenance areas outside an ozone transport region[1]	100
CO: All maintenance areas	100
PM10: All maintenance areas	100
PM2.5	
Direct emissions	100
SO_2	100
NO_X (unless determined not to be a significant precursor)	100
ROG/VOC or ammonia (if determined to be significant precursors)	100
Pb: All maintenance areas	25

Note: *de minimis* threshold levels for conformity applicability analysis.

[1] Ozone Transport Region is comprised of the States of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, the Consolidated Metropolitan Statistical Area that includes the District of Columbia and northern Virginia (Section 184 of the Clean Air Act).

Underlined text indicates pollutants for which the region is in maintenance, and a conformity determination must be made.

Source: 40 CFR 51.853.

Because the plan has federal funding, and is not a transportation project, it is subject to the General Conformity Rule. As indicated in Table 5.7-4, the plan area is classified federally as a marginal nonattainment area for the 8-hour O_3 standard, a pending nonattainment area for the PM2.5 standard, and a moderate maintenance area for CO. Consequently, to fulfill general conformity requirements, an analysis must be undertaken to identify whether the proposed action's total emissions of O_3, PM2.5, and CO are below the appropriate *de minimis* levels indicated in Tables 5.7-5 and 5.7-6.

It should be noted that after June 15, 2005, federal conformity for O_3 is based on the 8-hour standard rather than the 1-hour standard. To represent a worst-case scenario, the conformity determination in this analysis is based on the most stringent *de minimis* classification from Tables 5.7-5 and 5.7-6.Responsibility for achieving California's standards, which are more stringent than federal standards, is placed on the ARB and local air districts and is to be achieved through district-level air quality management plans that will be incorporated into the SIP. In California, the EPA has delegated authority to prepare SIPs to the ARB, which, in turn, has delegated that authority to individual air districts.

The ARB traditionally has established state air quality standards, maintaining oversight authority in air quality planning, developing programs for reducing emissions from motor vehicles, developing air emission inventories, collecting air quality and meteorological data, and approving SIPs.

Responsibilities of air districts include overseeing stationary source emissions, approving permits, maintaining emissions inventories, maintaining air quality stations, overseeing agricultural burning permits, and reviewing air quality–related sections of environmental documents required by CEQA.

The California Clean Air Act of 1988 (CCAA) substantially added to the authority and responsibilities of air districts. The CCAA designates air districts as lead air quality planning agencies, requires air districts to prepare air quality plans, and grants air districts authority to implement transportation control measures. The CCAA focuses on attainment of the state ambient air quality standards (CAAQS), which, for certain pollutants and averaging periods, are more stringent than the comparable federal standards.

The CCAA requires designation of attainment and nonattainment areas with respect to CAAQS. The CCAA also requires that local and regional air districts expeditiously adopt and prepare an air quality attainment plan if the district violates state air quality standards for CO, SO_2, NO_2, or O_3. These Clean Air Plans are designed specifically to attain these standards and must be designed to achieve an annual 5% reduction in district-wide emissions of each nonattainment pollutant or its precursors. No locally prepared attainment plans are required for areas that violate the state PM10 standards.

The CCAA requires that the CAAQS be met as expeditiously as practicable but, unlike the federal CAA, does not set precise attainment deadlines. Instead, the act established increasingly stringent requirements for areas that will require more time to achieve the standards.

Local

The air quality management agencies of direct importance in the plan area are the EPA, ARB, and the BAAQMD. The EPA has established federal standards for which the ARB and BAAQMD have primary implementation responsibility. The ARB and BAAQMD are responsible for ensuring that state standards are met, implementing strategies for air quality improvement, and recommending mitigation measures for new growth and development. At the local level, air quality is managed through land use and development planning practices and is implemented in the counties through the general planning process. The BAAQMD is responsible for establishing and enforcing local air quality rules and regulations that address the requirements of federal and state air quality laws. The SMP may be subject to the air quality management district rules discussed below. In addition, the plan may be subject to additional rules.

Bay Area Air Quality Management District

The following discussion describes applicable air quality plans in the plan area within the BAAQMD's jurisdiction. The most recent versions of these plans are the 2001 Revised San Francisco Bay Area Ozone Attainment Plan for the 1-Hour National Ozone Standard (OAP), the Bay Area 2000 Clean Air Plan and Triennial Assessment (CAP), and the Bay Area 2005 Ozone Strategy (BAOS).

Ozone Attainment Plan

The OAP is the Bay Area's portion of California's SIP to achieve the national O_3 standard. In 1999, the BAAQMD, Association of Bay Area Governments (ABAG), and the Metropolitan Transportation Commission (MTC) adopted the 1999 OAP, which was submitted to the ARB in June 1999. The 1999 OAP was approved by the ARB in July 1999 and submitted to the EPA for approval. The EPA proposed to partially approve and partially disapprove portions of the 1999 OAP on March 30, 2001. The disapproved portions were the reasonably available control measures (RACMs) demonstration, attainment demonstration, and motor vehicle emissions budgets (MVEBs). This disapproval by the EPA started a sanctions clock, and the Bay Area became subject to the imposition of a 2:1 offset sanction.

In response, the BAAQMD, ABAG, and MTC began preparation of the 2001 OAP to correct the deficiencies in the 1999 OAP. On October 24, 2001, they adopted the 2001 OAP. The 2001 OAP was approved by the ARB on November 1, 2001, and submitted to the EPA for approval as a revision to the California SIP on November 30, 2001. The 2001 OAP included two commitments for further planning—a commitment to conduct a mid-course review of progress toward attaining the national 1-hour O_3 standard by December 2003 and a commitment to provide a revised O_3 attainment strategy to the EPA by April 2004. On April 22, 2004, the EPA approved the following elements of the 2001 OAP: emissions inventory; RACMs; commitments to adopt and implement specific control measures; MVEBs; and commitments for further study measures. The EPA's approval of RACMs and MVEBs in the 2001 OAP terminated the sanctions clock for those plan elements.

The EPA made a final finding in April 2004 that the BAAQMD had attained the federal 1-hour O_3 standard. As a result, certain planning commitments outlined in the 2001 OAP were no longer required. Although the EPA has prepared a finding of attainment for the region, the Bay Area has not been formally reclassified as an attainment area for the 1-hour standard. To be reclassified as an attainment area, the region must submit a redesignation request to the EPA.

Clean Air Plan

The CAP is a plan to reduce ground-level O_3 levels in the Bay Area and attain the state 1-hour O_3 standard. It was developed by the BAAQMD, in cooperation with ABAG and the MTC, in response to the CCAA, which requires all air districts exceeding the state O_3 standard to reduce pollutant emissions by 5% per year (calculated from 1987) or achieve emission reductions through all feasible measures. The CCAA further requires that the CAP be updated every 3 years. Because the Bay Area attained the state CO standard in 1993, the CCAA planning requirements for CO nonattainment areas no longer apply to the Bay Area. The first CAP prepared in 1991 includes a comprehensive strategy to reduce air pollutant emissions by focusing on control measures to be implemented from 1991 to 1994, 1995 through 2000, and beyond. The 1994 update to the CAP continued the comprehensive strategy established by the 1991 CAP and its goals of reducing health impacts from O_3 levels above the CAAQS to compliance with the CCAA. The 1994 CAP included eight new proposed control measures for stationary and mobile sources, in addition to changes in the organization and scheduling of some of the control measures from the 1991 CAP. The control measures proposed in the 1994 CAP constitute all feasible O_3-reducing measures in the Bay Area. In addition, the 1994 CAP projects pollutant trends and possible control activities beyond 1997.

The BAAQMD adopted the most recent update of the CAP on December 20, 2000. It is the third triennial update of the original CAP. The 2000 CAP includes a review of control strategies to ensure that “all feasible measures” to reduce O_3 are incorporated into the CAP. In addition, the 2000 CAP updates the BAAQMD’s emission inventory, estimates emission reductions resulting from the CAP, and assesses air quality trends in the region.

Bay Area 2005 Ozone Strategy

The BAAQMD has finalized the BAOS in cooperation with ABAG and the MTC. The BAOS is a comprehensive document that describes the Bay Area’s strategy for compliance with state 1-hour O_3 standard planning requirements.

O_3 conditions in the Bay Area have improved significantly, but there is still a need for continued improvement to meet the state 1-hour O_3 standard. The BAOS describes how the Bay Area will fulfill CCAA planning requirements for the state 1-hour O_3 standard and transport mitigation requirements through a proposed control strategy. The control strategy includes stationary source, mobile source, and transportation control measures to be implemented through BAAQMD regulations, incentive programs, and transportation programs, respectively.

Environmental Consequences

Assessment Methods

The activities required for the proposed tidal wetland restoration may generate significant air emissions from construction activities. Terrestrial construction-related emissions are generally short-term but still may cause adverse air quality impacts. PM10 is the pollutant of greatest concern with respect to terrestrial construction activities. PM10 emissions can result from a variety of construction activities, including excavation, grading, demolition, vehicle travel on paved and unpaved roads, and emission of vehicle and equipment exhaust. Terrestrial construction-related emissions of PM10 can vary greatly depending on the level of activity, the specific operations taking place, the equipment being operated, local soils, weather conditions, and other factors.

Particulate emissions from construction equipment exhaust can lead to adverse health effects, as well as nuisance concerns such as reduced visibility and soiling of exposed surfaces (Bay Area Air Quality Management District 1999).

The URBEMIS 2007 (version 9.2.4) model was used to estimate emissions associated with construction of the proposed project. To estimate construction emissions, URBEMIS 2007 analyzes the type of construction equipment used and the duration of the construction period associated with construction of each of the land uses. URBEMIS calculates unmitigated emissions, but also calculates mitigated emissions based on standard measures that are incorporated into the model. These measures include the following:

- Soil disturbance (apply soil stabilizers to inactive soil, replace ground cover in disturbed areas, water exposed surfaces, and equipment loading/unloading);
- Unpaved roads (reduce speed and manage haul road dust);
- Off-road equipment (use aqueous diesel fuel, diesel particulate filters, and diesel oxidation catalysts).

The soil disturbance mitigation measures, which are typically used to mitigate for fugitive dust, were not used. The project area consists of marsh land and because much of the ground would be wet, soil disturbing activity would not cause dust. The URBEMIS 2007 model calculates both PM10 and PM2.5 in terms of exhaust and dust. For the purposes of this analysis, the PM dust emissions were zeroed out because construction activity would not create PM dust during soil disturbing activities due to the marshy nature of the project site.

The BAAQMD has developed thresholds of significance and because both restoration and management activities could occur simultaneously, they were modeled as such to determine the maximum potential impact of SMP implementation on air quality. Because a detailed schedule of construction activity is not available, it is assumed that construction would take place primarily between June through September for 30 years for restoration activity, and June through September on any given year for management activity. However, dredging would be conducted from September through November as described in Chapter 2.

The Puget Sound Maritime Air Emissions Inventory methodology was used to estimate tugboat emissions. The tugboat emissions calculation spreadsheet is attached as Appendix B. In addition, the SCAQMD Final Methodology to Calculate Particulate Matter (PM) 2.5 and PM2.5 Significance Thresholds (South Coast Air Quality Management District 2006) was used to calculate PM 2.5 for tug emissions.

Significance Criteria

Because the plan has federal funding, general conformity significance criteria must be considered. Further, because of the location of the plan area, both CEQA and the BAAQMD must be considered. The most stringent significance criteria must be applied to implementing the plan.

Federal General Conformity

Under general conformity, the implementation of the plan would adversely affect air quality if construction emissions of O_3 precursors (ROG and NO_X) would exceed 100 tons per year and CO emissions would exceed 100 tons per year.

California Environmental Quality Act

Based on the State CEQA Guidelines and standard professional practice, implementation of the SMP would result in a significant impact on air quality if it would:

- conflict with or obstruct implementation of the applicable air quality management plan;
- violate any air quality standard or contribute substantially to an existing or projected air quality violation;
- result in a cumulatively considerable net increase of any criteria pollutant for which the plan region is nonattainment under an applicable NAAQS or CAAQS (including releasing emissions that exceed quantitative thresholds for O_3 precursors);
- expose sensitive receptors to substantial pollutant concentrations; or
- create objectionable odors affecting a substantial number of people.

The State CEQA Guidelines further state that the significance criteria established by the applicable air quality management or air pollution control district may be relied on to make the determinations above.

Operational emissions are not evaluated because activities associated with restoration and management are considered construction. Therefore, only the BAAQMD draft construction thresholds are used.

Construction

BAAQMD currently does not require quantification of construction emissions. Instead, it requires implementation of effective and comprehensive feasible control measures to reduce PM10 emissions (Bay Area Air Quality Management District 1999). PM10 emitted during construction activities varies greatly depending on the level of activity, the specific operations taking place, the equipment being operated, local soils, and weather conditions. Despite this variability in emissions, experience has shown that a number of feasible control measures can be reasonably implemented to reduce PM10 emissions during construction; these measures are summarized in Environmental Commitments in Chapter 2. According to BAAQMD, if all control measures listed in Chapter 2 are implemented (as appropriate, depending on the size of the plan area), air pollutant emissions from construction activities are to be considered less than significant (Bay Area Air Quality Management District 1999). However, quantification of emissions for large projects is useful as a means to provide information on the magnitude of emissions from construction.

Construction equipment also emits CO and O_3 precursors (ROG and NO_X). Construction-related emissions of these pollutants were not estimated, however, because they are already included in the emission inventory that forms the basis for BAAQMD's regional air quality plans and because those emissions are not expected to impede attainment or maintenance of O_3 and CO standards in the Bay Area (Bay Area Air Quality Management District 1999).

Bay Area Air Quality Management District Draft Construction Thresholds

The BAAQMD recently has released draft significance thresholds for construction-related emissions (Bay Area Air Quality Management District 2009). According to the draft thresholds, construction would result in a significant impact on the environment if it would generate criteria air pollutant emissions in excess of those shown below in Table 5.7-7.

Table 5.7-7. Thresholds of Significance for Project Construction

Pollutant	Lbs/day
ROG	54
NO_X	54
SO2	219
PM10	82
PM2.5	54

For the purposes of this plan area, the draft construction thresholds were used because they likely will be adopted in the future.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, a small amount of wetland restoration would occur and managed wetland activities are expected to decrease. As such, it is expected that there would be a reduction or no change in PM10, CO, O_3 precursors, or other pollutants, and there would be no impacts.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Impact AQ-1: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Restoration

Temporary construction activity would involve the use of heavy equipment, which may generate emissions in excess of the draft BAAQMD construction thresholds. Construction impacts have been assessed in this analysis using the URBEMIS 2007 9.2.4 model and anticipated construction equipment that would be used during construction activities, which are based on typical restoration activity (Table 5.7-8). Construction would take place over a 30-year period in the form of small projects on parcels at an average of 300 acres.

Restoration projects generally are broken into three phases: site preparation, water management, and levee breaching. The site preparation phase entails grading, improving levees, and building channels and islands. The water management phase does not include the use of heavy equipment. Assumptions were made for the types of construction equipment that likely would be used for each phase, the total operating hours of each piece, and the horsepower of each piece to represent a worst-case scenario to demonstrate maximum emissions. These assumptions were based on what typically is used for restoration projects, information provided by the project proponent, and URBEMIS default values.

Table 5.7-8. Anticipated Construction Equipment for Restoration Activity

Equipment Pieces by Phase	Number of Equipment Pieces Used	Horsepower	Hours per Day
Site Preparation			
Tractor/loader/backhoe	1	180	8
Rubber-tired dozer	1	357	8
Excavator	1	168	8
Grader	1	174	8
Box scraper	1	313	8
Levee Breaching			
Excavator	1	168	8

Construction of the proposed project would result in the temporary increase in emissions of ROG, NO_X, CO, PM10, PM2.5, and CO_2. Total daily unmitigated and mitigated emissions resulting from construction of the proposed project are summarized in Table 5.7-9. As a worst-case scenario, site preparation and levee breaching emissions were combined into a total daily emissions value, because it is possible that two different projects could occur at the same time. Evaluating a worst-case scenario is necessary to compare emissions to the BAAQMD emission thresholds.

Table 5.7-9. Maximum 2009 Emissions from Restoration Activities for the Proposed Project Projects (lbs/day)

Project Phase	ROG	NO_X	CO	PM10 exhaust	PM2.5 exhaust	CO_2
Unmitigated						
Site Preparation	6.54	54.63	29.87	2.71	2.49	5,072.67
Levee Breaching	0.72	5.45	3.55	0.32	0.30	572.66
Total Daily Unmitigated Emissions	7.26	60.08	33.42	3.03	2.79	5,645.33
Mitigated						
Site Preparation	6.54	46.45	29.87	0.41	0.38	5,072.67
Levee Breaching	0.72	4.63	3.55	0.05	0.04	572.66
Total Daily Mitigated Emissions	7.26	51.08	33.42	0.46	0.42	5,645.33
BAAQMD Draft Construction Threshold	54	54	N/A	82	54	N/A
Exceeds Threshold?	No	No	N/A	No	No	N/A

As shown above, unmitigated emissions from two projects (one in the site preparation phase and one in the levee breaching phase) exceed the BAAQMD draft construction thresholds of 54 pounds per day of NO_X, but mitigated emissions from two projects do not. In addition, if two projects began simultaneously and both were in the site preparation phase at the same time, NO_X emissions would exceed the BAAQMD threshold of 54 pounds per day. It should be noted that the proposed project is located in a rural setting and these activities would be spread out over the landscape of 50,000 acres in the middle of 27,000 acres of agricultural uplands and 30,000 acres of bays and sloughs, over a long period of time. Nevertheless, Mitigation Measures AQ-MM-1, AQ-MM-2, and AQ-MM-3 are required to reduce this impact to less than significant.

Conclusion: Less than significant with Mitigation Measures AQ-MM-1, AQ-MM-2, and AQ-MM-3 incorporated.

Mitigation Measure AQ-MM-1: Limit Construction Activity during Restoration

The project proponent will limit construction activity so that site preparation can occur on only one parcel at a time. This will ensure that construction emissions do not exceed the draft BAAQMD threshold for NO_X.

Mitigation Measure AQ-MM-2: Reduce Construction NO_X Emissions

The project proponent will ensure that construction emissions do not exceed the BAAQMD's draft construction threshold of 54 pounds per day for NO_X. Tables 5.7-8 (above) and 5.7-10 (below) show appropriate levels of construction equipment that can be operating at any given time in the marsh. Such measures include, but are not limited to, the following:

- Implement off road equipment mitigation, including installing 1st tier diesel particulate filters (DPFs), and installing diesel oxidation catalysts to reduce NO_x emissions by 40%.

Mitigation Measure AQ-MM-3: Implement All Appropriate BAAQMD Mitigation Measures

The project proponent will implement BAAQMD standard mitigation measures where appropriate and feasible. These measures include:

- Cover all haul trucks transporting soil, sand, or other loose material off-site.
- Remove all visible mud or dirt track-out onto adjacent public roads.
- Minimize idling times either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of California Code of Regulations[CCR]). Clear signage shall be provided for construction workers at all access points.
- Maintain all construction equipment in accordance with manufacturer's specifications. All equipment shall be checked by a certified mechanic and determined to be running in proper condition prior to operation.

- Post a publicly visible sign with the telephone number and person to contact at the Lead Agency regarding dust complaints. This person shall respond and take corrective action within 48 hours. The Air District's phone number shall also be visible to ensure compliance with applicable regulations.

Impact AQ-2: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Current Management Activities

Various types of management activity, such as constructing ditches, coring and repairing levees, repairing and replacing structures, etc., currently occur in the Marsh. These activities would increase in frequency under the SMP. Temporary construction activity would involve the use of heavy equipment, which may generate emissions in excess of the draft BAAQMD construction thresholds.

Construction impacts regarding existing management activity that would increase in frequency have been assessed in this analysis using the URBEMIS 2007 9.2.4 model and anticipated construction equipment that would be used during construction activities, which are based on typical wetland management activity. Because it is unknown how much these activities would be increased, the maximum allowable mitigated emissions were modeled to find the appropriate number of pieces of construction equipment that would be permitted to operate at any given time in the Marsh. It was assumed that management projects would take place from June through September on parcels averaging 300 acres in size. Estimated construction equipment that would be used for these projects is shown in Table 5.7-10.

Table 5.7-10. Estimated Construction Equipment for Management Activity That Would Increase in Frequency

Equipment Pieces Used for Management Activities	Number of Equipment Pieces Used	Horsepower	Hours per Day
Excavator	2	168	8
Tractor/loader/backhoe	3	108	8
Grader	3	174	8
Rubber tired dozer	3	357	8

Increased frequency of management activities would result in the temporary increase in emissions of ROG, NO_X, CO, PM10, PM2.5, and CO_2. Total daily unmitigated and mitigated project emissions resulting from operations of the proposed project are summarized in Table 5.7-11.

Table 5.7-11. Maximum 2009 Emissions from Management Activity That Would Increase in Frequency under the Proposed Action (lbs/day)

Management Activity That Would Increase in Frequency	ROG	NO_X	CO	PM10 exhaust	PM2.5 exhaust	CO_2
Unmitigated	11.11	88.28	52.73	4.75	4.37	8,041.40
Mitigated	11.11	53.73	52.73	0.72	0.66	8,041.40
BAAQMD Draft Construction Threshold	54	54	N/A	82	54	N/A
Exceeds Threshold?						
Unmitigated	No	Yes	N/A	No	No	N/A
Mitigated	No	No	N/A	No	No	N/A

As illustrated in Table 5.7-11, emissions associated with increased frequency of management activities would be below the BAAQMD draft construction thresholds for all pollutants, if the equipment used does not exceed the anticipated construction equipment in Table 5.7-10. Mitigation Measures AQ-MM-2 and AQ-MM-3 will be implemented to reduce this impact to less-than-significant. In addition, environmental commitments, including annual monitoring of equipment and use of basic control measures to manage fugitive dust, would be implemented as part of the proposed action (see Chapter 2, environmental commitments section). The modeling in Table 5.7-11 is based on the anticipated construction equipment in Table 5.7-10.

Conclusion: Less than significant with Mitigation Measures AQ-MM-2 and AQ-MM-3 incorporated.

Impact AQ-3: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with New Management Activities

New management activities, including dredging tidal sloughs, interior levee construction, and replacing riprap, would occur under the SMP. Temporary construction activity would involve the use of heavy equipment that may generate emissions in excess of the draft BAAQMD construction thresholds.

Construction impacts regarding management activities have been assessed in this analysis using the URBEMIS 2007 9.2.4 model and anticipated construction equipment that would be used during construction activities, based on typical wetland management activity. The quantification of tug emissions was performed using emission factors provided by NONROAD2005 (U.S. Environmental Protection Agency 2005), entered into an Excel spreadsheet model.

To assess whether activity associated with the proposed action would exceed significance thresholds, the maximum placement per year was modeled by estimating a total of 100,000 cubic yards of dredge spoils. The analysis assumed a boxscraper, backhoe/loader, and pickup would be used from August through November for dredge spoil and riprap placement, and that 9,700 cubic yards would be moved per day. The calculated emissions, based on these assumptions, are presented in Table 5.7-12 and compared to the draft BAAQMD construction thresholds.

Table 5.7-12. Calculated Emissions Associated with New Management Activities

Activity	Emissions (lbs/day)					
	ROG	NO_X	CO	PM10 exhaust	PM2.5 exhaust	CO_2
Tug Activity	0.12	4.82	0.88	0.39	0.36	302.42
Dredging/Interior Levee Construction/Placement of Riprap, Unmitigated	3.91	34.23	15.13	1.52	1.40	3,590.34
Dredging/Interior Levee Construction/Placement of Riprap, Mitigated	3.91	20.56	15.13	0.23	0.21	3,590.34
Total Unmitigated	4.03	39.05	16.01	1.91	1.76	3,892.76
Total Mitigated	4.03	25.38	16.01	0.62	0.57	3,892.76
BAAQMD Draft Construction Significance Thresholds (lbs/day)	54	54	N/A	82	54	N/A
Exceeds Threshold?	No	No	N/A	No	No	N/A

As illustrated in Table 5.7-12, unmitigated emissions associated with implementing the marsh management activities would be below the BAAQMD draft construction thresholds for all pollutants. In addition, environmental commitments, including annual monitoring of equipment and use of PM10 control measures, would be implemented as part of the proposed action.

Conclusion: Less than significant. No mitigation required.

Impact AQ-4: Generation of Construction-Related Emissions in Excess of Draft BAAQMD Standards Associated with Restoration and Management Activities Combined

Construction activity associated with restoration and management activity potentially could occur simultaneously. Tables 5.7-13 and 5.7-14 summarize the combined emissions associated with restoration activity, management activity that would increase in frequency, and new management activity.

Table 5.7-13. Combined Unmitigated Emissions from Restoration and Management Activities

Activity	ROG	NO_x	CO	PM10 exhaust	PM2.5 exhaust	CO_2
Restoration	7.26	60.08	33.42	3.03	2.79	5,645.33
Management Activity That Would Increase in Frequency	11.11	88.28	52.73	4.75	4.37	8,041.40
New Management	4.03	39.05	16.01	1.91	1.76	3,892.76
Emission Totals	22.40	**187.41**	102.16	9.69	8.92	17,579.49
BAAQMD Draft Construction Threshold	54	54	N/A	82	54	N/A
Exceeds Threshold?	No	Yes	N/A	No	No	N/A

Table 5.8-14. Combined Mitigated Emissions from Restoration and Management Activities

Activity	ROG	NO_x	CO	PM10 exhaust	PM2.5 exhaust	CO_2
Restoration	7.26	51.08	33.42	0.46	0.42	5,645.33
Management Activity That Would Increase in Frequency	11.11	53.73	52.73	0.72	0.66	8,041.40
New Management	4.03	25.38	16.01	0.62	0.57	3,892.76
Emission Totals	22.67	**130.19**	102.16	1.8	1.65	17,579.49
BAAQMD Draft Construction Threshold	54	54	N/A	82	54	N/A
Exceeds Threshold?	No	Yes	N/A	No	No	N/A

The modeling shown in Tables 5.7-13 and 5.7-14 is based on the anticipated construction equipment in Tables 5.7-8 and 5.7-10. Therefore, if the construction equipment in Tables 5.7-8 and 5.7-10 changes, then the results in Tables 5.7-13 and 5.7-14 will change as well. As shown above in Table 5.7-14, the worst-case scenario mitigated emissions would exceed the BAAQMD draft construction thresholds for NO_X if all of the various restoration activity, new management activity that would increase in frequency, and new management activity were to all happen concurrently. While multiple phases of construction can overlap, the pieces of equipment being used on the marsh at any given time should not exceed the list of equipment described in Tables 5.7-8 and 5.7-10 so as not to exceed the BAAQMD threshold of 54 pounds per day of NO_X. Therefore, in addition to mitigation measures MM-AQ-1, MM-AQ-2, and MM-AQ-3, Mitigation Measure AQ-MM-4 is required to reduce this impact to less than significant.

Mitigation Measure AQ-MM-4: Limit Restoration and Management Activity

The project proponent will limit restoration and management activity so that the equipment being used in the SMP area does not exceed equipment described in

Tables 5.7-8 an 5.7-10. This will ensure that construction emissions do not exceed the draft BAAQMD threshold for NO_X.

Conclusion: Less than significant with Mitigation Measures AQ-MM-1, AQ-MM-2, AQ-MM-3 and AQ-MM-4 incorporated.

Impact AQ-5: Construction-Related Diesel Health Risk Associated with Restoration

Construction activities associated with restoration activity would involve the operation of diesel-powered equipment. In October 2000, the ARB identified diesel exhaust as a TAC. As described above, construction activities would occur in June through September over 30 construction seasons. The assessment of cancer health risks associated with exposure to diesel exhaust typically is associated with chronic exposure (70-year exposure period is often assumed). Although cancer can result from exposure periods of less than 70 years, acute exposure periods (2 to 3 years) to diesel exhaust are not anticipated to result in an increased health risk. Health impacts associated with exposure to diesel exhaust from implementing activities are anticipated to be less than significant because diesel particulate emission rates would be low, the emissions would be distributed over a large geographic area rather than clustered near any individual sensitive receptors, and construction activities would occur sporadically over a 30-year period and would not result in long-term emissions of diesel exhaust at the project sites. It also is anticipated that concentrations of diesel exhaust would attenuate to levels well below acceptable exposure limits because of the distances of sensitive receptors from construction activities. In addition, the environmental commitments described in Chapter 2 will be implemented.

Conclusion: Less than significant. No mitigation required.

Impact AQ-6: Construction-Related Diesel Health Risk Associated with Current Management Activities

Management activities, including dredging, would involve the operation of diesel-powered equipment. Health impacts associated with exposure to diesel exhaust from marsh management activities are anticipated to be less than significant because diesel particulate emission rates would be low, the emissions would be distributed over a large geographic area rather than clustered near any individual sensitive receptors, and construction activities would occur sporadically and would not result in long-term emissions of diesel exhaust at the project sites. It also is anticipated that concentrations of diesel exhaust would attenuate to levels well below acceptable exposure limits because of the distances of sensitive receptors from construction activities.

Conclusion: Less than significant. No mitigation required.

Impact AQ-7: Construction-Related Diesel Health Risk Associated with New Management Activities

Impacts from new management activities would be similar to those described above under Management Activities That Would Increase in Frequency.

Conclusion: Less than significant. No mitigation required.

Impact AQ-8: Construction-Related Diesel Health Risk Associated with Restoration and Management Activity Combined

Impacts from restoration and management activity combined would be similar to those described above under Restoration and Management Activities That Would Increase in Frequency.

Conclusion: Less than significant. No mitigation required.

Impact AQ-9: Increase in Construction Emissions in Excess of Federal *de Minimis* Thresholds

Table 5.7-15 summarizes annual emissions resulting from activities associated with both restoration and management activity combined. This represents worst-case scenario emissions that are not anticipated to exceed the *de minimis* thresholds of significance.

Table 5.7-15. Calculated Unmitigated Emissions Compared to Federal *de Minimis* Thresholds

	Pollutant Emissions (tons/year)					
Activity	ROG	NO_X	CO	PM10 exhaust	PM2.5 exhaust	CO_2
Restoration	0.35	2.10	1.55	0.02	0.02	276.24
Management Activities That Would Increase in Frequency	0.20	1.16	0.90	0.03	0.03	151.22
New Management Activities	0.18	1.30	0.70	0.03	0.03	171.28
Emission Totals	0.72	4.56	3.16	0.08	0.07	598.74
Federal *de Minimis* Significance Thresholds	50	100	100	100	N/A	N/A
Exceeds Thresholds?	No	No	No	No	N/A	N/A

Source: 2008 Estimated annual Average Emissions-San Francisco Bay Area Air Basin. <http://www.arb.ca.gov/ei/maps/basins/absfmap.htm>.

As shown in Table 5.7-15 above, even if all activities are running concurrently, federal *de minimis* thresholds would not be exceeded.

Conclusion: Less than significant. No mitigation required.

Impact AQ-10: Increase in Construction-Related Odor

The proposed action may generate odors during ground-disturbing activities, and disposal and settling of dredged material. However, the environmental commitments outlined in Chapter 2, for restoration activities, including dust management, would minimize the potential for odor generation. Furthermore, it is anticipated that any odors generated from the dredging spoils would not be any more objectionable than the naturally occurring odors around the Marsh.

Conclusion: Less than significant. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres

Under Alternative B, approximately 2,000–4,000 acres of tidal wetland would be restored, which is less than what would be restored under Alternative A. More management activity would occur under Alternative B than would occur under Alternative A. Although more projects related to Marsh management would occur annually under Alternative B, more would not occur on a daily basis. Thus daily emissions would not exceed those summarized above under Alternative A.

Alternative C: Restore 7,000–9,000 Acres

Under Alternative C, approximately 7,000–9,000 acres of tidal wetland would be restored, which is more than would be restored under Alternative A. Less management activity would occur under Alternative C than would occur under Alternative A. Although more restoration projects would occur annually under Alternative C, more would not occur on a daily basis. Thus daily emissions would not exceed those summarized above under Alternative A.

Section 5.8
Noise

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on noise.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts. For example, the setting identifies how noise would change as a result of construction and maintenance activities.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 5.8-1 summarizes noise impacts from implementing the SMP alternatives. There would be no significant impacts on noise from implementing the SMP alternatives.

Table 5.8-1. Summary of Noise Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
NZ-1: Temporary Increases in Ambient Noise during Construction Activities Associated with Restoration	A, B, C	Less than significant	None required	–
NZ-2: Temporary Exposure of Sensitive Land Uses to Groundborne Vibration or Noise from Construction Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
NZ-3: Permanent Increases in Ambient Noise	A, B, C	Less than significant	None required	–
NZ-4: Exposure of Noise-Sensitive Land Uses to Noise from Material Hauling Operations	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
NZ-2: Temporary Exposure of Sensitive Land Uses to Groundborne Vibration or Noise from Construction Activities	A, B, C	Less than significant	None required	–
NZ-3: Permanent Increases in Ambient Noise	A, B, C	Less than significant	None required	–
NZ-4: Exposure of Noise-Sensitive Land Uses to Noise from Material Hauling Operations	A, B, C	Less than significant	None required	–
NZ-5: Temporary Increases in Ambient Noise during Construction Activities Associated with Management Activities	A, B, C	Less than significant	None required	–
NZ-6: Exposure of Noise-Sensitive Land Uses to Noise from Portable Pump Operations	A, B, C	Significant	NZ-MM-1: Limit Noise from Pump Operations	Less than significant

Affected Environment

The plan area is located in Solano County. 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.

Noise Terminology

Following are brief definitions of acoustic and vibration terminology used in this section:

- **Sound.** A vibratory disturbance created by a vibrating object, which, when transmitted by pressure waves through a medium such as air, is capable of being detected by a receiving mechanism, such as the human ear or a microphone.
- **Noise.** Sound that is loud, unpleasant, unexpected, or otherwise undesirable.

- **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 that 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% 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 is usually expressed in inches/sec.

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.

Sources of Information

The following key sources of information were used in the preparation of this section:

- Solano County General Plan (Solano County 2008).
- *Noise Control Engineering Journal* article, “Construction noise control program and mitigation strategy at the Central Artery/Tunnel project” (Thalheimer 2000).
- Federal Transit Administration’s (FTA’s) transit noise and vibration impact assessment (Federal Transit Administration 2006).

- Clamshell dredge noise measurements taken in 1997 in support of the Oakland Harbor Navigation Improvement Project EIS (Geier & Geier Consulting 1997).
- Hoover and Keith's *Noise control for buildings, manufacturing plants, equipment and products* (Hoover and Keith 2000).

Regulatory Setting

In general, the federal government sets noise standards for transportation noise sources that are related to interstate commerce. These typically include aircraft, trains, and trucks. State governments establish noise standards for those sources not regulated by federal standards, such as automobiles, light trucks, motorboats and motorcycles. Other noise sources associated with construction and industrial and commercial activities are usually regulated by noise ordinances and general plan policies, which are established by local jurisdictions.

Federal

Federal Noise Control Act of 1972

The federal Noise Control Act of 1972 (Public Law 92-574) established a requirement that all federal agencies administer their programs to promote an environment free of noise that would jeopardize public health or welfare. The EPA was given the responsibility for:

- providing information to the public regarding identifiable effects of noise on public health and welfare,
- publishing information on the levels of environmental noise that will protect the public health and welfare with an adequate margin of safety,
- coordinating federal research and activities related to noise control, and
- establishing federal noise emission standards for selected products distributed in interstate commerce.

The Noise Control Act also directed that all federal agencies comply with applicable federal, state, interstate, and local noise control regulations.

U.S. Environmental Protection Agency

In 1974, in response to the requirements of the federal Noise Control Act, EPA identified indoor and outdoor noise limits to protect public health and welfare (communication disruption, sleep disturbance, and hearing damage). Outdoor L_{dn} limits of 55 dB and indoor L_{dn} limits of 45 dB are identified as desirable to protect against speech interference and sleep disturbance for residential, educational, and healthcare areas. Sound-level criteria to protect against hearing damage in commercial and industrial areas are identified as 24-hour L_{eq} values of 70 dB (both outdoors and indoors).

State

California Department of Health Services Guidelines

In 1987, the California Department of Health Services published guidelines for the noise elements of local general plans. These guidelines include a sound level/land use compatibility chart that categorizes various outdoor L_{dn} ranges by land use. These guidelines identify the normally acceptable range for low-density residential uses as less than 65 dB and conditionally acceptable levels as 55–70 dB.

Local

Solano County General Plan, Noise Element

Solano County has established policies and regulations concerning the generation and control of noise that could adversely affect its citizens and noise-sensitive land uses.

The County's General Plan is a document required by state law that serves as the County's guidance document for land use and development. The General Plan sets an overall framework for development in Solano County and protection of its natural and cultural resources; it is a comprehensive, long-term document that provides details for the physical development, sets policies, and identifies ways to put the policies into action. The noise element of the County General Plan contains planning guidelines relating to noise and identifies goals and policies to support achievement of those goals. Noise element guidelines relate primarily to land use compatibility with noise sources that are not regulated at the local level, such as traffic, aircraft, and trains. (Solano County 2008.)

The County's noise ordinance is the primary enforcement tool for operation of locally regulated noise sources such as mechanical equipment and construction activity.

The Solano County General Plan includes noise thresholds for permanent facilities and construction-related activities. The maximum allowable noise levels from construction equipment typically is 75 dBA at 50 feet. (Solano County 2008.) Solano County's Land Use Noise Compatibility Guidelines, Table 5.8-2, indicates that <70 CNEL is the normally acceptable standard for water-based recreational uses, and that <60 CNEL is the normally acceptable standard for residential uses.

Table 5.8-2. Land Use Noise Compatibility Guidelines

	Community Noise Exposure (L_{dn} or CNEL, dBA)			
Land Use Category	Normally Acceptable[1]	Conditionally Acceptable[2]	Normally Unacceptable[3]	Clearly Unacceptable[4]
All residential, lodging, schools, libraries, places of worship, nursing homes	<60	60–65	65–75	75+
Auditoriums, concert halls, amphitheaters	–	<70	70+	–
Sports arena, outdoor spectator sports	–<75	70+	–	
Playgrounds, neighborhood parks	<67.5	–	67.5–75	75+
Golf courses, riding stables, water recreation, cemeteries	<70	–	70–80	80+
Retail, movie theaters, restaurants	<65	65–75	75–80	80+
Office building, business commercial and professional	<67.5	67.5–77.5	77.5+	–
Industrial, manufacturing, utilities, agriculture	<75	70–80	75+	–
Noise-sensitive manufacturing and communications	<55	55–70	70–80	80+

Notes:

CNEL = community noise equivalent level; dBA = A-weighted decibel; Ldn = day-night average noise level.

1 Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

2 New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and needed noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.

3 New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design. Outdoor areas must be shielded.

4 New construction or development should generally not be undertaken.

5 These standards are not applicable for development within the airport compatibility review area. Development in the airport compatibility review areas are subject to standards in the applicable airport land use plan.

Source: Solano County 2008 Draft General Plan (Solano County 2008).

Physical Setting

Noise-Sensitive Land Uses

Noise-sensitive land uses generally are defined as locations 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. A noise-sensitive land use also can be defined as an area of frequent human use that would benefit from a lowered noise level. In general, an area of frequent human use is an area where people spend at least 1 hour on a regular basis.

Noise-sensitive uses in the plan area include scattered single-family residences and waterfowl hunting areas with associated clubhouses.

Existing Noise Environment

Although portions of Solano County are urbanized, most of the county is generally considered rural. Ambient noise levels in urban areas typically range from approximately 60 to 70 dBA, and in rural areas from approximately 40 to 50 dBA.

Ambient sound levels associated with noise-sensitive land uses in the vicinity of the project site vary depending on the proximity of major existing noise sources such as traffic, aircraft, and industrial uses. Ambient sound levels in similar suburban/rural settings are typically in the range of 40 to 60 dBA.

Environmental Consequences

Assessment Methods

Potential construction noise impacts were determined using methodology developed by the FTA (Federal Transit Administration 2006). The types of construction equipment used for each proposed activity have been developed based on the description of the proposed activity. Reference noise levels for each piece of equipment were taken from FTA (2006). Utilization factors were estimated from factors provided in Thalheimer (2000). Impacts were determined based on the assumption that no major site-specific projects would be implemented at the same time in the same vicinity.

Significance Criteria

The State CEQA Guidelines, county standards, and standard professional practice were used to determine whether constructing and operating the SMP alternatives would result in a significant noise impact. Noise impacts would be considered significant if constructing or operating the alternatives 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 vicinity above levels existing without the plan; or

- result in a substantial temporary or periodic increase in ambient noise levels in the vicinity above levels existing without the plan.

Solano County has a list of maximum allowable noise levels from construction equipment. Maximum noise levels for most construction equipment is 75 dBA at 50 feet but is up to 95 dBA for pile drivers.

For the purposes of this analysis, construction noise would be considered significant if it would exceed 75 dBA L_{max} at the outdoor use area of a residence or would occur within 1,000 feet of a residence during evening/nighttime hours (6:00 p.m. to 7:00 a.m.). Noise from trucking activities would be considered significant if it would exceed 60 dBA-L_{eq} at the outdoor use area of a residence.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, some construction would occur. As such, there could be minor, localized increases in noise levels during construction of the restoration areas. Noise generated by managed wetland activities is expected to decrease, but could continue to affect their associated sensitive receptors. Overall, a reduction in noise is expected as a result in a reduction in activities in the Marsh. Therefore, there would be no impact.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact NZ-1: Temporary Increases in Ambient Noise during Construction Activities Associated with Restoration

Most noise associated with construction activities would be highly localized. However, noise from trucks would not be localized and would occur on roads throughout the plan area and on roads used to access specific project sites. Because noise-sensitive land uses are sparsely located throughout the plan area, it is unlikely that noise from these activities would have a substantial impact on any sensitive receptors. However, as described above, noise impacts exceeding 75 dBA L_{max} at the outdoor use area of a residence or would occur within 1,000 feet of a residence during evening/nighttime hours (6:00 p.m. to 7:00 a.m.) would be considered significant. Truck noise would be considered significant if it would exceed 60 dBA L_{eq} at the outdoor use area of a residence. To ensure that there would be no significant impact associated with these temporary increases in ambient noise during construction, construction hours would be limited when occurring near residences and noise reduction practices would be implemented as described in the Environmental Commitments section of Chapter 2.

Conclusion: Less than significant. No mitigation required.

Impact NZ-2: Temporary Exposure of Sensitive Land Uses to Groundborne Vibration or Noise from Construction Activities

Noise-sensitive land uses could be exposed to vibration resulting from heavy equipment operation. Vibration produced by grading activities has been assessed using an analysis method recommended by FTA (Federal Transit Administration 2006). A reasonable worst-case assumption is that a bulldozer would generate the highest vibration of any heavy equipment used. The recommended reference vibration amplitude or reference PPV for a large bulldozer is 0.089 inch per second at 25 feet. The estimated vibration amplitude at various distances has been calculated and is summarized in Table 5.8-3.

Table 5.8-3. Estimated Vibration Amplitude from a Large Bulldozer

Distance (feet)	Peak Particle Velocity (inch/second)
25	0.089
50	0.031
100	0.011
200	0.0039

Source: California Department of Transportation 2004.

The threshold of perception for groundborne vibration is about 0.02 inch/second (California Department of Transportation 2004). Accordingly, perceptible vibration from the operation of heavy equipment is expected to be limited to an area within about 75 feet of the activity. Because residences are not anticipated to be located within 75 feet of heavy equipment operation, this impact is considered to be less than significant.

Conclusion: Less than significant. No mitigation required.

Impact NZ-3: Permanent Increases in Ambient Noise

Noise generated from individual site-specific projects would occur sporadically over the 30-year implementation period. This could result in slight, isolated occurrences of increased noise (described above under Impact NZ-1) that together would represent an overall permanent (30-year) increase in the ambient noise in Suisun Marsh. However, specific projects would occur throughout the plan area over time. As such, it is not expected that overlaps in substantial noise generation would occur in the same areas of the Marsh that would affect the same sensitive receptors at the same time in a manner that would be considered permanent.

Conclusion: Less than significant. No mitigation required.

Impact NZ-4: Exposure of Noise-Sensitive Land Uses to Noise from Material Hauling Operations

Truck traffic would increase temporarily to remove and import levee materials and import riprap and other construction materials. A description of anticipated trucking activity is provided in Section 5.7, Transportation and Navigation. It is not possible at this time to determine specific truck volumes on specific roadways. However, a reasonable worst-case assumption is that up to 20 heavy trucks per hour could use any given roadway. Using the Federal Highway Administration Traffic Noise Model (TNM) Version 2.5 and a nominal speed of 45 mph, 20 trucks per hour would produce the following hourly sound levels:

- 54 dBA at 100 feet
- 50 dBA at 200 feet
- 45 dBA at 400 feet

Because noise from project-related trucking operations is not predicted to exceed 60 dBA L_{eq} within about 100 feet of the trucking activity, it is unlikely that trucking noise would exceed 60 dBA L_{eq} at the outdoor use areas of any residences.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact NZ-2: Temporary Exposure of Sensitive Land Uses to Groundborne Vibration or Noise from Construction Activities

This impact would be similar to that described for restoration activities. Noise-sensitive land uses could be exposed to vibration resulting from heavy equipment operation. Perceptible vibration from the operation of heavy equipment is expected to be limited to an area within about 75 feet of the activity. Because residences are not anticipated to be located within 75 feet of heavy equipment operation, this impact would be considered less than significant.

Conclusion: Less than significant. No mitigation required.

Impact NZ-3: Permanent Increases in Ambient Noise

This impact would be similar to that described for restoration activities. Noise generated from individual site-specific projects would occur sporadically over the 30-year implementation period, which could result in slight, isolated occurrences of increased noise (described below under Impact NZ-5) that together would represent an overall permanent (30-year) increase in the ambient noise in Suisun Marsh. However, specific projects would occur throughout the plan area over time. Therefore, it is not expected that overlaps in substantial noise generation would occur in the same areas of the Marsh that would affect the same sensitive receptors at the same time in a manner that would be considered permanent.

Conclusion: Less than significant. No mitigation required.

Impact NZ-4: Exposure of Noise-Sensitive Land Uses to Noise from Material Hauling Operations

This impact would be similar to that described for restoration activities. Truck traffic would increase temporarily to remove and import levee materials and import riprap and other construction materials. Because noise from project-related trucking operations is not predicted to exceed 60 dBA L_{eq} within about 100 feet of the trucking activity, it is unlikely that trucking noise would exceed 60 dBA L_{eq} at the outdoor use areas of any residences.

Conclusion: Less than significant. No mitigation required.

Impact NZ-5: Temporary Increases in Ambient Noise during Construction Activities Associated with Management Activities

Some of the managed wetland activities would involve the use of heavy construction equipment. These activities include dredging equipment, box scrapers, dozers, and trucks. Table 5.8-4 summarizes typical noise levels produced by construction equipment commonly used for managed wetland activities. As indicated, equipment involved in construction is expected to generate noise levels ranging from 55 dB to 95 dB at a distance of 50 feet. Noise produced by construction equipment would be reduced at a rate of about 6 dB per doubling of distance.

Table 5.8-4. Construction Equipment Inventory and Noise Emission Levels and Utilization Factor

Equipment	Typical Noise Level (dBA) 50 ft from Source[1]	Utilization Factor[5]
Long-reach excavator	85 [1]	0.4
Diesel-powered barges	85 [2]	0.5
Small to medium bulldozers	85	0.4
Dump trucks	84	0.4
Small clamshell dredge	80 [3]	0.4
Crane	88	0.2
Front-end loader	85	0.4
Small boat	55 [4]	–

[1] Assumed same as excavator.
[2] Assumed same as dump truck.
[3] Geier & Geier Consulting 1997.
[4] Assumed same as pickup truck.
[5] Thalheimer 2000.

A reasonable worst-case assumption is that the three loudest pieces of equipment (crane, excavator, and bulldozer) would be operated simultaneously and continuously over a period of at least 1 hour within the same area. Table 5.8-4 shows the noise levels produced by each piece of equipment described above along with a related utilization factor (Thalheimer 2000). The predicted 1-hour L_{eq} value is calculated from the maximum noise level and the utilization factor. The combined noise level, assuming simultaneous operation of each piece of equipment, is provided along with predicted noise levels at various distances from the source. The predicted noise levels at various distances take into account geometric point-source attenuation (6 dB per doubling of distance) and ground absorption (1 to 2 dB per doubling of distance). The results in Table 5.8-5 indicate that construction operations could result in noise that exceeds 75 dBA within about 200 feet of construction operations.

Table 5.8-5. Construction Noise

Source Data	Maximum Sound Level (dBA)	Utilization Factor	L_{eq} Sound Level (dBA)
Construction Condition: Suisun Marsh Restoration			
Source 1: Crane—Sound level (dBA) at 50 feet	88	0.2	81.0
Source 2: Excavator—Sound level (dBA) at 50 feet	85	0.4	81.0
Source 3: Bulldozer—Sound level (dBA) at 50 feet	85	0.4	81.0
Average Height of Sources—Hs (feet)			10
Average Height of Receiver—Hr (feet)			5
Ground Type (soft or hard)			soft
Calculated Data:			
All Sources Combined—L_{max} sound level (dBA) at 50 feet			91
All Sources Combined—L_{eq} sound level (dBA) at 50 feet			86
Effective Height (Hs+Hr)/2			7.5
Ground Factor (G)			0.62

Distance between Source and Receiver (feet)	Geometric Attenuation (dB)	Ground Effect Attenuation (dB)	Calculated L_{max} Sound Level (dBA)	Calculated L_{eq} Sound Level (dBA)
50	0	0	91	86
100	-6	-2	83	78
200	-12	-4	75	70
300	-16	-5	71	65
400	-18	-6	67	62
500	-20	-6	65	60
600	-22	-7	63	58
700	-23	-7	61	56
800	-24	-7	60	54
900	-25	-8	58	53
1,000	-26	-8	57	52
1,200	-28	-9	55	50
1,400	-29	-9	53	48
1,600	-30	-9	52	46
1,800	-31	-10	50	45

Distance between Source and Receiver (feet)	Geometric Attenuation (dB)	Ground Effect Attenuation (dB)	Calculated L_{max} Sound Level (dBA)	Calculated L_{eq} Sound Level (dBA)
2,000	-32	-10	49	44
2,500	-34	-10	47	41
3,000	-36	-11	44	39

Source: Calculations based on Federal Transit Administration 2006.

Note: This calculation does not include the effects, if any, of local shielding from walls, topography or other barriers that may reduce sound levels further.

Although highly unlikely, management activities could take place within 200 feet of residences. Noise-reducing practices, as described in the Environmental Commitments section of Chapter 2, would be implemented if noise levels adjacent to a sensitive receptor are anticipated to exceed standards.

Conclusion: Less than significant. No mitigation required.

Impact NZ-6: Exposure of Noise-Sensitive Land Uses to Noise from Portable Pump Operations

Pumps would be used to dewater managed wetlands to augment flood and drain practices. It is reasonable to assume the pumps used for dewatering would be diesel-powered, and approximately 75 horsepower (Hp). It is anticipated that up to eight dewatering pumps may be used at any one time but would be spread throughout the plan area.

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 2000). A single 75-Hp dewatering pump is anticipated to generate a noise level of 80dBA at a distance of 50 feet.

A reasonable worst-case assumption is that eight pumps would operate simultaneously and continuously over a 24-hour day. Simultaneous operation of eight dewatering pumps would result in a combined source level of 89 dBA at 50 feet. For a sound source that operates continuously over a 24-hour period, the CNEL value is about 7 dB greater than the 1-hour L_{eq} value. In this case the CNEL value would be 96 CNEL at 50 feet. Table 5.8-6 calculates estimated sound levels from the operation of dewatering pumps as a function of distance. The predicted noise levels at various distances takes into account geometric point-source attenuation (6 dB per doubling of distance) and ground absorption (1 to 2 dB per doubling of distance).

The results in Table 5.8-6 indicate that pumping noise may exceed 70 CNEL within 275 feet of the pump. Noise-sensitive land uses may be located within 275 feet of the pump locations.

Table 5.8-6. Pump Operation Noise

Source Data	Maximum Sound Level (dBA)	Utilization Factor	L_{eq} Sound Level (dBA)
Condition: pump operation			
Source 1: 8 pumps - Sound level (dBA) at 50 feet =	96	0.4	92.0
Average Height of Sources - Hs (feet) =			2
Average Height of Receiver - Hr (feet) =			5
Ground Type (soft or hard) =			soft
Calculated Data:			
All Sources Combined - L_{eq} sound level (dBA) at 50 feet =			94
Effective Height (Hs+Hr)/2 =			3.5
Ground factor (G) =			0.66

Distance Between Source and Receiver (feet)	Geometric Attenuation (dB)	Ground Effect Attenuation (dB)	Calculated L_{eq} Sound Level (dBA)
50	0	0	94
100	-6	-2	86
200	-12	-4	78
300	-16	-5	73
400	-18	-6	70
500	-20	-7	67
600	-22	-7	65
700	-23	-8	63
800	-24	-8	62
900	-25	-8	60
1,000	-26	-9	59
1,200	-28	-9	57
1,400	-29	-10	55
1,600	-30	-10	54
1,800	-31	-10	52
2,000	-32	-11	51
2,500	-34	-11	48
3,000	-36	-12	46

Source: Calculations based on Federal Transit Administration 2006.

Note: This calculation does not include the effects, if any, of local shielding from walls, topography or other barriers which may reduce sound levels further.

In instances where the operation of portable pumps is occurring under the existing condition, there would be no impact unless additional pumps are used, it is placed in an area that increases the noise at sensitive land uses, or it generates additional noise. Otherwise, a significant impact could occur.

Conclusion: Less than significant with Mitigation Measure NZ-MM-1 incorporated.

Mitigation Measure NZ-MM-1: Limit Noise from Pump Operations
The specific project proponent will limit noise from pump operations, where feasible, such that noise from pump operations does not exceed 70 CNEL in the surrounding areas. Noise control measures that can be implemented to reduce noise from pumps on adjacent land uses include those following.

- All internal combustion engine–driven equipment will be equipped with intake and exhaust mufflers that are in good condition and appropriate for the equipment.
- Unnecessary idling of internal combustion engines will be strictly prohibited.

Staging of pump equipment within 275 feet of residences will be avoided. Where equipment must be located within 275 feet of residences, enclosures or barriers will be provided around pumps to reduce noise to acceptable levels.

Alternative B: Restore 2,000–4,000 acres

Impacts for Alternative B are the same as for Alternative A.

Alternative C: Restore 7,000–9,000 acres

Impacts for Alternative C are the same as for Alternative A.

Section 5.9
Climate Change

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives and how climate change may affect future restoration sites.

The Affected Environment discussion below describes the current setting of the plan area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the plan. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary. Adaptation refers to actions that are taken (separate from a specific project) to prepare for the effects of ongoing climate change. This section identifies mitigation measures, not adaptation measures, for addressing the effects of implementing the SMP in light of climate change through the 30-year planning horizon. However, indirect effects of implementation of the SMP itself can be considered a form of climate adaptation as restored wetlands would be more resilient to sea level rise effects.

Summary of Impacts

Table 5.9-1 summarizes climate change impacts from implementing the SMP alternatives. There would be no significant impacts on climate change from implementing the SMP action alternatives.

Table 5.9-1. Summary of Climate Change Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
CC-1: Construction-Related Changes in Greenhouse Gas Emissions	A, B, C	Less than significant	None required	–
CC-2: Permanent Changes in Greenhouse Gas Sources and Sinks	A, B, C	Beneficial	None required	–
CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated with Sea Level Rise	No Action Alternative	–	–	–
CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated with Sea Level Rise	A, B, C	Beneficial	None required	–

Affected Environment

Regulatory Setting

Federal

There are no federal standards for greenhouse gas (GHG) emissions or contributions to climate change and no requirements to address climate change in NEPA analysis. However, recent activity suggests that regulation may be forthcoming, with the EPA serving in a leadership role to implement such a program. However, EPA regulation may be preempted by congressional action should a cap and trade bill be passed prior to adoption of EPA regulation.

This section summarizes recent legal cases, legislation, and policy related to climate change and GHG regulation.

Massachusetts et al. v. *Environmental Protection Agency* (2007)

Twelve U.S. states and cities including California, in conjunction with several environmental organizations, sued to force the EPA to regulate GHGs as a pollutant pursuant to the Clean Air Act (CAA) in *Massachusetts* et al. v. *Environmental Protection Agency*. On April 2, 2007, the U.S. Supreme Court held that EPA has the authority to regulate GHG emissions as a pollutant pursuant to the CAA. However, the court did not decide whether EPA is required to regulate GHG emissions at this time, or may exercise discretion to not regulate at this time.

Despite the Supreme Court ruling and the EPA proposal, there are no promulgated federal regulations to date limiting GHG emissions that are applicable to the project.

EPA Finding of Endangerment (2007)

On April 17, 2009, the EPA issued a Proposed Endangerment and Cause or Contribute Finding for Greenhouse Gases under the CAA. Through this Finding of Endangerment, the EPA Administrator proposed that current and projected concentrations of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFC), and sulfur hexafluoride (SF_6) threaten the public health and welfare of current and future generations. Additionally, the Administrator proposed that combined emissions of CO_2, CH_4, N_2O and HFCs from motor vehicles contribute to the atmospheric concentrations and thus to the threat of climate change. Although the Endangerment Finding in itself does not place requirements on industry, it is an important step in the EPA's process to develop regulation.

Environmental Protection Agency Advance Notice of Proposed Rulemaking 2008

In June 2008, the EPA issued an Advance Notice of Proposed Rulemaking (ANPR) inviting comments on options and questions regarding regulation of GHGs under the CAA but has not yet proposed or adopted regulations in response to the Massachusetts case decision.

Environmental Protection Agency Rule: Mandatory Reporting of Greenhouse Gases (2009)

On September 22, 2009, the EPA Administrator signed a rule requiring mandatory reporting of emissions of GHGs from large sources within the United States. The rule was published in the *Federal Register* on October 30, 2009, and goes into effect December 29, 2010. The rule includes emissions of CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, nitrogen trifluoride (NF_3), hydrofluorinated ethers (HFE), and select other fluorinated compounds. Under the rule, suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions are required to report annual emissions to the EPA. The first annual reports for the largest emitting facilities, covering calendar year 2010, will be submitted to the EPA in 2011.

State

California Global Climate Change Solutions Act of 2006

In Assembly Bill 32 (AB32) (California Global Warming Solutions Act of 2006), the Legislature recognized California's vulnerability to weather events triggered by global warming. The Legislature found that global warming will "have detrimental effects on some of California's largest industries." Residents likely will be affected by many of these climate change effects, given the importance of agriculture, tourism, and recreation to Solano County (Yolo-Solano Air Quality Management District 2007).

AB32 mandates that emissions of GHGs be reduced to 1990 levels by 2020. Considering that 40% of GHG emissions come from motor vehicles, projects that generate new vehicle trips can conflict with AB32 goals.

Senate Bill 97 Chapter 185, Statutes of 2007

Senate Bill (SB) 97 requires that the Office of Planning and Research (OPR) prepare guidelines to submit to the California Resources Agency regarding feasible mitigation of GHG emissions or the effects of GHG emissions as required by CEQA. The Resources Agency is required to certify and adopt these revisions to the State CEQA Guidelines by January 1, 2010. The Guidelines will apply retroactively to any incomplete environmental impact report, negative declaration, mitigated negative declaration, or other related document.

Executive Order S-03-05 (2005)

California Executive Order S-03-05, issued by Governor Arnold Schwarzenegger, established the following GHG emission reduction targets for California's state agencies:

- By 2010, reduce GHG emissions to 2000 levels;
- By 2020, reduce GHG emissions to 1990 levels; and
- By 2050, reduce GHG emissions to 80% below 1990 levels.

The order also required that the Secretary of the California Environmental Protection Agency (CalEPA) oversee and coordinate emission reduction efforts with the Secretary of the Business, Transportation and Housing Agency, Secretary of the Department of Food and Agriculture, Secretary of the Resources Agency, Chairperson of the CARB, Chairperson of the CEC, and the President of the Public Utilities Commission (PUC). The Secretary of CalEPA is required to report to the governor and state legislature biannually on the impacts of global warming on California, mitigation and adaptation plans, and progress made toward reducing GHG emissions to meet the targets established in this executive order.

Executive Orders are directives to state agencies from the Governor of California. They do not govern local agency actions nor do they affect the state legislature. While S-03-05 is an indicator of state policy as interpreted by the governor, it may or may not reflect the view of the legislature. It is, however, one of the factors being considered by state agencies such as the CARB, CEC, and the Building Standards Commission in formulating their GHG reduction strategies.

Executive Order S-13-08 (2008)

California Executive Order S-13-08, issued by Governor Arnold Schwarzenegger, directed the California Resources Agency to develop a state Climate Adaptation Strategy by June 30, 2009, and complete the first California Sea Level Rise Assessment Report by December 1, 2010. The assessment report must advise how California should plan for future sea level rise and should account for California-specific sea level rise projections; scientific uncertainty; impacts on state infrastructure, natural areas, and coastal/marine ecosystems; and a discussion of future research needs. The Executive order also requires that state agencies must address, for construction projects in areas vulnerable to sea level rise, project vulnerability to sea level rise, and as feasible, reduce risks and increase resiliency to sea level rise.

The 2009 California Climate Adaptation Strategy was released in December, 2009, and summarizes the best known science on climate change impacts in seven specific sectors and provides recommendations on how to manage against those threats. This strategy discusses adaptation strategies related to sea level rise, biodiversity, and ocean and coastal resources. It calls for the creation of statewide guidance and regional planning forums to help local governments update local plans and make planning decisions in light of sea level rise. Strategies include:

- Management of Watersheds, Habitat, and Vulnerable Species
- Establish State Policy to Avoid Future Hazards and Protect Critical Habitat
- Provide Statewide Guidance for Protecting Existing Critical Ecosystems, Existing Coastal Development, and Future Investments
- State Agencies Should Prepare Sea Level–Rise and Climate Adaptation Plans
- Support Regional and Local Planning for Addressing Sea Level–Rise Impacts
- Complete a Statewide Sea Level–Rise Vulnerability Assessment Every Five Years

Senate Bill 1107, Chapter 230, Statutes of 2004

This bill, approved August 16, 2004, includes a provision requiring that the Secretary of CalEPA coordinate GHG emission reductions and climate change efforts in the state government (California Energy Commission 2005).

Senate Bill 812, Chapter 423, Statutes of 2002

SB 812 requires the California Climate Action Registry to cooperate with the CARB to develop and adopt protocols for reporting and certification of GHG emissions reductions from forestry conservation and conservation-based management projects. This bill also requires the registry to develop protocols for reporting and certifying GHG reduction projects of participants.

Senate Bill 527, Chapter 769, Statutes of 2001

SB 527, approved October 11, 2001, requires the California Climate Action Registry to coordinate with the State Energy Resources Conservation and Development Commission to adopt industry-specific GHG reporting metrics. The bill requires separate reporting of direct and indirect emissions of participants in the California Climate Action Registry and requires the registry to periodically report the number of participating organizations and the percentage of total state emissions represented by participants as well as any GHG reductions achieved by participating organizations. Under SB 527, the responsibilities of the California Climate Action Registry are adjusted to meet state goals to promote voluntary reporting and reduction of GHG emissions. The bill defines the terms *annual emissions results, baseline, certification, emissions, emissions inventory, greenhouse gases, material,* and *de minimis emissions* as they pertain to climate change and the California Climate Action Registry and CARB.

Senate Bill 1771, Chapter 1018, Statues of 2000

SB 1771 (Chapter 1018, Statutes of 2000) established the California Climate Action Registry (CCAR) in 2000. In 2001 SB 527 (Chapter 769, Statutes of 2001) modified CCAR as a nonprofit voluntary registry for GHG emissions. (SB 1771 enacted Sections 42800–42870 of the California Health and Safety Code and Public Resources Code Section 25730; SB 527 amended Sections 42810, 42821–42824, 42840–42843, 42860, and 42870 of the Health and Safety Code.) The purpose of CCAR is to help companies and organizations with operations in the state establish GHG emissions baselines against which future GHG emissions reduction requirements may be applied. CCAR has developed general protocols and additional industry-specific protocols that provide guidance on how to inventory GHG emissions for participation in the registry.

Local

Solano County General Plan

The Solano County General Plan (Solano County 2008) recognizes AB32 and its goal of reducing GHG emissions. The County's goal is to reduce GHG emissions by 20% below 1990 levels by 2020. The general plan integrates the reduction throughout different resource areas such as Land Use, Public Facilities and Services, Transportation and Circulation, Health and Safety, Economic Development, Resources, and Agriculture. One of the first strategies will be to develop and adopt the Solano County Climate Action Plan (CAP) by June 30, 2010. The CAP will address both GHG emissions from activity within the county (residential, commercial, industrial, transportation, and agricultural sectors) and emissions specifically from county operations. The CAP first will create a GHG emissions inventory for the base year 1990 and forecast GHG emissions for the year 2020. The CAP will determine the quantity of emissions to be reduced in order to meet the reduction target of 20% below 1990 levels. The CAP's third step will be to establish additional policies and programs necessary to achieve the county's reduction target. The fourth step of the CAP will describe strategies, policies, and measures that will be used to protect the county from and facilitate adaptation to the potential effects of climate change. Finally, the CAP will identify benchmarks, monitoring procedures, and other steps needed to ensure the county achieves its GHG reduction, protection, and adaptation goals. The following emission reduction benchmarks will be included (Solano County 2008: HS-102–109):

- overall emissions reductions of at least10% below 1990 levels by 2015,
- overall emissions reductions of at least 20% below 1990 levels by 2020, and
- reductions of total countywide energy consumption of at least 2% per year to achieve a minimum 20% reduction by 2020.

Solano County also will develop and adopt a Sea Level Rise Strategic Program (SLRSP). The SLRSP will have three primary objectives—(1) investigate the potential effects of sea level rise on Solano County, (2) identify properties and resources susceptible to sea level rise in order to prioritize management strategies, and (3) develop protection and adaptation strategies to meet the county's and region's goals. The program will encompass all areas identified within a sea level–rise planning area and will be coordinated with San Francisco BCDC, CBDA, and other relevant agencies (Solano County 2008: HS-13).

San Francisco Bay Conservation and Development Commission

The BCDC has developed a Climate Change Planning Project with the following goals:

1. identify and report on the impacts of climate change on San Francisco Bay;

2. identify strategies for adapting to climate change;
3. develop a regional task force to inform and coordinate local governments, stakeholders, and land use planning bodies in the Bay Area regarding the potential bay-related impacts of and approaches for adapting to global climate change;
4. identify the findings and policies in the San Francisco Bay Plan pertaining to climate change, such as the findings and policies on sea level rise, and update other relevant Bay Plan policies to incorporate new information about the impacts of climate change (San Francisco Bay Conservation and Development Commission 2006).

Current Climate Change Predictions

Global Warming and Greenhouse Gases

Global warming is the name given to the increase in the average temperature of the earth's near-surface air and oceans since the mid-20th century and its projected continuation. Warming of the climate system now is considered to be unequivocal (Intergovernmental Panel on Climate Change 2007) with global surface temperature increasing approximately 1.33°F over the last 100 years. Continued warming is projected to increase global average temperature between 2 and 11°F over the next 100 years.

The causes of this warming have been identified as both natural processes and as the result of human actions. The Intergovernmental Panel on Climate Change (IPCC) concludes that variations in natural phenomena such as solar radiation and volcanoes produced most of the warming from pre-industrial times to 1950 and had a small cooling effect afterward. However, after 1950, increasing atmospheric GHG concentrations resulting from human activity such as fossil-fuel burning and deforestation have been responsible for most of the observed temperature increase. These basic conclusions have been endorsed by more than 45 scientific societies and academies of science, including all of the national academies of science of the major industrialized countries. Since 2007, no scientific body of national or international standing has maintained a dissenting opinion.

Increases in GHG concentrations in the earth's atmosphere are thought to be the main cause of human-induced climate change. Greenhouse gases are gases that naturally trap heat by impeding the exit of solar radiation that has hit the earth and is being reflected back into space. Some greenhouse gases occur naturally and are necessary for keeping the earth's surface inhabitable. However, increases in the concentrations of these gases in the atmosphere during the last hundred years have decreased the amount of solar radiation that is reflected back into space, intensifying the natural greenhouse effect and resulting in the increase of global average temperature.

The principal greenhouse gases are CO_2, CH_4, N_2O, SF_6, PFCs, HFCs, and water vapor (U.S. Environmental Protection Agency 2009a). Each of the principal greenhouse gases has a long atmospheric lifetime (1 year to several thousand years). In addition, the potential heat-trapping abilities of each of these gases vary significantly from one another.

CH_4 is 21 times as potent as carbon dioxide, while SF_6 is 22,200 times more potent than CO_2. Conventionally, GHGs have been reported as carbon dioxide equivalents (CO_2e). CO_2e takes into account the relative potency of non-CO_2 GHGs and converts their quantities to an equivalent amount of CO_2 so that all emissions can be reported as a single quantity.

The primary human-made processes that release these gases are: burning of fossil fuels for transportation, heating and electricity generation; agricultural practices such as livestock grazing and crop residue decomposition that release CH_4; and industrial processes that release smaller amounts of high global warming–potential gases such as SF_6, PFCs, and HFCs. Deforestation and land cover conversion also have been identified as contributing to global warming by reducing the earth's capacity to remove CO_2 from the air and altering the earth's albedo or surface reflectance, allowing more solar radiation to be absorbed.

Although the international, national, state, and regional community is beginning to address GHGs and the potential effects of climate change, it is expected that worldwide GHG emissions will continue to rise over the next several years.

In the plan area, most GHG emissions are generated from vehicle use, industrial activities, and residential uses.

Greenhouse Gases and Wetlands

Analysis of GHG fluxes from wetlands has received a considerable amount of study in the last two decades. However, given that carbon cycling, CH_4 production, and nitrogen cycling vary substantially in different wetlands at different times of the year and because of highly site-specific chemical and biological characteristics, there is a substantial amount of uncertainty in estimating potential changes in GHG emissions and sequestration in such dynamic environments. The values below should be considered an illustrative evaluation of the potential changes in carbon sequestration and CH_4 production associated with the proposed project, but given the level of uncertainty in the underlying supporting research, the values derived below should not be considered predictive. However, as described below, the evidence does allow for concluding the direction of change in carbon sequestration and CH_4 production, but not for the precise determination of the extent of such change.

Water salinity plays a major role in wetland carbon cycling, CH_4 production, and nitrogen cycling. Wetlands with higher salinity tend to sequester more carbon and emit less CH_4 than wetlands with lower salinity. The concentration of salts (salinity) in ocean water is approximately 33 parts sea salt per thousand parts of water (ppt, or grams per liter [g/L]) (psu), while the salinity of fresh water is near zero (U.S. Geological Survey 2007). Salinity measurements taken at the Suisun wetlands between 2002 and 2003 are presented in Section 5.2, Water Quality. Figure 5.2-3 shows the variation in salinity within Suisun Bay from Martinez to Collinsville. Salinity in the Marsh varies with Delta outflow. Figure 5.2-4 indicates that salinity averages about 15 milliSiemens per centimeter (mS/cm) in the western Marsh and about 5 mS/cm in the eastern portion of the Marsh.

Carbon Dioxide Sequestration

Through the process of photosynthesis, plants take up CO_2 from the atmosphere. Along with water, nutrients, and minerals, CO_2 is incorporated into the living tissue of plants to allow for development, growth, and reproduction of the plant. This is the process through which carbon is sequestered into plants and stored as carbon stock. Some portion of the carbon removed from the atmosphere is returned to the atmosphere through several processes, including respiration, decay, and disturbance. CO_2 emissions from respiration can be as much as 25% of “gross primary productivity,” or the net rate at which plants fix and store carbon as energy.

Like other plant matter, vegetation in wetlands can capture carbon by taking in atmospheric CO_2, converting it to plant mass through photosynthesis and then sequestering the carbon in the inundated soils that form as plant matter decomposes. Pilot studies being undertaken in tule marshes on Twitchell Island (approximately 15 miles east of Suisun Marsh) have found a very high primary productivity (carbon fixation) and sequestration (C-immobilization, or long-term “storage”) of belowground carbon that would remain stable if continuously inundated. When coupled with the CO_2 emissions reduction associated with preservation of historic peat deposits, as much as 25 metric tons of carbon per acre per year may be sequestered by freshwater marshes in the Delta according to indications in these studies. The results vary widely depending on many factors such as temperature, inundation regime, and plant species (U.S. Geological Survey 2007, 2008).

Saline and freshwater wetlands can represent net sinks of CO_2. Because tidal marshes are extremely productive, they are one of the most effective environments for carbon sequestration (Chmura et al. 2003; Trulio 2007; Mitsch and Gosselink 2000). Recent research estimates the carbon sequestration potential of saline marshes to range between 0.8 and 5.7 metric tons per acre per year (54 g/m^2 and 385 g/m^2/year) (U.S. Climate Change Science Program 2007; Trulio 2007). Freshwater mineral soil wetlands also sequester CO_2. The first State of the Carbon Cycle Report (SOCCR) estimates the sequestration potential of freshwater wetlands to be 0.3 metric ton per acre per year (21 g/m^2/year) (U.S. Climate Change Science Program 2007). These values represent the net, long-term storage of carbon in the system, after accounting for losses attributable to respiration. Research on sequestration in brackish wetlands is limited. Because the salinity in these environments is lower than in a salt marsh, but higher than in a freshwater marsh, it can be theorized that the carbon sequestration potential of brackish wetlands likely would fall somewhere between the range of a freshwater wetland and the range of a saltwater wetland.

Methane Emissions

While freshwater, saltwater, and brackish wetlands sequester amounts of CO_2, they also produce CH_4 through anaerobic decomposition of biomass; CH_4 is a more potent GHG than CO_2.[1] Approximately 76% of global naturally produced CH_4 comes from wetlands (U.S. Environmental Protection Agency 2009b). CH_4 is naturally produced and emitted from wetlands by CH_4-producing bacteria that need anoxic conditions combined with labile organic matter.

Saline marshes, in general, often are thought to release less CH_4 than freshwater environments, but the absolute differences depend on site characteristics (Trulio 2007; U.S. Climate Change Science Program 2007). Sulfates can suppress CH_4 production from CO_2 respiration (Chmura et al. 2003). Research suggests that tidal brackish wetlands release 6.4 g/m^1 to 22.4 g/m^2 of CH_4 per year, or 0.5 to 1.9 metric tons of CO_2e per acre per year (U.S. Climate Change Science Program 2007; Bartlett et al. 1987), while freshwater wetlands release 18.7 to 91.4 g/m^2 of CH_4, or 1.6 to 7.8 metric tons of CO_2e per acre per year (U.S. Climate Change Science Program 2007).[2] As mentioned above, the salinity in Suisun Marsh ranges from 3 to 10 psu, which corresponds to the high range of CH_4 emissions for tidal brackish wetlands presented above, or 1.6 to 1.9 metric tons of CO_2e per acre per year (Bartlett et al. 1987). Because CH_4 is a far more potent GHG on a pound-for-pound basis than CO_2, in freshwater wetlands CH_4 production may overwhelm the benefits obtained from carbon sequestration (U.S. Climate Change Science Program 2007). Recent work on wetland mesocosms[3] and restored wetlands (Altor 2009) has shown that the soils that originally formed under flooded or saturated conditions and are continually inundated with water release higher levels of CH_4 than periodically inundated soils.

CH_4 flux out of the marsh is controlled by numerous environmental factors, one of which is evapotranspiration. Evapotranspiration is the transport of water from soil or surfaces (evaporation) and from the open stomata of plants (transpiration) to the atmosphere. Other gases, such as CH_4 or N_2O discussed below, follow physical paths similar to water vapor as they move from an ecosystem to the atmosphere; thus, the evapotranspiration potential (ETP) of an ecosystem and its GHG flux are related. In Suisun Marsh, the ETP is estimated to increase

[1] Different GHGs are compared using their global warming potential (GWP) over a 100-year period. On this basis, CH_4 is approximately 21 times more powerful on a pound for pound comparison to CO_2 and thus has a GWP of 21. N_2O has a GWP of 310.

[2] The highest CH_4 values for brackish and freshwater marshes, 97 and 213 g/m^2 respectively, were assumed to be outliers and excluded from the calculations. In addition, higher CH_4 values were reported for non-tidal marshes. Uncertainty associated with these statistics can be as high as 100%.

[3] A mesocosm is any system larger than a microcosm (a smaller system which is representative of or analogous to a larger one) but smaller than a macrocosm (a complex structure, such as a society, considered as a single entity that contains numerous similar, smaller-scale structures). In the research cited above, mesocosm refers to a small study area within the marsh that was examined and assumed to be representative of conditions throughout a larger area

dramatically from the western to eastern portions of the Marsh. This gradient, together with numerous other mediating factors, ultimately determines the amount and patterns of CH_4 released in the Marsh.

Nitrous Oxide Emissions

Natural emissions of N_2O result primarily from bacterial breakdown of nitrogen in soils and in the earth's oceans. Globally, tropical soils (primarily wet forest soils, but also savannas and agricultural systems) are estimated to produce 6.3 million tons (Tg) of N_2O annually, and oceans are thought to add around 4.7 Tg of N_2O annually to the atmosphere (Intergovernmental Panel on Climate Change 2001; U.S. Environmental Protection Agency 2009c). Together, these two sources account for more than 70% of the natural sources. Similar microbial processes in temperate-region soils produce smaller quantities of N_2O. In some ocean areas, large areas of surface water can become oxygen-depleted, allowing active denitrification in open water. Large amounts of oceanic N_2O also can arise from denitrification in marine sediments, particularly in nutrient-rich areas such as those of estuaries.

All wetlands produce N_2O through nitrification and denitrification processes, which are the generation and diagenesis of nitrate (NO_3), respectively. However, research on N_2O production rates from wetlands is limited. In addition, the research that has been conducted has an extremely high degree of uncertainty because of the compound's complex chemistry and unknown strength of nitrifying and denitrifying processes in certain environments. As such, depending on biogeochemical characteristics of a wetland (e.g., labile carbon availability, nitrate availability, redox potential), N_2O production could vary significantly. Given the current research limitations, N_2O production was not included in this analysis.

It is important in studies of N_2O emissions to account for the various interactions between natural processes and human influences in the nitrogen cycle, because human impacts can significantly enhance the natural processes that lead to N_2O formation. For example, the nitrogen nutrient loading in water bodies attributable to fertilization and runoff to streams can enhance N_2O emissions from these natural sources. Human-related ammonia emissions also have been shown to cause N_2O emissions in the atmosphere through ammonia oxidation.

Peat Soil Subsidence and Oxidation

Globally, peat oxidation accounts for 2–3 gigatons (Gt) per year of CO_2 equivalents (one tenth of fossil-fuel emissions) with rates ~tenfold greater in temperate and tropical soils than in boreal soils (Intergovernmental Panel on Climate Change 2007). In addition, global emissions of CO_2 from drained peatlands amounted to 1.4 Gt in 2008 (Wetlands International 2009).

Subsidence of organic soil in drained wetlands can produce CO_2 through microbial oxidation of the carbon in the organic component of the soil. Subsidence also can produce CH_4 and N_2O. Subsidence of organic soils is common in the Delta region. According to multiple studies, subsidence is caused primarily by microbial oxidation of soil organic carbon, which produces emissions of CO_2. Subsidence also can occur through anaerobic decomposition; consolidation; shrinkage; wind erosion; gas, water, and oil withdrawal; wetting and drying of the soil; and dissolution of organic matter (Deverel 2008). Peat soil lands in the Delta region are subsiding significantly, with an estimated subsidence rate between 0.2 and 2.5 inches per year that results primarily from the oxidation of the peat soil (Deverel and Rojstaczer 1996). However, research on peat soil oxidation rates from the Suisun area is limited. Much subsidence and peat soil oxidation in the Delta occur from agricultural practices on drained wetlands, and such practices are not occurring at Suisun. Consequently, subsidence at Suisun marsh is significantly less than subsidence in other Delta regions. In addition, oxidation and subsidence rates depend on soil organic content, carbon content, temperature, and other factors. Understanding these characteristics at Suisun improves the ability to predict net effects of hydrologic changes on peat oxidation.

Sea Level Rise

With respect to Suisun Marsh, the most critical climate change problem is the potential for significant increase in mean sea level. Such a rise may result from a combination of (a) the volumetric expansion of existing seawater as water temperatures rise significantly and (b) the increase in total (liquid) sea water as large ice deposits on land (e.g., in Antarctica, in Greenland, and worldwide in large glaciers) melt into the sea. Local sea level rise may be affected by both global sea level rise and geotectonic land mass movements and subsidence. Subsidence has the potential to affect local regional sea level to the same extent as climate change.

Atmospheric pressure, ocean currents, and local ocean temperatures also affect local rates of sea level rise. The sea level has risen approximately 4,800 inches (400 feet) since the peak of the last ice age about 18,000 years ago, but the bulk of that occurred before 6,000 years ago (Axelrod 1981). From 3,000 years ago to the late 1800s, the rate of sea level rise held almost constant (average rate of 0.0 to 0.2 millimeter per year, or 0.0 to 0.8 inch per century [Intergovernmental Panel on Climate Change 2007]); however, it appeared to increase worldwide in the twentieth century (e.g., 8.4 inches/century or 4.2 inches/50 years near San Francisco).

Most climate scientists agree that anthropogenically induced global warming will cause the rate of sea level rise to increase further. In 2001, the IPCC released a report with projections of global sea level rise over the next century. More recent studies project different rates of sea level rise for specific regions of the globe. These regional projections are considered more reliable on a region-by-region basis than the IPCC projections. To provide a comprehensive discussion of sea level rise, both IPCC and regional projections are presented below.

IPCC projections of sea level rise vary depending on several different GHG emissions scenarios analyzed in the IPCC Special Report on Emissions Scenarios. As such, the IPCC estimates sea level rise to be between 3.6 and 34.8 inches between years 1990 and 2100 (Intergovernmental Panel on Climate Change 2001). The IPCC model range of estimates for global sea level average rise by 2060 is predicted to be between 2.4 and 15.6 inches. However, the models used by the IPCC do not predict uniform global sea level rise, and there are substantial regional variations. The IPCC model predictions for the eastern Pacific indicate a range of sea level rise of 3.6 to 19.2 inches by 2100, which is on the lower end of the global range noted above. Most of the sea level rise predictions on the top end of the global range are for the top and bottom of the world (i.e., the polar latitudes), not the middle latitudes. Assuming net rise between 1990 and 2060 to be half of the net rise between 1990 and 2100, the geographic prediction for 2060 from the IPCC models for the eastern Pacific would be 1.8 to 9.6 inches.

While IPCC assessments of climate change and associated sea level rise rely on global models, adapting to climate change and associated sea level rise requires an understanding of how climate change will affect specific regions so that planning can take place at the state and regional levels. The California Climate Action Team relies on the IPCC Special Report on Emissions Scenarios for assessing primary impacts of climate change, namely changes in the frequency and intensity of precipitation and temperature increases, on a regional level (Cayan et al. 2006; Cayan et al. 2008). IPCC-projected temperature increases range from 2.5°F for the lowest emissions scenario to 10.4°F for the highest emissions scenario. However, the California Climate Action Team uses Rahmstorf's methodology for projecting sea level rise.

In 2007, German scientist, Stefan Rahmstorf, developed an empirical approach to projecting future sea level rise that entails calculating the relationship between sea level rise and global mean surface temperature. Rahmstorf first determined the historical trend in this relationship and then projected that trend into the future using IPCC's projected temperature increases associated with Special Report on Emissions Scenarios, which range from 2.5°F for the lowest emissions scenario to 10.4°F for the highest emissions scenario (Rahmstorf 2007). Rahmstorf's corresponding estimates of sea level rise by 2100 range from 10 inches to 55 inches.

IPCC's and Rahmstorf's sea level rise estimates did not include the effects of dams on sea level rise (Cayan et al. 2008). Dams constructed primarily during the 1950s to 1970s may have stored enough water worldwide to mask acceleration in the rate of sea level rise prior to the notable acceleration detected in 1993. As building of dams for additional upland water storage has slowed, sea level rise now may be accelerating faster than the IPCC and scientists such as Rahmstorf have predicted (Chao 2008).

The Delta Vision Blue Ribbon Task Force established by Governor Schwarzenegger to develop a strategic management plan for the Delta employed an Independent Science Board to review literature and provide recommendations on sea level rise. The Independent Science Board found that: (1) current IPCC projections are conservative and underestimate recently measured sea level rise; (2) empirical models, such as Rahmstorf's empirical method, yield significantly higher estimates of sea level over next few decades and are better for short- to mid-term planning; and (3) neither the IPCC nor Rahmstorf accounts for accelerating contributions from ice sheet melting, which likely will contribute significantly to future sea level rise with the potential for very rapid increases of up to 39 inches by 2100. Based on these findings, the Independent Science Board recommended adopting an estimated rise in sea level of 55 inches by 2100 and recommended adopting a sea level rise estimate for 2050 as well.

Therefore, even though the California Climate Action Team still relies on IPCC-projected temperature increases and Rahmstorf's methodology for projecting sea level rise, the team goes further to account for effects of dams and accelerated ice sheet melting on sea level rise. As a result, California Climate Action Team–funded research for a 2009 report (the 2009 California Climate Adaptation Strategy) to Governor Schwarzenegger estimates that sea level rise will increase in California between 12 and 17 inches by 2050 and between 20 and 55 inches by 2099 (San Francisco Bay Conservation and Development Commission 2009b). In addition, DWR supports a range in sea level rise of 7 to 55 inches along California's Coast by 2100 (California Department of Water Resources 2008). The most recent climate science report, the 2009 Copenhagen Diagnosis, estimates that global sea level rise will increase up to approximately 78.7 inches by 2100 (Allison et al. 2009). Based on these predictions, sea level rise would likely cause flooding in the urbanized areas of Suisun City and Fairfield.

The 2009 California Climate Adaptation Strategy includes many adaptation actions to respond to changes in sea level rise. Some of these actions are summarized below:

- identify and strategically prioritize for protection lands at the boundaries of the San Francisco Bay and the Delta that will provide the habitat range for tidal wetlands to adapt to sea level rise;
- minimize the adverse effects of sea level rise and storm activities by carefully consider new development within areas vulnerable to inundation;
- prepare agency-specific adaptation plans, guidance, and criteria, as appropriate (state agencies responsible for the management and regulation of resources and infrastructure subject to potential sea level rise); and
- identify and protect key habitats that may require more protection as a result of climate change impacts, including sea level rise.

See Chapter 2 of this EIS/EIR for further discussion of ways to respond to predicted sea level rise.

Water Quality

Trace elements such as copper can be present in wetland sediments, and copper toxicity to wildlife is a current water quality concern in the western Suisun Marsh. The increase in atmospheric CO_2 associated with climate change results in a decrease of ocean pH, because of carbonic acid increase associated with the ocean's increased absorption of CO_2. As copper desorption in aqueous environments is sensitive to changes in pH, copper toxicity is susceptible to increase as a result of climate changes. A change of 1 pH unit can result in a hundredfold increase in availability coming from copper bound in sediments (Sparks 1995). It is estimated that surface ocean pH will drop by up to 0.5 pH units by 2100, as the oceans absorb more CO_2. However, copper toxicity effects related to climate change would not change with implementation of the proposed project, as these copper toxicity effects would occur regardless of whether the proposed project is implemented. For more impact discussion related to wetland restoration and water quality, see Section 5.2, Water Quality.

Disease Vectors

There have been positive human test results for the West Nile virus across the United States, including the Bay Area, specifically Contra Costa County (U.S. Geological Survey 2009). Coccidioidomycosis (valley fever) also is located in the southwestern U.S. where temperatures are high and the soils are dry. With more severe, frequent, and lasting heat events associated with climate change, there could be a greater chance of infectious disease such as West Nile spread by insects (e.g., mosquitoes) or valley fever spread by fungi (e.g., *Coccidioides immitis*). This would be attributable to an increased range of warmer temperatures in the region that could lead to a wider ecosystem in which such insects and fungi thrive (U.S. Global Change Research Program 2000). Infectious disease effects related to climate change would not change with implementation of the proposed project, as the expansion of disease vectors would occur regardless of whether the proposed project is implemented. For more impact discussion related to wetland restoration and infectious diseases, see Section 7.8, Public Health and Environmental Hazards.

Temperature, Ecology, and Other Changes

Climate change impacts will substantially alter the bay ecosystem through erosion and loss of wetland habitat, changing sediment demand, altered species composition, changing freshwater inflow and salinity, altered food web, and impaired water quality. Warmer water temperatures and reducing amounts of tidal marsh may make it harder to recover the diverse range of threatened and endangered species living in the Bay and may increase the number of species considered threatened and endangered. These changes have the potential to overwhelm the bay ecosystem's ability to rebound and continue functioning (San Francisco Bay Conservation and Development Commission 2009a).

One predicted outcome of climate change is an increase in rainfall during the winter and spring months, and a decrease in snowmelt runoff in spring and summer months, making downstream areas more flood-prone in the winter and drier in the summer. Managed wetland draining within the bay could be more difficult because of the difference in water levels between the managed wetland interior and the exterior channels.

Climate change also may affect storm frequency and intensity, which can increase flooding when coupled with sea level rise. From 1993 to 2003, there was an increase in the number of storm surge events and high tides exceeding previously observed extremes. Increasing storm activity and more frequent extreme tides are projected to occur over time. If state water reservoirs lack the capacity to handle increased rainfall and earlier snowmelt, water managers may need to release flows through the Delta during winter months, resulting in even higher water levels (San Francisco Bay Conservation and Development Commission 2009a).

The combined effects of sea level rise, storm surge, and river flooding may result in water levels elevated as high as 51 inches for a period of 10 to 12 hours in the Delta and Suisun Marsh region, an area already below mean tide elevation surrounded by fragile levees (San Francisco Bay Conservation and Development Commission 2009a). Consequently, flooding impacts from sea level rise can be expected during the first half of this century as a result of winter storms and sea level rise.

Increased flows also would result in increased erosion, which may alter sediment loading, affecting the bay ecosystem by changing the dynamics of sedimentation over time. Decreased summertime flows may affect aquatic habitats by reducing the amount of open water and channel habitat, and by increasing the frequency of water quality issues related to temperature, salinity, and DO. These changes in how water is distributed throughout the year also will affect soil moisture. It is expected that climate change could result in drier soils in the summer and wetter soils in the winter. Reduced flows also could result in an increase in salinity, especially during the summer and fall months. Changing salinity affects fish, wildlife, and other aquatic organisms in intertidal and subtidal habitats.

Climate change may encourage new and existing invasive species to become established in the bay, causing biodiversity loss. Increasing temperatures and changes in salinity may result in conditions that better suit such invasive species or diseases that native species are not currently able to combat.

Environmental Consequences

Assessment Methods

This analysis discloses both the SMP's contribution to climate change and the effects that climate change may have on implementation of the SMP alternatives.

The only contributions to climate change that the SMP may make are related to construction activities that would be implemented as part of the plan and the potential sequestration of carbon and emissions of CH_4 as a result of creating tidal wetlands. These potential contributions are described here and in Chapter 10, "Cumulative Impacts," of this EIS/EIR.

Several assumptions were made to estimate the impacts implementation of the proposed project would have on carbon sequestration and CH_4 production in the Suisun wetlands. First, based on the salinity values from Section 5.2, it can be assumed that the western portion of the wetlands function more on the saline end of the brackish environment spectrum. Conditions in the eastern portion, on the other hand, function more on the fresh end of the brackish environment spectrum.[4] Second, because both areas of the wetland are flooded and drained seasonally such that they are saturated with water for about 9 months of the year, they are producing CH_4 only for these 9 months. When organic soil wetlands are dried, in general, they release more soil carbon through oxidation than taken up by photosynthesis, but also stop producing significant amounts of CH_4.[5]

Peat soil subsidence and organic matter oxidation also were analyzed because these processes release CO_2. It is likely that the soil is oxidized continuously when not submerged and that the oxidation rate would be reduced entirely if converted to tidal wetlands, thereby reducing CO_2 emissions. For purposes of this analysis, a potential range of peat soil oxidation reduction for the plan is presented below. However, it should be noted that quantifying the amount of released carbon is difficult and depends on the unique biology of the environment.

Carbon sequestration and CH_4 production in the Suisun wetlands were estimated for all plan conditions using values obtained from multiple literature sources (U.S. Climate Change Science Program 2007; Trulio 2007; Bartlett et al. 1987; Chmura et al. 2003; Deverel 2008). Potential net carbon fluxes resulting from these processes were estimated for both a brackish and freshwater wetland to better represent the actual conditions in the wetlands. It was assumed that under existing conditions, carbon flux in the wetlands while drained was zero or positive (as a result of carbon oxidation). Therefore, implementation of the proposed project would result in a 100% decrease in carbon oxidation and a 33% increase in CH_4 production (most CH_4 production occurs when the wetland is wet) relative to existing conditions because the wetlands no longer would be drained for 3 months of the year. As the values used to calculate CH_4 production, sequestration, and oxidation were obtained from different sources, there is a high degree of uncertainty in estimating the net CO_2e balance, considering the

[4] No specific boundary separates the eastern and western portions of the wetland. Assumptions were made using monitoring values for stations that are located in these regions. Water salinity between the monitoring stations will fall somewhere between the observed values, with salinity decreasing the farther east. Given this, sequestration potentials and methane production were estimated for both brackish and freshwater environments using the entire project acreage in each calculation.

[5] Regarding CH_4, during the dry period, anaerobic decay may continue in wetland vegetation, and thus there may be some methane production that will occur in buried vegetation, but aerobic exposure is expected to suppress methane production in general.

offsetting influences of carbon sequestration and CH_4 production. Therefore, the results of this analysis have been used to illustrate the carbon flux and CH_4 production changes, but the magnitude of the net change (considering the combined effect of carbon sequestration and CH_4 production) should be considered relatively uncertain.

The analysis does not assume that the restored marsh will be 100% vegetated. The amount of vegetation in wetlands is correlated with the CO_2 sequestration capacity of the wetland because sequestration is driven largely by photosynthesis of vegetation. The analysis assumes that the restored marsh would sequester carbon at a rate similar to other North American and Delta region marshes with similar salinity and characteristics as Suisun. These marshes include both vegetated areas and open water areas. It is currently unknown what percentage of the restored marsh would revegetate and what percentage would be open water. It is possible that the project would result in more open water or subtidal habitat than other North American or Delta marshes, potentially resulting in lower carbon sequestration rates than these marshes. To provide a conservative estimate of sequestration for the project, a relatively low range of sequestration values for similar wetlands was used in this analysis.

The sections below describe the potential sea level rise impacts of climate change on the study area and on the SMP alternatives. The sea level–rise impact of global climate change on Suisun Marsh is described as a quantitative range because local and regional projections of specific climate change impacts have high uncertainty. Scientific findings are summarized and discussed in terms of broad implications for the Bay-Delta, which encompasses Suisun Marsh.

Significance Criteria

The SMP alternatives' contributions to GHGs are assessed for significance. The following significance criterion applies only to the plan's emission and sequestration of GHGs: An impact would be considered significant if the alternative's GHG emissions would impede compliance with the GHG emissions reduction goals mandated in AB32.

With respect to the analysis of climate change impacts on the SMP alternatives (sea level rise, in this case), climate change effects on an alternative are compared to the climate change effects on the future no action scenario. The reasonably foreseeable affected environment, described under the No Action Alternative analysis, serves as the basis for evaluating and comparing the incremental effects of the SMP alternatives.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, some restoration activities would occur. Similar to Alternative A as described below, a temporary increase in GHG emissions could occur as a result of the construction activities, but it is not expected that substantial GHG emissions would be generated. Also, increased inundation caused by sea level rise likely would reduce current carbon sequestration rates.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Impact CC-1: Construction-Related Changes in Greenhouse Gas Emissions

Construction activities associated with tidal restoration and managed wetland activities would result in temporary increased emissions over the 30-year SMP implementation period. These activities would occur intermittently over time, and it is not expected that substantial GHG emissions would be generated during construction of any of the proposed project activities.

GHG emissions from construction activity are described in Section 5.7, Air Quality. According to this analysis, implementing the SMP alternatives would generate approximately 598.7 tons of CO_2 per year, of which 276.3 tons are from restoration activities and 322.5 tons are from management activities. Over the 30-year construction timeline, this is equivalent to 17,962 tons of CO_2, or 16,295 metric tons of CO_2. CO_2 emissions associated with management activities would occur beyond the 30-year construction timeline in the amount of 292.6 metric tons per year.

Because the activities are temporary and localized, it is not expected that implementation of the proposed project would result in a permanent or substantial increase in GHG emissions. In addition, construction emissions likely would be offset though changes in net GHG sources and sinks as a result of the proposed project described in Impact CC-2 below.

Conclusion: Less than significant. No mitigation required.

Impact CC-2: Permanent Changes in Greenhouse Gas Sources and Sinks

The proposed project would restore approximately 5,000 to 7,000 acres of tidal wetlands. Improved recreational access may result in a slight increase in the number of users and the associated vehicle use, but it is not expected that this increase would result in a substantial increase in permanent or short-term GHG emissions. Changes in the types of wetlands and the total area of tidal wetlands could result in changes in carbon sequestration. However, the existing wetlands cover a range of conditions—the entire marsh is a brackish environment, but the western portion is generally saltier, whereas the eastern portion of the wetlands is generally fresher. In addition, the wetlands are subject to drought-wet cycles that can create wide swings in salinity. For the purposes of this analysis to provide a conservative estimate of carbon sequestration and CH_4 emissions, the eastern portion of the marsh was assumed to be more similar to a freshwater environment. While both brackish and freshwater wetlands sequester, or act as a sink for, carbon (peat soil formation), brackish wetlands generally sequester more carbon per unit area than freshwater wetlands (U.S. Climate Change Science Program 2007; Trulio 2007).

Over the long term, changing managed wetlands to permanent tidal wetlands, where the potential for anoxic conditions and abundant organic matter is higher, has the potential to result in an increase in CH_4 production. As discussed above, wetlands produce CH_4 through anaerobic decomposition of biomass. While both brackish and freshwater tidal wetlands produce CH_4, brackish wetlands tend to produce less CH_4 per unit area than freshwater tidal wetlands (U.S. Climate Change Science Program 2007; Bartlett et al. 1987). Because CH_4 is a far more potent GHG than CO_2, in freshwater wetlands CH_4 production may overwhelm the benefits obtained from carbon sequestration (U.S. Climate Change Science Program 2007).

Table 5.9-2 presents the changes in carbon sequestration and CH_4 emissions associated with implementation of Alternative A, assuming that the restored wetlands fall within the widest possible range of carbon sequestration and CH_4 emission values for freshwater and brackish wetlands. Based on the information presented in Table 5.9-2, the following conclusions can be made:

1. Implementation of the plan alternatives would result in increased carbon storage in both brackish and freshwater environments for the restored wetlands relative to existing conditions. This increase in carbon storage would be roughly one-third the current potential.
2. Sequestration in the western, brackish portion of the wetlands would be higher than sequestration in the eastern, more freshwater environment.
3. Implementation of the plan alternatives would result in increased CH_4 production. This increase in CH_4 production would be roughly one-third the current production.
4. CH_4 production in the western, brackish portion of the wetlands would be lower than CH_4 production in the eastern, more freshwater environment.

The sequestration potential and CH_4 production of freshwater and brackish wetlands were combined to obtain net CO_2e production, as shown in Table 5.9-2. As stated previously, it should be noted that there is a high degree of uncertainty in the results, given the uncertainty in applying literature-based values from different studies of wetlands for carbon sequestration and CH_4 production to the plan area. The following conclusions are illustrated in Table 5.9-2, but should be considered a range of uncertainty for implementation of the SMP alternatives and are inconclusive with regard to the plan's net GHG impact.

1. Carbon benefits from sequestration in a brackish wetland may exceed emissions from CH_4 production. As such, implementation of the plan alternatives in the western portion of the Suisun wetlands could result in a net decrease in GHG emissions.
2. Carbon benefits from sequestration in a freshwater wetland may be overwhelmed by CH_4 production. As such, implementation of the plan alternatives in the eastern portion of the Suisun wetlands could result in a net increase in GHG emissions.

The analysis above shows the wide range of net GHG emissions from implementing Alternative A for wetlands ranging from pure fresh water to highly brackish. However, the plan activities would produce GHG emissions that fall between the high and low ranges. In addition to the broad analysis presented above, a more refined analysis using Suisun area–specific values was prepared to provide a smaller range of potential GHG emissions from the plan alternatives. This analysis was based on the following assumptions:

1. For the low range of CO_2 sequestration values (under the *low* category below), the restored wetlands are assumed to be freshwater, mineral soil wetlands.
2. For the high range of CO_2 sequestration values (under the *high* category below), the restored wetlands are assumed to be the average for tidal wetlands in the conterminous U.S.
3. For the high range of CH_4 emission values (under the *high* category below), the restored wetlands are assumed to be tidal brackish/fresh marsh with an average salinity of 5 ppt (characteristic of the eastern areas of Suisun Marsh).
4. For the low range of CH_4 emission values (under the *low* category below), the restored wetlands are assumed to be tidal brackish marsh with an average salinity of 10 ppt (characteristic of the western areas of Suisun Marsh).

These assumptions result in the low-high range of GHG emissions presented in Table 5.9-2, compared to the wider range of results presented above.

Table 5.9-2. Net Change over Baseline for Yearly Carbon Sequestration Benefits and Methane Production and Net CO_2e[1] Production for Alternative A

	Carbon Sequestration (metric tons CO_2)[1]		Methane Production (metric tons CO_2e)[1]		NET CO_2e Production (metric tons)[1]	
Scenario/Range[2]	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Freshwater (Yearly)						
Low	390	545	2,380	3,331	9,320	13,048
High	390	545	9,709	13,593	1,990	2,786

Scenario/Range[2]	Carbon Sequestration (metric tons CO_2)[1]		Methane Production (metric tons CO_2e)[1]		NET CO_2e Production (metric tons)[1]	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**
Brackish (Yearly)						
Low	1,002	1,402	595	833	1,378	1,929
High	7,141	9,997	2,380	3,331	-6,546	-9,165
Suisun Proxy Range (Yearly)						
Low	390	545	1,933	2,707	1,990	2,786
High	4,081	5,713	2,380	3,331	-2,147	-3,006

Sources: Trulio 2007; Bartlett et al. 1987; U.S. Climate Change Science Program 2007.

Notes: Net CO_2e only includes carbon sequestration and CH_4production because of limited information regarding other GHGs such as N_2O.

[1] Values include acreage for the entire project area. Net CO_2e production represents *low* carbon sequestration plus *high* CH_4 emissions to estimate the widest possible range of GHG emissions.

[2] Values are a range of carbon sequestration and CH_4 production in fresh to saline wetlands. Low values represent the low end of the range of potential carbon sequestration and CH_4 production for fresh and saline wetlands, and high values represent the high end of the range.

The above results suggest that implementation of the proposed project could increase or decrease net GHG emissions related to the Suisun wetlands, depending on the specific location of the restored wetlands (i.e., west versus east). If the restoration occurs more to the east where the salinity of the wetlands is lower, the restored wetlands likely would be a source of GHGs as presented above under the *low* classification. However, if the restoration occurs more to the west where the salinity of the wetlands is higher, the restored wetlands likely would be a sink of GHGs as presented above under the *high* classification. These results are representative of the net annual CO_2e emissions, after the initial 3–4 years required to offset the one-time construction emissions.

Additionally, Choi et al. (2001) found that as sea levels rise, marsh plains continue to build up (accrete), and they continually store carbon in the process. Thus, tidal marshes continue to take carbon from the atmosphere as sea levels rise, as long as there is a large enough input of mineral sediments to build marsh soil and keep pace with sea level rise. Biomass accumulation also can occur without the accretion of mineral soils. Over time, it is expected that the combination of sea level rise and sediment accretion would increase carbon sequestration in the marsh. However, in areas without enough sediment input to keep pace with sea level rise, marshes can break up and be converted to open water (Patrick 1990). Specific research is needed to quantify the precise carbon sequestration capacity and CH_4 production of the Suisun wetlands as well as the sediment fluxes and potential effects of sea level rise on GHG emissions. In addition, the results presented in these studies are likely relevant only up to a certain sea level rise, after which wetlands would be inundated with water and no longer would function as wetlands.

As discussed above, direct emissions of CO_2 are known to be emitted from oxidation of peat soils when those soils are exposed to the atmosphere. For example, research shows that when wetlands are drained, anaerobic soils become exposed to the air, thus releasing stored carbon (Trulio 2007). This process would occur during the periods when the Suisun wetlands are drained. Restoring these areas to permanent marshes would eliminate a majority of peat soil oxidation emissions, resulting in an additional GHG emissions benefit. A number of studies of peat soil subsidence and carbon loss in the Sacramento/San Joaquin Valley region show that carbon losses range from 0.05 gram/cm^2 to 0.15 gram/cm^2 per year (Deverel 2008; Volk 1973; Deverel and Rojstaczer 1996). This range is equivalent to approximately 7.4 to 22.3 metric tons of CO_2 release per acre per year. Another study found that measured subsidence rates in the Delta from 1988 to 2006 range from 0.7 to 3.7 cm/year, and up to 1.7 cm/year in western areas of the Delta, where soil organic matter contents are lower (Deverel 2008).

As noted above, subsidence and peat soil oxidation in the Delta region results mainly from agricultural practices on drained wetlands; such practices are not occurring in Suisun. In addition, oxidation and subsidence rates depend on soil organic content, carbon content, temperature, and other factors. Consequently, subsidence at Suisun Marsh is significantly less than subsidence in other Delta regions. However, subsidence in Suisun was estimated using the lower end of Delta subsidence rates to provide a potential range of oxidation rates for Suisun. The organic soil content affects carbon loss; Suisun Marsh is composed of Joice, Tamba, and Suisun soils (see Section 5.3, Geology and Groundwater), which range 15–60% in organic matter content (National Cooperative Soil Survey 2001). This analysis assumes an average soil organic composition in Suisun Marsh of 40%, based on an average of the three soil types. Assuming a carbon fraction of the organic content of 40%, this range is equivalent to approximately 1.8 to 4.2 metric tons of CO_2 release per acre per year. This range is equivalent to a subsidence rate of approximately 0.7 to 1.5 cm/year and falls within the lower range of estimated subsidence rates in western Delta marshes, representing a conservative estimate of peat soil oxidation.

The Suisun Proxy Range in Table 5.9-3 shows the possible net GHG emissions from implementing Alternative A for Suisun-area specific values. The following assumptions were made:

1. The restored wetlands are assumed to have lowest rates of peat soil oxidation presented above because the Suisun wetland soils vary in organic carbon content and are not currently under agricultural practices.
2. The soil is oxidized continuously when not submerged, and the soil oxidation rate would be reduced by 90% when converted to wetlands.

Table 5.9-3. CO_2 Reductions from Reduced Peat Soil Oxidation as a Result of Project Implementation for Alternative A (Net Change over Baseline)

Scenario/Range[2]	CO_2 Reduction (metric tons)[1]	
	Min	**Max**
Suisun Proxy Range (Yearly)		
Low	-2,041	-2,857
High	-4,723	-6,612

Sources: Trulio 2007; Deverel 2008; Deverel and Rojstaczer 1996; National Cooperative Soil Survey 2001.

Notes:

[1] Values include acreage for the entire project area.

[2] Values are a range of carbon sequestration and CH_4 production in fresh to saline wetlands. Low values represent the low end of the range of potential carbon sequestration and CH_4 production for fresh and saline wetlands, and high values represent the high end of the range.

See limitations and discussion of uncertainty in text.

This analysis demonstrates that implementation of SMP alternatives could result in a large reduction in CO_2 emissions, if peat soil oxidation is taken into account. However, these results should be considered estimates based on the best available science because the amount of released carbon depends on the unique biology of the environment and has not been measured specifically for the site.

Regardless of the uncertainty associated with the GHG benefits of Alternative A, restoring tidal wetlands is recommended by the IPCC as an effective method for removing CO_2 from the atmosphere (Intergovernmental Panel on Climate Change 2001). Table 5.9-4 presents the net change over baseline for CO_2e production for Alternative A in comparison to construction and operational emissions using the results from Table 5.9-3 above. As the net change over baseline in CO_2e production likely would fall within this range, a mid value for the net CO_2e change for wetlands also was estimated. Using this mid value, Alternative A would offset one-time construction emissions within about 6–9 years. The net lifetime result of the proposed project is a net sink of CO_2e over existing conditions.

Table 5.9-4. Direct Construction Emissions, Wetland Emissions, and Net Change over Baseline for CO_2e Production for Alternative A (Metric Tons CO_2e)

Emissions Type/Range		
Direct Emissions		
Construction One-Time Emissions (30 Years)		16,295
Management (Yearly)		292.6
Wetland Emissions (Yearly)	**Min**	**Max**
Carbon Sequestration		
Low	-390	-545

Emissions Type/Range		
High	-4,081	-5,713
Methane Production		
Low	1,933	2,707
High	2,380	3,331
Peat Soil Oxidation		
Low	-2,041	-2,857
High	-4,723	-6,612
Net CO_2e Change for Wetlands[1]		
Low	-51	-71
Mid[2]	-2,119	-2,967
High	-6,870	-9,618
NET CO_2e Change (Yearly)[3]		
Low	242	221
Mid[2]	-1,827	-2,675
High	-6,578	-9,326

Notes: Net CO_2e includes only carbon sequestration and CH_4production because of limited information regarding other GHGs such as N_2O.

[1]Represents net CO_2e production; represents *low* carbon sequestration plus *high* CH_4 emissions plus *low* peat soil oxidation to estimate the widest possible range of GHG emissions.

[2] Represents mid range of carbon sequestration and CH_4 production combined with the low range of peat soil oxidation.

[3] Represents the net change from direct emissions from maintenance activities and wetland emissions. Direct emissions from construction were not included in the net CO_2e because these emissions occur on a different time scale. The plan's overall benefit is equivalent to the yearly accumulation of the net CO_2e change minus the one-time construction emissions.

See limitations and discussion of uncertainty in text.

Although the low range of values presented in Table 5.9-4 above for net CO_2e change over baseline resulting from Alternative A are positive, it is likely that the mid values presented for the net CO_2e change would more closely represent actual project conditions. Using this mid value, as stated above, Alternative A would offset one-time construction emissions within about 6–9 years such that the proposed project would result in a net GHG benefit.

Conclusion: Beneficial. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres, and Alternative C: Restore 7,000–9,000 Acres

Alternatives B and C would have the same restoration and managed wetland activities, only over a different acreage of land. Impacts of both alternatives would be similar to Alternative A. However, Alternative B has less restoration and more managed wetland activities, so the potential for carbon sequestration and CH_4 emissions is lower. Alternative C has more restoration, and therefore greater potential for carbon sequestration and CH_4 emissions. It is assumed that construction-related emissions would be similar for all three alternatives as wetlands would be either restored or enhanced, requiring construction equipment and worker vehicles.

The same analysis prepared for Alternative A was prepared for Alternatives B and C. In addition, the same conclusions described for Alternative A can be made for Alternatives B and C. Table 5.9-5 presents the changes in carbon sequestration, CH_4 emissions, and net CO_2e production associated with implementation of Alternatives B and C. Table 5.9-5 also presents the possible net GHG emissions from implementing Alternatives B and C with a more refined analysis using Suisun area–specific values (Suisun Proxy Range). Table 5.9-6 presents the possible net GHG reductions from reduced peat soil oxidation from implementing Alternatives B and C using Suisun area–specific values (Suisun Proxy Range).

It should be noted again that a high degree of uncertainty is associated with these numbers because of the number of sources used in this analysis and limited data on Suisun Marsh characteristics. The conclusions should be considered uncertain and inconclusive, given the uncertainty of using literature-based values from different studies of wetlands for carbon sequestration and CH_4 production. Regardless of the uncertainty associated with the GHG benefits of Alternatives B and C, restoring tidal wetlands is recommended by the IPCC as an effective method for removing CO_2 from the atmosphere (Intergovernmental Panel on Climate Change 2001).

Table 5.9-7 presents the net change over baseline for CO_2e production for Alternatives B and C in comparison to construction and operational emissions using the results from Tables 5.9-5 and 5.9-6 below. Because the net change over baseline in CO_2e production likely would fall within this range, a mid value was estimated to represent the most likely plan conditions. Using this mid value, Alternative B would offset one-time construction emissions within about 12–29 years, and Alternative C would offset one-time construction emissions within about 5–7 years. The net lifetime result of the proposed project is a net sink of CO_2e over existing conditions.

Table 5.9-5. Net Change over Baseline for Yearly Carbon Sequestration Benefits and Methane Production and Net CO_2e Production for Alternatives B and C

	Carbon Sequestration (metric tons CO_2)[1]				Methane Production (metric tons CO_2e)[1]				NET CO_2e Production (metric tons)[1]			
	Alternative B		**Alternative C**		**Alternative B**		**Alternative B**		**Alternative B**		**Alternative B**	
Scenario/Range[2]	**Min**	**Max**	**Min**	**Min**	**Min**	**Min**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Freshwater (Yearly)												
Low	156	312	467	701	952	1,904	2,855	4,283	3,728	7,456	11,184	16,776
High	156	312	467	701	3,884	7,768	11,651	17,477	796	1,592	2,388	3,582
Brackish (Yearly)												
Low	401	801	1,202	1,803	238	476	714	1,071	551	1,102	1,654	2,480
High	2,856	5,713	8,569	12,854	952	1,904	2,855	4,283	-2,618	-5,237	-7,855	-11,783
Suisun Proxy Range (Yearly)												
Low	156	312	467	701	773	1,547	2,320	3,480	796	1,592	2,388	3,582
High	1,632	3,264	4,897	7,345	952	1,904	2,855	4,283	-859	-1,718	-2,577	-3,865

Sources: Trulio 2007; Bartlett et al. 1987; U.S. Climate Change Science Program 2007.

Notes: Net CO_2e includes only carbon sequestration and CH_4production because of limited information regarding other GHGs such as N_2O.

[1] Values include acreage for the entire project area. Net CO_2e production represents *low* carbon sequestration plus *high* CH_4 emissions to estimate the widest possible range of GHG emissions.

[2] Values are a range of carbon sequestration and CH_4 production in fresh to saline wetlands. Low values represent the low end of the range of potential carbon sequestration and CH_4 production for fresh and saline wetlands, and high values represent the high end of the range.

Table 5.9-6. CO_2 Reductions from Reduced Peat Soil Oxidation as a Result of Plan Implementation for Alternatives B and C (Net Change over Baseline)

	CO_2 Production (metric tons)[1]			
	Alternative B		Alternative C	
Scenario/Range[2]	Min	Max	Min	Max
Suisun Proxy (Yearly)				
Low	-816	-1,633	-2,449	-3,674
High	-1,889	-3,778	-5,668	-8,501

Sources: Trulio 2007; Deverel 2008; Deverel and Rojstaczer 1996; National Cooperative Soil Survey 2001.

Notes: Net CO_2e includes only carbon sequestration and CH_4production because of limited information regarding other GHGs such as N_2O.

[1] Values include acreage for the entire project area.

[2] Values are a range of carbon sequestration and CH_4 production in fresh to saline wetlands. Low values represent the low end of the range of potential carbon sequestration and CH_4 production for fresh and saline wetlands, and high values represent the high end of the range.

Table 5.9-7. Direct Construction Emissions, Wetland Emissions, and Net Change over Baseline for CO_2e Production for Alternatives B and C (Metric Tons CO_2e)

Emissions Type/Range	Alternative B		Alternative C	
Direct Emissions				
Construction One-Time Emission (30 years)	16,295		16,295	
Management (Yearly)	292.6		292.6	
Wetland Emissions (yearly)	**Min**	**Max**	**Min**	**Max**
Carbon Sequestration				
Low	-156	-312	-467	-701
High	-1,632	-3,264	-4,897	-7,345
Methane Production				
Low	773	1,547	2,320	3,480
High	952	1,904	2,855	4,283
Peat Soil Oxidation				
Low	-816	-1,633	-2,449	-3,674
High	-1,889	-3,778	-5,668	-8,501
Net CO_2e Change for Wetlands[1]				
Low	-20	-41	-61	-92
Mid[2]	-848	-1,696	-2,543	-3,815
High	-2,748	-5,496	-8,244	-12,366

Emissions Type/Range	Alternative B		Alternative C	
NET CO_2e Change (Yearly)[3]	**Min**	**Max**	**Min**	**Max**
Low	272	252	232	201
Mid[2]	-555	-1,403	-2,251	-3,522
High	-2,455	-5,204	-7,952	-12,074

Notes: Net CO_2e includes only carbon sequestration and CH_4production because of limited information regarding other GHGs such as N_2O.

[1]Represents net CO_2e production; represents *low* carbon sequestration plus *high* CH_4 emissions plus *low* peat soil oxidation to estimate the widest possible range of GHG emissions.

[2] Represents mid range of carbon sequestration and CH_4 production combined with the low range of peat soil oxidation.

[3] Represents the net change from direct emissions from maintenance activities and wetland emissions. Direct emissions from construction were not included in the net CO_2e because these emissions occur on a different time scale. The plan's overall benefit is equivalent to the yearly accumulation of the net CO_2e change minus the one-time construction emissions.

See limitations and discussion of uncertainty in text.

Although the low range of values presented in Table 5.9-7 above for net CO_2e change over baseline resulting from Alternative A are positive, it is likely that the mid values presented for the net CO_2e change would more closely represent actual project conditions. Using this mid value, as stated above, Alternative B would offset one-time construction emissions within about 12–24 years, and Alternative C would offset one-time construction emissions within about 5–7 years, such that the proposed project would result in a net GHG benefit.

Conclusion: Beneficial. No mitigation required.

Environmental Impacts in the Context of Climate Change

No Action Alternative

Impact CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated with Sea Level Rise

Global climate change has resulted and will continue to result in global mean sea level rise. Local mean sea level rise predictions for San Francisco Bay include up to 16 inches by 2050 and up to 55 inches by 2099 (San Francisco Bay Conservation and Development Commission 2009b). In addition, global sea level rise predictions include up to 78.7 inches by 2100 (Allison et al. 2009). The largest 2009 high-tide differential documented within Suisun Bay is 1.7 inches (National Oceanic and Atmospheric Administration 2009). Thus, sea level rise for the Suisun Bay area would equate to up to 17.7 inches at high tide in 2050 and up to 80.4 inches at high tide in 2099.

Under the No Action Alternative, major restoration would not occur in Suisun Marsh, and managed wetland activities would be substantially limited or suspended. As a result, levee integrity would continue to degrade. As the No Action Alternative would not result in levee improvements to protect against flood events, this analysis conservatively assumes that the existing, degraded levees would fail under the water force associated with predicted sea level rise. Based on the aforementioned sea level rise predictions and assuming the absence (because of failure) of existing levees and other shoreline protection, Suisun Marsh (including the sloping wetland/upland transition zone surfaces that would typically allow tidal wetland to shift upslope when floodwaters rise) would be inundated by the year 2050. Only the Potrero Hills and Kirby Hill areas of Suisun Marsh would not be inundated, because of their higher elevations.

The flood vulnerability of this area as a result of sea level rise and substandard levees is compounded by ongoing subsidence, the El Niño–Southern Oscillation effect, higher winter flows, and greater than 1-year tide or tributary flood events. The aforementioned BCDC local mean sea level rise predictions for San Francisco Bay, which are based on DWR 2006 to 2007 elevation data, do not take into account ongoing subsidence (Parris 2009). There is an ongoing 1 to 3 inches per year of subsidence in the region (U.S. Geological Survey 2000). However, it should be noted that if the levees fail in 2050 as predicted above, subsidence would cease. Based on this range of annual subsidence, relative sea level rise, which considers sea level rise and tidal and subsidence factors, in the Suisun Bay portion of the Bay-Delta is anticipated to be up to 140.7 inches (11.73 feet) at high tide in 2050 and up to 353.4 inches (29.45 feet) at high tide in 2099. El Niño–Southern Oscillation is a large, regional ocean current that moves water from one side of the Pacific to the other every 3 or 4 years, and during El Niño years warm water is pushed over to the eastern Pacific (and thus Suisun Bay), resulting in the ocean being up to 24 inches higher there. Thus, during El Niño years, relative sea level rise in the Suisun Bay portion of the Bay-Delta is anticipated to be up to 164.7 inches (13.73 feet) at high tide in 2050 and up to 377.4 inches (31.45 feet) at high tide in 2099. In addition, the anticipated 50% loss of the Sierra snowpack would lead to earlier runoff and increased winter storm peaks, resulting in temporary surges in Delta (and thus Suisun Bay) water volume even farther above this anticipated relative sea level rise (Knowles and Cayan 2002). Finally, the BCDC local mean sea level rise predictions for San Francisco Bay do not take into account greater than 1-year tide events[6] stacking on top of Bay water levels (Parris 2009). Thus, not only is the Suisun Marsh area susceptible to inundation as a result of large storm events, but under the No Project Alternative the Marsh also likely would become consistently inundated from the combined effect of increased sea level rise, levee degradation, subsidence, and loss of Sierra snowpack. This conclusion that coastal habitats,

[6] Refers to the level of high tide with a 100% chance (1 in 1) of occurring any 1 year. Does not account for the more extreme high tide events that are expected to occur on a more regular basis in the future as a result of rising sea levels. For example, these more extreme high tide events could occur10 or more times per year by 2050 instead of just once or twice per year.

such as wetlands, can become permanently inundated with water and eroded if sea level rises faster than these ecosystems can move inland is also reached in the California Climate Action Team 2009 report (the 2009 California Climate Adaptation Strategy) to Governor Schwarzenegger (California Climate Action Team 2009).

As previously mentioned, sea level rise associated with climate change could overwhelm levees to the point of breach, resulting in Marsh inundation. In addition, because Suisun Marsh primarily is surrounded by urban development and areas of greater elevation (specifically, the Montezuma Hills on the east, Suisun City and Travis Air Force Base on the north, and Benicia Hills on the west), there are no adequate areas for Suisun Marsh to retreat to if it were inundated. Thus, Marsh inundation would result in erosion and loss of wetland habitat, changing sediment demand, altered species composition, changing freshwater inflow and salinity, altered food web, and impaired water quality, all of which may overwhelm the system's ability to rebound and continue functioning (San Francisco Bay Conservation and Development Commission 2009a). Thus, Suisun Marsh habitat and ecosystem health would be adversely affected by climate change–induced sea level rise. Moreover, this loss of wetlands would increase the risk of shoreline flooding in the Suisun Bay area.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Impact CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated with Sea Level Rise

Within 30-Year Planning Horizon

Because Alternative A includes restoring 5,000 to 7,000 acres in Suisun Marsh to fully functioning, self-sustaining tidal wetland and improving the levee stability and flood and drain capabilities of the remaining 44,000 to 46,000 acres of managed wetland areas, this analysis assumes that, for at least 30 years, the improved levees would hold under the water force associated with predicted sea level rise. Based on the fact that sea level rise associated with climate change would be addressed throughout implementation of the SMP, sustainable vegetated tidal marshes are expected to develop in some of the tidally restored ponds within the plan's 30-year planning horizon.

As described under the No Action Alternative analysis, the flood vulnerability of this area as a result of sea level rise is compounded by ongoing subsidence, the El Niño-Southern Oscillation effect, and higher winter flows. Thus, the Suisun Marsh area is susceptible to inundation as a result of 100-year storm events, but under Alternative A, the Marsh would not likely become consistently inundated because of the proposed levee improvements and the ability of the tidally restored wetlands still to accrete sediment and eventually support vegetated tidal marsh, even if at a slower rate. In addition, under the proposed project, gradually sloping wetland/upland transition zone surfaces would provide an elevation gradient over which tidal wetland could shift upslope when floodwaters rise.

As a result, the system's ability to continue functioning and thrive would increase (San Francisco Bay Conservation and Development Commission 2009a). Thus, Suisun Marsh habitat and ecosystem health would not be adversely affected by climate change–induced sea level rise. Moreover, this restoration of wetland function would decrease the risk of shoreline flooding in the Suisun Bay area.

Alternative A would help maintain and restore natural wetland processes that enhance ecosystem function and protect marsh biodiversity. This would increase the capacity of Suisun Marsh to deal with uncertainty regarding climate change, and reduce stress on species resulting from events associated with climate change (i.e., increased sedimentation from flooding events). Alternative A therefore has the potential to increase the Marsh's ability to adapt to changes induced by climate change (i.e., by reducing subsidence, increasing biomass accumulation, and allowing natural tidal marsh functions to resume, etc.). Refer to the *Plan Response to Predicted Sea-Level Rise* section of Chapter 2 for more discussion regarding restoration efforts associated with Alternative A that support achieving long-term ecological functions and reduce impacts associated with climate change.

Within the 30-year planning horizon, the proposed project would result in a beneficial impact compared to the No Action Alternative related to loss of wetland habitat, ecosystem health, and flood risk associated with climate change–induced sea level rise.

Conclusion: Beneficial Impact. No mitigation required.

Beyond 30-Year Planning Horizon

The proposed project would result in some levee improvements, but beyond the 30-year planning horizon the improved levees could fail under the water force associated with predicted sea level rise. Based on the sea level rise predictions described under the No Action Alternative analysis and assuming the absence (because of failure) of existing levees and other shoreline protection, Suisun Marsh would be inundated by the year 2050. Only the Potrero Hills and Kirby Hill areas of Suisun Marsh would not be inundated, because of their higher elevations.

As described under the No Action Alternative analysis, the flood vulnerability of this area as a result of sea level rise and substandard levees is compounded by ongoing subsidence, the El Niño-Southern Oscillation effect, and higher winter flows. Thus, the Suisun Marsh area is not only susceptible to inundation as a result of 100-year storm events, but under Alternative A, the Marsh (including the sloping wetland/upland transition zone surfaces that would typically allow tidal wetland to shift upslope when floodwaters rise) likely would become consistently inundated from the combined effect of increased sea level rise, levee degradation, subsidence, and loss of Sierra snowpack. This outcome is likely even though some wetland restoration would occur, some new exterior levees would be built, and some levees would be maintained with dredging material, because there is not enough material authorized in the dredging program to improve all levees in the Marsh.

As a result, beyond the 30-year planning horizon, sea level rise associated with climate change could overwhelm levees to the point of breach, resulting in Marsh inundation. In addition, because Suisun Marsh primarily is surrounded by urban development and areas of greater elevation (specifically, the Montezuma Hills on the east, Suisun City and Travis Air Force Base on the north, and Benicia Hills on the west), there are no adequate areas for Suisun Marsh to retreat to if it were inundated. Thus, Marsh inundation would result in erosion and loss of wetland habitat, changing sediment demand, altered species composition, changing freshwater inflow and salinity, altered food web, and impaired water quality, all of which may overwhelm the system's ability to rebound and continue functioning (San Francisco Bay Conservation and Development Commission 2009a). Thus, Suisun Marsh habitat and ecosystem health would be adversely affected by climate change–induced sea level rise. Moreover, this loss of wetlands would increase the risk of shoreline flooding in the Suisun Bay area.

Alternative B: Restore 2,000–4,000 Acres, and Alternative C: Restore 7,000–9,000 Acres

Impact CC-3: Degradation of Wetland Habitat and Ecosystem Health as a Result of Inundation Associated with Sea Level Rise

Within 30-Year Planning Horizon

Alternatives B and C would have the same restoration and managed wetland activities, only over a different acreage of land. However, Alternative B has less restoration and more levee stability improvements, so the potential for habitat loss and degradation of ecosystem health associated with climate change–induced sea level rise would be lower. Thus, within the 30-year planning horizon, Alternatives B and C would result in a beneficial impact compared to the No Action Alternative related to loss of wetland habitat, ecosystem health, and flood risk associated with climate change–induced sea level rise, and with the incorporation of measures to improve levees to withstand sea level rise, this impact would be beneficial.

Conclusion: Beneficial Impact. No mitigation required.

Beyond 30-Year Planning Horizon

Alternatives B and C would have the same restoration and managed wetland activities, only over a different acreage of land. Alternatives B and C would result in some levee improvements (B more than C), but beyond the 30-year planning horizon the improved levees could fail under the water force associated with predicted sea level rise. Based on the sea level rise predictions described under the No Action Alternative analysis and assuming the absence (because of failure) of existing levees and other shoreline protection, Suisun Marsh would be inundated by the year 2050. This is likely even though some new exterior levees would be designed to protect against sea level rise and the dredging program would provide source materials for levee maintenance, because there is not enough material authorized in the dredging program to improve all levees in the Marsh.

Chapter 6
Biological Environment

This chapter provides environmental analyses relative to biological 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 6.1, “Fish”;
- Section 6.2, “Vegetation and Wetlands”; and
- Section 6.3, “Wildlife.”

Section 6.1
Fish

Introduction

This section describes the existing environmental conditions and the consequences of implementing tidal wetland restoration and managed wetland activities on fisheries resources.

The Affected Environment discussion below describes the current setting of the plan area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. This information is intended to be directly or indirectly relevant to the subsequent discussion of impacts.

The environmental changes associated with the alternatives are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Implementation of the SMP would include breaching levees to restore tidal wetlands, and increased frequency of implementation of some managed wetland activities such as repairing and upgrading existing levees, replacing infrastructure, installing fish screens, and new activities such as dredging. These actions could affect fish and fish habitat in Suisun Marsh. Repair and breaching of levees would result in less than significant impacts because environmental commitments (Chapter 2, "Environmental Commitments") including avoidance and minimization measures, such as construction work windows, will be implemented to reduce impacts on water quality and fish in the immediate construction area. Dredging would affect fish habitat by increasing channel depth and temporarily removing benthic organisms. Additional risks to fish from dredging include injury or mortality by the dredger or benthic disturbance (especially through mobilization of fine sediments) during the dredging process itself. Creation of subtidal and low intertidal wetland habitat, through tidal restoration, will provide resting and foraging habitat for special-status fish species and possibly spawning habitat for delta smelt and Sacramento splittail. Special-status fish species will derive indirect benefits from exported primary and secondary pelagic production in low, mid and high marsh areas.

Table 6.1-1 presents a summary of the impacts on fish and any associated mitigation measures for each plan alternative. In most instances, environmental commitments will be implemented to reduce the aggregate impacts to less-than-significant levels.

Table 6.1-1. Summary of Fish Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
FISH-1: Construction-Related Temporary Impairment of Fish Survival, Growth, and Reproduction by Accidental Spills or Runoff of Contaminants (Heavy Metals)	A, B, C	Less than significant	None required	–
FISH-2: Construction-Related Temporary Reduction of Special-Status Fish Rearing Habitat Quality or Quantity through Increased Input and Mobilization of Sediment	A, B, C	Less than significant	None required	–
FISH-3: Short-Term Impairment of Delta Smelt Passage and Reduced Availability of Spawning and Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-4: Short-Term Impairment of Chinook Salmon Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-5: Short-Term Impairment of Steelhead Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-6: Short-Term Impairment of Green Sturgeon Passage and Reduced Availability of Holding and Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-7: Short-Term Impairment of Sacramento Splittail Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Velocity Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-8: Short-Term Impairment of Longfin Smelt Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Velocity Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-9: Temporary Reduction of Delta Smelt Habitat Quantity or Quality through Removal and Destruction of Cover Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-10: Temporary Reduction of Chinook Salmon Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
FISH-11: Temporary Reduction of Steelhead Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-12: Temporary Reduction of Green Sturgeon Habitat Quantity or Quality as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-13: Temporary Reduction of Sacramento Splittail Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-14: Temporary Reduction of Longfin Smelt Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-15: Improved Fish Habitat Due to Increased Dissolved Oxygen Concentrations in Tidal Channels Attributable to Restoration Activities	A, B, C	Beneficial	None required	–
FISH-16: Salinity–Related Reduction of Delta Smelt Survival, Growth, Movement, or Reproduction Attributable to Restoration Activities	A, B, C	Less than significant	None required	–
FISH-17: Salinity–Related Reduction of Chinook Salmon Survival, Growth, or Movement as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-18: Salinity–Related Reduction of Steelhead Survival, Growth, or Movement as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-19: Salinity–Related Reduction of Green Sturgeon Survival, Growth, or Movement as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-20: Salinity–Related Reduction of Sacramento Splittail Survival, Growth, Movement, or Reproduction as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-21: Salinity–Related Reduction of Longfin Smelt Survival, Growth, Movement, or Reproduction as a Result of Restoration Activities	A, B, C	Less than significant	None required	–
FISH-22: Disturbance, Injury, or Mortality of Individual Fish Resulting from Work Adjacent to Bodies of Water	A, B, C	Less than significant	None required	–
FISH-23: Change in Fish Species Composition Attributable to Changes in Salinity or Water Quality from Managed or Natural Wetland Modifications	A, B, C	Less than significant	None required	–
FISH-24: Change in Benthic Macroinvertebrate Composition Attributable to Changes in Channel Morphology and Hydraulics as a Result of Tidal Restoration	A, B, C	Less than significant	None required	–
FISH-25: Change in Primary Productivity as a Result of Tidal Restoration	A, B, C	Beneficial	–	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Managed Wetland Activities Impacts				
FISH-26: Construction-Related Temporary Impairment of Fish Survival, Growth, and Reproduction by Accidental Spills or Runoff of Contaminants (Heavy Metals)	A, B, C	Less than significant	None required	–
FISH-27: Construction-Related Temporary Reduction of Fish Rearing Habitat Quality or Quantity through Increased Input and Mobilization of Sediment	A, B, C	Less than significant	None required	–
FISH-28: Construction-Related Mortality of Fish from Stranding	A, B, C	Less than significant	None required	–
FISH-29: Temporary Reduction of Delta Smelt, Chinook Salmon and Steelhead Habitat Quantity or Quality Attributable to Management Activities	A, B, C	Less than significant	None required	–
FISH-30: Temporary Reduction of Green Sturgeon Habitat Quantity or Quality as a Result of Management Activities	A, B, C	Less than significant	None required	–
FISH-31: Temporary Reduction of Sacramento Splittail Habitat Quantity or Quality as a Result of Management Activities	A, B, C	Less than significant	None required	–
FISH-32: Temporary Reduction of Longfin Smelt Habitat Quantity or Quality as a Result of Management Activities	A, B, C	Less than significant	None required	–
FISH-33: Reduction in Benthic Macroinvertebrate Abundance as a Result of Dredging	A, B, C	Less than significant	None required	–
FISH-34: Disturbance, Injury, or Mortality of Delta Smelt Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-35: Disturbance, Injury, or Mortality of Chinook Salmon Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-36: Disturbance, Injury, or Mortality of Steelhead Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-37: Disturbance, Injury, or Mortality of Green Sturgeon Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-38: Disturbance, Injury, or Mortality of Sacramento Splittail Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-39: Disturbance, Injury, or Mortality of Longfin Smelt Resulting from Dredging	A, B, C	Less than significant	None required	–
FISH-40: Reduction of Fish Habitat Quantity or Quality Resulting from Installation of New Riprap on Levees	A, B, C	Less than significant	None required	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- Schroeter, R., A. Stover, and P. B. Moyle. 2006. *Trends in Fish Populations of Suisun Marsh. January 2005–December 2005*. Annual report for Contract SAP 460001965. California Department of Water Resources. March 21, 2006.
- Suisun Ecological Workgroup. 2001. Final report to the State Water Resources Control Board. August.
- Seigel, Stuart. 2008. *Draft report of Suisun Marsh Tidal Marsh and Aquatic Habitats Conceptual Model*.
- U.S. Fish and Wildlife Service. 1996. Recovery plan for Sacramento/San Joaquin Delta native fishes.
- U.S. Fish and Wildlife Service. 2008. Biological opinion on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP).
- California Department of Fish and Game. 2009a. Fall midwater trawl survey.
- California Department of Fish and Game. 2010a. San Francisco Bay study.
- California Department of Fish and Game. 2010b. Smelt larvae survey.
- California Department of Fish and Game. 2008. Spring Kodiak survey.
- California Department of Fish and Game. 2009b. Summer townet survey.

Monitoring Surveys

Numerous programs to monitor the occurrence and relative abundance of fish species in the Delta and San Francisco Bay have, or continue to be, implemented by several resource agencies. These programs are summarized below and include mid-water trawl surveys, beach seine surveys, and townet surveys. Although some of the monitoring programs discussed below are intended to monitor a single species (e.g., the summer townet survey provides an index of striped bass abundance), their capture data, when viewed in aggregate, provide meaningful information relevant to the species' timing of occurrence and abundance relative to other species (especially nonnative species). Fish occurrence information for the plan area was gathered from, but not limited to, the following monitoring programs or surveys:

- DFG's San Francisco Bay Survey,

- DFG's Summer Townet Survey,
- DFG's Fall Midwater Trawl Survey (MWT),
- DFG's Smelt Larvae Survey,
- DFG's Spring Kodiak Survey, and
- UC Davis Suisun Marsh FishSurvey.

The San Francisco Bay Study (Bay Study) was established in 1980 to determine the effects of freshwater outflow on the abundance and distribution of all fish species and mobile crustaceans in the San Francisco Bay estuary, primarily downstream of the Delta. Abundance indices are routinely calculated for more than 35 fishes and several species of crabs and caridean shrimp (Fish et al. 2009). Delta smelt, longfin smelt, and Sacramento splittail population indices are all reported with this program. Sampling ranges from south of the Dumbarton Bridge in South San Francisco Bay, to just west of Alcatraz Island in Central San Francisco Bay, throughout San Pablo and Suisun Bays, north to the confluence of Steamboat and Cache Sloughs on the Sacramento River, and east to Old River Flats on the San Joaquin River (California Department of Fish and Game no date). In Suisun Marsh, a total of eight stations are located in Suisun Bay, Grizzly Bay and Honker Bay.

The Summer Townet Survey was initiated by DFG in 1959 to provide an index of striped bass abundance. This survey uses oblique tows in mid-channel sites located throughout the Delta, Suisun Bay, and San Pablo Bay to sample young-of-year fish. The original purpose was to predict recruitment to the adult stock but the index has proven valuable in gauging the environmental health of the estuary. Young striped bass abundance is primarily a function of Delta outflow, Delta water exports and egg production. Abundance indices for other species have also revealed important trends. For example, the index for delta smelt was useful in determining its status as a threatened species. This survey was mandated by the 1995 USFWS Biological Opinion (BO) for delta smelt on the operation of the SWP and CVP (California Department of Fish and Game no date) and continues to be used to determine delta smelt abundance. Ten sites in Suisun Marsh are surveyed; five in Suisun Bay, one in Honker Bay, one in Grizzly Bay, and three in Montezuma Slough.

The Fall MWT was initiated by DFG in 1967 and was originally designed to determine the relative abundance and distribution of age-0 striped bass in the estuary, but its data is also used for other upper estuary pelagic species, including American shad, threadfin shad, delta smelt, and longfin smelt. DFG records the occurrence of other fish species in most years. This monitoring program currently samples 100 sites extending from San Pablo Bay to Rio Vista on the lower Sacramento River, and to Stockton on the San Joaquin River (California Department of Fish and Game no date). Thirty-five sampling sites are located in Suisun Bay, Honker Bay, Grizzly Bay and Montezuma Slough.

The Smelt Larvae Study was initiated by DFG in January 2009 and provides near real-time distribution data for longfin smelt larvae in the Delta, Suisun Bay and

Suisun Marsh. These data are used by agency managers to assess vulnerability of longfin smelt larvae to entrainment in south Delta export pumps. Sampling takes place within the first two weeks in January and repeats every other week through the second week in March. A total of seven sampling sites are in Suisun Marsh: three in Montezuma Slough and four in Suisun Bay (California Department of Fish and Game no date).

The Spring Kodiak Trawl Survey runs every other week beginning January or February. Each 'Delta-wide' survey takes 4–5 days and samples 39 stations from the Napa River to Stockton on the San Joaquin River, and up to Walnut Grove on the Sacramento River. The 'Delta-wide' survey locates the areas of highest adult delta smelt concentration, and is followed by a 'Supplemental Survey' 2 weeks later. The 'Supplemental Survey' is designed to sample these areas of high concentration intensively, to estimate the proportion of ripe, unripe, and spent delta smelt (California Department of Fish and Game no date).

The UC Davis Suisun Marsh fish study was initiated in 1979 as a way to monitor fish populations in response to modifications being made affecting the way water moves through the Marsh. The California Department of Water Resources funds this study. The study focuses on the entire assemblage of fishes in the Marsh examining such factors as changes in species abundance and composition through time, use of the various habitats within the Marsh, and association of changes in the fish assemblages with natural and anthropogenic changes. There have been two major components to the Suisun Marsh fish study: juvenile and adult sampling and larval fish sampling. The larval fish sampling component was initiated in 1994 and discontinued after 2002. The larval fish sampling was conducted to gain a better understanding of larval fish use of Suisun Marsh. At present only juvenile and adult fishes are sampled (Schroeter et al. 2006). All fish species are discussed and reported annually.

Environmental Conditions

This section describes the life history, habitat requirements, and factors that affect the abundance of special-status fish species for the assessment of impacts of implementing the SMP. The response of special-status fish species to project actions provides an indicator of the potential response of other species. The full range of environmental conditions and fish habitat elements potentially affected is encompassed by the assessment for the species specifically discussed.

Table 6.1-2 lists native and nonnative fishes captured in Suisun Marsh from the UC Davis Study conducted from 1979 to 2006 (Schroeter et al. 2006).

Table 6.1-2. Suisun Marsh Fish Species Potentially Affected by the Proposed Alternatives

Common Name	Scientific Name	Distribution
Native Species		
Bay pipefish	*Syngnathus leptorhynchus*	San Francisco Bay estuary
California halibut	*Paralichthys californicus*	San Francisco Bay estuary
Chinook salmon (winter-, spring-, fall-, and late fall–runs)	*Oncorhynchus tshawytscha*	Central Valley rivers; Delta; San Francisco Bay estuary
Delta smelt	*Hypomesus transpacificus*	Delta and San Francisco Bay estuary
Green sturgeon	*Acipenser medirostris*	Central Valley rivers; Delta; San Francisco Bay estuary
Hardhead	*Mylopharodon conocephalus*	Central Valley rivers; Delta
Hitch	*Lavina exilicauda*	Central Valley rivers; Delta
Longfin smelt	*Spirinchus thaleichthys*	Delta and San Francisco Bay estuary
Longjaw mudsucker	*Gillichthys mirabilis*	San Francisco Bay estuary
Northern anchovy	*Engraulis mordax*	San Francisco Bay estuary
Pacific herring	*Clupea harengeus*	San Francisco Bay estuary
Pacific sanddab	*Citharichthys sordidus*	San Francisco Bay estuary
Pacific staghorn sculpin	*Leptocottus armatus*	San Francisco Bay estuary
Plain midshipman	*Porichthys notatus*	San Francisco Bay
Sacramento blackfish	*Orthodon microlepidotus*	Central Valley rivers; Delta
Sacramento pikeminnow	*Ptychocheilus grandis*	Central Valley rivers; Delta
Sacramento sucker	*Catostomus occidentalis*	Central Valley rivers; Delta
Shiner perch	*Cymatogaster aggregata*	San Francisco Bay estuary
Speckled sanddab	*Citharichthys stigmaeus*	San Francisco Bay estuary
Sacramento splittail	*Pogonichthys macrolepidotus*	Central Valley rivers; Delta; San Francisco Bay estuary
Starry flounder	*Platichthys stellatus*	San Francisco Bay estuary
Steelhead/rainbow trout	*Oncorhynchus mykiss*	Central Valley rivers; Delta; San Francisco Bay estuary
Surf smelt	*Hypomesus pretiosus*	San Francisco Bay estuary
Threespine stickleback	*Gasterosteus aculaetus*	Central Valley rivers; Delta; San Francisco Bay estuary
Tule perch	*Hysterocarpus traskii*	Central Valley rivers; Delta
White croaker	*Genyonemus lineatus*	San Francisco Bay
White sturgeon	*Acipenser transmontanus*	Central Valley rivers; Delta; San Francisco Bay estuary
Nonnative Species		
American shad	*Alosa sapidissima*	Central Valley rivers; Delta; San Francisco Bay estuary
Bigscale logperch	*Percina macrolepida*	Central Valley rivers; Delta
Black bullhead	*Ameiurus melas*	Central Valley rivers and reservoirs; Delta
Black crappie	*Pomoxis nigromaculatus*	Central Valley rivers and reservoirs; Delta
Bluegill	*Lepomis macrochirus*	Central Valley rivers and reservoirs; Delta
Brown bullhead	*Ameiurus nebulosus*	Central Valley rivers and reservoirs; Delta

Common Name	Scientific Name	Distribution
Common carp	*Cyprinus carpio*	Central Valley rivers and reservoirs; Delta
Channel catfish	*Ictalurus punctatus*	Central Valley rivers and reservoirs; Delta
Fathead minnow	*Pimephales promelas*	Central Valley rivers and reservoirs; Delta
Goldfish	*Carassius auratus*	Central Valley rivers and reservoirs; Delta
Green sunfish	*Lepomis cyanellus*	Central Valley rivers and reservoirs; Delta
Inland silverside	*Menidia audena*	Central Valley rivers; Delta
Largemouth bass	*Micropterus salmoides*	Central Valley rivers and reservoirs; Delta
Mosquito fish	*Gambusia affinis*	Central Valley rivers and reservoirs; Delta
Rainwater killifish	*Lucania parva*	Delta and San Francisco Bay estuary
Redear sunfish	*Lepomis microlophus*	Central Valley rivers and reservoirs; Delta
Shimofuri goby	*Tridentiger bifasciatus*	San Francisco Bay
Shokihaze goby	*Tridentiger barbatus*	San Francisco Bay
Striped bass	*Morone saxatilis*	Central Valley rivers and reservoirs; Delta; San Francisco Bay estuary
Threadfin shad	*Dorosoma petenense*	Central Valley rivers and reservoirs; Delta
Wakasagi	*Hypomesus nipponensis*	Central Valley rivers and reservoirs; Delta
Warmouth	*Lepomis gulosus*	Central Valley rivers and reservoirs; Delta
White catfish	*Ameiurus catus*	Central Valley rivers; Delta
White crappie	*Pomoxis annularis*	Central Valley rivers and reservoirs; Delta
Yellowfin goby	*Acanthogobius flavimanus*	Delta; San Francisco Bay estuary

Central Valley steelhead, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley fall-/late fall–run Chinook salmon, delta smelt, longfin smelt, Sacramento splittail, and green sturgeon are listed and special-status native species that occur in Suisun Marsh. Table 6.1-3 shows the status, distribution of these species in the project area, and likelihood of occurrence, and describes any designated critical habitat.

This section describes the key environmental requirements for each life stage of the selected species. Table 6.1-4 shows the assumed months of presence for special-status fish species, for each life stage that occurs in Suisun Marsh. The dark areas indicate the periods of assumed presence. Actual occurrence and relative abundance may vary between months and from year to year.

Table 6.1-3. Special-Status Fish Species with the Potential to Occur in the Study Area

Species Name	Status[1] Fed/State	Distribution	Habitat	Likelihood of Occurrence in the Study Area	Critical habitat designated
Central Valley spring-run Chinook salmon *Oncorhynchus tshawytscha*	T/CT	Upper Sacramento River and Feather River	Occurs in well-oxygenated, cool, riverine habitat with water temperatures from 8.0 to 12.5°C. Coldwater pools are needed for holding adults (Moyle 2002).	Migration through Suisun Bay.	Yes, but not in project area.
Sacramento River winter-run Chinook salmon *Oncorhynchus tshawytscha*	E/CE	Mainstem Sacramento River below Keswick Dam (Moyle 2002)	Occurs in well-oxygenated, cool, riverine habitat with water temperatures from 8.0 to 12.5°C. Habitat types are riffles, runs, and pools (Moyle 2002).	Migration through Suisun Bay.	Yes, but not in project area.
Central Valley fall-/late fall–run Chinook salmon *Oncorhynchus tshawytscha*	SC/CSC	Sacramento and San Joaquin rivers and tributary Central Valley rivers	Occurs in well-oxygenated, cool, riverine habitat with water temperatures from 8.0 to 12.5°C. Habitat types are riffles, runs, and pools (Moyle 2002).	Species observed in the study area. Suitable habitat in the study area.	No
Central California coast steelhead *Oncorhynchus mykiss*	T/–	Russian River to Soquel Creek, Santa Cruz Co.	Cold, clear water with clean gravel of appropriate size for spawning. Most spawning occurs in headwater streams. Steelhead migrate to the ocean to feed and grow until sexually mature.	Species observed in fresh water creeks above the study area.	Yes, but not in project area.
Central Valley steelhead *Oncorhynchus mykiss*	T/–	Sacramento River and tributary Central Valley rivers	Occurs in well-oxygenated, cool, riverine habitat with water temperatures from 7.8 to 18°C (Moyle 2002). Habitat types are riffles, runs, and pools.	Migration through Suisun Bay. Species observed in fresh water creeks above the study area.	Yes, but not in project area.
Green sturgeon (southern DPS) *Acipenser medirostris*	T/CSC	Sacramento, Klamath and Trinity rivers (Moyle 2002)	Spawn in large river systems with well-oxygenated water, with temperatures from 8.0 to 14°C	The study area may provide rearing habitat for juveniles and some adults.	Yes; all tidally influenced areas of Suisun Bay and Grizzly Bay up to the elevation of mean higher high water

Species Name	Status[1] Fed/State	Distribution	Habitat	Likelihood of Occurrence in the Study Area	Critical habitat designated
Delta smelt *Hypomesus transpacificus*	T/CE	Primarily in the Sacramento–San Joaquin estuary, but has been found as far upstream as the mouth of the American River on the Sacramento River and Mossdale on the San Joaquin River; range extends downstream to San Pablo Bay	Occurs in estuary habitat in the Delta where fresh and brackish water mix in the salinity range of 2–7 parts per thousand (Moyle 2002).	Found throughout the study area.	Yes; the entire Marsh area and bays are designated as critical habitat.
Longfin smelt *Spirinchus thaleichthys*	–/CT	Within California, mostly in the Sacramento River–San Joaquin River Delta, but also in Humboldt Bay, Eel River estuary, and Klamath River estuary.	Salt or brackish estuary waters with freshwater inputs for spawning.	Found throughout the study area.	No
Sacramento splittail *Pogonichthys macrolepidotus*	–/CSC	Occurs throughout the year in low-salinity waters and freshwater areas of the Sacramento–San Joaquin Delta, Yolo Bypass, Suisun Marsh, Napa River, and Petaluma River (Moyle 2002).	Spawning takes place among submerged and flooded vegetation in sloughs and the lower reaches of rivers.	Found throughout the study area.	No

[1] Status:

Federal

E = Listed as endangered under the federal Endangered Species Act (ESA).

T = Listed as threatened under ESA.

SC = Listed as a species of concern.

– = No federal status.

State

CE = Listed as endangered under the California Endangered Species Act (CESA).

CT = Listed as threatened under CESA.

CSC = California species of special concern.

– = No state status.

Table 6.1-4. Fish Life Stage Timing in Suisun Marsh

Life Stage	Distribution	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Central Valley Spring-Run Chinook Salmon													
Adult migration	Upper Sacramento River and Tributaries			■	■	■	■	■	■				
Juvenile (young of year) movement and rearing	Upper Sacramento River and Tributaries		■	■	■	■	■						
Yearling movement	Upper Sacramento River and tributaries to San Francisco Bay	■	■	■							■	■	■
Central Valley Fall-Run Chinook Salmon													
Adult migration	Upper Sacramento River and Tributaries, Mokelumne River and San Joaquin River Tributaries, Suisun Marsh							■	■	■	■	■	■
Juvenile movement and rearing	Upper Sacramento River and Tributaries, Mokelumne River and San Joaquin River Tributaries, Suisun Marsh	■	■	■	■	■	■						
Central Valley Late Fall-Run Chinook Salmon													
Adult migration	Sacramento River and Tributaries	■	■	■	■						■	■	■
Juvenile movement and rearing	Upper Sacramento River and Tributaries, Mokelumne River and San Joaquin River Tributaries	■	■	■	■						■	■	■
Sacramento Winter-Run Chinook Salmon													
Adult migration	Upper Sacramento River	■	■	■	■	■	■	■					■
Juvenile movement and rearing	Lower Sacramento River and Delta	■	■	■	■								
Steelhead													
Adult migration	Suisun Marsh	■	■	■								■	■
Juvenile rearing	Suisun Marsh	■											
Juvenile movement	Upper Sacramento River and Tributaries to San Francisco Bay	■	■	■	■	■	■						■
Longfin Smelt													
Spawning		■	■	■	■	■	■					■	■

Life Stage	Distribution	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult and juvenile rearing	Suisun Marsh	■	■	■	■	■				■	■	■	■
Larvae	Suisun Marsh		■	■	■	■							
Green Sturgeon													
Adult migration	Suisun Bay	■	■	■	■	■					■	■	■
Juvenile rearing*	Suisun Marsh	■	■	■	■	■	■	■	■	■	■	■	■
Juvenile migration*	Suisun Marsh, Suisun Bay	■	■	■	■	■	■	■	■	■	■	■	■
Sacramento Splittail													
Adult migration	Suisun Marsh, Upper Delta, Yolo and Sutter Bypasses, Sacramento River and San Joaquin River	■	■	■	■								■
Spawning	Suisun Marsh, Upper Delta, Yolo and Sutter Bypasses, Lower Sacramento and San Joaquin rivers	■	■	■	■	■							
Larval and early juvenile rearing and movement	Suisun Marsh, Upper Delta, Yolo Bypass, Sutter Bypass, Lower Sacramento and San Joaquin rivers			■	■	■	■						
Adult and juvenile rearing	Delta, Suisun Bay	■	■	■	■	■	■	■	■	■	■	■	■
Delta Smelt													
Adult migration	Delta	■	■	■									■
Spawning	Delta, Suisun Marsh	■	■	■	■	■							
Larval and early juvenile rearing	Suisun Marsh			■	■	■	■						
Estuarine rearing: juveniles and adults	Suisun Marsh	■	■	■	■	■				■	■	■	■

■ Primary occurrence included in the assessment of plan impacts.

* Juvenile life history in unknown. Assume in Suisun Marsh area year round.

Sources: Rosenfield and Baxter 2007; Wang and Brown 1993; U.S. Fish and Wildlife Service 1996; McEwan 2001; Moyle 2002; Hallock 1989.

Habitat quality and quantity have been identified as key factors influencing fish abundance and distribution in Suisun Marsh and San Francisco Bay estuary (Unger 1994). Habitat types important to the native fishes of Suisun Marsh include shallow bays and channels; tidal flats; and low, mid, and high tidal marshes (Goals Project 1999). Fish use of the Marsh is also reflective of water quality conditions such as salinity, water transparency/turbidity, and water temperature.

Moyle et al. (1983) identified two assemblages of fish in the Marsh—a native fish assemblage that existed in the dead-end sloughs and an assemblage of introduced and seasonal species that existed in the main channels. Native fish species found in dead-end sloughs include threespine stickleback and Sacramento splittail. Introduced species include striped bass, white catfish and common carp. Seasonal species are longfin smelt and delta smelt. Meng et al. (1994) confirmed that native species were found more often in small dead-end sloughs, and seasonal species were found in larger sloughs; introduced species were found in both habitats (Suisun Ecological Workgroup 2001). Matern et al. (1997, 1998, 2002) compared fish capture data from the UC Davis Suisun Marsh fish surveys for different years as discussed below.

Matern et al. (1997) compared slough data from 1995 to1996 and found that species diversity was highest in Spring Branch Slough and lowest in Nurse Slough. Their findings indicated species diversity was lower in all large and medium-sized sloughs than in small sloughs, except for Boynton Slough. Matern et al. (1998) conducted a similar analysis using data from 1995 through 1997, which indicated that the highest catch per trawl occurred in Spring Branch Slough, while the lowest occurred in Boynton Slough. Boynton Slough receives outflow from the Fairfield Sewage Treatment Plant, and Spring Branch is one of the few remaining areas of undiked tidal wetlands in Suisun Marsh (the Solano Farmlands and Open Space Foundation's Rush Ranch). However, Matern et al. (1998) note their results could reflect decreases in gear efficiency in the larger sloughs (Suisun Ecological Workgroup 2001). Overall they indicate species diversity and native fish abundance tend to be higher in smaller sloughs than in medium and large sloughs. As habitat complexity tends to be higher in smaller sloughs, these studies suggest habitat complexity is important to native fish abundance and distribution (Matern et al. 1997). The Suisun Ecological Workgroup (2001) suggests efforts to increase acreage and to rehabilitate edge habitat (e.g., shallow water, tidal), could lead to increases in native fish populations in the Marsh.

Matern et al. (2002) compared fish species abundance and distribution throughout Suisun Marsh with water quality parameters such as temperature, salinity, water transparency/turbidity, and freshwater inflow. Species abundance and distribution were related to four interacting factors: (1) timing and place of reproducing fish populations; (2) past reproductive success; (3) habitat differences between sloughs, and (4) physiological tolerances. Native fish species peaked in abundance during the early part of the year (January through July) while nonnative warmer water fish were most abundant mid-June to

September (page 805) indicating water temperature was a limiting factor. Native fish species abundance has declined since 1979, but has fluctuated at lower levels from 1990 to 1999 in the Marsh. Further declines in delta smelt and longfin smelt abundance from years 2000 to 2007 have been seen throughout the San Francisco estuary (Baxter et al. 2008). Nonnatives have followed the same pattern but remain more abundant than native species. Larvae of native fish appear in the winter through early spring, and nonnative larval fish appear later in the spring into the summer. The low variability of salinity and water temperature in Suisun Marsh allows fish to use the Marsh most of the year. Nonnative fish and invertebrate species will continue to be introduced into the Marsh primarily through ballast water.

Matern et al. (2002) also compared fish capture data between sloughs. The differences between slough size and chemical attributes of the sloughs determined fish composition. The largest sloughs had the least numbers of fish captured and least diversity. However, in larger sloughs there is a decrease in efficiency of sampling techniques. Boynton Slough is the exception to the rule. Although one of the smaller sloughs, it had low diversity and fish numbers. One reason may be that Boynton Slough receives sewage outflow from the Fairfield Sewage Treatment Plant. Water quality constituents may be unfavorable and limit fish species that could occur in the slough (Stover et al. 2005). Physical characteristics (substrate, position relative to other water bodies) of various sloughs also may play a part in where particular fish species are residing. High densities of threespine stickleback were captured near duck pond drains, indicating habitat preferences (Matern et al. 2002).

To summarize the three studies, the highest numbers of species are found in the smaller sloughs. Juvenile native species use the Marsh as a rearing area in the winter and spring months, while nonnative species use the Marsh in the summer and early fall months when the water is warmer. Native fish species population numbers have declined over the years.

Water quality conditions also reflect fish use in the Marsh. A literature review found most adult and juvenile fish species have a broad range of salinity tolerances, and changes in salinity throughout the year would not affect their abundance (Wang 1986). Native fish use of Suisun Marsh reflects salinity preferences—fish species that prefer higher salinity are present in the Marsh when salinities are higher and vice versa for fish species with lower tolerance. The majority of nonnative fish species prefers low salinity and inhabits the Marsh during low-salinity periods. Low-salinity periods typically are from spring to early summer when outflow is high. During the months of February through June, native fish species are spawning and rearing in the Marsh and require salinity less than 5 ppt. Many fish are larvae, juveniles, and young-of-the-year fish that were spawned upstream in freshwater areas but rear in the Marsh in the spring (Suisun Ecological Workgroup 2001). During dry and critical dry years, salinities are high and may preclude native fish from spawning. Higher salinities are seen in the summer into fall. The Suisun Ecological Workgroup (2001) has suggested keeping salinity variable from July to January to preclude nonnative fish species from establishing in the Marsh.

Table 6.1-5. Salinity and Velocity Tolerances of Special-Status Fish Species in Suisun Marsh

Species	Salinity[a]	Velocity
Longfin Smelt	Tolerance range: 0 to pure seawater Spawning: 0 to 0.5ppt Egg: 0 to 0.5 ppt Larvae: ≥0 ppt Juveniles: ≥0.5 ppt Adult: ≥0 ppt Larvae and early juveniles: 1.1 to 18.5 ppt	No information found.
Delta Smelt	Tolerance range: 0 to 18 ppt; 19 ppt lethal limit Spawning: 0 to 0.5ppt Egg: 0 to 5 ppt Larvae: 0 to 5 ppt Juveniles: 0.5 to 10 ppt Adult: 0.5 to 10 ppt Larvae and early juveniles: 0.3 to 1.8 ppt	Juveniles/adults <0.33 ft /s to 0.89 ft/s for 10 minute interval (Bennett 2003:15)
Chinook Salmon	Tolerance range: 0 to 32 ppt Spawning: 0 to 0.5 ppt Egg: 0 to 0.5 ppt Larvae: 0 to 0.5 ppt Juveniles: ≥ 0 ppt Adult: ≥ 0 ppt	Juvenile 0–1.97 ft/s preferred velocity (Raleigh 1986:11) Adult cruising speed 0–4 ft/sec (Bell 1991, 1986 cited in Frei 2006)
Steelhead	Tolerance range: 0 to 32 ppt Spawning: 0 to 0.5ppt Egg: 0 to 0.5 ppt Larvae: 0 to 0.5 ppt Juveniles: ≥ 0 ppt Adult: ≥ 0 ppt	Juvenile 0–0.98 ft/s preferred velocity (Raleigh 1984:8) Adult cruising speed 0–5 ft/sec (Bell 1991, 1986 cited in Frei 2006)
Sacramento Splittail	Tolerance range: 0 to 28 ppt; 22 to 27 ppt lethal limit (depends on size) Spawning: 0 to 5 ppt Egg: 0 to 5 ppt Larvae: 0 to 5 ppt Juveniles: 0 to 5 ppt Adult: 0 to 5 ppt Larvae and early juveniles: 0–8 ppt	Juvenile 0.66–1.31 ft/s critical swimming speed (Young and Cech 1996:671) Adult 1.31–2.07 ft/s critical swimming speed (Young and Cech 1996:671)
Green Sturgeon	Tolerance range: 0 to 32 ppt Spawning: 0 to 0.5 ppt Egg: 0 to 0.5 ppt Larvae: 0 to 0.5 ppt Juveniles: ≥0 ppt Adult: ≥0 ppt Juvenile tolerance depends on length. At 7 months, can tolerate 32 ppt (Allen et al. 2003)	Juvenile/adult 1.31–2.62 ft/s critical swimming speed (dependent on body size) (Allen et al. 2006:1365)

Species	Salinity[a]	Velocity

ft/s = feet per second.

[a] From Suisun Ecological Workgroup 2001.

[b] Allen et al. 2003.

Special-Status Fish Species Life History

Chinook Salmon

Four distinct runs of Chinook salmon occur in the Sacramento River system: winter-run, spring-run, fall-run, and late fall–run. Chinook salmon are anadromous fish, meaning that adults live in marine environments and return to their natal freshwater streams to spawn. Juveniles rear in freshwater for a period of up to 1 year until smoltification (i.e., a physiological preparation for survival in marine environs) and subsequent ocean residence.

Sacramento Winter-Run

Both ESA and CESA list winter-run Chinook salmon evolutionarily significant unit (ESU) as an endangered species. Critical habitat for winter-run Chinook salmon includes the Sacramento River from Keswick Dam (River Mile [RM] 302) to Chipps Island (RM 0) in the Delta (National Marine Fisheries Service 1997).

Adult winter-run Chinook salmon immigration (upstream migration) through the Delta and into the Sacramento River occurs from December through July, with peak immigration from January through April (Table 6.1-4). Winter-run Chinook salmon primarily spawn in the mainstem Sacramento River between Keswick Dam (RM 302) and the Red Bluff Diversion Dam (RM 242). Winter-run Chinook salmon spawn between late April and mid-August, with peak spawning generally occurring in June (Snider et al. 2000).

Juvenile emigration (downstream migration) past the Red Bluff Diversion Dam (RM 242) begins in late July, peaks during September, and may extend through mid-March (National Marine Fisheries Service 1997). The peak period of juvenile emigration through the lower Sacramento River into the Delta generally occurs between January and April (National Marine Fisheries Service 1997) (Table 6.1-4). Differences in peak emigration periods between these two locations suggest that juvenile winter-run Chinook salmon may exhibit a sustained residence in the upper or middle reaches of the Sacramento River before entering the lower Sacramento River/Delta. Although the location and extent of rearing in these lower or middle reaches is unknown, it is believed that the duration of fry presence in an area is directly related to the magnitude of river flows during the rearing period (Stevens 1989).

Central Valley Spring-Run

The Central Valley spring-run Chinook salmon ESU, which includes populations spawning in the Sacramento River and its tributaries, is listed as threatened under ESA and CESA. Spring-run Chinook salmon historically occurred from the upper tributaries of the Sacramento River to the upper tributaries of the San Joaquin River. However, they have been extirpated from the San Joaquin River system. The only streams in the Central Valley with remaining wild spring-run Chinook salmon populations are the Sacramento River and its tributaries, including the Yuba River, Mill Creek, Deer Creek, and Butte Creek. Critical habitat is designated for spring-run Chinook salmon in the Sacramento River and upper tributaries. Critical habitat does not include Suisun Marsh (70 FR 52531).

Spring-run Chinook salmon enter the Sacramento River from late March through September (Reynolds et al. 1993), but peak abundance of immigrating adults in the Delta and lower Sacramento River occurs from April through June (Table 6.1-4). Adult spring-run Chinook salmon remain in deep-water habitats downstream of spawning areas during summer until their eggs fully develop and become ready for spawning. Spring-run Chinook salmon spawn primarily upstream of the Red Bluff Diversion Dam in the mainstem Sacramento River and the aforementioned tributaries. Spawning occurs from mid-August through early October (Reynolds et al. 1993). A small portion of an annual year-class may emigrate as post-emergent fry (less than 1.8 inches long) and reside in the Delta undergoing smoltification. However, most are believed to rear in the upper river and tributaries during winter and spring, emigrating as juveniles (more than 1.8 inches long). The timing of juvenile emigration from the spawning and rearing reaches can vary depending on tributary of origin and can occur from November through June (Table 6.1-4).

Central Valley Fall-/Late Fall–Run

Central Valley fall-run and late fall–run Chinook salmon are commercially and recreationally important. These ESUs are federal species of concern. Because the fall-run Chinook salmon is currently the largest run of Chinook salmon in the Sacramento–San Joaquin River system, it continues to support commercial and recreational fisheries of significant economic importance.

In general, adult fall-run Chinook salmon migrate into the Sacramento River, San Joaquin River, and its tributaries from July through December, with immigration peaking from mid-October through November (Table 6.1-4). Fall-run Chinook salmon spawn in numerous tributaries of the Sacramento River, including the lower American River, lower Yuba River, Feather River, and tributaries of the upper Sacramento River. Most mainstem Sacramento River spawning occurs between Keswick Dam and the Red Bluff Diversion Dam. Fall-run fish also spawn in the San Joaquin River. Spawning generally occurs from October through December, with fry emergence typically beginning in late December and January. Fall-run Chinook salmon emigrate as post-emergent fry, juveniles, and smolts after rearing in their natal streams for up to 6 months. Consequently, fall-run emigrants may be present in the lower Sacramento River from January through June (Reynolds et al. 1993) (Table 6.1-4) and remain in the Delta for variable lengths of time before ocean entry.

Adult immigration of late fall–run Chinook salmon into the Sacramento River generally begins in October, peaks in December, and ends in April (Moyle et al. 1995) (Table 6.1-4). Primary spawning areas for late fall–run Chinook salmon are located in tributaries of the upper Sacramento River (e.g., Battle Creek, Cottonwood Creek, Clear Creek, Mill Creek), although late fall–run Chinook salmon are believed to return to the Feather and Yuba Rivers as well (Moyle et al. 1995). Juveniles emigrate through the lower Sacramento River primarily from October through April (Table 6.1-4).

Myrick and Cech (2001) have compiled the most comprehensive review of temperature effects on Central Valley Chinook salmon to date. These water temperatures apply to all runs of Chinook salmon. Chinook salmon eggs can survive at temperatures ranging from 35 to 62°F, but highest survival rates occur between approximately 45 and 50°F. Survival of juvenile Chinook salmon under high temperatures is a function of acclimation temperature and exposure time. In general, the maximum temperature at which eggs can survive is positively correlated with acclimation temperature. The reported chronic upper lethal limit for Central Valley Chinook salmon is approximately 77°F, although temperatures approaching 84°F may be tolerated for short periods. Growth of juvenile Chinook salmon occurs at temperatures ranging from approximately 46 to 77°F, with maximum to near-maximum growth rates reached at approximately 56 to 68°F (Myrick and Cech 2001).

Occurrence in Plan Area

Chinook salmon have been captured over the years in small numbers during the Summer Townet and the Fall Midwater Trawl surveys in Suisun, Grizzly, and Honker Bays and Montezuma Slough.

Five adult Chinook salmon and numerous juvenile salmon have been captured during the UC Davis Suisun Marsh fish surveys (1979 to 2005). Juveniles were measured and identified as fall-run Chinook salmon using the Fisher (1992) length at date criteria (Schroeter et al. 2006:10). Denverton, Suisun, Montezuma, Goodyear, Spring Branch, and Grant Sloughs were the primary areas of capture, with Denverton Slough having the most captured fish (Figure 5.6-3, "Surface Waters in and around Suisun Marsh"). Beach seining was the primary mode of capture, indicating that most were found in shallow-water habitat (Bay Delta and Tributaries no date). Juvenile Chinook salmon also are thought to rear in Suisun Marsh during some years, such as 1995 when presence and growth were seen for several months (Schroeter et al. 2006:10). Rearing juveniles move out of the Marsh once water temperatures reach above 17°C and is the determining factor on how long fish will stay in the Marsh (Schroeter et al. 2006:10).

Steelhead (Central California Coast and Central Valley)

Central California coast and Central Valley steelhead are both federally listed as threatened. Steelhead have one of the most complex life histories of any salmonid species. *O. mykiss* either can be anadromous and called *steelhead* or complete their life cycle within a given river reach. Freshwater residents typically are referred to as rainbow trout.

Historical records indicate that adult steelhead enter the mainstem Sacramento River in July, peak in abundance in September and October, and continue migrating through February or March (McEwan and Jackson 1996; Hallock 1989). Most steelhead spawn from December through April, with peak spawning occurring from January through March (Table 6.1-4). Unlike Pacific salmon, some steelhead may survive to spawn more than one time, returning to the ocean between spawning migrations.

Newly emerged steelhead fry use shallow, protected areas along streambanks and move to faster, deeper areas of the river as they grow. Most juveniles occupy riffles in their first year of life, and some of the larger steelhead live in deep fast runs or in pools. Juvenile steelhead feed on a variety of aquatic and terrestrial insects and other small invertebrates.

Juvenile steelhead migration to the ocean generally occurs from December through August (Table 6.1-4). Most Sacramento River steelhead migrate in spring and early summer (Reynolds et al. 1993). Sacramento River steelhead generally migrate as 1-year-olds (smolts) at a length of 6 to 8 inches (15.2 to 20.3 centimeters [cm]) (Barnhart 1986; Reynolds et al. 1993).

Occurrence in Plan Area

Small numbers of steelhead were captured during Fall Mid Water Trawl surveys in Suisun, Honker, Grizzly Bays and Montezuma Slough. Eleven steelhead have been captured in Suisun Marsh (1982 to 2002) during the UC Davis sampling. One juvenile, one smolt, and 9 adults ranging from 293 millimeters (mm) to 398 mm have been caught— all in November through February, with most caught in January (Bay Delta and Tributaries no date). Most fish were caught in Denverton Slough, followed by Peytonia, Spring Branch, Cutoff, and Montezuma Sloughs. Steelhead have not been caught since 2002 (Bay Delta and Tributaries no date). It is unknown how steelhead are using Suisun Marsh, but possibly they are using the Marsh as a migratory area either to freshwater streams such as Green Valley Creek and Suisun Creek to spawn (adults) or outmigration to the ocean (juveniles and smolts) (Table 6.1-4).

Longfin Smelt

Longfin smelt has been listed as a threatened species under CESA (April 9, 2010). Historically, longfin smelt populations were found in the Klamath, Eel, and San Francisco estuaries, and in Humboldt Bay. From recent sampling, populations reside at the mouth of the Klamath River and the Russian River estuary. In the Central Valley, longfin are rarely found upstream of Rio Vista or Medford Island in the Delta. Adults concentrate in Suisun, San Pablo, and North San Francisco Bays (Moyle 2002).

Longfin smelt are anadromous, euryhaline, and nektonic (free-swimming). Adults and juveniles are found in estuaries and can tolerate salinities from 0 ppt to pure seawater. The salinity tolerance of longfin smelt larvae and early juveniles ranges from 1.1 to 18.5 ppt. After the early juvenile stage, they prefer salinities in the 15–30 ppt range (Moyle 2002) (Table 6.1-5). Longfin smelt in the San Francisco estuary spawn in fresh or slightly brackish water (Moyle 2002: 236). Prior to spawning, these fish aggregate in deepwater habitats available in the northern Delta, including primarily the channel habitats of Suisun Bay and the Sacramento River (Rosenfield and Baxter 2007). Catches of gravid adults and larval longfin smelt indicate that the primary spawning locations for these fish are in or near the Suisun Bay channel, the Sacramento River channel near Rio Vista, and (at least historically) Suisun Marsh (Wang 1991; Moyle 2002; Rosenfield and Baxter 2007). Moyle (2002) indicated that longfin smelt may spawn in the San Joaquin River as far upstream as Medford Island. Two sampling programs operated by DFG during the spawning season—the Fall Mid-Water Trawl and the Bay Study—found most of the juveniles were caught in the lower Sacramento River and Suisun Bay. In the Delta, longfin smelt spend most of their life cycle in deep, cold, brackish-to-marine waters of the Delta and nearshore environments (Moyle 2002; Rosenfield and Baxter 2007). They are capable of living their entire life cycle in fresh water, as demonstrated by landlocked populations.

Prespawning adults are generally restricted to brackish (2–35 ppt) or marine habitats. In the fall and winter, yearlings move upstream into fresh water to spawn (Table 6.1-4). Spawning may occur as early as November, and larval surveys indicate it may extend into June (Moyle 2002) (Table 6.1-4). The exact nature and extent of spawning habitat are still unknown for this species (Moyle 2002), although major aggregations of gravid adults occur in the northwestern Delta and eastern Suisun Bay (Rosenfield and Baxter 2007).

Embryos hatch in 40 days at 7°C and are buoyant. They move into the upper part of the water column and are carried into the estuary. High outflows transport the larvae into Suisun and San Pablo Bays. In low outflow years, larvae move into the western Delta and Suisun Bay. Higher outflows are reflected positively in juvenile survival and adult abundance. Rearing habitat is highly suitable in Suisun and San Pablo Bays in part because juveniles require brackish water in the 2–18 ppt range (Table 6.1-5). Longfin smelt are pelagic foragers that feed extensively on copepods, amphipods, and shrimp (U.S. Fish and Wildlife Service 1996; Moyle 2002). Severe alterations in the composition and abundance of the primary producer and primary/secondary consumer assemblages in the Delta have been implicated in the recent decline of longfin smelt and other native fish species (U.S. Fish and Wildlife Service 1996; Kimmerer 2002).

Occurrence in Plan Area

Longfin smelt are common in the study area. The Summer Townet survey and Fall Mid Water Trawl survey captured numerous longfin smelt in Suisun, Honker, and Grizzly bays and Montezuma Slough. The 2008 Bay Study otter trawl age-0 longfin smelt index was 1.7 times the 2007 index, an abundance increase similar to the Bay Study Mid Water trawl. Age-0 fish were collected from June through December and abundance peaked in September. They were collected from South Bay through eastern Suisun Bay, but were most common in Central Bay most months (Fish et al. 2009). Larval longfin smelt were captured in 2009 from January to March in the bays and Montezuma Slough (California Department of Fish and Game 2009c).

Longfin smelt are found in Suisun Marsh throughout the year and in all sloughs. Highest numbers of longfin smelt were found in Cutoff, Goodyear, and Suisun Sloughs (Bay Delta and Tributaries no date) (Figure 5.6-3). They are prevalent from January to May and September to December (Table 6.1-4). Smaller numbers occur from June to August. In 2005, longfin smelt numbers were the lowest since 1998, and the eighth lowest since 1980. The Fall Midwater Trawl conducted by DFG and the Bay Study shows similar declines. It is unknown why longfin smelt numbers declined in 2005 because environmental parameters were suitable (Schroeter et al. 2006:9).

Green Sturgeon

Green sturgeon are federally listed as threatened. Critical habitat was designated for green sturgeon in Suisun Marsh on October 9, 2009 (74 FR 52300). Although green sturgeon are anadromous, they are the most marine-oriented species of sturgeon and are found in nearshore marine waters from Mexico to the Bering Sea (70 FR 17386). In fresh water, green sturgeon occur in the lower reaches of large rivers from British Columbia south to San Francisco Bay. The southernmost spawning population of green sturgeon occurs in the Sacramento River system (Moyle 2002).

Green sturgeon have been divided into two distinct population segments: the northern and southern distinct population segments. The Northern DPS and Southern DPS are distinguished based on genetic data and spawning locations, but their distribution outside of natal waters generally overlap with one another (Lindley et al. 2008). The northern distinct population segment consists of green sturgeon populations extending from the Eel River northward, and the southern distinct population segment includes populations extending from south of the Eel River to the Sacramento River. Spawning populations have been confirmed, however, only in the Rogue (Oregon), Klamath, and Sacramento rivers (70 FR 17386). In the Central Valley, spawning occurs in the Sacramento River upstream of Hamilton City, perhaps as far upstream as Keswick Dam (Adams et al. 2002), and possibly in the lower Feather River (Moyle 2002).

Adults migrate upstream into rivers between late February and late July, and spawn between March and July, when the water temperature is 46–57°F. Peak spawning occurs from mid-April to mid-June (Table 6.1-4). After hatching, young green sturgeon rear for several months in the Sacramento River as they migrate downstream from spawning areas. Trapping records indicate that larvae and juveniles spend the first 1 to 2 months in the Sacramento River between Hamilton City and Keswick Dam (National Marine Fisheries Service 2008). Laboratory studies of migration, foraging, and wintering behavior of green sturgeon from the Klamath River (Kynard et al. 2005) indicate that larvae and juveniles are strongly bottom-oriented and migrate downstream at night, remaining in the river downstream of spawning areas through their first winter. At 7 months of age, juvenile sturgeon are able to survive 32 ppt salinity (Allen et al. 2003). At all ages they are able to tolerate a wide range of salinities (Table 6.1-5).

Little is known about the movements and habits of green sturgeon. Green sturgeon have been salvaged at the state and federal fish collection facilities in every month, indicating that they are present in the Delta year-round. Between January 1993 and February 2003, a total of 99 green sturgeon were salvaged at the state and federal fish salvage facilities; no green sturgeon were salvaged in 2004 or 2005. Although it is assumed that green sturgeon are present throughout the Delta and rivers during any time of the year, salvage numbers probably indicate that their abundance is low. The diet of adult green sturgeon seems to be mostly benthic invertebrates and small fish (Ganssle 1966). Juveniles in the Delta feed on opossum shrimp and amphipods (Radtke 1966).

Occurrence in Plan Area

Six green sturgeon have been captured during the Fall Mid Water Trawl surveys in Suisun Bay. Three green sturgeon have been captured during the UC Davis Suisun Marsh fish survey. Two were caught in March 1998 and one in April 1996. Two were caught in Suisun Slough below Cordelia Slough, and the other was caught in Montezuma Slough at the boat ramp (Bay Delta and Tributaries no date) (Figure 5.6-3). All three sturgeon were longer than 300 mm, indicating they were at the end of their first year (70 FR 17386) and may have been migrating out to the ocean (Table 6.1-4). Because no other green sturgeon have been captured in Suisun Marsh since 1998, it is hard to determine how many sturgeon use the Marsh.

Delta Smelt

Delta smelt are listed as threatened under ESA and endangered under CESA (January 20, 2010). They are currently in review by the USFWS to be uplisted as endangered. Critical habitat is designated from the Delta into the Sacramento River. Their range extends from San Pablo Bay upstream to Verona on the Sacramento River and Mossdale on the San Joaquin River, encompassing the Delta.

The delta smelt life cycle is completed within the freshwater and brackish low salinity zone (LSZ) of the Bay-Delta. Delta smelt are moderately euryhaline (Moyle 2002). However, salinity requirements vary by life stage (Table 6.1-5). Delta smelt are a pelagic species, inhabiting open waters away from the bottom and shore-associated structural features (Nobriga and Herbold 2008). Although delta smelt spawning has never been observed in the wild, clues from the spawning behavior of related osmerids suggests delta smelt use bottom substrate and nearshore features during spawning. However, apart from spawning and egg-embryo development, the distribution and movements of all life stages are influenced by transport processes associated with water flows in the estuary, which also affect the quality and location of suitable open water habitat (Dege and Brown 2004; Feyrer et al. 2007; Nobriga et al. 2008).

Delta smelt are weakly anadromous and undergo a spawning migration from brackish water to freshwater annually (Moyle 2002). In early winter, mature delta smelt migrate from brackish, downstream rearing areas in and around Suisun Bay and the confluence of the Sacramento and San Joaquin rivers upstream to freshwater spawning areas in the Delta. Delta smelt historically have also spawned in the freshwater reaches of Suisun Marsh. In winters featuring high Delta outflow, the spawning range of delta smelt shifts west to include the Napa River (Hobbs et al. 2007).

Delta smelt spawning may occur from mid-winter through spring; most spawning occurs during April through mid-May when water temperatures range from about 12°C to 18°C (Moyle 2002). Spawning occurs primarily in sloughs and shallow edge areas in the Delta. Delta smelt spawning has also been recorded in Suisun Marsh and the Napa River (Moyle 2002). Most adult delta smelt die after spawning (Moyle 2002). However, some fraction of the population may hold over as two-year-old fish and spawn in the subsequent year. Most of what is known about delta smelt spawning habitat in the wild is inferred from the location of spent females and young larvae captured in the Summer Kodiak trawl (SKT) and 20-mm survey, respectively.

During and after a variable period of larval development, the young fish migrate downstream until they reach the LSZ (indexed as X2) where they reside until the following winter (Moyle 2002). Young-of-the-year delta smelt rear in the LSZ from late spring through fall and early winter. The location of the delta smelt population follows changes in the location of the LSZ which depends primarily on Delta outflow.

At all life stages, delta smelt are found in greatest abundance in the water column and usually not in close association with the shoreline. They inhabit open, surface waters of the Delta and Suisun Bay, where they presumably aggregate in loose schools where conditions are favorable (Moyle 2002). In years of moderate to high Delta outflow (above normal to wet water years), delta smelt larvae are abundant in the Napa River, Suisun Bay and Montezuma Slough, but the degree to which these larvae are produced by locally spawning fish and are transported by tidal currents to the Bay and Marsh is uncertain.

Delta smelt seem to prefer water with high turbidity, based on a negative correlation between the frequency of delta smelt occurrence in survey trawls during summer, fall, and early winter and water clarity. For example, the likelihood of delta smelt occurrence in trawls at a given sampling station decreases with increasing Secchi depth at the stations (Feyrer et al. 2007; Nobriga et al. 2008). This is very consistent with behavioral observations of captive delta smelt (Nobriga and Herbold 2008). The delta smelt’s preference for turbid water may be related to increased foraging efficiency (Baskerville-Bridges et al. 2004) and reduced risk of predation.

Temperature also affects delta smelt distribution. Swanson and Cech (1995) and Swanson et al. (2000) indicate delta smelt tolerate temperatures (<8°C to >25°C), however warmer water temperatures >25°C restrict their distribution more than colder water temperatures (Nobriga and Herbold 2008). Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the waters are well oxygenated and temperatures are usually less than 25°C in summer (Nobriga et al. 2008).

Occurrence in Plan Area

Suisun Marsh is a key habitat area for delta smelt. Mature adults and rearing juveniles have been detected in Suisun Marsh during all of the past 7 years of DFG Spring Kodiak surveys (California Department of Fish and Game 2008: <http://www.delta.dfg.ca.gov/data/skt/>). Larval delta smelt surveys (20-mm Survey) also are done by DFG and have taken place from 1995 to 2008. Larval delta smelt have been found every year, and numbers vary from year to year (California Department of Fish and Game 2008). Numerous delta smelt have been captured over the years during the UC Davis Suisun Marsh fish survey. However, their numbers have diminished over the years. The highest number caught was 230 fish in 1981, and in subsequent years (1982–2005), numbers ranged from 0 to 33 fish. In 2006, two fish were captured (Schroeter 2008 pers. comm.). They are present in most sloughs in the Marsh, with Suisun Slough having the most fish (Figure 5.6-3). Most adult and juvenile fish rear from January through May and September through December. There are few fish from June through August. Larval smelt are present in the plan area from February to May (Bay Delta and Tributaries no date) (Table 6.1-4).

Sacramento Splittail

Sacramento splittail was listed as a federally threatened species, but was delisted September 22, 2003. Adult splittail migrate from Suisun Bay and the Delta to upstream spawning habitat in the San Joaquin, Sacramento, lower American, and lower Feather rivers (Moyle 2002: 147) during December through March (Table 6.1-4). Surveys conducted indicate the Yolo and Sutter Bypasses provide important spawning habitat (Sommer et al. 1997). Both male and female splittail become sexually mature by their second winter at about 3.9 inches (10 cm) in length. Female splittail are capable of producing more than 100,000 eggs per year (Daniels and Moyle 1983). Adhesive eggs are deposited over flooded terrestrial or aquatic vegetation when water temperature is between 48 and 68°F (8.9 and 20°C) (Moyle 2002; Wang 1986). Splittail spawn in late April and May in Suisun Marsh and between early March and May in the upper Delta and lower reaches and flood bypasses of the Sacramento and San Joaquin rivers (Moyle et al. 2004). Spawning has been observed to occur as early as January and may continue through early July (Table 6.1-4) (Wang 1986; Moyle 2002).

The diet of adults and juveniles includes decayed organic material; earthworms, clams, insect larvae, and other invertebrates; and fish. The mysid *Neomysis mercedis* is a primary prey species, although decayed organic material constitutes a larger percentage of the stomach contents (Daniels and Moyle 1983).

Larval and young-of-the-year splittail are commonly found in shallow, vegetated areas near spawning habitat. Larvae eventually move into deeper and more open-water habitat as they grow and become juveniles. During late winter and spring, young-of- the-year juvenile splittail (i.e., production from spawning in the current year) are found in sloughs, rivers, and Delta channels near spawning habitat. Juvenile splittail gradually move from shallow, nearshore areas to deeper, open-water habitat of Suisun and San Pablo Bays (Wang 1986). In areas upstream of the Delta, juvenile splittail can be expected to be present in the flood bypasses when these areas are inundated during the winter and spring (Jones & Stokes Associates 1993; Sommer et al. 1997). Splittail of all sizes can survive in waters with dissolved oxygen (DO) levels <1 mg/L, allowing them to tolerate slow-moving sections of sloughs (Daniels and Moyle 1983).

Occurrence in Plan Area

Numerous splittail have been captured during the UC Davis Suisun Marsh surveys. Splittail are abundant in late summer when salinities are typically 6 to 10 ppt and temperatures are15 to 23°C (Meng et al. 1994; Meng and Moyle 1995). Adults and juveniles are present year-round in Suisun Marsh (Table 6.1-4) in all sloughs. Most fish were collected in Cutoff, Goodyear, Peytonia, Spring Branch, and Suisun Sloughs (Bay Delta and Tributaries no date) (Figure 5.6-3).

Some splittail have been captured in the Fall Mid Water Trawl surveys in Suisun, Grizzly, and Honker Bays, with most captured In Grizzly Bay and Montezuma Slough. The Bay Study Mid Water Trawl (BSMWT) collected no age-0 splittail in 2008, resulting in 8 consecutive years with very low or 0 indices. The BSMWT did collect 12 older splittail, most from the 2006 year class. Only 1 age-0 splittail was collected in 2008 by the Bay Study Otter Trawl (Fish et al. 2009).

Invertebrates

The benthic invertebrate community provides food for fishes in the shallow-water habitats of the plan area. Suisun Bay is a brackish-water embayment characterized by islands and shallow sub-bays intersected by tide and river - scoured channels. It is inhabited by fewer than 10 permanent benthic macroinvertebrate species because the region is inundated each winter by fresh water. Invertebrates that occur in the Bay include copepods, cladocera, amphipods, polychaete worms (Polychaeta), several marine mollusks, and a freshwater species of clam (*Corbicula fluminea*) when river inflow is unusually high.

The invasion of the clam *C. amurensis* in the late 1980s resulted in a fundamental shift in the benthic community. It is estimated these clams filter an equivalent volume of water equal to the entire North Bay 1-2 times per day (Schroeter et al. 2006); however; the center of distribution of *C. amurensis* and other benthic species varies with flow and the resulting salinity regime. So at any particular location in the estuary, the benthic community can change substantially from year to year as a result of environmental variation and species invasions.

Changes in the benthos can have major effects on food availability to pelagic organisms (Baxter et al. 2008). A consequence of their incredible filtering capacity is thought to be the virtual elimination of the spring phytoplankton bloom (Kimmerer 1998) and the summer/fall chlorophyll bloom as well as a shift from a pelagic food web to a benthic one (Thompson 1998).

CALFED funded a benthic invertebrate study on Suisun Marsh that was implemented by UC Davis (Schroeter, no date). One year (2004) of data was gathered by R. Schroeter. The most abundant components of benthic communities were the overbite clam (*Potamocorbula amurensis*) and several species of segmented worm (Oligochaeta). The overbite clam is an invasive species, and oligochaete worms are common components that provide food for some fish (Brown 2004:59). Both of these components are most abundant in the western Marsh area. Overall, the benthic community sampled is dominated by filterers and collectors (Schroeter, no date).

In addition to samples collected of benthic invertebrate communities in the Marsh, various species of marine shrimp (Caridea) have been caught in otter trawls throughout the sampling years. Five species of caridean shrimp that have been caught are common prey items for fish: *Crangon franciscorum*, *C. nigricauda, C. nigromaculata*, *Heptacarpus stimpsoni*, and *Palaemon macrodactylus*. The most commonly caught species in all years has been *C. franciscorum* and the highest number of shrimp have been captured in Suisun Slough (Schroeter no date). All of the shrimp use the estuary as a rearing area and have different tolerances of salinity. Their populations fluctuate year to year and are dependent on salinity and water temperature (Suisun Ecological Workgroup 2001:130).

The primary source of energy for salmonids in fresh water streams (Chinook salmon and steelhead) is non-biting midge larvae (Chironomidae) and other fly larvae (Diptera) (Merz and Vanicek 1996). Chironomid midges are sensitive to water quality and substrate changes, as well as to disturbance regimes. They are cosmopolitan and ubiquitous, but their abundance in the plan area is unknown. Chironomid colonization and juvenile Chinook salmon foraging have been documented within restored wetlands (Shreffler et al. 1992), suggesting they may occur in the Marsh and are resilient to habitat improvements.

Green and white sturgeon feed on opossum shrimp, amphipods and other benthic invertebrates in the Delta (Radtke 1966; Ganssle 1966). Other native fish prey largely on common and highly abundant species of amphipods (*Corophium* spp.). Euryhaline and estuarine fish such as yellowfin goby, stickleback, starry flounder, and sculpin also prey on these amphipods (Markmann 1986: 37).

Tidal Habitat Use by Fish in the Marsh

Subtidal, low intertidal, low marsh, mid marsh and high marsh all provide habitat for special-status fish species as described below.

Subtidal

Subtidal habitat is primarily open water with some fringing vegetation along the adjacent levees. This habitat is most likely to provide direct benefits to aquatic species such as juvenile Chinook salmon, splittail, striped bass, sturgeon, steelhead, and native resident species such as prickly sculpin, threespine stickleback, starry flounder, and tule perch. These species will derive direct benefits through primary and secondary pelagic production.

Low Intertidal

Low intertidal habitat generally ranges in elevation between subtidal and the lowest edge of vegetation. At this stage, the site is a mix of shallow open water and intertidal mudflats. The mudflats are exposed at low tides and submerged at high tides. Channels have begun to form on the mudflats. As with the subtidal stage, there is likely a fringe of upland vegetation along the existing levees. As with the subtidal, this stage is most likely to provide direct benefits to aquatic species such as juvenile Chinook salmon, splittail, striped bass, sturgeon, and native resident species such as prickly sculpin, threespine stickleback, and tule perch and indirect benefits to delta and longfin smelt from transported phytoplankton from the marshes.

Low Marsh

At this stage, vegetation has colonized and a marsh plain has begun to form. Vegetation likely consists primarily of a narrow set of low marsh such as *Schoenoplectus* species and *Typha* species. A small band of middle marsh vegetation may have established along the upper edges of the site and includes plants such as *Distichlis spicata, Sarcocornia pacifica, Cuscuta salina, and Jaumea carnosa*. Sinuous tidal channels have formed in the marsh plain with vegetated bank edges. Aquatic species such as splittail, striped bass, and resident native species may use the marsh plain when inundated, but are more likely to derive indirect benefits from exported primary and secondary pelagic production (Siegel 2008).

Mid Marsh

At this stage the marsh has evolved to incorporate an area of intertidal mudflats, low marsh, and middle marsh. During high tides the entire marsh plain is flooded, and the only refuge for wildlife is the fringe of upland along the remaining levees. As with low marsh, aquatic species such as splittail, striped bass, and resident native species may use the marsh plain when inundated, but are more likely to derive indirect benefits from exported primary and secondary pelagic production (Siegel 2008).

High Marsh

High marsh ranges from MHHW to the extreme high water line. This elevation provides refuge for wildlife during most tidal cycles, but is occasionally completely inundated. Aquatic species may benefit through increased export of secondary production (terrestrial insects and epibenthic invertebrates) and indirectly through export of organic carbon and nutrients that can support aquatic primary productivity (Siegel 2008).

Table 6.1-6 shows the type of tidal wetland habitat and regions special-status fish species use in Suisun Marsh. Tidal habitat restoration will provide these habitat types as restoration progresses (Figure 2-3).

Table 6.1-6. Special-Status Fish Species in Suisun Marsh and Habitat Use

Species	Tidal Marsh Elevation (low, mid, high)	Region
Chinook salmon	RF (low),RF (mid), RF (high)	All
Steelhead	RF (low)	All
Longfin smelt	RF (low), RF(mid), RF (high)	All
Green sturgeon	RF (low)	1,4
Delta smelt	RFB (low)	All
Sacramento splittail	RFB (low), RFB (mid), RFB (high)	All

Note: R = resting; F = foraging; B = breeding.
Information taken from Goals Project 1999.

Regulatory Setting

Federal

Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) establishes a management system for national marine and estuarine fishery resources of commercial importance. This legislation requires that all federal agencies consult with NMFS regarding all actions or proposed actions permitted, funded, or undertaken that may adversely affect essential fish habitat (EFH). EFH is defined as “waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” The legislation states that migratory routes to and from anadromous fish spawning grounds are considered EFH. The phrase *adversely affect* refers to the creation of any impact that reduces the quality or quantity of EFH. Federal activities that occur outside EFH but that may, nonetheless, have an impact on EFH waters and substrate also must be considered in the consultation process.

Under the Magnuson-Stevens Act, effects on habitat managed under the Pacific Salmon, Coastal Pelagic and Pacific Groundfish Fishery Management Plan also must be considered. The Magnuson-Stevens Act states that consultation regarding EFH should be consolidated, where appropriate, with the interagency consultation, coordination, and environmental review procedures required by other federal statutes such as NEPA, FWCA, CWA, and ESA. Essential fish habitat consultation requirements can be satisfied through concurrent environmental compliance if the lead agency provides NMFS with timely notification of actions that may adversely affect EFH and if the notification meets requirements for EFH assessments. As described in Chapter 1, NMFS is a Principal Agency for development of the SMP and a Cooperating Agency in accordance with NEPA. Additionally, NMFS will issue a BO for the SMP. The SMP BA will provide the required EFH analysis and the mechanism for consultation with NMFS.

Endangered Species Act

ESA is administered by USFWS and NMFS. In general, NMFS is responsible for protecting ESA-listed marine species and anadromous, commercially valuable fishes, whereas other listed species are under USFWS jurisdiction. Section 7 of the ESA is relevant to this plan and is discussed in greater detail in Chapter 10.

Clean Water Act

The federal CWA generally applies to all navigable waters of the United States. However, the CWA is administered in California by the State and Regional Water Boards. The San Francisco Regional Water Board has jurisdiction over Suisun Marsh and Suisun Bay. It issues water quality objectives for protection of beneficial uses of water, including uses of water to maintain fish and wildlife habitats. It also develops and implements its Water Quality Control (Basin) Plan, including total maximum daily load (TMDL) plans for determination of acceptable quantities of specific chemicals and pollutants, such as mercury and selenium. Water temperature also is regulated. The CWA is discussed in greater detail in Chapter 10, and a description of water quality impacts resulting from SMP alternatives is provided in Section 5.2. Information in that section provides information for the determination of impacts on fish related to changes in water quality.

Biological Opinions on the Central Valley Project and State Water Project

The biological opinions written by USFWS and NMFS for CVP and SWP operations discuss the operational effects of the water project on salmonids, steelhead, and sturgeon (National Marine Fisheries Service 2009) and delta smelt (U.S. Fish and Wildlife Service 2008). A discussion in the BOs includes the facilities in Suisun Marsh such as Suisun Marsh Salinity Control Gates, Roaring River Distribution System, Morrow Island Distribution System, and Goodyear Slough Outfall. The SMP plan area includes all of these facilities. Additionally, outflow and export requirements can affect flows and salinities in the Marsh. Additional detail is provided in Chapters, 1, 9, and 10.

State

California Endangered Species Act

The CESA requires take authorization from DFG when a proposed action may take state-listed endangered, threatened, or candidate species. DFG may provide take authorization for otherwise lawful projects when measures to avoid, minimize, fully mitigate, and to ensure adequate funding are provided.

Section 1602 California Fish and Game Code

Section 1602 requires a Streambed Alteration Agreement between DFG and the project applicant to protect resources and is discussed in detail in Chapter 10.

California Endangered Species Act Incidental Take Permit No. 2081-2009-001-03 Issued by California Department of Fish and Game

This permit authorizes take of longfin smelt by DWR in its operation of the SWP in the Delta. Included in the permit are facilities in Suisun Marsh that are operated by DWR: Suisun Marsh Salinity Control Gates, Roaring River Distribution System, Morrow Island Distribution System, and Goodyear Slough Outfall. Additionally, outflow and export requirements can affect flows and salinities in the Marsh. Additional detail is provided in Chapters, 1, 9, and 10.

San Francisco Bay Conservation and Development Commission

The 27-member BCDC was created by the California Legislature in 1965 in response to broad public concern over the future of San Francisco Bay. BCDC's jurisdiction includes Suisun Marsh and open waters, marshes and mudflats of greater San Francisco Bay, including Suisun, San Pablo, Honker, Richardson, San Rafael, San Leandro and Grizzly Bays and the Carquinez Strait.

The commission is charged with regulating all filling and dredging in San Francisco Bay, protecting Suisun Marsh, and other activities associated with San Francisco Bay. A full description of BCDC's authority and responsibilities is discussed in Chapter 10, "Regulatory Framework."

Local

Solano County General Plan

The Solano County General Plan has a separate addendum to the plan called the Suisun Marsh Policy addendum. The addendum specifically discusses the Suisun Marsh area and its resources. The Solano County component of the Suisun Marsh Local Protection Program was certified by the BCDC on November 3, 1982. Specifically, wildlife habitat within Suisun Marsh will be managed and preserved through the following policies (Solano County 2008: Appendix C-2, C-3):

- The diversity of habitats in Suisun Marsh and surrounding upland areas should be preserved and enhanced wherever possible to maintain the unique wildlife resource.
- Suisun Marsh waterways, managed wetlands, tidal marshes, seasonal marshes, and lowland and grasslands are critical habitats for marsh-related wildlife and are essential to the integrity of Suisun Marsh. Therefore, these habitats deserve special protection.
- Where feasible, historical marshes should be returned to wetland status, either as tidal marshes or managed wetlands. If, in the future, some of the managed wetlands are no longer needed for waterfowl hunting, they also should be restored as tidal marshes.

Environmental Consequences

This section describes methods used to analyze potential impacts of the alternatives and mitigation measures to reduce significant impacts to a less-than-significant level.

Assessment Methods

Fish species that occur or have potential to occur in the plan area were presumed to be indirectly affected by implementation of an alternative if the quantity or quality of habitats with which they are typically associated would be affected. Direct impacts on individual species were assessed qualitatively based on the potential sensitivity or susceptibility of the species to disruption as a result of activities that may be associated with implementation of the restoration alternative and managed wetland activities (e.g., dredging, inundation, noise associated with equipment operation). Additionally, impact assessments were based on hydrologic modeling of future site conditions, predicted extent and quality of habitat, and known thresholds for habitat/environmental suitability of these target species.

Significance Criteria

Activities or outcomes associated with the proposed restoration alternatives were identified as having a significant impact on the environment if it would result in:

- substantial reduction in the habitat of a fish species, including a substantial decrease in the acreage or quality of fish habitat;
- a fish population dropping below self-sustaining levels;
- reduction in the number or restriction of the range of an endangered or threatened, or state candidate fish species or species of special concern; or,
- substantial disruption of natural movement corridors.

The following also were considered in determining whether an impact on fish would be significant:

- federal or state legal protection of the resource;
- federal, state, and local agency regulations and policies regarding the resource;
- documented local or regional scarcity and sensitivity of the resource; and
- local and regional distribution and extent of the resource.

An alternative was considered to have a beneficial impact if it would result in a substantial increase in the quantity or quality of aquatic and wetland communities or of habitat for special-status fish species.

Environmental Impacts

No Action Alternative

The No Action Alternative would result in a limited amount of tidal wetland restoration, and some natural breaching may occur. Natural breaching either from levee instability or sea level rise could increase habitat for fish. Currently Suisun Marsh is a disturbed environment that is at least partially limited by a loss of diverse marsh channels because of levees and dikes. Additionally, the operations of some managed wetlands can contribute to seasonal water quality degradation, primarily because of the release of impounded water with low levels of DO and high levels of sulfates. However, it is assumed that the No Action alternative would result in increased limitations on managed wetland operations and maintenance activities, reducing some of the DO issues as a result of reducing flood and drain operations. Levees may not be maintained to the same extent they are currently and, as described above, could result in natural breaching. However, it is expected that most of the levees would stay intact and that the No Action Alternative would result in continued impacts on the species by leaving many of the current habitat-limiting factors in place.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Implementation of Alternative A would result in temporary habitat impacts for special-status fish species in the study area during construction activities. Tidal wetland restoration would occur by breaching and/or lowering exterior levees, resulting in the conversion of managed seasonal wetlands to tidal wetlands and subtidal habitat, depending on the elevations.

The following actions related to tidal wetland restoration could affect special-status fish species in the study area:

- temporary disturbance of fish and their habitats because of construction-related activities;
- temporary impacts to fish habitat because of levee breaching; and
- change in salinity due to breaching locations.

The following sections describe the impacts on special-status species and the associated mitigation measures. The impacts are separated into those resulting from Restoration and from Managed Wetland Activities.

Restoration Impacts

Restoration impacts would occur during activities such as breaching and/or lowering existing exterior levees and upgrading or constructing new exterior levees. Breaching of levees could change water quality (e.g., salinity). Additional tidal wetland within the Marsh would increase the tidal flows throughout Marsh channels and could increase salinity in the channels between Suisun Bay and the new tidal wetlands. The magnitude of the salinity effects would depend on the location (and breach connection) of the new tidal wetlands and the size (acreage) of the new tidal wetlands, but would not be a significant impact. New or upgraded levees would include installation of brush boxes or other biotechnical wave dissipaters to protect the levees from wind and wave erosion. Intertidal habitat such as habitat levees, benches, or berms would also be constructed. Habitat levee design and locations would vary by site but are expected to include widening of existing interior levees by 15 to 30 feet with a gradual slope or the construction of new interior levees or islands.

Impact FISH-1: Construction-Related Temporary Impairment of Fish Survival, Growth, and Reproduction by Accidental Spills or Runoff of Contaminants (Heavy Metals)

Construction activities, such as levee construction and levee breaching would only occur during the in-channel work window of August 1 through November 30, which is during the work window for special-status fish species. These activities accidentally could introduce contaminants into the sloughs in Suisun Marsh and Suisun Bay and could adversely affect special-status fish species and their habitat.

Disturbance of sediment in and around sloughs likely would result in a release of sediments into the slough channels and possibly release of soil contaminants into the water column. Refueling, operating, and storing construction equipment and materials could result in accidental spills of pollutants such as hydraulic fluids, oil, or fuel. Pollutants entering water bodies in the plan area would cause mortality to, and reduced growth of, the egg, larval, and juvenile life stages of fish. Furthermore, these pollutants could adversely affect the movement of special-status species, including juvenile Chinook salmon, steelhead, delta smelt, and green sturgeon. Larval and juvenile delta smelt would not be present during these months because most spawning occurs in the spring. Larger delta smelt, which are present during this time, could avoid adverse conditions.

Environmental commitments, including an erosion and sediment control plan, SWPPP, hazardous materials management plan, spoils disposal plan, and environmental training, will be developed and implemented before and during construction activities (Chapter 2, “Environmental Commitments”). USFWS, NMFS and DFG will be provided these plans for review 30 days prior to construction. Additionally, as described in the Water Quality section, no significant water quality changes are expected to occur during construction and long term changes would be mitigated through design of the breach location and sizes. Compliance with water quality standards and implementation of the erosion control BMPs will ensure that turbidity and suspended sediment levels remain within regulatory limits. Construction activities will be limited to August 1 to November 30 when special-status fish species are generally absent from the Marsh and could avoid adverse effects.

Conclusion: Less than significant. No mitigation required.

Impact FISH-2: Construction-Related Temporary Reduction of Special-Status Fish Rearing Habitat Quality or Quantity through Increased Input and Mobilization of Sediment

Construction activities, such as levee construction, levee breaching, placement of riprap, and dredging, could release sediments into sloughs and Suisun Bay. Once in the stream channel, mobilized sediments can result in direct impacts on resident fishes through gill damage and reduced capacity to take in oxygen. Indirect impacts can include reduced fitness as a result of decreased DO intake ability; increased metabolic costs associated with reduced DO intake ability, and reduced foraging ability as the result of decreased visibility. These activities could adversely affect special-status fish species and their habitat.

Delta smelt, longfin smelt, green sturgeon and Sacramento splittail may occur year-round in the Marsh. As such, all of these species inhabit turbid water during some of their life cycle. There is some evidence that turbidity may be moderately important as cover for juvenile splittail. Juvenile splittail are most abundant in shallow (<2 m deep), turbid waters (Moyle et al. 2004).

Steelhead typically do not use tidal marsh habitat for rearing. In the plan area, juvenile steelhead rear in the fresh water creeks such as Green Valley, Suisun, and Ledgewood Creeks.

Construction activities will be limited to August 1 to November 30. During this time frame most fish are of a larger size and/or less frequent in the Marsh. Chinook salmon and steelhead are uncommon in the Proposed Project area during this time frame.

Environmental commitments, including the erosion and sediment control plan, SWPPP, and environmental training, will be developed and implemented before and during construction activities (Chapter 2, "Environmental Commitments"). USFWS, NMFS and DFG will be provided these plans for review 30 days prior to construction. Additionally, as described in the Water Quality section, no significant water quality changes are expected to occur during construction and long term changes would be mitigated through design of the breach location and sizes. Compliance with water quality standards and implementation of the erosion control BMPs will ensure that turbidity and suspended sediment levels remain within regulatory limits. Therefore, special-status fish species would not likely be affected by short-term increases in turbidity.

Conclusion: Less than significant. No mitigation required.

Impact FISH-3: Short-Term Impairment of Delta Smelt Passage and Reduced Availability of Spawning and Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities

Channel morphology describes the linear, aerial, and volumetric features of a channel, including depth, length, width, and the shape or configuration of the channel (e.g., the characteristics of secondary channels, backwaters, and sloughs). Channel morphology, along with flow, affects stream hydraulics, which refers to a stream's depth, surface elevation, velocity, and turbulence. Together, channel morphology and hydraulics influence the conditions that support fish migration and movement and provide holding, rearing, and spawning habitat. Channel morphology and hydraulics have a major effect on cover and water temperature.

Changes in channel morphology and hydraulics can result when levees are breached and changes in water circulation occur. Depending on the size and location of the breach, the sloughs in Suisun Marsh can be hydraulically affected. These changes are expected to occur for a short time until the newly opened area becomes stabilized, provided that BMPs are implemented. Sediment gradually would fill in the sites, raising elevations and decreasing tidal prism and associated velocities (Figure 2-3).

The majority of larval delta smelt and some juveniles are found in Nurse, Suisun, Cordelia, Denverton, and Spring Branch Sloughs (Bay Delta and Tributaries no date). During high freshwater years, delta smelt may spawn in Suisun Marsh channels (Sweetnam 1999), as seen by the number of larval fish captured. Larvae are planktonic and move with the currents. Aasen (1999:161) found adult and juvenile smelt moved with the tides between Honker and Grizzly Bays.

Levee breaching would occur from August 1 to November 30 when delta smelt larvae and juveniles are larger and can avoid adverse effects in Marsh sloughs. Long-term impacts of velocity changes in the sloughs as a result of levee breaching could preclude delta smelt from rearing habitat depending on the breach location and size. A major change in velocities could have a significant impact on the availability of delta smelt habitat.

Preliminary modeling (Appendix A) suggested that potential project actions under all the alternatives could produce tidal velocities in excess of the sustained swimming speed of several sensitive species (Table 6.1-5). Prior to implementation, preliminary modeling and design of the potential breach areas would be done to assess effects on hydrologic conditions. Velocity changes would be addressed adaptively through modifications of breached areas. Final designs will attempt to account for potential adverse hydrologic modifications. This information will be used to modify or maintain levee breaches as needed to support fish passage and access to rearing habitat for delta smelt. Also, as described in Chapter 2, Environmental Commitments section, any adverse effects on special-status fish species and/or critical habitat, will be addressed by the project proponent, and any additional measures will be followed in compliance with ESA.

As the restored area evolves into a functioning tidal marsh, it is expected to provide indirect benefits through exported pelagic production for delta smelt. Additionally, restoration activities likely would be located throughout the Marsh and implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame. As such, only minimal changes in delta smelt habitat in the Marsh would occur at any one time. For most cases of restoration, adjacent areas would continue to provide suitable habitat in the interim between breaching the levee and a fully functioning tidal marsh.

The overall 30-year plan is expected to benefit delta smelt by encouraging development of a more natural habitat through restoration of managed wetlands to tidal wetlands. Because minor, temporary losses of delta smelt habitat would be compensated for through restoration design and over the long term as the tidal wetland matures, this impact would be less than significant.

Conclusion: Less than significant. No mitigation required.

Impact FISH-4: Short-Term Impairment of Chinook Salmon Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities

Juvenile Chinook salmon were captured in Cutoff, Boynton, Suisun, Montezuma, Nurse, Denverton, and Spring Branch Sloughs. The majority of salmon were captured in Suisun and Montezuma Sloughs, which are wide and deep, and also in Denverton Slough during beach seining (Suisun Ecological Workgroup 2001, Appendix 1:108). Chinook salmon are strong swimmers (Table 6.1-5) compared to delta smelt and can move in and out of higher velocity areas if necessary. However, preliminary modeling suggested that levee breaches in certain locations could result in velocity modifications in excess of the sustained swimming speeds of juvenile salmon and outside NMFS criteria of 2 ft/s for stream velocities with longer fish passageways (National Marine Fisheries Service 2001). The initial analysis suggests that velocity modifications would exceed these criteria only in Hunters Cut (Appendix A).

Prior to implementation, preliminary modeling and design of the potential breach areas will be done to assess effects on hydrologic conditions. Velocity changes will be addressed adaptively through modifications of breach sizes and locations. Final designs will attempt to account for potential adverse hydrologic modifications. This information will be used to modify or maintain levee breaches as needed to support fish passage and access to rearing habitat for Chinook salmon. Also, as described in Chapter 2, Environmental Commitments section, any adverse effects on special-status fish species, critical habitat, or EFH will be addressed by the project proponent, and any additional measures will be followed in compliance with CESA, ESA, and EFH.

Conclusion: Less than significant. No mitigation required.

Impact FISH-5: Short-Term Impairment of Steelhead Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities

A small population of Central California coast steelhead may migrate up Suisun Slough into Peytonia, Cordelia, and Chadborne Sloughs and ultimately into Suisun, Green Valley and Ledgewood Creeks. Various breach locations were modeled, and changes in velocities only rarely exceeded steelhead capabilities to swim upstream. As discussed above for Chinook salmon, preliminary modeling and design of the potential breach areas will be done to assess effects on hydrologic conditions. Velocity changes will be addressed adaptively through modifications of breach locations and sizes, and migratory pathways will be maintained. Therefore, it is unlikely steelhead would be affected by restoration activities in the long term.

Conclusion: Less than significant. No mitigation required.

Impact FISH-6: Short-Term Impairment of Green Sturgeon Passage and Reduced Availability of Holding and Rearing Habitat Resulting from Changes in Channel Morphology and Hydraulics Attributable to Restoration Activities

Green sturgeon are present in the system year-round. A total of three green sturgeon were captured in 1998 in Montezuma and Suisun Sloughs (Bay Delta and Tributaries no date). Green sturgeon are strong swimmers (Table 6.1-5), and it is unlikely they would be affected by temporary changes in hydraulics. As discussed above for delta smelt, Chinook salmon, and steelhead, velocity changes will be addressed adaptively through preliminary modeling and design and through modifications of breached locations and sizes, and migratory pathways will be maintained.

Conclusion: Less than significant. No mitigation required.

Impact FISH-7: Short-Term Impairment of Sacramento Splittail Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Velocity Attributable to Restoration Activities

Many splittail have been caught throughout the sloughs in Suisun Marsh. Adult splittail are known to swim against strong river and tidal currents (Moyle 2002:147). Sommer et al. (2002) studied adult and juvenile splittail in a model floodplain wetland. Splittail in the 15–20 mm range used shallow edgewater habitat with emergent vegetation. Larger fish used deeper water habitat in open and vegetated areas. Depending on the age and size of splittail in the restoration areas, young splittail are likely to be excluded from edge habitat if velocities are high and vegetation is absent. However, restoration designs will incorporate vegetation on benches and berms (habitat levees or other intertidal habitat), which would provide some rearing habitat and young splittail may also move to more favorable habitat within the Marsh. Adult fish use more open-water habitat and can swim against current. As discussed above for delta smelt, Chinook salmon, and steelhead, velocity changes will be addressed adaptively through preliminary modeling and design and through modifications of breached areas, and migratory pathways will be maintained. They are not likely to be affected by temporary changes in velocities.

Conclusion: Less than significant. No mitigation required.

Impact FISH-8: Short-Term Impairment of Longfin Smelt Passage and Reduced Availability of Rearing Habitat Resulting from Changes in Velocity Attributable to Restoration Activities

Longfin smelt have been caught in all the sloughs in Suisun Marsh (Bay Delta and Tributaries no date). Larval longfin smelt are pelagic and get washed downstream into Suisun Bay during high flows and rear in and near the Bay, depending on the location of X2. Juveniles and adults may move out into the ocean during the summer and fall months, when breaching activities would occur. They would probably be unaffected by temporary changes in velocities. As discussed above for delta smelt, Chinook salmon, and steelhead, velocity changes will be addressed adaptively through preliminary modeling and design and through modifications of breached areas, and migratory pathways will be maintained.

Conclusion: Less than significant. No mitigation required.

Impact FISH-9: Temporary Reduction of Delta Smelt Habitat Quantity or Quality through Removal and Destruction of Cover Attributable to Restoration Activities

Cover describes the physical components of an aquatic environment that provide shelter and hiding, resting, rearing, holding, and feeding areas for fish and other aquatic organisms. Aquatic plants, trees, and large woody debris (e.g., tree limbs, logs, rootwads) provide cover. The quantity and quality of cover for fish and aquatic invertebrates is a primary determinant of habitat availability and suitability for some species during life stages when they are associated with marsh habitat. The occurrence of many aquatic species depends on the size, density, and continuity of suitable cover.

Under the proposed project, cover could be temporarily or permanently removed during levee reconstruction and/or breaching. Levee breaching would affect only small areas, and scouring impacts on aquatic vegetation would be minimal compared to existing and created habitat. If removal of aquatic vegetation or instream woody material from slough channels is necessary in breach locations, this could temporarily remove cover that is an important component of adult spawning and juvenile rearing habitat. However, the restoration designs would include habitat levees or other intertidal habitat that would provide vegetative cover upon breaching, thus offsetting any losses along the slough channel.

Delta smelt critical habitat includes Suisun Marsh. Delta smelt may use tules for spawning, but spawning substrates are still unknown. Delta smelt often use shallow-water habitat for rearing. Adult delta smelt are primarily a pelagic species, so it is unlikely they require the structural complexity provided by the Marsh. However, they may benefit from prey production exported from the Marsh. Delta smelt also may physically enter restoration sites that are of relatively low elevation (early stage of evolution), as such sites are essentially shallow tidal aquatic environments during higher tide stages. The subtidal and low intertidal stages are most likely to provide such habitat.

Additionally, restoration activities likely would be located throughout the Marsh and implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame. As such, only minimal changes in delta smelt habitat in the Marsh would occur at any one time. Adjacent areas would continue to provide suitable habitat in the interim between breaching the levee and a fully functioning tidal marsh.

Conclusion: Less than significant. No mitigation required.

Impact FISH-10: Temporary Reduction of Chinook Salmon Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities

Project activities are not expected to reduce cover for juvenile Chinook salmon. Salmonids are dependent on riparian vegetation and instream woody material for cover when rearing in freshwater areas. Project activities would be outside of the riparian vegetation zone and are located in brackish water areas.

In the brackish water of the Marsh, juvenile Chinook salmon are known to forage in shallow areas with protective cover such as intertidal and subtidal mudflats, marshes, channels, and sloughs. Therefore, it is reasonable to conclude that juveniles would directly use restoration stages, such as subtidal, low intertidal, and low marsh. Mid marsh and high marsh areas likely will increase secondary production in the Marsh, which would benefit juvenile Chinook salmon. Restoration stages that improve marsh connectivity, such as subtidal and low intertidal, could be directly used for Chinook salmon migration and emigration.

Restoration designs would incorporate intertidal habitat such as habitat levees, benches, or berms to establish and promote a range of marsh elevation habitats, including intertidal and mudflats. As the restored area evolves into a functioning tidal marsh, it is expected to provide permanent, sustainable, suitable habitat for juvenile Chinook salmon. Additionally, restoration activities likely would be located throughout the Marsh and implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame. As such, only minimal changes in Chinook salmon habitat in the Marsh would occur at any one time. Adjacent areas would continue to provide suitable habitat in the interim between breaching the levee and a fully functioning tidal marsh.

Conclusion: Less than significant. No mitigation required.

Impact FISH-11: Temporary Reduction of Steelhead Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities

Juvenile steelhead rear in the freshwater creeks such as Suisun, Ledgewood, and Green Valley, located above the plan area. Once juveniles are ready to smolt, they migrate down into Marsh sloughs to move out to the ocean. Smolts may use the Suisun and Honker Bays for rearing, and depending on habitat conditions (water temperature, prey availability) they could move quickly or slowly through the bays (U.S. Bureau of Reclamation 2008). Cover is not anticipated to be removed in Suisun or Honker Bays. Tidal marsh restoration activities in smaller sloughs could affect rearing or migration during the period of time juveniles would be migrating downstream. However, any in-channel work will be conducted in the months that adult and juvenile steelhead are not present. Therefore they would not be affected by disturbance to existing tidal marsh habitat or other cover.

Conclusion: Less than significant. No mitigation required.

Impact FISH-12: Temporary Reduction of Green Sturgeon Habitat Quantity or Quality as a Result of Restoration Activities

Adult and juvenile green sturgeon tend to use deeper water channels during migration and juveniles move nocturnally to avoid predators. Restoration actions would not likely affect migrating sturgeon. However, resulting changes in habitat conditions could have an impact on habitat attributes because of changes in nutrient inputs and benthic communities. Green sturgeon feed primarily on secondary production, such as benthic invertebrates, and as they grow, other species of fish. Restoration stages, such as subtidal, low intertidal, low marsh and mid marsh, likely would increase prey production in the Marsh, which would increase food availability for sturgeon. Because it is thought that sturgeon move from deeper areas to intertidal areas at high tide for foraging, it is reasonable to conclude that green sturgeon would directly use restoration stages, such as subtidal, low intertidal, and low marsh.

Restoration activities would be located throughout the Marsh and implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame. As such, only minimal changes in green sturgeon habitat in the Marsh would occur at any one time. Adjacent areas would continue to provide suitable habitat in the interim between breaching the levee and a fully functioning tidal marsh.

Conclusion: Less than significant. No mitigation required.

Impact FISH-13: Temporary Reduction of Sacramento Splittail Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities

Project activities that remove aquatic vegetation could affect splittail spawning and rearing. Splittail spawn in flooded aquatic vegetation and larvae rear in the same area; however, splittail rarely spawn in Suisun Marsh. Juveniles use shallow open water, sloughs, and channels for rearing. Levee breaching would affect only small areas, and scouring impacts on aquatic vegetation would be minimal compared to existing habitat.

Restoration designs would incorporate intertidal habitat such as habitat levees, benches, or berms to establish and promote a range of marsh elevation habitats, including intertidal and mudflats. As the restored area evolves into a functioning tidal marsh, it is expected to provide permanent, sustainable, suitable habitat for splittail. Additionally, restoration activities likely would be located throughout the Marsh and implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame. As such, only minimal changes in splittail habitat in the Marsh would occur at any one time. Adjacent areas would continue to provide suitable habitat in the interim between breaching the levee and a fully functioning tidal marsh.

Conclusion: Less than significant. No mitigation required.

Impact FISH-14: Temporary Reduction of Longfin Smelt Habitat Quantity or Quality through Removal and Destruction of Cover as a Result of Restoration Activities

Longfin smelt are primarily a pelagic species, so it is unlikely they use cover such as aquatic vegetation or other in-water structures provided by the Marsh. Juvenile and sub-adults have been found to be more abundant at sampling locations over deep water (Rosenfield and Baxter 2007).

Conclusion: Less than significant. No mitigation required.

Impact FISH-15: Improved Fish Habitat Due to Increased Dissolved Oxygen Concentrations in Tidal Channels Attributable to Restoration Activities

Restoration activities that convert managed wetlands to tidal wetlands, especially those in areas with poor circulation or other conditions leading to low levels of DO, will promote increased water circulation and decrease the amount of high sulfide water discharged from managed wetlands into sloughs. Sloughs are important habitat for delta smelt, longfin smelt, splittail and other native fish species and DO is an important habitat quality factor. The extent of this improvement depends on the location and design of individual restoration sites. However, it is assumed that at least some areas currently contributing to low DO will be restored, resulting in an improvement in those areas. See Section 5.2, Water Quality, Impact WQ-5, for more details.

Conclusion: Beneficial.

Impact FISH-16: Salinity–Related Reduction of Delta Smelt Survival, Growth, Movement, or Reproduction Attributable to Restoration Activities

The magnitude of the salinity effects would depend on the location (and breach connection) of the new tidal wetlands and the size (acreage) of the new tidal wetlands. Restoration with tidal connection to Suisun Bay or Honker Bay may have the largest salinity effects. The effects would be greatest during periods of low Delta outflow when the Suisun Bay salinity is highest and the salinity gradient within Suisun Bay and along Montezuma Slough is strongest. However, the seasonal magnitude of the salinity in the Marsh would continue to be governed by Delta outflow and operation of the SMSCG.

Changes in salinity as a result of levee breaching could affect special-status fish species, but preliminary modeling results suggest that most salinity changes as a result of project activities would be well within the environmental tolerance for delta smelt (Table 6.1-5) with the highest salinity increase to 15 ppt in different areas of the Marsh. As discussed in Section 5.2, Water Quality, salinity is not expected to change dramatically from existing conditions; therefore restoration actions would not change the availability of delta smelt rearing habitat.

Figures 5.2-7 to 5.2-15 show simulated salinity in selected Marsh channels for the baseline conditions and two representative tidal restoration conditions with about 7,500 acres of new tidal wetlands for 2002 and 2003. Salinity changes in the existing Marsh sloughs would depend on the additional tidal restoration upstream and downstream from the stations, as well as the location within the Marsh. For example, Goodyear Slough (Figure 5.2-13) and Cordelia Slough (Figure 5.2-12) EC would not likely change with additional tidal wetlands restoration in the Marsh because salinity in the western Marsh is strongly controlled by Delta outflow and the corresponding Suisun Bay salinity.

Delta smelt have levels of tolerance that vary among life stages, with juveniles requiring lower levels of salinity than older fish (Table 6.1-5). There is some potential for small-scale hydrologic modifications that could produce a microcline of low salinity, especially where activities isolate freshwater inputs such as the wastewater discharge in Boynton Slough (Figures 5.2-7 to 5.2-15). These modifications would create habitats and habitat types that are suitable for delta smelt spawning. There is potential that those lower salinity zones would attract delta smelt, but not be suitable for spawning because of structural, predator, or other issues. However restoration areas will be modeled to determine the appropriate breach sizes and locations. Salinity changes will be addressed adaptively through modifications of breached areas. Final designs will attempt to account for potential adverse hydrologic modifications. Also, as described in Chapter 2 under Environmental Commitments, any adverse effects on special-status fish species or critical habitat will be addressed by the project proponent, and any additional measures will be followed in compliance with ESA. In general, these issues are expected to be less than significant in both the short and long term.

Conclusion: Less than significant. No mitigation required.

Impact FISH-17: Salinity–Related Reduction of Chinook Salmon Survival, Growth, or Movement as a Result of Restoration Activities

Juvenile Chinook salmon occur in Suisun Marsh during periods of low salinity and water temperature (Schroeter et al. 2006:10), which occur during the winter and spring months. Most juvenile Chinook salmon were captured from January through April (Table 6.1-4). As with delta smelt (FISH-16) there is little or no risk of adverse impacts attributable to water quality or salinity changes associated with restoration activities because of preliminary modeling and design of breach sites. Also, as described in Chapter 2 under Environmental Commitments, site-specific environmental documentation will be completed and any adverse effects on special-status fish species, critical habitat, or EFH will be addressed by the project proponent, and any additional measures will be followed in compliance with CESA, ESA, and EFH.

Conclusion: Less than significant. No mitigation required.

Impact FISH-18: Salinity–Related Reduction of Steelhead Survival, Growth, or Movement as a Result of Restoration Activities

Because so few steelhead have been captured in Suisun Marsh and because substantial changes in salinity are not expected, it is unlikely they would be affected by salinity changes on any significant level. Steelhead are known to have large environmental tolerances to salinity changes, especially during their migrations to and from the ocean. Therefore, even if steelhead were to encounter water quality changes as a result of restoration activities, it is highly unlikely that they would be affected.

Conclusion: Less than significant. No mitigation required.

Impact FISH-19: Salinity–Related Reduction of Green Sturgeon Survival, Growth, or Movement as a Result of Restoration Activities

Salvage and trawling records from the Delta indicate the majority of juveniles in the plan area are likely to be longer than 200 mm or at least 9 or 10 months of age. After 7 months of age, juvenile sturgeon are able to survive up to 32 ppt (pure seawater) (Allen et al. 2003) (Table 6.1-5). Therefore, the salinity tolerance range of green sturgeon is sufficiently large, and their residence in the plan area is sufficiently short, that there is little or no risk to green sturgeon associated with restoration activities. None of the modeled scenarios results in an increase of salinity greater than 15 ppt (Figures 5.2-7 to 5.2-15). As mentioned above, prior to implementation, preliminary modeling and design of the potential breach areas will be done to assess effects on hydrologic conditions.

Conclusion: Less than significant. No mitigation required.

Impact FISH-20: Salinity–Related Reduction of Sacramento Splittail Survival, Growth, Movement, or Reproduction as a Result of Restoration Activities

Splittail can tolerate a wide range of salinities (Young and Cech 1996) (Table 6.1-5). They are highly mobile swimmers that are not obligate to littoral areas. There is some risk that restoration actions would generate high salinity zones outside of the tolerances of Sacramento splittail; however, preliminary modeling (Appendix A) suggests that this is unlikely. Prior to implementation, preliminary modeling and design of the potential breach areas will be done to assess effects on hydrologic conditions.

Conclusion: Less than significant. No mitigation required.

Impact FISH-21: Salinity–Related Reduction of Longfin Smelt Survival, Growth, Movement, or Reproduction as a Result of Restoration Activities

Eggs and larvae have low salinity tolerances and would be excluded from restored habitat with salinities outside of their range. Adults and juveniles can survive salinities up to 32 ppt (Table 6.1-5). Longfin smelt typically do not use the plan area to spawn and none of the modeled scenarios results in an increase of salinity greater than 15 ppt (Figures 5.2-7 to 5.2-15). Therefore, there is little or no risk that this taxon would be affected by salinity changes attributable to restoration activities. Prior to implementation, preliminary modeling and design of the potential breach areas will be done to assess effects on hydrologic conditions.

Conclusion: Less than significant. No mitigation required.

Impact FISH-22: Disturbance, Injury, or Mortality of Individual Fish Resulting from Work Adjacent to Bodies of Water

Disturbance is exhibited as a change in the behavior of an individual organism, such as movement, cessation of feeding, or interruption of reproductive activities. Disturbance can be caused by human activities that generate sufficient noise, light, physical movement, or vibration to change the behavior of individual organisms. Disturbance may alter species' survival if vulnerability to predation is increased or if the disturbance affects growth or reproductive success.

Direct injury and mortality result from physical trauma, which can be caused by direct and indirect contact with humans or machinery. Direct injury may impair fish movement, feeding, and survival. Actions implemented next to streams may disturb fish but are unlikely to result in direct injury or mortality. Disturbance may result from the temporary movement of construction equipment and personnel, use of temporary lighting, grading, and construction of access roads and staging areas. Direct injury and disturbance of fish is most likely to occur during in-water work. Several restoration actions may include in-water work, such as:

- removal and disturbance of aquatic vegetation,
- creation and/or modification of exterior levees, and
- breaching of levees.

The effect of disturbance on fish depends on the sensitivity of the species' life stage and on the duration and frequency of disturbance. Disturbance may reduce feeding, interfere with reproduction, and cause movement from habitat. Movement could result in mortality attributable to predation. Long-term disturbance over a substantial proportion of a species' habitat may reduce species population abundance, distribution, and production.

Disturbance and direct injury would be avoided and minimized through implementation of environmental commitments and BMPs. These BMPs would include focusing instream work on high temperature periods when most special-status fish species are absent from the shallow-water habitat in the plan area (August 1 through November 30).

Conclusion: Less than significant. No mitigation required.

Impact FISH-23: Change in Fish Species Composition Attributable to Changes in Salinity or Water Quality from Managed or Natural Wetland Modifications

The salinity and temperature tolerances of fishes are highly variable. This variability is in part responsible for the diversity of fish communities across micro-scale habitat types in the Delta and Suisun Marsh. Patterns in these habitat affinities are notable across biological taxa, and between endemic versus introduced species (Moyle et al. 1986). In theory, habitat modification as a result of restoration activities could have a negative impact on species composition because of changing water quality conditions. However, preliminary modeling suggests that the resulting salinity conditions would be within the normal range for the plan area (Appendix A), and previously published literature suggests that the habitat types created as a result of restoration activities would be suitable for and beneficial to sensitive fish species resident in Suisun Marsh. Prior to implementation, preliminary modeling and design of the potential breach areas will be done to assess effects on hydrologic conditions.

Conclusion: Less than significant. No mitigation required.

Impact FISH-24: Change in Benthic Macroinvertebrate Composition Attributable to Changes in Channel Morphology and Hydraulics as a Result of Tidal Restoration

Benthic invertebrate composition could change if channel morphology and hydraulics change as a result of restoration. Higher velocities could occur at certain places in the channel, and if that occurs, the habitat could attract and retain a modified benthic macroinvertebrate community. However, preliminary modeling suggests that the project actions would result in minimal long-term hydrologic modifications (Appendix A) in the system, provided that BMPs are adhered to. The specific mixture and arrangement of particular hydrologic features may be altered, but the resulting conditions should be within the tolerances of the extant benthic macroinvertebrate community. An appropriate level of benthic monitoring or a benthic community evaluation will be conducted associated with the final site-specific breach design and anticipated influence on existing slough channel modifications from the tidal restoration actions, as needed. This monitoring or evaluation will be implemented to determine effects from tidal restoration activities on the macroinvertebrate community, and to ensure that impacts do not exceed the thresholds identified above.

Conclusion: Less than significant. No mitigation required.

Impact FISH-25: Change in Primary Productivity as a Result of Tidal Restoration

The proposed restoration activities would provide increased exchange between marsh, intertidal and subtidal habitat and the sloughs and bays in Suisun Marsh. Algal growth rates are limited by low availability of sunlight energy (Cloern 1999). Light limitation is most severe in deeper channels where algal respiration can balance or exceed photosynthesis. Primary production is highest in shallow water habitats (e.g., Blacklock), inundated floodplains (e.g., Yolo Bypass), and tidal sloughs (Sobczak et al. 2005). Also, fish would have increased access to higher productivity shallow-water areas such as blind channels and marsh channels.

Connectivity between the restoration site and the aquatic environments is important to provide the greatest ecological value. Most of the volume in the larger Suisun Marsh sloughs (e.g., Montezuma Slough, Suisun Slough) is below the photic zone and thus exhibits productivity deficits. When shallow productive habitats are hydrodynamically proximate to deep channel habitats, excess shallow habitat production can support biological production in the channels if hydrodynamic exchanges are optimal (Siegel 2008). Shallow-water marshes can function as donor habitats by exporting unconsumed phytoplankton biomass to support biological production in deep channel habitats (López et al. 2006; Cloern 2007). When the connectivity rate is optimized, production exported from shallow donor habitats subsidizes production in resource deficit habitats like deeper sloughs (Siegel 2008). The open water associated with newly restored areas could provide nutrients and primary productivity that would enhance secondary food web production in adjacent heterotrophic habitats. Habitats that are connected support more species than disconnected ones (Zedler and Callaway 2001).

Therefore, project activities would benefit the actual or available primary productivity of the plan area as a whole by increasing nutrient exchange and nutrient turnover rates. Nutrient levels would increase in an area where water quality is improved. In theory primary production would increase, and zooplankton would respond assuming the system is bottom-up controlled.

Conclusion: Beneficial.

Managed Wetland Activities Impacts

As described in Chapters 1 and 2, many of the managed wetland activities are baseline activities that currently are conducted and will continue under the SMP. As such, any effects of these activities on fish are part of the baseline. The diversion of water as part of managed wetland activities affects a number of fish species, including special-status fish species. Other activities that take place on the interior of levees are not expected to affect water quality or fish species. The management activities that take place on the exterior of levees such as the ones listed below have the potential to disturb the aquatic environment, including special status-fish species:

- Replacing Riprap on Exterior Levees
- Coring of Existing Exterior Levees
- Repairing Exterior Water Control Structures (Gates, Couplers, and Risers)
- Replacing Pipe for Existing Exterior Flood, Drain or Dual-Purpose Gate
- Installing, Repairing, or Re-installing Water Control Bulkheads
- Maintaining, and Repairing, Removing, and Relocating Existing Reclamation and DWR Facilities in the Marsh
- Removing Reclamation and DWR Monitoring Stations
- Installing New Reclamation and DWR Monitoring Stations
- Installing Alternative Bank Protection on Exterior Levees such as Brush Boxes and Biotechnical Wave Dissipaters
- Installing New Fish Screen Facilities
- Repairing Existing Exterior Levees

- Dredging from Tidal Sloughs as Source Material for Exterior Levee Maintenance
- Placing Riprap in New Areas Not Previously Riprapped

Chapter 2 identifies the following environmental commitments for managed wetland activities: restriction of construction times and development and implementation of hazardous spill plan(s). Specifically, in-water work will occur between August 1 and November 30, which avoids most of the special-status fish species. Additionally, most of the managed wetland activities are expected to be implemented from June to September when the wetlands are dry enough to conduct these activities. These environmental commitments are identified below where appropriate to clarify the types of environmental commitments related to managed wetland activities.

Impact FISH-26: Construction-Related Temporary Impairment of Fish Survival, Growth, and Reproduction by Accidental Spills or Runoff of Contaminants (Heavy Metals)

Many of the management activities listed above have the potential to release contaminants into slough channels. As identified in Chapter 2, Environmental Commitments for managed wetland activities will have construction period restrictions, and hazardous materials management plan(s) will be developed and implemented. Management activities would have a limited area of disturbance and shorter duration of management activities than restoration activities. Activities would be limited to August 1 to November 30 when special-status fish species are generally absent from the Marsh and thus would avoid adverse effects. Therefore, the limited area of disturbance, shorter duration, and environmental commitments would eliminate the likelihood of any substantial contaminant input. Contaminants would have a less-than-significant impact on special-status fish species and their habitat in Suisun Marsh because the potential of increased contaminant input is small.

Conclusion: Less than significant. No mitigation required.

Impact FISH-27: Construction-Related Temporary Reduction of Fish Rearing Habitat Quality or Quantity through Increased Input and Mobilization of Sediment

Many of the management activities listed above have the potential to release sediment into slough channels. As explained above, environmental commitments have been developed and will be implemented before and during construction activities (Chapter 2, “Environmental Commitments”). Management activities would have less effect on fish species because of the limited area and shorter duration of management activities than restoration activities. Furthermore, activities will be limited to August 1 to November 30 when special-status fish species are generally absent from the Marsh and would avoid adverse effects. . Sediment would have a less-than-significant impact on special-status fish species and their habitat in Suisun Marsh because the potential for increased sediment input is small.

Conclusion: Less than significant. No mitigation required.

Impact FISH-28: Construction-Related Mortality of Fish from Stranding

During the emergency repair of a breach in an exterior levee, tidal water may enter the managed wetland through the breach and could contain fish that move in with the tide. Once tidal waters recede and the breach is repaired, fish could become stranded behind the levee in the managed wetland and would be subject to a decrease in water quality (low dissolved oxygen levels, high water temperatures) and an increase in avian predation, causing an increase in mortality.

Direct injury and stranding would be minimized through implementation of the environmental commitments and BMP's. The BMP's would require that DFG be consulted to determine if fish rescue efforts are needed (Chapter 2, Environmental Commitments section) during or after the levee repair. Additionally, the restoration of tidal wetlands throughout the Marsh and implemented over the 30-year plan would increase fish habitat and benefit fish populations. Therefore, the increase in suitable tidal habitat for fish, including many special-status species, would ensure that this impact is less than significant.

Conclusion: Less than significant. No mitigation required.

Impact FISH-29: Temporary Reduction of Delta Smelt, Chinook Salmon and Steelhead Habitat Quantity or Quality Attributable to Management Activities

Management activities (i.e., dredging, new riprap placement, and fish screen installation) could remove aquatic and/or terrestrial vegetation, substrate, or other cover for special-status fish species in the plan area. Aquatic and other vegetation on slough banks will be avoided. Removal of substrate would remove invertebrates from the area. (See Impact FISH-33 for a more detailed discussion). Placement of new riprap and fish screen installation would be in small areas and of short duration. Adjacent areas would continue to provide habitat, and restoration of tidal wetlands throughout the Marsh would provide additional habitat.

Conclusion: Less than significant. No mitigation required.

Impact FISH-30: Temporary Reduction of Green Sturgeon Habitat Quantity or Quality as a Result of Management Activities

Management activities (i.e., dredging, new riprap placement, and fish screen installation) would disturb both edge and deeper water habitat. Green sturgeon tend to use deeper water channels during migration and shallow water habitat for foraging. As discussed in Chapter 2, dredging would be done in the center of slough channels and limited to once every 3 years in the same location. Dredging would not affect migratory pathways except during the actual dredging. Edge habitats would be temporarily disturbed by new riprap placement and fish screen installation. These activities would be in small areas and of short duration. Adjacent areas would continue to provide suitable rearing and migratory habitat.

Conclusion: Less than significant. No mitigation required.

Impact FISH-31: Temporary Reduction of Sacramento Splittail Habitat Quantity or Quality as a Result of Management Activities

Management activities (i.e., dredging, new riprap placement, and fish screen installation) could disturb aquatic vegetation. Project activities that remove aquatic vegetation could affect splittail spawning and rearing. Splittail spawn in flooded aquatic vegetation and larvae rear in the same area; however, splittail rarely spawn in Suisun Marsh. Juveniles use shallow open water, sloughs, and channels for rearing. Aquatic vegetation will be avoided to the extent feasible and adjacent areas would continue to provide suitable habitat.

Conclusion: Less than significant. No mitigation required.

Impact FISH-32: Temporary Reduction of Longfin Smelt Habitat Quantity or Quality as a Result of Management Activities

Management activities (i.e., dredging, and fish screen installation) would disturb deeper slough habitat. Longfin smelt are primarily a pelagic species and juvenile and sub-adults have been found to be more abundant at sampling locations over deep water (Rosenfield and Baxter 2007). Dredging will be limited to August 1 to November 30 when longfin are rare in the Marsh. Additionally, dredging will be limited each year, and the duration and extent of dredging in any one area is small. Adjacent areas would continue to provide suitable habitat.

Conclusion: Less than significant. No mitigation required.

Impact FISH-33: Reduction in Benthic Macroinvertebrate Abundance as a Result of Dredging

As discussed in Chapter 2 under Dredging from Tidal Sloughs as Source Material for Exterior Levee Maintenance and to Remove Sediment around Fish Screens and Other Areas, dredging would occur no more than once every 3 years in any given location of the Marsh. Dredging activities would be spread throughout the Marsh over time so that the total volume of dredging per year per region will be limited (Table 2-5). Table 6.1-7 below shows percentage of habitat that would be affected per year by dredging.

Dredging around fish screens would be done during low tide to minimize in-water work and minimize turbidity. Dredging would occur in the center of slough channels, adjacent to fish screen structures, and in historical dredger cuts (a small, linear channel area isolated by a vegetated berm from the major and minor slough channels, which was created immediately adjacent to the toe of the exterior levees during original levee construction and previous maintenance dredging events). Aquatic and other vegetation would be avoided.

Table 6.1-7. Total Percent Acres per Year Affected by Dredging

Habitat	Total Acres in Plan Area	Acres/Year Affected for Dredging 100,000 cubic yards	% of Total Area Affected/Year
Minor slough	1,108	7.1	0.6
Major Slough	2,212	5.7	0.2
Bays	22,346	0.8	<0.1
Dredger Cut	151	6.1	4.0

Removal of organisms through dredging, and burying of deposit feeders, suspension/deposit feeders, and suspension feeders would occur in portions of the dredging area. Removal of these organisms through dredging or disposal may cause short-term harm to fish species residing in the dredging area by limiting food resources.

Macroinvertebrate use of specific locations in Suisun Marsh is dependent on salinity, water velocity, and substrate conditions (Markmann 1986). Stable invertebrate communities require stable environmental conditions. Consistent with ecological theory, stable communities of low-mobility, long-lived species are more vulnerable to physical disturbance than short-lived species in changeable environments (National Research Council 2002). In Suisun Marsh, macroinvertebrate densities fluctuate as a result of constantly changing environmental conditions such as salinity and DO. If the natural environment has fluctuating water quality, macroinvertebrates in the habitat are likely to be resilient and dredging and disturbance would have less effect on them (U.S. Army Corps of Engineers 1978). Benthic communities normally subject to wave scour, high turbidity, and sediment redeposition recover in a short amount of time from dredging and sediment disposal because the residents are rapidly reproducing, opportunistic species with short life cycles (Oliver et al. 1977).

Recolonization of sites occurs within months, although sites may be recolonized by opportunistic species which are not normally dominant at the site (U.S. Army Corps of Engineers 1978). After a disturbance, the recovery of benthic assemblages has been shown to follow a predictive succession of community changes (Stages I–III). The disturbance abates over time, and begins with the initial stage (Stage I) of the benthic successional pattern (Carter et al. 2008). The Stage I taxa usually consist of small opportunistic polychaetes or bivalves and are represented by short-lived individuals. The pattern of succession following a disturbance is initially dominated by polychaetes; however over time, Stage II develops at which time the opportunistic taxa from Stage I are replaced by larger, longer-lived and deeper-burrowing species (Bolam and Rees 2003; Stanos and Simon 1980). With continued successional patterns, Stage III occurs. The late-successional Stage III assemblage consists of more diverse species, which are dominated by larger, longer-lived taxa (Bolam and Rees 2003). The current dominant species composition in the Marsh is polychaetes and bivalves (Schroeter, no date) which represent Stage I species. Dredging would remove these taxa, but should be replaced quickly by recolonization in dredged areas. Taxa would not change.

Invertebrates are expected to recolonize dredge locations within months; therefore, potential long-term impacts on fish associated with these activities are expected to be small. Moreover, the areas of dredging and deposition at any one time are small fractions of the total area of Suisun Marsh. Thus, the influx of organisms from the surrounding undisturbed areas can be rapid. Also, because many of the species in Suisun Marsh remain reproductively active for much of the year, they can quickly colonize a newly exposed sediment surface. As a result, benthic invertebrates in Suisun Marsh can be expected to be as resilient as in other estuaries (Boesch et al. 1976).

As discussed under the Environmental Commitments Section in Chapter 2, measures will be implemented to reduce the water quality effects of dredging. As shown in Table 6.1-7, only a very small area of total habitat would be affected annually. The highest percentage of habitat dredged would occur in dredger cuts and a Benthic Monitoring Program will be implemented to ensure that the impacts do not exceed the thresholds identified above. Benthic sampling will occur 30 days prior to dredging and then at specified time intervals after dredging. If the comparison of data collected prior to dredging and after dredging demonstrates that impacts are greater than what is expected, the dredging program will be modified to minimize the impacts to benthic communities.

Conclusion: Less than significant. No mitigation required.

Impact FISH-34: Disturbance, Injury, or Mortality of Delta Smelt Resulting from Dredging

Clamshell or a bucket excavator will be used to excavate channels for material for exterior levee maintenance when needed. The applicants propose that a total of 30 million cubic yards of materials be dredged from major and minor tidal sloughs and bays over the 30-year period.

Dredging is an activity that removes material from the benthic environment and thus would be more likely to affect benthic species. The potential for injury or direct mortality on fish depends on many factors, including: the abundance, swimming ability (which is positively related to size), and behavioral response of species to dredging activities; the total area dredged; the speed at which dredging is conducted; and possibly other factors.

The type of dredging equipment employed also can influence susceptibility of fish to injury or mortality. For example, fish entrainment rates generally have been shown to be greater for hydraulic dredges than for mechanical dredges, because of the strong suction field associated with hydraulic dredges (Nightingale and Simenstad 2001). Hydraulic dredges will not be used for dredging.

Dredging some areas of Suisun Marsh sloughs theoretically could result in direct mortality of rearing delta smelt if individuals are present when these activities occur. Environmental commitments restrict construction to months when delta smelt are rare in the plan area, thereby minimizing or eliminating potential interactions between this species and the dredging activities.

Dredging practices are outlined in Chapter 2 and include environmental commitments to avoid negative habitat modifications of tidal areas. More specifically, dredging would occur during months when special-status fish species are least likely to be negatively affected and in dredger cuts and other areas that have been dredged previously for levee construction and maintenance. Dredging would take place in the center of the channels, therefore avoiding shallow water habitat and aquatic vegetation. Tidally influenced berms represent key habitat for migratory and resident species in the Marsh, and avoiding these areas would minimize the impacts of dredging to a great extent.

Conclusion: Less than significant. No mitigation required.

Impact FISH-35: Disturbance, Injury, or Mortality of Chinook Salmon Resulting from Dredging

Adult fall-run Chinook salmon could be present in the Marsh from August to November 30. Adult salmon would avoid areas of disturbance and because of their large size and swimming abilities could easily avoid dredging areas. Fish generally will avoid areas of high noise when free to do so (Carlson et al. 2001). The number of adult Chinook salmon interacting with the dredging equipment is likely to be very small. Juvenile Chinook salmon are not expected to be in the Marsh during dredging activities. The primary emigration season is during high flows which typically occur from December to April.

Conclusion: Less than significant. No mitigation required.

Impact FISH-36: Disturbance, Injury, or Mortality of Steelhead Resulting from Dredging

Juvenile steelhead may rear and hold in shallow marsh habitat to some extent, although their affinity for these habitat types is much lower than that of fall-run Chinook salmon (Fresh et al. 2004). As with delta smelt (FISH-34), environmental commitments restrict dredging from August 1 to November 30 when steelhead would be at low densities in the plan area.

Conclusion: Less than significant. No mitigation required.

Impact FISH-37: Disturbance, Injury, or Mortality of Green Sturgeon Resulting from Dredging

Green sturgeon are expected to occur during any month of the year in Suisun Marsh. Lack of information on the numbers of green sturgeon in Suisun Marsh makes it difficult to estimate with any certainty the number of green sturgeon that potentially would be injured or killed during dredging activities. However, their susceptibility to injury or mortality may be higher than that of other fish species (e.g., Chinook salmon) because of their strong association with soft bottom substrates.

A clamshell dredge or long-reach excavator would be used in Suisun Marsh. Clamshell dredgers have caused mortality of sturgeon during operation by injuring fish with the bucket (Killgore and Clarke 2009; Bolden 2009). Environmental commitments limit dredging to August 1 to November 30. Adult green sturgeon are found in Suisun Bay from January to July. Information about juvenile movements and habitat use is currently unknown, but juveniles may be in Suisun Bay year round (Israel 2009).

Dredging in Suisun Marsh would occur in slough channels and also in Suisun Bay. If dredging occurs in slough channels where juvenile green sturgeon are rearing, they could become injured or killed by the dredger. However, it is unknown how many juveniles could become harmed. If dredging occurs in Suisun Bay during the months of August 1 to November 30, injury of adults would probably be low. However, as with juveniles, it is unknown how many adults would be present in Suisun Bay at the time of dredging.

Three green sturgeon were captured in 1998 in Montezuma and Suisun Sloughs by the UC Davis Suisun Marsh fish survey (Bay Delta and Tributaries no date). Fifty-six white sturgeon were caught in the UC Davis sampling efforts from 1980 to 2003 (Bay Delta and Tributaries no date). Because of the small number of green sturgeon and the low density of individuals in any given location, it is unlikely they would become injured.

While dredging is expected to have minimal impacts on green sturgeon, an indeterminable number of green sturgeon could be taken as a result of dredging. The increase in suitable habitat for green sturgeon as a result of the restoration component of the SMP would ensure this impact is less than significant.

Conclusion: Less than significant. No mitigation required.

Impact FISH-38: Disturbance, Injury, or Mortality of Sacramento Splittail Resulting from Dredging

Splittail are present year-round in Suisun Marsh. Splittail would use Suisun Marsh for rearing. They rear in shallow water habitats and move into deeper habitats at night (Sommer et al. 2008: 11). Splittail appear to be highly tolerant of a broad range of environmental conditions (Young and Cech 1996) (Table 6.1-5). During dredging, splittail are expected to move away from any areas of disturbance. They are highly motile and not obligate to the dredged areas during the warm summer and early fall months of the instream work window. Therefore, very minimal, if any, interaction between this taxon and the dredging equipment is expected.

Conclusion: Less than significant. No mitigation required.

Impact FISH-39: Disturbance, Injury, or Mortality of Longfin Smelt Resulting from Dredging

Dredging will be done during the months of August to November using a clamshell dredge. Longfin smelt are generally not present in the Marsh during this time. Therefore, minimal, if any interaction between the dredging equipment and longfin smelt is expected.

Conclusion: Less than significant. No mitigation required.

Impact FISH-40: Reduction of Fish Habitat Quantity or Quality Resulting from Installation of New Riprap on Levees

Riprap replaces naturally occurring bank habitat that eroded due to high energy wind driven waves, boat wake damage, and strong tidal currents, which decreases fish habitat. When riprap is placed in or adjacent to channels to prevent erosion, the suitability of fish habitat is often affected by changes in nearshore cover and local hydraulics. Placement of riprap often is preceded by erosion and degradation of vegetation. Riprap creates a "hydraulically efficient" surface along the riprapped bank; reduces hydrodynamic complexity; decreases nearshore roughness; reduces bank erosion which reduces habitat complexity; and impedes vegetation growth (U.S. Fish and Wildlife Service 2000).

New riprap placement would be limited to 2,000 feet on exterior levees over the 30-year plan period. Levees in the marsh total 200 miles. New riprap placement compared to total levee banks available would be small. New riprap placed as part of the managed wetland activities would generally be in areas that cannot accommodate vegetative or other more natural erosion control methods, which are typically in areas of high velocities or wave energy. Most fish species in the plan area would not use edge habitat in high velocity areas. Additionally, restoration activities specified in the SMP include restoring tidal wetlands and marsh habitat, which increases fish habitat value. The net short- and long-term impacts of project activities would result in increased availability of and access to fish habitat that is suitable for special-status fish species in Suisun Marsh. Therefore, no negative impacts associated with the quantity of habitat are expected.

Conclusion: Less than significant. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres

Alternative B would have the same general impacts as Alternative A. However, Alternative B would restore less tidal marsh and implement more managed wetland activities. Restoring less tidal marsh would decrease beneficial habitat for special-status fish species compared to Alternative A. However, the temporary impacts associated with restoration would occur less frequently.

Alternative C: Restore 7,000–9,000 Acres

Alternative C also would have the same general impacts as Alternative A. Alternative C restores more tidal marsh area and implements fewer managed wetland activities. There would be more long-term tidal marsh habitat benefits for special-status fish species compared to Alternative A, but more temporary construction-related impacts.

Section 6.2
Vegetation and Wetlands

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on vegetation and wetland resources.

The Affected Environment portion of this section describes the current setting of the action area, including a discussion of the Suisun Marsh regions, land cover types that occur in the action area and special-status species that could occur in the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes proposed by the plan. The environmental setting information is intended to be relevant to the subsequent discussion of impacts.

The environmental changes associated with the plan are discussed under Environmental Consequences. The Environmental Consequences portion of this section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 6.2-1 presents a summary of the impacts on vegetation and wetlands and mitigation measures that are associated with each plan alternative. See the impact section for each alternative for a detailed discussion of all impacts and mitigation measures.

Table 6.2-1. Summary of Vegetation and Wetlands Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
VEG-1: Short-Term Loss or Degradation of Tidal Wetlands and Tidal Perennial Aquatic Communities in Slough Channels Downstream of Restoration Sites as a Result of Increased Scour	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
VEG-2: Loss or Degradation of Tidal Wetlands Adjacent to Restoration Sites as a Result of Levee Breaching/Grading	A, B, C	Less than significant	None required	–
VEG-3: Loss of Managed Wetlands as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
VEG-4: Loss of Upland Plant Communities and Associated Seasonal Wetland Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
VEG-5: Spread of Noxious Weeds as a Result of Restoration Construction	A, B, C	Less than significant	None required	–
VEG-6: Loss of Special-Status Plants or Suitable Habitat as Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
VEG-7: Degradation of Native Plant Species and Spread of Invasive Plant Species as a Result of Increased Public Access	A, B, C	Less than significant	None required	–
VEG-8: Loss or Degradation of Tidal Native Plant Species and Spread of Invasive Plant Species as a Result of Tidal Muting	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
VEG-9: Loss of Special-Status Plants or Suitable Habitat as Result of Exterior Levee Activities	A, B, C	Less than significant	None required	–
VEG-10: Loss or Degradation of Wetland Communities and Special-Status Plant Species in Slough Channels as a Result of Channel Dredging	A, B, C	Less than significant	None required	–
VEG-1: Loss or Degradation of Rare Natural Communities and Special-Status Plant Species as a Result of New Fish Screen Facilities	A, B, C	Less than significant	None required	–
VEG-12: Loss or Disturbance of Managed Wetlands as a Result of Activities within Managed Wetlands	A, B, C	Less than significant	None required	–
VEG-13: Loss or Disturbance of Tidal Wetlands or Other Waters of the United States and Special-Status Plant Species as a Result of Placement of New Riprap and Alternative Bank Protection Methods	A, B, C	Less than Significant	None required	–
VEG-14: Loss or Disturbance of Wetlands and Special-Status Plant Species as a Result of DWR/Reclamation Facility Maintenance Activities	A, B, C	Less than significant	None required	–
VEG-15: Introduction or Spread of Noxious Weeds as Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–

Affected Environment

Definition of Study Area

The study area, as defined for this chapter, includes the four Suisun Marsh regions (Figure 1-3). All of the Marsh could be subject to the SMP, either through restoration actions or implementation of managed wetland activities.

Sources of Information

The following sections describe the information used to prepare the affected environment section for vegetation and wetlands:

- previous studies conducted in the study area,
- published literature,
- Draft Suisun Marsh Tidal Marsh and Aquatic Habitats Conceptual Model (2010)
- California Natural Diversity Database (CNDDB) records search (California Natural Diversity Database 2010), and
- USFWS species lists (U.S. Fish and Wildlife Service 2010).
- Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California (U.S. Fish and Wildlife Service 2010).

Environmental Conditions

The study area consists of a mosaic of tidally influenced bays and sloughs, tidal marsh, managed wetlands, and uplands (Table 6.2-2). Managed wetlands compose approximately 50% of the total acreage in the study area. Bays and sloughs (26%), tidal wetlands (7.5%), and upland (16%) are the other significant land cover types in the study area (Figure 6.2-1). Freshwater streams, seasonal wetlands, and riparian habitat also occur in the study area but compose only a small percentage of the overall area.

The sections that follow describe:

- the Suisun Marsh regions;
- existing land cover types, including wetlands; and
- special-status plant species.

Suisun Marsh Regions

The Suisun Marsh study area consists of 102,142 acres of wildlife habitats which is divided into four regions. These four regions consist of 77, 584 acres of terrestrial and aquatic habitats and 24,558 acres of bays and major sloughs (Table 6.2-2). As described in Chapter 2, the regions were developed to ensure that restoration activities are distributed throughout the Marsh. The acreage for each of the four regions and for each habitat type was calculated by using the most recent geographic information system (GIS) layers from:

- 1999 and 2003 DFG vegetation maps and associated files,
- interpretation of the 2003 aerial photos of the Marsh,
- 2003 SRCD property map, and
- San Francisco Estuary Institute 1998 EcoAtlas.

Table 6.2-2. Suisun Marsh Acreage by Habitat Type and Region

Habitat	Region 1	Region 2	Region 3	Region 4	Total
Tidal	2,046	1,981	704	2,940	7,672
Diked managed wetlands and uplands	12,343	7,503	2,824	29,442	52,112
Minor sloughs[2]	479	234	295	101	1,108
Developed[3]	133	147	14	18	312
Riparian	26				26
Upland[4]	3,157	6,543	3,042	3,610	16,354
Suisun Slough					913
Montezuma Slough					1,299
Bays (including Little Honker)[5]					22,346
TOTAL acres	18,184	16,408	6,880	36,112	**102,142**

Source: California Department of Fish and Game, January 16, 2008.

1 Acreages based on the map of regions provided by SRCD and with data layers primarily from San Francisco Estuary Institute (SFEI). 1998. EcoAtlas: Spatial analysis of the baylands ecosystem. Version 1.50b4, as well as the following sources:

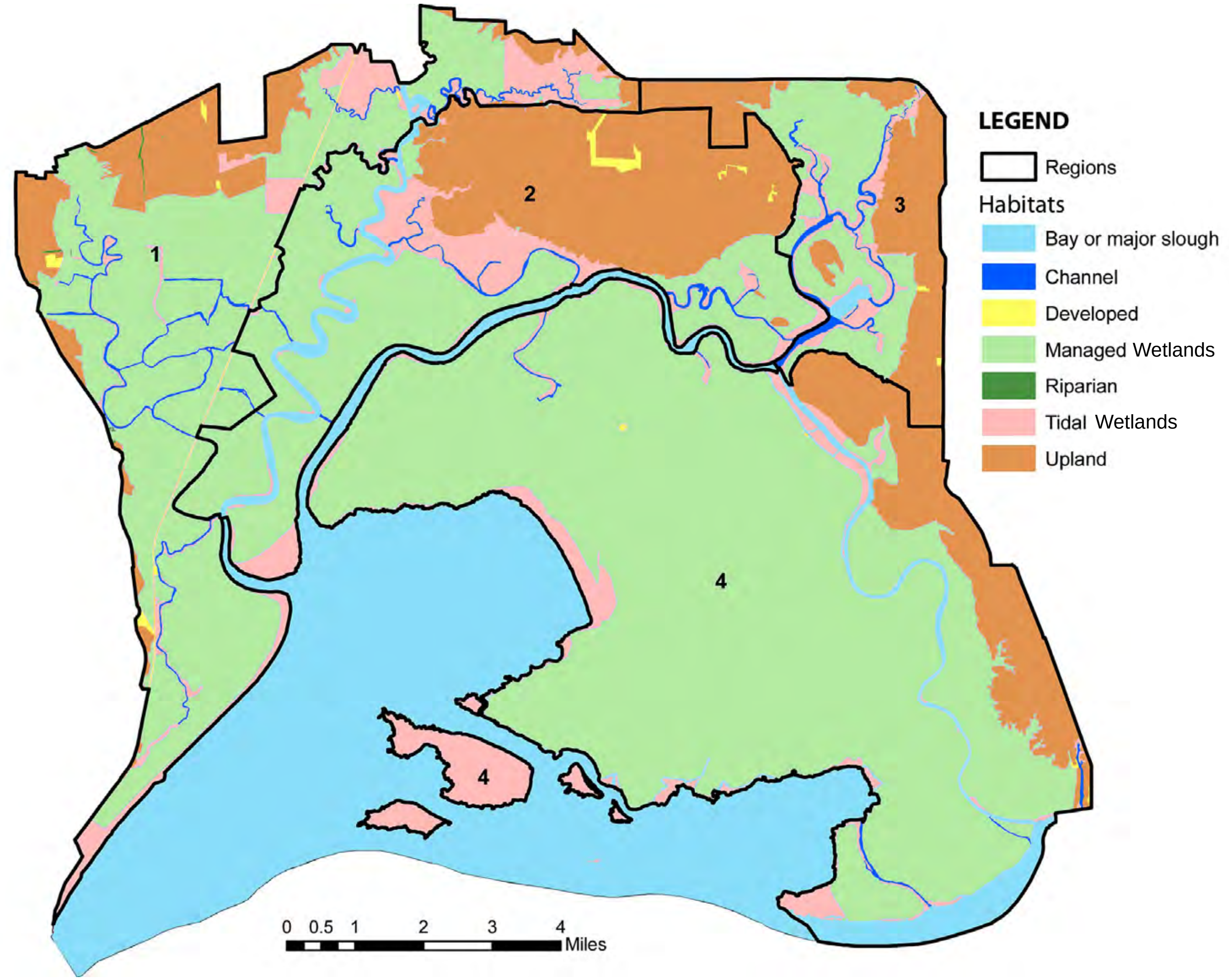
- 1999 and 2003 DFG vegetation maps and associated files
- Interpretation of the 2003 aerial photos of Suisun Marsh
- 2003 property line map

2 Includes all tidal sloughs except Montezuma and Suisun Sloughs.

3 Parking lots, major structures (excludes most homes and clubhouses), railroads, etc.

4 Above tidal inundation. Includes Potrero Hills, Kirby Hill, and acreage on the east and northwest edges of Suisun Marsh.

5 Includes Suisun and Honker Bays to the county line and Little Honker Bay.



Source: California Department of Fish and Game.

Graphics/Projects/project number/document (date) SS

Figure 6.2-1
Regions and Habitats in Suisun Marsh

Bays and Major Sloughs

Bays and major sloughs compose approximately 25% of the total acreage in the study area (Table 6.2-2). Bays in the study area are the portions of Suisun and Honker Bays north of the Contra Costa County line, Grizzly Bay, and Little Honker Bay. The major sloughs in the study area are Suisun and Montezuma Sloughs.

Region 1

Region 1 is predominantly privately owned, and the primary land use is private duck clubs. Several management units of the Grizzly Island Wildlife Management Area are in this region as are the Peytonia Slough Ecological Preserve and the Hill Slough Wildlife Management Area.

The 18,051 acres of terrestrial and aquatic habitat in Region 1 represent approximately 23% of the total land area in the study area. Managed wetlands and tidal wetlands account for 67% and 12%, respectively, of the land cover in this region. Managed wetlands divert and drain water into medium to small tidal sloughs that characterize this area of the Marsh, including Cordelia Slough, Goodyear Slough (GYS), and Wells Slough. Some of these tidal sloughs are influenced significantly by freshwater inflow from the Green Valley, Suisun, and Ledgewood Creeks. The Morrow Island Distribution System is also located in this region. The system allows the adjacent managed wetlands to receive less saline water from GYS and drain into Suisun Slough and Grizzly Bay. Additionally, there are several dead-end sloughs in this region of the Marsh in which tidal exchange is minimal.

Region 2

Region 2 consists of private and public lands, including the Potrero Hills in the northeast portion of this region and managed wetlands in the south and western portions of the region. The Joice Island management unit of the Grizzly Island Wildlife Management Area is in this region. The 16,261 acres of terrestrial and aquatic habitat in Region 2 represent approximately 21% of the total land area in the study area. Managed wetlands and tidal wetlands account for 45% and 12% of the land cover in this region, respectively. Upland habitat, consisting primarily of the Potrero Hills, composes approximately 41% of the total acreage in this region. The Potrero Hills are used for ranching, a landfill facility, and other private uses. A wastewater discharge facility provides a freshwater input source in this region on Boynton and Peytonia Sloughs.

This region of the Marsh is characterized as managed wetland areas that flood off of a small tidal slough, but drain primarily into Suisun Slough, the second largest tidal slough in the Marsh, or Montezuma Slough (the largest tidal slough). Suisun Slough is similar to Montezuma, as a large, highly energetic channel terminating at Grizzly Bay running north into the interior heart of the Marsh. Rush Ranch, the largest remnant tidal wetland in the Marsh, also is located in Region 2. A wastewater discharge facility provides a freshwater input source in this region.

Region 3

Region 3, at 6,880 acres, is the smallest region in the Marsh (6.5% of total marsh area) and consists of private lands. Managed wetlands are the primary land use in the south and western portions of the region, and rangeland is the primary land use to the east as the region transitions into the Montezuma Hills.

Managed wetlands and tidal wetlands account for approximately 45% and 10%, respectively, of the land cover in this region. Upland habitat, consisting primarily of the Kirby Hills and the transition zone to the Montezuma Hills, account for approximately 45% of the land surface area. Bays and sloughs in this region are Little Honker Bay and Nurse, Denverton, and Luco Sloughs. Managed wetland units flood and drain primarily into fairly large to medium-sized tidal sloughs and Little Honker Bay in this area of the Marsh.

Region 4

Region 4 represents the largest geographic region of the Marsh. The 36,094 acres in this region make up approximately 47% of the terrestrial and aquatic habitat in the study area. Managed wetlands and tidal wetlands account for 80% and 8%, respectively, of the land cover in this region.

This region includes Grizzly, Van Sickle, Hammond, Simmons, Chipps, and Wheeler Islands. Montezuma Slough, the Sacramento and San Joaquin Rivers, and Grizzly, Suisun, and Honker Bays hydrologically dominate this area. All of these channel and bays are highly energetic with enormous daily movements of water driven by tides, Delta outflow, wind, and the SMSCG.

This region of the Marsh has had significant investment in fish-screened facilities over the last 15 years, with diversions to about 20,000 acres of managed wetlands screened. The presence of numerous fish-screened facilities, including the RRDS, has changed the management strategies of these managed wetlands. Almost all of these wetland areas obtain their water from Montezuma Slough and drain to the bays if physically possible. If not, the wetland areas drain directly into the large tidal sloughs.

Land Cover Types

History of Change of Land Cover Types

Suisun Marsh is a dynamic tidal wetland system that has been evolving since the last ice age. This process has been accelerated and modified over the last 300 years as a result of anthropogenic changes. As a result of these changes only 5–10% of the historic tidal wetland acreage remains and the functions and values have decreased for much of the remaining acreage for tidal wetland-dependent plant and wildlife species.

Prior to human management, Suisun Marsh consisted primarily of a mosaic of bays and tidal sloughs, tidal marsh, upland transitional zones, and grasslands. The Marsh, bays, and sloughs were subject to daily tidal fluctuations and seasonal variations in water surface level and quality resulting from inflows from the Sacramento and San Joaquin River systems.

Anthropogenic changes have affected the Marsh beginning with the use of fire by Native Americans to control the vegetation cover types. The Suisun Marsh landscape began to transform in the 1700s when Spanish settlers introduced nonnative plants. Fire, which had been used by the Native Americans, continued to be used to manage vegetation communities (California Department of Water Resources 2001).

In the mid- to late 1800s hydraulic mining on Central Valley rivers resulted in the discharge of substantially large sediment loads into valley rivers and eventually the Suisun Bay estuary. Sediment deposition provided additional substrate for tidal wetland development. However, during this time period dike construction was also implemented in Suisun Marsh to convert tidal wetlands to agricultural land.

The most significant changes that have affected the Marsh are the construction of dikes and ditches, the conversion of tidal wetland habitat to agriculture and later managed wetlands, sedimentation associated with hydraulic mining and other land uses that resulted in soil erosion, and the management of seasonal water inflow from Central Valley river systems, including through the operation of the Initial Facilities as described in Section 5.1. In the late 1870–1880s Grizzly Island was leveed and by the 1930s approximately 90% of the original tidal wetlands had been leveed and converted to agricultural lands or other land uses. The last tidal wetlands were leveed in the 1960s–1970s (California Department of Water Resources 2001).

Existing Land Cover Types

A land cover type represents the dominant features of the land surface and can be defined by natural vegetation, water, or human uses. As a result of the Suisun Marsh Preservation Act of 1977 a Plan of Protection was developed to survey and record vegetation communities in Suisun Marsh. The Plan of Protection required triennial vegetation surveys to document overall vegetation composition of Suisun Marsh and to monitor salt marsh harvest mouse habitat. Initial surveys were conducted in 1981, 1988, 1991, and 1994 (California Department of Fish and Game 2000). The survey methods were revised and approved in July 1997.

DFG conducted subsequent vegetation surveys and aerial photograph assessments in 1999 and 2000 (California Department of Fish and Game 2001) and 2003 (California Department of Fish and Game 2004).Additional information on land cover types was reviewed in documents previously prepared for the Suisun Marsh region (California Department of Water Resources 2001). The Suisun Marsh Tidal Marsh and Aquatic Habitat Conceptual Model (Conceptual Model 2010) were also reviewed.

Land cover types in the study area have been mapped and defined for numerous studies and documents. As a result, the definitions of the various land cover types vary slightly. For the purpose of this document, the land cover types will be identified by DFG (California Department of Fish and Game 2008). Waters of the United States have not been formally delineated as part of this plan. Waters of the United States, including wetlands that are expected to fall under the jurisdiction of the Corps are bays and sloughs, tidal wetlands, and managed wetlands are expected to include a majority of the plan area. All of the managed wetlands are considered jurisdictional, and work in these areas is typically permitted by the Corps through RGP 3, as described in Chapter 1. As specific restoration projects are proposed, the project proponent will delineate wetlands in the project area.

In the study area, land cover types can be divided into natural vegetation communities, managed vegetation communities, aquatic communities, and developed land. The land cover types mapped in the study area are listed in Table 6.2-2 and are discussed below. Table 6.2-2 also includes the extent of each land cover type as mapped throughout the study area.

Bays and Sloughs

Bays and sloughs, as defined for this plan, include all areas of tidally influenced open water. Bays and sloughs compose approximately 25% of the total acreage in the study area (Table 6.2-2). Bays in the study area are the portions of Suisun and Honker Bay north of the Contra Costa County line, Grizzly Bay, and Little Honker Bay (Figure 5.6-3). Major sloughs in the study area are Suisun and Montezuma Sloughs. Minor sloughs are smaller channels that are hydrologically connected to the bays and major sloughs.

Tidal sloughs within tidal marshes perform two fundamental functions. First, tidal sloughs are the conduits through which water, sediment, nutrients, and aquatic organisms circulate into, around, and out of the marsh, providing a critical connectivity mechanism between marsh plain and open water environments. Second, tidal sloughs provide essential habitat for a wide variety of fish and wildlife species. Tidal slough edges provide habitat for common and special-status wildlife, fish, and plant species. Tidal sloughs provide shallow water habitat for waterfowl (Conceptual Model 2010).

Bays and sloughs are considered tidal perennial aquatic habitat. Tidal perennial aquatic habitat is characterized by open water and is defined as deepwater aquatic (more than 3 meters [10 feet] deep from mean low tide), shallow aquatic (less than or equal to 3 meters [10 feet] deep from mean low tide), and unvegetated intertidal (tidal flats) zones of estuarine bays, river channels, and sloughs (CALFED Bay-Delta Program 2000). The substrate of the bays and sloughs is primarily mud. Deep open-water areas are largely unvegetated, and beds of intertidal plants may occur in shallower open-water areas. Bays and sloughs are jurisdictional waters of the United States under Section 404 of the CWA and the Rivers and Harbors Act.

No special-status plants are known to occur in the open-water portions of bays and sloughs in the study area. Special-status plants that may occur in the tidal wetlands that border the bays and sloughs are assessed under tidal wetland or other land cover types.

Bays and sloughs and associated tidal wetlands may provide suitable habitat for *Microcystis aeruginosa*, a harmful cyanobacteria known to occur in the Delta, Suisun Bay, San Francisco Bay, and San Pablo Bay. *Microcystis aeruginosa* is not known to occur in the Marsh. This cyanobacterium typically occurs in areas of low salinity and where water mixing is limited. *Microcystis aeruginosa* could occur in the project area under current and proposed conditions; however, no elements of the Proposed Project are expected to change the potential for this cyanobacterium to occur in Suisun Marsh.

Tidal Wetlands

Tidal wetlands are influenced by tidal salt water from San Francisco Bay and an inflow of freshwater from the Delta and smaller local watersheds. Salinity levels vary throughout the year and are influenced largely by inflow from the Delta (Suisun Marsh Ecological Workgroup 2001). Tidal wetlands account for approximately 7,672 acres, or 10%, of the study area. Tidal wetlands are most abundant in Region 4, where they compose 2,940 acres (8.1%) of the land surface. In Regions 1, 2, and 3, tidal wetlands account for 11.6%, 12.2%, and 9.6%, respectively, of the land surface. DFG conducted a habitat monitoring and assessment study of Suisun Marsh vegetation in 1999 (Keeler-Wolf et al. 2000) and performed additional surveys in 2003 to map changes in Marsh vegetation (California Department of Fish and Game 2004).

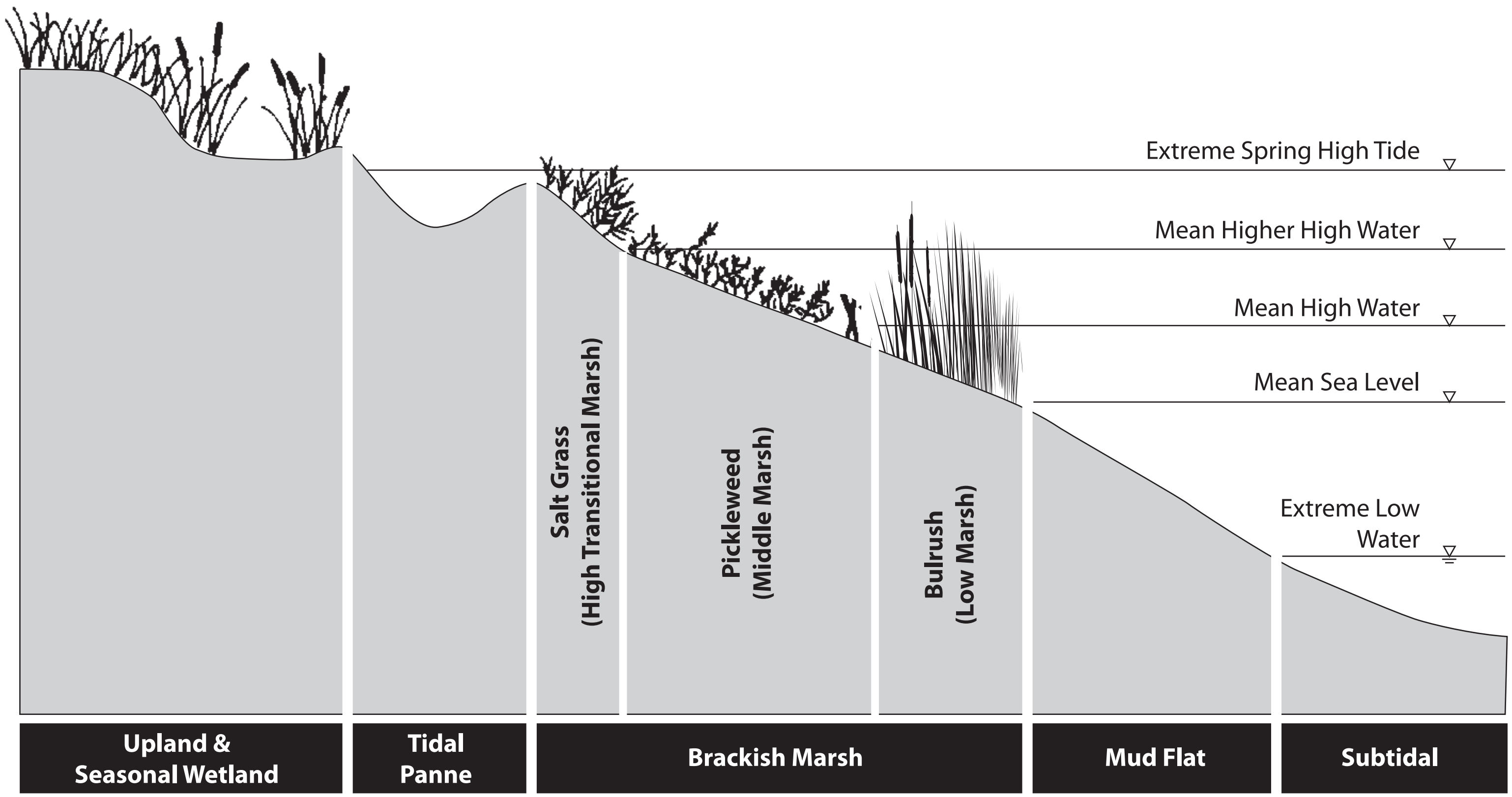
Tidal wetlands in the study area consist of tidal brackish wetlands that occur either as relatively large tracts (complex tidal wetlands) or in narrow bands (fringing tidal wetlands) (Figure 5.1-3). Complex tidal wetlands are larger marsh complexes that have a high area-to-edge ratio and typically have greater geomorphic complexity. Natural and restored complex marshes are found in the SMP area. Complex tidal wetlands typically have large marsh plains, a network of sinuous tidal channels, ponds and pannes on the marsh plain and, when located adjacent to uplands, an upland transition. Fringing tidal marsh exists along the outboard side exterior levees and generally has formed since diking for managed wetlands began. Fringing tidal wetlands vary in size and vegetation composition, are generally far less complex geomorphically, and have a low area-to-edge ratio. Fringing marshes lack connection with the upland transition, are often found in small, discontinuous segments, and can limit movement of terrestrial marsh species (Conceptual Model 2010).

Tidal wetlands consist of several distinct features described in this section: vegetated marsh plains, tidal channels, ponds and pannes within the marsh plain, and aquatic and upland edges. Tidal wetlands are divided into three zones—low marsh, middle marsh, and high marsh. Historically, the high marsh was typically an expansive transitional zone between the tidal wetlands and adjacent uplands. The high marsh and associated upland transition zone have been significantly affected by land use changes (e.g., managed wetlands, agriculture).

The low tidal wetland zone occurs from the mean lower high water (MLHW) elevation to the mean high water (MHW) elevation. This zone is tidally inundated once or twice per day. Plant zonation is influenced by inundation regime and salinity. At the lowest elevations, vegetation is inhibited by frequent, prolonged, often deep inundation and by disturbance by waves or currents. As a result this zone typically has the lowest species richness of the tidal wetland zones (Conceptual Model 2010). The dominant plant species are hardstem bulrush (*Schoenoplectus acutus*) and common bulrush (*S. californicus*). Other common species occurring in the low tidal wetland zone are pickleweed, low-club rush (*Schoenoplectus cernua*), common reed (*Phragmites australis*), common cattail (*Typha latifolia*), and narrow leaf cattail (*Typha angustifolia*) (Suisun Marsh Ecological Workgroup 2001).

The middle tidal wetland zone occurs from MHW to mean higher high water (MHHW). This zone is tidally inundated at least once per day. This zone provides food for wildlife; however, there is relatively little cover and no refuge from higher tides, which completely flood the vegetation of the middle marsh. Plant species composition and richness vary strongly with salinity and thus location in Suisun Marsh. Middle marsh elevations in brackish tidal marshes often exhibit high plant-species richness. The dominant plant species in this zone are pickleweed, saltgrass, and American bulrush (*Schoenoplectus americanus*). Other common species occurring in the middle tidal marsh are fleshy jaumea (*Jaumea carnosa*), sea milkwort (*Glaux maritima*), Baltic rush (*Juncus balticus*), salt marsh dodder (*Cuscuta salina*), alkali heath (*Frankenia salina*), Mexican rush (*Juncus mexicanus*), alkali bulrush (*Bolboschoenus maritimus*), narrow-leafed cattail (*Typha angustifolia*), sneezeweed (*Helenium bigelovii*), and marsh gumplant (*Grindelia stricta* ssp. *angustifolia*) (Suisun Marsh Ecological Workgroup 2001; Conceptual Model 2010).

The high tidal wetland zone occurs between approximately the MHHW elevation to the extreme high water (EHW) elevation (Figure 6.2-2). In fringing tidal wetlands this zone typically is confined to natural levees along tidal creek banks and edges of artificial dikes. In complex tidal wetlands this zone may resemble more natural high tidal wetland elevations. This zone receives intermittent



Source: Woodward-Clyde 1998.

Figure 6.2-2
Schematic of Habitats by Tide Levels

inundation during the monthly tidal cycle, with the higher elevations being inundated during only the highest tides. As a result, soil salinity is higher in the high tidal marsh than it is in the other tidal zones because of less frequent leaching of soil salts. High tidal wetlands often accumulate the greatest portion of drift litter (Conceptual Model 2010).

The dominant plant species in this zone are native species, including saltgrass, pickleweed, and Baltic rush (*Juncus balticus*), and nonnative species, including peppergrass (*Lepidium latifolium*), poison hemlock (*Conium maculatum*), and fennel (*Foeniculum vulgare*). Other common species occurring in the high tidal marsh are fat hen (*Atriplex triangularis*), saltmarsh dodder (*Cuscuta salina* var. *major*), fleshy jaumea, seaside arrowgrass (*Triglochin maritima*), alkali heath (*Frankenia salina*), brass buttons (*Cotula coronopifolia*), and rabbitsfoot grass (*Polypogon monospeliensis*). The high tidal marsh also provides habitat for special-status plants, including Suisun Marsh aster (*Symphyotrichum lentum*), Soft bird's beak (*Cordylanthus mollis* ssp. *mollis*), and Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*). (Suisun Marsh Ecological Workgroup 2001; Conceptual Model 2010.)

The upland transition occurs between the high wetland zone and adjacent uplands. This zone provides refuge to wildlife during high tides. It is generally dominated by a variety of plant species, including a mix of high tidal wetland zone species such as pickleweed and Baltic rush as well as more upland species such as yarrow (*Achillea millefolium*), coyote brush (*Baccharis pilularis*), creeping wildrye (*Leymus triticoides* and *L*. x *multiflorus*), California rose (*Rosa californica*), gumplant (*Grindelia stricta*), and alkali heath (*Frankenia salina*) (Conceptual Model 2010).

Managed Wetlands

Managed wetlands in the study area are located in the historical limit of the high tidal marsh and adjacent uplands that were diked and leveled for agricultural purposes and later managed to enhance waterfowl habitat. Diked managed wetlands and uplands are the most common land cover type in the study area, accounting for approximately 52,112 acres, or 66.5%, of the study area. Managed wetlands are most abundant in Region 4, where they compose 28,628 acres (80%) of the land surface. In Regions 1, 2, and 3, managed wetlands account for 67%, 45%, and 45%, respectively, of the land surface (Figure 6.2-1). Managed wetlands are considered seasonal wetlands because they are flooded and drained several times throughout the year.

Managed wetland activities, including the operation of flood and drain gates and the storage and movement of water in the managed wetlands, influence the vegetation communities in the managed wetlands (Suisun Marsh Ecological Workgroup 2001). Additionally the timing, duration, and depth of inundation; salinity of the water used; and soil type and salinity influence the plant communities that occur in a given managed wetland. Typically, the salinity gradient increases from north to south and from east to west (Suisun Marsh Ecological Workgroup 2001).

Water management on privately owned lands in Suisun Marsh varies according to each individual management plan and, as a result, the plant communities vary depending on the management practices. Most management plans stress the importance of a 30-day flood and drain cycle. The objective of water management is to control soil salinities in order to promote a diversity of wetland types within each managed wetland. Plant species diversity is dependent on the depth and duration of soil submergence and wetland topography. The managed wetlands often are graded to provide uniform flooding and draining and managed wetland managers control the timing and duration of flooding to promote growth of waterfowl food plants. Ditches are often dug to increase water circulation throughout the managed wetlands (Conceptual Model 2010). All of the managed wetland activities described in Chapter 2 assist managed wetland managers in meeting their flood and drain goals.

SRCD has developed 11 water management schedules that typify water management strategies used in the Marsh. Site specific regulatory and physical conditions influence actual water management activities for each managed wetland (Conceptual Model 2010). Under existing salinity standards and if late drawdown management is practiced, the wetlands would be dominated by alkali bulrush, cattail, and tule (*Scirpus acutus*) (California Department of Water Resources 2001). Watergrass (*Echinochloa crusgalli*) and smartweed (*Polygonum* spp.) are typically the dominant species in managed wetlands that use fresher water. In managed wetlands that employ late drawdown management bulrush, cattail, and tule are the dominant species. Pickleweed, fat hen, and brass buttons are common in the higher elevations of the managed wetlands. In marshes with higher soil salinity, pickleweed, salt grass, and other salt-tolerant species are dominant. Other plant species that are important for waterfowl production and that occur in the managed wetlands are sea purslane (*Sesuvium verrucosum*), wigeongrass (*Ruppia maritima*), sago pondweed (*Potamageton pectanatus*) and swamp timothy (*Heleochloa schoenoides*). Suisun Marsh aster *(Symphyotrichum lentum)* also is known to occur along interior supply ditches and managed wetlands.

Riparian

Riparian habitat that has been mapped in the study area is limited to small, narrow bands of vegetation along sections of Suisun Creek and several unnamed drainages in the northwest portion of Region 1. The unnamed drainages are associated with creeks that enter Suisun Marsh from the northwestern watersheds and that pass through areas of managed wetlands. Riparian habitat cover varies greatly with the land use and environmental characteristics. Although riparian habitat has been mapped only in Region 1, it is presumed that riparian vegetation also occurs in small isolated areas with suitable water availability, soil textures, and soil salinity gradients throughout the Marsh.

Uplands

Historically, lands adjacent to tidal wetlands were large areas of uplands dominated by grasslands, some of which contained vernal pools. Today much of this habitat is diked, farmed (as in the northern part of the Marsh), or managed for pheasant hunting. Upland habitats that occur in the SMP area include grassland and ruderal areas adjacent to the tidal and managed wetlands. Only small areas of upland habitat remain, and grazing has degraded much of the habitat. Uplands in the Marsh comprise annual grasslands, native perennial grasslands, coyote brush, agricultural areas, and disturbed areas dominated by ruderal herbaceous vegetation associated with the managed wetlands and other developed areas within the Marsh. Upland habitat also may include isolated clusters of woody upland vegetation, both native and nonnative species (e.g., eucalyptus). Uplands provide nesting, foraging, and cover habitat for wildlife in Suisun Marsh. Mallards are the most common breeding waterfowl in the upland nesting areas.

Seasonal Wetlands and Vernal Pools

Historically, seasonal wetlands and vernal pools and associated grassland habitats occurred in upland areas surrounding the Marsh. Seasonal wetlands and vernal pools probably never were widespread in the SMP area. However, low-gradient alluvium surrounds the Marsh, which suggests that vernal pools had a broad historical distribution in the southeastern limits outside the SMP area. A small portion of the study area, directly adjacent to SR 12, falls in the Solano-Colusa Vernal Pool Region (in the northeastern section of the Marsh), as described by USFWS in their *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (December 2005).

Only small areas of seasonal wetland and vernal pool complexes remain, and grazing has degraded much of the habitat. The seasonal wetland and vernal pool complexes remaining in the study area occur in the northern and eastern portions of the study area. These seasonal wetland complexes occur in the Potrero Hills and the south limits of the Montezuma Hills. Seasonal wetland and vernal pools occur outside the limits of the managed wetlands. Grasslands that occur in this land cover type typically are dominated by annual grasslands and forbs, native perennial grasslands, and agricultural areas. These wetland complexes provide nesting, foraging, and cover habitat for wildlife in Suisun Marsh. The seasonal wetland complexes outside of the Marsh and managed wetlands also provide habitat for special-status species, including California tiger salamander and vernal pool invertebrates and plants.

Developed

Developed land mapped in the plan area includes areas with roads, buildings, pipelines, easements, power lines, and other utilities and structures. It also includes barren areas that have been disturbed and are unvegetated. Developed areas also may include areas of ornamental landscaping.

Special-Status Plants

Special-status plant surveys have not been performed specifically for this EIS/EIR; however, a consolidated list of special-status plant species that potentially occur in the study area was generated from several sources:

- USFWS Species List, dated August 25, 2010 (Appendix C; U.S. Fish and Wildlife Service 2010);
- CNDDB (Appendix D; California Natural Diversity Database 2010); Antioch North, Bird's Landing, Denverton, Fairfield South, Honker Bay, and Vine Hill quadrangles;
- California Native Plant Society (CNPS) Inventory of Rare and Endangered Plants of California (California Native Plant Society 2008); and
- Review of documents and reports prepared for the Suisun Marsh region.

Special-status plant species are species legally protected under the California Endangered Species Act (CESA), the ESA, or other regulations, as well as species considered sufficiently rare by the scientific community to qualify for such listing. Special-status plants and animals are species in the following categories:

- species listed or proposed for listing as threatened or endangered under the ESA (50 CFR 17.12 and various notices in the FR [proposed species]);
- species that are candidates for possible future listing as threatened or endangered under the ESA (69 FR 24876, May 4, 2004);
- species listed or proposed for listing by the State of California as threatened or endangered under CESA (14 CCR 670.5);
- species that meet the definitions of rare or endangered under CEQA (State CEQA Guidelines, Section 15380);
- plants listed as rare under the California Native Plant Protection Act (California Fish and Game Code, Section 1900 *et seq.*);
- plants considered by CNPS to be "rare, threatened, or endangered in California" (Lists 1B and 2); and
- plants listed by CNPS as plants about which more information is needed to determine their status and plants of limited distribution (Lists 3 and 4), which may be included as special-status species on the basis of local significance or recent biological information.

Table 6.2-3 includes a list of special-status plants that have suitable habitat in the plan area, occur in the plan region, and/or were observed in the study area. The table includes the plant species name, status, habitat, and occurrence in the study area. Appendix D includes a map showing the location of all CNDDB records for special status species in the study area. Each species was evaluated for its potential to occur in the study area; species that are not found in land cover types present in the study area were eliminated from further consideration and are not included in Table 6.2-3. Additionally, species that may occur in the study area but are outside of areas that would be affected by the plan activities are considered in Table 6.2-3 but are not assessed in this document.

The following sections identify the special-status species that occur in tidal or managed wetlands that could be affected by plan actions. These species will be evaluated in the impact section.

Table 6.2-3. Special-Status Plant Species with Potential to Occur in the Study Area

Species Name	Status[a] Fed	Status[a] State	Status[a] Other	Distribution	Preferred Habitats	Period Identifiable	Known Occurrences in the Vicinity of the Study Area
Suisun Marsh aster *Symphyotrichum lentum*	–	–	1B, CSC	Sacramento–San Joaquin Delta, Suisun Marsh, Suisun Bay, and Contra Costa, Napa, Sacramento, San Joaquin, and Solano Counties	Tidal brackish and freshwater marsh: 0–10 feet	May–November	Populations recorded in suitable habitat throughout the study area.
Alkali milk-vetch *Astragalus tener* var. *tener*	–	–	1B	Alameda, Contra Costa, Merced, Monterey, Napa, San Benito, Santa Clara, San Francisco, San Joaquin, San Luis Obispo, Solano, Sonoma, Stanislaus, and Yolo Counties	Valley and foothill grassland, vernal pools, playas: 0–200 feet	March–June	Several occurrences in suitable habitat in the northern portion of the study area
Heartscale *Atriplex cordulata*	–	–	1B	Alameda, Butte, Fresno, Glenn, Kern, Madera, Merced, San Joaquin, San Luis Obispo, Solano, Stanislaus, Tulare, and Yolo Counties	Valley and foothill grasslands on sandy, alkaline or saline soils; meadows and seeps: 0–1,200 feet	April–October	Alkali meadows on the east side of Highway 12.
Brittlescale *Atriplex depressa*	–	–	1B	Alameda, Contra Costa, Colusa, Fresno, Glenn, Merced, Solano, Stanislaus, Tulare, and Yolo Counties	Valley and foothill grasslands, vernal pools; playas; meadows and seeps; and chenopod scrub: 0–1,040 feet	May–October	Occurrences on the east side of Montezuma Slough northwest of Molena and in the Potrero Hills.
San Joaquin spearscale *Atriplex joaquiniana*	–	–	1B	Alameda, Contra Costa, Colusa, Fresno, Glenn, Merced, Monterey, Napa, San Benito, Santa Clara, San Joaquin, San Luis Obispo, Solano, Tulare, and Yolo Counties	Valley and foothill grasslands, playas; meadows and seeps; and chenopod scrub: 0–2,700 feet	April–October	Several occurrences in suitable habitat in the northern portion of the study area.
Big tarplant *Blepharizonia plumosa* ssp. *plumosa*	–	–	1B	Interior Coast Range foothills and Alameda, Contra Costa, San Joaquin, Stanislaus*, and Solano* Counties	Annual grassland, on dry hills and plains: 50–1,500 feet	July–October	Species known to occur within the CNDDB search area however there are no occurrences in the study area.

Species Name	Status[a] Fed	State	Other	Distribution	Preferred Habitats	Period Identifiable	Known Occurrences in the Vicinity of the Study Area
Round-leaved filaree *Erodium macrophyllum*	–	–	1B	Alameda, Butte, Contra Costa, Colusa, Fresno, Glenn, Kings, Kern, Lake, Lassen, Los Angeles, Merced, Monterey, Napa, Riverside, Santa Barbara, San Benito, Santa Clara, San Diego, San Joaquin, San Luis Obispo, San Mateo, Solano, Sonoma, Stanislaus, Tehama, Ventura, and Yolo Counties	Valley and foothill grassland: 50–3,900 feet	March–May	One occurrence in vicinity of Antioch, may be extirpated.
Congdon's tarplant *Centromadia [Hemizonia] parryi* ssp. *congdonii*	–	–	1B, CSC	East San Francisco Bay Area, Salinas Valley, and Los Osos Valley	Annual grassland on lower slopes, flats, and swales, sometimes on alkaline or saline soils: 3–700 feet	June–November	Species known to occur within the CNDDB search area however there are no occurrences in the study area.
Pappose tarplant *Centromadia [Hemizonia] parryi* ssp. *parryi*	–	–	1B,	Butte, Colusa, Glenn, Lake, Napa, San Mateo, Solano, and Sonoma Counties	Valley and foothill grassland, meadows and seeps, marshes and swamps, coastal prairie: 0–1,365 feet	May–November	Species known to occur within the CNDDB search area however there are no occurrences in the study area.
Suisun thistle *Cirsium hydrophilium* var. *hydrophilium*	E	–	1B	Solano County	Salt marshes	July–September	Four occurrences in the study area
Suisun thistle Critical habitat							
Hispid bird's-beak *Cordylanthus mollis* ssp. *hispidus*	–	–	1B	Alameda, Fresno, Kern, Merced, Placer, and Solano Counties	Valley and foothill grassland, meadows and seeps, playas: 0–500 feet	June–September	One occurrence northeast of the study area.
Soft bird's-beak *Cordylanthus mollis* ssp. *mollis*	E	R	1B	Contra Costa, Marin, Napa, Sacramento, Solano, and Sonoma Counties	Salt marshes	July–November	Eleven occurrences in the study area.
Soft bird's-beak Critical habitat							

Species Name	Status[a] Fed	State	Other	Distribution	Preferred Habitats	Period Identifiable	Known Occurrences in the Vicinity of the Study Area
Hoover's Cryptantha *Cryptantha hooveri*	–	–	1B	Contra Costa, Kern, Madera, and Stanislaus Counties.	Valley and foothill grassland, inland dunes: 10–500 feet	April–May	One occurrence in vicinity of Antioch, may be extirpated.
Dwarf Downingia *Downingia pusilla*	–	–	2	Fresno, Merced, Napa, Placer, Sacramento, San Joaquin, Solano, Sonoma, Stanislaus, Tehama, and Yuba Counties	Valley and foothill grassland, vernal pools: 0–1,450 feet	March–May	Two occurrences in Region 3 and one occurrence in Region 4.
Contra Costa wallflower *Erysimum capitatum* ssp. *angustatum*	E	E	1B	Contra Costa County	Inland dunes: 6–70 feet	March–July	Known only from the Antioch Dunes. No occurrences in the study area.
Contra Costa wallflower Critical habitat							
Diamond-petaled California poppy *Eschscholzia rhombipetala*	–	–	1B	Alameda, Contra Costa, Colusa, San Joaquin, San Luis Obispo, and Stanislaus Counties	Valley and foothill grassland: 0–3,200 feet	March–April	One occurrence in vicinity of Antioch, may be extirpated.
Fragrant fritillary *Fritillaria liliacea*	–	–	1B	Alameda, Contra Costa, Monterey, Marin, San Benito, Santa Clara, San Francisco, San Mateo, Solano, and Sonoma Counties	Valley and foothill grassland, coastal prairie, and scrub, cismontane woodland: 6–1,300 feet	February–April	One occurrence in the Montezuma Wetlands Project site in Region 3.
Marsh gumplant *Grindelia stricta* ssp. *angustifolia*	–	–	4	Alameda, Contra Costa, Marin, Napa, Riverside, Santa Clara, San Francisco, San Mateo, Solano, Sonoma	Salt marshes, estuarine wetlands: 0–33 feet		No occurrences in the study area. Suitable habitat in the study area.
Rose-mallow *Hibiscus lasiocarpus*	–	–	2	Central and southern Sacramento Valley, deltaic Central Valley, and Butte, Contra Costa, Colusa, Glenn, Sacramento, San Joaquin, Solano, Sutter, and Yolo Counties	Wet banks and freshwater marshes: generally sea level to 135 feet	August–September	No known occurrences in the study area.
Carquinez goldenbush *Isocoma arguta*	–	–	1B, CSC	Deltaic Sacramento Valley, Suisun Slough, and Contra Costa and Solano Counties	Annual grassland on alkaline soils and flats: generally 3–60 feet	August–December	Several occurrences on the east side of Regions 3 and 4.

Species Name	Status[a] Fed	State	Other	Distribution	Preferred Habitats	Period Identifiable	Known Occurrences in the Vicinity of the Study Area
Northern California black walnut (native stands) *Juglans californica* var. *hindsii*	–	–	1B, CSC	Native stands in Contra Costa, Napa, Sacramento*, Solano*, and Yolo* Counties	Riparian scrub and woodland: 150–2,700 feet	April–May	Scattered trees occur throughout south Delta but not as entire stands. No CNDDB records within 5 miles of project area. One tree is present near Grant Line site.
Contra Costa goldfields *Lasthenia conjugens*	E	–	1B	Alameda, Contra Costa, Mendocino, Monterey, Marin, Napa, Santa Barbara, Santa Clara, Solano, and Sonoma Counties	Valley and foothill grassland, vernal pools, playas, and cismontane woodland: 0–1,500 feet	March–June	Several occurrences in the Suisun Marsh Secondary Management Area.
Contra Costa goldfield Critical habitat							
Delta tule pea *Lathyrus jepsonii* var. *jepsonii*	–	–	1B, CSC	Central Valley (especially the San Francisco Bay region) and Alameda, Contra Costa, Fresno, Marin, Napa, Sacramento, San Benito, Santa Clara, San Joaquin, and Solano Counties	Coastal and estuarine marshes: sea level–15 feet	May–June	Numerous occurrences throughout the study area.
Legenere *Legenere limosa*	–	–	1B	Alameda, Lake, Napa, Placer, Sacramento, Santa Clara, Shasta, San Joaquin, San Mateo, Solano, Sonoma, Stanislaus, Tehama, and Yuba Counties	Vernal pools: 0–2,860 feet	April - June	Two occurrences in suitable habitat outside the study area.
Mason's lilaeopsis *Lilaeopsis masonii*	–	R	1B, CSC	Southern Sacramento Valley, Sacramento–San Joaquin Delta, northeast San Francisco Bay area, and Alameda, Contra Costa, Marin*, Napa, Sacramento, San Joaquin, and Solano Counties	Freshwater and intertidal marshes and streambanks in riparian scrub: generally sea level–30 feet	April–October	Several occurrences throughout the study area.
Delta mudwort *Limosella subulata*	–	–	2	Contra Costa, Sacramento, San Joaquin, and Solano Counties; Oregon; Atlantic coast	Intertidal marshes: sea level–10 feet	May–August	Suitable habitat in the study area. One occurrence along Montezuma Slough.

Species Name	Status[a] Fed	State	Other	Distribution	Preferred Habitats	Period Identifiable	Known Occurrences in the Vicinity of the Study Area
Showy madia *Madia radiata*	–	–	1B	Contra Costa, Fresno, Kings, Kern, Monterey, Santa Barbara, San Benito, San Joaquin, San Luis Obispo, and Stanislaus Counties	Valley and foothill grassland, cismontane woodland: 80–2,900 feet	March–May	No occurrences in the study area.
Antioch Dunes evening-primrose *Oenothera deltoides* ssp. *howellii*	E	E	1B	Contra Costa and Sacramento Counties	Inland dunes: 0–100 feet	March–September	No occurrences in the study area.
Antioch Dunes evening-primrose Critical habitat							
Bearded popcorn-flower *Plagiobothrys hystriculus*	–	–	1B	Solano County	Valley and foothill grassland, vernal pools: 0–170 feet	April–May	Suitable habitat occurs on study area. Two occurrences in eastern portion of the study area.

Notes:

CNDDB = California Natural Diversity Database.

[a] Status

Federal

E = Endangered

– = No federal status.

State

CE = Listed as endangered under the California Endangered Species Act.

R = Listed as rare under California Native Plant Protection Act.

California Native Plant Society (CNPS)

1B = CNPS List 1B—rare or endangered in California and elsewhere

2 = CNPS List 2—rare or endangered in California, more common elsewhere

4 = CNPS List 4 – plants of limited distribution

CALFED

CSC = Other species of concern identified by CALFED.

– = No state status.

Soft Bird's-Beak

Soft bird's-beak (*Cordylanthus mollis* var. *mollis*) is an annual herb that occurs in the high marsh and upland transitional zones and in seasonally flooded alkaline wetlands (California Department of Water Resources 2001). Soft bird's-beak is federally listed as endangered, is state-listed as rare, and is listed by CNPS as a Category 1B species. There are 11 occurrences in the study area (California Natural Diversity Database 2010 [Appendix D]). Soft bird's-beak is thought to be limited to three general locations in Suisun Marsh: Rush Ranch, DFG's Joice Island Unit of the Grizzly Island Wildlife Management Area, and the Hills Slough marsh (California Department of Water Resources 2001); however, this species also occurs on Luco Slough and east of Bradmoor Island (California Natural Diversity Database 2010). The Hill Slough population accounts for more than 80% of the occurrences of this species in the study area (California Department of Water Resources 1999).

Two critical habitat units identified for soft bird's-beak occur in the study area. These units are Unit 2, Hill Slough Wildlife Management Area, and Unit 4, Rush Ranch/Grizzly Island Wildlife Management Area (72 FR 18528, April 12, 2007).

Suisun Thistle

Suisun thistle (*Cirsium hydrophilium* var. *hydrophilium*) is a perennial herb that occurs in tidal saltmarsh habitat along sloughs and rivers. This species is known to exist only in Suisun Marsh. This species typically is found in the study area in the middle to high marsh zone along tidal channels and in irregularly flooded estuarine wetlands (California Department of Water Resources 2001). Suisun thistle is federally listed as endangered and is listed by CNPS as a Category 1B species. Three populations of Suisun thistle are known (California Department of Water Resources 2001), and there are four occurrences in the study area (California Natural Diversity Database 2010 [Appendix D]). One population occurs on DFG's Peytonia Slough Ecological Reserve in Region 1. The second population and the remaining occurrences are associated with the Cutoff Slough tidal marshes and DFG's Joice Island Unit of the Grizzly Island Wildlife Management Area.

Three critical habitat units have been identified for Suisun thistle in the study area. These units are Unit 1, Hill Slough Marsh; Unit 2, Peytonia Slough Marsh; and Unit 3, Rush Ranch/Grizzly Island Wildlife Area (72 FR 18527, April 12, 2007).

Suisun Marsh Aster

Suisun Marsh aster (*Symphyotrichum lentum*) is a perennial herb that occurs in tidal brackish marsh habitat along sloughs and rivers. This species is typically found in the study area in the middle marsh zone and in regularly flooded estuarine wetlands and intertidal banks (California Department of Water Resources 2001). Suisun Marsh aster also is known to occur along interior supply ditches and managed wetlands. Suisun Marsh aster is a federal species of concern and is listed by CNPS as a Category 1B species. There are 36 occurrences of Suisun Marsh aster in the study area (California Natural Diversity Database 2010 [Appendix D]).

Delta Tule Pea

Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*) is a perennial herb that occurs in the middle to high marsh zones, tidally influenced banks channels, and in regularly flooded estuarine wetlands (California Department of Water Resources 2001). Delta tule pea is a federal species of concern and is listed by CNPS as a Category 1B species. There are 61occurrences of delta tule pea in the study area (California Natural Diversity Database 2010 [Appendix D]).

Mason's Lilaeopsis

Mason's lilaeopsis (*Lilaeopsis masonii*) is a diminutive rhizomatous perennial herb that typically occurs in the intertidal zone on clay or silt tidal mudflats with high organic matter content (Golden and Fiedler 1991). Mason's lilaeopsis is state-listed as rare and listed by CNPS as a Category 1B species. Field surveys performed by DWR and DFG between 1990 and 1993 located Mason's lilaeopsis throughout most regions of the Marsh (California Department of Water Resources 1999). Based on CNDDB records there are 27 occurrences of Mason's lilaeopsis in the study area (California Natural Diversity Database 2010 [Appendix D]).

Delta Mudwort

Delta mudwort (*Limosella subulata*) is a low-growing, herbaceous perennial that occurs on muddy or sandy intertidal flats, sometimes in association with Mason's lilaeopsis (Golden and Fiedler 1991).

Delta mudwort has no federal or state designation but is listed by CNPS as a Category 2 species. Field surveys performed by DWR and DFG between 1990 and 1993 located Mason's lilaeopsis throughout most regions of the Marsh (California Department of Water Resources 1999), and there is one CNDDB record of delta mudwort in the study area (California Natural Diversity Database 2010 [Appendix D]).

Regulatory Setting

This section provides preliminary information on the major requirements for permitting and environmental review and consultation related to vegetation and waters of the United States for implementation of the SMP. Certain local, state, and federal regulations require issuance of permits before plan implementation; other regulations require agency consultation but may not require issuance of any entitlements before plan implementation. The exact requirements will be determined at a project-specific level as projects are proposed. The sections below outline the general regulatory requirements for projects of this nature. It is possible that over the 30-year implementation period, regulations may be modified, eliminated, or created and that species may be listed or delisted. As such, project-specific analysis will include relevant updates and changes in impact assessment as necessary.

Federal

The following federal requirements are discussed in detail in Chapter 10: ESA, Fish and Wildlife Coordination Act, CWA Section 404(b)(1) Guidelines and Section 401, River and Harbors Appropriation Act of 1899 and Executive Order 11990 (Protection of Wetlands).

State

The following state requirements are discussed in detail in Chapter 10: CESA, Section 1602 of the California Fish and Game Code and San Francisco Bay Conservation and Development Commission. Additional State requirements pertinent to vegetation and wetlands are discussed below.

California State Wetlands Conservation Policy

The Governor of California issued an executive order on August 23, 1993, that created a California State Wetlands Conservation Policy. This policy is being implemented by an interagency task force that is jointly headed by the State Resources Agency and the California Environmental Protection Agency (Cal-EPA). The policy's three goals are to (Cylinder et al. 1995):

1. ensure no overall net loss and a long-term net gain in wetlands acreage and values in a manner that fosters creativity, stewardship, and respect for private property;
2. reduce the procedural complexity of state and federal wetland conservation program administration; and
3. encourage partnerships that make restoration, landowner incentives, and cooperative planning the primary focus of wetlands conservation.

California Water Resources Control Board

Water Code Section 13260 requires “any person discharging waste, or proposing to discharge waste, in any region that could affect the waters of the state to file a report of discharge (an application for waste discharge requirements).” Under the Porter-Cologne definition, the term *waters of the state* is defined as “any surface water or groundwater, including saline waters, within the boundaries of the state.” Although all waters of the United States that are within the borders of California are also waters of the state, the converse is not true (i.e., in California, waters of the United States represent a subset of waters of the state). Thus, California retains authority to regulate discharges of waste into any waters of the state, regardless of whether the Corps has concurrent jurisdiction under Section 404.

Local

The following local and regional regulations are discussed in detail in Chapter 10: Suisun Marsh Protection Act of 1974 and Suisun Marsh Protection Act of 1977. The applicable Solano General Plan elements are discussed below.

Solano County General Plan

The Solano County General Plan (SCGP) identifies several issues and opportunities related to biological resources (EDAW/AECOM 2006):

1. An issue identified in the SCGP is declining critical habitat. Natural habitats in Solano County have been altered and degraded by urban development and agricultural practices, among other actions. In the study area, critical habitat has been designated for Suisun thistle and soft bird’s-beak.
2. Biological resource conservation practices throughout Solano County also may provide for the preservation of agricultural lands.

Environmental Consequences

Assessment Methods

Vegetation and wetland resources could be directly or indirectly affected by the SMP. Tidal wetland restoration will result in the loss/conversion of managed wetland or other land cover types. Additionally, the following types of SMP activities could cause varying degrees of temporary or permanent impacts on these resources (e.g., loss or degradation of habitat):

- levee breaching or grading (e.g., direct loss of habitat);

- increased scour due to levee breaching (e.g., degradation of tidal wetlands and tidal perennial aquatic habitat);
- grading and other ground-disturbing activities (e.g., loss or degradation of land cover types or special-status plant populations);
- installation of temporary water-diversion structures (e.g., loss or degradation of land cover types or special-status plant populations);
- temporary stockpiling and sidecasting of soil, construction materials, or other construction debris(e.g., loss or degradation of land cover types or special-status plant populations);
- introduction of invasive nonnative species in construction areas could displace native plant species in adjacent open space areas (e.g.; spread of peppergrass [*Lepidium latifolium*] in construction areas through movement of soil);
- dredging activities in wetlands and channels that contain ponded or flowing water and saturated soils (e.g., degradation of tidal wetlands and tidal perennial aquatic habitat);
- placement of dredged material on the crown and backslope of levees (e.g., loss or degradation of land cover types or special-status plant populations).

Impact Analysis Assumptions

The SMP would result in temporary and permanent impacts on vegetation and wetland resources in the plan area. Temporary impacts would be those that occur only during the construction period associated with restoration and enhancement of wetlands. Permanent impacts would occur as a result of irreversible changes in land cover types.

Impact Assessment Approach and Methods

This vegetation and wetland resources impact analysis is based on:

- the most current proposed implementation of the SMP, as summarized in the above assumptions and described in Chapter 2, and
- existing biological resource information (sources are discussed under Affected Environment).

The mitigation measures for impacts on vegetation and wetland resources were developed through review of the plan description, prior environmental impact studies and reports for affected resources, discussions with resource agency personnel, and professional judgment.

Significance Criteria

The criteria for determining significant impacts on biological resources were developed by reviewing the State CEQA Guidelines. Based on these sources of information, the SMP likely would cause a significant impact if it would result in:

- Net loss of wetland acres and functions and values including waters of the United States;
- substantial loss of woody riparian vegetation;
- substantial loss of occupied special-status species habitat;
- a reduction in the area and functions within Suisun Marsh of rare natural communities;
- cause a plant population to drop below self-sustaining levels;
- the spread or introduction of new noxious weed species into the plan area; and
- reduce the number or restrict the range of an endangered, rare, or threatened plant species or plant species of special concern..

Environmental Impacts

No Action Alternative

Under the No Action Alternative, the SMP would not be implemented. As a result, the amount of restoration in the Marsh likely would be limited, as described in Chapter 2. Additionally, any levee breaches that occur in inaccessible areas would not be fixed, and passive restoration would occur in those areas.

Under the No Action Alternative, most habitat types and values for sensitive species would not change. Diversion restrictions on managed wetlands would continue to be enforced, and programs to encourage landowners to manage properties to protect certain habitat values would continue to be implemented. Additionally, programs to control managed wetland vegetation would continue. Installation of new water diversions would continue to be prohibited and fish screens would continue to be installed on existing diversions where feasible. Existing programs to control nonnative species and protect sensitive wetlands from the adverse effects of grazing would continue to be implemented.

No additional significant effects of the No Action Alternative are anticipated. No mitigation is required.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact VEG-1: Short-Term Loss or Degradation of Tidal Wetlands and Tidal Perennial Aquatic Communities in Slough Channels Downstream of Restoration Sites as a Result of Increased Scour

Tidal wetland restoration would occur by breaching and/or lowering exterior levees to restore tidal inundation to restoration sites. Breach locations would be chosen to minimize upstream tidal muting, tidal elevation changes, channel scour, and hydraulic changes. Temporary increased scour could occur as a result of greater flows near breach sites (See Section 5.6, Sediment Transport).

As such, existing tidal wetlands in the vicinity of the affected levee sections may be impacted as a result of increased scour. This could result in a temporary conversion of a small amount of tidal wetlands to tidal perennial aquatic habitat (e.g., bay or slough habitat), depending on the site-specific conditions. As the area stabilizes, some or all of the tidal wetlands may reestablish.

Existing tidal perennial aquatic habitat in the vicinity of the affected levee sections may be degraded because of increased scour. Tidal perennial aquatic habitat would be restored within the restoration sites in the Marsh. The quantity of tidal perennial aquatic habitat restored at a specific location would vary depending on the existing or graded land surface elevations and tidal water surface elevations within each restoration site.

Tidal wetland restoration sites, including the created habitat levees, intertidal zones, and tidal wetland habitat that form over time from sediment accumulation and the tidal perennial aquatic habitat that would be restored, would more than offset any temporary loss or degradation of tidal wetland habitat or tidal perennial aquatic habitat.

Conclusion: Less than significant. No mitigation required.

Impact VEG-2: Loss or Degradation of Tidal Wetlands Adjacent to Restoration Sites as a Result of Levee Breaching/Grading

Tidal wetland restoration would occur by breaching and/or lowering exterior levees to restore tidal inundation to restoration sites. Existing tidal wetlands in the vicinity of the affected levee sections may be lost because of construction-related activities. Although a relatively small amount of tidal wetlands may be lost or degraded during levee breaching, the restoration of tidal action would restore a much greater acreage of tidal wetland habitat that would be impacted.

Conclusion: Less than significant. No mitigation required.

Impact VEG-3: Loss of Managed Wetlands as a Result of Tidal Wetland Restoration

Tidal wetland restoration would occur by breaching and/or lowering exterior levees that currently protect managed wetlands and/or upland habitats from tidal inundation, resulting in the restoration and conversion of managed wetlands to tidal wetlands and perennial aquatic habitat. The restoration sites are expected to evolve into tidal wetlands providing a range of elevations to support different wetland types. There would be an overall decrease in the quantity of managed wetlands in Suisun Marsh. The effects of this land cover type conversion on wetlands and special-status plant species are assessed below and the effects on wildlife and fish are assessed in Sections 6.3 and 6.1, respectively.

The loss of managed wetlands may range from 5,000 to 7,000 acres under the Proposed Project. The construction of habitat levees or other levees may result in fill of managed wetlands, but this would not result in a loss of jurisdictional wetlands acres because the managed wetlands would be converted to tidal wetlands and associated open water habitat, and includes the removal of some exterior levees.

The restoration design includes construction of habitat levees, benches and other features which would be constructed prior to levee breaching and would provide some of the functions and values as the managed wetlands. As the tidal wetlands become established, they would increase a variety of wetland functions and values. The tidal wetlands would provide habitat and food sources that benefit tidal wetland-dependent species and many, but not all, managed-wetland dependent species.

Conclusion: Less than significant. No mitigation required.

Impact VEG-4: Loss of Upland Plant Communities and Associated Seasonal Wetland Habitat as a Result of Tidal Wetland Restoration

Tidal wetland restoration would occur by breaching and/or lowering exterior levees to allow tidal inundation of the lands within the levees. Upland plant communities, including annual grasslands and ruderal vegetation, may occur on the interior levee surfaces or on natural or altered land surfaces that were previously protected by the levees. Natural seasonal wetlands (e.g., vernal pools) may occur in some of the upland communities within or immediately adjacent to Suisun Marsh. Upland areas and associated natural seasonal wetland habitat would be protected as described in Chapter 2. This includes selection of breach sizes and locations in consideration of habitats that would be affected. Therefore, the primary impact on upland plant communities is expected to occur on the levee surfaces that are altered to create habitat levees or that become subject to tidal inundation. No impact to associated seasonal wetland habitat would occur.

Existing levee surfaces could support upland/high marsh transition plant species, including special-status plant species. The proposed restoration may result in minor inundation of some areas if the natural tidal stage is higher than the managed wetland water level. Although immediately upon inundation there could be changes in habitat types on the levee surfaces, the tidally restored area would increase the high marsh habitat available to these species through the construction of habitat levees and islands. It is expected that the plants would shift to occupy the new and expanded high marsh habitat.

Conclusion: Less than significant. No mitigation required.

Impact VEG-5: Spread of Noxious Weeds as a Result of Restoration Construction

Construction activities related to tidal restoration actions could result in the introduction or spread of noxious weed species, which could displace native species, thereby changing the diversity of species or number of any species of plants. Soil-disturbing activities during construction could promote the introduction of plant species that currently are not found in the project area, including exotic pest plant species. Construction activities also could spread exotic pest plants that already occur in the project area.

As described in the Environmental Commitments section of Chapter 2, several measures would be implemented to avoid the spread of nonnative plants. Additionally, proposed restoration sites would be managed to promote tidal wetland vegetation so when inundation occurs, there is minimal potential to support nonnative species.

Conclusion: Less than significant. No mitigation required.

Impact VEG-6: Loss of Special-Status Plants or Suitable Habitat as Result of Tidal Wetland Restoration

Special-status plants and suitable habitats are known to occur in the study area. Species and suitable habitat potentially impacted include soft bird’s-beak, Suisun thistle, Mason’s lilaeopsis , Delta tule pea, Delta mudwort, and Suisun Marsh aster. For soft bird’s-beak, four critical habitat units have been identified and three critical habitat units have been identified for Suisun thistle. Construction activities associated with tidal wetland restoration could affect populations of soft bird’s beak. As described in the Environmental Commitments section of Chapter 2, if initial screening by a qualified biologist identifies the potential for special-status plant species to be directly or indirectly affected by a site-specific project, the biologist will establish an adequate buffer area to exclude activities that would directly remove or alter the habitat of an identified special-status plant population or result in indirect adverse effects on the species’ habitat. However, indirect effects related to restoration, such as scour adjacent to the breach location, could result in a loss of suitable habitat for bird’s-beak. As described in Chapter 2, breach size and location would be selected to minimize effects of scour on special-status species. Any potential impacts to suitable special-status plant species habitat from temporary tidal restoration actions would be more than offset by the range of marsh elevations and associated habitats that would be created and restored by the tidal restoration actions, resulting in more suitable habitat for all special-status plant species and contributing to the recovery of these species.

Conclusion: Less than significant. No mitigation required.

Impact VEG-7: Degradation of Native Plant Species and Spread of Invasive Plant Species as a Result of Increased Public Access

Public access is restricted throughout most of Suisun Marsh because much of the Marsh is private land. Tidal wetland restoration projects may occur on private or public lands and may result in an increase in public access. Increased public access could result in increased pedestrian traffic in the vicinity of sensitive habitat or special-status plant populations. As described for Recreational Environmental Commitments in Chapter 2, access would be restricted through signage, buffers, and seasonal restrictions to minimize adverse effects on sensitive wildlife and vegetation.

Conclusion: Less than significant. No mitigation required.

Impact VEG-8: Loss or Degradation of Tidal Native Plant Species as a Result of Tidal Muting

Tidal wetland restoration would occur by breaching and/or lowering exterior levees to restore tidal inundation to restoration sites. Breach locations would be chosen to minimize temporary upstream tidal muting and the implementation of restoration over a 30-year period and spread throughout the Marsh, as well as sea level rise would minimize the potential for substantial tidal muting. Although tidal muting could result in a temporary reduction in the tidal water surface elevation range, the overall acreage of tidal wetlands in the Marsh would substantially increase as a result of restoration actions.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact VEG-9: Loss of Special-Status Plants or Suitable Habitat as Result of Exterior Levee Activities

The increased frequency of currently implemented managed wetland activities and the new activities intended to maintain or improve exterior levees would have the potential to affect special-status plants, including soft bird’s-beak, Suisun thistle, Suisun Marsh aster, Delta tule pea, Mason’s lilaeopsis, and Delta mudwort. These species occur throughout the Marsh in mid- to high-marsh areas. The most common practices for repairing exterior levees in Suisun Marsh involve the removal of accumulated silt and vegetation from water circulation ditches or pond bottom grading in managed wetlands and placement of spoil material on the crown of adjacent levees to raise the crown to its original or design height and/or improve interior side slopes. Material also is proposed to come from dredging of adjacent tidal sloughs. (The impact of dredging is discussed specifically below.)

It is unlikely that a significant amount of levee repair material would be lost to the outboard side of an exterior levee below the mean high water line. A limited amount of material on the outside slope of the levee from the crown probably would not significantly impact special-status plants or their suitable habitat. Exterior levee activities would not result in changes in tidal stage, flows, or erosion that would significantly impact special-status plants or their suitable habitat. As described in the Environmental Commitments section of Chapter 2, if initial screening by a qualified biologist identifies the potential for special-status plant species to be directly or indirectly affected by a site-specific project, the biologist will establish an adequate buffer area to exclude activities that would directly remove or alter the habitat of an identified special-status plant population or result in indirect adverse effects on the species' habitat.

Conclusion: Less than significant. No mitigation required.

Impact VEG-10: Loss or Degradation of Wetland Communities and Special-Status Plant Species in Slough Channels as a Result of Channel Dredging

Excavator bucket or clamshell dredging could occur either from a barge in the river channel or from the top of a levee, depending on restrictions caused by vegetation on channel banks or the width and depth of a channel. Dredging would occur in the center of slough channels, adjacent to fish screens, and in historical dredger cuts. As much as possible, vegetation would be avoided by not dredging adjacent to tidal berms more than 50 feet wide, dredging from the center channel to avoid emergent vegetation often found along levee slopes, and avoiding other areas with prominent vegetation.

Excavator bucket or clamshell dredging would avoid direct impacts on tidal emergent wetlands and managed wetlands. Indirect impacts of dredging could include temporary decreased water quality caused by turbidity. Tidal wetland vegetation would not be significantly affected by the temporary, small increase in channel water turbidity.

Equipment operation and dredged material placement could affect tidal and managed wetland habitat and associated special-status plant species populations. As described in the Environmental Commitments section of Chapter 2, if initial screening by a qualified biologist identifies the potential for special-status plant species to be directly or indirectly affected by a site-specific project, the biologist will establish an adequate buffer area to exclude activities that would directly remove or alter the habitat of an identified special-status plant population or result in indirect adverse effects on the species' habitat.

Conclusion: Less than significant. No mitigation required.

Impact VEG-11: Loss or Degradation of Rare Natural Communities and Special-Status Plant Species as a Result of New Fish Screen Facilities

New fish screens could be constructed on existing diversion facilities or at new diversion locations. Construction activities associated with construction of new fish screen facilities could temporarily affect tidal wetlands, managed wetland habitat, and associated special-status plant species populations. As described in Chapter 2 under Environmental Commitments, several measures would be in place to identify and avoid special-status plants and sensitive habitat communities, and fish screen structures would only affect small areas throughout the Marsh. Temporarily disturbed areas would reestablish following completion of fish screen activities. Additionally, restoration activities would result in an increase of quality and quantity of habitat for many rare natural communities in the Marsh and associated special-status plant species.

Conclusion: Less than significant. No mitigation required.

Impact VEG-12: Loss or Disturbance of Managed Wetlands as a Result of Increased Frequency of Activities within Managed Wetlands

Several activities would occur in managed wetlands with increased frequency (e.g., new interior levee construction, grading, duck blinds, v-ditches), which could disturb managed wetlands. Activities would occur throughout the Marsh over the 30-year period of the Proposed Project and would typically be implemented in dry conditions during August and September.

Construction activities could result in temporary and permanent impacts on managed wetland habitat, however there will be no net loss of wetland acres and functions and values, since any impacts on managed wetlands will be offset on-site or through tidal wetland restoration.

Conclusion: Less than significant. No mitigation required.

Impact VEG-13: Loss or Disturbance of Tidal Wetlands or Other Waters of the United States and Special-Status Plant Species as a Result of Placement of New Riprap and Alternative Bank Protection Methods

The placement of new riprap and alternative bank protection (i.e., brush boxes, biotechnical wave dissipaters) on exterior and interior levee surfaces in areas that were not previously riprapped could result in temporary and permanent effects on tidal wetland, bays and sloughs or special-status plant species. Pre-construction surveys for special-status plant species will be performed in locations proposed for riprap and alternative bank protection placement. If special-status plants are identified, their populations will be avoided. Riprap and alternative bank protection would be needed primarily in areas that currently do not have vegetation, and as described in Chapter 2 under Environmental Commitments, special-status plant species would be identified and avoided so there would be no impacts on special-status plant species or their habitat, including critical habitat.

Although riprap and alternative bank protection placement could result in permanent fill of other waters of the United States, there will be no net loss of wetland acres and functions and values, since any impacts will be offset by managed wetland on-site enhancement and through tidal wetland restoration, resulting in high functions and values for restored tidal wetlands and other waters of the United States.

Conclusion: Less than Significant. No mitigation required.

Impact VEG-14: Loss or Disturbance of Wetlands and Special-Status Plant Species as a Result of DWR/Reclamation Facility Maintenance Activities

DWR/Reclamation facility maintenance activities, as described in Chapter 2 under Managed Wetland Activities, could result in temporary and permanent effects on tidal wetland, bays and sloughs, managed wetlands, and special-status plant species populations. These maintenance activities would be implemented to improve water conditions within the Marsh and result in higher quality wetland habitat by improving water quality and providing more reliable water conveyance systems. Areas of temporary disturbance would be restored following completion of the maintenance activity. Restoration activities included in the SMP would increase the total acreage of tidal wetlands, including suitable habitat for special-status plant species. The Environmental Commitments as described in Chapter 2 would be implemented to protect wetlands and special-status plants.

Conclusion: Less than significant. No mitigation required.

Impact VEG-15: Introduction or Spread of Noxious Weeds as Result of Managed Wetland Activities

Some managed wetland activities that disturb the soil have the potential to create barren areas in which noxious weeds may establish. Additionally, all construction equipment, if not properly cleaned, could import noxious species to construction areas. Managed wetland activities are intended to improve water management to promote certain vegetation communities. Disturbed areas will be seeded and/or plant with native species to promote the desired vegetation and control the spread of noxious weeds, thus limiting the potential for colonization of noxious weeds.

Conclusion: Less than significant. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres

Impacts for Alternative B are similar to impacts for Alternative A for site-specific impact mechanisms. The overall Marsh landscape would change slightly compared to existing conditions and less than Alternative A. Because there would be less restoration, the frequency of restoration impacts would be less, and the frequency of managed wetland activities and their impacts would be more.

Alternative C: Restore 7,000–9,000 Acres

Impacts for Alternative C are similar to impacts for Alternative A for site-specific impact mechanisms. The overall Marsh landscape would change more compared to existing conditions and more than Alternative A. Because there would be more restoration, the frequency of restoration impacts would be greater, and the frequency of managed wetland activities and their impacts would be less.

Section 6.3
Wildlife

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on wildlife resources.

The Affected Environment discussion below describes the current setting of the plan area. The purpose of this information is to establish the existing environmental context so the reader can understand the environmental changes caused by the implementation of the SMP alternatives. The environmental changes associated with the plan are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

The tidal wetland restoration actions, specifically levee breaching, initially would result in the establishment of tidal open water habitat. Tidal wetland vegetation would establish as sediment accrues over time (Figure 2-1). There initially would be some impacts on managed wetland habitats. These values would be replaced as part of the restoration design and increased as tidal wetland vegetation becomes established. Additionally, the implementation of the managed wetland activities would ensure that the remaining managed wetlands continue to provide suitable habitat.

Table 6.3-1 presents a summary of the impacts on wildlife and applicable mitigation measures that are associated with each plan alternative. The impact sections provide a detailed discussion of all impacts and mitigation measures.

Table 6.3-1. Summary of Wildlife Impacts and Mitigation Measures

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
Restoration Impacts				
WILD-1: Loss or Disturbance of Salt Marsh Harvest Mouse Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
WILD-2: Loss or Disturbance of California Clapper Rail Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-3: Loss or Disturbance of California Black Rail Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-4: Loss or Disturbance of Suisun Shrew Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-5: Loss or Disturbance of California Least Tern Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-6: Loss of Suisun Song Sparrow and Salt Marsh Common Yellowthroat Suitable Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-7: Loss or Disturbance of Raptor Nest Sites or Foraging Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-8: Loss or Disturbance of Western Pond Turtle as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-9: Loss or Disturbance of Tricolored Blackbird as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
WILD-10: Effects on Southern Resident Killer Whales as a Result of Changes in Salmon Populations	A, B, C	No impact	–	–
WILD-11: Loss or Disturbance of Waterfowl and Shorebird Habitat as a Result of Tidal Wetland Restoration	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
WILD-12: Loss or Disturbance of Salt Marsh Harvest Mouse Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-13: Loss or Disturbance of California Clapper Rail Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-14: Loss or Disturbance of California Black Rail Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-15: Loss or Disturbance of Suisun Shrew Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-16: Loss or Disturbance of California Least Tern Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measure	Significance after Mitigation
WILD-17: Loss or Disturbance of Suisun Song Sparrow and Salt Marsh Common Yellowthroat Suitable Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-18: Loss or Disturbance of Raptor Nest Sites or Foraging Habitat as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-19: Loss or Disturbance of Western Pond Turtle as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-20: Loss or Disturbance of Tricolored Blackbird as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-21: Effects on Southern Resident Killer Whales as a Result of Changes in Salmon Populations as a Result of Managed Wetland Activities	A, B, C	Less than significant	None required	–
WILD-22: Changes in Waterfowl Nesting and Wintering Habitat as a Result of Marsh Management Activities	A, B, C	Beneficial	–	–
WILD-23: Changes in Shorebird Nesting and Wintering Habitat as a Result of Marsh Management Activities	A, B, C	Beneficial	–	–

Affected Environment

Definition of Study Area

The study area, as defined for this section, includes the four Suisun Marsh regions (Figure 1-3).

Sources of Information

Information sources used to prepare the affected environment section for wildlife include:

- previous studies conducted in the study area,
- published literature,
- *Draft Suisun Marsh Tidal Marsh and Aquatic Habitats Conceptual Model* (Conceptual Model 2010),
- *Conceptual Model for Managed Wetlands in Suisun Marsh* (California Department of Fish and Game 2007)
- CNDDB records search (California Natural Diversity Database 2010), and

- USFWS species list (Appendix C) (U.S. Fish and Wildlife Service 2010a).
- Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California (U.S. Fish and Wildlife Service 2010b).

Environmental Conditions

The study area consists of a mosaic of tidally influenced bays and sloughs and tidal wetland habitats, managed wetlands, and uplands (Table 6.2-2; Section 6.2, Vegetation and Wetlands). Managed wetlands make up approximately 51% of the total acreage in the study area and are primarily managed for wildlife, including but not limited to waterfowl production and overwintering habitat. Bays and sloughs (26%), tidal wetlands (7.5%), and upland (16%) are the other significant land cover types in the study area. Freshwater streams, seasonal wetlands, and riparian habitat also occur in the study area but account for only a small percentage of the overall area.

The following sections summarize the existing land cover types in the study area and identify special-status and common wildlife species that occur in the study area. Additional detailed information regarding the Suisun Marsh regions and the land cover types in the study area is provided in Section 6.2, Vegetation and Wetlands.

Land Cover Types

A land cover type represents the dominant features of the land surface and can be defined by natural vegetation, water, or human uses. Land cover types in the study area have been mapped and defined for numerous studies and documents. As a result, the definitions of the various land cover types vary slightly. For the purpose of this document, most land cover types were mapped by DFG (2000, 2004). Additional information on land cover types was reviewed in documents previously prepared for the Suisun Marsh region (California Department of Fish and Game, Wildlife Habitat Data Analysis Branch 2004; California Department of Water Resources 2001).

Historically Suisun Marsh consisted primarily of a mosaic of tidal wetland, dominated by saltgrass and pickleweed on the tidal plains and bulrushes along the slough margins (Suisun Marsh Ecological Workgroup 2001). The historic marshlands, bays, and sloughs were subject to daily tidal fluctuations and seasonal variations in water surface level resulting from inflows from the Sacramento and San Joaquin River systems.

Anthropogenic changes have affected the Marsh beginning with the use of fire by Native Americans to control the vegetation cover types. The most significant changes to the Marsh include the construction of dikes and ditches, the conversion of wetland habitat to agriculture and later to managed wetlands, sedimentation associated with hydraulic mining and other land uses that resulted in soil erosion, and the management of seasonal water inflow from Central Valley river systems.

In the study area, land cover types can be divided into natural vegetation communities, managed vegetation communities, aquatic communities, and developed land. The land cover types mapped in the study area are listed as habitat types in Table 6.2-2 and are discussed below. Table 6.2-2 also shows the extent of each habitat type as mapped throughout the study area. Waters of the United States have not been formally delineated as part of this plan. Waters of the United States, including wetlands, that are expected to fall under the jurisdiction of the Corps include bays and sloughs, tidal wetlands, and managed wetlands.

Bays and Sloughs

Bays and sloughs, as defined for this plan, include all areas of tidally influenced open water. Bays and sloughs make up approximately 25% of the total acreage in the study area (Table 6.2-2). Bays in the study area include the portions of Suisun and Honker Bay north of the Contra Costa County line, Grizzly Bay, and Little Honker Bay. Major sloughs in the study area are Suisun and Montezuma Sloughs. Minor sloughs are smaller channels that are hydrologically connected to the bays and major sloughs (Figure 5.6-3).

Bays and sloughs provide foraging habitat for several species of diving ducks, cormorants, grebes, and other waterfowl that are permanent residents or that winter in the study area. The upper reaches of the sloughs, composed of brackish or fresh water, provide foraging habitat for diving and dabbling ducks, other waterfowl species, kingfishers, and wading birds. Shallow freshwater aquatic areas provide rearing, escape cover, and foraging habitat for reptiles and amphibians and may be used as foraging habitat by river otter and raccoon.

Tidal Wetlands

Tidal wetlands in the study area consist of tidal wetlands that occur as relatively large tracts (complex tidal wetlands) or in narrow bands (fringing tidal wetlands), as described in Section 6.2, Vegetation and Wetlands.

Tidal wetlands are divided into three zones—low marsh, middle marsh, and high marsh. Historically, the high marsh was typically an expansive transitional zone between the tidal wetlands and adjacent uplands. The high marsh and associated upland transition zone have been affected significantly by land use changes (e.g., managed wetlands, agriculture).

The low tidal wetland occurs from the MLHW elevation to the MHW elevation. This zone receives tidal inundation once or twice per day. Plant zonation is influenced by inundation regime and salinity. The dominant plant species are hardstem bulrush and common bulrush. Other common species occurring in the low tidal wetland zone are pickleweed, low-club rush, common reed, and cattail (Suisun Marsh Ecological Workgroup 2001). The low tidal wetland zone provides foraging habitat for waterfowl and shorebirds, California clapper rail, California black rail, and other wading birds.

The middle tidal wetland occurs from MHW to MHHW. This zone receives tidal inundation at least once per day. Plant species composition and richness vary strongly with salinity and thus location in Suisun Marsh. Middle marsh elevations in brackish tidal wetlands often exhibit high plant species richness. The dominant plant species in this zone are pickleweed, saltgrass, and American bulrush. Other common species occurring in the middle tidal wetland are fleshy jaumea, sea milkwort, Baltic rush, salt marsh dodder, and alkali-heath, among others (Suisun Marsh Ecological Workgroup 2001; Conceptual Model 2010).

The middle tidal wetland zone provides foraging habitat for salt marsh harvest mouse and Suisun shrew, as well as common and special-status bird species, including waterfowl and shorebirds, California clapper rail, California black rail and other wading birds. This marsh zone also provides nesting and foraging habitat for Suisun song sparrow and salt marsh common yellowthroat.

The high tidal wetland occurs between approximately the MHHW elevation and the EHW elevation. This zone receives intermittent inundation during the monthly tidal cycle, with the higher elevations being inundated during only the highest tides. High tidal wetlands often accumulate the greatest portion of drift litter, which provides foraging and cover habitat for Suisun shrew (Conceptual Model 2010). The high tidal wetland provides escape cover for salt marsh harvest mouse and Suisun shrew, and California clapper rail during periods when the middle and lower portions of the high tidal wetland zone are inundated. The high marsh zone provides foraging and nesting habitat for special-status species such as salt marsh harvest mouse and Suisun shrew and provides foraging and nesting habitat for waterfowl, shorebirds, California clapper rail, California black rail, and other birds.

The upland transition occurs between the high wetland zone and adjacent uplands. This zone provides refuge for tidal wetland–dependent wildlife species during periods of extreme high tides and storm surges. It is generally dominated by a variety of plant species, including a mix of high tidal wetland zone species such as pickleweed and Baltic rush, as well as more upland species (Conceptual Model 2010).

Managed Wetlands

Managed wetlands are the most common land cover type in the study area, accounting for approximately 52,112 acres, or 51%, of the study area. The vegetation communities in the managed wetlands vary depending on the water management practices and the water source. In marshes with higher soil salinity, pickleweed, salt grass, and other salt-tolerant species are dominant. Alkali bulrush, cattail, and salt grass are common species in wetlands that use brackish water (California Department of Water Resources 2001; California Department of Fish and Game 2007). Watergrass and smartweed are typically the dominant species in managed wetlands that use fresher water. Pickleweed, fat hen, and brass buttons are common in the higher elevations of the managed wetlands. Other plant species that are important for waterfowl production and that occur in the managed wetlands are sea purslane, widgeongrass, sago pondweed, and swamp timothy.

Managed wetlands are a key component of the project site. The biodiversity of the Marsh can be attributed to the conservation efforts and long-term maintenance of the private and public lands.

Managed wetlands in the study area provide nesting, foraging, and wintering habitat for waterfowl and shorebirds and are managed to support waterfowl for hunting. Suisun Marsh is a key waterfowl wintering area in the Pacific Flyway (Suisun Marsh Ecological Workgroup 2001). Common wintering waterfowl include dabbling and diving ducks such as northern pintail (*Anas acuta*), mallard, green-winged teal (*Anas crecca*), American wigeon (*Anas americanus*), bufflehead (*Bucephala albeola*), and common goldeneye (*Bucephala clangula*) and geese such as white-fronted goose (*Anser albifrons*) and Canada goose (*Branta canadensis*). Managed wetlands provide nesting habitat for resident waterfowl, including mallard, pintail, cinnamon teal, northern shoveler, gadwall, and wood duck (California Department of Fish and Game 2007). Depending on the water management regime and time of year, shorebirds, waterfowl, and other wildlife depend on aquatic invertebrates found in this habitat.

Managed wetlands also provide foraging, nesting, and cover habitat for numerous wildlife species. Common resident and seasonal shorebirds include black-necked stilt (*Himantopus mexicanus*), American avocet (*Recurvirostra americanus*), black-bellied plover (*Pluvialus squatarola*), long-billed dowitcher (*Limnodromus scolopaceus*), long-billed curlew, greater yellowlegs, western sandpiper, and least sandpiper. Managed wetlands provide foraging habitat for several wading birds and water birds, including great blue heron, great egret, snowy egret, black-crowned night heron, double-crested cormorants, white pelicans, and American coot. Common passerine birds include Suisun song sparrow, Suisun common yellowthroat, marsh wren, red-winged blackbird, and Brewer’s blackbird (California Department of Fish and Game 2007). Raptors that use managed wetlands for breeding and roosting include short-eared owl (*Asio flammeus*) and white-tailed kite (*Elanus leucurus*).

Managed wetlands also provide nesting and foraging area for several special-status species. Species use of these wetlands is dependent on the vegetation communities and water management cycles with any given managed wetland. Special-status species that may use managed wetlands are salt marsh harvest mouse, Suisun shrew, California black rail, western pond turtle, Suisun song sparrow, and salt marsh common yellowthroat. Managed wetlands provide breeding and resting habitat for short-eared owl and white-tailed kite. Managed wetlands also provide ecotone habitat for migratory and resident songbirds. Additionally, they provide seasonal habitat for numerous other common wildlife species such as pheasant, tule elk, coyote, beaver, river otter, skunk, raccoon, black-tailed jackrabbit, and long-tailed weasel.

Riparian Habitat

Riparian habitat that has been mapped in the study area is limited to small narrow bands of vegetation along sections of Suisun Creek and several unnamed drainages in the northwest portion of Region 1. Riparian habitat cover varies greatly with the land use and environmental characteristics. Although riparian habitat has been mapped only in Region 1, it is anticipated that riparian vegetation also occurs in small isolated areas throughout the Marsh in areas with suitable water availability, soil textures, and soil salinity gradients. However, the overall riparian cover in Suisun Marsh is low.

Mature riparian vegetation provides suitable nesting and roosting habitat for raptors, nesting and foraging habitat for migratory and resident songbirds, and roosting habitat for bats. Smaller riparian trees and shrubs also provide nesting and foraging habitat for migratory and resident songbirds. Riparian habitat also provides cover for common wildlife species, including mammals, reptiles, and amphibians.

Uplands

Upland habitats that occur in the SMP area include grassland and ruderal areas adjacent to the tidal and managed wetlands, and areas on the perimeter of the Marsh that are within the primary management zone. Uplands in the Marsh comprise annual grasslands, native perennial grasslands, coyote brush, agricultural areas, and disturbed areas dominated by ruderal herbaceous vegetation associated with the managed wetlands and other developed areas within the Marsh.

Uplands provide valuable wildlife habitat for reptiles, amphibians, and small and large mammals and nesting and foraging habitat for waterfowl, raptors, and several species of resident and wintering songbirds. Uplands present within the Marsh provide an extremely important ecotone or buffer zone between urban areas and wetlands. Mallards are the most common breeding waterfowl in the upland nesting areas. Other waterfowl species that use uplands are Canada goose, gadwall, northern pintail, and cinnamon teal. Common mammals include tule elk, ground squirrels, pheasant, coyote, skunk, raccoon, and black-tailed jackrabbit. Raptors that use uplands for breeding and roosting include short-eared owl, white-tailed kite, and northern harrier (*Circus cyaneus*). Several other raptors forage in upland habitat, including northern harrier, white-tailed kite, red-tailed hawk, American kestrel, and great-horned owl. Uplands also provide foraging and haul-out areas for several aquatic wildlife species, potential nesting habitat for western pond turtles, and high tide refugia for mammals otherwise preferring marsh habitat, such as the salt marsh harvest mouse.

Seasonal Wetlands and Vernal Pools

Only small areas of seasonal wetland and vernal pool complexes remain, and grazing has degraded much of the habitat. The seasonal wetland and vernal pool complexes remaining in the study area occur in the northern and eastern portions of the study area. These seasonal wetland complexes occur in the Potrero Hills and the south limits of the Montezuma Hills. Vernal pool critical habitat has been identified in the Potrero Hills. Seasonal wetland and vernal pools occur outside the limits of the managed wetlands and are not expected to be affected by implementation of the SMP.

Vernal pools and seasonal wetlands provide habitat for several species of vernal pool invertebrates as well as California tiger salamander. These wetlands provide foraging habitat for waterfowl and wading birds when the wetlands are inundated. Other common species may include: American avocet, black-necked stilt, long- and short-billed dowitchers, greater yellowlegs, godwit, long-billed curlew, killdeer, sandpipers, coot, rails, swallows, phoebes, finches, loggerhead shrikes, sparrows, meadowlarks, pheasants, doves, larks, and blackbirds. Important habitat also exists for reptile and amphibians such as fence lizard, gopher snake, garter snake, and western toad.The surrounding uplands provide nesting, foraging, and cover habitat for waterfowl as well as several species of songbirds.

Developed Land

Developed land mapped in the plan area includes areas with roads and buildings but also barren areas that have been disturbed and are unvegetated. Developed areas may also include areas of ornamental landscaping. Although developed areas are not a naturally occurring habitat, they provide additional habitat diversity in the project area that is used for nesting and shelter by a variety of resident and migrating birds. Eucalyptus trees can provide nesting habitat and foraging perches for different raptors, including red-shouldered hawk (*Buteo lineatus*), American kestrel (*Falco sparverius*), white-tailed kite (*Elanus lecurus*), and great horned owl (*Buteo virginianus*). Human-made structures such as pump houses, duck clubs, barns and outbuildings found in the project area may offer protection to nesting barn owl (*Tyto alba*), swallows (*Hirundinidae*), black phoebe, and roosting bats.

Special-Status Species

Special-status wildlife species are defined as species that are legally protected under ESA, the California Endangered Species Act (CESA), or other regulations and species that are considered sufficiently rare by the scientific community to qualify for such listing. Special-status wildlife species are:

- listed or proposed for listing as threatened or endangered under ESA (50 CFR 17.11 [listed wildlife], and various notices in the FR [proposed species]);
- candidates for possible future listing as threatened or endangered under ESA (66 FR 54808, October 30, 2001);
- listed or proposed for listing by the State of California as threatened or endangered under CESA (14 CCR 670.5);
- identified as species of general concern that have the potential to occur in the plan area because suitable or marginal habitat may exist for those species;
- identified as species of special concern to the DFG and Special Animals list (California Department of Fish and Game 2009) (mammals) that have the potential to occur in the plan area because suitable or marginal habitat may exist for those species;
- identified as species determined to meet the definitions of rare or endangered under CEQA (State CEQA Guidelines, Section 15380); or
- fully protected under California Fish and Game Code Section 3511(birds), Section 4700 (mammals), Section 5515 (fish), and Section 5050 (reptiles and amphibians).

This section provides a summary of the special-status species analysis for the study area. Special-status species that have the potential to occur in the study area were determined through a review of various sources, including a USFWS species list and the CNDDB (Table 6.3-2). Those species that are likely to occur in the study area and would be affected by SMP actions are further evaluated in this section. Those species that occur in habitats in the study area but would not be affected by SMP actions are not further evaluated in this section. For example, vernal pool–dependent species and several bat species are known to occur in the study area but will not be evaluated because habitat for these species would not be affected. Appendix D includes maps showing the locations of all CNDDB records for special-status species by Region in the study area.

Table 6.3-2. Special-Status Wildlife Species with the Potential to Occur in the Study Area

Species Name	Status[1] Fed/State	Distribution	Habitat	Likelihood of Occurrence in the Study Area	Proposed for Evaluation in the EIR
MAMMALS					
Salt marsh harvest mouse *Reithrodontomys raviventris*	CE, FP	San Francisco, San Pablo, and Suisun Bays; western edge of the Delta.	Salt marshes with a dense plant cover of pickle-weed and fat hen; adjacent to an upland site.	Species observed in the study area. Suitable habitat in the study area.	Yes
San Joaquin kit fox *Vulpes macrotis mutica*	E/CT	Principally occurs in the San Joaquin Valley and adjacent open foothills to the west; recent records from 17 counties extending from Kern County to Contra Costa County.	Saltbush scrub, grassland, oak, savanna, and freshwater scrub.	Outside the species known range. No suitable habitat in the study area.	No
Suisun shrew *Sorex ornatus sinuosus*	–/CSC	Restricted to San Pablo Bay and Suisun Bay, both in Solano County.	Tidal, salt, and brackish marshes containing pickleweed, grindelia, bulrushes, or cattails; requires driftwood or other objects for nesting cover.	Species observed in the study area. Suitable habitat in the study area.	Yes
Western red bat *Lasiurus blossevillii*	–/CSC	Central and coastal California	Roosts in trees in forests or in scattered trees in grasslands	Species observed in the study area. Suitable habitat in the study area.	No
Townsend's Big-eared bat *Corynorhinus townsendii*	–/CSC	Western United States, northward to British Columbia, as far east as the Rocky Mountain States from Idaho to Texas, including Kansas and Oklahoma, and there are also populations in Arkansas, Missouri, Kentucky, Virginia, and West Virginia		One record in study area.	No
Hoary bat *Lasiurus cinerus*	–/CSC	Forested areas throughout most of California	Roosts in trees; typically in forests	One historic record in study area. May occur in study area during migration	No

Species Name	Status[1] Fed/State	Distribution	Habitat	Likelihood of Occurrence in the Study Area	Proposed for Evaluation in the EIR
BIRDS					
California black rail *Laterallus jamaicensis coturniculus*	/CT, FP	Permanent resident in the San Francisco Bay and east-ward through the Delta into Sacramento and San Joaquin Counties; small populations in Marin, Santa Cruz, San Luis Obispo, Orange, Riverside, and Imperial Counties.	Tidal salt marshes associated with heavy growth of *Scirpus americanus* and pickleweed; also occurs in brackish marshes or freshwater marshes at low elevations.	Species observed in the study area. Suitable habitat present in the study area.	Yes
California brown pelican *Pelecanus occidentalis californicus*	E/CE, FP	Present along the entire coastline, but does not breed north of Monterey County; extremely rare inland.	Typically in littoral ocean zones, just outside the surf line; nests on offshore islands.	May occur rarely in study area. Suitable foraging habitat in the study area.	No
California clapper rail *Rallus longirostris obsoletus*	E/CE, FP	Marshes around the San Francisco Bay and east through Suisun Marsh.	Restricted to salt marshes and tidal sloughs; usually associated with heavy growth of pickle-weed; feeds on mollusks removed from the mud in sloughs.	Species observed in the study area. Suitable habitat in the study area.	Yes
California least tern *Sterna antillarum browni*	E/CE, FP	Nests on beaches along the San Francisco Bay and along the southern California coast from southern San Luis Obispo County south to San Diego County.	Nests on sandy, upper ocean beaches, and occasionally uses mudflats; forages on adjacent surf line, estuaries, or the open ocean.	Species observed in the study area. Suitable habitat in the study area.	Yes
Cooper's hawk *Accipiter cooperii*	/–	Throughout California except high altitudes in the Sierra Nevada. Winters in the Central Valley, southeastern desert regions, and plains east of the Cascade Range.	Nests in a wide variety of habitat types, from riparian woodlands and digger pine-oak woodlands through mixed conifer forests.	May occur during migration or winter. Suitable foraging habitat present in the study area.	No
Ferruginous hawk *Buteo regalis*	/CSC	Does not nest in California; winter visitor along the coast from Sonoma County to San Diego County, east-ward to the Sierra Nevada foothills and south-eastern deserts, the Inyo-White Mountains, the plains east of the Cascade Range, and Siskiyou County.	Open terrain in plains and foothills where ground squirrels and other prey are available.	May occur during migration or winter. Suitable foraging habitat present in the study area.	No

Species Name	Status[1] Fed/State	Distribution	Habitat	Likelihood of Occurrence in the Study Area	Proposed for Evaluation in the EIR
Great blue heron (rookery) *Ardea herodias*	–/SB	Common throughout most of California, less common mountains above the foothills.	Occurs in shallow estuaries and fresh and saline emergent wetlands, ponds and other slow moving waterways. Nests in colonies in tops of large snags or live trees.	Rookery sites present in the study area; however project actions would not affect this species because mature trees will not be removed and nearby work will occur outside the nesting season.	No
Northern harrier *Circus cyaneus*	/CSC	Occurs throughout lowland California. Has been recorded in fall at high elevations.	Grasslands, meadows, marshes, and seasonal and agricultural wetlands.	Species known to occur in the study area.	Yes
Saltmarsh common yellowthroat *Geothlypis trichas sinuosa*	/CSC	Found only in the San Francisco Bay Area in Marin, Napa, Sonoma, Solano, San Francisco, San Mateo, Santa Clara, and Alameda Counties.	Freshwater marshes in summer and salt or brackish marshes in fall and winter; requires tall grasses, tules, and willow thickets for nesting and cover.	Species observed in the study area. Suitable habitat in the study area.	Yes
Short-eared owl *Asio flammeus*	/CSC	Permanent resident along the coast from Del Norte County to Monterey County although very rare in summer north of San Francisco Bay, in the Sierra Nevada north of Nevada County, in the plains east of the Cascades, and in Mono County; small, isolated populations.	Freshwater and salt marshes, lowland meadows, and irrigated alfalfa fields; needs dense tules or tall grass for nesting and daytime roosts.	Species observed in the study area. Suitable habitat in the study area.	Yes
Snowy egret (rookery) *Egretta thula*	–/SB	Occurs in the Central Valley, coastal lowlands, on the northeastern plateau and in the Imperial Valley.	Occurs in shallow estuaries and fresh and saline emergent wetlands, ponds and other slow moving waterways. Nests in colonies in tops of large snags or live trees.	Rookery sites present in the study area; however project actions would not affect this species because mature trees will not be removed and nearby work will occur outside the nesting season.	No

Species Name	Status[1] Fed/State	Distribution	Habitat	Likelihood of Occurrence in the Study Area	Proposed for Evaluation in the EIR
Suisun song sparrow *Melospiza melodia maxillaris*	/CSC	Restricted to the extreme western edge of the Delta, between the cities of Vallejo and Pittsburg near Suisun Bay.	Brackish and tidal marshes supporting cattails, tules, various sedges, and pickleweed.	Species observed in the study area. Suitable habitat in the study area.	Yes
Swainson's hawk *Buteo swainsoni*	/CT	Lower Sacramento and San Joaquin Valleys, the Klamath Basin, and Butte Valley. Highest nesting densities occur near Davis and Woodland, Yolo County.	Nests in oaks or cottonwoods in or near riparian habitats. Forages in grasslands, irrigated pastures, and grain fields.	Species observed in the study area. Suitable habitat present in the study area.	Yes
Tricolored blackbird *Agelaius tricolor*	/CSC	Permanent resident in the Central Valley from Butte County to Kern County. Breeds at scattered coastal locations from Marin County south to San Diego County; and at scattered locations in Lake, Sonoma, and Solano Counties. Rare nester in Siskiyou, Modoc, and Lassen Counties.	Nests in dense colonies in emergent marsh vegetation, such as tules and cattails, or upland sites with blackberries, nettles, thistles, and grainfields. Habitat must be large enough to support 50 pairs. Probably requires water at or near the nesting colony.	Species observed in the study area. Suitable habitat present in the study area.	Yes
Western burrowing owl *Athene cunicularia hypugea*	/CSC	Lowlands throughout California, including the Central Valley, northeastern plateau, southeastern deserts, and coastal areas. Rare along south coast.	Level, open, dry, heavily grazed or low stature grassland or desert vegetation with available burrows.	Species observed in the study area.	Yes
White-tailed kite *Elanus leucurus*	/FP	Lowland areas west of Sierra Nevada from the head of the Sacramento Valley south, including coastal valleys and foothills to western San Diego County at the Mexico border.	Low foothills or valley areas with valley or live oaks, riparian areas, and marshes near open grasslands for foraging.	Suitable habitat present in the study area.	Yes
REPTILES					
Alameda whipsnake *Masticophis lateralis euryxanthus*	T/CT	Restricted to Alameda and Contra Costa Counties; fragmented into 5 disjunct populations throughout its range.	Valleys, foothills, and low mountains associated with northern coastal scrub or chaparral habitat; requires rock outcrops for cover and foraging.	Outside the species known range.	No
Alameda whipsnake critical habitat				Outside the species known range.	No

Species Name	Status[1] Fed/State	Distribution	Habitat	Likelihood of Occurrence in the Study Area	Proposed for Evaluation in the EIR
Giant garter snake *Thamnophis gigas*	T/CT	Central Valley from the vicinity of Burrel in Fresno County north to near Chico in Butte County; has been extirpated from areas south of Fresno.	Sloughs, canals, low gradient streams and freshwater marsh habitats where there is a prey base of small fish and amphibians; also found in irrigation ditches and rice fields; requires grassy banks and emergent vegetation for basking and areas of high ground protected from flooding during winter.	Outside the species range. No suitable habitat in the study area.	No
Western pond turtle *Clemmys marmorata*	/CSC	Northwestern subspecies occurs from the Oregon border of Del Norte and Siskiyou Counties south along the coast to San Francisco Bay, inland through the Sacramento Valley, and on the western slope of Sierra Nevada. Southwestern subspecies occurs along the central coast of California east to the Sierra Nevada and along the southern California coast inland to the Mojave and Sonora Deserts; range overlaps with that of the northwestern pond turtle throughout the Delta and in the Central Valley.	Occupies ponds, marshes, rivers, streams, and irrigation canals with muddy or rocky bottoms and with watercress, cattails, water lilies, or other aquatic vegetation in woodlands, grasslands, and open forests. Woodlands, grasslands, and open forests; aquatic habitats, such as ponds, marshes, or streams, with rocky or muddy bottoms and vegetation for cover and food.	Species observed in the study area. Suitable habitat present in the study area.	Yes
AMPHIBIANS					
California red-legged frog *Rana aurora draytonii*	T/CSC	Found along the coast and coastal mountain ranges of California from Marin County to San Diego County and in the Sierra Nevada from Tehama County to Fresno County.	Permanent and semipermanent aquatic habitats, such as creeks and cold-water ponds, with emergent and submergent vegetation. May aestivate in rodent burrows or cracks during dry periods.	No suitable habitat in the study area.	No
California tiger salamander *Ambystoma californiense*	T/CSC	Central Valley, including Sierra Nevada foothills, up to approximately 1,000 feet, and coastal region from Butte County south to northeastern San Luis Obispo County.	Small ponds, lakes, or vernal pools in grass-lands and oak woodlands for larvae; rodent burrows, rock crevices, or fallen logs for cover for adults and for summer dormancy.	No suitable habitat in the study area.	No

Species Name	Status[1] Fed/State	Distribution	Habitat	Likelihood of Occurrence in the Study Area	Proposed for Evaluation in the EIR
INVERTEBRATES					
Antioch Dunes anthicid beetle *Anthicus anthiochensis*	/–	Population in Antioch Dunes believed extinct; Now known only from Grand Island and in and around Sandy Beach County Park, Sacramento County.	Loose sand on sand bars and sand dunes.	No suitable habitat in the study area.	No
Callippe silverspot *Speyeria callippe callippe*	E/–	San Bruno Mountain, San Mateo County, and a single location in Alameda County.	Open hillsides where wild pansy (*Viola pedunculata*) grows; larvae feed on Johnny jump-up plants, whereas adults feed on native mints and non-native thistles.	No suitable habitat in the study area.	No
Conservancy fairy shrimp *Branchinecta conservatio*	E–	Disjunct occurrences in Solano, Merced, Tehama, Ventura, Butte, and Glenn Counties.	Large, deep vernal pools in annual grasslands.	Suitable habitat present in the study area. Vernal pools will not be affected by the project.	No
Conservancy fairy shrimp Critical habitat *Branchinecta conservatio*	E/–			North of Potrero Hills in Secondary Management Area. Critical habitat would not be affected by the project.	No
Delta green ground beetle *Elaphrus viridis*	T/–	Solano County	Vernal pools in annual grasslands.	Outside the species known range.	No
Delta green ground beetle Critical habitat *Elaphrus viridis*				Study area is not within the area designated as critical habitat.	No
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T/–	Streamside habitats below 3,000 feet throughout the Central Valley.	Riparian and oak savanna habitats with elderberry shrubs; elderberries are the host plant.	Outside species range.	No
Valley elderberry longhorn beetle critical habitat *Desmocerus californicus dimorphus*				Study area is not within the area designated as critical habitat.	No

Species Name	Status[1] Fed/State	Distribution	Habitat	Likelihood of Occurrence in the Study Area	Proposed for Evaluation in the EIR
Vernal pool fairy shrimp *Branchinecta lynchi*	T/–	Central Valley, central and south Coast Ranges from Tehama County to Santa Barbara County. Isolated populations also in Riverside County.	Common in vernal pools; also found in sandstone rock outcrop pools.	Suitable habitat present in the study area. Vernal pools will not be affected by the project.	No
Vernal pool fairy shrimp critical habitat				In Potrero Hills in Secondary Management Area. Critical habitat would not be affected by the project.	No
Vernal pool tadpole shrimp *Lepidurus packardi*	E/–	Shasta County south to Merced County.	Vernal pools and ephemeral stock ponds.	Suitable habitat present in the study area. Vernal pools will not be affected by the project.	No
Vernal pool tadpole shrimp critical habitat				In Potrero Hills in Secondary Management Area. Critical habitat would not be affected by the project.	No
California freshwater shrimp *Syncaris pacifica*	E/CE	Marin, Napa, and Sonoma Counties.	Perennial freshwater streams	No suitable habitat in the study area.	No

Species listed in table are generated from the U.S. Fish and Wildlife Service (USFWS) project species list, California Department of Water Resources (DWR) field survey data, and California Natural Diversity Database (CNDDB) records. Species shown in highlight are species covered under the CALFED Bay-Delta Program (CALFED) programmatic biological opinions and the Natural Community Conservation Plan (NCCP) determination.

[1] Status:

Federal

E = Listed as endangered under the federal Endangered Species Act (ESA).

T = Listed as threatened under ESA.

– = No federal status.

State

CE = Listed as endangered under the California Endangered Species Act (CESA).

CT	=	Listed as threatened under CESA.
CSC	=	California species of special concern.
FP	=	Fully protected under California Fish and Game Code.
SB	=	Specified birds under California Fish and Game Code.
–	=	No state status.

Special-Status Species in the Study Area

The following sections describe special-status species that are known or are likely to occur in the study area. The following information is provided for each species:

- habitat requirements,
- suitable land cover types (habitats) available for each species in the study area,
- surveys performed for the species in the study area, and
- status of each species in the study area.

The special-status species listed in Table 6.3-2 include 14 species that are likely to occur or have been observed in the study area. Several of these species are known to occur in the study area. The other species are not known to occur in the study area, but they historically have occurred in the study area, and the study area contains breeding or nonbreeding habitat for these species. Table 6.3-3 identifies the habitat types used by each of these species in the study area.

The 14 species with potential to occur in the study area are:

- salt marsh harvest mouse,
- California clapper rail,
- California black rail,
- Suisun shrew,
- California least tern,
- Suisun song sparrow,
- salt marsh common yellowthroat,
- western pond turtle,
- tricolored blackbird,
- western burrowing owl,
- short-eared owl,
- northern harrier,
- white-tailed kite, and
- Swainson's hawk.

Managed wetlands were designed primarily to preserve and enhance habitat for migratory waterfowl; however, they also provide ancillary benefits for other wildlife and wetland-dependent species (e.g., salt marsh harvest mouse, Suisun shrew, short-eared owl). Much of the public land within the Marsh, including

Grizzly Island Wildlife Area, is managed to conserve and enhance diversity among all wildlife, fish, and special-status species. Table 6.3-3, below, shows all the special-status species in the Marsh and which habitats they use. Table 6.3-4 identifies the season in which special-status species are known to occur in the study area.

Table 6.3-3. Habitat Preferences of Special-Status Wildlife Species in Suisun Marsh

	Habitat									
		Tidal Wetland								
Species	Bays and Sloughs	Low Tidal Zone	Middle Tidal Zone	High Tidal Zone	Upland Transition Zone[2]	Managed Wetland	Upland	Riparian	Seasonal Wetland and Vernal Pool	Developed
Western pond turtle[1]	R, F, B	–	–	–	–	R, F, B	R, B	–	–	–
Salt marsh harvest mouse	–	–	R, F, B	R, F, B	R	R, F, B	–	–	–	–
Suisun shrew	–	–	R, F, B	R, F, B	R, F, B	R, F, B	–	–	–	–
California clapper rail	–	F	R, F, B	R, F, B	R	–	–	–	–	–
California black rail	–	–	F	R, F, B	R	R, F, B	–	–	–	–
California least tern[3]	F	F	F	F	R, B	F	R, B	–	–	–
Suisun song sparrow	–	F	R, F, B	R, F, B	R	R, F, B	F	–	–	–
Salt marsh common yellowthroat	–	F	R, F, B	R, F, B	R	R, F, B	–	–	–	–
Tricolored blackbird	–	–	–	R,F, B	–	R, F, B	F	R, F	–	–
Western burrowing owl	–	–	–	–	–	–	R, F, B	–	–	–
Short-eared owl	–	–	–	F	F	F	R, F, B	–	–	–
Northern harrier	–	–	–	F	F	R, F, B	R, F, B	–	–	–
White-tailed kite	–	–	–	–	–	R, F, B	R, F, B	R, B	–	–
Swainson's hawk	–	–	–	–	–	–	F	R, B	–	–

Source: Information obtained from Goals Project 1999 (additional information provided by ICF International).

R: resting

F: foraging

B: breeding

[1] Western pond turtle are restricted to freshwater portions of sloughs.

[2] The upland transition zone provides refugia from high water events for several species.

[3] California least tern may forage in tidal wetlands when they are inundated.

Table 6.3-4. Wildlife Life Stage Timing in Suisun Marsh

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Salt Marsh Harvest Mouse												
Breeding and Rearing			■	■	■	■	■	■	■	■	■	
Foraging	■	■	■	■	■	■	■	■	■	■	■	■
California Clapper Rail												
Breeding and Rearing		■	■	■	■	■	■	■				
Foraging	■	■	■	■	■	■	■	■	■	■	■	■
California Black Rail												
Breeding and Rearing			■	■	■	■	■					
Foraging	■	■	■	■	■	■	■	■	■	■	■	■
Suisun Shrew												
Breeding and Rearing				■	■	■	■	■	■	■		
Foraging	■	■	■	■	■	■	■	■	■	■	■	■
California Least Tern												
Breeding and Rearing					■	■	■	■				
Foraging					■	■	■	■				
Suisun Song Sparrow												
Breeding and Rearing			■	■	■	■	■					
Foraging	■	■	■	■	■	■	■	■	■	■	■	■
Salt Marsh Common Yellowthroat												
Breeding and Rearing			■	■	■	■	■					
Foraging	■	■	■	■	■	■	■	■	■	■	■	■
Tricolored Blackbird												
Breeding and Rearing			■	■	■	■	■					
Foraging	■	■	■	■	■	■	■	■	■	■	■	■
Western Pond Turtle												
Breeding and Rearing				■	■	■	■					
Foraging	■	■	■	■	■	■	■	■	■	■	■	■
Waterfowl (Managed Wetland Spp.)												
Breeding and Rearing			■	■	■	■	■	■				
Foraging	■	■	■	■	■	■	■	■	■	■	■	■
Shorebirds												
Breeding and Rearing				■	■	■	■	■				
Foraging	■	■	■	■	■	■	■	■	■	■	■	■
Raptors												
Breeding and Rearing		■	■	■	■	■	■	■				
Foraging	■	■	■	■	■	■	■	■	■	■	■	■

Sources: Marschalek 2007; Suisun Ecological Workshop 2001.

Salt Marsh Harvest Mouse

Salt marsh harvest mouse (*Reithrodontomys raviventris* ssp. *raviventris*) is federally and state-listed as endangered (FR 35:16047; October 13, 1970) and is fully protected under Fish and Game code. Critical habitat has not been designated for this species. The northern subspecies inhabits the Suisun Bay and San Pablo Bay regions. A recovery plan for this species was prepared by the USFWS in 1984 and updated in the Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California in 2010 (U.S. Fish and Wildlife Service 2010b).

Thirteen areas on state lands have been set aside in the Marsh, totaling more than 2,500 acres, to conserve habitat for salt marsh harvest mouse and other wetland dependent species. The salt marsh harvest mouse preserves are Peytonia Slough; Hill Slough West Ponds 1, 2, 4, and 4A; Hill Slough East Areas 8 and 9; a portion of Joice Island, Crescent Unit, a portion of Lower Joice Island; Blacklock; and Grizzly Island Ponds 1 and 15. Mitigation areas are Island Slough Ponds 4 and 7.

Salt marsh harvest mice are dependent on dense cover, including that provided by pickleweed- or non-pickleweed-dominated mixed wetlands. Mixed stands of native salt marsh vegetation dominated by pickleweed have higher habitat value than pure stands (Conceptual Model 2010). As such, habitat complexity in the form of other halophytes such as chairmaker’s bulrush, fat hen, alkali heath, and other species that provide vertical habitat complexity is also preferred (U.S. Fish and Wildlife Service 1984). Studies by DFG have identified that salt marsh harvest mouse populations in Suisun Marsh frequently used bulrush (Sustaita et al. 2010). Salt marsh harvest mice use the higher tidal wetland and upland transitional zone as ecape cover from high tides. Nests are minimal and constructed of loose grass and vegetative matter that is placed on the ground or over old bird nests (U.S. Fish and Wildlife Service 1984). Harvest mice feed on vegetation and seeds as well as insects (Jameson 1988).

There are 42 documented CNDDB occurrences of salt marsh harvest mouse in the Marsh (California Natural Diversity Database 2010) (Appendix D). This species has been observed in tidal wetlands and along sloughs as well as within managed wetlands. Suitable habitat for harvest mice in the managed wetlands, in terms of halophytic species, typically occurs at the higher elevations in the wetlands or in wetlands with higher soil salinity.

Suisun Shrew

Suisun shrew (*Sorex ornatus sinuosus*) is a state species of special concern (California Natural Diversity Database 2010). There is no federal listing for this species, and critical habitat has not been designated.

Suisun shrews occur in tidal wetlands in Suisun Bay, Grizzly Island, and San Pablo Bay (Jameson 1988). Suisun shrews require areas of fairly constant soil moisture with dense, low-lying plant cover, and abundant invertebrates (Conceptual Model 2010). This species occupies the same middle and high marsh zone habitat as the salt marsh harvest mouse (Williams 1986). Driftwood and organic litter above the high tide inundation zone may be used for nesting and foraging. Suisun shrews excavate or may use existing subterranean burrows as movement corridors and for foraging (California Department of Water Resources 2001). Suisun shrews use the higher tidal wetland zones and upland transition zones as escape cover from high tides. Suisun shrews feed on invertebrates and small crustaceans (Jameson 1988).

There are six documented CNDDB occurrences of Suisun shrew in the study area (California Natural Diversity Database 2010) (Appendix D). This species has been observed in tidal wetlands and in managed wetlands. Occurrences were documented in Grizzly Island, Cordelia Salt Marsh, Cutoff Slough, Hill Slough, and Suisun Slough.

California Clapper Rail

California clapper rail (*Rallus longirostris obsoletus*) is federally and state-listed as endangered (FR 35:16047; October 13, 1970) and is also a fully protected species under Fish and Game Code Section 3511. Critical habitat has not been designated for this species. A recovery plan for this species was prepared by the USFWS in 1984 and updated in the Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California in 2010 (U.S Fish and Wildlife Service 2010b).

Historically, the salt marshes of San Francisco Bay supported the largest populations of California clapper rail in the state. Populations also were recorded in coastal marshes from San Luis Obispo County to Humboldt County. Presently, this species is known to occur only in the marshes of San Francisco Bay, San Pablo Bay, and Suisun Bay.

California clapper rails occur in tidal saline and brackish sloughs and tidal wetlands (U.S. Fish and Wildlife Service 1984) typically dominated by pickleweed and other halophytic species. Clapper rails are most often found in larger marshes and close to other large marshes and prefer marshes with established vegetative cover. Habitat that has direct tidal circulation, abundant high marsh cover, and an intricate network of tidal sloughs that provide abundant invertebrate populations is preferred. Other factors that affect rail use of tidal wetlands are inundation regime, access to high ground refugia, salinity, and vegetation communities (Conceptual Model 2010).

In the study area, the California clapper rail historically has been restricted to the western, more saline portions of Suisun Marsh. The intertidal zone may provide marginal foraging habitat for California clapper rail. The low and middle tidal wetland zones may be used for foraging and refugial habitat. High tidal wetland zones provide optimal foraging, refugial, and nesting habitat. The upland transition zone provides escape cover from high tides (Conceptual Model 2010).

Nests are located in dense wetland vegetation and are constructed off the ground and above the high tide elevation. The nests typically are constructed of cordgrass or other vegetation and are capped with vegetation (Lewis and Garrison1983). California clapper rails feed primarily on mollusks, crustaceans, and aquatic and terrestrial invertebrates along tidal sloughs and marshes. California clapper rails in the study area are found primarily in vegetation that includes bulrush, cattail, and silverweed (*Potentilla anserina*) (California Department of Fish and Game 2000, 2004).

There are 14 documented CNDDB occurrences of California clapper rail in the study area (California Natural Diversity Database 2010) (Appendix D). This species has been detected at several locations in Suisun Marsh, including occurrences along Suisun Slough, Cutoff Slough, Hill Slough, Goodyear Slough, and Ryer Island. As few as four clapper rails were detected in the study area during the breeding season in seven survey years from 2002 to 2008; however, eight were detected during the fall of the same years (California Department of Fish and Game 2007; unpublished California Department of Fish and Game survey 2008). Surveys conducted by DFG in 2006 identified two clapper rail occurrences in the Marsh and three occurrences near Point Edith on the south side of Grizzly Bay. The two occurrences in the Marsh were from First Mallard Slough (California Department of Fish and Game 2007).

California Black Rail

California black rail (*Laterallus jamaicensis coturniculus*) is state-listed as threatened (California Natural Diversity Database 2010) and is also a fully protected species under Fish and Game Code Section 3511. There is no federal listing for this species, and critical habitat has not been designated. California black rails are small birds, approximately the size of a sparrow, and are year-round residents of the study area.

California black rails occur along tidal sloughs, brackish marsh, and tidal wetlands and typically occur in marshes dominated by pickleweed or low-growing forms of bulrush (Manolis 1978). California black rails are associated with habitat features representative of mature, well-developed marshes. Black rails most often are found in larger marshes and close to other large marshes. California black rails require high marshes with moist soil and shallow water. Other factors that affect black rail use of tidal wetlands are inundation regime and marsh geomorphology, stable water levels that seldom flood, dense stands of low growing vegetation, and access to high-ground refugia (Conceptual Model 2010).

Diked marshes do not appear to provide suitable breeding habitat, possibly because they have lower food resource levels than tidal wetlands (Manolis 1978). California black rail nests are located in the high marsh zone and occasionally the upper limits of the middle marsh zone above the limits of tidal inundation. Nests are constructed of loosely placed vegetation concealed in dense marsh vegetation. California black rails feed primarily on invertebrates.

California black rails occur primarily in tidal salt marshes in the northern San Francisco Bay region, including the Delta, Suisun Bay, and San Pablo Bay. Smaller populations occur in San Francisco Bay, coastal Marin County, freshwater marshes of the Sierra Nevada, and along the lower Colorado River (Spautz et al. 2005). Surveys conducted in the San Francisco Bay region in 1977 identified 32 occurrences, 22 in the San Pablo Bay region and 7 in the Suisun Bay region (Manolis 1978). Surveys conducted in 2001 (Spautz et al. 2005) estimated the black rail population in the Suisun Bay region to be approximately 12,000 (range 6,700–17,200).

There are 18 documented CNDDB occurrences of California black rail in the study area (California Natural Diversity Database 2010) (Appendix D). These occurrences were from Peytonia, Cutoff, Hill, Goodyear, Suisun, Denverton, and Boynton Sloughs, and Roe and Ryer Islands. The vegetation communities associated with these occurrences were tidal brackish marsh dominated by pickleweed, bulrush, and other halophytes. Breeding season surveys conducted in 2006 identified 60 occurrences of California black rail in the study area (California Department of Fish and Game 2007).

California Least Tern

California least tern (*Sternula antillarium browni*) is federally and state-listed as endangered (California Natural Diversity Database 2010) and is also fully protected underFish and Game code. USFWS recommends changing the California least tern's status to threatened (U.S. Fish and Wildlife Service 2007). Critical habitat has not been designated for this species. The USFWS published a recovery plan for this species in 1985 (U.S. Fish and Wildlife Service 1985).

California least tern occurs along the Pacific Coast from San Francisco Bay to Baja California. These birds forage by hovering over and diving into water to catch fish, shrimp, and sometimes other invertebrates (U.S. Fish and Wildlife Service 2007). They forage over shallow to deep water, and also may skim tidal pools on mudflats to capture prey. Nests consist of shallow scrapes in sand or fine substrate gravel with sparse vegetation near open water along coastal beaches and estuaries (U.S. Fish and Wildlife Service 1985).

There is one documented CNDDB occurrence of California least tern in the study area (California Natural Diversity Database 2010) (Appendix D). A breeding colony was located on the east side of Montezuma Slough near Collinsville in 2006 at a dredge spoils disposal site.

Suisun Song Sparrow

Suisun song sparrow (*Melospiza melodia maxillaris*) is a state species of special concern (California Natural Diversity Database 2010). There is no federal listing for this species, and critical habitat has not been designated. The Suisun song sparrow is a distinct subspecies of song sparrows and is completely endemic to Suisun Bay (Conceptual Model 2010).

Suisun song sparrows are permanent residents and generally favor well-developed middle and high marsh zones characterized by bulrush, cattail, and other emergent marsh vegetation. Suisun song sparrow also has been observed in distribution channels, permanent ponds, and other managed wetlands within the study area that provide the required vegetation communities and brackish water conditions (Conceptual Model 2010). Suisun song sparrow nests are located in the marsh vegetation above the limits of tidal inundation. Suisun song sparrows forage on the ground and on the mudflats in the high marsh zone. Their diet consists of invertebrates and seeds (California Department of Water Resources 2001).

There are 19 documented CNDDB occurrences of Suisun song sparrow in the study area (California Natural Diversity Database 2010) (Appendix D). Several hundred Suisun song sparrows were detected in 2005 during point count surveys at eight locations in the study area (Liu et al. 2005). This species has been observed in tidal wetlands and in managed wetlands.

Salt Marsh Common Yellowthroat

Salt marsh common yellowthroat (*Geothylpis trichus sinuosa*) is a state species of special concern (California Natural Diversity Database 2010). There is no federal listing for this species, and critical habitat has not been designated. The salt marsh common yellowthroat is one of four subspecies that occur in California. The range of this subspecies includes Tomales Bay to the north, Suisun Bay to the east and Santa Cruz County to the south (Foster 1977).

Salt marsh common yellowthroats are permanent residents and occur in tidal and brackish marshes and managed wetlands in the study area. This species occupies marshes characterized by bulrush, cattail, pickleweed, and other emergent marsh vegetation. Salt marsh common yellowthroat nests are located in the marsh vegetation above the limits of tidal inundation. Salt marsh common yellowthroat is insectivorous and forages in emergent wetland vegetation. Their diet consists of invertebrates and seeds (California Department of Water Resources 2001).

There are 13 documented CNDDB occurrences of salt marsh common yellowthroat in the study area (California Natural Diversity Database 2010) (Appendix D). In addition to the CNDDB records, several hundred salt marsh common yellowthroat were observed during breeding bird surveys performed by the Point Reyes Bird Observatory (PRBO) between 2003 and 2006 (Point Spautz et al. 2003; Herzog et al. 2004; Liu et al. 2006; Liu et al. 2007). Several hundred salt marsh common yellowthroat were observed in 2005 during point count surveys at eight locations in the study area (Point Reyes Bird Observatory 2006). This species has been observed in tidal wetlands and in managed wetlands throughout the study area.

Western Pond Turtle

Western pond turtle (*Actinemys marmorata*) is a state species of special concern (California Natural Diversity Database 2010). There is no federal listing for this species, and critical habitat has not been designated.

Western pond turtles inhabit permanent or nearly permanent waters with little or no current and suitable salinity gradients (Behler and King 1998). The channel banks of inhabited waters usually have thick vegetation, but basking sites such as logs, rocks, or open banks also must be present (Zeiner et al. 1988). In Suisun Marsh, the upper reaches of tidal sloughs and the managed wetlands provide suitable habitat. Eggs are laid in nests in upland areas. Nest sites typically are found on a slope that is unshaded and has a high clay or silt composition and in soil at least 4 inches deep (Jennings and Hayes 1994).

Although there are only two documented CNDDB occurrences of western pond turtles in the study area (California Natural Diversity Database 2010) (Appendix D), this species is common and is known to occur in suitable habitat (e.g., permanently flooded water supply ditches).

Tricolored Blackbird

Tricolored blackbird (*Agelaius tricolor*) is a state species of special concern (California Natural Diversity Database 2010). There is no federal listing for this species, and critical habitat has not been designated.

Tricolored blackbirds are permanent residents of the Sacramento–San Joaquin Valley. This species nests in colonies in large, dense stands of tule, cattail, Himalayan blackberry thickets, and fallow fields (California Department of Water Resources 2001). Suitable nesting habitat in extensive stands of emergent wetland vegetation is associated with tidal and brackish wetlands and managed wetlands. Tricolored blackbirds feed on insects and seeds and may forage in agricultural and pasture lands, grasslands, and the margins of managed wetlands in the study area.

There is one historical documented CNDDB occurrence of tricolored blackbird in the Region 2 of the study area (Appendix D). This occurrence is now believed to be extirpated (California Natural Diversity Database 2010). Tricolored blackbirds were observed in the Potrero Hills in 2000 and 2003 (Solano County 2006). Approximately 200 birds also were observed at Rush Ranch in 2008.

Western Burrowing Owl

Western burrowing owl (*Athene cunicularia*) is a state species of special concern (California Natural Diversity Database 2010). There is no federal listing for this species, and critical habitat has not been designated.

Western burrowing owls are permanent residents in the study area. Suitable habitat occurs in upland habitats and in the vicinity of agricultural lands throughout the study area. The western burrowing owl nests and roosts in abandoned ground squirrel and other small-mammal burrows (Zeiner et al. 1990) as well as artificial burrows (e.g., culverts, concrete slabs, and debris piles). The breeding season is from March to August, peaking in April and May.

There are five documented occurrences of western burrowing owl in the study area (California Natural Diversity Database 2010) (Appendix D). This species has been observed in upland habitats in the northern portion of the Marsh, including the Potrero Hills, and on the east side of Montezuma Slough near Collinsville Road. This species is expected to occur in suitable habitat throughout the study area.

Short-Eared Owl

Short-eared owl (*Asio flammeus*) is a state species of special concern (California Natural Diversity Database 2010). There is no federal listing for this species, and critical habitat has not been designated.

Historically, short-eared owls bred throughout California. Breeding populations of short-eared owls have been extirpated from the San Joaquin Valley (Remsen 1978); however, this species is a permanent resident and still breeds in the southern portion of the Sacramento Valley (Yolo and Solano Counties), the Delta, and Suisun Marsh. Short-eared owls nest in upland portions of Suisun Marsh and also occur in the study area during the winter months with migrating birds arriving in September and October and leaving in April (Zeiner et al. 1990). Nests are built on the ground in tall stands of grasses in lowland habitats in marshes, meadows, and even agricultural fields. These lowland nesting habitats are situated near hunting grounds (Grinnell and Miller 1944).

There is one documented CNDDB occurrence of short-eared owl in the study area (California Natural Diversity Database 2010) (Appendix D, Region 2). Nesting short-eared owls have been observed over the last 20 years on Grizzly Island during waterfowl nesting surveys. A Jones & Stokes biologist also observed a short-eared owl on Grizzly Island during a 1996 survey. This species is expected to occur in suitable habitat throughout the study area.

Northern Harrier

Northern harrier (*Circus cyaneaus*) is a state species of special concern (California Natural Diversity Database 2010). There is no federal listing for this species, and critical habitat has not been designated.

Northern harriers are permanent residents of the study area, and the breeding range of the Delta population includes most of the Central Valley, the Delta, Suisun Marsh, and portions of San Francisco Bay (Zeiner et al. 1990). Northern harrier nest and roost in herbaceous vegetation in wetlands and field borders (Zeiner et al. 1990). It will roost on the ground in shrubby vegetation, often near the marsh edge (Brown and Amadon 1968). Foraging habitat in the study area includes tidal and brackish marshes, managed wetlands, agricultural lands, and pasturelands.

There is one documented CNDDB occurrences of northern harriers in the study area (California Natural Diversity Database 2010). This species is known to occur in suitable habitat throughout the study area. Nesting harriers have been observed over the last 20 years on Grizzly Island during waterfowl nesting surveys in upland portions of Suisun Marsh. This species also has been observed by DFG and DWR personnel.

White-Tailed Kite

White-tailed kite (*Elanus leucurus*) is a fully protected state species of special concern (California Natural Diversity Database 2010). There is no federal listing for this species, and critical habitat has not been designated.

White-tailed kites are permanent residents in the study area and may inhabit ruderal habitat, managed wetlands, and agricultural and pasture lands. Some large trees or shrubs are required for nesting; therefore, nesting may be limited throughout much of the study area.

There is one documented CNDDB occurrence of white-tailed kite in the study area (California Natural Diversity Database 2010) (Appendix D); however, this species is known to occur in suitable habitat throughout the study area. Nesting kites have been observed over the last 20 years on Grizzly Island during waterfowl nesting surveys in upland portions of Suisun Marsh.

Swainson's Hawk

Swainson's hawk (*Buteo swainsonii*) is state-listed as threatened (California Natural Diversity Database 2010). There is no federal listing for this species, and critical habitat has not been designated.

Swainson's hawks are summer residents in California and small numbers of this species are known to winter in the Delta. Swainson's hawks nest primarily in riparian areas adjacent to agricultural fields or pastures, although they sometimes use isolated trees or roadside trees (California Department of Fish and Game 1994). Nest sites typically are located in the vicinity of suitable foraging areas. The primary foraging areas for Swainson's hawk are open agricultural lands and pastures (California Department of Fish and Game 1994).

There is one documented CNDDB occurrence of Swainson's hawk in the study area (California Natural Diversity Database 2010) (Appendix D). This occurrence, in 2004, was an active nest located in riparian vegetation along Cordelia Slough. This species may occur only in small numbers in the study area because of the lack of suitable nesting and foraging habitat.

Waterfowl

The study area provides nesting, foraging, and wintering habitat for waterfowl, and Suisun Marsh is a key waterfowl wintering area in the Pacific Flyway. The large expanses of managed wetlands provide nesting and foraging habitat for resident and migratory species. Tidal and brackish wetland, bays, and sloughs of Suisun Marsh also provide habitat for waterfowl. One-day winter counts commonly tally more than 125,000 waterfowl (Suisun Marsh Ecological Workgroup 2001). The common waterfowl species known occur in the Marsh, and the habitats in which they occur, are identified in Table 6.3-5.

Table 6.3-5. Habitat Use by Waterfowl

Species	Managed Wetland	Tidal Wetland	Bays and Sloughs
Waterfowl—Dabbling Ducks			
Mallard	F, L, B	F,L	FL
Gadwall	F, L, B	F,L	F,L
Green-winged teal	F, L		
American widgeon	F, L	F,L	F,L
Northern pintail	F, L, B	F,L	F,L
Northern shoveler	F, L, B	F,L	F,L
Cinnamon teal	F, L, B		
Wood duck	F, L, B		
Waterfowl—Diving Ducks			
Ruddy duck	F, L, B	F,L	F, L
Canvasback	F, L	F,L	F, L
Redhead	F, L	F,L	F, L
Ring-necked duck	F, L	F,L	F, L
Greater scaup	F, L	F,L	F, L
Lesser scaup	F, L	F,L	F, L
Black scoter			F, L
Surf scoter			F, L
White-winged scoter			F, L
Barrow's goldeneye	F, L	F,L	F, L
Common goldeneye	F, L	F,L	F, L
Bufflehead	F, L	F,L	F, L
Common merganser	F, L		
Waterfowl—Geese			
Canada Goose	F, L, B	F,L,B	
Greater white-fronted goose	F, L	F,L	
Tule white-fronted goose	F, L		
Snow goose	F, L		
Ross' goose	F, L		
Waterfowl—Swans			
Tundra swan	F, L	F,L	
F: foraging; L: loafing; B: breeding.			

Common wintering waterfowl include both dabbling and diving ducks such as mallard, northern pintail (*Anas acuta*), American wigeon (*Anas americanus*), bufflehead (*Bucephala albeola*), and common goldeneye (*Bucephala clangula*) and geese such as white-fronted goose (*Anser albifrons*) and Canada goose (*Branta canadensis*).

Suisun Marsh also supports a high level of waterfowl production. A study by McLandress et al. (1996) found mallard nest density was 4 to 23 times the density in other areas of California (California Department of Water Resources 2001). Mallard, gadwall (*Anas strepera*), northern shoveler (*Anas clypeata*), northern pintail, cinnamon teal (*Anas cyanoptera*), wood duck (*Aix sponsa*), ruddy duck (*Oxyura jamaicensis*), and Canada goose are also known to nest in the study area.

The value of individual managed wetlands to waterfowl production and overwintering habitat varies depending on water management practices, soil salinity, and the associated plant communities. The goal of most managed wetlands in Suisun Marsh is to provide wintering habitat for waterfowl (California Department of Water Resources 2001). Wetland managers usually begin flooding their ponds in early October, and drainage of the ponds begins after the waterfowl season ends in January. Most ponds in the Marsh are completely drained by June. Vegetation composition is controlled by soil salinity, water management, and mechanical vegetation control (e.g., disking).

Taxonomically, migratory waterfowl using Suisun managed wetlands for wintering habitat are, dabbling ducks, diving ducks (or bay ducks), sea ducks, stiff-tailed ducks, geese, and swans (Conceptual Model 2010). For the purpose of this document diving ducks will include those species taxonomically considered diving ducks as well as sea ducks and stiff-tailed ducks. Table 6.3-5 identifies the waterfowl species known to occur in Suisun Marsh, the season and land cover type in which these species typically occur, and habitat function provided by the land cover types.

Dabbling Ducks

Suisun Marsh provides foraging habitat for resident, migratory, and wintering dabbling ducks. Dabbling ducks are omnivorous, and dietary preferences vary by species. Dabbling ducks feed primarily on seeds. Dabbling ducks forage primarily in managed wetlands but also may forage in tidal wetlands. Resident species known to nest in the study area include mallard, gadwall, northern shoveler, northern pintail, and cinnamon teal. Migratory and wintering dabbling ducks also include green-winged teal, and American wigeon.

Diving Ducks

The bays, sloughs, tidal wetlands, and managed wetlands of Suisun Marsh provide important foraging habitat for diving ducks. Diving ducks that occur in the study area include bufflehead, common goldeneye, Barrow’s goldeneye, canvasback, redhead, ring-necked duck, great scaup, lesser scaup, common merganser, black scoter, surf scoter, white-winged scoter, and ruddy duck. Habitat preferences vary by species. All of these species, with the exception of greater scaup, forage in tidal wetlands, bays, and sloughs. Other species such as bufflehead, common goldeneye, and ruddy duck commonly forage in managed wetlands. Their use of managed wetlands is dependent on water depths and vegetation cover. Diving ducks feed on benthic organisms and fish, with dietary requirements varying by species.

Geese

Several goose species occur in the study area. The most common species observed are Canada geese (*Branta canadensis*), tule greater white-fronted geese (*Anser albifrons*), and snow geese (*Chen caerulescens*). Other geese known to occur in the study area are cackling Canada goose, greater white-front goose, and Ross' goose (Conceptual Model 2010). Geese graze on grains and foliage in the winter and also are known to occur in managed wetlands. Canada goose is the only nesting species in Suisun Marsh.

Swans

The tundra swan (*Cygnus columbianus*) winters in the study area. Tundra swans feed by dabbling in waters up to 3 feet in depth and also forage on grains. They feed primarily on seeds, stems, roots and tubers of submerged and emergent vegetation (Conceptual Model 2010). Tundra swans in Suisun Marsh typically occur in managed wetlands but also may use tidal wetlands.

Shorebirds

The tidal wetlands and managed wetlands in the study area provide habitat for several species of shorebirds, particularly migrating and overwintering birds. Managed wetlands make up approximately 67% of all bay land habitat in Suisun Bay (Hickey and W.D. Shuford 2003). The value of these wetlands to shorebirds varies depending on water level, salinity, and the vegetation communities present. These wetlands provide foraging habitat for the black-necked stilt (*Himantopus mexicanus*), American avocet (*Recurvirostra americana*), greater yellowlegs (*Tringa melanoleuca*), dunlin (*Calidris alpine*), and long-billed dowitcher (*Limnodromus scolopaceus*) and nesting habitat for the killdeer (*Charadrius vociferous*), black-necked stilt, and American avocet (Hickey and W.D. Shuford 2003). The common shorebird species that occur in the Marsh and the habitats in which they occur are identified in Table 6.3-6.

Table 6.3-6. Habitat Use by Shorebirds

Species	Tidal Areas (Mud Flats)	Managed Wetland
Shorebirds—Probers		
Semipalmated plover	F, L	F, L
Killdeer	F, L	F, L, B
Black-bellied plover	F, L	F, L
Marbled godwit	F, L	F, L
Long-billed curlew	F, L	F, L
Willet	F, L	
Greater yellowlegs	F, L	F, L
Lesser yellowlegs	F, L	F, L
Short-billed dowitcher	F, L	F, L
Long-billed dowitcher	F, L	F, L
Wilson's snipe	-	F, L
Dunlin	F, L	F, L
Western sandpiper	F, L	F, L
Least sandpiper	F, L	F, L
Shorebirds—Sweepers		
American avocet	F, L	F, L, B
Black-necked stilt	F, L	F, L, B
Wilson's phalarope	F, L	F, L
Red-necked phalarope	F, L	F, L

F: foraging; L: loafing; B: breeding.

Shorebirds include shallow and deep probers and shallow feeders. Probers forage by probing saturated or ponded substrates for invertebrates, crustaceans, and insects. The depth of available foraging substrate is dependent on bill length. Shallow probers such as western and least sandpiper and dunlin have relatively short bills and forage at or near the surface. Deep probers such as long-billed and short-billed dowitchers and greater yellowlegs have relatively long bills and probe deeper into the substrate. Shallow feeders such as black-necked stilt and American avocet feed by pecking or sweeping prey from the water column or surface.

Habitat suitability for shorebirds is dependent on water depth, percent of vegetation cover, and substrate. Tidal flats at low tide are the principal foraging area for most shorebirds in San Francisco Bay. Tidal flats and other tidal wetlands may be used by larger, longer-legged shorebirds as water levels rise, while smaller shorebirds have to move to foraging areas with exposed or shallower habitat. The presence of vegetation cover reduces the amount of suitable habitat for both probers and shallow feeders.

Species that forage on tidal flats include the black-bellied plover (*Pluvialis squatarola*), semipalmated plover (*Charadrius semipalmatus*), willet

(*Catoptrophorus semipalmatus*), long-billed curlew (*Numenius americanus*), marbled godwit (*Limosa fedoa*), red knot (*Calidris canutus*), dunlin, western sandpiper (*Calidris mauri*), least sandpiper (*Calidris minutilla*), short-billed dowitcher (*Limnodromus griseus*), and long-billed dowitcher (Hickey and W.D. Shuford 2003). Marsh channels, ponds, and wrack are used by many species of shorebirds for foraging. Vegetated portions of tidal wetland habitat are used to a lesser degree than tidal flats (Stralberg et al. 2003; Hickey and Shuford 2003). Vegetated portions of tidal wetland may be used for roosting and occasionally for nesting.

Table 6.3-6 identifies the shorebird species known to occur in Suisun Marsh, the season and land cover type in which these species typically occur, and habitat function provided by the land cover types.

Regulatory Setting

This section provides preliminary information on the major requirements for permitting, environmental review, and consultation related to wildlife resources for implementation of the SMP alternatives. Certain state and federal regulations require issuance of permits before implementation; other regulations require agency consultation but may not require issuance of any entitlements before implementation. The plan's requirements for permits and environmental review and consultation may change during the EIS/EIR review process as discussions with involved agencies proceed. Local regulatory requirements related to biological resources are described in Section 6.2, Vegetation and Wetlands.

Federal

The Endangered Species Act and the Fish and Wildlife Coordination Act are discussed in detail in Chapter 10, "Regulatory Framework." The Migratory Bird Treaty Act (MBTA) is discussed below.

Migratory Bird Treaty Act

The MBTA (16 USC 703) enacts the provisions of treaties between the United States, Great Britain, Mexico, Japan, and the Soviet Union and authorizes the U.S. Secretary of the Interior to protect and regulate the taking of migratory birds. It establishes seasons and bag limits for hunted species and protects migratory birds, their occupied nests, and their eggs (16 USC 703; 50 CFR 21; 50 CFR 10). Most actions that result in taking or in permanent or temporary possession of a protected species constitute violations of MBTA. USFWS is responsible for overseeing compliance with MBTA.

State

CEQA and CESA are discussed in detail in Chapter 10, "Regulatory Framework." Additional regulations pertinent to wildlife are discussed below.

California Fish and Game Code

Section 1600: Streambed Alteration Agreements

Under Sections 1600–1607 of the California Fish and Game Code, DFG has jurisdictional authority over wetland resources associated with rivers, streams, and lakes. DFG has the authority to regulate all work under the jurisdiction of the State of California that would substantially divert, obstruct, or change the natural flow of a river, stream, or lake; substantially change the bed, channel, or bank of a river, stream, or lake; or use material from a streambed.

DFG enters into a streambed alteration agreement with an applicant and can impose conditions on the agreement to ensure that no net loss of wetland values or acreage will be incurred. The streambed or lakebed alteration agreement is a discretionary permit subject to CEQA.

Sections 3503 and 3503.5: Protection of Bird Nests

California Fish and Game Code 3503 prohibits the killing of birds and the destruction of bird nests. California Fish and Game Code 3503.5 prohibits the killing of raptor species and the destruction of raptor nests and eggs. Many bird species potentially could nest in the study area or vicinity, and their nests would be protected under these sections of the California Fish and Game Code.

Multiple Sections: Fully Protected Species

The California Fish and Game Code provides protection from take for a variety of species, referred to as *fully protected species*. Section 5050 lists protected amphibians and reptiles. Section 5515 prohibits take of fully protected fish species. Section 3511 prohibits take of fully protected bird species. Fully protected mammals are protected under Section 4700. The California Fish and Game Code defines *take* as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." Migratory nongame birds are protected under Section 3800.

Environmental Consequences

Assessment Methods

Wildlife resources could be directly or indirectly affected by the SMP. The following types of actions could cause varying degrees of impacts on these resources:

- loss or degradation of habitat as a result of levee breaching or grading;

- loss or degradation of habitat as a result of increased scour;
- loss or conversion of managed wetlands or other land cover types as a result of tidal wetland restoration;
- loss of special-status species as a result of tidal wetland restoration;
- vegetation removal, grading, and other ground-disturbing activities;
- channel dewatering or installation of temporary water diversion structures;
- temporary stockpiling and sidecasting of soil, construction materials, or other construction wastes;
- dredging activities in wetlands and channels that contain ponded or flowing water and saturated soils; and
- disposal of dredged material on the waterside of levee banks or adjacent to the landside of levees.

Impact Analysis Assumptions

The SMP would result in temporary and permanent impacts on wildlife resources in the plan area. Temporary impacts would occur only during the construction or maintenance periods. Permanent impacts would be changes in land cover types. Potential changes to land cover types are described quantitatively in the Action Alternatives. Because of the nature of this plan analysis, other temporary and permanent impacts cannot be quantified, but they are discussed qualitatively.

This analysis assumes that tidal wetland restoration actions, specifically levee breaching, initially would result in the establishment of primarily tidal open water habitat, and also intertidal habitat areas for vegetation and special-status wildlife species. Some topography to support intertidal habitat will be established prior to breaching. Tidal wetland vegetation would establish as sediment accrues over time, reducing the amount of open water habitat and increasing tidal habitat. Impacts would occur to managed wetland habitats. Habitat values impacted would be offset, replaced and increased as tidal wetland vegetation becomes established. (See Figure 2-1.)

Impact Assessment Approach and Methods

This wildlife resources impact analysis is based on:

- the most current proposed implementation of the SMP, as developed by the Principal Agencies and summarized in the above assumptions; and
- existing biological resource information (sources are discussed under Affected Environment).

The mitigation measures for impacts on wildlife resources were developed through review of the plan description, prior environmental impact studies and reports for affected resources, discussions with resource agency personnel, and professional judgment.

Significance Criteria

The criteria for determining significant impacts on wildlife resources were developed by reviewing State CEQA Guidelines. Based on this information, the SMP likely would cause a significant impact if it would result in:

- a substantial temporary or permanent disruption of wildlife movement or fragmentation or isolation of habitats;
- a permanent loss of upland land cover types used by wildlife for breeding, roosting or foraging habitat;
- substantially reduce the habitat of a wildlife species;
- cause a wildlife population to drop below self-sustaining levels;
- reduce the number or restrict the range of an endangered, threatened or candidate wildlife species or species of special concern

Beneficial impacts are changes that would result in net increases in the extent or quality of habitat for special-status wildlife species. Substantial beneficial impacts are identified.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, the SMP would not be implemented. As a result, the amount of restoration in the Marsh likely would be limited.

The No Action Alternative includes the following assumptions related to activities and associated impacts:

- It is assumed for purposes of this No Action Alternative evaluation that approximately 700 additional acres could be restored without the SMP.
- Managed wetland activities may become less frequent as a result of permitting difficulty. This could lead to difficulty in maintaining and operating managed wetlands, which could lead to reduced habitat values for species that use these areas.
- Impacts on habitat conditions such as water quality would continue to occur and could be exacerbated by the reduced implementation of maintenance activities that aid in flood and drain practices.

- Diversion restrictions on managed wetlands would continue to be enforced, and programs to encourage landowners to manage properties to protect certain habitat values would continue to be implemented.
- Programs to control managed wetland vegetation would continue.
- Any levee breaches that occur in inaccessible areas may not be fixed, and passive restoration could occur in these areas.

Overall, the No Action Alternative would result in habitat degradation as managed wetlands operations and maintenance are deferred, minimal tidal wetlands are created, and existing issues related to habitat functions such as water quality, food availability, and vegetative cover worsen. Absent the SMP, including both tidal restoration and managed wetland enhancement, all wildlife that uses the Marsh would be subject to increasingly degraded habitat conditions.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Implementation of Alternative A would result in the temporary or permanent loss or degradation of tidal wetlands, managed wetlands, and other land cover types in the study area. The impact on these land cover types and the associated mitigation measures are described in Section 6.2, Vegetation and Wetlands.

Tidal wetland restoration would occur by breaching and/or lowering exterior levees that currently protect managed wetlands from tidal inundation, resulting in the conversion of managed wetlands to tidal wetlands. The following actions related to tidal wetland restoration could affect special-status wildlife species, waterfowl, and other wildlife in the study area:

- the permanent and temporary loss of tidal wetlands, managed wetlands or other habitats because of construction-related activities;
- the permanent and temporary loss of habitat from the conversion of managed wetlands to tidal wetlands, including tidal inundation of vegetation communities previously protected by exterior levees;
- the change of waterfowl and shorebird nesting and conversion of overwintering habitat from the conversion of managed wetlands to tidal wetlands;
- the loss of tidal wetland habitat at breach locations as a result of increased scour;
- the loss or conversion of tidal wetlands from the potential impacts of upstream tidal muting; and
- the disturbance of breeding habitat for special-status species, waterfowl, and shorebirds by construction-related activities.

The following sections describe the impacts on special-status species and the associated mitigation measures.

Restoration Impacts

Impact WILD-1: Loss or Disturbance of Salt Marsh Harvest Mouse Suitable Habitat as a Result of Tidal Wetland Restoration

The salt marsh harvest mouse inhabits suitable vegetation communities in tidal and managed wetlands in the study area. Conversion of habitat in managed wetlands to tidal wetlands would result in a temporary reduction in salt marsh harvest mouse habitat. As the restored area evolves into a functioning, vegetated tidal wetland, it is expected to provide permanent suitable and sustainable habitat for the salt marsh harvest mouse. Restoration activities likely would be located throughout the Marsh and would be implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame that would have a potentially greater effect on this species. It is expected that suitable adjacent areas would continue to provide habitat for salt marsh harvest mouse between breaching the levee and the establishment of a fully functioning tidal wetland.

Restoration activities would include the construction of habitat levees that include benches or berms, which would provide opportunities for the establishment of high marsh/upland transition habitat. Habitat levees may be planted and seeded with native marsh species and/or allowed to colonize naturally with native and naturalized species. The habitat levees would provide habitat for the salt mouse harvest mouse as the remainder of the tidal wetland areas become established.

Environmental commitments in Chapter 2, Restoration Environmental Commitments, Mammals, address monitoring activities for salt marsh harvest mouse. Before and during restoration activities, a biologist will look for salt marsh harvest mouse and if it is found, construction activities will be stopped and continue once the individual has moved from the area. Pickleweed habitat may be removed during construction. Because temporary losses of suitable habitat would be offset by the restoration of tidal wetlands, this impact is considered less than significant.

Conclusion: Less than significant. No mitigation required.

Impact WILD-2: Loss or Disturbance of California Clapper Rail Suitable Habitat as a Result of Tidal Wetland Restoration

California clapper rails inhabit suitable tidal wetlands and tidal sloughs in the study area. Restoration activities in these areas could disrupt clapper rail breeding habitat and foraging habitat in tidal wetlands. Clapper rails do not occupy managed seasonal wetlands; therefore, flooding of managed wetlands for the purpose of restoration would not affect clapper rails.

Breeding would not be disturbed during construction, and impacts on breeding habitat would be minimal, with implementation of the environmental commitments described in Chapter 2. Construction activity, including vegetation clearing, would be limited to months outside the breeding season, and staging areas would be sited at least 100 feet from water bodies. If construction activities are necessary during the breeding season, preconstruction surveys of suitable nesting habitat in and adjacent to the construction areas would be performed to identify the general location of clapper rail nest sites in the project area and nesting habitat areas will be flagged for avoidance, if construction activities would occur during the nesting season. Disturbance in these areas will be avoided until after the nesting season. Additionally, breach sites and other restoration features would be designed to avoid sensitive habitats to the extent possible.

There could be a minor, temporary loss of foraging habitat as a result of construction-related activities throughout the Marsh. Additionally, increased scour and tidal muting that could occur as a result of restoration could result in the temporary loss of California clapper rail foraging habitat. Regardless, restoration actions are not expected to adversely affect clapper rail because the minor and temporary loss of foraging habitat is not considered substantial given the amount of foraging habitat remaining and restored.

Conversion of managed wetlands to tidal wetlands would result in increased clapper rail breeding and foraging habitat. The plan includes design features that would promote the establishment of natural permanent clapper rail habitat, including habitat levees that provide tidal habitats. As the restored area evolves into a functioning, vegetated tidal wetland, it is expected to provide permanent, sustainable, suitable habitat for the clapper rail. Habitat levees also would provide refugia from high water events.

Restoration activities likely would be located throughout the Marsh and would be implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame that would have a potentially greater effect on this species. It is expected that suitable adjacent areas would continue to provide habitat for clapper between breaching the levee and the establishment of a fully functioning tidal wetland.

Because breeding season impacts will be avoided and temporary losses of suitable habitat would be offset by the restoration of tidal wetlands, this impact is considered less than significant.

Conclusion: Less than significant. No mitigation required.

Impact WILD-3: Loss or Disturbance of California Black Rail Suitable Habitat as a Result of Tidal Wetland Restoration

California black rails inhabit suitable tidal wetlands and managed wetlands in the study area. The types of impacts described for clapper rail above also apply to the black rail, although the black rail is more common and more widely distributed throughout the Marsh than the clapper rail. The same environmental commitments (Chapter 2), including avoiding construction during breeding season or a preconstruction survey, would apply, thus avoiding disturbance during breeding season.

Construction-related activities, the inundation of suitable habitat in managed wetlands, and the impacts of increased scour and tidal muting could result in the temporary loss of black rail breeding and foraging habitat. As described above for the clapper rail, the overall 30-year plan is expected to benefit black rail by encouraging development of a more natural habitat through restoration of managed wetlands to tidal wetlands.

Restoration activities likely would be located throughout the Marsh and would be implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame that would have a potentially greater effect on this species. It is expected that suitable adjacent areas would continue to provide habitat for black rail use between breaching the levee and the establishment of a fully functioning tidal wetland.

Because breeding season impacts will be avoided and temporary losses of suitable habitat would be offset by the restoration of tidal wetlands, this impact is considered less than significant.

Conclusion: Less than significant. No mitigation required.

Impact WILD-4: Loss or Disturbance of Suisun Shrew Suitable Habitat as a Result of Tidal Wetland Restoration

Suisun shrews inhabit suitable vegetation communities in tidal and managed wetlands in the study area. Construction-related activities, the inundation of suitable habitat in managed marshes, and the impacts of increased scour and tidal muting could result in the temporary loss of Suisun shrew breeding and foraging habitats. As the restored area evolves into a functioning, vegetated tidal wetland, it is expected to provide permanent suitable and sustainable habitat for the Suisun shrew. Additionally, breach sites and other restoration features would be designed to avoid sensitive habitats to the extent possible.

Conversion of suitable habitat in managed wetlands to tidal wetlands would result in a temporary reduction in suitable habitat. The plan includes design features that would promote the establishment of natural permanent Suisun shrew habitat, including habitat levees that provide tidal wetland and transitional zone habitat. As the restored area evolves into a functioning tidal wetland, it is expected to provide permanent suitable habitat for the shrew.

Restoration activities would include the construction of habitat levees that include benches or berms, which would provide opportunities for the establishment of high marsh/upland transition habitat. Habitat levees may be planted and seeded with native marsh species and/or allowed to colonize naturally with native and naturalized species. The habitat levees would provide habitat for the Suisun shrew as the remainder of the tidal wetland areas become established.

Restoration activities likely would be located throughout the Marsh and would be implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame that would have a potentially greater effect on this species. It is expected that suitable adjacent areas would continue to provide habitat for Suisun shrew between breaching the levee and the establishment of a fully functioning tidal wetland.

Because temporary losses of suitable habitat would be offset by the restoration of tidal wetlands, this impact is considered less than significant.

Conclusion: Less than significant. No mitigation required.

Impact WILD-5: Loss or Disturbance of California Least Tern Suitable Habitat as a Result of Tidal Wetland Restoration

California least terns are known to breed at one location on the east side of Suisun Marsh and to forage in the bays, sloughs, tidal wetlands and managed wetlands in the Marsh. Preconstruction surveys would be performed to identify least tern nest sites, and construction-related activities during the breeding season in the vicinity of active nests would be avoided as described in the Environmental Commitments section in Chapter 2. Construction activities would not significantly affect foraging habitat because open water habitat is abundant in the study area.

Conversion of suitable foraging habitat in managed wetlands to tidal wetlands would result in an increase in suitable foraging habitat because the tidal wetland restoration areas would be subject to tidal action and therefore would be inundated permanently or more frequently than the managed wetlands. As the restored area evolves into a functioning tidal wetland, it will continue to provide suitable habitat for the least tern.

Because breeding season impacts will be avoided and temporary losses of suitable habitat would be offset by the restoration of tidal wetlands, this impact is considered less than significant.

Conclusion: Less than significant. No mitigation required.

Impact WILD-6: Loss of Suisun Song Sparrow and Salt Marsh Common Yellowthroat Suitable Habitat as a Result of Tidal Wetland Restoration

Suisun song sparrows and salt marsh common yellowthroats are known to breed in suitable habitat in tidal and managed wetlands throughout the Marsh. Restoration activities in these areas could disrupt breeding habitat and foraging habitat in tidal wetlands.

Breeding would not be disturbed during construction, and impacts on breeding habitat would be minimal with implementation of the environmental commitments described in Chapter 2. Preconstruction surveys would be performed to identify nest sites in the project area, and construction activity in the vicinity of active nests would be limited to months outside the breeding season. Any sensitive resources, such as nests, would be flagged and avoided. Breach sites and other restoration features would be designed to avoid sensitive habitats to the extent possible.

The plan includes design features that would promote the establishment of natural permanent breeding and foraging habitat, including habitat levees that provide tidal wetland and transitional zone habitat. As the restored area evolves into a functioning tidal wetland, it is expected to provide permanent suitable habitat for these species.

Restoration activities likely would be located throughout the Marsh and would be implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame that would have a potentially greater effect on this species. It is expected that suitable adjacent areas would continue to provide habitat for Suisun song sparrow and salt marsh common yellowthroat between breaching the levee and the establishment of a fully functioning tidal wetland.

Because breeding season impacts will be avoided and temporary losses of suitable habitat would be offset by the restoration of tidal wetlands, this impact is considered less than significant.

Conclusion: Less than significant. No mitigation required.

Impact WILD-7: Loss or Disturbance of Raptor Nest Sites or Foraging Habitat as a Result of Tidal Wetland Restoration

Raptors, including northern harrier, short-eared owl, white-tailed kite, Swainson’s hawk, and western burrowing owl, are known to breed in suitable habitats in the study area. Western burrowing owl occurs in upland habitats associated with grassland, therefore this species is not expected to occur in potential construction areas and would not be affected by the plan. Swainson’s hawk requires mature trees for nesting. Although potential nest trees are available, the study area is on the edge of the species’ range and foraging habitat is limited to grasslands in the northern and eastern borders of the study area. Therefore Swainson’s hawk is not expected to be affected by the plan.

White-tailed kites require trees and shrubs for nesting and grassland and open habitats for foraging. Northern harrier and short-eared owl are ground nesters.

Breeding would not be disturbed during construction and impacts on breeding habitat would be minimal with implementation of the environmental commitments described in Chapter 2. Environmental commitments include preconstruction surveys performed to identify nest sites in the project area, and construction activity in the vicinity of active nests would be limited to months outside the breeding season. All woody and herbaceous vegetation would be removed from the construction areas during the nonbreeding season (September 1–February 1) to minimize effects on nesting birds. Any sensitive resources, such as nests, would be flagged and avoided.

A temporary reduction in foraging habitat could occur for those species that forage in managed wetlands. Restoration activities likely would be located throughout the Marsh and would be implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame that would have a potentially greater effect on this species. It is expected that suitable adjacent areas would continue to provide habitat for raptors between breaching the levee and the establishment of a fully functioning tidal wetland.

Because breeding season impacts will be avoided and temporary losses of suitable habitat would be offset by the restoration of tidal wetlands, this impact is considered less than significant.

Conclusion: Less than significant. No mitigation required.

Impact WILD-8: Loss or Disturbance of Western Pond Turtle as a Result of Tidal Wetland Restoration

Western pond turtles occur in the upper reaches of tidal sloughs, managed wetlands, brackish habitats, permanently flooded water supply ditches, and other areas throughout the study area where there is permanent or nearly permanent water. The conversion of suitable habitat in managed wetlands to tidal wetlands would result in the permanent or temporary loss of breeding habitat for western pond turtles.

Preconstruction surveys will be performed in all managed wetlands and in adjacent sloughs that provide suitable habitat. If pond turtles are identified, the area will be surveyed for nesting sites, if construction activities would occur during the nesting season. Breaching of levees in occupied breeding habitat would occur outside of the breeding months of April to July. If pond turtles are identified in managed wetlands to be breached, the ponds and associated drainages will be dewatered and, to the extent feasible, any turtles observed will be captured and released to other suitable locations within a nearby managed wetland or drainage. Breach sites and other restoration features would be designed to avoid sensitive habitats to the extent possible.

Restoration activities likely would be located throughout the Marsh and would be implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame that would have a potentially greater effect on this species. It is expected that suitable adjacent areas and some restored wetlands would provide habitat for pond turtles.

Because most impacts on pond turtles will be avoided and permanent or temporary loss of suitable habitat would be offset by the restoration of tidal wetlands and enhancement of managed wetlands, this impact is considered less than significant.

Conclusion: Less than significant. No mitigation required.

Impact WILD-9: Loss or Disturbance of Tricolored Blackbird as a Result of Tidal Wetland Restoration

Tricolored blackbirds may breed in emergent wetland vegetation associated with tidal and managed wetlands. Conversion of suitable habitat in managed wetlands to tidal wetlands may result in a permanent or temporary reduction in suitable habitat.

Breeding would not be disturbed during construction, and impacts on breeding habitat would be minimal with implementation of the environmental commitments described in Chapter 2. Preconstruction surveys would be performed to identify nest sites in the project area, and construction activity in the vicinity of active nests would be limited to months outside the breeding season. Any sensitive resources, such as nesting colonies, would be flagged and avoided. Breach sites and other restoration features would be designed to avoid sensitive habitats to the extent possible.

Restoration activities likely would be located throughout the Marsh and would be implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame that would have a potentially greater effect on this species. It is expected that suitable adjacent areas would continue to provide habitat for tricolored blackbirds.

Because impacts on tricolored blackbirds will be minimized and any loss of suitable habitat would be compensated for by the enhancement of managed wetlands, this impact is considered less than significant.

Conclusion: Less than significant. No mitigation required.

Impact WILD-10: Effects on Southern Resident Killer Whales as a Result of Changes in Salmon Populations

Tidal wetland restoration has the potential to affect the prey base (Chinook salmon) of southern resident killer whales. Restoration could have an effect on salmonid populations (see Section 6.1, Fish), which would indirectly affect southern resident killer whales. If Chinook salmon populations were negatively affected, a reduction in prey availability for the southern resident killer whales could occur. Reductions in prey availability may force the whales to travel longer distances to find prey or select lesser-quality prey, resulting in reduced reproductive rates and higher mortality.

Tidal wetland restoration is expected to increase rearing habitat for juvenile Chinook salmon in Suisun Marsh. Tidal wetlands are more productive and would allow better growth and survival of Chinook salmon. The portion of the killer whale prey base that comes from Suisun Marsh is small compared to Pacific Northwest and Central Valley streams. Salmon distribution and population also are affected by many factors, which include ocean conditions and pollution.

Conclusion: No impact. No mitigation required.

Impact WILD-11: Loss or Disturbance of Waterfowl or Shorebird Habitat as a Result of Tidal Wetland Restoration

Managed wetlands provide nesting, foraging, and wintering habitat for waterfowl and shorebirds. Tables 6.3-5 and 6.3-6 identify how various guilds and species use habitat in the Marsh.

Breeding would not be disturbed during construction, and impacts on breeding would be minimal with implementation of the environmental commitments described in Chapter 2. Preconstruction surveys would be performed to identify nest sites in the project area, and construction activity in the vicinity of active nests would be limited to months outside the breeding season. Any sensitive resources, such as nests, would be flagged and avoided. These actions would minimize effects on actively nesting waterfowl or shorebirds during the construction period. Additionally, prior to breaching the levee, specific project proponents would manage vegetation and other resources to promote growth of tidal wetland plant species.

Restoration activities likely would be located throughout the Marsh and would be implemented over the 30-year plan period, rather than concentrated in a small geographic area or time frame. It is expected that suitable adjacent areas would continue to provide habitat and enhancement activities would offset this loss by improving remaining managed wetlands and therefore improving habitats that support waterfowl and shorebirds. Most of the diving ducks in the Marsh will benefit during the tidal marsh establishment period, and will continue to use deeper areas of wetlands and channels as the tidal wetlands become established. Additionally, as tidal wetlands are established, shorebirds are expected to benefit as a result of more natural habitat developed through restoration activities.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact WILD-12: Loss or Disturbance of Salt Marsh Harvest Mouse Suitable Habitat as a Result of Managed Wetland Activities

The salt marsh harvest mouse inhabits suitable vegetation communities in tidal and managed wetlands in the study area. Some of the proposed management activities would occur in managed wetlands and have the potential to temporarily disrupt suitable habitat areas. The activities that would occur in the managed wetlands have the potential to increase in magnitude under the Proposed Project. This change in magnitude is not expected to result in a substantial change in disturbance to salt marsh harvest mouse habitat because most of the managed wetlands would continue to provide habitat. Restoration actions would contribute to recovery of the salt marsh harvest mouse over the 30-year implementation period.

Managed wetland activities would be implemented on individual parcels throughout the 30-year implementation period and would improve flood and drain capabilities and levee stability in the Marsh. The improvement of flood and drain capabilities could result in the creation or enhancement of suitable habitat in the managed wetlands. Providing levee stability would minimize the potential for catastrophic loss of salt marsh harvest mouse habitat in managed wetlands. Levee stability activities have been occurring for decades, and the SMP would increase their frequency thereby reducing the frequency of impacts due to levee breaches..

Conclusion: Less than significant. No mitigation required.

Impact WILD-13: Loss or Disturbance of California Clapper Rail Suitable Habitat as a Result of Managed Wetland Activities

California clapper rails inhabit suitable tidal wetlands and tidal sloughs in the study area. Managed wetland activities in these areas could disrupt clapper rail habitat. Specifically, levee maintenance activities for managed wetland levees, that would affect tidal wetland vegetation have the potential to temporarily reduce or disturb clapper rail habitat in tidal wetlands.

Authorized work will not be conducted in the areas shown on the California clapper rail breeding habitat maps between February 1 and August 31 (Figure 2-6). Breeding would not be disturbed during maintenance activities, and impacts on breeding habitat would be minimal with implementation of the other environmental commitments described in Chapter 2.

Many of the managed wetland activities that have the potential to affect California clapper rail habitat in tidal wetlands are currently being implemented but would occur more frequently under the Proposed Project. This change in magnitude is not expected to result in a substantial change in foraging habitat, nests would continue to be avoided, and maintenance activities would not occur during the breeding season. New activities such as dredging and placement of new riprap in tidal and nontidal areas have the potential to remove a minor amount of vegetation. Similar to other managed wetland activities, restrictions related to breeding season and nest sites would be in place. California clapper rail do not use managed wetlands. Therefore, marsh management activities that occur or affect the managed wetlands would not affect this species.

Additionally, as described in Chapter 2, these maintenance activities would be designed to avoid and minimize effects on tidal wetland vegetation. All managed wetland activities would occur over the 30-year implementation period and throughout the Marsh, avoid nests and breeding season in applicable areas, and not substantially change the foraging habitat available to the rail at any one time. Additionally, restoration actions would contribute to recovery of the clapper rail over the 30-year implementation period.

Conclusion: Less than significant. No mitigation required.

Impact WILD-14: Loss or Disturbance of California Black Rail Suitable Habitat as a Result of Managed Wetland Activities

California black rails inhabit suitable tidal wetlands and managed wetlands in the study area. The types of impacts described for clapper rail above also apply to the black rail, although the black rail does occur in managed wetlands and is more common and more widely distributed throughout the Marsh than the clapper rail. Managed wetland activities that remove vegetation have the potential to temporarily reduce foraging habitat.

Breeding would not be disturbed during construction, and impacts on breeding habitat would be minimal with implementation of the environmental commitments described in Chapter 2. Maintenance activities would be limited to months outside the breeding season. As described above for the clapper rail, the small change in magnitude of currently implemented activities and the new activities are not expected to result in substantial changes in suitable foraging habitat or breeding. Additionally, restoration actions would contribute to recovery of the black rail over the 30-year implementation period.

Conclusion: Less than significant. No mitigation required.

Impact WILD-15: Loss or Disturbance of Suisun Shrew Suitable Habitat as a Result of Managed Wetland Activities

Suisun shrews inhabit suitable vegetation communities in tidal and managed wetlands in the study area. Managed wetland activities in managed wetlands would result in a temporary reduction in suitable habitat.

The change in magnitude of the currently implemented activities is not expected to result in a substantial increase in shrew habitat disturbance, and new activities would occur primarily on the waterside of managed wetlands. Placement of new riprap in tidal areas, constructing new interior levees, and constructing cofferdams have the potential to remove shrew habitat, but the amount is considered minimal given the extent of managed wetland areas that would continue to provide suitable habitat. Suisun shrew do not use managed wetlands. Therefore, marsh management activities that occur or affect the managed wetlands would not affect this species.

Conclusion: Less than significant. No mitigation required.

Impact WILD-16: Loss or Disturbance of California Least Tern Suitable Habitat as a Result of Managed Wetland Activities

California least terns are known to breed at one location on the east side of Suisun Marsh and to forage in the bays, sloughs, and managed wetlands in the Marsh. New activities such as dredging, new riprap placement, brushboxes, and construction of new interior levees and cofferdams have the potential to disrupt nest sites, but no SMP work will occur in the vicinity of that occupied habitat.

Maintenance activities would not significantly affect foraging habitat because open water habitat is abundant in the study area.

Currently implemented activities also have the potential to affect breeding habitat. However, the change in magnitude of the currently implemented managed wetland activities would not result in a substantial temporary or permanent change in foraging habitat. Additionally, restoration actions would contribute to recovery of the least tern over the 30-year implementation period.

Marsh management activities, specifically providing levee stability, also would contribute to maintaining California least tern foraging habitat habitat in managed wetlands. These activities would be implemented on individual parcels throughout the 30-year implementation period and would improve flood and drain capabilities and levee stability in the Marsh. Providing levee stability would minimize the potential for catastrophic loss of California least tern foraging habitat in managed wetlands because managed marsh water levels would not be affected by levee breaches.

Conclusion: Less than significant. No mitigation required.

Impact WILD-17: Loss or Disturbance of Suisun Song Sparrow and Salt Marsh Common Yellowthroat Suitable Habitat as a Result of Managed Wetland Activities

Suisun song sparrow and salt marsh common yellowthroat breed in tidal and managed wetlands throughout the Marsh. Managed wetland activities in the vicinity of active nests would be avoided during breeding season.

Currently implemented activities also have the potential to affect breeding habitat. However, the change in magnitude of the currently implemented managed wetland activities would not result in a substantial temporary or permanent change in foraging habitat. Additionally, restoration actions would contribute to recovery of the Suisun song sparrow and salt marsh common yellowthroat over the 30-year implementation period.

Marsh management activities also would contribute to maintaining Suisun song sparrow and salt marsh yellowthroat habitat. These activities would be implemented on individual parcels throughout the 30-year implementation period and would improve flood and drain capabilities and levee stability in the Marsh. The improvement of flood and drain capabilities could result in the creation or enhancement of suitable habitat in the managed wetlands by improving water quality and promoting the establishment of suitable breeding habitat. Providing levee stability would minimize the potential for catastrophic loss of habitat in managed wetlands.

Conclusion: Less than significant. No mitigation required.

Impact WILD-18: Loss or Disturbance of Raptor Nest Sites or Foraging Habitat as a Result of Managed Wetland Activities

Raptors, including northern harrier, short-eared owl, white-tailed kite, Swainson's hawk, and western burrowing owl, are known to breed in suitable habitats in the study area. These species generally forage in areas near nest sites. Managed wetland activities in the vicinity of active nests would not be implemented during breeding season.

Breeding would not be disturbed during maintenance activities, and impacts on breeding habitat would be minimal with implementation of the environmental commitments described in Chapter 2. A temporary reduction in foraging habitat could occur for those species that forage in managed wetlands.

Currently implemented activities also have the potential to affect breeding habitat. However, the change in magnitude of the currently implemented managed wetland activities would not result in a substantial temporary or permanent change in foraging habitat. Additionally, many of these species breed and forage in upland areas that are less likely to be affected by managed wetland activities in managed wetlands and tidal sloughs.

Conclusion: Less than significant. No mitigation required.

Impact WILD-19: Loss or Disturbance of Western Pond Turtle as a Result of Managed Wetland Activities

Western pond turtles occur in the upper reaches of tidal sloughs, managed wetlands, brackish habitats, permanently flooded water supply ditches, and other areas throughout the study area where there is permanent or nearly permanent water. Currently implemented activities have the potential to affect breeding and foraging habitat. However, the change in magnitude of the currently implemented managed wetland activities would not result in a substantial temporary or permanent change in habitat, and activities are conducted when the managed wetlands are dry.

Marsh management activities also would contribute to maintaining western pond turtle habitat. These activities would be implemented on individual parcels throughout the 30-year implementation period and would improve flood and drain capabilities and levee stability in the Marsh. The improvement of flood and drain capabilities could result in the creation or enhancement of suitable habitat in the managed wetlands. Improved water quality (i.e., water that is less saline) will also benefit western pond turtles. Providing levee stability would minimize the potential for catastrophic loss of western pond turtle habitat in managed wetlands.

Conclusion: Less than significant. No mitigation required.

Impact WILD-20: Loss or Disturbance of Tricolored Blackbird as a Result of Managed Wetland Activities

Tricolored blackbirds may breed in emergent wetland vegetation associated with tidal and managed wetlands. Breeding would not be disturbed during construction, and impacts on breeding habitat would be minimal with implementation of the environmental commitments described in Chapter 2.

Currently implemented activities also have the potential to affect breeding habitat. However, the change in magnitude of the currently implemented managed wetland activities would not result in a substantial temporary or permanent change in foraging habitat. Enhancement of managed wetlands could result in an increase in suitable habitat for tricolored blackbirds.

Marsh management activities also would contribute to maintaining tricolored blackbird habitat. These activities would be implemented on individual parcels throughout the 30-year implementation period and would improve flood and drain capabilities and levee stability in the Marsh. The improvement of flood and drain capabilities could result in the creation or enhancement of suitable habitat in the managed wetlands. Providing levee stability would minimize the potential for catastrophic loss of breeding habitat in managed wetlands.

Conclusion: Less than significant. No mitigation required.

Impact WILD-21: Effects on Southern Resident Killer Whales as a Result of Changes in Salmon Populations Result of Managed Wetland Activities

Managed wetland activities have the potential to affect the prey base (Chinook salmon) of southern resident killer whales. If Chinook salmon populations were substantially negatively affected, a reduction in prey availability for the southern resident killer whales could occur. Reductions in prey availability may force the whales to travel longer distances to find prey or select lesser quality prey, resulting in reduced reproductive rates and higher mortality.

Some managed wetland activities could benefit Chinook salmon through water quality improvements achieved by improving flood and drain capabilities and installation of fish screens. However, activities in tidal sloughs such as dredging and riprap placement could reduce or alter Chinook salmon habitats. The portion of the killer whale prey base that comes from Suisun Marsh is small compared to Pacific Northwest and Central Valley streams. Salmon distribution and population are also affected by many factors that include ocean conditions and pollution. It is not expected that change in magnitude of currently implemented activities or the addition of new activities would affect salmon populations to the extent that a substantial change in prey base for killer whales would occur. Additionally, restoration actions would contribute to recovery of the Chinook salmon over the 30-year implementation period.

Conclusion: Less than significant. No mitigation required.

Impact WILD-22: Changes in Waterfowl Nesting and Wintering Habitat as a Result of Marsh Management Activities

Managed wetlands provide nesting and overwintering habitat for resident and migratory waterfowl. These wetlands are managed primarily for ducks and other hunted waterfowl. Marsh management activities generally are implemented in the late summer when waterfowl are not present. Activities are intended to improve habitat for these species by managing flood and drain cycles that support the desired assortment of vegetation communities and protecting managed wetland from catastrophic flood events. These activities are expected to improve the overall habitat values within the managed wetlands. As such, it is expected that the increase in magnitude of the currently implemented activities and the new activities would result in a net benefit to waterfowl.

Conclusion: Beneficial.

Impact WILD-23: Changes in Shorebird Nesting and Wintering Habitat as a Result of Marsh Management Activities

Managed wetlands provide nesting and overwintering habitat for resident and migratory shorebirds. These wetlands are managed primarily for ducks and other hunted waterfowl, but also benefit shorebirds. Marsh management activities generally are implemented in the late summer when shorebirds are not nesting or wintering. Although these activities are designed specifically to benefit ducks and other waterfowl, they are expected also to benefit shorebirds by improving habitats and reducing the likelihood of catastrophic flood events that could reduce available suitable habitats. As such, it is expected that the increase in magnitude of the currently implemented activities and the new activities would result in a net benefit to shorebirds.

Conclusion: Beneficial.

Alternative B: Restore 2,000–4,000 Acres

The types of impacts and their level of significance that would occur under Alternative B are the same as described for Alternative A. Under Alternative B, there would be less tidal restoration and more managed wetland activities than under Alternative A; therefore, impacts related to restoration would occur less frequently and impacts related to managed wetland activities would occur more frequently. In general, bird (except waterfowl), raptor, and mammal species that use managed wetlands would be exposed to a similar level of temporary changes in suitable habitat while restoration and managed wetland activities are implemented. However, the temporary magnitude of effect on suitable habitat for these species is expected to be less because less land type conversion (restoration) would occur. Long-term benefits to these species would be less because managed wetlands may not be able to provide optimum habitat that is expected to be provided by restoring parcels to tidally inundated habitats.

Alternative C: Restore 7,000–9,000 Acres

The types of impacts and their level of significance that would occur under Alternative C are the same as described for Alternative A. Under Alternative C, there would be more tidal restoration and less managed wetland subject to managed wetland activities than under Alternative A; therefore, impacts related to restoration would occur more frequently and impacts related to managed wetland activities would occur less frequently. In general, bird (except waterfowl), raptor, and mammal species that use managed wetlands would be exposed to a similar level of temporary changes in suitable habitat while restoration and managed wetland activities are implemented. However, the temporary magnitude of effect on suitable habitat for these species is expected to be greater because more land type conversion (restoration) would occur. However, long-term benefits to these species would be greater because managed wetlands may not be able to provide optimum habitat that is expected to be provided by restoring parcels to tidally inundated habitats.

Chapter 7
Land and Water Use, Social Issues, and Economics

This chapter provides environmental analyses relative to social 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 7.1, "Land and Water Use";
- Section 7.2, "Social and Economic Conditions";
- Section 7.3, "Utilities and Public Services";
- Section 7.4, "Recreation Resources";
- Section 7.5, "Power Production and Energy";
- Section 7.6, "Visual/Aesthetic Resources";
- Section 7.7, "Cultural Resources";
- Section 7.8, "Public Health and Environmental Hazards";
- Section 7.9, "Environmental Justice"; and
- Section 7.10, "Indian Trust Assets."

Section 7.1
Land and Water Use

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on land and water use.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts.

The environmental changes associated with the alternatives are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 7.1-1 summarizes land and water use impacts from implementing the SMP alternatives. There are no significant impacts on land and water use from implementing the SMP alternatives.

Table 7.1-1. Summary of Land and Water Use Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
LU-1: Alteration of Existing Land Use Patterns	A, B, C	Less than significant	None required	–
LU-2: Conflict with Existing Land Use Plans, Policies, and Regulations	A, B, C	No impact	–	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
LU-3: Conflict with Any Applicable Habitat Conservation Plan or Natural Community Conservation Plan	A, B, C	No impact	–	–
Managed Wetland Activities Impacts				
LU-1: Alteration of Existing Land Use Patterns	A, B, C	Less than significant	None required	–
LU-2: Conflict with Existing Land Use Plans, Policies, and Regulations	A, B, C	No impact	–	–
LU-3: Conflict with Any Applicable Habitat Conservation Plan or Natural Community Conservation Plan	A, B, C	No impact	–	–

Affected Environment

Sources of Information

The Solano County General Plan (Solano County 2008) was used as a source of information in the preparation of this section.

Land Use at the Project Site

Historically, Suisun Marsh consisted of tidally inundated islands separated by sloughs. Prior to human alteration, the Marsh contained 68,000 acres of tidal wetlands. Diking of the Marsh began in the mid-1860s for livestock grazing. Shortly after, the first duck clubs were established around the ponds. By the early 1900s, livestock grazing was being replaced by other agricultural activities. Increasing salinity and land subsidence caused agriculture to fail and be replaced by duck clubs. The original levees constructed for farming now provide the infrastructure of the duck clubs. Approximately 7,672 acres of tidal wetland remain (Interagency Ecological Program 2008).

Suisun Marsh is divided between the Primary Management Area and the Secondary Management Area. The Primary Management Area consists of tidal marshes, seasonal marshes, managed wetlands, and lowland grasslands within the Marsh. The intent is for this area to remain in its existing marsh and related uses as provided for in the Suisun Marsh Protection Plan. The Secondary Management Area comprises upland grasslands and agricultural lands, which provide significant buffer habitat to the Marsh (Solano County 2008). Within this area, existing grazing and agricultural uses should continue, and agricultural practices favoring wildlife use and habitat enhancement should be encouraged (Solano County 2008). Current land use in the Marsh is a mixture of privately and state-managed lands (Figure 7.1-1). Suisun Marsh has approximately 51,416 acres of managed seasonal wetlands. Most of the properties surrounding the slough and in the Marsh are privately owned duck and hunting clubs with some public recreation lands. It is home to public waterfowl hunting areas managed by DFG (13,500 acres) and 158 private duck clubs (37,500 acres). Agricultural lands in the study area are shown as grazing areas (Figure 7.1-2) and are covered under the Williamson Act (Solano County 2008).

Existing land use in the Marsh is zoned as marsh and agriculture, both having a resource conservation overlay (Figure 7.1-1). The marsh designation provides for protection of marsh and wetland areas. The land use permits aquatic and wildlife habitat, marsh-oriented recreational uses, agricultural activities compatible with the marsh environment and marsh habitat, educational and scientific research, educational facilities supportive of and compatible with marsh functions, and restoration of historical tidal wetlands (Solano County 2008).

The agriculture designation provides areas for the practice of agriculture as the primary use, including areas that contribute significantly to the local agricultural economy, and allows secondary uses that support the economic viability of agriculture. Agricultural land use designations protect these areas from intrusion by nonagricultural uses and other uses that do not directly support the economic viability of agriculture. Agricultural areas in Solano County are identified within one of 10 geographic regions. Within these regions, uses include both irrigated and dryland farming and grazing activities. Agriculture-related housing also is permitted within areas designated for agriculture to provide farm residences and necessary residences for farm labor housing (Solano County 2008).

The resource conservation overlay identifies and protects areas of the county with special resource management needs. This designation recognizes the presence of certain important natural resources in the county while maintaining the validity of underlying land use designations. The overlay protects resources by (1) requiring study of potential effects if development is proposed in these locations, and (2) providing mitigation to support urban development in cities (Solano County 2008). Resources to be protected through this overlay are those identified through technical studies as the highest priority areas within the habitat conservation planning process. Conservation measures used to achieve the County's resource goals vary based on the targeted resource. Removal of a resource conservation overlay from a subject property may be possible through a General Plan amendment (Solano County 2008).

Water Use at the Project Site

Water management for the managed wetlands within the Marsh is described generally as waterfowl habitat flooding operations and soil leaching for vegetation management. The majority of diversions occur in October and November at the beginning of the waterfowl habitat flooding period but extend into the spring. Most drainage from these managed wetlands occurs between

February and May. The wetlands generally are drained to allow vegetation growth during the summer.

Because the total managed wetland acreage is about 52,112 acres, and the flooded depth for waterfowl averages about 1 foot, the total diversions in October are likely about 52,112 acre-feet. The water used for soil leaching and evapotranspiration of the drained wetlands/vegetation in the summer is harder to estimate but would not exceed seasonal evaporation (about 4 feet). Some of this water is supplied by rainfall, so the total water diversions are likely between 100,000 and 150,000 acre-feet.

Regulatory Setting

Federal

The Farmland Protection Policy Act is discussed in detail in Chapter 10.

State

The San Francisco Bay Conservation and Development Commission is discussed in detail in Chapter 10.

California Land Conservation Act of 1965

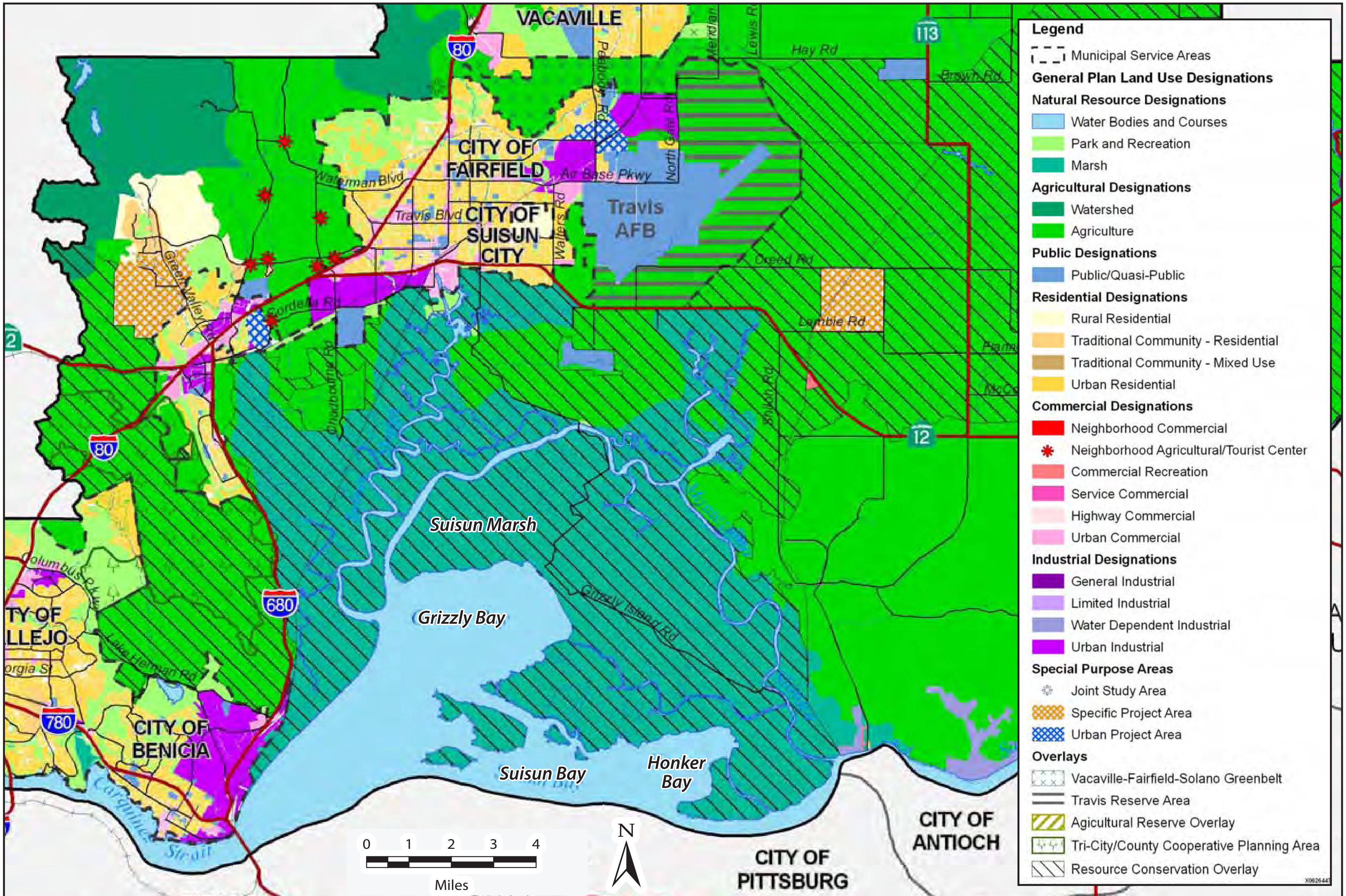
The California Land Conservation Act of 1965 (Williamson Act) helps preserve agricultural and open space lands by discouraging conversion to urban uses. The act creates an arrangement whereby private landowners enter into a 10-year contract with counties and cities to maintain their land in agricultural and compatible open-space uses in exchange for a reduction in property taxes. The contract is automatically renewed each year for 1 additional year unless the contract is non-renewed or cancelled.

Local

The County has applied Marsh Preservation and Limited Agricultural zoning districts to the Primary and Secondary Management Areas, consistent with the General Plan (Solano County 2008).

Solano County Airport Land Use Commission

The Solano County Airport Land Use Commission regulates land use around Travis Air Force Base (AFB) by recommending to cities that projects in their



Source: Solano County General Planning Documents, 2006 and 2008.

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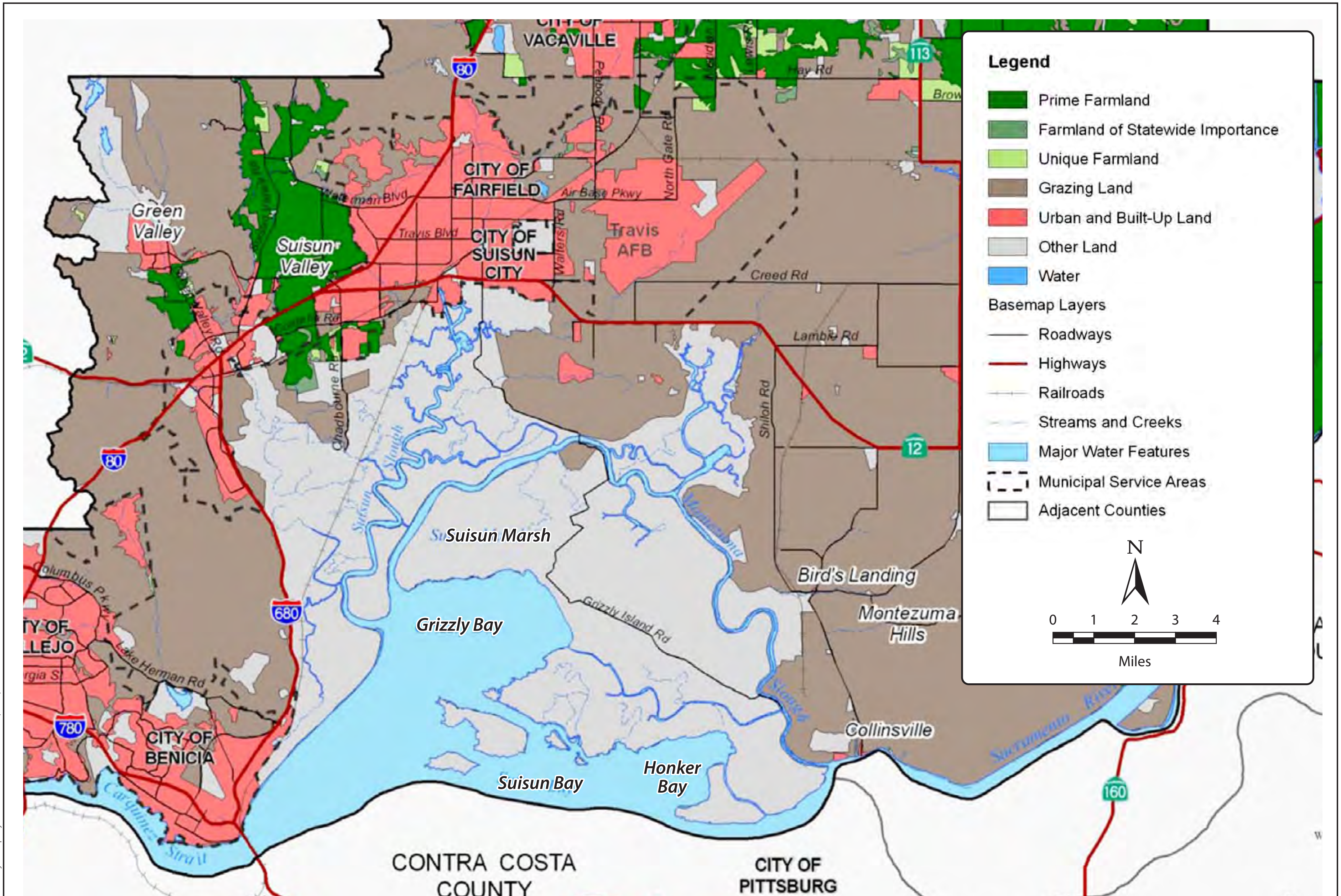
Figure 7.1-1
Land Use Diagram



Source: Solano County General Planning Documents, 2006 and 2008.

Graphics/Projects/project number/document (date) SS

Figure 7.1-2
Agricultural Lands in the Study Area

jurisdictions comply with the Travis AFB Land Use Compatibility Plan. The plan identifies land use compatibility policies applicable to future development near Travis AFB. The policies are designed to ensure that future land uses in the surrounding area would be compatible with potential aircraft activity at the base. In certain circumstances, local governments have the ability to override the decisions of the Airport Land Use Commission.

The Travis Air Force Base Land Use Compatibility Plan prohibits land uses that would create glare or distracting lights; sources of dust, steam, or smoke; sources of electrical interference with aircraft communications or navigation; or any land use (e.g., landfills) that may attract an increased number of birds. Land has been acquired to the north and east of Travis AFB and is reserved for open space or future base expansion. Areas surrounding Travis AFB also are designated as Zones A, B1, B2, C, and D (Figure 7.1-3). Compatibility Zone D, in which Suisun Marsh is located, includes all other locations beneath any of the Travis AFB airspace protection surfaces delineated in accordance with Federal Aviation Regulations Part 77. Limitations on the height of structures are the only compatibility factors within this zone.

Solano County General Plan

Wildlife habitat within the Suisun Marsh shall be managed and preserved through the following policies (Solano County 2008):

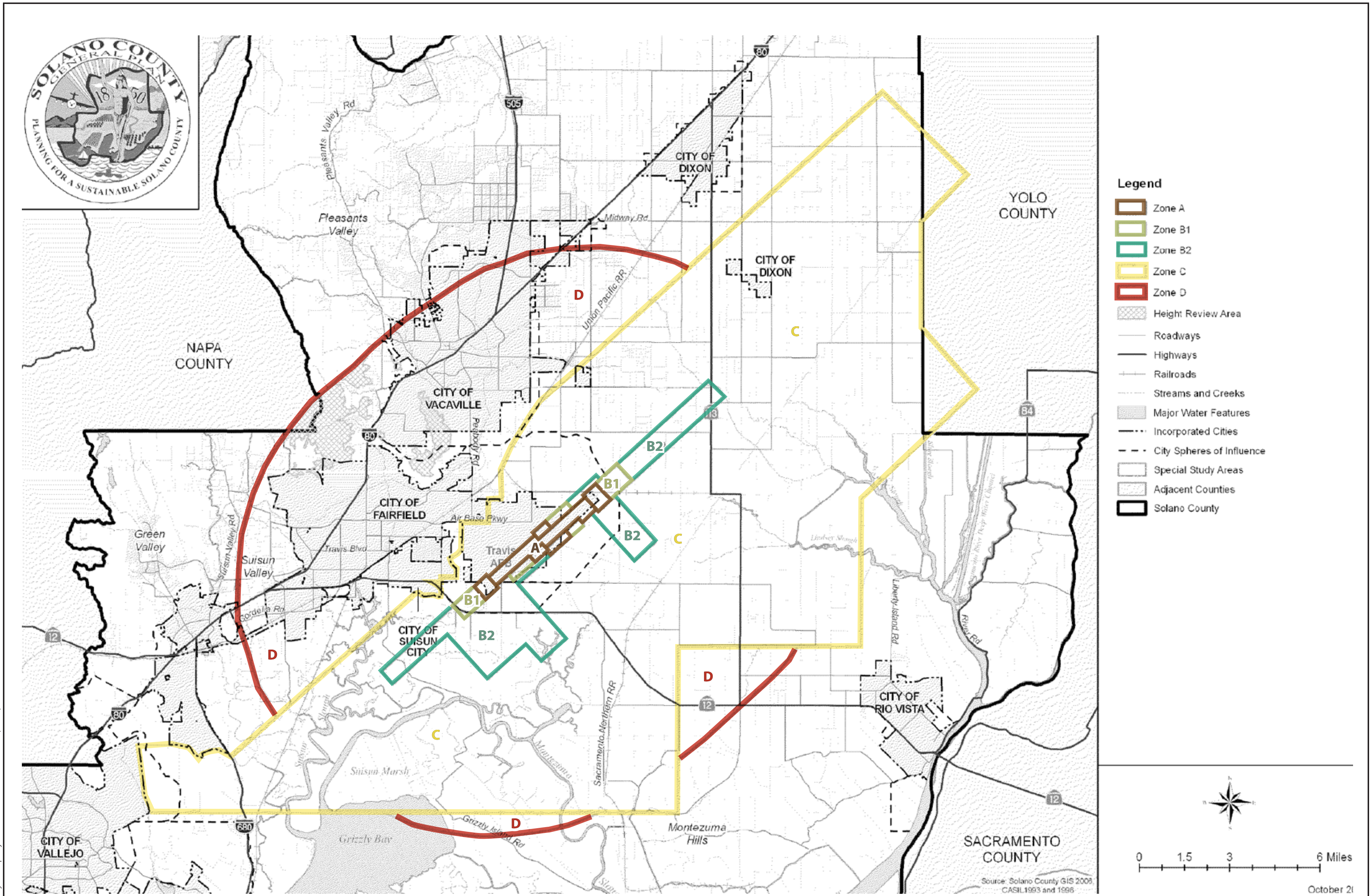
- **Policy 1.** The diversity of habitats in the Suisun Marsh and surrounding upland areas should be preserved and enhanced wherever possible to maintain the unique wildlife resource.
- **Policy 2.** The marsh waterways, managed wetlands, tidal marshes, seasonal marshes, and lowland and grasslands are critical habitats for marsh-related wildlife and are essential to the integrity of the Suisun Marsh. Therefore, these habitats deserve special protection.
- **Policy 3.** The eucalyptus groves in and around the marsh, particularly those on Joice and Grizzly Islands, should not be disturbed.
- **Policy 4.** Burning in the primary management area is a valuable management tool. However, it should be kept to a minimum to prevent uncontrolled fires that may destroy beneficial plant species and damage peat levees, and to minimize air pollution.
- **Policy 5.** Where feasible, historical marshes should be returned to wetland status, either as tidal marshes or managed wetlands. If, in the future, some of the managed wetlands are no longer needed for waterfowl hunting, they also should be restored as tidal marshes.

The following policies apply specifically to the Suisun Marsh area. These policies are more specific than the balance of the general plan to address the requirements of the *Suisun Marsh Protection Plan* and the Suisun Marsh Protection Act of 1977 (Solano County 2008).

- **RS.P-10.** The County shall preserve and enhance wherever possible the diversity of wildlife and aquatic habitats found in the Suisun Marsh and surrounding upland areas to maintain these unique wildlife resources.
- **RS.P-11.** The County shall protect its marsh waterways, managed and natural wetlands, tidal marshes, seasonal marshes and lowland grasslands, which are critical habitats for marsh-related wildlife.
- **RS.P-12.** Existing uses should continue in the upland grasslands and cultivated areas surrounding the critical habitats of the Suisun Marsh in order to protect the marsh and preserve valuable marsh-related wildlife habitats. Where feasible, the value of the upland grasslands and cultivated lands as habitat for marsh-related wildlife should be enhanced.
- **RS.P-13.** Agriculture within the Primary Management Area of the Suisun Marsh should be limited to activities compatible with, or intended for, the maintenance or improvement of wildlife habitat. These activities include extensive agricultural uses such as grain production and grazing. Intensive agricultural activities involving removal or persistent plowing of natural vegetation and maintenance of fallow land during part of the year should not be permitted.
- **RS.P-14.** Agricultural uses consistent with protection of the Suisun Marsh, such as grazing and grain production, should be maintained in the Secondary Management Area. In the event such uses become infeasible, other uses compatible with protection of the marsh should be permitted.
- **RS.P-15.** In marsh areas, the County shall encourage the formation and retention of parcels of sufficient size to preserve valuable tidal marshes, seasonal marshes, managed wetlands, and contiguous grassland areas for the protection of aquatic and wildlife habitat.
- **RS.P-16.** The County shall ensure that development in the County occurs in a manner that minimizes impacts of earth disturbance, erosion, and water pollution.
- **RS.P-17.** The County shall preserve the riparian vegetation along significant County waterways in order to maintain water quality and wildlife habitat values.
- **RS.P-18.** The County shall ensure that public access at appropriate locations is provided and protected along the County's significant waterways within the Suisun Marsh.
- **RS.P-19.** Within the watershed of the Suisun Marsh, the County shall encourage sound agricultural practices that conserve water quality and the riparian vegetation.

The following policies apply to all lands designated Agriculture on the Land Use Diagram (Solano County 2008).

- **AG.P-3.** Encourage consolidation of the fragmented pattern of agricultural preserves and contracts established under the Williamson Act and the



Source: EDAW

Graphics/Projects/project number/document (date) SS

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Figure 7.1-3
Travis Air Force Base Land Use Zones

retention of agricultural preserves and contracts in agricultural, watershed, and marshland areas.

- **AG.P-25.** Facilitate partnerships between agricultural operations and habitat conservation efforts to create mutually beneficial outcomes. Although such partnerships are to be encouraged throughout the county, additional emphasis should be focused in locations where the resource conservation overlay and agricultural reserve overlay coincide.
- **AG.P-35.** Lands within the Agriculture designations may be redesignated to Watershed or Marsh.

Environmental Consequences

Assessment Methods

Information related to land use in the Marsh was reviewed and compared to the alternatives to evaluate the potential for land use conflicts. Potential impacts were compared to the thresholds of significance described below to determine the level of significance of each impact.

Significance Criteria

The following significance criteria were used to evaluate the proposed project site. Regarding land use, the proposed project was identified as resulting in a significant impact on the environment if it would:

- conflict with any applicable land use plan, policy, or regulation of local jurisdictions, or state or federal regulatory agencies, including general plans, community plans, and zoning;
- be inconsistent or conflict with statutes of the California Coastal Act or the land use goals, objectives, or policies of BCDC or other applicable state and federal agencies;
- substantially conflict with an existing on-site land use; or
- substantially conflict with existing or future adjacent land uses.

Environmental Impacts

No Action Alternative

Under the No Action Alternative some restoration activities would occur and managed wetlands would continue to be operated, although the frequency and magnitude of managed wetland activities would likely decrease. These activities would not change land use. Therefore, no land use–related impacts would occur under the No Action Alternative.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact LU-1: Alteration of Existing Land Use Patterns

Alternative A would restore 5,000–7,000 acres of tidal wetlands. The entire Marsh would remain classified as marsh or agriculture. If agricultural lands are obtained for restoration and converted to marsh, the newly designated use is consistent with the Solano County General Plan for Agriculture, which states that agricultural land may be redesignated to marsh (See AG.P-35 above).

Although there could be a shift in site-specific uses, the overall current use of the Marsh for recreational activities (hunting, fishing, wildlife viewing, walking, etc.) would not change. Additional analysis related to specific changes in recreational use is provided in Section 7.4, Recreation Resources. However, the overall land uses in the Marsh would be consistent with current land use designations.

Conclusion: Less than significant. No mitigation required.

Impact LU-2: Conflict with Existing Land Use Plans, Policies, and Regulations

The Solano County General Plan, Suisun Marsh Protection Plan, and the Suisun Marsh Protection Act of 1977 are the primary existing policies that have jurisdiction and provide land use guidance in the plan area. These plans and act call for the preservation and enhancement of aquatic habitat wherever possible. The SMP is aligned with and intended to further these and other preexisting goals.

The Travis AFB Land Use Compatibility Plan also includes a restriction of land use in the Marsh regarding the height of any structures. The proposed project would not build any new structures beyond duck clubs and other small facilities. Additional analysis on this topic is provided in Section 5.6, Transportation and Navigation.

Conclusion: No impact.

Impact LU-3: Conflict with Any Applicable Habitat Conservation Plan or Natural Community Conservation Plan

The proposed project is a habitat management, preservation, and restoration plan and does not conflict with the existing Suisun Marsh Protection Plan (discussed above). There are no other known conservation plans that affect the proposed project area.

Conclusion: No impact.

Managed Wetland Activities Impacts

Impact LU-1: Alteration of Existing Land Use Patterns

This impact would be similar to that described for restoration activities. Under Alternative A, 44,000–46,000 acres of managed wetlands would be subject to managed wetland activities. However, the overall land uses in the Marsh would be consistent with current land use designations. The entire Marsh would remain classified as marsh or agriculture and the overall current use of the Marsh for recreational activities (hunting, fishing, wildlife viewing, walking, etc.) would not change.

Conclusion: Less than significant. No mitigation required.

Impact LU-2: Conflict with Existing Land Use Plans, Policies, and Regulations

This impact would be similar to that described for restoration activities. The SMP is consistent with land use policies and the goal of the Solano County General Plan, Suisun Marsh Protection Plan, and the Suisun Marsh Protection Act of 1977, the primary existing policies that have jurisdiction and provide land use guidance in the plan area. The Travis AFB Land Use Compatibility Plan also includes a restriction of land use in the Marsh regarding the height of any structures. The proposed project would not build any new structures beyond duck clubs and other small facilities.

Conclusion: No impact.

Impact LU-3: Conflict with Any Applicable Habitat Conservation Plan or Natural Community Conservation Plan

This impact would be similar to that described for restoration activities. The proposed project does not conflict with the existing Suisun Marsh Protection Plan (discussed above). There are no other known conservation plans that affect the proposed project area.

Conclusion: No impact.

Alternative B: Restore 2,000–4,000 Acres

Alternative B would restore 2,000–4,000 acres of marsh, leaving the remaining 46,000–48,000 acres of wetlands subject to managed wetland activities. Impacts for Alternative B are the same as for Alternative A because even though there would be less restoration than under Alternative A, the overall land uses would be consistent with all applicable planning policies.

Alternative C: Restore 7,000–9,000 Acres

Alternative C would restore 7,000–9,000 acres of marsh, leaving the remaining 41,000–44,000 acres of wetlands subject to managed wetland activities. Impacts for Alternative C are the same as for Alternative A, because even though there would be more restoration than under Alternative A, the overall land uses would be consistent with all applicable planning policies.

Section 7.2
Social and Economic Conditions

Introduction

This section describes the existing conditions and the consequences of implementing the SMP alternatives on social and economic conditions in the plan area.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing social and economic context against which the reader can understand the changes caused by the action. The setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts. For example, the setting identifies groups of people who reside in the action area because the action could change economic activity.

The changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 7.2-1 summarizes social and economic conditions impacts from implementing the SMP alternatives. There are no significant impacts on socioeconomics from implementing the SMP alternatives.

Table 7.2-1. Summary of Social and Economic Conditions Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
SOC-1: Change in Employment and Income Resulting from Construction, Restoration, and Other Expenditures	A, B, C	Beneficial	–	–
SOC-2: Changes in Employment and Income Resulting from Changes in Managed Wetland–Related Recreation Opportunities and Use	A, B, C	Beneficial	–	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
SOC-3: Changes in Property Tax Revenues as a Result of Purchasing and Restoring Private Lands	A, B, C	Less than significant	–	–
Managed Wetland Activities Impacts				
SOC-1: Change in Employment and Income Resulting from Construction Restoration, and Other Expenditures	A, B, C	Beneficial	–	–
SOC-2: Changes in Employment and Income Resulting from Changes in Managed Wetland–Related Recreation Opportunities and Use	A, B, C	Beneficial	–	–
SOC-4: Changes in Employment and Income Resulting from Increased Expenditures for Wetland Management Activities	A, B, C	Less than significant	–	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- California Department of Finance;
- California Employment Development Department;
- United States Department of Commerce, Bureau of the Census; and
- Solano County Assessor's Office.

Setting

This section describes the social and economic conditions in Solano County that could be affected by implementing the SMP alternatives. The study area for this analysis has been limited to Solano County because the plan area falls entirely within the county and changes in employment and expenditures for restoration and managed wetland activities are expected to occur primarily within the county. The three focus areas of this assessment are population, employment, and tax revenues.

Population

Population in Solano County was estimated to total approximately 425,000 residents in 2006. This represents an increase of approximately 7%

from the 2000 population of 397,000 residents. Population is projected to reach 441,000 by 2010.

Major communities in the county are Vallejo, with a population of 121,400, followed by Fairfield with 105,400 residents and Vacaville with 96,500 residents. Fairfield is located immediately northeast of Suisun Marsh.

Employment

Employment in Solano County totaled approximately 132,100 jobs in 2006 (U.S. Bureau of Labor Statistics 2008a). This represents an increase of 12% from 117,400 jobs in 2000 (U.S. Bureau of Labor Statistics 2008b). The unemployment rate in the county was 4.9% in 2006, the same as the California statewide average (California Employment Development Department 2008). The largest employment sector in the county is trade, transportation, and utilities, which accounted for 21% of total employment, followed by government accounting for approximately 20% of total employment.

Income

Personal income in Solano County totaled just over $13.7 billion in 2005. Per capita personal income in 2005 was $33,494, below the statewide average of $36,936. Median household income was approximately $57,700 in 2004, substantially higher than the statewide average of $49,900. An estimated 8.7% of the population fell below the poverty level in 2004, less than the statewide rate of 13.2%.

Tax Revenues

Sales tax revenues are distributed by the state to Solano County and incorporated cities. Sales tax revenues distributed to the county and cities totaled approximately $47.8 million in 2006 (California State Board of Equalization 2007). Fairfield received the most sales tax revenue at $14.2 million followed by Vacaville at $12.1 million. Solano County received $1.8 million in sales tax revenues in 2006.

The assessed value of property in Solano County totaled approximately $42.6 billion in 2006 (California State Board of Equalization 2007). Property taxes generated in the county totaled $408 million in 2006 (California State Board of Equalization 2007).

Environmental Consequences

Assessment Methods

Employment and Income

The analysis of potential changes in employment and income is a qualitative assessment of the changes in economic activity that may occur as a result of changes in expenditures on infrastructure maintenance and improvements and changes in recreation-related expenditures. A qualitative assessment was conducted because the location and duration of infrastructure maintenance and improvements activities are not known. A qualitative assessment of changes in recreation spending also was conducted to mirror the conclusions and assessment methods used to determine changes in recreation opportunities.

Property Tax Revenues

The potential changes in property tax revenue resulting from purchase of private lands to facilitate restoration of tidal marsh habitat were estimated by applying a semi-quantitative assessment methodology. A representative group of parcels was selected to help estimate property taxes generated for each acre of land that would be purchased. The five parcels ranged in size from approximately 50 acres to 620 acres. The assessed value of land and improvements for each parcel was determined by accessing Solano County Assessor's Office records. The average assessed value of the five parcels then was calculated, and the Solano County tax rate was applied to estimate an average per-acre property tax. This value then was used to estimate the total amount of property tax that would be generated by the land that would be purchased and converted to tidal marsh habitat. This evaluation did not attempt to estimate the rate at which lands would be purchased or converted. The analysis can be considered a worst-case assessment because it assumed all property would be purchased and converted simultaneously.

Significance Criteria

Impacts were considered significant if the plan alternatives would result in a substantial change in:

- population levels,
- employment and personal income levels, and/or
- tax revenues generated in Solano County.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, a limited amount of restoration would occur. The socioeconomic impact is considered less than significant because even though there would be a reduced frequency of managed wetland activities, no substantial change in land use or recreation opportunities resulting in changes in economic activity is expected to occur.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact SOC-1: Change in Employment and Income Resulting from Construction, Restoration, and Other Expenditures

The proposed project includes infrastructure improvements, reconstructing existing levees, constructing new levees, and restoring up to 7,000 acres of tidal wetlands. Implementing these improvements would require expenditures on labor and materials. Although the exact location, duration, and timing of these improvements are not known, it is assumed that expenditures required to implement the proposed project would be greater than the expenditures under the No Action Alternative. This increased level of expenditures is expected to benefit employment and income in the region. Although greater than the estimated management and maintenance expenditures made under the No Action Alternative, any increase in expenditures attributable to the proposed project would be very small compared to the total economic activity occurring in Solano County.

Conclusion: Beneficial.

Impact SOC-2: Changes in Employment and Income Resulting from Changes in Managed Wetland–Related Recreation Opportunities and Use

As discussed in Section 7.4, Recreation Resources, implementing Alternative A could benefit some recreation by increasing boating opportunities and increasing non-consumptive recreation opportunities by restoring up to 7,000 acres of tidal wetlands. These changes would be very small compared to the total economic activity occurring in Solano County.

New boating and non-consumptive recreation opportunities in Suisun Marsh could increase employment and income levels in Solano County as a result of increased expenditures made by recreationists visiting these new sites. Although positive compared to the No Action Alternative, these changes would be very small compared to the total economic activity occurring in Solano County.

Conclusion: Beneficial.

Impact SOC-3: Changes in Property Tax Revenues as a Result of Purchasing and Restoring Private Lands

Restoring tidal wetlands would require the purchase of private lands from willing sellers. Under Alternative A, between 5,000 and 7,000 acres of private lands may be purchased and restored as tidal wetlands. Removing 7,000 acres from the property tax role would result in an estimated annual reduction in Solano County property tax revenues of approximately $31,100. This represents substantially less than 1% of Solano County's tax revenue in 2006.

Although not substantial compared to the total property tax revenues collected by Solano County, the purchase of private lands under Alternative A would adversely affect the County's tax revenue base. Section 1504 of the California Fish and Game Code requires DFG to pay annually to counties in which wildlife areas are located fees in lieu of taxes equal to the amount of property taxes levied upon the property at the time of acquisition by the state. If the private lands purchased for purposes of tidal restoration become part of the Grizzly Island Wildlife Area or are otherwise held by DFG, they would be subject to in-lieu payments. These payments generally would offset the loss of property tax revenue.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact SOC-1: Change in Employment and Income Resulting from Construction Restoration, and Other Expenditures

This impact would be similar to that described for restoration activities. Infrastructure improvements under the proposed project would require expenditures on labor and materials. This increased level of expenditures, relative to the No Action Alternative, is expected to benefit employment and income in the region.

Conclusion: Beneficial.

Impact SOC-2: Changes in Employment and Income Resulting from Changes in Managed Wetland–Related Recreation Opportunities and Use

This impact would be similar to that described for restoration activities. Under Alternative A there could be an increase in boating opportunities and non-consumptive recreation opportunities in Suisun Marsh. This increase in recreation opportunities could increase employment and income levels in Solano County as a result of increased expenditures made by recreationists visiting these new sites.

There would be a net loss of managed wetlands, but the remaining managed wetlands would be enhanced, minimizing the loss of habitat for birds and other wildlife that provide consumptive recreation.

Conclusion: Beneficial.

Impact SOC-4: Changes in Employment and Income Resulting from Increased Expenditures for Managed Wetland Activities

As managed wetlands are restored to tidal wetlands, there could be a change in employment and income related to a decrease in managed wetland activities. However, the increased frequency of the managed wetland activities, including channel dredging, is expected to offset any losses in employment or income that may occur as a result of restoration activities.

Conclusion: Less than significant. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres

Impacts of Alternative B are similar to Alternative A. However, there would be a smaller impact on Solano County tax revenue (loss of $21,500) because fewer acres would be restored. However, impact conclusions for Alternative B are the same as for Alternative A.

Alternative C: Restore 7,000–9,000 Acres

Impacts of Alternative C are similar to Alternative A. However, there would be a greater impact on Solano County tax revenue (loss of $44,800) because fewer acres would be restored. However, impact conclusions for Alternative C are the same as for Alternative A.

Section 7.3

Utilities and Public Services

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on utilities and public services, including electricity and natural gas, water supply, stormwater, wastewater, solid waste disposal, and emergency services.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing conditions against which the reader can understand the changes caused by the action. The setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 7.3-1 summarizes utilities and public services impacts from implementing the SMP alternatives.

Table 7.3-1. Summary of Utilities and Public Services Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
UTL-1: Damage to Pipelines and/or Disruption of Electrical, Gas, or Other Energy Services during Construction or Restoration Activities	A, B, C	Significant	UTL-MM-1: Relocate or Protect Overhead Powerlines or other Utilities that Could be Affected by Construction UTL-MM-2: Avoid Ground-Disturbing Activities within Pipeline Right-of-Way	Less than significant

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
UTL-2: Damage to Utility Facilities or Disruption to Service as a Result of Restoration	A, B, C	Significant	UTL-MM-3: Relocate or Upgrade Utility Facilities that Could be Damaged by Inundation UTL-MM-4: Test and Repair or Replace Pipelines that Have the Potential for Failure	Less than significant
UTL-3: Reduction in Capacity of Local Solid Waste Landfills	A, B, C	Less than significant	None required	–
UTL-4: Increase in Emergency Service Response Times	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
UTL-3: Reduction in Capacity of Local Solid Waste Landfills	A, B, C	Less than significant	None required	–
UTL-4: Increase in Emergency Service Response Times	A, B, C	Less than significant	None required	–
UTL-5: Damage to Pipelines and/or Disruption of Electrical, Gas, or Other Energy Services during Dredging	A, B, C	Significant	UTL-MM-2: Avoid Ground-Disturbing Activities within Pipeline Right-of-Way	Less than significant

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- Solano County General Plan Update, Public Facilities and Services, EDAW; and
- Draft EIR/EIS for the ISDP, Volume I, July 1996.

Electricity

Electricity for Solano County is provided by The Pacific Gas and Electric Company (PG&E), as regulated by the California Public Utilities Commission (CPUC) and the Federal Energy Regulatory Commission. All public electrical energy for Solano County is generated outside of the county and is supplied via transmission lines. Major transmission line corridors that serve the greater metropolitan San Francisco Bay Area traverse Solano County (EDAW/AECOM 2006a).

Electricity in the plan vicinity is provided to local customers via high-voltage overhead transmission lines and distribution lines. Several sets of high-voltage transmission lines owned by PG&E traverse the Suisun Marsh area (EDAW/AECOM 2006a); however, only some islands in the Marsh have electrical service. In the event that transmission lines would need to be relocated as part of implementing the proposed project, the construction of transmission and power lines would be regulated by the CPUC.

Solano County electrical energy sources also include power plants, solar facilities, dams and hydroelectric facilities, geothermal resources, and wind facilities. Wind energy is of particular importance as Solano County's wind resource area contributes 6% of all new wind development in California and has the capacity to generate 165 megawatts (MW). Current and planned wind energy facilities are located adjacent to the eastern boundary of Suisun Marsh, in the western portion of the Collinsville–Montezuma Hills Wind Resource Area (EDAW/AECOM 2006a).

Natural Gas

Natural gas service for Solano County is provided by PG&E, as regulated by the CPUC and the Federal Energy Regulatory Commission. PG&E provides natural gas service to Solano County through underground and aboveground transmission and distribution facilities. In Solano County, natural gas distribution facilities are constructed within easements on private property and within existing streets to increase capacity (EDAW/AECOM 2006a).

Natural gas production fields are located throughout Solano County (Figure 5.3-3). Locations include Lindsey Slough, Van Sickle Island, Elkhorn Slough, Millar, Cache Slough, Sherman Island, Winters, Ryer Island, Suisun Bay, and the Rio Vista field (EDAW/AECOM 2006b).

Five working natural gas well sites are within Suisun Marsh. In addition, several energy companies are seeking county permits to drill exploratory and permanent wells in the Marsh area. Venoco Inc. of Santa Barbara conducted seismic exploration on Grizzly Island (EDAW/AECOM 2006b).

Various natural gas, product, natural gas liquids, and empty liquid pipelines run through Suisun Marsh (Figure 7.3-1). The majority of these pipelines are product and natural gas lines. On the western side of the Marsh, a product pipeline crosses under Peytonia, Boynton, and Goodyear Sloughs. On the eastern side, natural gas and product pipelines occur under Nurse and Montezuma Sloughs (U.S. Department of Transportation 1999).

Pipelines

Several pipelines traverse the Marsh as shown in Figure 7.3-1. Of greatest concern related to impacts from restoration and managed wetland activities are the three pipelines that traverse the west and east perimeters of the Marsh as shown in Figure 7.3-1. This figure shows the various pipeline alignments, and in some instances, more than 1 pipeline could be in the alignment. The scale of the figure does not allow distinction between alignments within several feet. Additionally, a pipeline serving Travis AFB runs along the northern end of the Marsh, just south of Highway 12. The pipelines that could be affected by the SMP activities transport natural gas and other usable product. Many of these pipelines traverse open water over some portion of their alignment and were constructed more than 50 years ago. They are an integral part of the transmission system. All of the pipeline locations are marked throughout the Marsh.

Water Supply and Distribution

The Marsh includes both managed wetlands and agriculture, and water supplies for these land uses are provided from within the Marsh. Water supply for managed wetlands is necessary to properly flood for habitat management. This water supply is diverted directly from the adjacent channels in the Marsh. For irrigation purposes, those in the Marsh rely entirely on groundwater unless they have individual rights to surface water supplies with Solano Irrigation District (Bell pers. comm.). Although Solano County Water Agency (SCWA) is Solano County’s wholesale water provider, they do not provide water to the Marsh.

Wastewater

No wastewater infrastructure is located in unincorporated Solano County. Wastewater needs in these locations are met by septic systems installed by individual landowners. These systems are not connected to sewer lines, but are self-contained systems permitted and inspected by Solano County (Bell pers. comm.). Most likely, there are some nonconforming systems that predate wastewater permitting that are leaching into the shallow water table.

Stormwater Drainage

The Marsh is dependent on levees for flood and high-tide protection of land, structures, and key infrastructure. The need to maintain and enhance the Delta levee system is an urgent flood control concern in Solano County (EDAW/AECOM 2006a).

Impervious surfaces in the Suisun Marsh area are limited to Grizzly Island Road and the roofs of a small number of structures. Agricultural areas are drained

Graphics … 06888.06 (03-10)

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Figure 7.3-1
Pipeline Locations in Suisun Marsh

primarily by overland flow into human-made ditches, natural drainage swales, and watercourses that discharge into Delta waterways (Bell pers. comm.).

Solid Waste Disposal

Solano County contracts solid waste management services. Various contractors serve unincorporated communities, including Allied Waste Industries, Vacaville Sanitary Service (Norcal Waste Systems), Solano Garbage Company (Waste Connections, Inc.), and Rio Vista Sanitation Service (Garaventa Enterprises). Two privately-owned landfills are located in the unincorporated Solano County—Potrero Hills Landfill (owned by Wasted Connections and located outside of Suisun City near SR 12) and Hay Road Landfill (owned by Norcal Waste Systems and located east of Vacaville and Dixon near SR-113) (Entrix and Resource Insights 1996). Potrero Hills Landfill has 3 years remaining before capacity is reached for Phase I build-out. A Phase II expansion is currently being proposed to increase the life expectancy of the facility for an additional 35 years. The Hay Road Landfill has approximately 64 years of operation remaining before reaching capacity. No new landfills are planned in the County or for use by the County. No incinerators or other non-landfill facilities in Solano County accept solid waste for disposal (Entrix and Resource Insights 1996).

Communications

AT&T (formerly SBC), provides local telephone communication service for Solano County. AT&T is one of the country's largest telecommunications providers and offers local phone service, long distance phone service, and high speed internet service. Major telephone transmission lines traverse Solano County and generally follow rights-of-way that parallel County roadways and rail lines (EDAW/AECOM 2006a).

Internet Digital Subscriber Lines (DSL) are available only in limited areas in the unincorporated County. Solano Wireless Internet (a business unit of Guacamole Press, LLC) specializes in high-speed wireless internet access to rural and unincorporated areas of Solano County. They provide service to Allendale, Cordelia, Elmira, English Hills, Green Valley, Suisun Marsh, and Travis Air Force Base (EDAW/AECOM 2006a).

The major cable television provider for Solano County is Comcast. Comcast offers a wide variety of entertainment products ranging from digital cable to high speed to "video on demand." Cable service is available in only a couple of areas in the unincorporated County (around Vallejo and Tolenas and in the Fairfield/Suisun City area (EDAW/AECOM 2006a).

Police, Fire, and Ambulance Services

The Solano County Sheriff's Department is responsible for law enforcement in unincorporated areas of Solano County and on Delta waterways, including Suisun Marsh. Emergency response uses vehicles or boats, depending on the location's accessibility, predicted response time, and availability of resources (Page pers. comm.).

The main Sheriff's office is located at 530 Union Avenue in Fairfield. The Sheriff's Office has an operating budget of $68 million and employs more than 500 people including 116 sworn law enforcement professionals. This amounts to approximately 0.006 officer per unincorporated County resident (EDAW/AECOM 2006a).

The Solano County Marine Patrol Program provides public safety resources to recreational boaters and commercial vessels operating on the navigable waterways in the county of Solano. The Marine Patrol Program is staffed with four full-time deputies. The program is operational 10 hours each day, 7 days each week, year-round, providing professional public safety services to the community. The Marine Patrol deputies are subject to callout 24 hours a day, 7 days a week to provide search and rescue operations on the waterways of Solano County (Entrix and Resource Insights 1996). Per the Penal Code, the County Sheriff's Department is responsible for criminal offenses in unincorporated Solano County (including robberies, rapes, and murders), while the Solano County CHP is responsible for traffic-related offenses (traffic accidents, DUIs, etc.) (Page pers. comm.).

Police protection services are provided by California Highway Patrol (CHP) from their Solano Office, located at 3050 Travis Boulevard in Fairfield. The Solano CHP has jurisdiction from the west end of the City of Davis to the Benicia Bridge and Carquinez Bridge. Because Suisun Marsh lies at the end of the jurisdiction of the CHP, adjacent roads are not routinely patrolled (Page pers. comm.).

The California State Department of Forestry and Fire Protection (CDF) provides fire protection to several unincorporated communities in Solano County. Suisun Marsh is primarily within the jurisdiction of Suisun Fire Protection District (FPD). The eastern and western portions of the Marsh are serviced by the Montezuma FPD and Cordelia FPD, respectively. There are no fire hydrants in the Suisun Marsh area. Montezuma FPD and Suisun FPD do not report their average response time performance (EDAW/AECOM 2006a).

Staff members in each fire district may consist of full or part-time fire fighters, administrative staff, and volunteers. CDF has 21 administrative units statewide with 806 fire stations. The Montezuma FPD has three full-time firefighters and 28 volunteers. The Cordelia FPD consists of three full-time firefighters and 55 volunteers (Entrix and Resource Insights 1996). Suisun FPD has two stations located at 4965 Clayton Road in Suisun Valley and 625 Jackson Street in Fairfield. Montezuma FPD has four stations located at 21 N. Fourth Street in

Rio Vista and in the County at 2251 Collinsville Road, 3545 Shiloh Road, and 6669 Birds Landing. Cordelia FPD has two stations, one in Suisun Valley at 1624 Rockville Road and one in Old Town Cordelia at 2155 Cordelia Road (EDAW/AECOM 2006a).

In the event of a fire emergency, the Montezuma, Cordelia, and Suisun fire departments would communicate with one another to determine the exact location of the fire and the appropriate FPD to respond, based on jurisdiction. If a fire is occurring near electric sources, the nearest FPD would respond (Solano County Office of Emergency Services 2008).

Many of the duck clubs in Suisun Marsh are gated and locked. Adjacent Fire Departments are in possession of keys to these gates (Solano County Office of Emergency Services 2008; Page pers. comm.).

The Solano Emergency Medical Services Cooperative (SEMSC), in its role as the local emergency medical service (EMS) agency, provides pre-hospital emergency care to any persons within its jurisdiction needing such service through a comprehensive and coordinated arrangement of appropriate health and safety resources (EDAW/AECOM 2006a).

Essential elements of the SEMSC's duties include:

- rapid response: to minimize the time from emergency event to arrival of resources;
- competency in practice: to apply clinical field medicine to highest standards using best practices; and
- accountability: to measure, validate, report and improve processes for the delivery of care.

Environmental Consequences

Assessment Methods

To evaluate potential impacts on public services and utilities, the Solano County General Plan and General Plan Update were reviewed to obtain information regarding known public services and utilities in the plan vicinity.

Significance Criteria

For the purposes of this analysis, impacts on public services and utilities are considered significant if implementation of the alternatives would:

- require the construction or expansion of electrical or natural gas transmission or distribution facilities;

- require the construction or expansion of a water conveyance or treatment facilities or require new or expanded water supply entitlements;
- require the construction of new or expanded stormwater drainage facilities;
- require the construction or expansion of wastewater treatment facilities;
- cause the capacity of a solid waste landfill to be reached sooner than it would without the plan;
- require the construction or expansion of communications facilities (telephone, cell, cable, satellite dish);
- adversely affect public utility facilities that are located underground or aboveground along the local roadways from project construction activities; or
- create an increased need for new fire protection, police protection, or ambulance services or adversely affect existing emergency response times or facilities.

Environmental Impacts

No Action Alternative

Under the No Action Alternative some restoration activities are assumed. However, there would be no change in the regional demand for electricity, natural gas, or communications facilities compared to existing conditions. There would also be no change in local or regional water supply distribution systems. Stormwater, wastewater, and solid waste disposal services would remain unchanged in the plan vicinity, and there would be no change in the need for police or fire protection or ambulance services in the Marsh compared to existing conditions.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact UTL-1: Damage to Pipelines and/or Disruption of Electrical, Gas, or Other Energy Services during Construction or Restoration Activities

Construction of the proposed restoration would have no impact on water conveyance or treatment facilities, stormwater drainage facilities, or communication facilities. On properties on which utilities are present, there is potential for disruption of services during construction. Restoration activities may occur on properties with overhead lines, underground pipelines, or wells. Ground-disturbing and other activities have the potential to damage these facilities or otherwise cause outages.

Conclusion: Less than significant with Mitigation Measures UTL-MM-1 and UTL-MM-2 incorporated.

Mitigation Measure UTL-MM-1: Relocate or Protect Overhead Powerlines or other Utilities that Could be Affected by Construction
If overhead utilities are present on a property that could be damaged or affected during construction or restoration activities, the specific project proponent will coordinate with the utility owner and/or operator to have the lines protected or relocated to ensure there is no potential for disruption to service or damage to the facilities during or after construction. The area of relocation would be selected to ensure that there are minimal or no sensitive resources that would be affected. Environmental commitments included in Chapter 2 will be incorporated into this activity. Relocation would occur prior to inundation.

Mitigation Measure UTL-MM-2: Avoid Ground-Disturbing Activities within Pipeline Right-of-Way
The specific project proponent will coordinate with pipeline owners and/or operators to determine the location of the pipelines and design restoration to ensure that no ground-disturbing activities occur within the right-of-way. However, ground-disturbing activities associated with the repair or replacement of the pipelines as described below under Mitigation Measure MM-UTL-4 would need to occur. These activities are intended to improve the integrity of the pipelines and therefore, would not result in any additional impacts on the pipeline. Avoidance of these areas for purposes of restoration construction would ensure that no construction-related damage or disruption to services would occur.

Impact UTL-2: Damage to Utility Facilities or Disruption to Service as a Result of Restoration

Areas restored to tidal wetlands would change the general nature of properties from seasonally flooded to tidally inundated year-round. This has the potential to affect facilities that were installed prior to inundation that were not designed to exist in a tidally-inundated environment. This could result in damage to these facilities.

Inundation could also change how owners/operators of these facilities respond to emergencies such as leaks and ruptures. Since many of the pipelines in the Marsh are older than their design life, there is potential for these pipes to leak or rupture. Due to the change in the environment from seasonally inundated to permanently inundated, repair of these leaks or ruptures would require different techniques than are currently employed. These techniques may take longer, resulting in an increased period of service disruption to customers. Damage caused by inundation or an increase in service disruption time as a result of inundation would be a significant impact.

Conclusion: Less than significant with Mitigation Measures UTL-MM-3 and UTL-MM-4 incorporated.

Mitigation Measure UTL-MM-3: Relocate or Upgrade Utility Facilities that Could be Damaged by Inundation

Pipelines or other utilities that could be damaged by inundation would be relocated or upgraded by the utility owner and/or operator based on a determination by the utility owner and/or operator that inundation could cause damage to the facilities. Relocation would occur in areas with minimal or no sensitive resources. Upgrades could include buoyancy controls, reinforcements, or other improvements that would allow the facility to continue its normal operation under the inundated condition. Relocation and/or upgrading would occur prior to inundation of the site.

Mitigation Measure UTL-MM-4: Test and Repair or Replace Pipelines that Have the Potential for Failure

All pipelines have some potential for failure, but as pipes age, this potential may increase. Prior to inundation of a site, specific project proponents will coordinate with pipeline owners and/or operators to have them test existing pipelines for leaks or other weaknesses that could result in a failure. Depending on the results of these tests, repairs to or replacement of the existing pipe may be conducted. Various methods for pipe repair and replacement exist, including directional drilling, open trench replacement, and placement of a secondary pipeline around the existing pipeline. All of these treatments would occur within or adjacent to the existing alignment right of way. The impacts of this mitigation measure are similar to other restoration impacts on traffic, noise, air quality, biological resources, cultural resources, and soils. Mitigation for impacts of these resources resulting from pipeline repair or replacement along with Environmental commitments described in Chapter 2 for major construction activities would be implemented to ensure there are no additional effects related to implementing this mitigation measure.

Impact UTL-3: Reduction in Capacity of Local Solid Waste Landfills

Construction related to the proposed restoration is not expected to generate substantial amounts of solid waste. Materials removed from levees would be reused onsite as part of the restoration. Dredged material would be used for levee reinforcement, and the small amount of waste generated during construction over the 30 year plan implementation period is not expected to substantially decrease the lifespan of landfills in the plan vicinity.

Conclusion: Less than significant. No mitigation required.

Impact UTL-4: Increase in Emergency Service Response Times

The proposed restoration would result in a temporary increase in the number of construction vehicles traveling on local roadways. These construction vehicles are not expected to cause a substantial reduction in response times by emergency service providers because there would be minimal construction vehicles, activities would occur throughout the Marsh, and roads in the Marsh generally operate at a high LOS. Additionally, emergency access via water would not be disrupted because the in-water work would not result in channel inaccessibility or other delays. See Section 5.6, Transportation and Navigation, for a more detailed discussion.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact UTL-3: Reduction in Capacity of Local Solid Waste Landfills

This impact would be similar to that described for restoration activities. Construction related to marsh maintenance activities is not expected to generate substantial amounts of solid waste. Materials removed from levees would be reused and dredged material would be used for levee reinforcement. The small amount of waste generated during construction over the 30 year plan implementation period is not expected to substantially decrease the lifespan of landfills in the plan vicinity.

Conclusion: Less than significant. No mitigation required.

Impact UTL-4: Increase in Emergency Service Response Times

This impact would be similar to that described for restoration activities. The proposed managed wetland activities would result in a temporary increase in the number of construction vehicles traveling on local roadways. However, a substantial reduction in response times by emergency service providers is not expected because there would be minimal construction vehicles, activities would occur throughout the Marsh, and roads in the Marsh generally operate at a high LOS. Additionally, emergency access via water would not be disrupted because the in-water work would not result in channel inaccessibility or other delays.

Conclusion: Less than significant. No mitigation required.

Impact UTL-5: Damage to Pipelines and/or Disruption of Electrical, Gas, or Other Energy Services during Dredging

It is assumed that implementation of the current managed wetland activities would not result in any disruptions because these activities occur in the same or similar location each time they are conducted. However, dredging has the potential to disrupt underground facilities in the dredging areas. Figure 7.3-1 depicts the location of each of the pipelines. As described above, the location of these pipelines is marked in the Marsh. To ensure that dredging does not affect pipelines and this impact is less than significant, Mitigation Measure MM-UTL-2: Avoid Ground-Disturbing Activities within Pipeline Right-of-Way, will be implemented.

Conclusion: Less than significant with Mitigation Measure UTL-MM-2 incorporated.

Mitigation Measure UTL-MM-2: Avoid Ground-Disturbing Activities within Pipeline Right-of-Way

The specific project proponent will coordinate with pipeline owners and/or operators to determine the location of the pipelines and ensure that no ground-disturbing activities occur within the right-of-way. Avoidance of these areas for purposes of dredging would ensure that no construction-related damage or disruption to services would occur.

Alternative B: Restore 2,000–4,000 Acres

Impacts for Alternative B would be the same as for Alternative A.

Alternative C: Restore 7,000–9,000 Acres

Impacts for Alternative C would be the same as for Alternative A.

Section 7.4
Recreation Resources

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on recreation resources. The SMP does not propose the construction or change of existing recreation facilities that would be evaluated in terms of impacts or significance under CEQA, but does affect certain recreational opportunities. The discussion in this section is therefore strictly a NEPA analysis regarding potential effects to recreation resources, access, and social effects such as recreational uses.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action.

The environmental changes associated with the action are discussed under Environmental Consequences.

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- Solano County General Plan (2008a), and
- Internet resources.

Suisun Marsh Recreation Use and Activities

Suisun Marsh's proximity to major highways and urban areas makes the Marsh accessible to many people. Duck hunting is the major recreational activity in the Marsh occurring from late October until January. Fishing accounts for nearly as much recreational use in the Marsh as duck hunting. In addition, several other forms of recreation such as water sports, upland game hunting, hiking, and wildlife observation are popular in the Marsh (Solano County 2008b). Much of the recreation associated with Suisun Marsh is water-dependent (boating and fishing) or water-enhanced (picnicking, hiking, hunting, and scenic/wildlife viewing). Recreation is a multimillion-dollar industry in the state. The demand for recreational resources in California is expected to increase with future population growth. Increasing demand is expected to put additional pressure on limited recreation resources and potentially contribute to deterioration of the quality of recreation experiences.

Fishing occurs year-round in the Marsh. In 2009, there were 6,600 visitors to the Grizzly Island Wildlife Area for fishing (Grizzly Island Wildlife Area Recreation User Survey 2009), and over the last several years, use of Belden's Landing for visitors for boat launching and pier fishing has ranged from 12,000 to 16,000 (Solano County Parks and Recreation 2009).

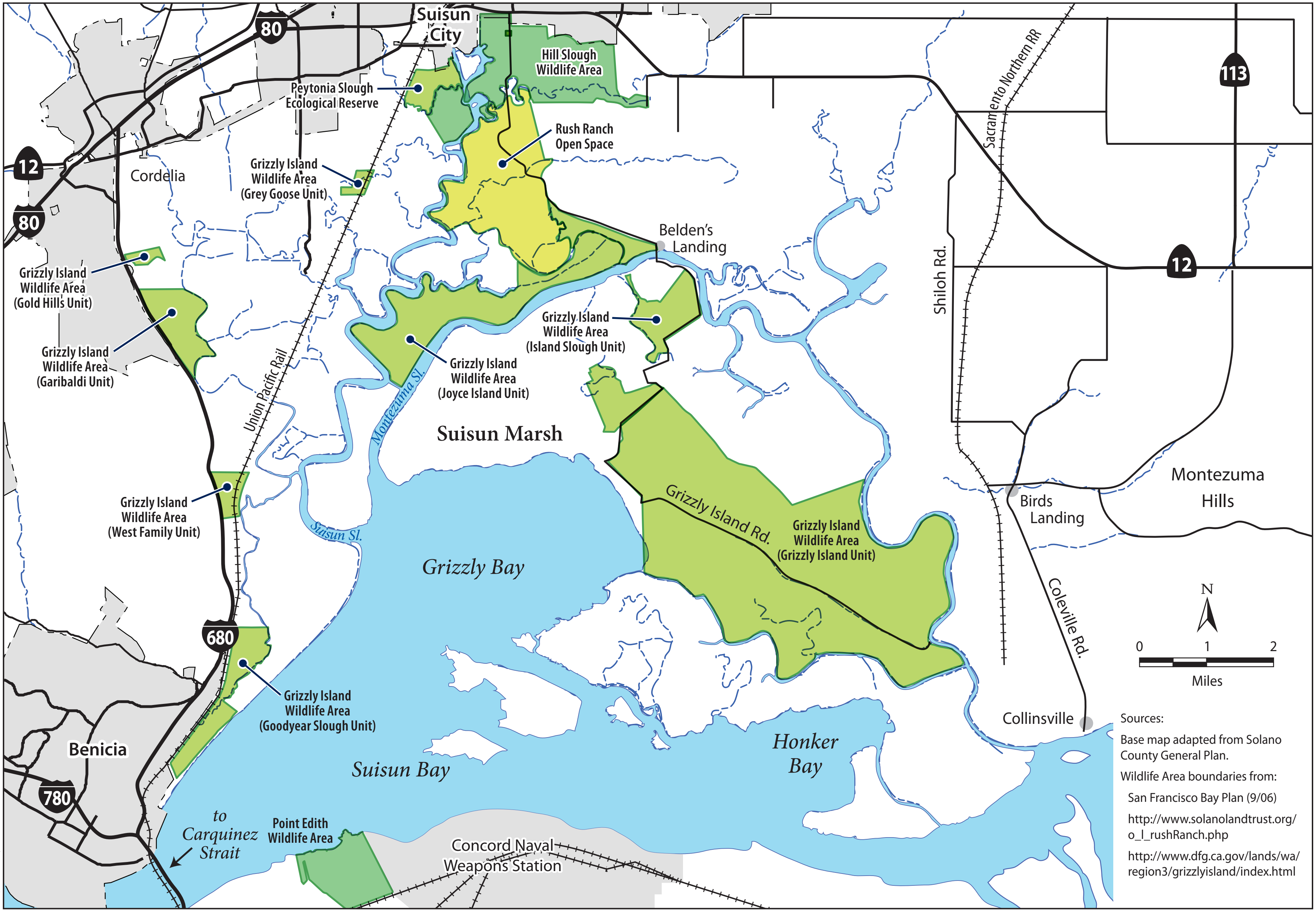
Duck hunting occurs from late October until January. Approximately 158 private duck clubs are located in the Marsh (California Department of Water Resources 2010). Private duck clubs compose approximately 37,500 acres of the Marsh and provide 41,000 waterfowl hunter days each year (Solano County Planning Department 1982). In addition to private clubs, DFG manages 15,300 acres of wildlife habitat for hunting and fishing opportunities and other public uses in the Grizzly Island Wildlife Area. Over the last several years, approximately 6,200 hunters visited Grizzly Island Wildlife Area during each hunting season (California Department of Fish and Game no date). Wildlife observation, photography, nature study, canoeing, kayaking, and motor boating are also popular recreational activities within the Marsh and occur year-a-round.

Figure 5.6-3 shows the major surface waters in and around the Marsh. Bays and minor and major sloughs compose 25,666 acres of navigable channels (Table 6.2-2). The two major channels are Montezuma and Suisun Sloughs. Suisun Slough runs from Grizzly Bay to the northern portion of the Marsh, and Montezuma Slough runs from the eastern side of Grizzly Bay to the western side, with several smaller channels diverging from it. Other navigable waterways are Cordelia, Denverton, Nurse, and Hill Sloughs.

Most of the Marsh is navigable by small boats, and some channels, such as Montezuma and Suisun Sloughs, are navigable by much larger boats. A major navigation channel, the Suisun Bay channel, connects to the Carquinez Strait. Ability to navigate or access smaller channels and outer edges of the bay is influenced by the tides and type of watercraft used.

Existing Plan Area Facilities and Access

Figure 7.4-1 shows the location of the following existing recreation areas.



Sources:

Base map adapted from Solano County General Plan.

Wildlife Area boundaries from:

San Francisco Bay Plan (9/06)

http://www.solanolandtrust.org/o_l_rushRanch.php

http://www.dfg.ca.gov/lands/wa/region3/grizzlyisland/index.html

Graphics/Projects/06888.06/ 6-EIS-EIR (09-10)

ICF INTERNATIONAL

Figure 7.4-1
Locations of Recreational Areas in Suisun Marsh

Grizzly Island Wildlife Area

Grizzly Island Wildlife Area encompasses approximately 15,300 acres in seven units dispersed throughout the Marsh. It is owned and managed by DFG. Hunting, fishing, wildlife viewing, boating, hiking, dog training, and nature tours are available at Grizzly Island. Hunting includes waterfowl, snipe, coots, moorhens, doves, pheasants, tule elk, and rabbits. Grizzly Island is also open for fishing and an extremely popular destination. Fish species caught include striped bass, catfish, white sturgeon, and the occasional largemouth bass, Chinook salmon, and steelhead. A herd of 100–150 tule elk reside on Grizzly Island. Grizzly Island access operates as follows (California Department of Fish and Game 2008b):

February–July	Open for hiking, fishing, nature viewing (dog training allowed only in February and July).
August–September	Area closed to all general public use during special tule elk hunts.
Late September	Area opens for last 1–2 weeks in September for hiking, nature viewing, fishing, and dog training.
October–January	Area closed to all general public use during waterfowl and pheasant hunting season.

Belden’s Landing Water Access Facility

Belden’s Landing Water Access Facility was purchased by the DFG in the 1980s and added to the County Parks system in spring 2002. This day-use facility includes a boat launch ramp, a fishing pier, restrooms, and parking (Solano County 2008a). As described above, visitors to this access area have ranged from 12,000 to 16,000 over the last several years.

Peytonia Slough Ecological Preserve

Peytonia Slough Ecological Preserve is open for public boating (kayaking), hiking, fishing, and wildlife observation.

Hill Slough Wildlife Area

Hill Slough Wildlife Area has 1,722 acres of tidal marsh, managed marsh, sloughs, and upland grasses (California Department of Fish and Game 2008a). Recreational angling is the number one public use, and more than 10,000 anglers use Hill Slough annually, fishing mostly for striped bass or catfish. Bird watching, hiking, and sightseeing are other popular uses that attract visitors to Hill Slough (Rogers 2001).

Suisun City Marina and Solano Yacht Club

Suisun City Marina and Solano Yacht Club are privately owned and have 153 boat slips. It is located on Suisun Channel. Gas and diesel, a pumpout station, and a launch ramp (City of Suisun City 2008) are available at the marina. Charter boats are available for bird watching. Most boats are motorized and fishing and recreational uses are the most popular activities at the marina. Most anglers catch striped bass, white sturgeon, catfish, and carp.

Suisun City Boat Launch

Suisun City Boat Launch is located on Suisun Slough and offers boat launching, picnicking, pier fishing, gas, and repairs. Kayaks and canoes can launch at the Suisun City Boat Launch free of charge.

McAvoy Yacht Harbor and Yacht Club

McAvoy Yacht Harbor and Club is located on Suisun Bay at Bay Point. Gas, a launch ramp and dock are available at the marina.

Rush Ranch

Rush Ranch is owned and managed by Solano Land Trust. It is 2,070 acres of open space, about one half is undiked tidal marsh, 80 acres are diked managed wetlands, and the remainder is upland areas of the Potrero Hills. Picnicking, hiking, and docent tours are available for groups (Rush Ranch no date).

Regulatory Setting

Federal

National Environmental Policy Act

NEPA requires that lead agencies evaluate potential effects on the built environment, which can include social effects such as those on recreational uses and facilities. As such, this section includes an analysis of potential effects on recreational uses in the Marsh.

Other Federal Plans, Programs, and Policies

There are no federal regulations, programs, or policies directly related to recreation activities.

State

California Environmental Quality Act

Unlike NEPA, CEQA requires only the evaluation of impacts on the physical environment and does not require disclosure of social impacts unless they lead to a change in the physical environment. As such, impacts described in this section related to changes in recreational uses that do not in turn result in changes to the physical environment are for purposes of meeting NEPA requirements only.

McAteer-Petris Act and San Francisco Bay Plan

The McAteer-Petris Act of 1965 established BCDC as the state agency responsible for increasing public access to the bay shoreline. The San Francisco

Bay Plan (San Francisco Bay Conservation and Development Commission 1968, as amended) was developed in response to a planning effort mandated by the McAteer-Petris Act. It encourages public access via marinas, waterfront parks, and beaches and requires the provision of maximum access along the waterfront and shorelines, except where public uses conflict with other significant uses, or where public use is inappropriate because of safety concerns. BCDC is responsible for implementing the policies of the Bay Plan.

Local

Solano County General Plan

Solano County's adopted acres-to-population park standards are 10 total acres of local and regional parkland for each 1,000 persons. As of 2002, 2,858 acres of neighborhood, community, and regional parkland were available for a population of 394,542, which results in a ratio of approximately 7.25 acres of local and regional parkland per 1,000 persons. Therefore, Solano County is currently below the established standard (Solano County 2008a).

The Solano County Park and Recreation Commission

The purpose of the Solano County Park and Recreation Commission is to:

A. act as a resource agency and advisory body to the Board of Supervisors in matters regarding park and recreation needs in Solano County as well as the protection and propagation of fish and game;

B. act in an advisory capacity to the Board of Supervisors and Planning Commission on park and recreation needs as may apply to the Solano County Code, Chapter 26, Subdivisions and California Government Code, Section 66477;

C. promote the use of park and recreation facilities and the protection and propagation of fish and game for the education, pleasure, and welfare of the Solano County residents and visitors;

D. make specific recommendations on all matters pertaining to regional parks in or adjacent to Solano County;

E. review and make recommendations to the Board of Supervisors concerning the role of Solano County on all proposed buffer zones, open spaces, and greenbelts;

F. review and evaluate implementation of the Park and Recreation Element of the Solano County General Plan and make recommendations and modifications as needed, in conjunction with all related documentation to the Board of Supervisors;

G. provide appropriate and timely review, comment, and recommendations to the Board of Supervisors on environmental impact reports, environmental impact statements, and other such reports, studies, and findings as may have an effect on the recreation facilities, either existing or proposed, of Solano County Regional Parks; and

H. conduct an annual grant award process for disbursement of fish and wildlife propagation funds, contained and designated in a separate and exclusive budget pursuant to Section 13103 of the Fish and Game Code, and make recommendations to the Board of Supervisors for approval of recommended awards (Solano County 2005).

Solano County Policies and Regulations

As described in the Solano County Policies and Regulations Governing the Suisun Marsh, the general plan also sets policies related to land use in Suisun Marsh and Secondary Management Area. The plan sets the following policies:

- within Suisun Marsh, provision should be made for public and private recreation development to allow for public recreation and access to the Marsh for such uses as fishing, boating, picnicking, hiking, and nature study;
- recreational uses in the Marsh should be located on the outer portions near population centers and easily accessible from existing roads; and
- recreation activities that could result in adverse impacts on the environment of Suisun Marsh should not be permitted.

Environmental Consequences

Assessment Methods

The impacts of implementing the proposed alternatives on recreation and public access were analyzed qualitatively, focusing on existing and proposed recreation and public access policies related to the plan area, the types of changes expected to result, and the potential of the restoration changes to adversely affect access and recreational uses in the plan area.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, some restoration and natural breaching may occur. The primary change to recreation resources would occur if natural breaches to levees were not repaired and these breaches allowed channels to form that could allow more public access via navigable waters to inland areas of the Marsh. Such a change may also result in displacing hunters from flooded private duck clubs that would no longer be suitable for managed marsh hunting.

Additionally, the reduction in frequency of managed wetland activities would reduce hunting opportunities. If the SMP is not implemented, recreational users would not reap the benefit of improved wildlife habitats in the Marsh. Under this alternative, existing conditions would persist, and changes to recreation would be minimal.

Alternatives A (Proposed Project), B, and C

The SMP action alternatives propose to convert managed wetlands to tidal wetlands and to protect and enhance existing tidal wetland acreage. Existing managed wetlands would be enhanced by implementing the managed wetland activities. The SMP does not propose the construction or change of existing recreation facilities that would be considered under CEQA, but does affect certain recreational opportunities.

Recreation areas that could be affected by restoration activities would be Belden's Landing, Peytonia Slough Ecological Preserve, Hill Slough Wildlife Area, Grizzly Island Wildlife Area, Rush Ranch, and some private duck clubs. Most land-based activities would be unaffected by actions relating to implementing the SMP or its alternatives. Non-motorized recreational boating (e.g., kayaking and canoeing) would be the most affected if velocity changes were substantial in sloughs where breaching occurred. As discussed in Section 5.1, Water Supply, Hydrology, and Delta Water Management, the highest velocities are simulated in Hunter Cut. The tidal elevation difference (caused by the lag in the tidal wave propagation) allows a large flow with a peak of about 10,000 cfs, creating velocities of about 4 feet/second in Hunter Cut; temporary velocity increases may occur as a result of restoration activities (Appendix A: Figure 5-48 on page 103 of the RMA report). Belden's Landing would remain the same for each scenario (Figure 7.4-2).

Over the 30-year implementation of the SMP, up to 7,000 acres of managed wetlands that provide hunting opportunities would be purchased from willing sellers and converted to tidal wetlands. This represents a potential loss of up to 10% of existing managed wetlands. Some of these restored tidal wetlands within public ownership should continue to provide waterfowl and other hunting opportunities. These new areas should be accessible via navigable sloughs or existing public access areas. Remaining private duck clubs within the Marsh would continue their operations. The conversion to tidal wetlands may alter use patterns of these areas by dabbling ducks which are favored by local Marsh hunters and clubs. This waterfowl guild includes mallard, gadwall, northern shoveler, northern pintail, green-winged teal, and Canada goose. Additionally, the shift from managed to tidal wetlands as a result of the club owners willful sale of their property, may reduce the total number of private hunters allowed in the Marsh on busy days, such as opening day of the hunting season, due to the reduction in acres of managed wetlands. It is expected however, that existing and newly restored public lands and the remaining duck clubs would provide plenty of hunting opportunities during most days of the year. Additionally, the tidal restoration areas will attract many species of wildlife, including shorebirds, threatened and endangered species, and numerous dabbling and diving ducks. Fishing opportunities may increase due to the increase in tidal wetland and open-water habitats via navigable waters. Although there would be some displacement of dabbling duck habitat through tidal marsh restoration, other forms of wildlife habitat will be created. Hunting and other recreational activities still would occur on the public lands and public opportunity may increase as a result of the tidal restoration.

Most of the land surrounding the Marsh is private. Public recreational access within the Marsh is primarily via county roads, navigable waters, and publically owned land and designated areas.

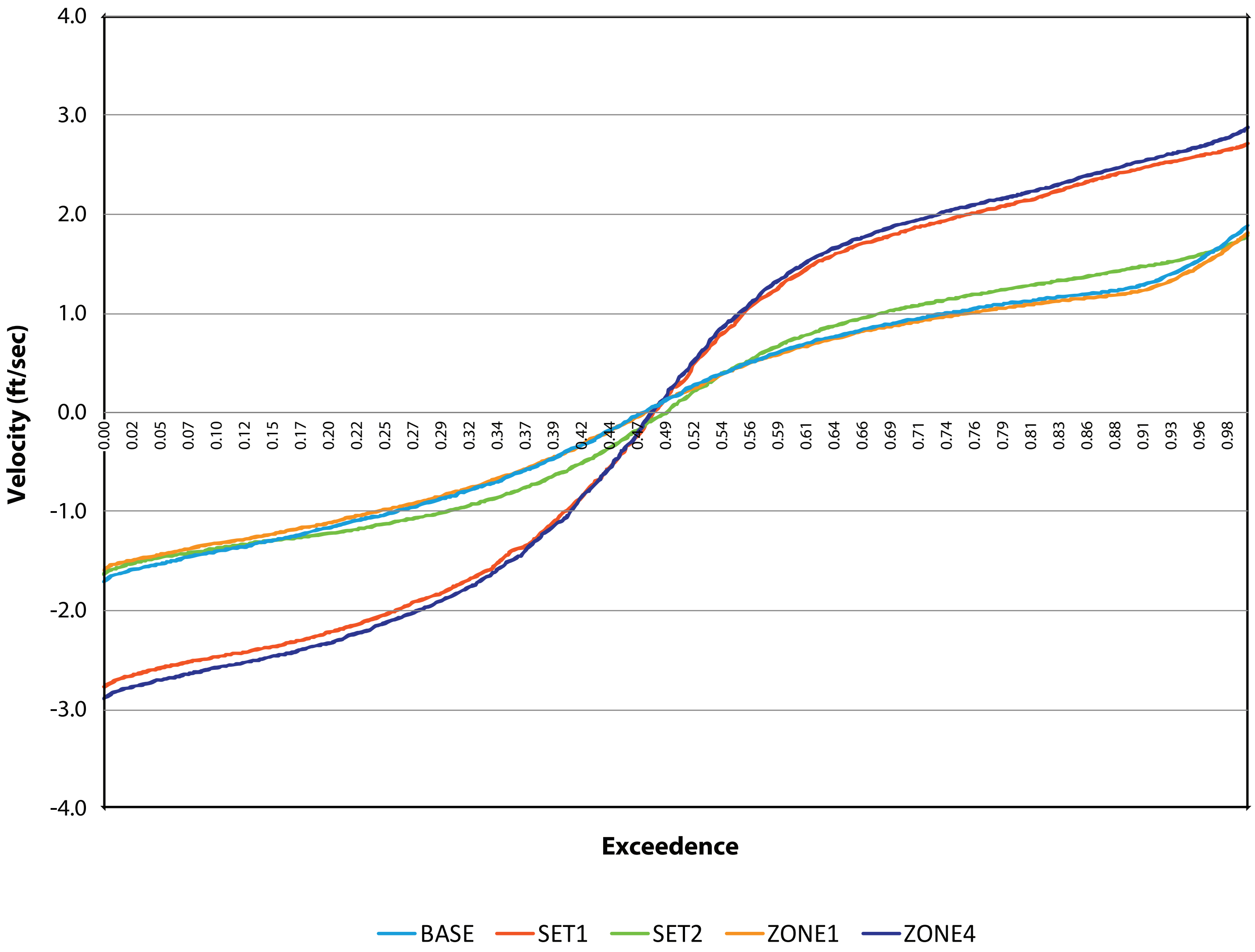
Restoration activities that affect the waterside of exterior levees could temporarily disrupt recreational boating, personal watercraft use, and fishing in the area. In-channel or near-channel work may require that a portion of the channel be temporarily blocked to reduce the risk of boating hazards. Restoration activities are not proposed to occur in established recreation areas.

Environmental commitments related to these effects include:

- construction and restoration activities will occur in a manner that allows boating access through half the channel cross section at all times;
- construction will not occur during major summer holiday periods;
- warning signs and buoys will be posted at, upstream of, and downstream of all construction equipment, sites, and activities; and
- adequate warning will be provided regarding activities and equipment in construction sites.

The plan would result in a net increase in navigable areas, thus increasing potential boating opportunities in the Marsh. Velocities are not expected to change at Belden’s Landing (Figure 7.4-2), where boat launching occurs. Modeling shows there may be a temporary increase in velocity at Hunter Cut (Appendix A). Velocity changes are not expected to be significant in other sloughs (See Impact HYD-2). Existing areas presently accessed by motorized boats would not be affected by increased velocities because breaches would be designed to ensure that velocities do not exceed 2fps. However, kayaks, canoes, and other non-motorized boats may have trouble traversing or traveling past areas that are newly breached during incoming or outgoing tides. This difficulty would be temporary, and as described in Chapter 2 under Environmental Commitments, warning signs and buoys will be installed to direct boaters to safe locations and routes. Restoration is expected to occur throughout the Marsh over 30 years, resulting in minor, sporadic, temporary changes in velocities in localized areas.

Managed wetland activities that affect the waterside of exterior levees, such as replacing riprap on exterior levees, could temporarily disrupt recreational boating, personal watercraft use, and fishing in the area.



Source: RMA 2008, Numerical Modeling in Support of Suisun Marsh PEIR/EIS

Graphics/Projects/project number/document (date) SS

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Figure 7.4-2
Velocity Distributions for the Five Scenarios at Belden's Landing, July 2002

Proposed dredging activities on the sloughs throughout Suisun Marsh could temporarily disrupt boating access, personal watercraft use, and fishing during operation of dredging equipment from a barge. Boating and other recreation access would be restricted in the dredged area while equipment is operating, which could result in delays in or temporary loss of recreation opportunities on the slough. Dredging activities could occur in center channels, adjacent to fish screens, and in historical dredger cuts. The disruption of recreational boating in the area would be temporary and the environmental commitment described in Chapter 2 to reduce construction-related effects on recreational boating will be implemented. This environmental commitment includes measures to ensure that:

- construction will not occur during major summer holiday periods;
- in sloughs and exterior waters, warning signs and buoys will be placed at, upstream of, and downstream of all construction equipment, sites, and activities;
- adequate warning will be provided regarding activities and equipment in construction sites to recreationists by postings and/or notices; and
- signs describing alternate boating routes will be posted in convenient locations when boating access is restricted.

Section 7.5
Power Production and Energy

Introduction

This section describes the existing conditions and the consequences of implementing the SMP alternatives on power production and energy resources.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing context against which the reader can understand the changes caused by the action. The setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts.

The environmental changes associated with the alternatives are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 7.5-1 summarizes impacts on power production and energy from implementing the SMP alternatives. There would be no significant impacts on power production and energy from implementing the SMP alternatives.

Table 7.5-1. Summary of Impacts on Power Production and Energy

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
POW-1: Substantial Temporary Increase in Energy Use during Construction and Restoration Activities	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
POW-2: Substantial Temporary Increase in Energy Use during Construction and Managed Wetland Activities	A, B, C	Less than significant	None required	–

Affected Environment

Sources of Information

The following key source of information was used in the preparation of this section:

- Energy Background Report. Solano County General Plan Update. August 2006.

Environmental Setting

Solano County electrical energy sources include power plants, wind facilities, solar facilities, dams and hydroelectric facilities, and geothermal resources. Imported fossil fuels make up the vast majority of transportation fuels. All public electrical energy for Solano County is supplied via transmission lines by PG&E, some of which pass through the Suisun Marsh Region (EDAW/AECOM 2006).

Renewable energy and conservation measures are important elements of Solano County's energy management, with wind energy being of particular importance. Solano County wind resource area contributes 6% of all new wind development in California, has a capacity to generate 165 megawatts (MW), and produces 102 gigawatt hours (GWh) of wind power generation, with most of that power produced during spring and summer (April through September) when winds are stronger (California Energy Commission). Current and planned wind energy facilities are located in the western portion of the Collinsville-Montezuma Hills Wind Resource Area, which is adjacent to the eastern boundary of the Suisun Marsh region (EDAW/AECOM 2006).

Natural gas production fields are located throughout Solano County with locations including Lindsey Slough, Van Sickle Island, Elkhorn Slough, Millar, Cache Slough, Sherman Island, Winters, Ryer Island, Suisun Bay, and the Rio Vista field. In December 2005, from these fields in Solano County 1,030,173 million cubic feet (mcf) of gas were produced, with the daily production of 33,231 mcf from 148 operational wells (California Department of Conservation 2005). Many of these fields are located within the Suisun Marsh region (EDAW/AECOM 2006). Gas pipelines are located in the Marsh and are discussed in Chapter 7.3, Utilities.

Three geothermal springs have been identified in Solano County, all in the western portion. These are of a low temperature and thus not used for electric power generation. However, the potential for new sources capable of electric power generation does exist (EDAW/AECOM 2006).

Solar and hydroelectric facilities are not located in the plan area and therefore would not be affected by the SMP.

Transportation fuels are primarily fossil fuel–derived and imported. Solano County has a major petroleum refinery located in Benicia to the west of the plan area (EDAW/AECOM 2006) that would not be affected by implementation of the SMP. Consumption of fossil fuels would temporarily increase during restoration and related activities as a result of pumping, dredging, transportation, etc., but not in a wasteful manner.

Environmental Consequences

Assessment Methods

The following qualitative evaluation was based on the description of basic actions for each of the alternatives addressed in Chapter 2. Because all of the SMP alternatives include the same basic components but differ in the amount of tidal wetland restored and managed wetlands subject to managed wetland activities, the primary difference is not the actions themselves, but rather their scale. Therefore, a range of potential effects is addressed in the Environmental Impacts section below. Effects assessed are based on potential impacts on energy consumption and generation.

Significance Criteria

Evaluation of SMP effects on power production and energy was based on criteria used in the CALFED Bay-Delta Program Final Programmatic EIS/EIR (July 2000), the SFO Environmental Analysis of Tidal Marsh Restoration in San Francisco Bay (Jones & Stokes 2001), and those suggested in Appendix G of the State CEQA Guidelines. Based on these criteria an effect would be considered significant if implementation of the plan:

- causes net electricity consumption to increase substantially, causing availability reduction to other customers—for this analysis, a substantial increase is defined as an increase in net electricity consumption of more than 5% on existing supply infrastructure during an average year or any single month of an average year;
- causes utility rates to increase to levels higher than available in open-market conditions;
- encourages activities that result in the use of large amounts of fuel or energy in a wasteful manner; or
- requires or results in construction of new electrical power or transmission facilities or expansion of existing facilities, the construction of which causes substantial effects.

Environmental Impacts

No Action Alternative

Power production and energy impacts under the No Action Alternative would be minimal. Although the limited activities of maintenance, levee alterations, dredging, pumping, etc., involved in the estimated restoration would temporarily increase energy consumption, it would not be considered wasteful or substantial.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact POW-1: Substantial Temporary Increase in Energy Use during Construction and Restoration Activities

Under Alternative A, 5,000–7,000 acres of the Marsh would be restored to fully functioning, self-sustaining tidal wetlands, and 44,000 to 46,000 acres of managed wetlands would be enhanced.

Restoration activities would include upgrading or constructing new exterior levees, breaching levees, and dredging. These activities have the potential to be energy intensive. However, actions would have limited influence on the electrical grid and depend primarily on on-site energy generation (e.g., internal combustion engines). This would temporarily increase fuel use and emissions but not in a wasteful or substantial manner.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities Impacts

Impact POW-2: Substantial Temporary Increase in Energy Use during Construction and Managed Wetland Activities

This impact would be similar to Impact POW-1, described for restoration activities. Managed wetland activities include modifying levees, breaching levees, and dredging. These activities have the potential to be energy intensive, but would likely have limited influence on the electrical grid and depend primarily on on-site energy generation (e.g., internal combustion engines). This would temporarily increase fuel use and emissions but not in a wasteful or substantial manner.

Conclusion: Less than significant. No mitigation required.

Alternative B: Restore 2,000–4,000 Acres

Impacts for Alternative B would be the same as for Alternative A.

Alternative C: Restore 7,000–9,000 Acres

Impacts for Alternative C would be the same as for Alternative A.

Section 7.6
Visual/Aesthetic Resources

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on visual/aesthetic resources.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts. For example, the setting identifies groups of people who have views of the action area because the action could change their views and experiences.

The environmental changes associated with the action alternatives are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 7.6-1 summarizes impacts on visual/aesthetic resources from implementing the SMP alternatives. There would be no significant impacts on visual/aesthetic resources from implementing the SMP alternatives.

Table 7.6-1. Summary of Impacts on Visual/Aesthetic Resources

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
VIS-1: Temporary Changes in Views Caused by Construction Activities	A, B, C	Less than significant	None required	–
VIS-2: Temporary Changes in Views Caused by Habitat Reestablishment Period	A, B, C	Less than significant	None required	–

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
VIS-3: Changes in Views to and from Suisun Marsh	A, B, C	Less than significant	None required	–
VIS-4: Damage to Scenic Resources along Scenic Highway	A, B, C	No impact	–	–
VIS-5: Create a New Source of Light and Glare That Affects Views in the Area	A, B, C	Less than significant	None required	–
VIS-6: Conflict with Policies or Goals Related to Visual Resources	A, B, C	No impact	–	–
Managed Wetland Activities Impacts				
VIS-1: Temporary Changes in Views Caused by Construction Activities	A, B, C	Less than significant	None required	–
VIS-3: Changes in Views to and from Suisun Marsh	A, B, C	Less than significant	None required	–
VIS-4: Damage to Scenic Resources along Scenic Highway	A, B, C	No impact	–	–
VIS-5: Create a New Source of Light and Glare That Affects Views in the Area	A, B, C	Less than significant	None required	–
VIS-6: Conflict with Policies or Goals Related to Visual Resources	A, B, C	No impact	–	–

Concepts and Terminology

Identifying a project area's visual resources and conditions involves three steps:

1. objective identification of the visual features (visual resources) of the landscape;
2. assessment of the character and quality of those resources relative to overall regional visual character; and
3. determination of the importance to people, or *sensitivity*, of views of visual resources in the landscape.

The aesthetic value of an area is a measure of its visual character and quality, combined with the viewer response to the area (Federal Highway Administration 1988). Scenic quality can best be described as the overall impression that an individual viewer retains after driving through, walking through, or flying over an area (U.S. Bureau of Land Management 1980). Viewer response is a combination of viewer exposure and viewer sensitivity. Viewer exposure is a function of the number of viewers, number of views seen, distance of the viewers, and viewing duration. Viewer sensitivity relates to the extent of the public's concern for a particular viewshed. These terms and criteria are described in detail below.

Visual Character

Natural and artificial landscape features contribute to the visual character of an area or view. Visual character is influenced by geologic, hydrologic, botanical, wildlife, recreational, and urban features. Urban features are those associated with landscape settlements and development, including roads, utilities, structures, earthworks, and the results of other human activities. The perception of visual character can vary significantly seasonally, even hourly, as weather, light, shadow, and elements that compose the viewshed change. The basic components used to describe visual character for most visual assessments are the elements of form, line, color, and texture of the landscape features (USDA Forest Service 1995; Federal Highway Administration 1988). The appearance of the landscape is described in terms of the dominance of each of these components.

Visual Quality

Visual quality is evaluated using the well-established approach to visual analysis adopted by the Federal Highway Administration, employing the concepts of vividness, intactness, and unity (Federal Highway Administration 1988; Jones et al. 1975), which are described below.

- **Vividness** is the visual power or memorability of landscape components as they combine in striking and distinctive visual patterns.
- **Intactness** is the visual integrity of the natural and human-built landscape and its freedom from encroaching elements; this factor can be present in well-kept urban and rural landscapes and in natural settings.
- **Unity** is the visual coherence and compositional harmony of the landscape considered as a whole; it frequently attests to the careful design of individual components in the landscape.
- **Visual quality** is evaluated based on the relative degree of vividness, intactness, and unity, as modified by its visual sensitivity. High-quality views are highly vivid, relatively intact, and exhibit a high degree of visual unity. Low-quality views lack vividness, are not visually intact, and possess a low degree of visual unity.

Visual Exposure and Sensitivity

The measure of the quality of a view must be tempered by the overall sensitivity of the viewer. Viewer sensitivity or concern is based on the visibility of resources in the landscape, proximity of viewers to the visual resource, elevation of viewers relative to the visual resource, frequency and duration of views, number of viewers, and type and expectations of individuals and viewer groups.

The importance of a view is related in part to the position of the viewer of the resource; therefore, visibility and visual dominance of landscape elements depend on their placement in the viewshed. A viewshed is defined as all of the surface area visible from a particular location (e.g., an overlook) or sequence of locations (e.g., a roadway or trail) (Federal Highway Administration 1988). To identify the importance of views of a resource, a viewshed must be broken into distance zones of foreground, middleground, and background. Generally, the closer a resource is to the viewer, the more dominant it is and the greater its importance to the viewer. Although distance zones in a viewshed may vary between different geographic region or types of terrain, the standard foreground zone is 0.25–0.5 mile from the viewer, the middleground zone from the foreground zone to 3–5 miles from the viewer, and the background zone from the middleground to infinity (USDA Forest Service 1995).

Visual sensitivity depends on the number and type of viewers and the frequency and duration of views. Visual sensitivity is also modified by viewer activity, awareness, and visual expectations in relation to the number of viewers and viewing duration. For example, visual sensitivity is generally higher for views seen by people who are driving for pleasure; people engaging in recreational activities such as hiking, biking, or camping; and homeowners. Sensitivity tends to be lower for views seen by people driving to and from work or as part of their work (USDA Forest Service 1995; Federal Highway Administration 1988; U.S. Soil Conservation Service 1978). Commuters and non-recreational travelers have generally fleeting views and tend to focus on commute traffic, not on surrounding scenery; therefore, they generally are considered to have low visual sensitivity. Residential viewers typically have extended viewing periods and are concerned about changes in the views from their homes; therefore, they generally are considered to have high visual sensitivity. Viewers using recreation trails and areas, scenic highways, and scenic overlooks usually are assessed as having high visual sensitivity.

Judgments of visual quality and viewer response must be made based on a regional frame of reference (U.S. Soil Conservation Service 1978). The same landform or visual resource appearing in different geographic areas could have a different degree of visual quality and sensitivity in each setting. For example, a small hill may be a significant visual element on a flat landscape but have very little significance in mountainous terrain.

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- direct observation through a site visit occurring on November 1, 2007;
- Suisun Marsh land ownership map; and
- Google Earth.

Regional Character

Suisun Marsh is located east of San Pablo Bay and the Carquinez Strait in the Delta, just south of Suisun City and Fairfield, Solano County. The plan region, as discussed in this section, is considered the area within 30 miles of a project site. The greater San Francisco Bay region is a complex system of mountain ranges, valleys, and waterways that together create areas that are unique and not only define the character of the region but also contribute to the overall character of California. Some of these notable areas include the wine country of the Napa and Sonoma Valleys, the distinctive urban center of San Francisco, and the vertical cliffs of the Marin Headlands' Pacific coastline. In addition, the region is characterized by panoramic views from the Berkeley/Oakland hills; rolling hillsides whose grasslands range from green and sprinkled with wildflowers in the spring to brown contrasting against stately valley oaks with dark green foliage in the summer; and numerous waterways traversed by vessels ranging from enormous tankers to small sailboats.

The plan region is characterized by a mix of industrial, commercial, residential, agricultural, and public open space uses. Waterfront industry is an established element in this setting and locally includes the C&H sugar refinery in Crockett and oil refineries in Hercules, Martinez, Benicia, and Richmond. The region has many public open space areas, including the Mount Diablo State Park to the south; Benicia State Recreation Area, Carquinez Strait Regional Park, and San Pablo Bay National Wildlife Refuge to the west; and the Point Pinole Regional Shores and Wildcat Canyon Regional Parks and the Golden Gate National Recreation Area to the southwest. Major waterways in the region are the Pacific Ocean; Suisun, Grizzly, Honker, San Pablo, San Rafael, and San Francisco Bays; Sacramento, San Joaquin, Napa, and Petaluma Rivers; Mare Island and Carquinez Straits; and numerous other sloughs, creeks, and tidally influenced waterways of the Bay-Delta.

Vicinity Character

The project vicinity is defined as the area within 0.5 mile of a project site. The character of Suisun Marsh is influenced by its geographic setting and the historical, present, and future planned uses on the Marsh. The Marsh is bounded by Interstate 80 (I-80) and Highway 12 to the north; Montezuma Hills to the east; Grizzly, Suisun, and Honker Bays to the south; and Sulphur Springs Mountain to the west. Key viewpoints, shown in Figure 7.6-1, have been chosen for their representation of the views within the Marsh. The Sacramento Northern Railroad runs along the eastern border and into the southeastern portions of the Marsh, and the Union Pacific runs through the western portion, both lines carrying freight cars (Figure 7.6-2, Photo 1). The Marsh is relatively flat and is submerged land, tidal marsh, or managed wetlands. The Potrero Hills and Kirby Hill offer the greatest topographic relief, each rising more than 100 feet in the northern and eastern reaches of the Marsh, respectively (Figure 7.6-2, Photo 2). Sloughs of the Marsh form dendritic channel patterns that wind and branch through the low-lying landscape. Many of these channels are contained by the low levees that have contributed to maintaining historical channel patterns. A few human-made channels have been created to allow access to areas of the Marsh, such as Roos Cut, or to connect sloughs, such as the Suisun and Montezuma Sloughs connector, Hunter Cut.

Development in the Marsh historically was patterned by the functions associated with early agricultural practices, dairy mike production, beef cattle grazing and managing the land for waterfowl hunting. Land parcels are divided by levees to create a visible patchwork of land ownership that still persists. Prior to the static footprint imposed by humans upon the landscape, the Marsh was a highly naturalized system of tidally influenced marshland that metamorphosed through tidal action, sedimentation, vegetation establishment, and weathering. The Marsh lacked the trappings of infrastructure needed to maintain the static footprint and intended land use, including levees, riprap, outfalls, flap gates, roadways, utility lines, and buildings. Prior to the presence of infrastructure, sweeping and uninterrupted views would have been present over the Marsh.

Presently, the numerous navigable waterways allow inland access to much of the Marsh and provide view corridors. Utilities and infrastructure present in the plan area include wooden utility poles and lines, drainage outfalls, riprap, piers and pylons, and buildings but are not very invasive and do not detract greatly from overall character of the Marsh (Figure 7.6-2, Photos 3 and 4). The form and natural character of the Marsh; its geographic location in the landscape; outstanding views offered by, of, and from the Marsh; and abundance of wildlife combined with the presence of human-made elements contribute to a setting that is moderately high in vividness, intactness, and unity to create an overall visual character that is moderately high.

Existing Viewer Groups and Viewer Responses

Residents

The largest cities surrounding Suisun Marsh are Suisun City and Fairfield to the north; Pittsburg, Bay Point, and Martinez to the south; and Benicia to the west. The outskirts of these cities have scenic views of Grizzly, Suisun, and Honker Bays and the outline of opposite landforms and larger vegetation massings, but the distance between the Marsh and cities makes detail of the Marsh indistinguishable from those vantages. Because of the distance from the site, these residents are considered to have low sensitivity to visual changes resulting from implementing the SMP alternatives.

Residents on parcels of land within the Marsh are very few, but they are physically closer to the terrestrial and aquatic features that give the Marsh its astounding scenic quality. These residents have chosen to live here for those scenic qualities and for the resources offered by the Marsh, such as boating, fishing, wildlife viewing, and hunting. Residents within the Marsh are likely to

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Figure 7.6-1
Key Viewpoints and Photo Locations

Photo 1. Looking northwest from Cordelia Slough toward the Union Pacific Railroad. Note eucalyptus trees in the middle right of the photo and the Sulpher Spring Mountains in the background.

Photo 2. Looking southeast from Suisun Slough towards Potrero Hills.

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Figure 7.6-2
Representative Photographs of the Project Area

Photo 3. This photo depicts an outfall structure that is common to the project area.

Photo 4. This photo depicts common infrastructure in the marsh including a pier and pylons, outfall structure, and riprap (inset). The building in the inset photo is the lower Joice Island Fish Screen Facility.

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Figure 7.6-2 (continued)
Representative Photographs of the Project Area

Photo 5. This photo depicts boating recreational use within the marsh.

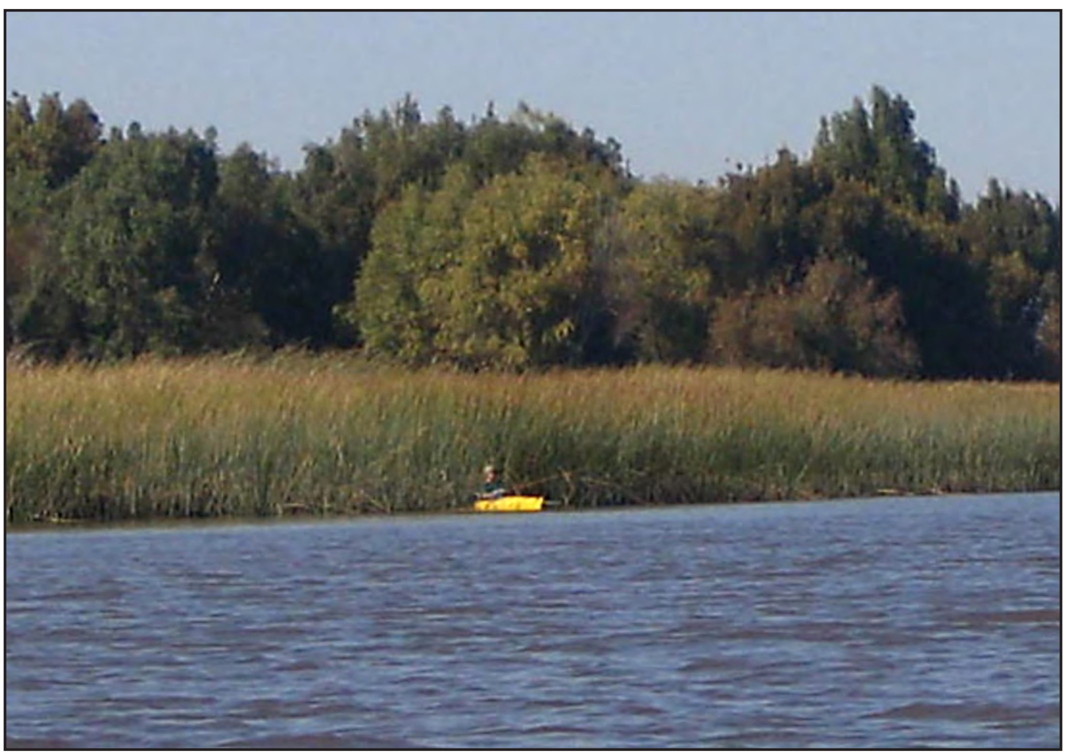

Photo 6. This photo depicts kayaking and fishing recreational uses within the marsh.

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Figure 7.6-2 (continued)
Representative Photographs of the Project Area

Photo 7. This photo depicts water-based hunting recreational use within the marsh.

Photo 8. This photo depicts land-based fishing recreational uses within the marsh.

Photos 9 and 10. These photos depict picturesque views within the marsh.

Photos 11 and 12. These photos depict how atmospheric conditions, such as fog, create picturesque views within the marsh and how wildlife contributes to the overall aesthetic quality of the marsh.

Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

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Figure 7.6-2 (continued)
Representative Photographs of the Project Area

Photo 13. This photo depicts a hunting club house within the marsh. Note that the height and color of the building help it to blend better with the natural surroundings.

Photo 14. This photo depicts a hunting club house within the marsh. Note that the building does not detract from the natural setting.

Graphics/Projects/0688.06 Suisun Marsh EIR/EIS (07-10) SS

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Figure 7.6-2 (continued)
Representative Photographs of the Project Area

Photo 15. This photo depicts the heavy equipment present within the marsh used for maintenance activities.

Photo 16. This photo also depicts the heavy equipment present within the marsh used for maintenance activities.

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Figure 7.6-2 (continued)
Representative Photographs of the Project Area

have high sensitivity to visual changes because of their proximity to features in the Marsh, appreciation of the surrounding natural environment and visual experience, and high sense of ownership over such experiences and features.

Roadway Users

Major roadways that border the plan vicinity include I-80 and SR 12 to the north and I-680 to the west. The majority of roadways in the vicinity are smaller local roadways that wind through the Marsh, many of them on the levees that are used to manage the Marsh. Travelers on major roadways drive at varying speeds; normal highway speeds differ based on the traveler's familiarity with the route and roadway conditions (i.e., presence/absence of rain or potholes). While scenic views do exist of the bays and Marsh, views from the interstates and highways typically are of short duration, except on straighter stretches where views last slightly longer. Viewers who frequently travel these routes generally possess low visual sensitivity to their surroundings. The passing landscape becomes familiar to these viewers, and their attention typically is not focused on the passing views but on the roadway, roadway signs, and surrounding traffic.

Travelers on the local roadways within the Marsh are likely to have a higher sensitivity to visual changes in the Marsh than interstate and highway travelers. Local routes within the Marsh often have immediate views over the surrounding landscape that are noted for scenic quality. Local routes within the Marsh can be seen in Figure 5.6-2. Motorists traveling along these roadways include area residents and recreationists. Roadway speeds are generally much slower than highway speeds because of the safety considerations of driving on top of levees and on narrower roadways of varying conditions. Roadways within the Marsh offer limited public access because the majority of these travelers are using the roadways to reach the specific destination of private hunting clubs and not public facilities. Roadway users are more likely to be interested in sweeping views of the Marsh, bays, and surrounding hills and mountains experienced when en route to their destination. They are likely to possess moderately high visual sensitivity to their surroundings because they are likely to have high regard for the natural environment and view it as a holistic visual experience.

Recreationists

Recreational users view the action area from lands within the Marsh, public parks or use areas, surrounding waterways, and from public roadways. The primary uses in the plan vicinity are boating, fishing, hunting, hiking, and wildlife and nature viewing (Figure 7.6-2, Photos 5 through 8). Other recreational uses in the plan vicinity are running, jogging, and bicycling along local public roads. Waterway users have differing views, based on their location in the landscape, and are accustomed to variations in the level of industrial, commercial, and recreational activities in the vicinity. Most recreationists in the vicinity are moving around in the landscape and are not in one area for extended periods of time, except for hunters and fisherman on land. Hunters and fishermen are often situated in one location for a longer time than other recreationists. During this time, views may differ based on location in the landscape, and attention is often focused more on the activity itself than on the surrounding landscape (Figure 7.6-2, Photos 9 through 12). Hunting clubhouses are often physically close to the terrestrial and aquatic features that give the Marsh its astounding scenic quality (Figure 7.6-2, Photos 13and 14). These locations offer both the scenic qualities and resources of the Marsh, such as boating, fishing, wildlife viewing, and hunting. Users of parks or public use areas in the vicinity, such as Rush Ranch and Grizzly Island Wildlife Area, are likely to seek out sweeping views of the bay and natural areas from hiking trails, park roadways, and other access points.

Recreationists who frequent the vicinity and surrounding area likely are accustomed to seeing some level of maintenance activities taking place (including the presence of heavy equipment) that are associated with wetland management (Figure 7.6-2, Photos 15 and 16). Generally, those participating in recreational activities in the plan vicinity are more likely to value the natural environment highly, appreciate the visual experience, and be sensitive to changes in views. Because of this appreciation of the natural landscape combined with limited viewing times and focus on tasks at hand, this viewer group is considered to have moderately high sensitivity to changes in views.

Regulatory Setting

Federal

Coastal Zone Management Act of 1972

Section 302 of the Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. § 1451). (Congressional findings) states that

> (b) The coastal zone is rich in a variety of natural, commercial, recreational, ecological, industrial, and esthetic resources of immediate and potential value to the present and future well-being of the Nation and that (e) important ecological, cultural, historic, and esthetic values in the coastal zone which are essential to the well-being of all citizens are being irretrievably damaged or lost.

Section 303 (16 U.S.C. § 1452). (Congressional declaration of policy) declares that

> it is the national policy (2) to encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone, giving full consideration to ecological, cultural, historic, and esthetic values as well as the needs for compatible economic development, which programs should at least provide for (F) assistance in the redevelopment of deteriorating urban waterfronts

and ports, and sensitive preservation and restoration of historic, cultural, and esthetic coastal features.

Section 306 (16 U.S.C. § 1455). (Administrative grants) states that management programs for administrative grants submitted by coastal states are required to have "(2G) a definition of the term *beach* and a planning process for the protection of, and access to, public beaches and other public coastal areas of environmental, recreational, historical, esthetic, ecological, or cultural value." This section also states that "(9) the management program includes procedures whereby specific areas may be designated for the purpose of preserving or restoring them for their conservation, recreational, ecological, historical, or esthetic values."

San Francisco Bay Conservation and Development Commission

The BCDC is designated by the federal government to uphold and enforce the CZMA for the San Francisco Bay Area of the California Coastal Zone. As such, the BCDC has the authority to confirm or deny permits regarding the placement or extraction of materials, including dredged material, along the coast of the state of California. The CZMA guidelines suggest that visual access to San Francisco Bay and San Pablo Bay is an important component of public access. Therefore, waterfront projects approved by BCDC must enhance visual access to the bay and shoreline by including public views from public thoroughfares and the bay. BCDC also requires that structure locations and the height and placement of landscaping maintain or improve bay views. In addition, new roads should be planned to keep bay and access areas in view as much as possible, especially where roads change direction (San Francisco Bay Conservation and Development Commission 2007, 2008, 2010).

State

Suisun Marsh Protection Plan of 1976

The Suisun Marsh Protection Plan contains the following aesthetic-related findings and policies (San Francisco Bay Conservation and Development Commission 2010).

Utilities, Facilities and Transportation

Policy 1 (a). New electric power transmission utility corridors should be located at least one-half mile from the edge of the Marsh. New transmission lines, whether adjacent to the Marsh or within existing utility corridors, should be constructed so that all wires are at least six feet apart.

Policy 1 (c). Within the Marsh, new electric lines for local distribution should be installed underground unless undergrounding would have a greater adverse environmental effect on the Marsh than above-ground construction, or the cost of underground installation would be so expensive as to preclude service. Any distribution line necessary to be constructed above ground should have all wires at least six feet apart.

Policy 1 (d). New telephone lines installed in the Marsh and within one-half mile of the Marsh should be buried underground. Existing telephone lines in the Marsh should be buried at the time of line repair. All new telephone cables routed through the Suisun Marsh area should be buried, and the alignment should avoid wetland areas whenever possible.

Policy 8 (g). Industrial facilities should be located and designed to avoid visual intrusion on the Suisun Marsh. Where sloping land is to be used for industrial development, it should be terraced, rather than leveled, and soil erosion and storm water run-off should be controlled. Buildings should not be highly visible against the skyline, should have a low profile, be well designed and unobtrusive in appearance, and use colors and materials compatible with the surrounding landscapes. Appropriate landscaping should be used to reduce the impact of industrial structures on views from the Suisun Marsh.

Policy 8 (h). The industrial waterfront is attractive and interesting to many people and public access to the shoreline should be provided wherever feasible, unless it will result in interference with industrial activities or hazards to the public. Public access to exceptional natural features within industrial areas should also be provided wherever feasible.

Recreation and Access

Finding 1. The Suisun Marsh is a major open-space resource of the San Francisco Bay region, and recreation is the major human use of the Suisun Marsh. A major attraction of the Marsh for recreational use is its undisturbed open-space character.

Finding 3. The demand for existing recreational uses of the Suisun Marsh is presently high and will probably increase in the future. There is also a high demand for water sports and passive recreational activities, such as nature walks, picnicking, and sightseeing. Participation in these activities would increase if better facilities were provided.

Finding 6. Due to the diversity of vegetation and fish and wildlife species the Suisun Marsh has high potential for scientific and educational use.

Finding 7. The Solano County Park Department has proposed parks for two sites in the Suisun Marsh: at Beldon's Landing on Montezuma Slough and on Hill Slough. These would increase opportunities for public access and recreation activities in the Marsh.

Policy 3. Land should also be purchased for public recreation and access to the Marsh for such uses as fishing boat launching and nature study. These areas should be located on the outer portions of the Marsh near the population centers and easily accessible from existing roads. Improvements for public use should be consistent with protection of wildlife resources.

Policy 4. Public agencies acquiring land in the Marsh for public access and recreational use should provide for a balance of recreational needs by expanding and diversifying opportunities for activities such as bird watching, picnicking, hiking, and nature study.

Policy 6. Recreational activities that could result in adverse impacts on the environmental or aesthetic qualities of the Suisun Marsh should not be permitted. Levels of use should also be monitored to insure that their intensity is compatible with other recreation activities and with protection of the Marsh environment. For example, boat speeds and excessive noise should be controlled and activities such as water skiing and naval training exercises should be kept at an acceptable level.

Land Use and Marsh Management

Finding 4. There are several seasonal marshes around the periphery of the managed wetlands. They have high value for Marsh-related wildlife and also serve to buffer the Suisun Marsh to a certain extent from potential adverse ecological and aesthetic impacts. The seasonal marshes are presently used for grazing during the dry summer months.

Finding 8. The upland grasslands and cultivated areas adjacent to the Suisun Marsh are critical to its protection. These undeveloped areas, presently used for grazing cattle and cultivated agricultural lands, function as a buffer for the Marsh. Development in the uplands adjacent to the Marsh would remove this protective function and result in potential adverse ecological and aesthetic impacts. Furthermore, these areas represent valuable habitats for many species of Marsh-related wildlife.

Policy 9. The upland grasslands and cultivated lands surrounding the Marsh should be included in a secondary management area. The function of the secondary management area should be to act as a buffer area insulating the habitats within the primary management area from adverse impacts of urban development and other uses and land practices incompatible with preservation of the Marsh. The boundaries of the secondary management area should, for the most part, correspond to physical barriers to wildlife movement, with exceptions where necessary to control specific potential threats to the Marsh from beyond the wildlife barrier. The proposed boundary of the secondary management area is shown on the Protection Plan Map.

Suisun Marsh Preservation Act of 1977

The General Provisions of the SMPA state that the act was prepared “(29004a) for the orderly and long-range conservation, use, and management of the natural, scenic, recreational, and manmade resources of the Marsh.” Under this act, SMPA protection program shall include “(29401g) enforceable standards for the design and location of any new development in the Marsh to protect the visual characteristics of the Marsh and, where possible, to enhance views of the Marsh” (San Francisco Bay Conservation and Development Commission 2007).

Local

Solano County Policies and Regulations Governing the Suisun Marsh

The County Policies and Regulations Governing the Suisun Marsh (Solano County 1982) includes policies found in the Solano County General Plan (2008). In addition, these policies have been implemented by the BCDC under the Suisun Marsh Protection Plan (Bay Conservation and Development Commission 2008). Both contain the following aesthetic-related policies:

Land Use and Circulation Elements (Page 12)

Recreation Land Use

Policy 1. Within Suisun Marsh, provision should be made for public and private recreational development to allow for public recreation and access to the Marsh for such uses as fishing, hunting, boating, picnicking, hiking, and nature study.

Resource Conservation and Open Space Elements

Utilities, Facilities, and Transportation

Policies (Pages 22–25). This resource section includes undergrounding electrical (Policy 1c) and telephone lines (Policy 1d), as well as pipelines, wires, and cables (Policy 2).

Recreation and Marsh Access

Policy 2. Land should be purchased for public recreation and access to the Marsh for such uses as fishing, boat launching, and nature study. These areas should be located on the outer portions of the Marsh near the population centers and easily accessible from existing roads. Improvements for public use should be consistent with protection of wildlife resources.

Policy 3. Public agencies acquiring land in the Marsh for public access and recreational use should provide for a balance of recreational needs by expanding and diversifying opportunities for activities such as bird watching, picnicking, hiking, and nature study.

Policy 5. Recreational activities that could result in adverse impacts on the environment or aesthetic qualities of Suisun Marsh should not be permitted. Levels of use should be monitored to insure that their intensity is compatible with other recreation activities and with protection of the Marsh environment. For example, boat speeds and excessive noise should be controlled and activities such as water skiing and naval training exercises should be kept at an acceptable level.

Scenic Roadways Element

I-680 and the entire length of SR 12 are Solano County Designated Scenic Roadways (page 51) (Solano Transportation Authority 2001). As such, the following policies would apply:

General Requirements (Pages 49–50)

Policy 1. Current general plan provisions of the county which designate foreground and distant view components of the scenic roadways for agriculture and other open space uses should be retained.

Policy 2. The number of man-made interruptions or incidents along a scenic roadway (housing, commercial uses, signs, driveways, etc.) should be limited to maintain the current visual values as the prevalent feature of the route. Individual driveways and garages, for example, should not connect directly with a scenic roadway unless necessitated by severe topographic constraints. Rather, they should combine before intersecting with the scenic route to minimize visual and functional disruption.

Specific Policies (Page 51)

These policies apply to the foreground (≤0.25 miles from the roadway) of scenic corridors.

Marshlands Policy 1. Immediately adjoining dry land and upland within and around a marsh should remain in open space use (grazing, cropland, or other extensive uses).

Marshlands Policy 2. Existing animal and vegetative habitats should be protected from encroachment due to their own visual value and their role in maintaining the marsh ecosystem and its overall scenic value.

Marshlands Policy 3. Public roadway construction and improvements activities should be subject to restrictions permitting the natural water movement necessary to sustain the marsh environment.

Marshlands Policy 4. Since such a flat and expansive natural environment tends to exaggerate vertical elements, undergrounding of utility lines is highly recommended.

Eucalyptus Windbreaks Policy 1. Maintenance and protection of existing windbreaks should be encouraged to provide a contrasting visual element on flatland landscapes and to call attention to distant farm development or to places where major changes occur in the alignment or the scenic roadway.

Eucalyptus Windbreaks Policy 2. Where appropriate, expansion or addition of new windbreaks should be encouraged to identify distant changes in visual units, road alignments, land use activities, etc.

Ordinances in the Solano County Code

The Marsh falls largely within the Marsh Preservation District (page 66) that has zoning requirements for site design, including signage (Section 28-23.6b3 and 28-23.6b4). In addition, there are area requirements for features on a parcel, building heights, and potential need for architectural approval (Sections 28-23.6d through 28-23.6h).

Environmental Consequences

Assessment Methods

This section describes the NEPA/CEQA impact analysis relating to visual resources for the SMP alternatives. It describes the methods used to determine impacts and lists the thresholds used to conclude whether an impact would be significant. Because evaluating visual impacts is inherently subjective, federal and professional standards of visual assessment methodology have been used to determine potential impacts on aesthetic values of the plan area. Measures to mitigate (avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany each impact discussion.

Methodology

Using the concepts and terminology, described at the beginning of this section, and criteria for determining significance, described above, analysis of the visual impacts of implementing the plan is based on:

- direct field observation from vantage points, including neighboring buildings, property, and roadways (conducted date);
- photographic documentation of key views of and from the plan area, as well as regional visual context;
- review of project construction drawings; and
- review of the project in regard to compliance with state and local ordinances and regulations and professional standards pertaining to visual quality.

Professional Standards

According to professional standards, the plan may be considered to have significant impact if it would significantly:

- conflict with local guidelines or goals related to visual quality;
- alter the existing natural viewsheds, including changes in natural terrain;

- alter the existing visual quality of the region or eliminate visual resources;
- increase light and glare in the project vicinity;
- result in backscatter light into the nighttime sky;
- result in a reduction of sunlight or introduction of shadows in community areas;
- obstruct or permanently reduce visually important features; or
- result in long-term (that is, persisting for 2 years or more) adverse visual changes or contrasts to the existing landscape as viewed from areas with high visual sensitivity.

Significance Criteria

Standards for Determining Significance under NEPA

NEPA criteria for determining significance are listed in Title 40 CFR §1508.27, but are considered broader and less stringent than CEQA criteria, set forth below. Also, the CEQA criteria below incorporate NEPA standards. For these reasons, identification of impacts as significant under CEQA is treated herein as sufficient for identifying impacts considered significant under NEPA. Mitigation measures set forth to minimize CEQA significant impacts are presumed also to mitigate NEPA significant impacts. These assumptions are made only for the purpose of identifying the magnitude of particular impacts; this document complies with NEPA requirements and uses the CEQA analysis only as a source of supporting information.

Criteria for Determining Significance under CEQA

The State CEQA Guidelines were used to determine whether the proposed action would have a significant environmental impact. The proposed action may have a significant impact on visual resources under CEQA if it would:

- cause a substantial, demonstrable negative aesthetic impact on a scenic vista or view open to the public or have a substantial adverse impact on a scenic vista;
- substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway;
- substantially degrade the existing visual character or quality of the site and its surroundings; or
- create a new source of substantial light or glare that would adversely affect day or nighttime public views.

Environmental Impacts

No Action Alternative

Under this scenario, some restoration and natural breaches to levees would occur. The primary change to visual resources would occur if the natural breaches allowed channels to form that would allow more public access to inland areas of the Marsh via the channels. Such a change also would result in displacing hunters from lands no longer suitable for hunting; however, this displacement would not be so great as to negatively affect this viewer group. If the SMP is not implemented viewer groups would not reap the benefit of improved aesthetics associated with increasing visual access to marshlands and having those views be of tidal marshes that are more natural with less of an infrastructure imprint. Under this alternative, existing conditions would persist, so changes to views would be less than significant.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact VIS-1: Temporary Changes in Views Caused by Construction Activities

The following actions would result in physical activities resulting in changes to the existing visual environment. Other actions not specifically addressed would not require much, if any, physical activity and would not result in much physical change, and therefore are not discussed under this impact.

Breaching and lowering exterior levees; upgrading or creating new interior levees; the creation of habitat levees increasing connectivity between marsh plain and waters; and redirecting intakes, discharges, and outfalls all would require construction activities. In addition, acquiring public property and using it to increase access to public lands may require infrastructure improvements such as roadways, parking lots, and bringing utilities to the site, and the construction of new public facilities such as interpretive facilities and restrooms. Construction of these proposed actions would create temporary changes in views of and from the project area.

Construction activities associated with restoration would introduce considerable heavy equipment and associated vehicles, including dozers, graders, scrapers, and trucks, into the viewshed of all viewer groups in the vicinity. Construction activities would take place over a period of 30 years, often during a relatively short window each year, and the overall intensity and duration of each action would vary based on the individual project. In addition, the dredged material would be placed on the landside and crown of the levee so would be visible to only a very small number of viewers, primarily hunters. Presently, it is not uncommon for heavy equipment to be seen, intermittently, during levee maintenance operations and for use in managing wetlands. Evening and nighttime construction activities would require the use of extremely bright lights to accomplish the task at hand, and this would affect nighttime views of and from the plan area. However, the environmental commitment for visual/aesthetic resources in Chapter 2 include minimizing fugitive light from portable sources for nighttime operations and installing visual barriers to prevent light spill from truck headlights in areas with sensitive view receptors.

The temporary nature of construction, scattering of construction activities in different locations throughout the Marsh, over the 30-year plan implementation period, varying intensity and duration of construction, and implementing the above-mentioned Environmental Commitment would make temporary changes in views associated with construction less than significant.

Conclusion: Less than significant. No mitigation required.

Impact VIS-2: Temporary Changes in Views Caused by Habitat Reestablishment Period

After construction, the tidal areas restored may be denuded of vegetation, or appear to be so from a distance because of immature planted vegetation, and look more like a mud flat or open water where mature vegetative communities once existed. The sites would be in a transitional state, and over a period of a couple of years, plant species would mature and vegetation would re-colonize the sites. Furthermore, the sites would be scattered in different locations throughout the Marsh so would not create a visual imposition upon the landscape or be perceived as a centralized, large-scale visual change. In addition, restored sites would increase the amount of native vegetative communities that attract wildlife, thus helping to improve the visual quality of the Marsh.

Conclusion: Less than significant. No mitigation required.

Impact VIS-3: Changes in Views to and from Suisun Marsh

Views to and from Suisun Marsh would not be greatly affected by the proposed actions. Breached and lowered exterior levees; upgraded or new interior levees; created habitat levees; increased connectivity between marsh plain and waters; and redirected intakes, discharges, and outfalls would all quickly appear to be part of the existing visual landscape as they would not alter the existing visual character of the Marsh. Shortly after construction, these elements would not be discernable to most viewer groups, except those viewers who have an acute visual reference of the Marsh and the change between past and present features. Once the restoration sites have become established, they would blend with the surrounding landscape, and actually open up the landscape for more public access.

Restored sites likely would provide more public access to the Marsh via navigable waterways and controlled public access to certain restoration sites, should it be determined to permit such access via land. If it is determined that restored lands would be open to public access, infrastructure improvements like roadways, parking lots, utilities, and new public facilities such as interpretive facilities and restrooms likely would be implemented.

Installed fencing to improve grazing management and to protect sensitive habitat areas; constructed brush boxes; planted upland, riparian, and tidal vegetation; would be barely noticeable, are in keeping with the existing visual character, and would not detract from the existing visual character.

Restored lands with increased public access would act to improve the aesthetic quality of the Marsh and increase availability of those aesthetic resources. In addition, restoration of sites would increase the amount of native vegetative communities that would attract wildlife, so they would help improve the visual quality and resources of the Marsh available to viewer groups, primarily recreationists.

Conclusion: Less than significant. No mitigation required.

Impact VIS-4: Damage to Scenic Resources along Scenic Highway

There is no roadway in or near the plan area that is designated in California plans as a scenic highway or route worthy of protection for maintaining and enhancing scenic viewsheds. However, SR 12 is a County-designated scenic route. Implementing the proposed project would not affect resources along this roadway and could even improve views from the roadway by restoring the Marsh to a more natural state. Therefore, implementation of the plan alternatives would not damage scenic resources such as trees, rock outcroppings, and historic buildings along a scenic highway.

Conclusion: No impact.

Impact VIS-5: Create a New Source of Light and Glare That Affects Views in the Area

Glare would be minutely increased by implementation of restoration that would increase the amount of water surface that is present in the Marsh through the creation of new waterways.

There is already a great deal of glare from the existing water surfaces, and the addition of water surface from created channels would be negligible in comparison to the larger whole of the Marsh.

Other actions may require the installation of permanent lighting features, and some restoration activities may require the use of portable lighting and maintenance vehicles during the night. The environmental commitment for visual/aesthetic resources, in Chapter 2, include the minimization of fugitive light from portable sources for nighttime operations and permanent lighting features and installation of visual barriers to prevent light spill from truck headlights in areas with sensitive view receptors.

Construction of new buildings could result in created glare from windows and the use of inappropriate building materials, finishes, or colors. As described in the environmental commitments, any constructed buildings would blend with the natural environment and not create a new source of glare.

Conclusion: Less than significant. No mitigation required.

Impact VIS-6: Conflict with Policies or Goals Related to Visual Resources

The SMP is consistent with the intent and purpose behind the establishment of the policies and goals created to help protect and enhance the aesthetic value of the Marsh. Furthermore, the actions would aid in the facilitation of goals to preserve and enhance the aesthetic resources of the Marsh and, therefore, improve views of, from, and within the Marsh.

Conclusion: No impact.

Managed Wetland Activities Impacts

Impact VIS-1: Temporary Changes in Views Caused by Construction Activities

This impact would be similar to that described for restoration activities. The continuation of currently authorized managed wetland activities would not affect visual resources, because these activities are already a part of the existing visual environment and would not alter the character of the Marsh or detract from existing visual resources. The activities authorized under the RGP and IP that would change include accounting for levee repairs by lineal footage instead of parcel acreage. This change would not affect visual resources, because it is an administrative change, and the action of repairing existing levees still would take place as it presently does.

Of the three categories of managed wetland activities, the one that has the potential to affect visual resources is new activities because these new actions would take place on the landscape and would be visible to all viewer groups. Dredging from tidal sloughs for source material for exterior levee maintenance would require the use of a clamshell dredger or long-reach excavator that is operated on an in-channel barge pulled by a tugboat or on land from the levee. Use of the barge would create temporary changes in views of and from the project area by introducing considerable heavy equipment and associated vehicles into the viewshed of all viewer groups in the vicinity.

The placement of riprap in new locations would alter the appearance of existing vegetated levees. However, only 6,000 feet of new riprap would be placed within the reaches of the Marsh. The integration of “living” bank protection, where feasible to do so, would help to visually reduce the appearance of the riprap once the vegetation matures.

Activities such as installing fencing to improve grazing management and to protect sensitive habitat areas; installing brush boxes; and planting upland, riparian, and tidal vegetation would not introduce considerable heavy equipment.

Brush boxes and biotechnical wave dissipaters would be installed by hand so would not require the use of heavy equipment and would not adversely affect the visual environment. Plants would mature and appear to be naturally recruited after a short period of time. Furthermore, such features already have been used in the Marsh and are visible if one pays close attention. These soft features do not adversely affect the visual environment and would not detract from the existing visual quality of the Marsh. Also, revegetation of exposed levee toes would improve the aesthetics of a degraded levee toe.

Installation of new fish screens would require construction activities and equipment for implementation, which would be temporary. Once the screens are installed they would, after a short period of time, appear to be part of the existing visual landscape as they presently exist in the Marsh and would not alter the existing visual character of the Marsh. They would not be discernable to most viewers as a new feature.

Construction activities associated managed wetland activities would introduce heavy equipment and associated vehicles into the viewshed of all viewer groups in the vicinity. Construction activities would take place over a period of 30 years, often during a relatively short window each year, and the overall intensity and duration of each action would vary based on the individual project. Presently, it is not uncommon for heavy equipment to be seen, intermittently, during levee maintenance operations and for use in managing wetlands.

The temporary nature of construction, scattering of construction activities in different locations throughout the Marsh, over the 30-year plan implementation period, varying intensity and duration of construction, and implementation of the environmental commitment for visual/aesthetic resources in Chapter 2 would make temporary changes in views associated with construction less than significant.

Conclusion: Less than significant. No mitigation required.

Impact VIS-3: Changes in Views to and from Suisun Marsh

This impact would be similar to that described for restoration activities. Views to and from the project area would not be greatly affected by the proposed actions. Replaced water management infrastructure; placed dredged materials for exterior levee maintenance; and redirected intakes, discharges, and outfalls would all quickly appear to be part of the existing visual landscape and would not permanently alter the existing visual character of the Marsh.

Conclusion: Less than significant. No mitigation required.

Impact VIS-4: Damage to Scenic Resources along Scenic Highway

There is no roadway in or near the plan area that is designated in California plans as a scenic highway or route worthy of protection for maintaining and enhancing scenic viewsheds. However, SR 12 is a County-designated scenic route. Implementing the proposed project would not affect resources along this roadway and could even improve views from the roadway by restoring the Marsh to a more natural state. Therefore, implementation of the plan alternatives would not damage scenic resources such as trees, rock outcroppings, and historic buildings along a scenic highway.

Conclusion: No impact.

Impact VIS-5: Create a New Source of Light and Glare That Affects Views in the Area

This impact would be similar to that described for restoration activities. Glare would be minutely increased by implementation of new managed wetland activities that would increase the amount of reflective material present by increasing the amount of riprap in the Marsh.

Riprap is already a common feature in the Marsh, and there is already a great deal of glare from the existing water surfaces. The addition of new riprap would be negligible (no more than 200 feet per year) in comparison to the total amount in the Marsh, and the riprap would weather over a short period of time and vegetation would colonize the rock interstices. In this way the slightly altered appearance associated with the addition of fresh riprap would be reduced.

Other managed wetland activities may occasionally require the use of portable lighting and maintenance vehicles during the night. Implementation of the environmental commitment for visual/aesthetic resources in Chapter 2, which include the minimization of fugitive light and installation of visual barriers to prevent light spill from truck headlights in areas with sensitive view receptors, would ensure that new managed wetland activities combined with the environmental commitment would not create a new source of light or glare that would affect views in the area.

Conclusion: Less than significant. No mitigation required.

Impact VIS-6: Conflict with Policies or Goals Related to Visual Resources

This impact would be the same as that described for restoration activities. The SMP is consistent with the intent and purpose behind the establishment of the policies and goals created to help protect and enhance the aesthetic value of the Marsh.

Conclusion: No impact.

Alternative B: Restore 2,000–4,000 Acres and Alternative C: Restore 7,000–9,000 Acres

Alternatives B and C call for the same restoration and managed wetland activities, but with different amounts of land being restored . In comparison to the overall size of the Marsh, these differences in acreage between Alternatives A and C and Alternative B would not be a great enough difference to affect the existing visual resources or alter the existing visual character. Implementation of these actions also would take place over 30 years, with the overall intensity and duration of each action varying based on the individual project. Like Alternative B, these alternatives would act to improve the overall visual quality of the Marsh. In summary, all changes resulting from implemented actions would be the same for Alternatives B and C as they are for Alternative A.

Section 7.7
Cultural Resources

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on cultural resources. *Cultural resource* is a general term that encompasses the National Historic Preservation Act's (NHPA's) *historic property* as well as CEQA's *historical resource* and *unique archaeological resource* (see Regulatory Setting below for definitions of historical resource and unique archaeological resource). Cultural resources are defined as buildings, sites, structures, or objects, each of which may have historical, architectural, archaeological, cultural, or scientific importance. According to guidance published by the Office of Historic Preservation (1995:2), any "physical evidence of human activities over 45 years old may be recorded for purposes of inclusion in the [Office of Historic Preservation's] filing system." In other words, physical evidence of human activities more than 45 years old is considered a cultural resource.

Summary of Impacts

Table 7.7-1 summarizes impacts on cultural resources, including the plan's potential to result in significant impacts, from implementing the SMP alternatives.

Table 7.7-1. Summary of Cultural Resource Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
CUL-1: Damage to Montezuma Slough Rural Historic Landscape as a Result of Ground-Disturbing Activities along Montezuma Slough	A, B, C	Significant	CUL-MM-1: Document and Evaluate the Montezuma Slough Rural Historic Landscape, Assess Impacts, and Implement Mitigation Measures to Lessen Impacts	Significant and unavoidable
CUL-2: Damage to or Destruction of Known Cultural Resources as a Result of Ground-Disturbing Activities in Restoration Areas	A, B, C	Significant	CUL-MM-2: Evaluate Previously Recorded Cultural Resources and Fence NRHP- and CRHR-Eligible Resources prior to Ground-Disturbing Activities	Less than significant
CUL-3: Damage to Known Cultural Resources as a Result of Inundation	A, B, C	Significant	CUL-MM-3: Protect Known Cultural Resources from Damage Incurred by Inundation through Plan Design (Avoidance) CUL-MM-4: Resolve Adverse Effects prior to Construction	Significant and unavoidable
CUL-4: Inadvertent Damage to or Destruction of As-Yet-Unidentified Cultural Resources as a Result of Ground-Disturbing Activities in Restoration Areas	A, B, C	Significant	CUL-MM-5: Conduct Cultural Resource Inventories and Evaluations and Resolve Any Adverse Effects	Significant and unavoidable
CUL-5: Damage to or Destruction of Human Remains as a Result of Ground-Disturbing Activities	A, B, C	Less than significant	None required	–
Managed Wetland Activities Impacts				
CUL-6: Damage to or Destruction of Shipwrecks or Other Submerged Resources as a Result of Channel Dredging	A, B, C	Significant	CUL-MM-6: Stop Ground-Disturbing Activities, Evaluate the Significance of the Discovery, and Implement Mitigation Measures as Appropriate	Less than significant
CUL-7: Damage to or Destruction of Known Cultural Resources Resulting from Managed Wetland Activities	A, B, C	Significant	CUL-MM-7: Complete NHPA Section 106 Consultation and Prepare and Implement Context Study; Evaluate Previously Recorded Cultural Resources and Fence NRHP- and CRHR-Eligible Cultural Resources prior to Ground-Disturbing Activities	Less than significant
CUL-8: Damage to or Destruction of As-Yet-Unidentified Cultural Resources in Uninspected Areas as a Result of Other Ground-Disturbing Managed Wetland Activities	A, B, C	Significant	CUL-MM-8: Complete NHPA Section 106 Consultation and Prepare and Implement Context Study; Conduct Cultural Resources Inventories and Evaluations and Resolve Any Adverse Effects	Significant and unavoidable

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- detailed records searches obtained from the California Historical Resources Information System (CHRIS), and
- a review of published literature pertinent to Suisun Marsh environment, prehistory, ethnography, and history.

Methods

A records search was conducted at the Northwest Information Center (NWIC) of the CHRIS on July 24, 2007 (NWIC File No. 07-132). The NWIC maintains the CHRIS's official records of previous cultural resource studies and known cultural resources for a 16-county area that includes Solano County. The records search covered the entire SMP area (plan area) and consisted of a review of maps of previous cultural resource studies and recorded cultural resources.

The records search and literature review indicate that approximately 35% of the plan area has been surveyed for the presence of cultural resources, principally in upland, non-marsh environs or reclaimed marsh (CALFED Bay-Delta Program 1996; California Department of Water Resources and U.S. Department of the Interior, Bureau of Reclamation 2006; Chavez 1990; Ecumene Associates 1980; EDAW 2003; Esser 1999; Flynn et al. 1989; Holson et al. 1989; Johnson and Johnson 1974; Jones & Stokes Associates 1974, 1985; Jones & Stokes Associates and Geier and Geier Consulting 1995; Kenton 1980; Lee and Page 1993; Mabry 1979; Martin and Self 2002, 2003, 2004; Napton 1985; Nelson et al. 2000; Owens 1991; Parks 1996; Sullivan and Allen 1996; Theodoratus et al. 1980; William Self Associates 1993).

The records search and literature review also indicate that 34 previously recorded cultural resources are present in the plan area. Brief descriptions of these cultural resources are provided in Table 7.7-2.

Table 7.7-2. Previously Recorded Cultural Resources in the Plan Area

Resource Designation	Description	Environmental Context	Suisun Marsh Region	Significance
Prehistoric Cultural Resources				
CA-SOL-13	Burial and village site	High elevation tidal marsh, managed wetland area	2	Undetermined
CA-SOL-66	Destroyed village site	Upland	1	Undetermined
ISO 20	Isolated projectile point	Managed wetland area	4	Undetermined
Historic-Era Cultural Resources				
CA-SOL-268H	Historic ranch	Upland	4	Undetermined
CA-SOL-282H	Historic ranch	Upland	4	Undetermined
CA-SOL-290H	Molena railroad station	Upland	4	Undetermined
CA-SOL-291H	Windmill	Upland	4	Undetermined
CA-SOL-366H	Historic refuse scatter	Lowland grassland	4	Undetermined
CA-SOL-367H	Historic refuse scatter	Upland	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-368H	Historic refuse scatter	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-369H	Historic refuse scatter	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-370H	Historic refuse scatter	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-371H	Historic refuse scatter	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-372H	Historic pump house	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-373H	Historic pump house and refuse	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-374H	Historic refuse scatter	Grazed bayland	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-375H	Historic dump	Grazed bayland	4	Recommended ineligible (NRHP/CRHR)
Ca-SOL-376H	Ranching related	Grazed bayland	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-377H[1]	Historic railroad grade, trestles, and station	Farmed bayland, managed wetland area, uplands	4	Recommended eligible (NRHP/CRHR)
CA-SOL-378H	Ranching debris	Grazed bayland	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-415H	Montezuma Wetlands flume structure	Managed wetland area	4	Undetermined
P-48-207	Historic ditch	Managed wetland area	1	Undetermined
P-48-209	Southern Pacific Railroad	Managed wetland area	1	Undetermined

Resource Designation	Description	Environmental Context	Suisun Marsh Region	Significance
P-48-442	Utility line	Managed wetland area	1	Undetermined
P-48-443	Lingos Landing	Major slough	4	Undetermined
P-48-491	Historic ranch house	Upland	1	Undetermined
P-48-492	Ranch, Garibaldi Wildlife Refuge	Upland	1	Recommended ineligible (NRHP)
P-48-513[1]	Birds Landing dock and road	Managed wetland area	4	Undetermined
P-48-514[1]	Dutton's Landing	Ruderal	4	Undetermined
P-48-549	Central Pacific Railroad	Marsh, upland	1	Undetermined
P-48-568	Windmill	Upland	3	Recommended ineligible (NRHP/CRHR)
TCR 41H	Structural depression and historic debris scatter	Managed wetland area	4	Undetermined
None	Mein's Landing[1]	Major slough	4	Undetermined
None	Montezuma Slough Rural Historic Landscape[2]	Major slough, marsh	3, 4	Undetermined

[1] These resources are also constituent elements of the Montezuma Slough Rural Historic Landscape.

[2] The Montezuma Slough Rural Historic Landscape includes four previously recorded cultural resources as constituent elements, as indicated above.

NHRP = National Register of Historic Places.

CRHR = California Register of Historic Resources.

To date, three Native American archaeological resources have been identified in or adjacent to the plan area: CA-SOL-13, CA-SOL-66, and ISO 20. CA-SOL-13 and ISO 20 are located in lowland marsh contexts, whereas CA-SOL-66 is situated at the edge of Suisun Marsh. An additional five prehistoric archaeological sites are located at the margin of the plan area, as shown in Table 7.7-3.

Table 7.7-3. Previously Recorded Prehistoric Cultural Resources in and Immediately Outside of the Plan Area

Resource Designation	Description	Environmental Context	Suisun Marsh Region	Significance
CA-SOL-22		Upland	1	
CA-SOL-24	Burial and village site with historic-period component	Upland	1	Undetermined
CA-SOL-25/H	Occupation and burial site with historic component	Upland, high elevation marsh	1	Undetermined
CA-SOL-263		Upland	1	
CA-SOL-273		Upland	1	

NHRP = National Register of Historic Places.
CRHR = California Register of Historic Resources.

Thirty of the 34 previously recorded cultural resources in and immediately adjacent to the plan area are non–Native American, historic-period archaeological sites, buildings, and structures. Eight of these resources are located in or extend through uplands, and 23 are located on or extend through marshes and other lowlands[1]. The resources relate to railroad travel, ranching and farming, refuse disposal, water conveyance, utilities, and maritime economy (Table 7.7-2).

Montezuma Slough Rural Historic Landscape

Of the previously recorded cultural resources listed in Table 7.7-2, the Montezuma Slough Rural Historic Landscape deserves special mention, as it is a property type that is not commonly discussed in environmental impact documents. The National Register of Historic Places (NRHP; see Regulatory Setting below) recognizes five general property types: districts, sites, buildings, structures, and objects. The NRHP defines a *district* as

> a geographically definable area, urban or rural, possessing a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united by past events or aesthetically by plan or physical development. A district may also comprise individual elements separated geographically but linked by association or history. (36 CFR 60.3[d].)

A rural historic landscape is a type of district defined as

> a geographic area that historically has been used by people, or shaped and modified by human activity, occupancy, or intervention, and that possesses

[1] The apparent discrepancy in the total number of historic-period cultural resources stems from the fact that some linear cultural resources (such as railroads) extend through uplands and lowlands and therefore are included in the tally for more than one context.

> a significant concentration, linkage, or continuity of areas of land use, vegetation, buildings and structures, roads and waterways, and natural features (McClelland et al. 1995:3).

The Montezuma Slough Rural Historic Landscape is a linear district extending the length of Montezuma Slough from the town of Collinsville on the east to Grizzly Bay on the west. The rural historic landscape is otherwise generally contained within the outside banks of Montezuma Slough. Esser (1999:Figure 3) documents the portion of the rural historic landscape from Collinsville to the confluence of Nurse Slough and Montezuma Slough; Esser's documentation of this section of the rural historic landscape is not complete and does not contain a formal significance evaluation (see Regulatory Setting for an explanation of significance evaluations) of the district.

Numerous historic buildings, structures, sites, and objects—both formally recorded and unrecorded—constitute the Montezuma Slough Rural Historic Landscape. Features include siphons and pump stations, pilings, deliberate landscaping such as eucalyptus windbreaks, railroad crossings, levees, shipwrecks, cuts, salinity control gates, landings (such as Mein's and Dutton's Landings), and railroad sidings (Esser 1999:58–60, 62). These historic features constitute a district by virtue of their association with common historic contexts, namely maritime transportation and economy.

Setting

The setting presented here (Natural Environment, Prehistoric Archaeology, Ethnographic Setting, and Historical Setting) describes the historically dynamic nature of the plan area and the effects that natural and cultural changes in this area impose upon the distribution and visibility of cultural resources. The setting begins with a summary overview of the modern plan area then outlines its development from the terminal Pleistocene Epoch (about 18,000–10,000 years ago) to present conditions.

The setting next summarizes what is known of the plan area's aboriginal inhabitants, first as manifested in the prehistoric archaeological record, then as known from ethnographic and historical sources. Historic-period cultural developments, focused on Mexican and Euroamerican cultures, are reviewed next. The discussion concludes by analyzing the setting's implications for cultural resource distributions in the project area.

Natural Environment: Overview

The plan area encompasses Suisun Marsh, as well as the Potrero and Kirby Hills. It is flanked on the west by the North Coast Ranges and on the east by the Montezuma Hills. South of the area are Grizzly, Suisun, and Honker Bays. To the north, the wetlands of the plan area gradually give way to alluvial plains that emanate from Green Valley and Suisun Creeks.

Suisun Marsh is the largest remaining wetland complex in the San Francisco Bay area. It consists of 85,000 acres of tidal marsh, managed wetlands, and waterways. The Marsh supports diverse avian, reptile, mammalian, fish, invertebrate, and amphibian fauna. (Jones & Stokes Associates 1985:65.) As a key wintering area for waterfowl that traverse the Pacific Flyway, the Marsh supports wading and dabbling ducks, geese, water birds, shorebirds, and raptors in abundance. The wetland environments and adjacent uplands provide habitat for numerous animals of economic importance to Native Americans, historic-period Euroamericans, and modern populations. Such animals include pheasant, ducks, tule elk, beaver, river otter, and black-tailed jackrabbit. Important fisheries include Chinook salmon and steelhead. Detailed species lists can be found in Sections 6.1 and 6.3.

Land cover types in the plan area consist of bays and sloughs, tidal wetlands, managed wetlands, riparian corridors, uplands, seasonal wetlands and vernal pools, and developed land. With the exception of developed land, the mosaic of land cover types provides economically important plants as well as habitat. Such plants include rushes, seed-bearing grasses, reeds, and cattails. Proximity to Green Valley and the North Coast Ranges provided Native American inhabitants with ready access to acorns and buckeyes, as well as certain toolstone materials, such as sandstone. Available land cover types in the marsh proved of lesser subsistence importance to later, non-Indian populations, although swampland reclamation efforts did foster a local dairy farming industry in the marsh—a use in which green pastures were a boon. Some of the same toolstone localities and geologic formations of interest to Native American later drew the attention of Euroamericans, as these areas frequently provided cement and coarse aggregate for building projects.

Geomorphologic Formation of the Plan Area

The modern plan area and Delta are the most recent of several that formed during a sequence of depositional and erosional cycles in the Quaternary Period (1.6 million years ago to present) (Shlemon 1971; Shlemon and Begg 1975). These cycles resulted from fluctuations in climate and sea level related to the advance and retreat of glacial ice. The most recent cycle is one of deposition, resulting from a rise in sea level initiated by deglaciation following the height of the last (Tioga) glaciation approximately 20,000 years ago, a time when sea level was approximately 394 feet lower than it is today (Hickman 1993; U.S. Army Corps of Engineers 1974). As glacial ice retreated, sea level rose more rapidly at first, then slowed to a rate of about 0.4–0.8 inches per year, a rate that has persisted from about 6,000 years ago to the present time (Atwater et al. 1977).

Unlike most marshes and deltas, the modern plan area and Delta formed during the Holocene (ca. 10,000 years ago to present) in an inland direction as rising sea levels intruded upstream and flooded a pre-Holocene valley, creating a broad tidal marsh. Rising sea levels gradually submerged the plan area, creating anaerobic conditions that greatly reduced the rate of plant decomposition. As a result, the accumulation of decomposing plant material kept pace with rising sea levels over approximately 7,000 to 11,000 years, resulting in the formation of thick peat deposits (Prokopovich 1988; Shlemon and Begg 1975), and permitted the formation of extensive tidal-marsh deposits during the Middle Holocene (7000–4000 B.P.) (Meyer and Rosenthal 2007). These deposits are currently the thickest in the west and central parts of the Delta (i.e., the plan area) and grade to thinner accumulations inland toward the Delta margins (California Department of Water Resources 1995).

As base levels increased in response to sea-level rise, the lower reaches of stream and river channels became choked with sediment that spilled onto the surface of existing fans and floodplains, forming large alluvial plains (Meyer and Rosenthal 2007:3). The plan area expanded in response to higher sea levels and the decomposition, compaction, and subsidence of inter-tidal deposits. As a result, many older land surfaces were covered by at least 6.6–9.8 feet of Holocene-age alluvial deposits. These older buried land surfaces usually are marked by well-developed soils that represent a significant stratigraphic boundary in the region, typically characterized by distinct A, B, and C horizons (Meyer and Rosenthal 2007:3, 6).

In general, the landscape history of the plan area represents alternate sequences of flooding and alluvial deposition as well as decomposition of organic matter. Holocene sea level rise led to estuarine transgression and burial of old surfaces as the estuary expanded upward and landward. Most likely, all major waterways (including the Sacramento and San Joaquin Rivers) occupied their present position during the Holocene period of organic matter accumulation (Bates 1977; Pierce 1988). Similar to the major waterways, tidal marshes tend to hold the planform position of their channels as they rise up (Siegel 2010). Finally, the various small streams entering the plan area probably would fall into two stability categories: (a) dynamic, where streams cross low-gradient alluvial fans like those in the northwest portion of the plan area, and (b) fairly stable, where they emerged out of the adjacent hillslopes, like those on the southeast side around Birds Landing and the Montezuma Hills.

Prehistoric Archaeology

The prehistory of the project vicinity has been described in the following sections in terms of archaeological patterns, following Fredrickson's (1973) system (Table 7.7-4). A pattern is a general mode of life characterized archaeologically by technology, particular artifacts, economic systems, trade, burial practices, and other aspects of culture. Fredrickson's (1973) periods also are employed in the discussion below:

- Paleoindian: 12,000–8000 B.P.
- Lower Archaic: 8000–5000 B.P.

- Middle Archaic: 5000–2500 B.P.
- Upper Archaic: 2500–950 B.P.
- Lower Emergent: 950–450 B.P.
- Upper Emergent: 450–150 B.P. (White et al. 2002:Figure 15.)

In Fredrickson's use, periods served as arbitrary intervals that could be used to compare patterns over space and time. Only with the clear identification of pervasive temporal patterns would periods acquire specific archaeological meaning.

Table 7.7-4. Characteristics of Archaeological Patterns in the Lower Sacramento Valley and Delta

Pattern	Windmiller	Berkeley	Augustine
Dates	~4500–2800 B.P.	2800–1200 B.P.	1200–100 B.P.
Characteristics	Sites in the lower Sacramento Valley are clearly concentrated on low rises or knolls within the floodplains of major perennial watercourses, doubtless to obtain protection from seasonal flooding while maintaining proximity to riverine, marsh, and valley grassland biotic communities. Most sites include cemeteries, suggesting a degree of sedentism, in which skeletons are typically extended ventrally, oriented toward the west, and accompanied by abundant mortuary accoutrements. Subsistence apparently focused on hunting and fishing, as evidenced by large projectile (spear or spear thrower) points, clay net sinkers, bone fishhooks and spears, and abundant faunal remains. Procurement of plant resources is inferred from handstone and milling slab fragments recovered from a few of the sites; milling slabs appear more frequently than mortars from 4500–2500 B.P. Other characteristic artifacts include charmstones, quartz crystals, bone awls and needles, *Haliotis* spp. and *Olivella* spp. shell beads and ornaments. Trade is reflected in the material from which utilitarian, ornamental, and ceremonial objects were produced.	Sites are more widely distributed than Windmiller Pattern sites. Sites are typified by deep midden deposits, suggesting intensified occupation. The abundance of millingslabs, mortars, and pestles indicates a dietary emphasis on vegetal resources—especially the acorn, as evidenced by the greater frequency of mortars and pestles relative to millingslabs and handstones. Fishing technology improved and diversified, suggestive of greater reliance on riverine foodstuffs. Artifacts similar to the Windmiller Pattern items include types of mortars and millingslabs, quartz crystals, charmstones, projectile point styles, shell beads, shell ornaments, and bone tools. New material culture items include steatite beads, tubes and ear ornaments and slate pendants. The dead were buried in flexed positions with variable orientation or cremations accompanied by fewer grave goods.	Possible affiliation with the southward expansion of Wintuan populations into the Sacramento Valley. Represents peoples engaged in intensified hunting, fishing, and gathering subsistence strategies. An even greater number of sites than in the previous 1,600 years imply that regional population was large, with people participating in highly developed trade networks. Ceremonial and mortuary practices reach their height of elaboration and mortuary treatments evince social stratification. The base technology and specific manufactures of the preceding patterns are retained, but new elements appear in the material record: shaped mortars and pestles, bone awls for basketry, bone whistles and stone pipes, clay effigies, small notched and serrated projectile points—the latter evidence for the introduction of the bow and arrow, which occurs at this time throughout the western United States. Pottery is also found at a few sites. Burials were flexed with variable orientation and generally lacked grave goods.

Source: ICF Jones & Stokes 2009a:Table 7.

The plan area is situated at the southeastern margin of the North Coast Ranges between two regions of California that have seen intensive archaeological research: the San Francisco Bay area and the Delta. The Suisun Marsh vicinity, however, witnessed little archaeological research until the advent of environmental impact review legislation in the 1960s. The greatest concentration of nearby archaeological excavations is in Green Valley, north of the plan area, with seven sites excavated (Jones & Stokes 2004:9).

Work in Green Valley produced assemblages from a cluster of sites: CA-SOL-356, CA-SOL-355/H, CA-SOL-315, and CA-SOL-69. These sites are all clustered around Green Valley Creek, north of the present town of Cordelia (Wiberg 1992, 1993, 1996). Excavations at CA-SOL-356 revealed a range of dates spanning the Upper and Lower Emergent Periods. Time markers included clamshell and magnesite disk beads. The faunal and floral assemblages suggested a diversification of diet commensurate with expectations for a growing population: mollusk, acorn, migratory bird, fish, and mammalian remains all were recovered from the site. Nearby CA-SOL-355/H produced obsidian hydration measurements revealing occupation from 4650 to 450 B.P.—spanning from the Middle Archaic to Lower Emergent Periods. Grave goods included bone tube beads, atlatl spurs, unmodified faunal bone, olive snail shell saddle beads, circular abalone beads, obsidian lanceolate points, and red ochre. These materials showed Berkeley Pattern affiliations (Wiberg 1993:4). Work at nearby CA-SOL-69 produced six burials with no associated artifacts. Obsidian hydration analysis revealed a span of occupation at CA-SOL-69 spanning from 4550 to 1500 B.P. (Wiberg 1992:4–5). The comparatively rich assemblage at CA-SOL-315 produced 51 burials, 43 projectile points, a rich collection of large basalt cores and core tools, and 300 mortar and millingstone fragments. The mortuary assemblage had only five associated non-diagnostic bone tools—thus lacking data revealing affiliations with existing patterns. Obsidian hydration dates indicated an occupation from 7950 to 1450 B.P. Radiocarbon dates by comparison suggested an occupation spanning 950 to 1450 B.P. Overall, materials recovered from CA-SOL-315 did not allow placement with existing central California archaeological taxa, as described in Table 7.7-4 above).

Work in Vacaville and the immediate surroundings has focused largely on two sites, CA-SOL-320 and CA-SOL-270 (Jones & Stokes 2004:12). The assemblage recovered from CA-SOL-320 included unassociated human bone fragments, Napa Valley obsidian debitage, numerous fragmentary faunal remains, and clamshell disk beads. This assemblage evinces an Upper Emergent age deposit. By contrast, work at CA-SOL-270 produced evidence of occupation spanning the Archaic to Emergent periods, with the strongest presence in the Middle and Upper Archaic. Excavation efforts at CA-SOL-270 (the Cook Site) identified three distinct midden strata beneath a 1.5-foot lens of sterile alluvium. (Jones & Stokes 2004:13.) The Cook Site yielded approximately 45 burials. Of these, 75% were flexed, one individual was extended, and the remaining burials were too fragmentary and disturbed to infer positioning. A rich assemblage of grave goods and non-funerary artifacts also was recovered, including atlatl spurs, mortar fragments, olive snail shell beads, baked clay cooking balls, and flaked stone. Analysis of the combined assemblage and obsidian hydration data suggests that the greatest population density and period of use occurred during the Upper Archaic Period and conformed to the Berkeley Pattern (Bennyhoff and Fredrickson 1994; Moratto 1984:184).

Ethnographic Setting

The plan area falls within the territory of the Patwin, whose language (Patwin) is part of the Wintuan language family (consisting of Nomlaki, Patwin, and Wintu). The Wintuan language family, in turn, belongs to the Penutian linguistic stock (Milliken et al. 2007:Figure 8.1). In addition to the Wintuan languages, the Penutian linguistic stock is made up of the Utian, Maiduan, and Yokutsan language families (Milliken et al. 2007:Figure 8.1; McCarthy 1985:Map 5). The word patwin is a native word meaning “people” that was used by several tribelets in reference to themselves, but has since been used to distinguish southern Wintun from their linguistic and cultural relatives to the north (Johnson 1978). Like all central California indigenous people, the Patwin probably moved seasonally within their territory between a small number of semi-permanent villages and a great number of temporary campsites. Their territory ranged from the Sacramento River to the east and within 5 miles east of Clear Lake to the west and from the town of Princeton in the north to San Pablo and Suisun Bays in the south (Johnson 1978:Figure 1). In all, this territory encompassed an area approximately 90 miles north to south and 40 miles east to west. Most of the population was concentrated along the river in large villages, and because most of the plains were submerged in winter and dry in the summer, occupation of this region was sparse and seasonal. Tribelets in the hills lived in the numerous intermontane valleys, particularly along the drainages of Cache and Putah Creeks (Johnson 1978:351).

The Patwin people on the north shore of Suisun Bay in the Fairfield area were known as the Suisuns and Malacas and were not culturally identical to their neighbors to the north, with whom they shared the Patwin language. Mission register evidence shows that the Suisuns were heavily intermarried with the Bay Miwok–speaking Chupcans across Suisun Bay to the south. (Milliken 1995:241, 247, 255.)

The main Patwin political unit was the tribelet, consisting of one primary and several satellite villages, with a definite sense of territoriality and autonomy (Johnson 1978:354). Four types of permanent structures were typical within the Patwin village. The family house could be placed anywhere; the ceremonial dance house was built at a short distance to the north or south end of the village; the sweathouse was built to the east or west of the dance house; and the menstrual hut was placed on the edge of the village, farthest from the dance house. All of the structures were earth-covered, semi-subterranean structures in either an elliptical or circular form. The family house was built by the paternal relatives, and all the other structures were built with the help of everyone in the village. The men commonly wore no clothing, and the women wore skirts of animal skin or shredded plant fiber. (Johnson 1978:357–358.)

Hunting and fishing were done by either individuals or small groups. Fish, including salmon, trout, and steelhead, were caught using nets, and mussels were collected from the river bed. Many other animals, including tule elk, deer, antelope, bear, ducks, geese, quail, and other birds, were hunted, using the bow and arrow and, in some cases, decoys. Acorns were a primary staple among the Patwin, who would gather two types of valley oak acorns, along with the hill and the mountain oak acorns. Baskets mostly were used in the gathering of acorns, buckeye, pine nuts, juniper berries, manzanita berries, blackberries, wild grapes, brodiaea bulbs, and tule roots. Sunflower, alfilaria, clover, bunch grass, and wild oat, all which grew on the open plains, provided seeds that were parched or dried and then pounded into meal. Each village had its own locations for gathering these various resources, and the village chief was in charge of assigning particular families to collection areas. (Johnson 1978:355.)

Tools most commonly were made from bone, wood, and stone. Obsidian and chert were used to make arrow points, drill points, and spearheads, as well as scrapers and knives for butchering animals. Bows and arrows were made from buckeye, juniper, dogwood, and elderberry wood. Mortars and pestles were used to process acorns and other seeds or to pound meat. Mussel shells were used as knives to cut fish and other meats into strips. Tule boats were constructed of bundles of round tule bound together to form crafts up to 20 feet long and 6 feet wide. Baskets were used for food collection and preparation and to hold burial goods. More than 40 types of baskets were used by the Patwin, including a mush boiler, winnowing tray, burden basket, cooking basket, fish traps, and mortar hoppers (Johnson 1978:356).

The southern Patwin traded salmon, river otter pelts, game, cordage, feathered headbands, and shell beads with the Pomo, Nomlaki, Wappo, and Southern Maidu groups (Johnson 1978:352). Bows were also a common trade item from the Southeastern Pomo and from the Nomlaki to the north. Obsidian either was brought in or was retrieved from the west and east.

The Southern Patwin were dislocated from their homeland immediately following Spanish contact, and many were forced into subjugation at the missions. By 1821, nearly all Patwins had been removed from their homeland and were baptized at Mission San Francisco. In 1824, many of these converts were moved to Mission San Francisco Solano in Sonoma Valley to form a core population at the new mission. Euroamerican settlement of the area in the 1850s resulted in the dislocation of the remaining Patwin and assimilation to a white labor economy. By 1972, the Bureau of Indian Affairs census listed only 11 Patwin individuals (Johnson 1978:352). By 2001–2003, Bureau of Indian Affairs survey data indicate that there are 313 individuals of Patwin descent among the three federally recognized tribes of Cachil DeHe Band of Wintun Indians, the Cortina Indian Rancheria of Wintun Indians, and the Yocha Dehe Wintun Nation (formerly Rumsey Indian Rancheria of Wintun Indians) (Bureau of Indian Affairs 2003:10–11).

Historic Setting

Because of its distance from San Francisco Bay, the project vicinity was of minor importance to the Spanish and Mexican governments in California. The earliest overland exploration of the Bay Area was completed in 1772 by the Fages-Crespi Expedition. Subsequent to additional overland and waterborne expeditions, more lasting Spanish influence reached the plan area vicinity through the establishment of Bay Area missions and proselytizing efforts among interior tribes. The most visible effects of missionary efforts were disease and decimation of the Native American populations in the area. Many punitive and exploratory expeditions were made into the project vicinity by the Spanish, both to "convert" those who had not been Christianized and to pursue runaway mission neophytes. (ICF Jones & Stokes 2009b:37.)

In the 1840s, Mexico took over rule of California from Spain, and the mission system was abandoned. Mission lands were divided, and land grants or ranchos were established. These lands were used predominantly for cattle grazing and the raising of livestock. In Solano County, Rancho Suisun was the first of six Mexican land grants that were established in the area. The land, consisting of 17,754 acres west of the present day city of Fairfield, was granted to a Suisun chief named Sem-Yeto, later baptized as Francisco Solano, in 1845. (Hoover et al. 1990:463.)

Deterioration of relations between the United States and Mexico resulted in the Mexican War, ending with the relinquishment of California to the United States under the Treaty of Guadalupe Hidalgo in 1848. The formation of the new state of California and the onset of the American Period were to bring rapid change to the region. The California Gold Rush of 1848 brought an increase in population to the region, and the focus of land use changed from ranching to agriculture in order to feed the swelling population of miners in the Sierra Nevada foothills. (ICF Jones & Stokes 2009b:37–38.)

Suisun City

Named for its original indigenous inhabitants, the Suisun area had few European residents until the 1860s. Within the boundaries of the original Suisun Township lay land that General Vallejo purchased from Francisco Solano in 1849, and land that Antonio Armijo inherited from his father, Francisco Jose Armijo. In 1850, as Dr. John Baker and Curtis Wilson sailed through Suisun Slough, they became the first Americans to visit the island upon which Suisun City took shape (Gregory 1912:73; Hoover et al. 1990:471; Munro-Fraser 1879:288–289). Development of the geographically well-situated island began in 1851 when Captain Josiah Wing raised Suisun's wharf and its first building, a warehouse. Suisun quickly became a port for boat shipments of locally grown grain and meat to San Francisco (Gregory 1912:73; Hoover et al. 1990:471; Hunt 1926:238; Keegan 1989:37; Munro-Fraser 1879:290, 298–300).

In the summer of 1851, John W. Owens and A. W. Hall opened the town's first store. In 1854, Suisun City's streets were laid out. That year, J. G. Edwards and S. C. Reed built a mill that was expanded in 1858 into a three-story steam-powered grain processor. Robert Waterman, acting on behalf of the estate of Archibald Ritchie and his own one-third interest in the Suisun Rancho, had sold off much of the nearby land by 1860.

By 1862, Suisun City had a fire company, an engine and a firehouse. In 1868 a large main constructed by the Suisun and Fairfield Water Company began delivering water from Fairfield to the south side of Suisun City. Known popularly as the “Cal P,” the California Pacific Railroad began passenger service from Vallejo to Suisun in 1868. That year, the County Board of Supervisors approved the city’s incorporation petition (Gregory 1912:73; Hunt 1926:239; Keegan 1989:37, 46, 49–50; Munro-Fraser 1879:290).

Over the next two decades, Suisun thrived amid change. Public support and anti-monopoly sentiment could not keep the Cal P from being purchased in 1871 by the Central Pacific Railroad, whose leaders resented competition from the smaller upstart railroad and refused to allow it access to Sacramento. Now Suisun City had shipping access to distant markets via the transcontinental railroad. In 1878 the Central Pacific added a new line from Benicia to Suisun. A wood-plank path linking Suisun City and Fairfield was removed and the marsh underneath filled in, ending Suisun’s days as an island. Nevertheless, the two cities remained separate entities, and, to a certain extent, rivals.

In 1876 the Bank of Suisun was established under the directorships of R. D. Robbins, C. F. D. Hastings, E. P. Hilborn, W. H. Turner, and J. B. Hoyt. By 1878 the town had three lawyers, five physicians, three dentists, three warehouses, two wagon factories, seven dry-goods and grocery stores, two hardware stores, two harness shops, two boot and shoe shops, three drug stores, a newspaper, a printer, and a livery stable. As of 1880, 600 people resided in Suisun City. The town’s streets were first lighted by electricity in 1888, the same year during which a major fire destroyed eight of the city’s blocks (Gregory 1912:73; Kaplan 1976:3, 10; Keegan 1989:49–50; Lucy 1987:7; Munro-Fraser 1879:290, 298; Thompson & West 1878:14).

Suisun City’s period of major prosperity took place from roughly 1880 to 1920. Replacing ranching and wheat farming, fruit cultivation flourished in the Suisun Valley, aided by the development of refrigerated railcars and large-scale fruit drying and canning operations. The combination of railroad access and a slough wharf allowed Suisun-area growers to benefit from favorable shipping rates compared to Vacaville. By 1888, Saunders & Reeves Lumber Yard (later the Suisun Lumber Company) operated along the Suisun Slough with offices, storage sheds, and a lumber yard on Main Street. Main Street also offered specialty stores selling goods and services such as dry goods, clothing, banking, and laundry. In 1903, the city received telephone service. Reclaimed marshland at Grizzly and Joyce Islands on the outskirts of Suisun was profitably devoted to dairy farming. Located approximately 6 miles northwest of Suisun City, the cement production facilities of the Pacific Portland Cement Company added a new industrial element to the local economy. Pacific Portland constructed a company town that housed 500 resident workers adjacent to its factory.

In the 1910s, the federal government deepened the waterway connecting Suisun City to the bay, in part to enable larger shipments from the Portland Cement plant. In 1913, the new Northern Electric Railroad initiated passenger and freight service between Suisun and Vacaville (Gregory 1912:74–75; Kaplan 1976:4–5; Keegan 1989:58, 62, 67–68, 70–71).

Suisun City retained its status as a shipping and banking center for several decades, but the Great Depression brought hard times locally. Even before the onset of economic depression, the nearby Pacific Portland Cement Plant ceased operations in 1927. A rapidly declining national fruit market resulted in closure of both the California Packing Company's drying facilities and the Armsby cannery in Fairfield. Some growers in the Suisun-Fairfield area lost their land to foreclosure while others endured. A substantial number of retail stores also closed in Suisun City during the Great Depression. The Works Progress Administration brought some relief to the area's jobless by employing local residents in the reconstruction of sidewalks in Suisun City and Fairfield (Bates 1982:14–15; Kaplan 1976:9; Keegan 1989:74–75; McElvaine 1984).

World War II brought generalized economic recovery to the area and marked Fairfield's final eclipse of Suisun City as the preeminent municipality in central Solano County. The founding of the Fairfield-Suisun Army Airfield in 1942 and the subsequent development of what became Travis Air Force Base brought an abundance of new jobs to the Fairfield-Suisun area. A revived national fruit market generated prosperity for growers who survived the Great Depression, but no sizable cannery again operated in the area. Instead, fruit that was not devoted to the market for fresh produce was sent to increasingly large industrialized canneries in Sacramento and the Bay Area. Over time, area orchardists tailored their crops to the preferences of such large canneries, investing more and more of their land in Bartlett pears, Royal apricots, and Elberta peaches. These growers also benefited from water development undertaken by the Solano Irrigation District, which included a partnership with Reclamation to carry out the Solano Project, including construction of Monticello Dam and Lake Berryessa.

Striking heavy blows to waterway shipping out of Suisun City, trucking activity was boosted in northern California and Solano County by bridge construction in the Bay Area during the 1930s, and by the expansion of U.S. Highway 40 through Fairfield into a modern, multi-lane freeway during the 1960s (present-day Interstate 80). The Suisun City wharf never regained its status as a shipping point central to the local agricultural economy. Now it serves mainly as a launch for recreational boaters (Bates 1982; Kaplan 1976:14; Keegan 1989:79–84).

In the late 1970s, city officials embarked on an effort to revitalize the historic core of Suisun City centered on Main Street and surrounding streets. City officials encouraged businesses fronting Main Street to maintain an "Old West" look that represented how Main Street looked in the 1880s (Drew 1986:B6). In 1982, the city drafted a Specific Plan to revitalize Old Town and the harbor (Terrain.org 2009). The plan was not fully implemented and was revised in 1990 (City of Suisun 1999:I-1). The Specific Plan proposed keeping the historic character of Old Town and the Main Street commercial district. On Main Street, city officials wanted to create businesses that sold present-day specialty items (e.g., clothing, jewelry, and antiques) just as the original businesses did during the turn of the century (butcher, bakers, shoe shops, etc.) (City of Suisun 1999:IV-13).

Suisun Marsh continues to support a 150-year-old recreational institution: the duck club. San Francisco duck hunters started conducting expeditions to the Marsh in 1859. A hunting report dating to 1879 stated that one person could shoot 100–200 ducks every day during the September–November hunting season. The accessibility of the Marsh was improved for duck hunters in 1879, at which time the California Pacific Railroad train tracks ran within the Marsh connecting Benicia and Fairfield. Several whistle-stop stations were established in the marsh, including Teal, Cygnus, and Jacksnipe stations. The tracks subsided at least 1 foot each year despite constant upkeep. Currently more than 150 hunting clubs occupy the marsh. The typical club consists of a frame building on piers with a veranda. (EDAW/AECOM 2006:15.)

Distribution of Cultural Resources in the Plan Area

The foregoing background information demonstrates that numerous natural and historical factors influenced human uses of the plan area, as well as the location and character of the remains of those uses on the modern landscape. The archaeological record is a product of both cultural and geologic factors. Where and when people engage in activities and leave behind artifacts are cultural phenomena. Once a site is abandoned, however, its preservation or destruction is influenced by natural and cultural processes unrelated to previous uses. Equally important in assessing the archaeological record is the potential for younger deposits to bury sites and prevent their detection. These two processes—erosion (destruction) and burial (preservation and potentially concealment)—profoundly shape the archaeological record as well as perceptions of that record. In some cases, geomorphic processes (e.g., erosion, fluvial transport, burial) can move, disturb, or bury culturally deposited artifacts, sometimes leading to pronounced misreading of the archaeological record (Rosenthal et al. 2007:151). Moreover, geomorphic processes can result in patterned natural deposits resembling cultural ones, also leading to potential misinterpretation of archaeological materials. Geoarchaeology is the study of these processes and the application of geological principles to attempt to locate buried archaeological resources.

Buried Prehistoric Site Sensitivity

Because buried sites typically lack visible features or artifacts indicating their presence to a field observer, they are often not identified during surface surveys. This issue is partially resolved by assessing the probability of discovering buried sites in different parts of a study area using geoarchaeological investigation. The ability to locate buried sites ultimately depends on a number of factors, particularly the presence of depositional or stable landforms and/or appropriate soils. In the Bay Area, where Holocene-aged alluvial fans and floodplains often obscure or cover archaeological deposits, and where such features are causally related to the area's ample rainfall and associated runoff, depositional processes are of particular interest.

Different landscapes, landforms, and locations have differential probabilities of: (1) ever being used by humans; (2) preserving archaeological remains; and (3) containing buried archaeological sites. These factors are important in assessing the sensitivity of different areas for the presence of buried archaeological sites. Accordingly, this analysis assesses the plan area for the presence of buried archaeological sites using relevant geoarchaeological datasets (i.e., age of landform, soils, settlement pattern data).

Buried archaeological deposits can be present only in landforms that developed during the Holocene (10,000 B.P. to present), based on the known duration of human presence in California. Meyer and Rosenthal (2007:Figures 6, 8) map the following landforms in the plan area:

- Holocene- to historic-age (10,000–150 B.P.) estuarine deposits (comprises the majority of the plan area;
- undifferentiated pre-Holocene landforms (Kirby and Potrero hills);
- latest Pleistocene- to historic-age (30,000–150 B.P.) alluvial fans (northwestern portion of the plan area); and
- historic and modern (<150 B.P.) cut-and-fill areas (cuts and canals).

Of these landforms, the undifferentiated pre-Holocene deposits have minimal potential to contain buried cultural resources because these landforms developed before human presence in the plan area. Pre-Holocene landforms may, however, contain archaeological materials and other cultural resources (prehistoric and historic) on the surface. Holocene- to historic-age depositional landforms have a generally high potential to contain buried archaeological deposits; the sensitivity of latest Pleistocene- to historic-age and historic and modern landforms is more variable and poorly understood by comparison (Meyer and Rosenthal 2007:26).

The likelihood of encountering surface and buried archaeological resources in the plan area can be assessed better through regional geotechnical and soils data, as well as the distribution of known archaeological sites with respect to landform and soil types. Because it was conducted on a regional scale using relatively coarse-grained chronological data for landforms, it is important to refine Meyer and Rosenthal's (2007:Figure 6) landform age assignments with local chronological and stratigraphic data. Such data have been collected from nearby Green Valley Creek and Brown Island (ICF Jones & Stokes 2009c:6; Meyer and Rosenthal 2007:Figure 4). Bates (1977) provides additional stratigraphic information, albeit without chronological control.

In 2008, radiocarbon samples were collected from two geotechnical borings—C08 and C09. Both are near Green Valley Creek, just north of I-80, approximately 5 miles from the plan area. Fibrous charcoal samples from a depth of approximately 29 feet resulted in an 11,980–11,320 cal B.P. date from

Boring 08. The sample was collected in silty sand, about 15 feet below bay mud. The sample from Boring 09 was collected in sand with gravel from approximately 30 feet below the surface. The calibrated date for this sample is 13,260–12,970 B.P. These dates further confirm that the age of soils is conducive to the accepted timeframe for human habitation in this area and indicate that buried soils may be present at depths less than 30 feet. The radiocarbon samples are also important in that they appear to date the river valley (marked by silty sand) that preceded the marsh (indicated by bay mud) to the latest Pleistocene. (ICF Jones & Stokes 2009c:6.)

Cores obtained at Brown Island, just southeast of Van Sickle Island, indicate that Suisun Bay changed from a freshwater tidal flat to a more brackish-water tidal flat as a result of the rise in sea level about 6,000 years ago, during the middle to late Holocene. This development coincided with a period of soil formation between ca. 6000 and 4000 B.P. (Meyer and Rosenthal 2007:Figure 4).

Six soil types in the plan area have been identified as having the potential to contain buried soils, representing former land surfaces. These soil types were identified by reviewing a soil survey of Solano County and regional archaeological studies. In the Solano County soil survey, Bates (1977) describes the various soils series and variants throughout the county, including the plan area. In this soil survey, four soil variants in the plan area are described as containing buried soils (buried A horizons, abbreviated “Ab”):

- Alviso silty clay loam (An);
- Joice muck, clay subsoil variant (Jb);
- Sycamore silty clay loam, saline (St); and
- Valdez silty clay loam, clay substratum (Ve) (Table 7.7-5).

Additionally, buried archaeological deposits (CA-SOL-69, SOL-263, SOL-391, and SOL-355/H) have been identified in two soil variants that Bates (1977:16) did not identify as containing Ab horizons: Clear Lake clay (CeB) and Rincon clay loam (RoA) (Table 7.7-5). These sites are situated 4–5 miles north of the plan area, in the Green Valley vicinity (ICF Jones & Stokes 2009b).

Table 7.7-5. Soil Series in the Plan Area That Contain Buried Soils

Soil Series	Description of Buried Soil	Map Sheet(s) (after Bates 1977)	SMP Region	Acreage within Plan Area
Alviso silty clay loam (An)	Silt clay loam buried 19–60 inches below ground surface	35, 47, 52	1	1,380.70
			2	2.51
			3	184.74
			4	36.13
Clear Lake clay, 0 to 2% slopes (CeB)	28 inches below ground surface	30, 31, 35, 36, 42	2	143.72
			3	0.79
			4	18.60
Joice muck, clay subsoil variant (Jb)	Buried mineral clay at 25–35 inches below ground surface	31	1	785.43
			2	6.44
			3	453.56
Rincon clay loam, 0 to 2% slopes (RoA)	Buried	34, 35		
Sycamore silty clay loam, saline (St)	Buried silty clay loam 20–36 inches below ground surface	30, 47	1	1,894.77
Valdez silty clay loam, clay substratum (Ve)	Buried clay at 35–50 inches below ground surface	36, 48, 53, 54	4	6,866.46

The presence of buried soils in six plan area soil variants at depths of 19 to 60 inches suggests that buried landforms are located in the plan area and, by extension, buried archaeological resources may be present. One must make this inference cautiously, however, because Bates (1977:1–2) does not report where or at what intervals soil test pits were dug. Additionally, the soil survey generally characterizes only the top 5 feet of soil; no data are provided on deeper deposits. These limitations are highlighted by the fact that four known archaeological sites in the region (CA-SOL-69, SOL-263, SOL-391, and SOL-355/H) have buried archaeological materials in Clear Lake clay (CeB) and Rincon clay loam (RoA). Given Meyer and Rosenthal's (2007:27) observation that stratigraphy—including buried soils—often occurs at the scale of landforms, it is probable that buried soils are contained in the soil series or variants at depths comparable to those reported by Bates (1977).

Holocene-age sediments in the plan area are expected to be thick. Geologic studies and cores, as well as archaeological studies, indicate that the middle Holocene marsh dates to approximately 6000 B.P. and is located approximately 6–9 feet below ground surface (Meyer and Rosenthal 2007:3). The buried soils identified in Table 7.7-5, therefore, are Holocene in age and represent landforms that once could have supported human occupation prior to the onset of a new depositional cycle. Figure 7.7-1 depicts soils within the plan area that are sensitive for the presence of buried archaeological resources. Figure 7.7-1

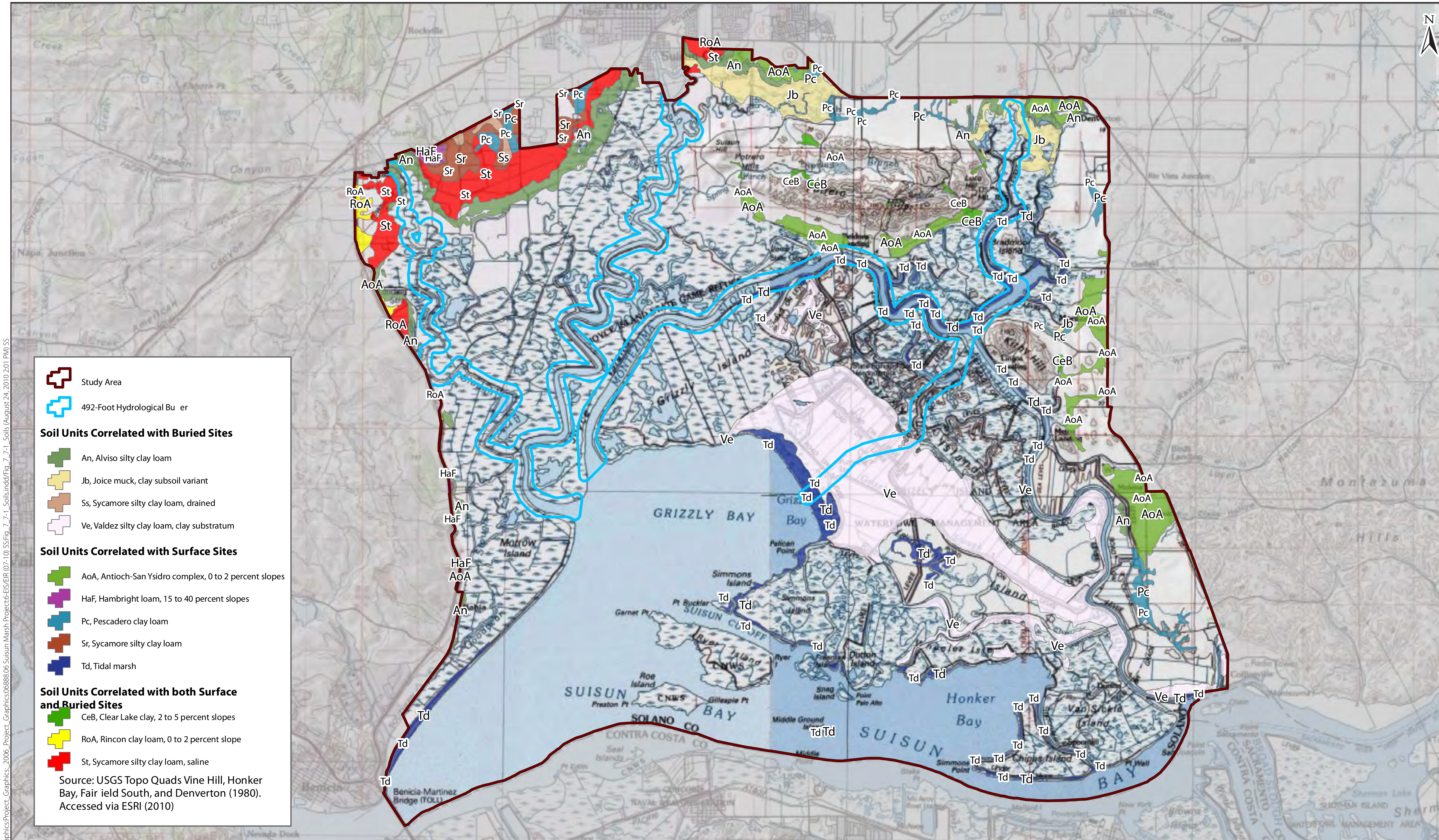

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Figure 7.7-1
Suisun Marsh Plan Area Showing Soils Correlated with Surface and Buried Sites

indicates that approximately 11,848 acres of the plan area are sensitive for the presence of buried archaeological resources (see Table 7.7-6).

All 11,848 acres of the plan area, however, are not equally sensitive for the presence of buried archaeological resources. Prehistoric settlement decisions were made with respect to the presence of valued resources such as the distribution of freshwater sources. In a previous study north of the plan area, ICF Jones & Stokes (2009b) found that of the 25 archaeological sites located within 2 miles of the I-80/I-680/SR 12 Interchange Project, 14 are located 0–492 feet from a waterway. Eight of these sites are recorded as having a buried component of some kind (ICF Jones & Stokes 2009b:Table 5); however, many sites have not been excavated using modern techniques, and some have not been excavated at all. The majority of buried sites or sites with a buried component are mapped within Clear Lake clay (also found in the plan area) or Yolo loam (not found in the plan area), although one site each is located in Brentwood and Rincon clay (ICF Jones & Stokes 2009b:Figure 17). Based on these patterns, the highest potential for archaeological sites in the plan area occurs within the following soil units within 492 feet of a prehistoric waterway[2] (Figure 7.7-1):

- Alviso silty clay loam (An) [19–60 inches below ground surface];
- Clear Lake clay, 2 to 5% slopes (CeB) [about 28 inches below ground surface];
- Joice muck, clay subsoil variant (Jb) [25–35 inches below ground surface];
- Rincon clay loam, 0 to 2% slope (RoA) [depth unknown];
- Sycamore silty clay loam, saline (St) [20–36 inches below ground surface]; and
- Valdez silty clay loam, clay substratum (Ve) [35–50 inches below ground surface].

[2] This 984-foot-wide band (492 feet on either side of streams) is termed the hydrological buffer throughout this section.

Table 7.7-6. Portions of the Plan Area Sensitive for the Presence of Buried Archaeological Resources

Map Unit Symbol	Description	Region	Within Hydrologic Buffer?	Acres
An	Alviso silty clay loam	1	No	1,325.57
An	Alviso silty clay loam	1	Yes	55.13
An	Alviso silty clay loam	2	No	2.51
An	Alviso silty clay loam	3	No	179.59
An	Alviso silty clay loam	3	Yes	5.15
An	Alviso silty clay loam	4	No	36.13
CeB	Clear Lake clay, 2 to 5% slopes	2	No	143.72
CeB	Clear Lake clay, 2 to 5% slopes	3	No	0.79
CeB	Clear Lake clay, 2 to 5% slopes	4	No	18.60
Jb	Joice muck, clay subsoil variant	1	No	785.43
Jb	Joice muck, clay subsoil variant	2	No	6.44
Jb	Joice muck, clay subsoil variant	3	No	384.26
Jb	Joice muck, clay subsoil variant	3	Yes	69.30
RoA	Rincon clay loam, 0 to 2% slope	1	No	194.07
St	Sycamore silty clay loam, saline	1	No	1,764.45
St	Sycamore silty clay loam, saline	1	Yes	10.20
Ve	Valdez silty clay loam, clay substratum	4	No	6,544.08
Ve	Valdez silty clay loam, clay substratum	4	Yes	322.39
				11,847.79

The hydrologic buffer runs parallel to freshwater streams and extends 492 feet to either side of the streams.

In addition, the soil variants named immediately above are moderately sensitive for the presence of buried prehistoric archaeological resources outside the hydrological buffer (Figure 7.7-1). At depths of 6–9 feet below the present ground surface, the entire plan area is expected to contain a buried landform that represents an earlier form of Suisun Marsh (Meyer and Rosenthal 2007:3). Portions of the plan area within the hydrological buffer are highly sensitive for the presence of buried prehistoric archaeological resources to a minimum depth of 6–9 feet, whereas areas outside of the hydrological buffer are moderately sensitive for buried archaeological resources.

Prehistoric Site Sensitivity on the Plan Area's Surface

The historic-period and present-day suite of plant and animal resources in the plan area presented numerous opportunities for the Patwin. Whereas hydrological and topographic conditions in the plan area may have constrained human occupation of the Marsh, the presence of prehistoric archaeological site

CA-SOL-13 along Nurse Slough suggests that such constraints were not prohibitive. Rather, the low number of prehistoric archaeological sites recorded in the plan area is likely a product of survey bias. Of the approximately 35% of the plan area that has been surveyed, the most extensive surveys have been in reclaimed areas on the eastern margin of the plan area and in uplands such as Potrero Hills (EDAW 2003; Jones & Stokes Associates 1974, 1985; Jones & Stokes Associates and Geier and Geier Consulting 1995; Theodoratus et al. 1980; William Self Associates 1993). Table 7.7-7 summarizes information on 30 prehistoric archaeological sites in the Suisun region: landform, soil type, and whether they contain buried or surface manifestations. Of these resources, only eight are situated on soils that are not represented in the plan area and the location of one prehistoric resource (ISO-19) is unknown. The remaining 22 resources are located in soils present in the plan area, suggesting that the distribution of surface prehistoric sites may be tied to similar soil contexts and landforms in the plan area.

Table 7.7-7. Regional Prehistoric Archaeological Sites and Soil Context

Site #	Landform (Meyer and Rosenthal 2007:Figure 8)	Soils (Bates 1977)	Buried/Surface	Site in Plan Area?	Soil Unit in Plan Area?
CA-SOL-391	Alluvial fan/levee	Clear Lake clay (CeB)	Buried	No	Yes
ISO-19	N/A	N/A	Surface	No	Unknown
ISO-20	Alluvial fan/levee	Pescadero clay loam (Pc)	Surface	Yes	Yes
CA-SOL-13	Estuarine deposits	Tidal marsh (Td)	Surface	Yes	Yes
CA-SOL-14	Alluvial fan/levee	Conejo clay loam (Cr)	Surface	No	No
CA-SOL-18	Alluvial fan/levee	Yolo loam (Yo)	Surface	No	No
CA-SOL-22	Pre-Holocene, undifferentiated	Sycamore silty clay loam, saline (St)	Surface	No	Yes
CA-SOL-24/H	Alluvial fan/levee	Hambright loam (HaF)	Surface	No	Yes
CA-SOL-25/H	Alluvial fan/levee	Hambright loam (HaF)	Surface	No	Yes
CA-SOL-60	Alluvial fan/levee	Sycamore silty clay loam (Sr)	Surface	No	Yes
CA-SOL-66	Bay mud (at contact with Holocene fan deposits)	Sycamore silty clay loam (Sr)	Surface	No	Yes
CA-SOL-68	Late Pleistocene to Holocene fan deposits	Rincon clay loam (RoA)	Surface	No	Yes
CA-SOL-71/H	Alluvial fan/levee	Hambright loam (edge of Brentwood clay loam) (HaF)	Surface	No	Yes
CA-SOL-239	Alluvial fan/levee	Clear Lake clay (CeB)	Surface	No	Yes
CA-SOL-242	Alluvial fan/levee	Clear Lake clay (CeB)	Surface	No	Yes
CA-SOL-242S	Alluvial fan/levee	Clear Lake clay (CeB)	Surface	No	Yes
CA-SOL-247	Alluvial fan/levee	Sycamore silty clay loam (Sr)	Surface	No	Yes

Site #	Landform (Meyer and Rosenthal 2007:Figure 8)	Soils (Bates 1977)	Buried/Surface	Site in Plan Area?	Soil Unit in Plan Area?
CA-SOL-262	Late Pleistocene to Holocene fan deposits	Rincon clay loam (RoA)	Surface	No	Yes
CA-SOL-263	Alluvial fan/levee	Rincon clay loam (RoA)	Surface	No	Yes
CA-SOL-268	Alluvial fan/levee	Antioch-San Ysidro complex (AoA)	Surface	No	No
CA-SOL-273	Pre-Holocene, undifferentiated	Rincon clay loam (RoA)	Surface	No	Yes
CA-SOL-310	Alluvial fan/levee	Brentwood clay loam (BrA)	Surface	No	No
CA-SOL-315	Alluvial fan/levee	Clear Lake clay (CeB)	Surface	No	Yes
CA-SOL-364	Alluvial fan/levee	Brentwood clay loam (BrA)	Surface	No	No
CA-SOL-69	Alluvial fan/levee	Clear Lake clay (CeB)	Surface with buried component	No	Yes
CA-SOL-243	Alluvial fan/levee	Brentwood clay loam (BrA)	Surface with buried component	No	No
CA-SOL-263	Alluvial fan/levee	Rincon clay loam (RoA)	Surface with buried component	No	Yes
CA-SOL-355/H	Alluvial fan/levee	Clear Lake clay (CeB)	Surface with buried component	No	Yes
CA-SOL-356	Alluvial fan/levee	Yolo loam (Yo)	Surface with buried component	No	No
CA-SOL-363	Alluvial fan/levee	Yolo loam (Yo)	Surface with buried component	No	No

Table 7.7-7 shows that previously recorded prehistoric sites occur on eight soil series or variants. The same soils series and variants occupy about 7,388 acres of land within the plan area (Table 7.7-8). Figure 7.7-1 shows that these soil series and variants are located at the margins of the modern Marsh (primarily on alluvial fan uplands) and tidal flats fronting on Suisun Bay, Honker Bay, and Nurse Slough. Although other soil variants in the plan area may be sensitive for the presence of surface prehistoric sites, the soil series and variants in Table 7.7-8 and the Pleistocene-aged Potrero and Kirby Hills are regarded as highly sensitive for the presence of such resources. Additional survey outside these areas may indicate that other areas have heightened sensitivity.

Table 7.7-8. Portions of the Plan Area Sensitive for the Presence of Surface Prehistoric Sites

Map Unit Symbol	Description	Region	Within Hydro Buffer?	Acres
AoA	Antioch–San Ysidro complex, 0 to 2% slopes	1	No	211.366
AoA	Antioch–San Ysidro complex, 0 to 2% slopes	2	No	503.245
AoA	Antioch–San Ysidro complex, 0 to 2% slopes	2	Yes	6.856
AoA	Antioch–San Ysidro complex, 0 to 2% slopes	3	No	567.169
AoA	Antioch–San Ysidro complex, 0 to 2% slopes	4	No	755.667
CeB	Clear Lake clay, 2 to 5% slopes	2	No	143.723
CeB	Clear Lake clay, 2 to 5% slopes	3	No	0.785
CeB	Clear Lake clay, 2 to 5% slopes	4	No	18.605
HaF	Hambright loam, 15 to 40% slopes	1	No	102.725
Pc	Pescadero clay loam	1	No	314.464
Pc	Pescadero clay loam	3	No	177.729
Pc	Pescadero clay loam	4	No	254.107
RoA	Rincon clay loam, 0 to 2% slope	1	No	194.066
Sr	Sycamore silty clay loam	1	No	541.965
St	Sycamore silty clay loam, saline	1	No	1,764.453
St	Sycamore silty clay loam, saline	1	Yes	10.196
Td	Tidal marsh	1	No	175.004
Td	Tidal marsh	2	No	51.332
Td	Tidal marsh	2	Yes	172.513
Td	Tidal marsh	3	No	97.473
Td	Tidal marsh	3	Yes	60.910
Td	Tidal marsh	4	No	1,094.925
Td	Tidal marsh	4	Yes	168.483
				7,387.76

Historic-Period Cultural Resources in the Plan Area

Table 7.7-2 demonstrates that a variety of historic-period cultural resources is present in the plan area: ranch properties; railroad grades, stations, and trestles; refuse scatters; pump houses; levees; fish screens; water conveyance features; landings; utility lines; duck clubs; roads; and a historic district (Montezuma Slough Rural Historic Landscape). The majority of known historic-period cultural resources in the plan area are located along sloughs and levees, bays, or within 492 feet of sloughs, levees, and bays. The distribution of historic-period resources in the plan area is largely predictable from historic maps and aerial photographs of the Marsh.

Cultural Resources Sensitivity of the Plan Area: A Summary

The preceding Affected Environment for cultural resources described human use of the plan area from prehistoric to recent times, as well as the range of cultural resources expected to be present in the Marsh. The Affected Environment section indicates that the plan area is not homogenous with respect to cultural resource sensitivity (see Table 7.7-9). Regions 1 and 4 have more sensitivity for the presence of buried archaeological resources than they do for surface archaeological sites. Regions 2 and 3, on the other hand, are more sensitive for the presence of surface archaeological resources than buried ones. Historic-period cultural resources are distributed relatively evenly across the plan area, and the majority are evident on historic maps (see Owens 1991).

Table 7.7-9. Summary of Cultural Resource Sensitivity in the Plan Area

Region	# Recorded Resources	High Buried Site Potential (ac)	Moderate Buried Site Potential (acres)	High Surface Site Potential (acres)	Moderate Surface Site Potential (acres)
1	7	65.33	4,069.51	10.20	3,304.04
2	1	0	152.68	179.37	698.30
3	2	74.45	564.63	60.91	843.16
4	25	322.39	6,598.81	168.48	2,123.30

Regulatory Setting

Federal

Under NEPA, federal agencies must "preserve important historic, cultural and natural aspects of our national heritage" (Section 101 [b][4]). Section 106 of NHPA (16 USC 470f) requires federal agencies to take into account the effect(s) of their undertakings on historic properties and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment. For tidal wetland restoration, the Section 106 lead agency would be the USFWS, whereas Reclamation would be the lead agency for the managed wetland activities (including activities funded by the PAI fund). The Section 106 process normally includes the following steps:

1. Initiate the Section 106 process.
2. Identify and evaluate historic properties.
3. Assess the effects of the undertaking on historic properties within the area of potential effects (APE).
4. If historic properties are subject to adverse effects, Reclamation, the State Historic Preservation Officer (SHPO), and any other consulting parties

(including Native American Tribes) continue consultation to seek ways to avoid, minimize, or mitigate the adverse effect. A memorandum of agreement (MOA) is usually developed to document the measures agreed upon to resolve the adverse effects.

5. Proceed in accordance with the terms of the MOA.

The standard Section 106 process for assessing effects on historic properties entails a thorough program of research, consultation, fieldwork, and reporting, commensurate with the scale of the undertaking and its effects. This is the process outline in the list above. On the other hand, where property access is restricted, undertakings are unusually large or complex, or the effects of the undertaking or group of undertakings are repetitive and predictable in nature, 36 CFR 800.14(b) permits the federal agency to implement a phased approach to historic properties management, codified in a programmatic agreement (PA). Such a document identifies the parties responsible for various cultural resource management tasks, standards, and procedures for all expectable management tasks, and reporting and monitoring procedures.

Historic properties are any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the NRHP (36 CFR 800.16[1]). For federal projects, cultural resource significance is evaluated in terms of eligibility for listing in the NRHP. The NRHP criteria for evaluation are defined at 36 CFR 60.4 as follows: The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects of state and local importance that possess integrity of location, design, setting, materials, workmanship, feeling and association, and that

A. are associated with events that have made a contribution to the broad pattern of our history;

B. are associated with the lives of people significant in our past;

C. embody the distinct characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. have yielded, or are likely to yield, information important in prehistory or history (36 CFR 60.4).

State

CEQA requires that public agencies (in this case, DFG) that finance or approve public or private projects must assess the impacts of the project on cultural resources. CEQA requires that alternative plans or mitigation measures be considered if a project would result in significant impacts on important cultural resources. However, only impacts on significant cultural resources need to be addressed. Therefore, prior to the development of mitigation measures, the importance of cultural resources must be determined. The steps that normally are taken in a cultural resources investigation for CEQA compliance are listed below.

1. Identify cultural resources.
2. Evaluate the significance of resources.
3. Evaluate the impacts of a project on all resources.
4. Develop and implement measures to mitigate the impacts of the project only on significant resources, namely historical resources and unique archaeological resources.

The State CEQA Guidelines define three ways that a cultural resource may qualify as a historical resource for the purposes of CEQA review.

1. The resource is listed in or determined eligible for listing in the California Register of Historical Resources (CRHR).
2. The resource is included in a local register of historical resources, as defined in Public Resources Cord (PRC) 5020.1(k), or is identified as significant in a historical resource survey meeting the requirements of PRC 5024.1(g) unless the preponderance of evidence demonstrates that it is not historically or culturally significant.
3. The lead agency determines the resource to be significant as supported by substantial evidence in light of the whole record (14 California Code of Regulations [CCR] 15064.5[a]).

A cultural resource may be eligible for inclusion in the CRHR if it:

- is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;
- is associated with the lives of persons important in our past;
- embodies the distinctive characteristics of a type, period, region, or method of construction; represents the work of an important creative individual; or possesses high artistic values; or
- has yielded, or may be likely to yield, information important in prehistory or history.

In addition, CEQA distinguishes between two classes of archaeological resources: archaeological resources that meet the above definition of a historical resource, and unique archaeological resources. An archaeological resource is considered unique if it:

- is associated with an event or person of recognized significance in California or American history or of recognized scientific importance in prehistory;
- can provide information that is of demonstrable public interest and is useful in addressing scientifically consequential and reasonable research questions; or

- has a special or particular quality such as oldest, best example, largest, or last surviving example of its kind. (PRC 21083.2.)

Local

Solano County General Plan

The Solano County General Plan contains two policies concerning Historical and Archaeological Features.

1. The County shall identify and preserve its significant historical structures and features.
2. The County shall establish a mechanism for the identification, review and protection of significant archaeological sites. (Solano County Planning Department 1992:47.)

Environmental Consequences

Assessment Methods

Impact assessments for cultural resources focus on properties eligible for listing in the NRHP (historic properties) or the CRHR, or considered significant resources or unique archaeological resources under CEQA. The criteria described immediately below are used to determine whether the impacts of the proposed project on cultural resources are significant.

Significance Criteria

Federal

According to 36 CFR 800.5, an undertaking would have an adverse effect on historic properties if the effect alters the characteristics[3] that make a property eligible for inclusion in the NRHP. Such effects also would be considered significant under NEPA. Adverse effects can occur when prehistoric or historic archaeological sites, structures, or objects listed in or eligible for listing in the NRHP are subjected to the following phenomena:

[3] Cultural resource managers often refer to these characteristics as character-defining elements or features. Character-defining features are those characteristics of a historic property, historical resource, or unique archaeological resource that convey its significance; the loss of character-defining elements impedes a property's ability to convey its historical significance. The importance of character-defining elements in cultural resource assessments is made clear in National Register Bulletin 15, which mentions "character" in this context 42 times (Andrus and Shrimpton 1997).

1. Physical destruction of or damage to all or part of the property.
2. Alteration of the property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation, and provision of handicapped access, that is not consistent with the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (36 CFR 68) and applicable guidelines.
3. Removal of the property from its historic location.
4. Change in the character of the property's use or of physical features within the property's setting that contribute to its historic significance.
5. Introduction of visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features.
6. Neglect of the property that causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe or Native Hawaiian organization.
7. Transfer, lease, or sale of the property out of federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

State

This analysis uses criteria from 14 CCR 15064.5(b)(1) and (2) that identify a significant impact as one with the potential to cause a substantial adverse change in the significance of a historical resource or unique archaeological resource. *Substantial adverse change in the significance of a resource* means the physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of the resource would be materially impaired. The significance of a historical resource is materially impaired when a project results in demolition or material alteration in an adverse manner of those physical characteristics of a resource that:

- convey its historical significance and that justify its inclusion in, or eligibility for inclusion in, the CRHR;
- account for its inclusion in a local register of historical resources pursuant to PRC 5020.1(k) or its identification in a historical resources survey meeting the requirements of PRC 5024.1(g), unless the public agency reviewing the effects of the project establishes by a preponderance of evidence that the resource is not historically or culturally significant; or
- convey its historical significance and that justify its eligibility for inclusion in the CRHR as determined by a lead agency for purposes of CEQA.

Local

No local significance criteria have been established by the County of Solano or the City of Suisun.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, the SMP would not be implemented. As a result, the amount of restoration in the Marsh likely would be limited.

The No Action Alternative includes the following assumptions related to activities and associated impacts:

- It is assumed for purposes of this No Action Alternative evaluation that approximately 700 additional acres could be restored without the SMP.
- Managed wetland activities may become less frequent as a result of permitting difficulty. This could result in fewer ground-disturbing activities within the plan area.
- Any levee breaches that occur in inaccessible areas would not be fixed and passive restoration would occur in these areas. Such events would result in damage to recorded and as-yet-unidentified cultural resources (at a minimum including any failed historic-era levees).

Although damage to or loss of cultural resources likely would occur under the No Action Alternative, the expected minimal habitat restoration and levee maintenance likely would engender fewer impacts on cultural resources than would Alternatives A–C.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

The locations of restoration activities, which could be implemented by the Principal Agencies or other agencies, are presently unknown. Tidal restoration activities in the plan area would engender several effects on cultural resources. These activities are:

- maintenance of levee and water control features,
- levee lowering or breaching,
- upgrading or constructing new exterior levees adjacent to restoration areas, and

- inundation of restoration areas.

Impact CUL-1: Damage to Montezuma Slough Rural Historic Landscape as a Result of Ground-Disturbing Activities along Montezuma Slough

Ground-disturbing activities such as levee modifications, conversion of managed wetlands and uplands to managed wetlands, replacement of infrastructure, and enhancement of vernal pool and riparian habitat may result in damage to character-defining features of the Montezuma Slough Rural Historic Landscape. Character-defining features of this historic district include the slough levees, landscaping elements that define existing and former historic landings, pilings and piers, standing structures, archaeological sites, and shipwrecks. Damage to or the loss of one or more character-defining elements of the district may constitute an adverse impact on the resource as a whole. Such impacts may be restricted in scope; the impact need not be at an extensive, “landscape” level to constitute an adverse impact on the Montezuma Slough Rural Historic Landscape but may affect individual elements that contribute to the landscape. The Montezuma Slough Rural Historic Landscape is potentially eligible for listing in the NRHP and CRHR and therefore is a likely candidate for designation as a historic property under Section 106 of the NHPA and a historical resource for the purposes of CEQA. Therefore, the loss of or damage to character-defining features of this district, would constitute a potentially significant impact. Implementation of Mitigation Measure CUL-MM-1 would reduce the severity of Impact CUL-1, although not necessarily to a less-than-significant level.

Conclusion: Significant and unavoidable.

Mitigation Measure CUL-MM-1: Document and Evaluate the Montezuma Slough Rural Historic Landscape, Assess Impacts, and Implement Mitigation Measures to Lessen Impacts

No formal evaluation of the Montezuma Slough Rural Historic Landscape to determine resource significance under the NRHP criteria and CEQA has been undertaken to date; Esser (1999) identifies the presence of this rural historic landscape, but this study does not constitute complete documentation of the resource nor does it evaluate its significance. Similarly, the exact locations of the effects described above (Impact CUL-1) are unknown, as are the frequency and severity of impacts on the Montezuma Slough Rural Historic Landscape. Because this impact is defined only conceptually in this EIS/EIR (commensurate with the detail of the project description), mitigation measures for this impact can be posed only conceptually.

During subsequent project-level environmental impact analyses conducted for the programmatic plan actions identified herein, the state or federal lead agency (as applicable) will conduct an inventory and significance evaluation of the Montezuma Slough Rural Historic Landscape. The inventory and evaluation will be conducted according to the following standards.

- The implementing regulations for Section 106 of the NHPA (36 CFR 800.4).
- The State CEQA Guidelines (14 CCR 15064.5[a]).

- *Archeology and Historic Preservation: Secretary of the Interior's Standards and Guidelines* (48 Federal Register [FR] 44716–44742).
- *The Secretary of the Interior's Standards and Guidelines for Federal Agency Historic Preservation Programs Pursuant to the National Historic Preservation Act* (including the Guidelines for the Treatment of Cultural Landscapes).
- Applicable NRHP bulletins and National Park Service technical briefs (Andrus and Shrimpton 1997; Birnbaum 1994; McClellan et al. 1995).

If, based on the findings of the inventory, the Montezuma Slough Rural Historic Landscape does not constitute a historic property or historical resource, implementation of the mitigation measure would reduce the severity of Impact CUL-1 to a less-than-significant level.

On the other hand, if the Montezuma Slough Rural Historic Landscape constitutes a historic property or historical resource, the lead federal agency, through consultation with SHPO, and the state lead agency for project implementation, as applicable, will devise measures to reduce the severity of significant effect(s) on the property and will require implementation of the measures prior to implementation of the proposed project. Under CEQA, the lead agency will propose such mitigation measures in an EIR. For federal actions or undertakings, the lead federal agency will resolve any adverse impacts through the provisions of 36 CFR 800.6, which would be codified in an MOA and in the proposed action's EIS and ROD. Implementation of the mitigation measures would reduce the severity of the impact, although not necessarily to a less-than-significant or non-adverse level.

Impact CUL-2: Damage to or Destruction of Known Cultural Resources as a Result of Ground-Disturbing Activities in Restoration Areas

Twenty-four previously recorded cultural resources are located in lowland and marsh areas and therefore could be affected by tidal marsh restoration in these areas (Table 7.7-10). Restoration activities could damage or destroy these cultural resources by displacing or breaking artifacts or demolishing structural features. With the exception of ISO 20[4], the cultural resources listed in Table 7.7-10 are considered historic properties and historical resources for the purposes of the proposed project.

[4] Isolated artifacts are rarely considered historic properties, historical resources, or unique archaeological resources because of their limited information potential.

Table 7.7-10. Previously Recorded Cultural Resources Affected by Impacts CUL-2 and CUL-3

Resource Designation	Description	Environmental Context	Suisun Marsh Region	Significance[5]
CA-SOL-13	Burial and village site	High elevation tidal marsh, managed wetland area	2	Undetermined
CA-SOL-366H	Historic refuse scatter	Lowland grassland	4	Undetermined
CA-SOL-368H	Historic refuse scatter	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-369H	Historic refuse scatter	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-370H	Historic refuse scatter	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-371H	Historic refuse scatter	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-372H	Historic pump house	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-373H	Historic pump house and refuse	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-374H	Historic refuse scatter	Grazed bayland	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-375H	Historic dump	Grazed bayland	4	Recommended ineligible (NRHP/CRHR)
Ca-SOL-376H	Ranching related	Grazed bayland	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-377H	Historic railroad grade, trestles, and station	Farmed bayland, managed wetland area, uplands	4	Recommended eligible (NRHP/CRHR)
CA-SOL-378H	Ranching debris	Grazed bayland	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-415H	Montezuma Wetlands flume structure	Managed wetland area	4	Undetermined
P-48-207	Historic ditch	Managed wetland area	1	Undetermined
P-48-209	Southern Pacific Railroad	Managed wetland area	1	Undetermined
P-48-442	Utility line	Managed wetland area	1	Undetermined
P-48-443	Lingos Landing	Major slough	4	Undetermined
P-48-513	Birds Landing Dock and Road	Managed wetland area	4	Undetermined
P-48-514	Dutton's Landing	Ruderal	4	Undetermined
P-48-549	Central Pacific Railroad	Marsh, upland	1	Undetermined
ISO 20	Isolated projectile point	Managed wetland area	4	Ineligible

[5] Cultural resources recommended as ineligible for NRHP/CRHR listing are included in this table because a federal agency and the SHPO have not made formal significance determinations concerning them. The previous recommendations would need to be taken into account, not taken at face value, when assessing effects on cultural resources in the plan area.

Resource Designation	Description	Environmental Context	Suisun Marsh Region	Significance[5]
None	Mein's Landing	Major slough	4	Undetermined
None	Montezuma Slough Rural Historic Landscape	Major slough, marsh	3, 4	Undetermined

Conclusion: Less than significant with Mitigation Measure CUL-MM-2 incorporated.

Mitigation Measure CUL-MM-2: Evaluate Previously Recorded Cultural Resources and Fence NRHP- and CRHR-Eligible Resources prior to Ground-Disturbing Activities

The lead federal or state agency, as applicable, will evaluate previously recorded cultural resources located in restoration areas for NRHP and CRHR eligibility. The lead federal or state agency will ensure that all NRHP- and CRHR-eligible properties are fenced prior to start of ground-disturbing activities; no further action will be required for ineligible properties. The lead federal or state agency will use the maps contained in the site records for the eligible properties to establish site boundaries in the field. The lead federal or state agency will demarcate the site boundaries using t-stakes and orange fencing. Signs marking the fenced area as an environmentally sensitive area will be placed at suitable intervals along the fence. The lead federal or state agency will examine the fencing periodically to ensure that the barrier is not crossed and clearly delimits the site boundaries throughout the duration of ground-disturbing activities. Implementation of this mitigation measure would reduce Impact CUL-2 to a less-than-significant level.

Impact CUL-3: Damage to Known Cultural Resources as a Result of Inundation

Twenty-four previously recorded cultural resources are located in lowland and marsh areas and therefore could be affected by inundation of such areas (Table 7.7-10). Inundation would create an aqueous environment in the vicinity of these cultural resources, which is known to hasten the degradation of character-defining elements of cultural resources, such as historic buildings and structures and archaeological sites. The effects of prolonged and repeated inundation include structural degradation (oxidation and weakening of metals) and the decay of archaeological site constituents[6] (Thorne 1991:Figure 1). The loss of or damage to character-defining features of historic properties, historical resources, or unique archaeological resources would constitute a significant effect under NEPA and a significant impact under CEQA. With the exception of ISO 20[7], the cultural resources listed in Table 7.7-10 are considered historic properties and historical resources for the purposes of the proposed project.

[6] Affected site constituents include animal bones, shell, plants, charcoal, granular stone artifacts, and ceramics.
[7] Isolated artifacts are rarely considered historic properties, historical resources, or unique archaeological resources because of their limited information potential.

Implementation of Mitigation Measure CUL-MM-3 or CUL-MM-4 would reduce Impact CUL-3, but not necessarily to a less-than-significant level.

Conclusion: Significant and unavoidable.

Mitigation Measure CUL-MM-3: Protect Known Cultural Resources from Damage Incurred by Inundation through Plan Design (Avoidance)

The lead federal or state agency, as applicable, will evaluate the significance of the cultural resources listed in Table 7.7-10 prior to inundation of lands in the restoration areas. For cultural resources that the lead federal or state agency determines ineligible for listing in the NRHP and CRHR, no further action would be required. The lead federal or state agency will, on the other hand, avoid damaging NRHP- and CRHR-eligible cultural resources through plan design, using detailed maps of the cultural resources concerned and field reviews to avoid any eligible properties. Implementation of Mitigation Measure CUL-MM-3 would reduce Impact CUL-3 to a less-than-significant level. In the event that implementation of CUL-MM-3 is infeasible, the lead federal or state agency will implement Mitigation Measure CUL-MM-4.

Mitigation Measure CUL-MM-4: Resolve Adverse Effects prior to Construction

Prior to approval and final design of restoration activities, the lead federal or state agency, as applicable will resolve adverse effects in accordance with Section 106 of the NHPA and CEQA, as applicable. Such effects resolutions may include Historic American Building Survey/Historic American Engineering Record (HABS/HAER) documentation of historic buildings and structures, data recovery excavations of archaeological sites, preparation of public interpretive documents, and documentation of these actions. Additional mitigation work would reduce the severity of Impact CUL-3, although not necessarily to a less-than-significant level.

Impact CUL-4: Inadvertent Damage to or Destruction of As-Yet-Unidentified Cultural Resources as a Result of Ground-Disturbing Activities in Restoration Areas

Cultural resource professionals have surveyed little of the plan area, yet 34 cultural resources have been identified to date and more than 11,000 acres of the plan area are sensitive for the presence of buried prehistoric archaeological resources (Tables 7.7-2, 7.7-5, and 7.7-6). In the absence of professionally conducted cultural resource inventories, tidal marsh restoration has a high probability of damaging or destroying cultural resources, inclusive of the historic built environment and archaeological resources. Because of multiple property-access prohibitions, the conceptual nature of the actions in the proposed project, and because not all portions of the plan area would be affected by these activities, it is not feasible to conduct a cultural resources survey of the plan area in support of this EIS/EIR. Impact analysis therefore must be conceptual in nature, with detailed impact analyses transpiring during project-specific implementation.

To estimate the likelihood that restoration activities would affect as-yet-unidentified surface and buried cultural resources, Table 7.7-11 compares the extent of restoration activities to the pervasiveness of archaeologically sensitive areas in the plan area. The table treats the plan area regions separately because these regions differ in size, acreage slated for restoration, and archaeological potential. The scope of potential effects on cultural resources is assessed by comparing the amount of restoration within each region to the extent of archaeologically sensitive areas in each region. The amounts given in Table 7.7-11 are expressed as percentages of regional acreage.

Table 7.7-11. Comparison of Restoration Areas to Archaeologically Sensitive Areas, Alternative A

Region	Total Acreage	Restoration Acreage	Percent Slated for Restoration	High Buried Site Potential (%)	Moderate Buried Site Potential (%)	High Surface Site Potential (%)	Moderate Surface Site Potential (%)
1	11,905	1,000	8.4	0.6	34.2	0.1	27.8
		1,500	12.6				
2	7,302	920	12.6	0.0	2.1	2.5	9.6
		1,380	18.9				
3	2,975	360	12.2	2.5	19.0	2.1	28.3
		540	18.2				
4	28,667	1,720	6.0	1.1	23.0	0.6	7.4
		2,580	9.0				

Table 7.7-11 suggests that the probability of restoration areas being located in areas that are highly sensitive for the presence of buried and surface-manifested prehistoric archaeological resources is low. Moderately sensitive areas, on the other hand, are prevalent throughout the plan area, with the exception of Region 2. Historic-period archaeological and built-environment resources in the plan area, however, are almost exclusively located along existing waterways; this proximity renders historic-period resources vulnerable to damage from restoration activities. These resources include duck clubs, levees, water conveyance and drainage features, and transportation features; their locations largely can be predicted through the use of historic maps (see Owens 1991).

Comparatively speaking, Region 1 possesses the highest percentage of restoration activities occurring within areas sensitive for the presence of buried archaeological resources (34.8%), even considering that a larger proportion of Region 3 would see restoration activities than would Region 1. Region 2 has the lowest percentage (2.1) of areas sensitive for buried archaeological resources. The likelihood of restoration activities being situated in areas sensitive for the presence of surface-manifested prehistoric resources is highest in Region 3 (30.4%), lowest in Region 4 (8.0%).

Given the above information, construction in unsurveyed areas likely would result in damage to or destruction of cultural resources that may meet the criteria of historic property, historical resource, or unique archaeological resource. Damage to or destruction of historical resources and unique archaeological resources constitutes a significant impact under CEQA (14 CCR 15064.5) and an adverse effect under Section 106 of the NHPA.

Conclusion: Significant and unavoidable.

Mitigation Measure CUL-MM-5: Conduct Cultural Resource Inventories and Evaluations and Resolve Any Adverse Effects

Prior to ground-disturbing activities in restoration areas, the lead federal or state agency, as applicable, will conduct a cultural resources inventory of the restoration areas according to the standards cited in Mitigation Measure CUL-MM-1. Identification methods will include surface surveys and, for areas likely to contain buried archaeological resources, subsurface testing methods commensurate with the scale of ground disturbance.

If any cultural resources are determined to be historic properties and ground-disturbing activities are found to result in adverse effects, the lead federal or state agency will resolve the effects in accordance with Section 106 of the NHPA or CEQA, as applicable.

If no cultural resources are identified in specific restoration areas, or identified resources are not determined to be significant, implementation of CUL-MM-5 would reduce this impact to a less-than-significant level.

If significant cultural resources are present in the restoration areas, the post-mitigation significance of Impact CUL-4 would depend on the magnitude of the physical effect. In cases where small portions of the resources are affected by the project, CUL-MM-5 would reduce this impact to a less-than-significant level. In the event of major damage or complete destruction of any significant cultural resources, CUL-MM-5 would reduce the severity of the impact, although it would still be significant.

Impact CUL-5: Damage to or Destruction of Human Remains as a Result of Ground-Disturbing Activities

Human remains have been identified in the plan area at previously recorded Native American archaeological sites. Human remains can constitute a special class of cultural resource and are protected by state and federal legislation. In addition, human remains, particularly those of Native Americans, are sometimes found in levees because of the incorporation of archaeological sites into levees or the inadvertent use of borrow material obtained from archaeological sites. Much of the plan area has not been surveyed for the presence of cultural resources, leaving moderate potential for ground-disturbing activities to unearth and damage human remains. Tidal marsh restoration, creation, and protection; conversion of managed wetlands and uplands; vernal pool habitat enhancement; riparian habitat enhancement (passive flooding, setback and perimeter levee building); and levee management have the potential to damage or destroy human remains during ground-disturbing activities. Implementation of the Environmental Commitment Inadvertent Discovery of Cultural Resources (Chapter 2) that complies with applicable state and federal laws and regulations concerning human remains would reduce this impact to less than significant.

Conclusion: Less than significant. No mitigation required.

Managed Wetland Activities

Managed wetland activities will be undertaken by landowners in the Marsh. The location of these activities within the plan area is presently unknown.

Impact CUL-6: Damage to or Destruction of Shipwrecks[8] or Other Submerged Resources as a Result of Channel Dredging

A review of the California State Lands Commission's (CSLC's) California Shipwreck database failed to indicate the presence of known shipwrecks in tidal sloughs in the plan area, although one is reported in Collinsville (Esser 1999:62). Nevertheless, the CSLC's website does not provide information concerning the comprehensiveness of the database or the methods employed in compiling it. The database likely does not include all shipwrecks in the project vicinity but only those reported or whose location could be reconstructed from navigational data. Therefore, channel dredging in project-area tidal sloughs may damage or destroy shipwrecks that have not yet been identified. Historic-era shipwrecks may qualify as historic properties under Section 106 of the NHPA as well as historical resources or unique archaeological resources for the purposes of CEQA.

Conclusion: Less than significant with Mitigation Measure CUL-MM-6 incorporated.

Mitigation Measure CUL-MM-6: Stop Ground-Disturbing Activities, Evaluate the Significance of the Discovery, and Implement Mitigation Measures as Appropriate

In the event that a shipwreck is encountered during channel dredging, all channel-disturbing activities within a minimum of 100 feet of the shipwreck must cease. Reclamation, DFG, or DWR (as appropriate) will notify and commission a qualified maritime or underwater cultural resource specialist to inspect the find. The cultural resource specialist will record the location of the shipwreck, the circumstances leading to the inadvertent discovery, the condition and character of the shipwreck, and the degree of damage incurred as a result of channel dredging. The cultural resource specialist also will make recommendations as to the appropriate distance from the shipwreck at which channel dredging may continue. The cultural resource specialist will evaluate the shipwreck to determine whether it constitutes a historic property, historical resource, or unique archaeological resource. The cultural resource specialist and all work associated with documentation and evaluation of shipwrecks must meet the Secretary of the

[8] Delgado and A National Park Service Maritime Task Force (1992:3) define a shipwreck as a "submerged or buried vessel that has foundered, stranded, or wrecked. This includes vessels that exist as intact or scattered components on or in the sea bed, lake bed, river bed, mud flats, beaches, or other shorelines." As submerged or buried examples of historic vessels, a shipwreck may be "any craft built to navigate a waterway…regardless of type of construction or motive of power employed" (Delgado and A National Park Service Maritime Task Force 1992:3). In short, a shipwreck may range in size and complexity from canoe to battleship; shipwrecks in the relatively shallow Suisun Marsh waterways are likely to represent the smaller end of this range.

Interior's Standards for professional archaeologist or historian (48 FR 44720–44723) and incorporate the National Park Service's guidance concerning the nomination of shipwrecks to the NRHP (Delgado and A National Park Service Maritime Task Force 1992).

Impact CUL-7: Damage to or Destruction of Known Cultural Resources Resulting from Managed Wetland Activities

Fifteen previously recorded cultural resources are located in managed wetland areas and therefore could be affected by discing, construction of new interior ditches, and construction of new interior levees in these areas (Table 7.7-12, 7-13). These activities would damage or destroy these cultural resources by displacing or breaking artifacts or demolishing structural features.

Table 7.7-12. Previously Recorded Cultural Resources That Could Be Affected by Discing, Construction of New Interior Ditches, and Construction of New Interior Levees in Managed Wetland Units

Resource Designation	Description	Environmental Context	Suisun Marsh Region	Significance
CA-SOL-13	Burial and village site	High elevation tidal marsh, managed wetland area	2	Undetermined
CA-SOL-368-H	Historic refuse scatter	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-369-H	Historic refuse scatter	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-370-H	Historic refuse scatter	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-371-H	Historic refuse scatter	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-372-H	Historic pump house	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-373-H	Historic pump house and refuse	Managed wetland area	4	Recommended ineligible (NRHP/CRHR)
CA-SOL-377-H	Historic railroad grade, trestles, and station	Farmed bayland, managed wetland area, uplands	4	Recommended eligible (NRHP/CRHR)
CA-SOL-415-H	Montezuma Wetlands flume structure	Managed wetland area	4	Undetermined
P-48-207	Historic ditch	Managed wetland area	1	Undetermined
P-48-209	Southern Pacific Railroad	Managed wetland area	1	Undetermined
P-48-442	Utility line	Managed wetland area	1	Undetermined
P-48-513	Birds Landing Dock and Road	Managed wetland area	4	Undetermined
ISO 20	Isolated projectile point	Managed wetland area	4	Ineligible for listing (NRHP/CRHR)
None	Montezuma Slough Rural Historic Landscape	Major slough, marsh	3, 4	Undetermined

The SMP will be implemented over 30 years in several phases. The current level of detail in the project description is insufficient to discuss project impacts, knowledge of which would influence with certainty the level of inventory effort with respect to the historic landscape. Similar problems with other project effects confound attempts to inventory and evaluate cultural resources in the plan area according to the standard Section 106 process described at 36 CFR 800. Therefore, implementation of CUL-MM-7 is required.

Conclusion: Less than significant with Mitigation Measure CUL-MM-7 incorporated.

Mitigation Measure CUL-MM-7: Complete NHPA Section 106 Consultation and Prepare and Implement Context Study; Evaluate Previously Recorded Cultural Resources and Fence NRHP- and CRHR-Eligible Properties prior to Ground-Disturbing Activities

The SMP will be implemented over 30 years in several phases, confounding attempts to inventory and evaluate cultural resources in the plan area according to the standard Section 106 process described at 36 CFR 800. Therefore, a context study will be prepared in association with completion of an NHPA Section 106 Consultation with the SHPO. The contextual study approach will include a geoarchaeological sensitivity model, land use history and evaluation of classes of architectural features, and application of effects per Section 106 Part 800.4(2). Reclamation will assess the effects of the activities to classes of architectural features, rather than individual sites, due to the complexity of the history and interrelationship of the features, as well as the potential for features contributing to the eligibility of other features of the Suisun Marsh water and salinity management system. If deemed appropriate through coordination with the SHPO and the results of the context study, a Programmatic Agreement (PA) and Historic Properties Treatment Plan (HPTP) will be completed as described below.

Programmatic Agreement and Historic Properties Treatment Plan

The proposed project will be implemented over 30 years in several phases. The current level of detail in the project description is insufficient to discuss project impacts, knowledge of which would influence with certainty the level of inventory effort with respect to the historic landscape. Similar problems with other project effects identified in this section (see below) confound attempts to inventory and evaluate cultural resources in the plan area according to the standard Section 106 process described at 36 CFR 800. Therefore, a Programmatic Agreement (PA) and Historic Properties Treatment Plan (HPTP) are the most effective ways to accommodate both the program requirements and compliance with CEQA, NEPA, and Section 106 of the NHPA. Under Section 106, a PA can be used:

i. when effects on historic properties are similar and repetitive or are multi-state or regional in scope;

ii. when effects on historic properties cannot be fully determined prior to approval of an undertaking;

iii. when nonfederal parties are delegated major decision-making responsibilities;

iv. where routine management activities are undertaken at federal installations, facilities, or other land-management units; or

v. where other circumstances warrant a departure from the normal Section 106 process. (36 CFR 800.14[b][1].)

The proposed project meets the first four criteria for use of a PA. First, certain effects, particularly under the managed wetland activities (see impact discussion later herein), would be implemented repeatedly. Second, the present project description is not in a stage of development that is sufficient to complete historic property identification efforts. Third, nonfederal parties likely will have major decision-making responsibilities with respect to implementation of the SMP. Finally, routine management (maintenance) activities will be undertaken at federal facilities under the SMP.

Reclamation will prepare the PA, which will identify standards, responsible parties, and timeframes for identifying and resolving effects on historic properties. The purpose of the PA is to document the fact that all responsible parties to the project understand there will be adverse effects on historic properties and that they agree on methods by which to resolve those adverse effects. The HPTP, on the other hand, will explain just how adverse effects will be resolved. The HPTP will provide a tailored program for historic property identification and treatment for the undertaking. The HPTP will contain research themes for expected property types (prehistoric archaeological properties, historic built environment properties, etc.) to guide all aspects of cultural resources inventories conducted for the undertaking. The research themes will be geared specifically to frame NRHP and CRHR evaluations of identified properties. The PA and HPTP will contain provisions for project activities undertaken by nonfederal entities such as DWR and SRCD. Preparation and implementation of the PA and HPTP will be completed prior to implementation of the SMP.

The PA and HPTP will stipulate evaluation procedures for the determination of, and consultation regarding, NRHP and CRHR eligibility. Reclamation will ensure that any eligible properties are fenced prior to commencement of ground-disturbing activities; no further action will be required for ineligible properties. Reclamation will use the maps contained in the site records for the eligible properties to establish site boundaries in the field. Reclamation will demarcate the site boundaries using t-stakes and orange fencing. Signs marking the fenced area as an environmentally sensitive area will be placed at suitable intervals along the fence. Reclamation will examine the fencing periodically to ensure that the barrier is not crossed and clearly delimits the site boundaries throughout the duration of ground-disturbing activities. Implementation of this mitigation measure would reduce Impact CUL-7 to a less-than-significant level.

Impact CUL-8: Damage to or Destruction of As-Yet-Unidentified Cultural Resources in Uninspected Areas as a Result of Other Ground-Disturbing Managed Wetland Activities

Impact CUL-8 is similar to the impact described for the project under Impact CUL-4. The management activities proposed could result in damage or destruction of unknown cultural resources. In addition, some current activities would be modified and some additional activities created. The activities and the types of cultural resources likely to be affected by each activity are summarized in Table 7.7-13 below.

Table 7.7-13. Managed Wetland Activities and Their Potential to Affect Cultural Resources

Marsh Management Activity	Likely Affected Resource Type	Applicable PAI Funding
Repairing existing interior and exterior levees	HBE	JUFI (interior levees only)
Coring existing interior levees	HBE	JUFI, PAI Fund 50/50
Grading pond bottoms for water circulation	HBE; PArch; HArch; BArch	JUFI, PAI Fund 50/50
Creating pond bottom spreader V ditches	HBE; PArch; HArch; BArch	JUFI, PAI Fund 50/50
Repairing existing interior water control structures	HBE	JUFI, PAI Fund 75/25, PAI Fund 50/50
Replacing pipe for existing water control structures or installing new interior water control structures	HBE	JUFI, PAI Fund 75/25, PAI Fund 50/50
Installing new blinds or relocating, replacing, or removing existing blinds	HBE; PArch; HArch; BArch	
Discing managed wetlands	HBE; PArch; HArch; BArch	
Installing drain pumps and platforms	HBE	JUFI, PAI Fund 75/25
Replacing riprap on interior levees	No, if screened	
Replacing riprap on exterior levees	No, if screened	
Coring of existing exterior levees	HBE	JUFI, PAI Fund 50/50
Repairing exterior water control structures (gates, couplers, and risers)	HBE	PAI Fund 75/25
Installing or replacing pipe for existing exterior flood or dual-purpose gate	HBE	
Installing, repairing, or re-installing water control bulkheads	HBE	PAI Fund 75/25
Removal of floating debris from pipes, trash racks, and other structures	No	
Installing alternative bank protection such as brush boxes, biotechnical wave dissipaters, and vegetation on exterior and interior levees	HBE	
Constructing cofferdams in managed wetlands	HBE; PArch; HArch; BArch	
Installing new fish screen facilities	HBE; Sub	

Marsh Management Activity	Likely Affected Resource Type	Applicable PAI Funding
Suisun Marsh salinity control gates repair and maintenance	HBE	
Roaring River distribution system fish screen cleaning	No	
Salinity monitoring station maintenance, repair, and replacement	HBE	
Salinity station relocation, installation, and removal	HBE	
Clearing existing interior ditches	HBE; PArch; HArch	JUFI, PAI Fund 50/50
Constructing new interior ditches	HBE; PArch; HArch; BArch	JUFI, PAI Fund 50/50
Repairing existing exterior levees	HBE	JUFI
Dredging from tidal sloughs as source material for exterior levee maintenance	Sub	
Placing new riprap in areas that were not previously riprapped	HBE; PArch; HArch	
Constructing new interior levees for improved water control and habitat management within the managed wetland units	PArch; HArch	

BArch = buried archaeological resource; HArch = historic-period archaeological resource; historic HBE = historic-period built environment; PArch = prehistoric archaeological resource (surface); Sub = submerged resource

The affected resource column of Table 7.7-13 identifies the broad class(es) of resource that most likely would be affected by each activity, although project-specific design specifications or work methods could result in effects to other classes of resource. The impacts identified in Table 7.7-13 likely would be significant, although some activities such as replacing riprap on interior and exterior levees could result in non-adverse effects. Construction staging and vehicular movement associated with riprap replacement, however, could result in cultural resource impacts off the levees. Such impacts could be significant.

If significant cultural resources are present in the managed wetland areas, the post-mitigation significance of Impact CUL-8 would depend on the magnitude of the physical effect. In cases where small portions of the resources are affected by the project, Mitigation Measure CUL-MM-8 would reduce this impact to a less-than-significant level. In the event of major damage or complete destruction of any significant cultural resources, Mitigation Measure CUL-MM-8 would reduce the severity of the impact, although it would still be significant.

If no cultural resources are identified in specific project areas, or identified resources are not determined to be significant, implementation of Mitigation Measure CUL-MM-8 would reduce this impact to a less-than-significant level.

Conclusion: Significant and unavoidable

Mitigation Measure CUL-MM-8: Complete NHPA Section 106 Consultation and Prepare and Implement Context Study; Conduct Cultural Resource Inventories and Evaluations and Resolve Any Adverse Effects
Prior to implementation of managed wetland activities under the new SMP, Reclamation will complete an NHPA Section 106 Consultation with SHPO and prepare a context study as described in CUL-MM-7. If deemed appropriate through coordination with the SHPO and the results of the context study, a PA and HPTP will be completed. These documents will clearly identify the lead agency responsible for PA/HPTP compliance for each class of activity (for instance, Reclamation for PAI-funded projects), as well as historic properties identification methods. If any cultural resources are determined to be historic properties and ground-disturbing activities are found to result in adverse effects, the lead agency for the subject activities will resolve the effects in accordance with the PA and HPTP.

Alternative B: Restore 2,000–4,000 Acres

Restoration Impacts

The character of Alternative B's impacts on cultural resources is identical to that described for Alternative A (Impacts CUL-1 through CUL-5). Similarly, Mitigation Measures CUL-MM-1 through CUL-MM-5 apply to Alternative B. Table 7.7-14, however, shows that the likelihood of restoration areas intersecting archaeologically sensitive areas is considerably lower under Alternative B, as the restoration target acreage for this alternative is half of the target for Alternative A. Restoration impacts under Alternative B, therefore, are expected to be fewer than under Alternatives A and C.

Table 7.7-14. Comparison of Restoration Areas to Archaeologically Sensitive Areas, Alternative B

Region	Total Acreage	Restoration Acreage	Percent Slated for Reclamation	High Buried Site Potential (%)	Moderate Buried Site Potential (%)	High Surface Site Potential (%)	Moderate Surface Site Potential (%)
1	11,905	500	4.2	0.6	34.2	0.1	27.8
		1,000	8.4				
2	7,302	460	6.3	0.0	2.1	2.5	9.6
		920	12.6				
3	2,975	180	6.1	2.5	19.0	2.1	28.3
		360	12.2				
4	28,667	860	3.0	1.1	23.0	0.6	7.4
		1,720	6.0				

Managed Wetland Activities

The cultural resources impacts of managed wetland activities under Alternative B are likely to be more intensive than under Alternative A because more of the plan area will remain or be subjected to managed wetland activities. Impacts CUL-6 through CUL-8 and Mitigation Measures CUL-MM-6, CUL-MM-7, and CUL-MM-8 apply to managed wetland activities under Alternative B.

Alternative C: Restore 7,000–9,000 Acres

Restoration Impacts

The character of Alternative C's impacts on cultural resources is identical to that described for Alternatives A and B (Impacts CUL-1 through CUL-5). Similarly, Mitigation Measures CUL-MM-1 through CUL-MM-5 apply to Alternative C. Table 7.7-15, however, shows that the likelihood of restoration areas intersecting archaeologically sensitive areas is considerably greater under Alternative C than under Alternatives A or B because the restoration acreage target for Alternative C is 50–75% greater than either Alternative A or B. Restoration impacts under Alternative C, therefore, are expected to be more severe than under Alternatives A and B.

Table 7.7-15. Comparison of Restoration Areas to Archaeologically Sensitive Areas, Alternative C

Region	Total Acreage	Restoration Acreage	Percent Slated for Restoration	High Buried Site Potential (%)	Moderate Buried Site Potential (%)	High Surface Site Potential (%)	Moderate Surface Site Potential (%)
1	11,905	1,500	12.6	0.6	34.2	0.1	27.8
		2,250	18.9				
2	7,302	1,380	18.9	0.0	2.1	2.5	9.6
		2,070	28.4				
3	2,975	540	18.2	2.5	19.0	2.1	28.3
		810	27.2				
4	28,667	2,580	9.0	1.1	23.0	0.6	7.4
		3,870	13.5				

Managed Wetland Activities

The cultural resources impacts of managed wetland activities under Alternative C are likely to be less intensive than under Alternatives A and B because less of the plan area will remain or be subjected to managed wetland activities. Impacts CUL-6 through CUL-8 and Mitigation Measures CUL-MM-6, CUL-MM-7, and CUL-MM-8 apply to managed wetland activities under Alternative C.

Section 7.8
Public Health and Environmental Hazards

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on public health and environmental hazards.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 7.8-1 summarizes public health and environmental hazards impacts from implementing the SMP alternatives.

Table 7.8-1. Summary of Public Health and Environmental Hazard Impacts

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impacts				
HAZ-1: Increased Risk of Mosquito-Borne Diseases	A, B, C	Less than significant	None required	–
HAZ-2: Exposure to or Release of Hazardous Materials during Construction	A, B, C	Less than significant	None required	–
HAZ-3: Release of Hazardous Materials into Surrounding Water Bodies during Construction	A, B, C	Less than significant	None required	–
HAZ-4: In-Channel Construction-Related Increase in Emergency Response Times	A, B, C	Less than significant	None required	–
HAZ-5: Increased Human and Environmental Exposure to Mercury	A, B, C	Less than significant	None required	–
HAZ-6: Reduction in Potential for Catastrophic Flooding	A, B, C	Beneficial	–	–
HAZ-7: Increased Human and Environmental Exposure to Natural Gas and Petroleum	A, B, C	Significant	UTL-MM-2: Avoid Ground-Disturbing Activities within Pipeline Right-of-Way UTL-MM-3: Relocate or Upgrade Utility Facilities That Could Be Damaged by Inundation UTL-MM-4: Test and Repair or Replace Pipelines That Have the Potential for Failure	Less than significant
Managed Wetland Activities Impacts				
HAZ-2: Exposure to or Release of Hazardous Materials during Construction	A, B, C	Less than significant	None required	–
HAZ-4: In-Channel Construction-Related Increase in Emergency Response Times	A, B, C	Less than significant	None required	–
HAZ-5: Increased Human and Environmental Exposure to Mercury	A, B, C	Less than significant	None required	–
HAZ-6: Reduction in Potential for Catastrophic Flooding	A, B, C	Beneficial	–	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- *Central Valley Joint Venture Technical Guide to Best Management Practices for Mosquito Control in Managed Wetlands* (Central Valley Joint Venture 2004);
- Environmental Analysis of Tidal Marsh Restoration in San Francisco Bay (Jones & Stokes 2001);
- Solano County Mosquito Abatement District Website;
- Map of pipelines in the plan area (U.S. Department of Transportation 1999);
- Envirostor hazardous waste and substances site list (Envirostor 2007);
- California Integrated Waste Management Board. Facility/Site Listings (2008); and
- GeoTracker mapped cleanup sites (GeoTracker 2008).

Hazardous Materials

Hazardous materials and waste are those substances that, because of their physical, chemical, or other characteristics, may pose a risk of endangering human health or safety or of endangering the environment (California Health and Safety Code Section 25260). Types of hazardous materials include petroleum hydrocarbons, pesticides, and volatile organic carbons (VOCs). In the Suisun Marsh area, potential hazardous waste sites may be associated with historical agricultural or managed wetland and vegetation control activities and may include storage facilities contaminated with fertilizers, pesticides, or herbicides. Underground pipelines that carry natural gas and other products are present in the study area.

The locations of various pipelines in the plan area were mapped using data from the U.S. Department of Transportation (USDOT) (Figure 7.3-1). USDOT, Research and Special Projects Administration (RSPA), and the Office of Pipeline Safety (OPS) are working with other federal and state agencies and the pipeline industry to create a national pipeline mapping system (NPMS). The NPMS is a full-featured geographic information systems (GIS) containing the location and selected attributes of the major natural gas transmission lines and hazardous liquid trunklines, and liquefied natural gas (LNG) facilities operating in the United States and other offshore entities. Source data are contributed by pipeline operators to the National Repository.

Pipelines

Natural gas, product, natural gas liquids, and empty liquid pipelines run through the Marsh, into Suisun Bay, and into Contra Costa County (Figure 7.3-1). The majority of pipelines that run through the Marsh and cross the sloughs are product and natural gas lines. On the western side of the Marsh, a product pipeline crosses under Peytonia and Boynton Sloughs, and two product pipelines cross under Goodyear Slough. On the eastern side, natural gas and product pipelines occur under Nurse and Montezuma Sloughs.

One leaking underground fuel tank (LUFT) site was identified in an isolated pond off of Montezuma Slough (GeoTracker 2008). Additionally, the plan area has a history of agricultural use and may have areas of previously unknown contamination related to the use or storage of agricultural compounds such as pesticides, fertilizers, or fuels. Potrero Hills Landfill is located east of Suisun Bay near Nurse Slough. It is approximately 0.2 mile from the slough (California Integrated Waste Management Board 2008).

Waste Sites

A search of Solano County was done for all Superfund, state response, voluntary cleanup, school cleanup, permitted, and corrective action sites (Envirostor 2007). No hazardous waste sites were identified in the plan area.

Emergency Response/Evacuation Plans

Hazardous Materials

The Solano County Office of Emergency Services (OES) is responsible for planning emergency response actions to hazardous material incidents. Area response plans incorporate hazardous materials inventory data, training for emergency responses, and plans for evacuation.

Pipelines

While emergency response procedures are company specific, they are all developed to protect sensitive resources to the maximum extent practicable. In general, the procedures would include shutting down the pipeline operations, de-pressurizing the line, notifying local emergency response providers, evacuating people to a safe distance, monitoring for flammable vapors, setting up material collection sites (low elevation spots where product has settled), and recovering the product with vacuum trucks. In spills that occur in streams or waterways, additional dams and absorbent booms would be deployed to control the release of product into the ecosystem.

Law Enforcement

The Solano County Sheriff's Department provides law enforcement on waterways in the county, including Suisun Marsh. By authority and responsibility, the Sheriff's office is the designated "scene manager" for any disaster, from hazardous materials spills to major flood activity. Emergency response is carried out using vehicles or boats, depending on the location's accessibility, predicted response time, and availability of resources. Sheriffs have access to all gates and may use fields as well as levee roads to access channel areas in the Delta.

The Solano County Marine Patrol Program provides public safety resources to recreational boaters and commercial vessels operating on the navigable waterways in the county of Solano. The Marine Patrol Program is staffed with four full-time deputies. The program is operational 10 hours each day, 7 days each week, year-round, providing professional public safety services to the community. The Marine Patrol deputies are subject to callout 24 hour a day, 7 days a week, to provide search-and-rescue operations on the waterways of Solano County.

U.S. Coast Guard

In addition to the Sheriff's Department, the U.S. Coast Guard provides search-and-rescue and emergency response by boat to those areas of the Delta not accessible by vehicle. Because of the Delta's many meandering sloughs and canals, response is typically faster by driving to the nearest boat launch. The U.S. Coast Guard Station in Vallejo is the primary coast guard station responding to emergencies in the Marsh. They coordinate closely with the Suisun City Police Department and the CHP as needed. They typically respond with a boat launched from Vallejo Marina, but if weather or access to the emergency site is an issue, aircraft could be used or boats could be trailered and launched from Suisun City or Grizzly Island Marinas. The typical response time is approximately 35 minutes (Villa pers. comm.).

The U.S. Coast Guard station in Rio Vista is the primary responder to a very small portion of the eastern Marsh area and maintains two boats at the Rio Vista station dock. When responding to emergencies in Suisun Marsh, a boat is taken from the dock to the Marsh, which takes approximately 20 minutes (Flagerty pers. comm.).

In 2006 (the most recent year for which complete data are available), there were 71 accidents in the Delta, four of which occurred in Solano County. Of the four accidents in Solano County, two included fatalities (California Department of Boating and Waterways 2007).

Health Hazards

Water Quality

Potential sources that could compromise water quality are two-stroke boat engines (which use an oil-gas mixture) and four-stroke boat engines (which use pure gasoline). These petroleum products could be accidentally discharged into Suisun Marsh, compromising water quality. Continuous testing and monitoring of water by federal, state, and local agencies minimize the impact of hazardous waste discharges on public health.

Mosquito Breeding Conditions, Habitat, and Disease Transmission

Mosquitoes as Vectors of West Nile Virus

The California Health and Safety Code defines a *vector* as "…any animal capable of transmitting the causative agent of human disease or capable of producing human discomfort or injury…" (Division 3, Chapter 1, Article 1, Section 2002 [k]).

The CDC has documented the presence of West Nile virus in samples of all the species described above in data for 2006. *Culex tarsalis* is considered to be the primary vector of West Nile virus in Solano County based on test results since 2005. The life cycle of West Nile involves the transmission of the virus from infected mosquitoes to people and animals. Wild birds serve as the main source of virus for mosquitoes which can transmit it to other birds or "Accidental Hosts" such as humans and horses which can become ill, but do not serve as sources of the virus at adequate levels to infect other mosquitoes. In Suisun Marsh, current mosquito control efforts focus on species that are capable of transmitting West Nile virus or that occur in such large numbers that they create a "public nuisance" by limiting outdoor activities not only in the Marsh, but in urban parks and the residential areas surrounding it. The West Nile virus is now considered to have become established in California since its arrival in 2003. In 2009 and 2010, there were no reported human cases of West Nile Virus in Solano County, although there has been in previous years and the disease remains active in the county (California West Nile Virus Website 2010).

General Mosquito Biology

Mosquitoes have four distinct life stages: egg, larva, pupa, and adult. The first three stages are aquatic, and therefore all mosquito species require standing water to complete their growth cycles. As such, any body of standing water that remains undisturbed for more than 3 days represents a potential mosquito breeding site. Most species of mosquitoes lay their eggs on the surface of fresh stagnant water, though some species use damp soil. Areas that are flushed daily by tidal action generally do not create problems unless they contain depressions or cracked ground that holds water for at least 5 days after being inundated by extreme high tides. These tides occur during nine months of the year in Suisun and San Pablo Bay Marshes and have the potential to produce billions of *Aedes* mosquitoes. Suisun Marsh has a number of tidal areas that can be problematic after extreme high tides.

Although most species of mosquitoes lay their eggs on the surface of stagnant water, those of the genus *Aedes* deposit their eggs singly (up to 150) on soil or at the base of grasses where they may remain dormant for months or a number of years before hatching. Most eggs laid by *Aedes*, known as floodwater species, must undergo a drying period before hatching occurs upon inundation. The other two genera commonly associated with Suisun Marsh are *Culex* and *Culiseta*. These genera deposit eggs on standing water in groups called rafts that contain 150 or more eggs. The egg of an *Aedes* mosquito can hatch within hours of coming in contact with water, while those of *Culex* and *Culiseta* generally require 2 to 3 days.

A larva hatches by cutting its way out of the egg by means of the egg breaker on the top side of the head. During growth the larva sheds its skin or molts four times; the stages between molts are called instars. Mosquito larvae breathe at the water surface at frequent intervals. Small organic particles and microorganisms suspended in the water are fed upon either at the bottom or near the water surface.

At the end of the larval stage, the mosquito molts and becomes a pupa. Although aquatic, the pupa of Aedes species can survive on damp soil for 2 days. The pupa is active only if disturbed, for this is the resting stage when no feeding occurs. After this transformation has been completed, the adult swallows some of the air in the pupal skin, which enables it to exert enough internal pressure to split it and emerge. It takes from 7 to 10 days for the newly hatched larvae to emerge as adults, depending upon the environmental conditions.

Mosquito Species in the Primary and Secondary Management Areas of Suisun Marsh

Six species of mosquitoes have the potential to be found in the primary Marsh area—*Aedes dorsalis* (pale marsh mosquito), *Aedes melanimon* (dark marsh mosquito), *Aedes squamiger* (California saltmarsh mosquito), *Culex tarsalis* (encephalitis mosquito), *Culex erythrothorax* (tule mosquito) and *Culiseta inornata* (winter mosquito). The prevalent species in the secondary area are *Culiseta incidens* (cool weather mosquito), *Culiseta inornata*, *Culex tarsalis*, and *Culex pipiens* (northern house mosquito). A brief life history of each of these species follows.

In general, the potential for mosquito breeding habitat increases with more emergent vegetation and within water bodies with water levels that slowly increase or recede compared to water levels that are stable or that rapidly fluctuate.

***Aedes dorsalis* (pale marsh mosquito)**—The larvae are found primarily along the coastal areas in both saline and brackish tidal marshes and ponds as well as freshwater marshes and temporary pools in overflow areas. The adults are vicious biters in both daytime and evenings. They have been known to fly in excess of 20 miles.

***Aedes melanimon* (dark marsh mosquito)**—The larvae are found primarily in irrigated pastures (alone or in association with *Ae. nigromaculis*), alfalfa fields, duck clubs, and waterfowl areas. Duck clubs and waterfowl areas provide habitat for *Ae. melanimon* alone or in association with *Ae. dorsalis* (in brackish water areas of the Delta). At a concentration of 1% salt, equal numbers of both species can be found. As the percentage rises to 2%, *Ae. melanimon* disappears (Bohart 1956). This species is capable of flights of 10 miles or more from a source when assisted by prevailing winds.

***Aedes squamiger* (California salt marsh mosquito)**—The larvae are found in salt marsh areas resulting from tidal overflow or rains. Adults are vicious daytime and early dusk biters, and undergo an annual flight from their larval sources.

***Culex erythrothorax* (tule mosquito)**—The larval populations occur in ponds, lake margins, irrigation and drainage canals, swamps, and marshes, all of which usually contain heavy growth of tule-type vegetation. The adults are active at dusk, but will bite readily during the day when their habitat is invaded.

***Culex tarsalis* (encephalitis mosquito)**—The larvae may be found in a variety of water sources, including rain pools, irrigated pastures, rice fields, stream margins, brackish and sewage waste sources, and seasonal waterfowl habitat. This species is the primary vector of West Nile and western encephalitis viruses in Solano County.

***Culiseta incidens* (cool weather mosquito)**—The larvae are found in a wide variety of sources such as streams, brackish water pools, stagnant and polluted pools, clear or semi-clear pools with partial shade, and artificial containers. In some areas the adults bite humans but ordinarily feed on fowl and domestic animals. Cool weather mosquitoes are most abundant during the seasons of cool, moderate temperatures and most numerous in early spring and late fall.

***Culiseta inornata* (winter mosquito)**—The larvae are found in stream pools, marshes, temporary rain pools, and occasionally in artificial containers and have been found in brackish water with *Ae. squamiger*. Adults will bite humans readily in brackish marsh areas. They are particularly bothersome to livestock in most areas.

Mosquitoes breed year-round in Suisun Marsh, but breeding of *Culex* and *Aedes* species diminishes (with the exception of *Aedes squamiger*) substantially during cooler weather, typically from late November through March. *Culiseta inornata* has population peaks in November and February.

Construction Worker Safety

Federal and state laws contain occupational safety standards to minimize safety risks from physical and chemical hazards in the workplace. The federal Occupational Safety and Health Administration (OSHA) and California Division of Occupational Safety and Health (CalOSHA) are the agencies responsible for assuring worker safety in the workplace. CalOSHA assumes primary responsibility for developing and enforcing standards for safe workplaces and work practices and requires that employers evaluate potential health hazards in the workplace and communicate the results and appropriate protective measures to employees.

Bioaccumulation of Mercury

Mercury can enter Suisun Marsh from four primary pathways: the Delta, coastal marine embayments, local watershed runoff, and the atmosphere. Mercury enters the Delta in the form of contaminated sediment deposits and contaminated runoff from the Coast Range and Sierra Nevada (Davis et al. 2003; Heim et al. 2003; Slotten et al. 2002; Weiner et al. 2003). The origin of the mercury contamination stems from the historical mining of mercury in the Coast Range and the subsequent use of elemental mercury for gold and silver extraction in the Sierra Nevada (Heim et al. 2003; Marvin-DiPasquale and Agee 2003; Slotten et al. 2002; Weiner et al. 2003). Recent studies have determined that about 350–750 kg of mercury is still being transported annually into the Bay-Delta from both the Coast Range and the Sierra Nevada (California Department of Water Resources 2005).

Mercury exposure poses health risks for both humans and wildlife. There are three forms of mercury: elemental, inorganic, and organic compounds, each with different toxicological characteristics (Goyer 1991). Methylmercury is the most important form of mercury in terms of toxicity and ability to biomagnify. Methylmercury concentrations increase with each step in the food chain, whereas inorganic mercury is not readily transferred between trophic levels (Weiner et al. 2003). Humans are exposed primarily through consumption of contaminated fish (Cooke et al. 2004; Heim et al. 2003; Johnson and Looker 2003). Concentrations of mercury found in the San Francisco estuary are high enough to warrant concern for the health of humans and wildlife. The Office of Environmental Health Hazard Assessment (2009) has posted an advisory limiting consumption of fish from the San Francisco Bay and Delta region because of mercury contamination (California Department of Water Resources 2005).

Mercury is a neurotoxicant, posing the greatest risk to developing embryos (Cooke et al. 2004; Goyer 1991). All forms of mercury cross the placenta to the fetus; however, methylmercury levels in fetal red blood cells are 30% higher than in maternal red blood cells. Exposure to mercury *in utero* or postnatally can cause irreversible neurotoxicity, resulting in delayed motor skills, seizures, and other mental symptoms (Goyer 1991). In adults, the major health effects are neurotoxic and include numbness and tingling in the extremities, inability to walk, difficulty in swallowing and talking, weakness and fatigue, vision and hearing loss, tremors, and finally coma and death (Cooke et al. 2004; Goyer 1991; California Department of Water Resources 2005).

Regulatory Setting

Regulations and policies considered relevant to the SMP alternatives are summarized below.

Federal

The principal federal regulatory agency responsible for the safe use and handling of hazardous materials is the EPA. Two key federal regulations pertaining to hazardous wastes are described below. Other applicable federal regulations are contained primarily in CFR Titles 29, 40, and 49.

Resource Conservation and Recovery Act

The federal Resource Conservation and Recovery Act enables the EPA to administer a regulatory program that extends from the manufacture of hazardous materials to their disposal, thus regulating the generation, transportation, treatment, storage, and disposal of hazardous waste at all facilities and sites in the nation.

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (also known as *Superfund*) was passed to facilitate the cleanup of the nation’s toxic waste sites. In 1986, the act was amended by the Superfund Amendment and Reauthorization Act Title III (community right-to-know laws). Title III states that past and present owners of land contaminated with hazardous substances can be held liable for the entire cost of the cleanup, even if the material was dumped illegally when the property was under different ownership.

State

California regulations are equal to or more stringent than federal regulations. The EPA has granted the State of California primary oversight responsibility to administer and enforce hazardous waste management programs. State regulations require planning and management to ensure that hazardous wastes are handled, stored, and disposed of properly to reduce risks to human and environmental health. Several key laws pertaining to hazardous wastes are discussed below.

California Environmental Protection Agency Certified Unified Program

The California Environmental Protection Agency (CalEPA) is directly responsible for administrating a Unified Program consolidating and coordinating permits, inspections, and enforcement activities for environmental and emergency management programs. The Unified Program is intended to provide relief to businesses complying with overlapping and sometimes conflicting requirements and is implemented at the local level by Certified Unified Program Agencies (CUPA).

The Solano County Environmental Health Department has been certified by CalEPA to implement the Unified Program as a CUPA. As a CUPA, the department is responsible for administering/overseeing compliance with state and federal regulations and has established a program that consolidates and coordinates administrative requirements, permits, inspection activities, enforcement activities, and associated fees into a consolidated permit for use throughout the county.

Hazardous Materials Release Response Plans and Inventory Act of 1985

The Hazardous Materials Release Response Plans and Inventory Act, also known as the Business Plan Act, requires businesses using hazardous materials to prepare a plan that describes their facilities, inventories, emergency response plans, and training programs. The Business Plan Act defines hazardous materials as unsafe raw or unused materials that are part of a process or manufacturing step. The California Health and Safety Code Chapter 6.95 also includes hazardous waste as part of this definition and requires hazardous wastes to be included in chemical inventories and addressed in emergency response plans submitted to the CUPA. Health concerns pertaining to the release of hazardous materials, however, are similar to those relating to hazardous waste.

Hazardous Waste Control Act

The Hazardous Waste Control Act created the state hazardous waste management program, which is similar to but more stringent than the federal Resource Conservation and Recovery Act program. The act is implemented by regulations contained in Title 26 CCR, which describes the following required aspects for the proper management of hazardous waste:

- identification and classification;
- generation and transportation;
- design and permitting of recycling, treatment, storage, and disposal facilities;
- treatment standards;
- operation of facilities and staff training; and
- closure of facilities and liability requirements.

These regulations list more than 800 materials that may be hazardous and establish criteria for identifying, packaging, and disposing of such waste. Under the Hazardous Waste Control Act and Title 26, the generator of hazardous waste must complete a manifest that accompanies the waste from generator to transporter to the ultimate disposal location. Copies of the manifest must be filed with the California Department of Toxic Substances and Control.

Emergency Services Act

Under the Emergency Services Act, the state developed an emergency response plan to coordinate emergency services provided by federal, state, and local agencies. Rapid response to incidents involving hazardous materials or hazardous waste is an important part of the plan, which is administered by the California OES. The office coordinates the responses of other agencies, including EPA, the CHP, RWQCBs, air quality management districts, and county disaster response offices.

Local and Regional Laws, Regulations, and Programs

Solano County Mosquito Abatement District

The Solano County Mosquito Abatement (SCMAD) was founded in 1930, specifically at the request of local taxpayers in order to control the pestiferous *Aedes* mosquitoes that were being produced in Suisun and San Pablo Bay Marshes. It was formed according to guidelines set forth by the Mosquito Abatement Act of 1915 and the California Health and Safety Code. Mosquito control in California has its origin in the San Francisco Bay Area, where efforts were undertaken to control this pest by ditching to enhance drainage and water circulation. The SCMAD, a county-wide agency, has jurisdiction over the primary marsh areas and secondary upland management areas. There are distinct management control practices in secondary upland areas as opposed to primary marsh areas. Mosquito control in secondary management areas relate to upland watershed, such as creekside and drainageway development, sedimentation, land development and agriculture. In primary areas, mosquito control practices are concerned with water management of seasonal waterfowl habitat (on privately and publicly owned land), irrigated livestock pasture lands, and tidal marshes. The SCMAD has been successful in reducing and suppressing the production of mosquitoes in primary management areas.

The SCMAD is empowered to and may, under the California Health and Safety Code (Division 3, Chapter 1, Article 1, Sections 2000 through 2093) abate mosquitoes and other insect pests and collect the cost thereof from the property owners.

Other Laws, Regulations, and Programs

Various other state regulations have been enacted that affect hazardous waste management, including:

- Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65), which requires labeling of substances known or suspected by the State of California to cause cancer; and
- California Government Code Section 65962.5, which requires the Office of Permit Assistance to compile a list of possible contaminated sites in the state.

State and federal regulations also require that hazardous materials sites be identified and listed in public records. These lists include:

- Comprehensive Environmental Response, Compensation, and Liability Information System;
- National Priorities List for Uncontrolled Hazardous Waste Sites;
- Resource Conservation and Recovery Act;
- California Superfund List of Active Annual Workplan Sites; and
- Lists of state-registered underground and leaking underground storage tanks.

Environmental Consequences

Assessment Methods

The evaluation of potential impacts on public health and environmental hazards addresses the potential for health and safety hazards during and after project construction. Information was collected through site visits; information regarding mosquito production and control; information gathered through the incorporation of findings from Sections 5.4, Flood Control and Levee Stability, and 5.2, Water Quality; and from assumptions made using the USDOT map. The analysis includes potential effects on workers related to construction activities, as well as general safety and hazards to both workers and the public.

Significance Criteria

Criteria used to determine the significance of an impact on public health and environmental hazards are based on the State CEQA Guidelines and professional standards and practices. Impacts were considered significant if an alternative would:

- create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials;
- create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials to the environment;
- be located on a hazardous materials sites pursuant to California Government Code 65962.5, and as a result would create a significant hazard to the public or the environment;
- 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;
- place within a 100-year flood hazard area structures that would impede or redirect flood flows;
- expose people to a significant risk of contracting a disease; or
- impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.

Environmental Impacts

No Action Alternative

Suisun Marsh is susceptible to flooding during major storm events, and several miles of exterior levees are at risk of failure as a result of subsidence, wave erosion, climate change, and other factors. Suisun Marsh levees protect extensive private and public infrastructure, including wildlife habitat, infrastructure, residences, roads, and railways. The El Niño storms of February 1998 brought high tides and winds that caused 11 exterior levee breaches, threatened SWP and CVP facilities,[1] (California Department of Water Resources 2008) and completely inundated 22,000 acres of public and private lands on Van

[1] http://www.drms.water.ca.gov/

Sickle, Wheeler, Simmons, and Hammond Islands (and partially inundated Grizzly, Joice, and Lower Joice islands).[2] (GlobalSecurity.org 2008)

Currently, private landowners, local Reclamation Districts and DFG are primarily responsible for repairs and maintenance of Suisun Marsh levees. However, because of difficulties of importing and obtaining materials s for levee repair, maintenance efforts currently consist of using materials from managed wetland areas. This practice contributes to ongoing land subsidence from the microbial decomposition of organic soil. Because maintenance activities are not able to keep pace with the current rate of levee degradation, it is likely that the No Action Alternative would result in a continued decrease in levee system integrity throughout the Marsh, potentially leading to natural breaching.

The No Action Alternative would rely on the existing level of maintenance to inspect, assess, and maintain the exterior levee system. In the event of a levee failure, it is not certain that levees would be repaired. Therefore, there is a potential for increased hazards over time attributable to deferred levee maintenance.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impacts

Impact HAZ-1: Increased Risk of Mosquito-Borne Diseases

Most species of mosquitoes lay their eggs on the surface of fresh stagnant water, although some species use damp soil. Any body of standing water represents potential breeding habitat, with the exception of areas that are flushed daily by tidal action and that are either too saline or not stagnant long enough to support mosquito larvae to maturity (Tietze 2001).

The greatest numbers of mosquitoes are produced in water bodies with poor circulation, high temperatures, and high organic content (Collins and Resh 1989). Typically, greater numbers of mosquitoes are produced in water bodies with water levels that slowly increase or recede, and fewer numbers of mosquitoes are produced in water bodies with rapidly fluctuating water levels (Jones & Stokes Associates 1995).

Control technicians routinely inspect sources within the SCMAD on a 7- to 10-day cycle. Areas affected by high tides or intentional flooding require more inspections because of the developmental time of the species of mosquitoes involved as well as climatic conditions.

Tidal restoration projects in Suisun Marsh generally have a potential for producing large numbers of mosquitoes. The extent of tidal flow depends on the

[2] http://www.globalsecurity.org/military/facility/suisun-bay.htm

relative elevation of the site to tide. Tidal flushing itself does not create mosquito problems. Mosquito problems arise if residual tidal and floodwaters remain in depressions and cracked ground. At least one mosquito species produced in these types of areas is an aggressive pest of man and is capable of flying in excess of 20 miles.

The tidal restoration occurring as part of the Proposed Project is restoring managed wetlands to tidal wetlands. Since managed wetlands more than tidal wetlands demonstrate the characteristics described above that can lead to increased mosquito production, the change from the baseline managed wetland condition to tidal wetlands along with appropriate tidal wetland design, and the implementation of mosquito abatement best management practices, as described in the Environmental Commitments section of Chapter 2, will reduce the potential for mosquito production in the Marsh from baseline conditions. Overall there is not expected to be any increase in mosquito production that could result in increases in human exposure to diseases.

Conclusion: Less than significant. No mitigation required.

Impact HAZ-2: Exposure to or Release of Hazardous Materials during Construction

Construction of the proposed action would not require treatment, disposal, or transport of significant quantities of hazardous materials. However, fuel and lubricant fluids associated with construction equipment could expose construction workers and the environment to hazardous materials if materials are improperly handled. This impact would be temporary.

Implementing the SMP would involve levee breaching. Digging could affect gas pipelines occurring below the ground level. If pipelines were damaged during digging, release of natural gas or other materials could expose construction workers and the environment to hazardous materials. The plan will be designed to avoid impacting existing pipelines and other facilities.

The standard design features and construction practices outlined in the Environmental Commitments section of Chapter 2 will be implemented at a site-specific level to mitigate short-term, construction-related impacts. Access points/staging areas will be established for equipment, storage and maintenance, construction materials, fuels, lubricants, solvents, and other possible contaminants as outlined in Chapter 2. Additionally, no hazardous material would be used in reportable quantities unless approved in advance by the OES, and compliance reporting will be conducted and a risk management plan submitted as outlined in Chapter 2, Hazardous Materials Management Plan. Hazardous materials and wastes present in quantities equal to or in excess of 55 gallons of liquids, 200 cubic feet of gases, and 500 pounds of solids triggers the Hazardous Materials Business Plan that consists of a chemical inventory, emergency response plan, and site diagram submitted to Solano County Environmental Health Services Division as the CUPA. In addition, a SWPPP will be prepared including BMPs for spill prevention and control and the storage and handling of hazardous materials and wastes.

Conclusion: Less than significant. No mitigation required.

Impact HAZ-3: Release of Hazardous Materials into Surrounding Water Bodies during Construction

At least one LUFT is located in an isolated pond off of Montezuma Slough (GeoTracker 2008). Levee breaching in the area could flood the pond and connect it to Montezuma Slough. Any leaking fuel could spread into Montezuma Slough and other adjacent water bodies, causing water contamination. Restoration designs will avoid the LUFT area.

Additionally, the plan area has a history of agricultural use and may have areas of previously unknown contamination related to the use or storage of agricultural compounds such as pesticides, fertilizers, or fuels. Project construction or maintenance activities thus could encounter unknown contamination. As described in Chapter 2 (see Environmental Commitments), in the event that contamination is encountered during construction, all construction or maintenance activities in the area of the find will stop and the proponent will conduct appropriate hazardous materials investigations to identify and delineate the extent and nature of the contamination. If clean-up or remediation is required, the proponent will ensure that any hazardous waste materials removed during construction are handled, transported, and disposed of according to federal, state, and local requirements. With these procedures in place, impacts related to the discovery of unknown hazardous waste or hazardous substance sites within the plan area are expected to be less than significant, and no mitigation is required.

Conclusion: Less than significant. No mitigation required.

Impact HAZ-4: In-Channel Construction-Related Increase in Emergency Response Times

Suisun Marsh waterways occasionally are used by emergency service providers. In-channel work, such as levee breaching, could slightly increase emergency response times if the channels used as access routes are blocked by these activities. Construction equipment is not expected to impede emergency access provided over levee roads. Upon completion of construction, no changes in emergency access or response times would occur. As described in the environmental commitments section of Chapter 2, project proponents will coordinate with the Coast Guard and the Solano County Marine Patrol prior to commencing any activities that may impede their boats to ensure that response times in Suisun Marsh are not affected.

Conclusion: Less than significant. No mitigation required.

Impact HAZ-5: Increased Human and Environmental Exposure to Mercury

As described in Section 5.2, Water Quality, and Impact WQ-4: Increased Methylmercury Production from Suisun Marsh Tidal Channels, Tidal Wetlands, and Managed Wetlands, this impact would be less than significant.

Conclusion: Less than significant. No mitigation is required.

Impact HAZ-6: Reduction in Potential for Catastrophic Flooding

Alternative A includes a levee system integrity component that would result in the improvement of exterior levee stability throughout the Marsh. As such, the potential for catastrophic flooding would be reduced as specific levee improvements are made. This would reduce the risk to the public related to flooding.

Conclusion: Beneficial.

Impact HAZ-7: Increased Human and Environmental Exposure to Natural Gas and Petroleum

Tidal restoration has the potential to occur in areas where natural gas and petroleum pipelines exist. In some instances, these pipelines were installed under conditions in which the areas that would be restored were not tidally inundated. Restoration would result in permanent tidal inundation, which would increase the potential for exposure of natural gas and petroleum to the environment and humans because, should a leak occur, it is more difficult to contain than under existing conditions.

Conclusion: Less than significant with Mitigation Measures UTL-MM-2, “Avoid Ground-Disturbing Activities within Pipeline Right-of-Way,” UTL-MM-3, “Relocate or Upgrade Utility Facilities That Could Be Damaged by Inundation,” and UTL-MM-4, “Test and Repair or Replace Pipelines That Have the Potential for Failure,” incorporated.

Mitigation Measures UTL-MM-2, UTL-MM-3, and UTL-MM-4 are described in Section 7.3, Utilities and Public Services, and would minimize the potential for a failure of natural gas and/or petroleum pipelines.

Managed Wetland Activities Impacts

Impact HAZ-2: Exposure to or Release of Hazardous Materials during Construction

This impact would be similar to that described for restoration activities. Fuel and lubricant fluids associated with construction equipment used in managed wetland activities could expose construction workers and the environment to hazardous materials if materials are improperly handled. Most of the managed wetland activities would occur in the managed wetland areas, which would be dry at the time of construction activities. As such, they would be easily contained and the impact would be temporary.

The standard design features and construction practices outlined in the environmental commitments section of Chapter 2, including BMPs for spill prevention and control and the storage and handling of hazardous materials, will be implemented at a site-specific level to minimize the potential for short-term, construction-related impacts.

Conclusion: Less than significant. No mitigation required.

Impact HAZ-4: In-Channel Construction-Related Increase in Emergency Response Times

This impact would be similar to that described for restoration activities. Suisun Marsh waterways occasionally are used by emergency service providers. In-channel work, such as dredging or placement of riprap, could slightly increase emergency response times if the channels used as access routes are blocked by these activities. Approximately 100,000 cubic yards of material would be dredged annually from throughout the Marsh. Some dredging would take place from the levee crown, disrupting minimal channel area, and some dredging would take place from a barge in the channel. Dredging conducted from a barge, especially in a narrow channel, has the potential to block emergency access to boats and other watercraft. As described in the environmental commitments section of Chapter 2, alternate boating routes will be identified if dredging impedes navigation. Additionally, the majority of the managed wetland activities would occur on private lands. Therefore, based on the occasional use of the waterways by emergency service providers and the location of activities, the increase in emergency response times would not be significant. Furthermore, upon completion of construction, no changes in emergency access or response times would occur.

Conclusion: Less than significant. No mitigation required.

Impact HAZ-5: Increased Human and Environmental Exposure to Mercury

As described in Section 5.2, Water Quality, and Impact WQ-8: "Increased Methylmercury Production from Suisun Marsh Tidal Channels, Tidal Wetlands, and Managed Wetlands," this impact would be less than significant.

Conclusion: Less than significant. No mitigation is required.

Impact HAZ-6: Reduction in Potential for Catastrophic Flooding

This impact would be similar to that described for restoration activities. Managed wetland activities that would result in the improvement of exterior levee stability throughout the Marsh would reduce the potential for catastrophic flooding as specific levee improvements are made. This would reduce the risk to the public related to flooding.

Conclusion: Beneficial.

Alternative B: Restore 2,000–4,000 Acres

Impacts under Alternative B are similar to those described under Alternative A. Under Alternative B, there would be less tidal restoration and, therefore, less potential for increased mosquito populations. However, hazards related to hazardous materials and worker safety would be similar, as there would be more managed wetland enhancement activities. Benefits related to levee system integrity would be the same. Alternative B would have the same significance findings as described for Alternative A.

Alternative C: Restore 7,000–9,000 Acres

Impacts under Alternative C are similar to those described under Alternative A. Under Alternative C, there would be more tidal restoration and, therefore, a slightly higher potential for increased mosquito populations. Mitigation Measure HAZ-MM-2 would reduce this impact to a less-than-significant level. Risks related to hazardous materials and worker safety would be similar to those under Alternative A. Hazards would be managed by environmental commitments at each individual project site. Benefits related to levee system integrity would be the same. Alternative C would have the same significance findings as described for Alternative A.

Section 7.9
Environmental Justice

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on environmental justice.

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing context against which the reader can understand the changes caused by the action. The setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts.

The changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

Summary of Impacts

Table 7.9-1 summarizes impacts on environmental justice from implementing the SMP alternatives. There are no significant impacts on environmental justice from implementing the SMP alternatives.

Table 7.9-1. Summary of Impacts on Environmental Justice

Impact	Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Restoration Impact				
EJ-1: Disproportionate Impact of Management of Suisun Marsh on Minority and/or Low-Income Communities	A, B, C	No impact	–	–
Managed Wetland Activities Impact				
EJ-1: Disproportionate Impact of Management of Suisun Marsh on Minority and/or Low-Income Communities	A, B, C	No impact	–	–

Affected Environment

Sources of Information

The following key sources of information were used in the preparation of this section:

- Association of Bay Area Governments 2008,
- Solano County census data 2000 and 2006 (Bay Area Census 2008), and
- aerial photography of Suisun Marsh.

Regulatory Setting

Federal

Executive Order 12898, Environmental Justice is discussed in greater detail in Chapter 10.

State

The State of California passed a series of environmental justice regulations in 2001. These laws define environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies.

Environmental Setting

The SMP area is located in Solano County. In 2006, it was estimated that the county had a minority population of approximately 48%. The largest minority communities in the county have been identified as Black or African American (14.8%), followed by Asians (14.3%). (Association of Bay Area Governments 2008.)

Census data were also gathered for persons of Hispanic origin. An origin can be viewed as a heritage, nationality group, lineage, or country of birth of the person or person's parents or ancestors before their arrival in the United States. People that identify their origin as Spanish, Hispanic, or Latino may be of any race. Therefore, those who are counted as Hispanic are also counted under one or more race categories. Approximately 22% of the Solano County population was considered Hispanic in 2006 (Association of Bay Area Governments 2008).

Of the total population, approximately 43,000 residents income falls below the poverty level (Association of Bay Area Governments 2008).

Review of aerial photographs of the SMP area, and in particular areas within the SMP area in which levee improvements could occur or may be purchased and restored as tidal wetlands, indicates that these areas are open space and do not support urban development.

Environmental Consequences

Assessment Methods

Demographic information was gathered for Solano County to describe the extent of minority and low-income communities occurring in the county. Aerial photographs were evaluated to determine the location of any urban development within the SMP area that could suggest the presence of a low-income or minority community.

Significance Criteria

The following significance criteria were applied to determine whether the SMP alternatives would result in a disproportionate effect on a minority or low-income community:

- changes in the natural or physical environment that may also adversely affect minority or low-income populations, or
- changes in the natural or physical environment that may result in an adverse effect on minority or low-income populations that appreciably exceeds or is likely to appreciably exceed the effects on the general population.

Environmental Impacts

No Action Alternative

Under the No Action Alternative, there would be a decrease in managed wetland activities as a result of permitting difficulties. However, none of the effects associated with the No Action Alternative would result in disproportionate effects on minority or low-income communities.

Alternative A, Proposed Project: Restore 5,000–7,000 Acres

Restoration Impact

Impact EJ-1: Disproportionate Impact of Management of Suisun Marsh on Minority and/or Low-Income Communities

As discussed in Chapter 2, the proposed project includes upgrading or constructing new levees, and restoring up to 7,000 acres of tidal wetlands. Implementing these improvements would necessitate construction activities and purchase of private lands to allow restoration of tidal wetlands. Most, if not all, lands purchased for tidal wetlands restoration would be from hunting clubs or agricultural operations. No low-income or minority communities would be affected by activities associated with upgrading or constructing new levees or restoring tidal wetlands because none are located in the area encompassed by the SMP.

Implementing the proposed project would not result in a disproportionate adverse effect on minority or low-income communities.

Conclusion: No impact.

Managed Wetland Activities Impact

Impact EJ-1: Disproportionate Impact of Management of Suisun Marsh on Minority and/or Low-Income Communities

This impact would be similar to that described for restoration activities. Managed wetland activities include infrastructure improvements, reconstructing existing levees, and constructing new levees. Implementing these improvements would necessitate construction activities. Modifications to infrastructure within the SMP area generally include improvements to existing levees and infrastructure required for management of water. No low-income or minority communities would be affected by improving the existing infrastructure because none are located in the area encompassed by the SMP.

Implementing the proposed project would not result in a disproportionate adverse effect on minority or low-income communities.

Conclusion: No impact.

Alternative B: Restore 2,000–4,000 Acres

Impacts on low-income or minority communities would be the same as described for Alternative A. Implementing Alternative B would not result in a disproportionate adverse effect on minority or low-income communities.

Alternative C: Restore 7,000–9,000 Acres

Impacts on low-income or minority communities would be the same as described for Alternative A. Implementing Alternative C would not result in a disproportionate adverse effect on minority or low-income communities.

Section 7.10
Indian Trust Assets

Introduction

This section describes the existing environmental conditions and the consequences of implementing the SMP alternatives on Indian Trust Assets (ITAs).

The Affected Environment discussion below describes the current setting of the action area. The purpose of this information is to establish the existing environmental context against which the reader can understand the environmental changes caused by the action. The environmental setting information is intended to be directly or indirectly relevant to the subsequent discussion of impacts.

The environmental changes associated with the action are discussed under Impact Analysis. This section identifies impacts, describes how they would occur, and prescribes mitigation measures to reduce significant impacts, if necessary.

ITAs are legal interests in property held in trust by the United States for federally recognized Indian tribes or individual Indians. An Indian trust has three components: (1) the trustee, (2) the beneficiary, and (3) the trust asset. ITAs can include land, minerals, federally reserved hunting and fishing rights, federally reserved water rights, and instream flows associated with trust land. Beneficiaries of the Indian trust relationship are federally recognized Indian tribes with trust land; the United States is the trustee. By definition, ITAs cannot be sold, leased, or otherwise encumbered without approval of the United States. The characterization and application of the United States trust relationship have been defined by case law that interprets Congressional acts, executive orders, and historical treaty provisions.

Summary of Impacts

There are no impacts on ITAs from implementing the SMP alternatives.

Affected Environment

Regulatory Setting

Consistent with President William J. Clinton's 1994 memorandum, "Government-to-Government Relations with Native American Tribal Governments," Reclamation assesses the effect of its programs on tribal trust resources and federally recognized tribal governments. Reclamation is tasked with actively engaging federally recognized tribal governments and consulting with such tribes on a government-to-government level (59 FR 1994) when its actions affect ITAs. The U.S. Department of the Interior (DOI) Departmental Manual Part 512.2 ascribes the responsibility for ensuring protection of ITAs to the heads of bureaus and offices (U.S. Department of the Interior 1995). Part 512, Chapter 2 of the Departmental Manual states that it is the policy of the DOI to recognize and fulfill its legal obligations to identify, protect, and conserve the trust resources of federally recognized Indian tribes and tribal members.

All bureaus are responsible for, among other things, identifying any impact of their plans, projects, programs, or activities on Indian trust assets; ensuring that potential impacts are explicitly addressed in planning, decision, and operational documents; and consulting with recognized tribes who may be affected by proposed activities. Consistent with this, Reclamation's Indian trust policy states that Reclamation will carry out its activities in a manner that protects ITAs and avoids adverse impacts when possible, or provides appropriate mitigation or compensation when it is not. To carry out this policy, Reclamation incorporated procedures into its NEPA compliance procedures to require evaluation of the potential effects of its proposed actions on trust assets (Bureau of Reclamation July 2, 1993). Reclamation is responsible for assessing whether the SMP has the potential to affect ITAs and will comply with procedures contained in Departmental Manual Part 512.2 guidelines, which protect ITAs.

Reclamation's ITA policy states that Reclamation will carry out its activities in a manner that protects ITAs and avoids adverse impacts when possible. When Reclamation cannot avoid adverse impacts, it will provide appropriate mitigation or compensation. The USFWS does not have a specific ITA policy.

Sources of Information

The following key sources of information were used in the preparation of this section:

- GIS coverage of Indian reservations and rancherias for the State of California maintained by Reclamation, and
- maps of ITAs and their proximity to the plan area.

Indian Trust Assets

There are no ITAs in the vicinity of the proposed project area. The nearest ITA to the plan area is the Lytton Rancheria located 33 miles west-northwest away from the plan area in Healdsburg, California. The closest water body to this ITA is Dry Creek, a tributary to the Russian River. The Environmental Consequences subsection below concludes there are no adverse effects on the trust assets of the Lytton Rancheria.

Environmental Consequences

Assessment Methods

Reclamation maintains GIS coverage of Indian reservations and rancherias for the state of California. Impact assessments for ITAs were based on this GIS coverage and maps of ITAs for the area.

Significance Criteria

The presence of an ITA within the plan area or the potential effects of a project on an ITA (regardless of the project's proximity to it) trigger evaluation of potential impacts on ITAs. If during the course of this evaluation an impact on an ITA is determined, consultation with the potentially affected tribes would ensue to ensure that the affected tribe(s) may fully evaluate the potential impact of the proposed SMP alternatives on ITAs. Plan effects that conceivably could affect ITAs, such as water rights or other assets that might be located off-reservation, also trigger further evaluation and consultation with affected tribes.

Environmental Impacts

The proposed project and alternatives would not result in any direct or indirect impacts on Dry Creek, Russian River, or other resources used by the Lytton Rancheria. As such, there would be no impacts on ITAs resulting from the SMP.

Index

Index

Suisun Marsh
Habitat Management, Preservation, and Restoration Plan

Draft
Environmental Impact Statement/ Environmental Impact Report

Volume II: Appendices

U.S. Department of the Interior
Bureau of Reclamation

U.S. Fish and Wildlife Service

California Department of Fish and Game

October 2010

Mission Statements

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

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

The Mission of the Department of Fish and Game is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public.

Suisun Marsh
Habitat Management, Preservation, and Restoration Plan

Draft
Environmental Impact Statement/ Environmental Impact Report

Volume II: Appendices

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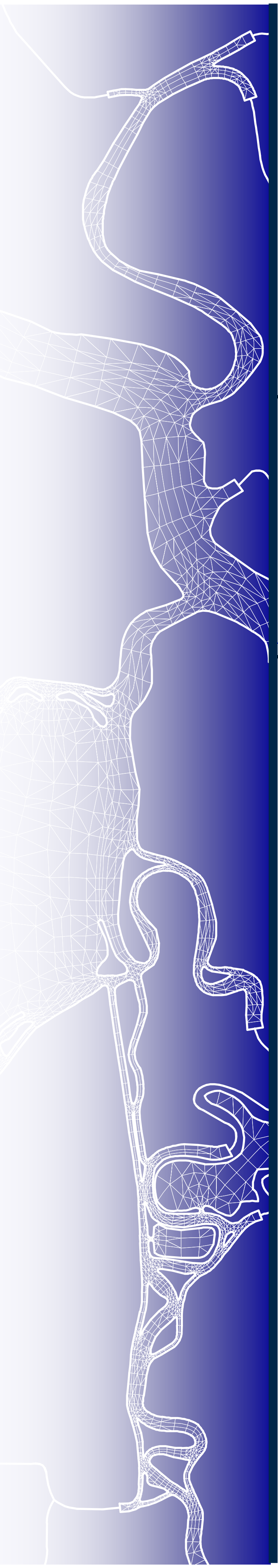
October 2010

Contents

Appendix A

Numerical Modeling in Support of Suisun Marsh PEIR/EIS—Technical Appendix, September 2009



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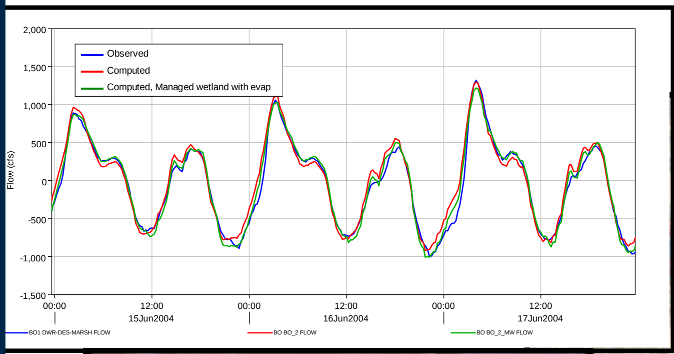

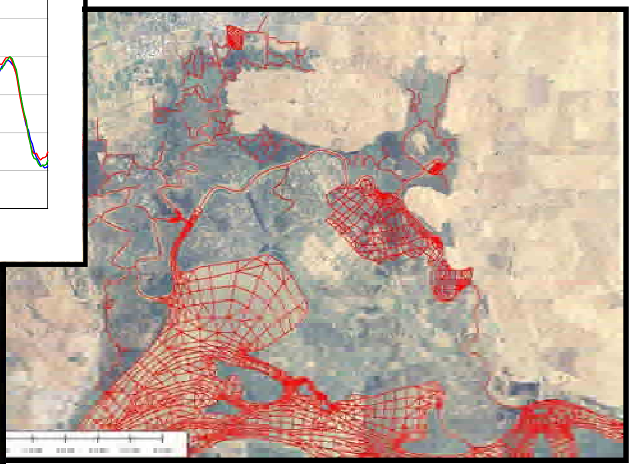

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Table of Contents

Table of Figures

List of Tables

1. Executive Summary

1.1. Background

Resource Management Associates, Inc. (RMA) has developed a numerical model of the Suisun Marsh area to simulate the current hydrodynamics and salinity of the marsh as well as the changes to this regime under a set of four marsh restoration scenarios. RMA refined the representation of the Suisun Marsh area in their current numerical model of the San Francisco Bay and Sacramento-San Joaquin Delta system (Bay-Delta model). The computer programs used in the Bay-Delta model, RMA2 (King 1990) and RMA11 (King 1998), utilize a finite element formulation to simulate the one- and two-dimensional flow and water quality transport[1], respectively, in streams and estuaries. The Bay-Delta model, which uses electrical conductivity[2] (EC) as a surrogate for salinity, has been successively updated, refined and recalibrated in numerous studies over the past 11 years, for example, to evaluate the water quality responses of treated wastewater discharges, and the potential effects of various Suisun Marsh levee breach scenarios.

1.2. Report Summary

This Technical Summary of the Suisun Marsh Modeling Project describes:

- the refined Bay-Delta model;
- the calibration of this representation;
- the further development of the model to represent four representative marsh restoration scenarios; and
- analysis of the modeling results of these scenarios to evaluate their effects on tidal range, scour velocities, and tidal prism in Suisun Marsh, and on salinity in Suisun Marsh and the Delta in comparison with simulated Base case conditions.

1.3. Summary of the Calibration

RMA's Bay-Delta model was refined in the Suisun Marsh area, with increased detail to represent off-channel storage in overbank/fringe marsh regions, a better representation of precipitation and evaporation, estimation of local creek flows, inflows and withdrawals within the Suisun Marsh, plus an overall refinement of the mesh. These additions generally improved the representation of tidal dynamics and EC in Suisun Marsh. A recent Delta calibration effort (RMA, 2005) was used as the starting point for the current effort. There was no recalibration in the Delta, as the focus was on improving the representation of Suisun Marsh.

Hydrodynamic calibration of the refined model took place in the period April – July, 2004 to take advantage of new LiDAR elevation data and data from new flow and stage measurement stations in the Suisun Marsh area (DWR 2007). Stage calibration was generally good in Suisun Marsh. The results of the flow calibration were mixed. Flows in

[1] RMA11 can also be used to simulate three-dimensional transport in conjunction with other RMA model formulations, for both conservative and non-conservative constituents.

[2] EC measurements give an estimate of the amount of total dissolved solids in the water; units are typically given in µmhos cm^{-1} or, equivalently, µS cm^{-1}

the smaller sloughs were greatly improved by the increased detail and refinement of the grid, the addition of off-channel storage, withdrawals for managed wetlands, and representation of evaporation in the tidal marsh areas. Flow through Montezuma Slough was low in comparison with measured data, and low flows through Hunter Cut were compensated by higher flows through Suisun Slough. These results have the potential of biasing modeled EC in the marsh restoration scenarios.

EC calibration results were also mixed, with some areas showing good correspondence with measured data, while other areas suffered from approximations intrinsic to the model or from the lack of sufficient data. In particular, density stratification is not explicitly represented in the 2-dimensional depth-averaged formulation used in the Bay-Delta model, leading to variations in the representation of EC. In the current model, diffusion coefficients are used to approximate effects due to density stratification. Using this method to improve the representation of EC during high flow periods tends to bias modeled EC when outflow is low. As a consequence, modeled EC at Martinez is low winter through spring and high summer through fall. This bias in modeled EC at Martinez propagates through western Suisun Marsh. In general, EC was low everywhere in the marsh in winter 2003. EC was low year-round in the eastern end of Montezuma Slough.

1.4. Summary of the Modeling Results

Four scenarios (Figure 1-1) for representative tidal marsh restoration in Suisun Marsh were modeled and compared to a Base case. The scenarios present a range of locations and acreages for restoration projects. Locations where levees were breached are indicated on Figure 1-1. As expected, each of the scenarios increased the tidal prism, i.e., the volume of water exchanged in the Suisun Marsh area, but muted the tidal range and shifted stage timing throughout the marsh in comparison with the Base case. Average tidal flow generally increased in the larger sloughs and decreased in smaller sloughs in the interior regions of Suisun Marsh. The peak velocity increased in sloughs near the breaches of the flooded areas, with the largest velocity changes localized at and near the mouths of the breached levees.

Electrical conductivity (µmhos cm^{-1} or µSiemens cm^{-1}), or EC, was modeled as a surrogate for salinity. One part per thousand EC is equivalent to about 1.5 µmhos cm^{-1} of EC. EC in the Delta was similar to the Base case in each scenario January – June, but changed July – December in several of the scenarios. Delta EC decreased during the latter period for the Zone 4 and Set 1 scenarios where the breached areas were located in channels further from Suisun, Grizzly and Honker Bays. The Set 2 scenario resulted in EC increase in the Delta due to tidal trapping[3] in the breached area adjacent to Suisun Bay. Tidal trapping in Zone 1 caused only minor increases in Delta EC.

Tidal restoration scenarios that decreased Delta EC tended to increase EC in Suisun Marsh, although changes in the details of the EC profile for each scenario depended on

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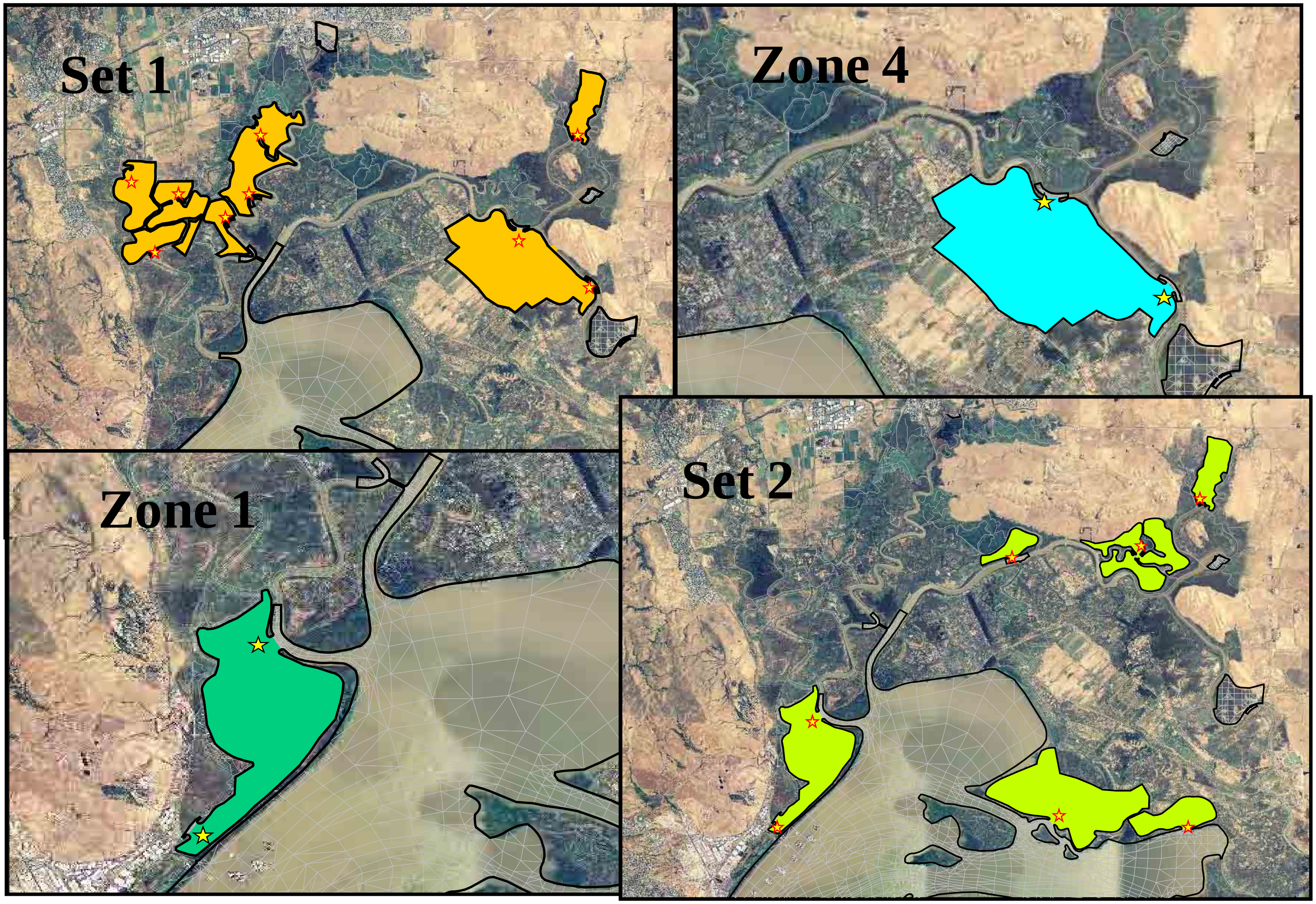
the particular location examined, the operation of the Suisun Marsh Salinity Control Gate (SMSCG), and the season. The Zone 1 scenario was most similar to the Base case, with little or no EC change in the eastern marsh but some increase in the west. The Zone 4 scenario decreased EC in most of the marsh whenever the SMSCG was operating, except in eastern Montezuma Slough where it increased EC. The Set 1 scenario generally resulted in the highest EC conditions in the Marsh, except upstream of the Zone 4 breaches on Montezuma Slough. The Set 2 scenario tended to increase EC in much of the marsh when the SMSCG was operating, with variable increase or decrease otherwise.



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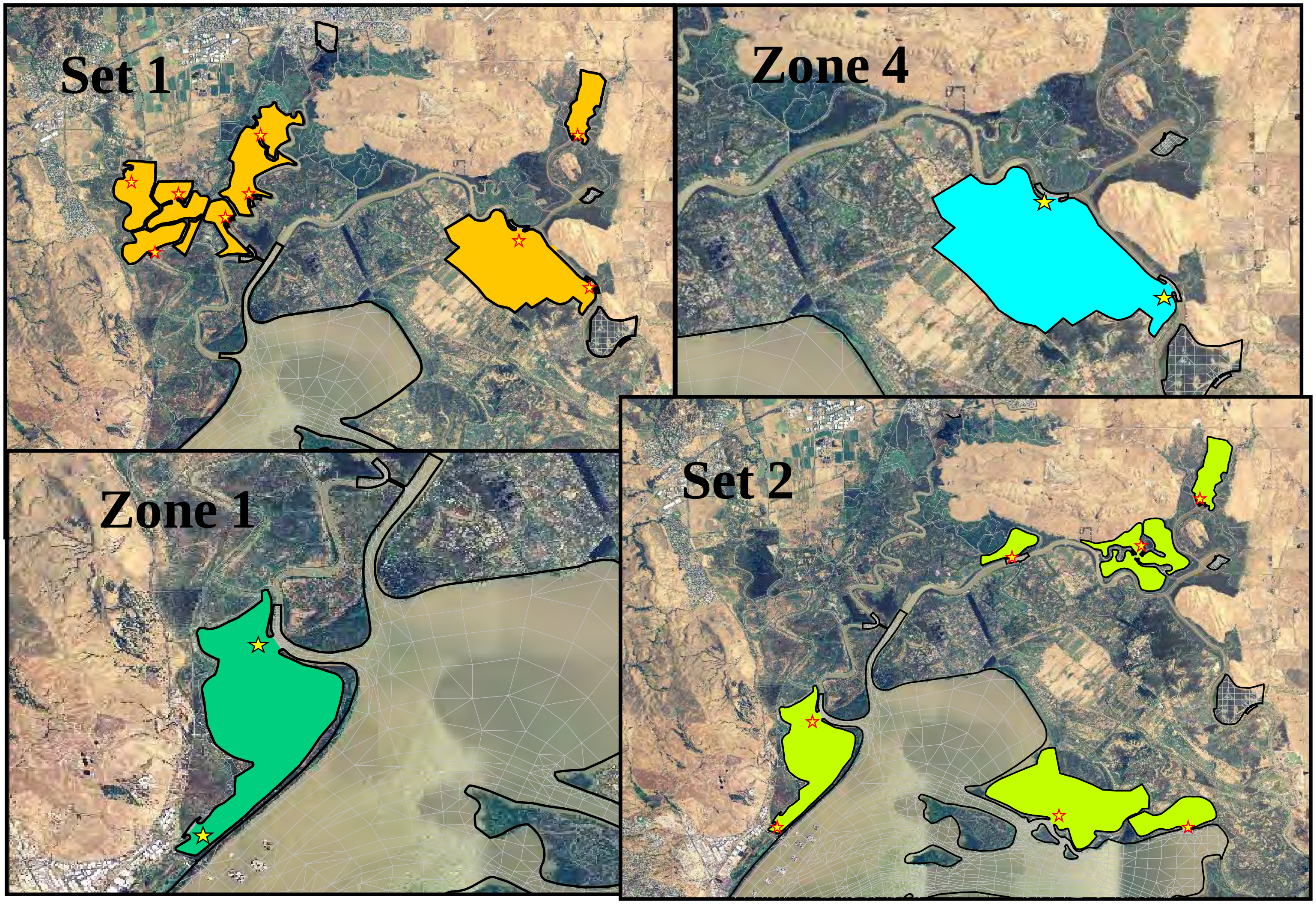


Figure 1-1 Regions flooded as tidal marsh in each of the scenarios, with the location of breaches in levees indicated by stars.

2. RMA Suisun Marsh Modeling

2.1. Introduction

The goal of the Suisun Marsh project numerical modeling effort is to evaluate the effects of each of the four marsh restoration scenarios (Figure 1-1) on tidal range, scour, and tidal prism in Suisun Marsh, and on salinity in Suisun Marsh and the Delta. To accomplish these objectives, Resource Management Associates, Inc. (RMA) was tasked with developing a numerical model of the Suisun Marsh area to accurately simulate the current hydrodynamics and salinity regimes in the marsh, as well as the changes to these regimes in the marsh and to the salinity regime in the Delta under the four scenarios. EC is used as a surrogate for salinity in the Bay-Delta model for this project – this is discussed in more detail in Section 2.3.

During the Suisun Marsh Levee Breach modeling project (RMA, 2000), considerable detail was added to the representation of Suisun Bay and the western Delta, and to a lesser extent to representations of the Central Bay and Carquinez Strait. Wetting and drying of the tidal mudflats was represented in sufficient detail to provide a good definition of change in the tidal prism with change in tidal stage. The current model development and calibration efforts focused on further refinement of the finite element mesh and model capabilities in and around Suisun Marsh.

When the RMA Bay-Delta model was first developed, there was very limited observed data available to verify its performance in Suisun Marsh Region. Comparison of RMA model results to recent DWR monitoring data collected in 2004 and 2005 identified some deficiencies in the previous model representation of the Suisun Marsh Region. The discrepancies in flow results were primarily due to inaccurate representation of tidal prism at high tide. Before the model was used for alternative analysis simulations, the model was updated to better represent observed flows. The update primarily included assessment of inundated area and review/refinement of model geometry.

2.2. Background

RMA has developed and refined a numerical model of the San Francisco Bay and Sacramento-San Joaquin Delta system (Bay-Delta model) utilizing the RMA finite element models for surface waters. RMA2 (King, 1990) is a generalized free surface hydrodynamic model that is used to compute two-dimensional depth-averaged velocity and water surface elevation. RMA11 (King, 1998) is a generalized two-dimensional depth-averaged water quality model that computes a temporal and spatial description of conservative and non-conservative water quality parameters. RMA11 uses the results from RMA2 for its description of the flow field. As shown in Figure 2-1, the full model extends from the Golden Gate to the confluence of the American and Sacramento Rivers and to Vernalis on the San Joaquin River.

The current version of RMA's Bay-Delta model has been developed and continually refined during numerous studies over the past 11 years. One of the most important additions has been the capability to accurately represent wetting and drying in shallow estuaries. The most comprehensive calibration efforts in recent years were performed during studies for the City of Novato (RMA, 1997), the City of Palo Alto Regional Water Quality Control Plant (RMA, 1998), Central Contra Costa Sanitary District (RMA, 2000), CALFED (RMA, 2000), and Flooded Islands Feasibility Study (RMA, 2005).

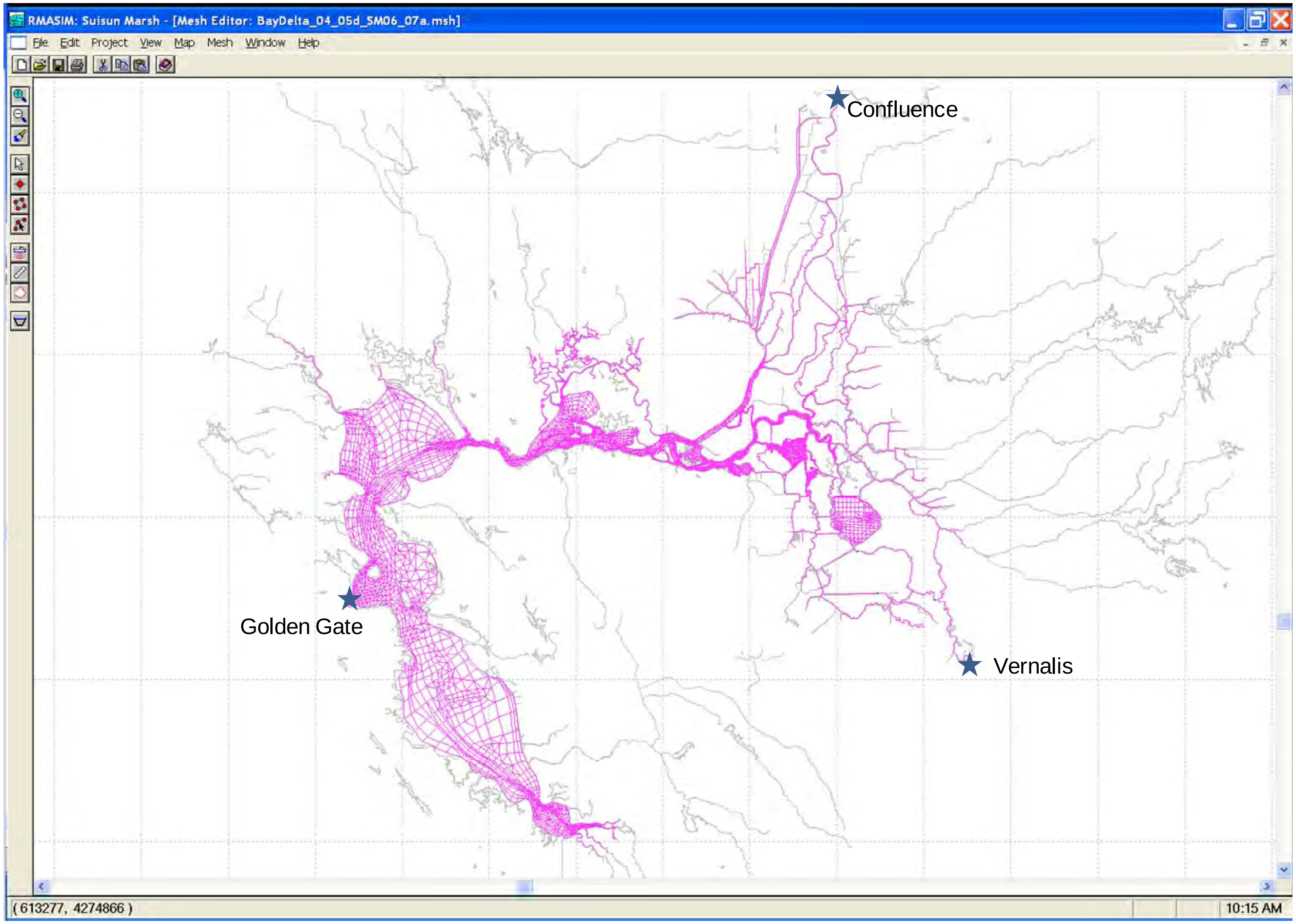


Figure 2-1 RMA Bay-Delta model finite element mesh.

2.3. General Description of Model Capabilities

Hydrodynamic and water quality model output from RMA's Bay-Delta models, RMA2 and RMA11, provided temporal and spatial descriptions of velocities and water depths, and EC (µmhos cm^{-1}), respectively, throughout the model domain. The results of the flow simulation are saved and used by the water quality model to compute EC[4]. The computational time step used for modeling the depth-averaged flow and EC transport in the Delta is 7.5 minutes, and output from each model is saved every 15 minutes.

The version of the Bay-Delta model used in this study sets the tidal boundary condition at the Golden Gate. Although the RMA11 formulation assumes transport of a conservative constituent, EC is used as a practical surrogate for modeled salinity in the Bay-Delta model for several reasons, despite concerns about its non-conservative behavior. The number and reliability of measurement locations in the Bay-Delta region is much greater for EC than for other measures of salinity. In addition, transformation relationships between EC and constituents generally considered conservative, such as chloride and Total Dissolved Solids (TDS), can introduce additional error. EC underestimates true salinity at high concentrations (DWR, 2002). Because the Bay-Delta transport model is calibrated using EC, dispersion coefficients may be too high to utilize the model for truly conservative constituents.

Significant vertical salinity gradients are often present in the western Delta and Suisun Bay which can lead to three dimensional circulation patterns not fully represented by a two-dimensional depth-averaged model, but are instead approximated by two-dimensional mixing parameters.

Due to the variable grid capability of the finite element method, fine detail can be added to emphasize specific areas in the vicinity of the current project without increasing detail elsewhere in the model grid.

3. Model Set-up

The standard Bay-Delta Model hydrodynamic model operation (RMA2) requires specification of the tidal stage at the Golden Gate and inflow and withdrawal rates at other boundaries. Inflows include Sacramento River, Yolo Bypass, San Joaquin River and other rim flows, channel depletions and exports (SWP, CVP, Contra Costa Canal, and North Bay Aqueduct). The water quality model (RMA11) requires specification of EC boundary conditions at all inflow boundaries. The refined model developed for the current project added new boundary conditions for flow and EC within Suisun Marsh that are covered in Section 3.3.

[4] RMA11 can also compute the transport of other water quality constituents with more complex interactions

3.1. Model Geometry

Figure 2-1 shows the entire mesh of the Bay-Delta model used in the calibration effort (the calibration effort is covered in Section 4 of this report). In the previous version of the model, a two-dimensional, depth-averaged representation was used for the San Francisco Bay and Suisun Bay regions, the Sacramento-San Joaquin confluence area, Sherman Lake, the Sacramento River up to Rio Vista, Big Break, the San Joaquin River up to its confluence with Middle River, False River, Frank's Tract and the surrounding channels, and the Delta Cross Channel. Suisun Marsh and Delta channels, and tributary streams were represented using a one-dimensional cross-sectionally averaged approximation.

The Bay-Delta finite element network was developed using an in-house GIS based graphical user interface program. This program allows for specification of the finite element mesh over layers of bathymetry points and contours, USGS digital line graph (DLG) and digital orthoquad (DOQ) images, and aerial photo surveys processed by USGS and Stanford University. Bottom elevations and the extent of mudflats were based on bathymetry data collected by NOAA, DWR, USACE and USGS. These data sets have been compiled by DWR and can be downloaded from DWR's Cross Section Development Program (CSDP) website at http://baydeltaoffice.water.ca.gov/modeling/deltamodeling/models/csdp/index.html.

Additional data were collected around Franks Tract by DWR and the USGS in 2004. USGS 10 m resolution Delta Bathymetry grids were obtained from the Access USGS website at http://sfbay.wr.usgs.gov/access/Bathy/Delta/.

3.2. Network Refinement

The existing finite element mesh was refined in the Suisun Marsh area. The length of the 1-D elements was reduced and additional channels were added. Overbank/fringe marsh was added as off-channel storage based on flow data, LIDAR elevation data and aerial photos. An example illustrating the level of detail in the old and new meshes is shown in Figure 3-1. The entire updated Suisun Marsh network is shown in Figure 3-2.

Five new models grids, each with a project-specific finite element mesh, were developed for the four marsh restoration scenarios as well as for a Base case. The Base case added three new tidal areas to the calibration grid, at Hill Slough, Meins Landing and Blacklock. Hill Slough and Meins Landing represent projects that are under development. The model details for each scenario and the Base case are discussed in Section 5 of this report.

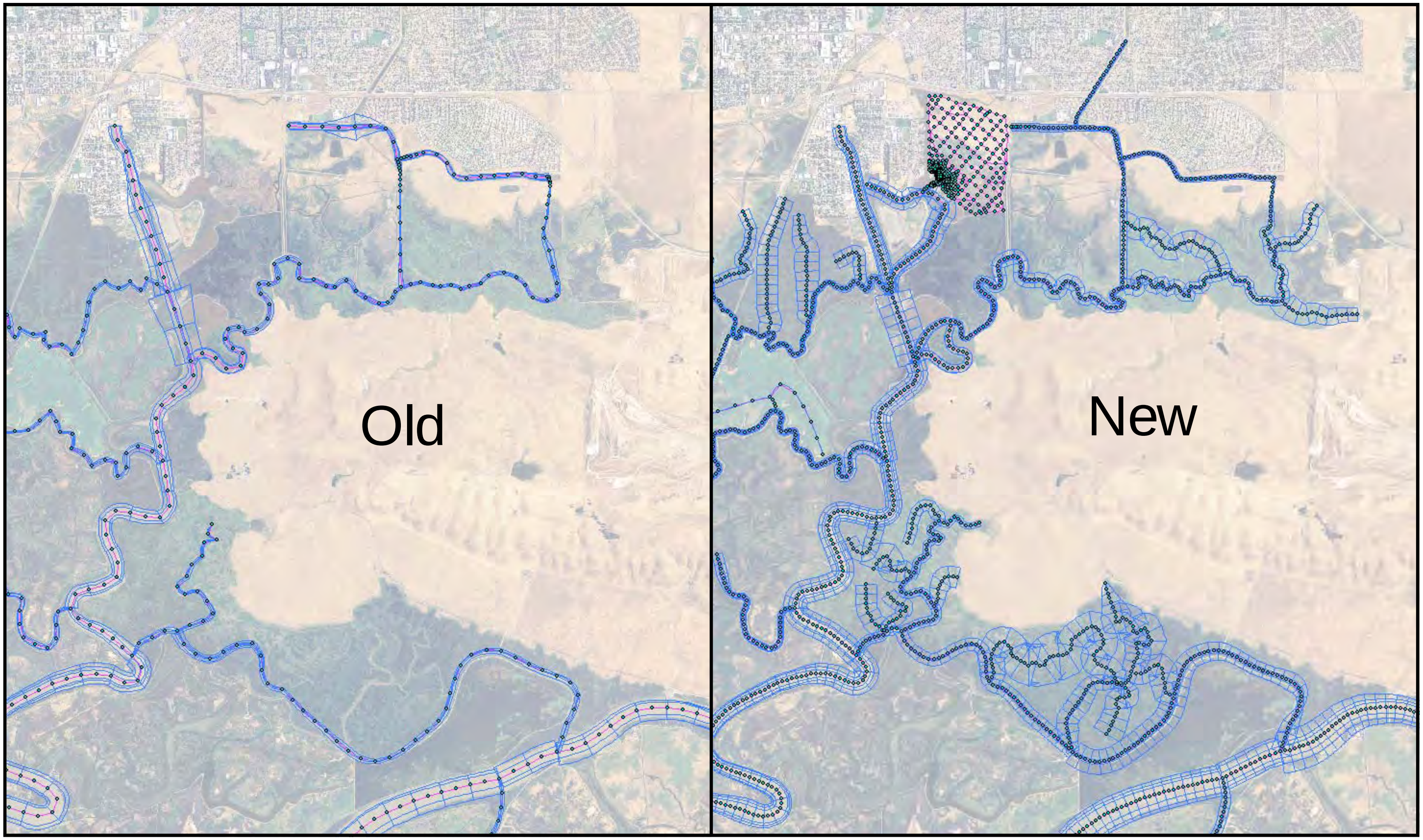


Figure 3-1 Comparison between old and new grid details in the Suisun Marsh Area.

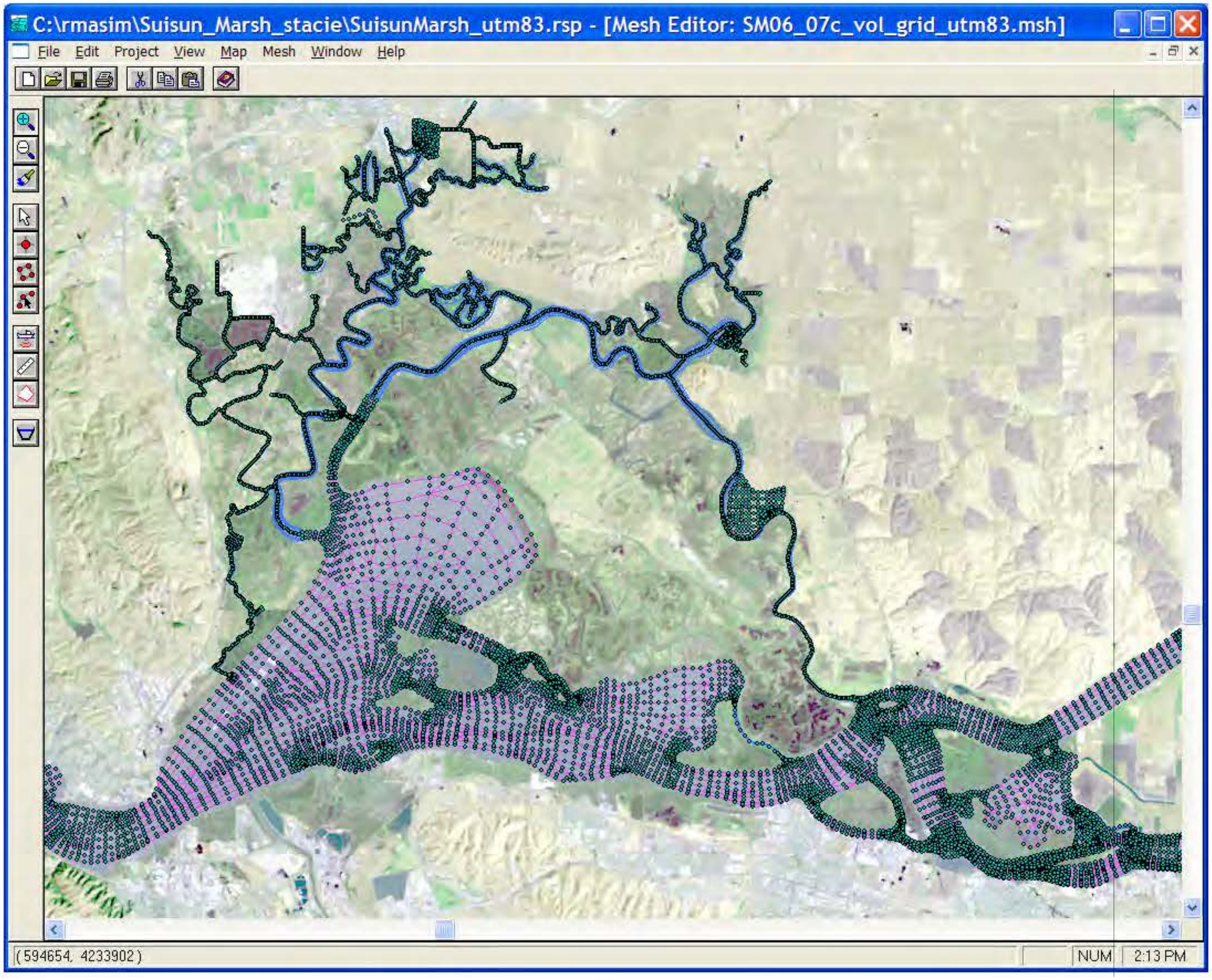


Figure 3-2 Base case Suisun Marsh finite element network.

3.3. Boundary Conditions

Boundary conditions are specified for all inflow and outflow locations and for flow control structures. The locations of the model boundaries for the calibration grid are shown in Figure 3-4.

3.3.1. Simulation periods

The hydrodynamic calibration was April – July, 2004, a period where a DWR data collection effort (DWR 2007) provided a crucial dataset. The EC calibration period was April 2002 through December 2003, the same as for the Base case and marsh restoration scenarios simulations. Delta outflow during this period, shown in Figure 3-5, ranged from below average to slightly above average. With a few exceptions noted in Section 5.1, the scenario and Base case boundary conditions are the same as those used in the EC calibration.

3.3.2. Tidal boundary

The tidal boundary is set at the Golden Gate, the western boundary of the model, using observed data for the NOAA station at San Francisco. These data were smoothed using a 5 point moving average of the 6-minutes data, and shifted to NGVD + 0.1 m. The 0.1 m shift accounts for density effects between the tidal boundary and Suisun Marsh. The result at Martinez varies with Delta outflow, tidal and atmospheric conditions. An example plot of computed and observed stage at Martinez is shown in Figure 3-3.

3.3.3. Flows, exports, precipitation, evaporation, DICU

Inflow locations in the model are shown in Figure 3-4, with the exception of Delta Island Consumptive Use (DICU), which is discussed below. DICU flows incorporate channel depletions, infiltration, evaporation, and precipitation, as well as Delta island agricultural use. (DWR 1995)

Time series of daily average inflow boundary conditions are plotted in Figure 3-5 to Figure 3-7 for the 2002-2003 EC calibration/scenario simulation period and in Figure 3-9 and Figure 3-10 for the 2004 hydrodynamic calibration period. These flows are applied for the Sacramento River, Yolo Bypass, Napa River, San Joaquin River, Cosumnes River, Mokelumne River, and miscellaneous eastside flows which include Calaveras River and other minor flows. The model interpolates between the daily average flows at noon each day. Data from Dayflow (http://www.iep.ca.gov/dayflow/index.html) and the IEP database (http://iep.water.ca.gov/dss/) are used to set these boundary conditions.

Estimated Fairfield Wastewater Treatment Plant (WWTP) flows were are plotted in Figure 3-6 (lower) for the 2002-2003 period. The reported average dry weather flow (ADWF) for the Fairfield WWTP is 13.2 – 14.8 mgd, with a peak wet weather capacity of 34.8 mgd. During dry periods, the WWTP flow in the model was set to 14 mgd. Daily precipitation data from the CIMIS station at Suisun Valley were used to estimate wet weather flows. Total wet weather flows were 14 mgd plus an additional flow of 3.8 mgd for each inch of the previous day's precipitation. These flows were not included in the hydrodynamic calibration because, although they have a large effect on EC, their effect on hydrodynamics is insignificant.

Flow data for Suisun Creek at Putah South Canal and Green Valley Creek at Green Valley Country Club are plotted in Figure 3-7 for the 2002-2003 period. Data were provided by Solano County Water Agency. Gaps in the Suisun Creek data were filled using flows estimated from Napa River flows scaled based on drainage area. This Suisun Creek data set was in turn scaled by drainage area for application to Ledgewood and Laurel Creeks. These flows were not included in the hydrodynamic calibration, as their effect on hydrodynamics is only significant during storm flow periods.

DICU values are applied on a monthly average basis and were derived from monthly DSM2 input values (DWR, 1995). Table 3-1 summarizes the total monthly diversions (incorporates agricultural use, evaporation and precipitation), drains (agricultural returns), seeps (channel depletions) and total flows used for DICU flows. Negative flows indicate net withdrawal from the system. These flows are distributed to multiple elements throughout the Delta using an in-house utility program.

Delta exports applied in the model include SWP, CVP, Contra Costa exports at Rock Slough and Old River intakes, and North Bay Aqueduct intake at Barker Slough. Exports are plotted for the 2002-2003 period in Figure 3-8 and the 2004 period in Figure 3-10. Dayflow and IEP database data are used to set daily average export flows for the CVP, North Bay Aqueduct and Contra Costa's exports.

Hourly SWP export flows for 2003 and 2004 are computed using the Clifton Court gate ratings and inside and outside water levels. The flows are adjusted on a monthly basis so the total computed flow matches the monthly SWP export. For 2002, when water levels inside and outside the gates were not available, SWP exports were defined using DSM2 node 72 flow, modified to remove erroneously large flows. Further details on Clifton Court Forebay gate operations can be found in (RMA, 2000), RMA's Flooded Islands Feasibility Study (RMA, 2005), and in (DWR 2004).

Duck club ponds are filled and drained seasonally to provide appropriate habitat and opportunity to attract migrating ducks. Flows had to be estimated to approximate diversion (filling) and return (draining) flows in the vicinity of the marsh. For modeling purposes, it was assumed that they filled at a constant rate (no tidal variation) from a depth of -1.0 ft to +1.0 ft over a 14 day period beginning October 1. The ponds were subsequently drained at a constant rate between March 1 and June 1. Flow rates were computed as the area to be filled multiplied by the depth of water (2.0 ft) divided by the time to fill or drain. No exchange between the modeled marsh flows and the duck club ponds occurred during the summer, from June 1 through October 1.

Evaporation and precipitation data were used to compute flows required to maintain ponds at a constant level from October 15 (following filling) through February. Flow volumes were based on areas for the following locations: Montezuma Slough (East, Middle and West), Suisun Slough, Nurse Slough, Morrow Island (fill only) and Roaring

River. Locations of inflow/withdrawal in the Marsh are shown for the Base case mesh in Figure 3-13 – these locations are the same for the four scenarios.

Daily Suisun Valley CIMIS station precipitation data was used to compute additional inflows from tidal marsh areas during rainfall events. Areas of tidal marsh were estimated and multiplied by the daily precipitation data. Inflows from tidal marsh were input at Beldon's Landing, Boynton Slough, Cutoff Slough, First Mallard Slough, Hill Slough and Peytonia Slough. Locations are shown in Figure 3-12.

3.3.4. Electrical Conductivity (EC)

The western EC boundary of the model, at the Golden Gate is set at 50,000 µmhos cm^{-1}, the EC of seawater. EC boundary conditions are set at all inflow boundaries. Table 3-2 gives the source of the EC boundary conditions. Figure 3-13 shows the EC time series boundary conditions at the major boundaries.

3.3.5. Suisun Marsh Slough Salinity Control Gate operation

The model representation of the Suisun Marsh Salinity Control Gates (SMSCG) consists of a series of three tide gates to represent the radial gates, and a standard gate to represent the flashboard (Figure 3-14). All four gates can be operated individually. Figure 3-15 and Figure 3-16 illustrate the timing of the radial gate operation and the flashboard structure placement during the 2002-2003 simulation period, and the 2004 hydrodynamic calibration period, respectively. The SMSCG control season is from early October through the end of May.

3.3.6. Precipitation and evaporation by element type

The ability to apply daily time series of precipitation and evaporation was added to the model for the Suisun Marsh simulations. In previous versions of the model, the monthly DICU inflows/outflows were the only evaporation and precipitation inputs, and these were applied to individual model elements only in the Delta. In Suisun Marsh, the impacts of evaporation and short time scale variations in precipitation were incorporated in selected areas of the grid by element type ID, and applied on a per-unit-area basis using daily time series of precipitation and evaporation data from the Suisun Valley CIMIS Station.

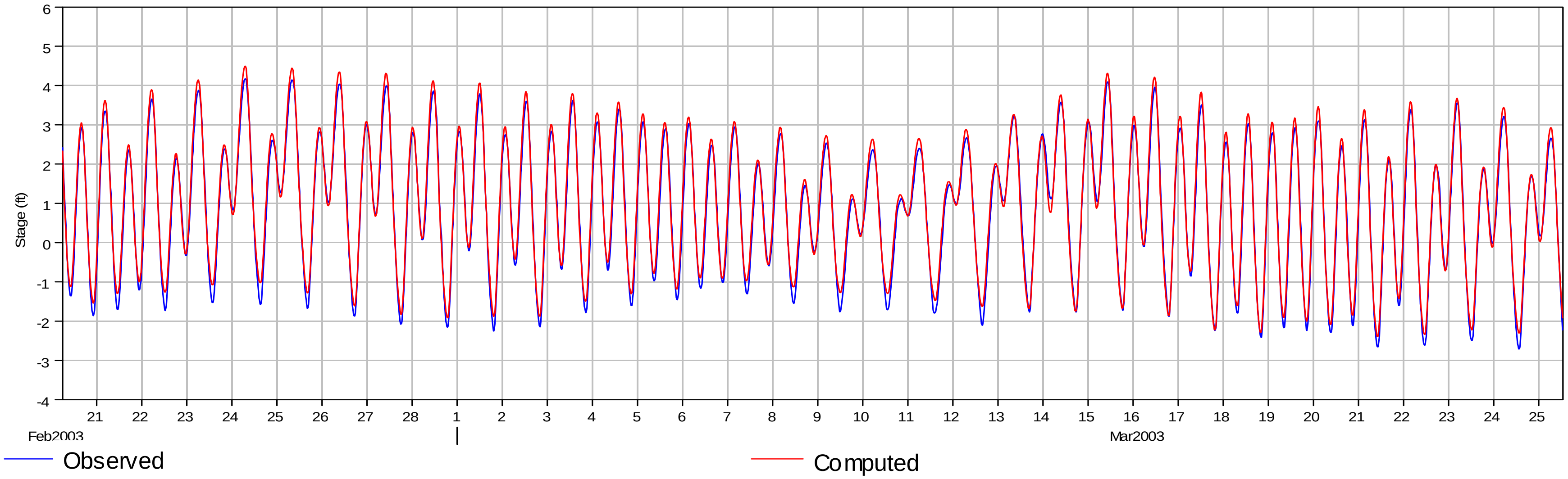


Figure 3-3 Example of computed and observed stage at Martinez.

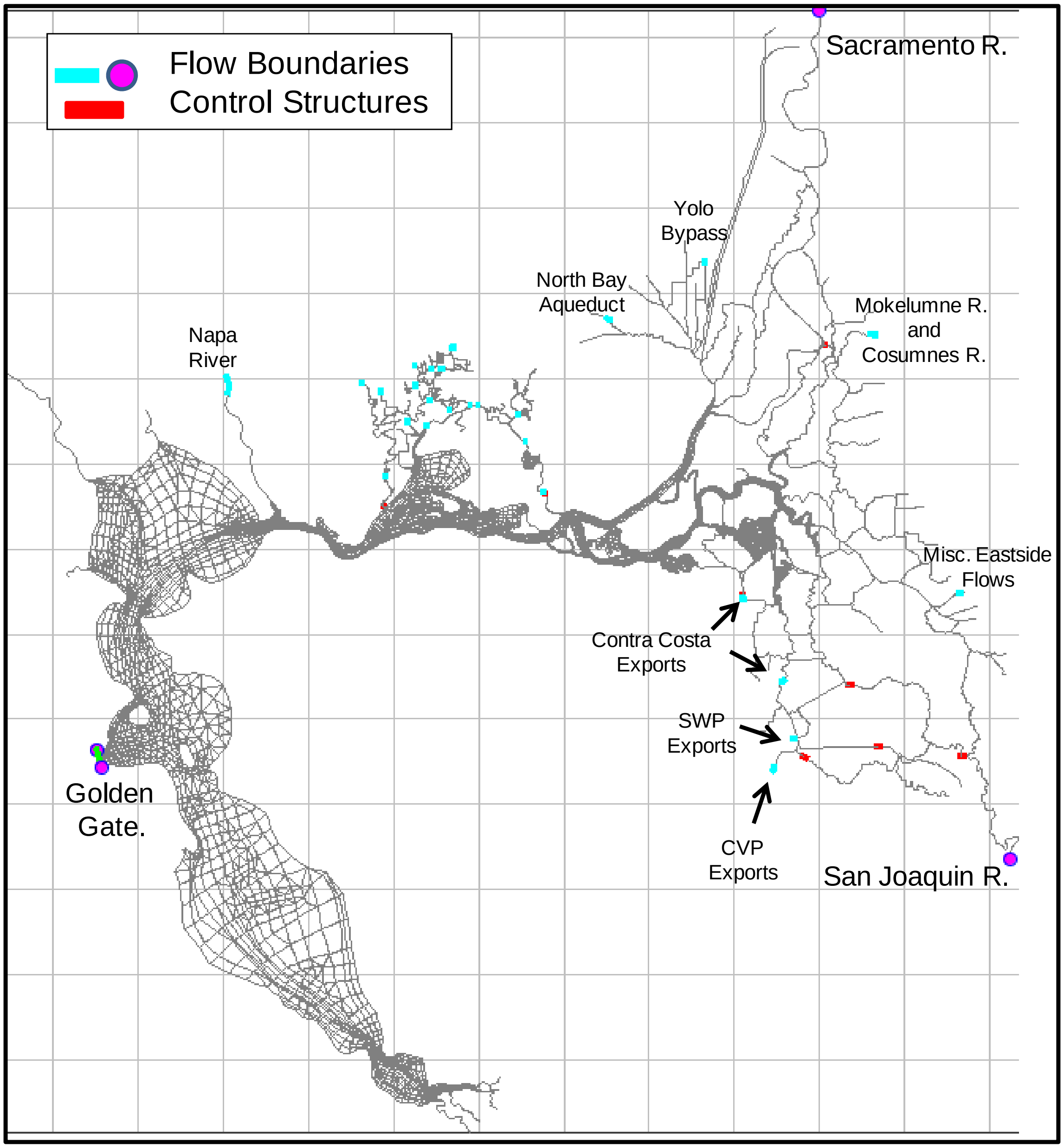


Figure 3-4 Model grid showing inflow and export locations, and flow control structures.

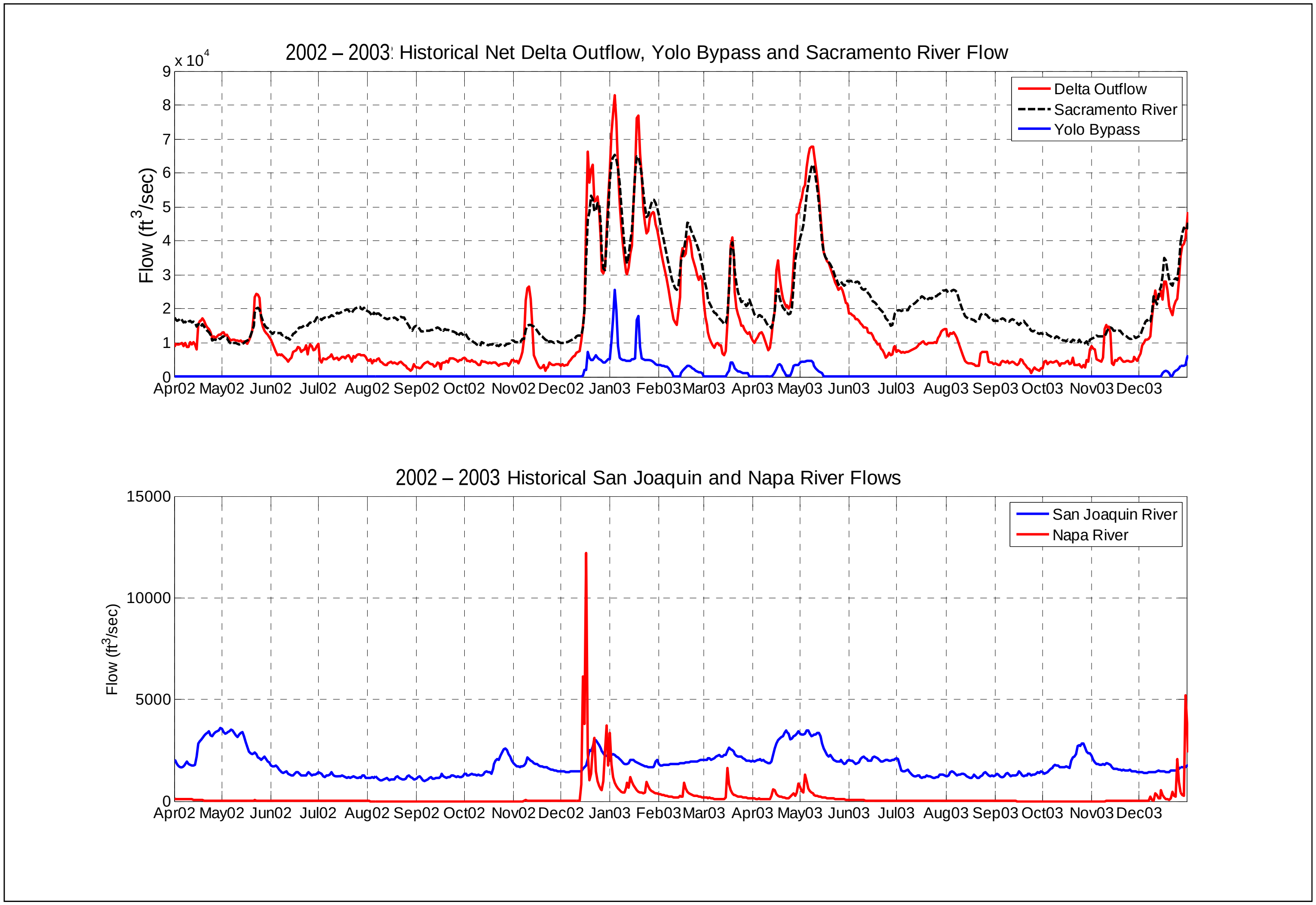


Figure 3-5 Net Delta outflow and major boundary flows for the 2002-2003 EC calibration/scenario simulation period.

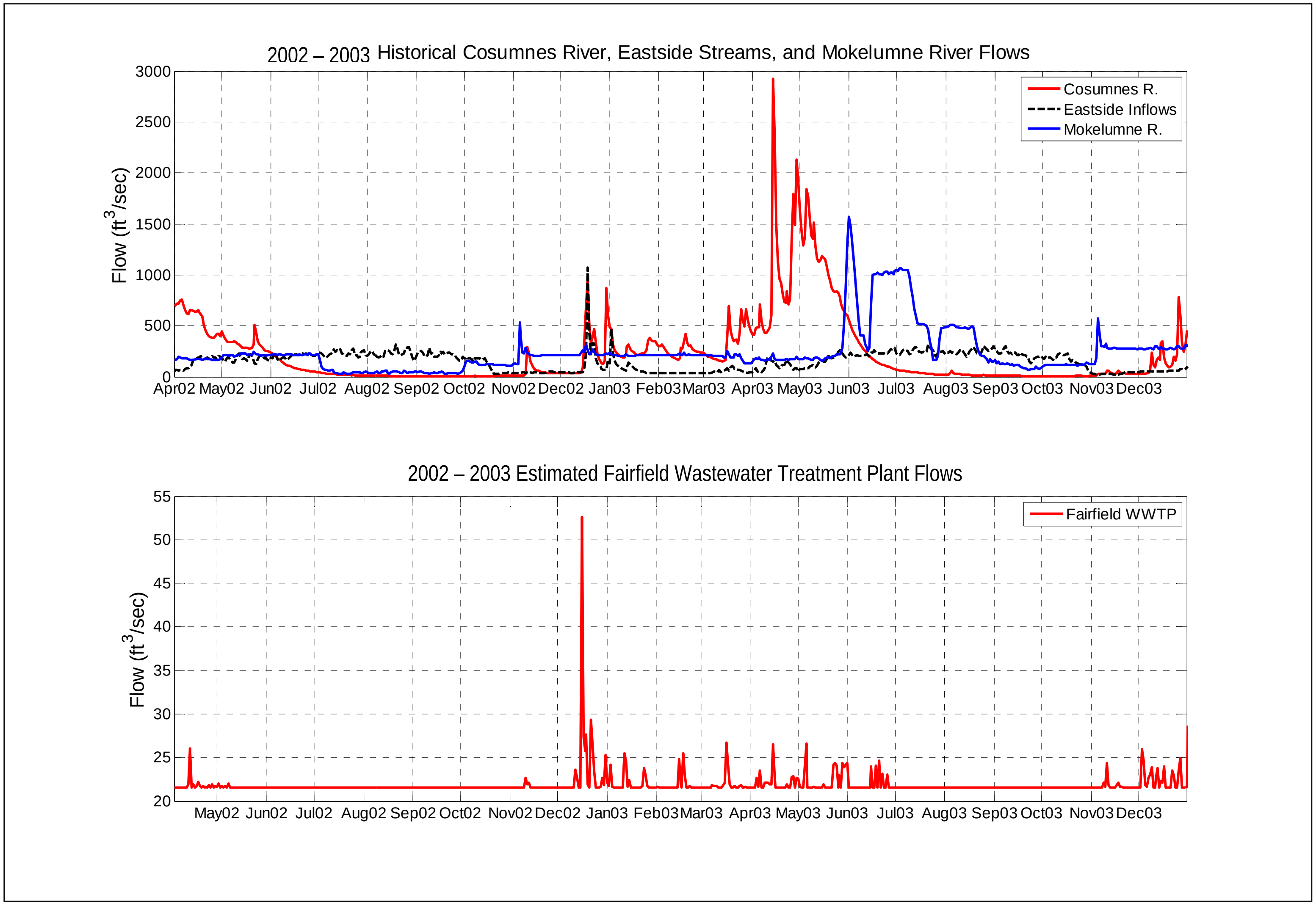


Figure 3-6 Minor boundary flows for the 2002-2003 EC calibration/scenario simulation period.

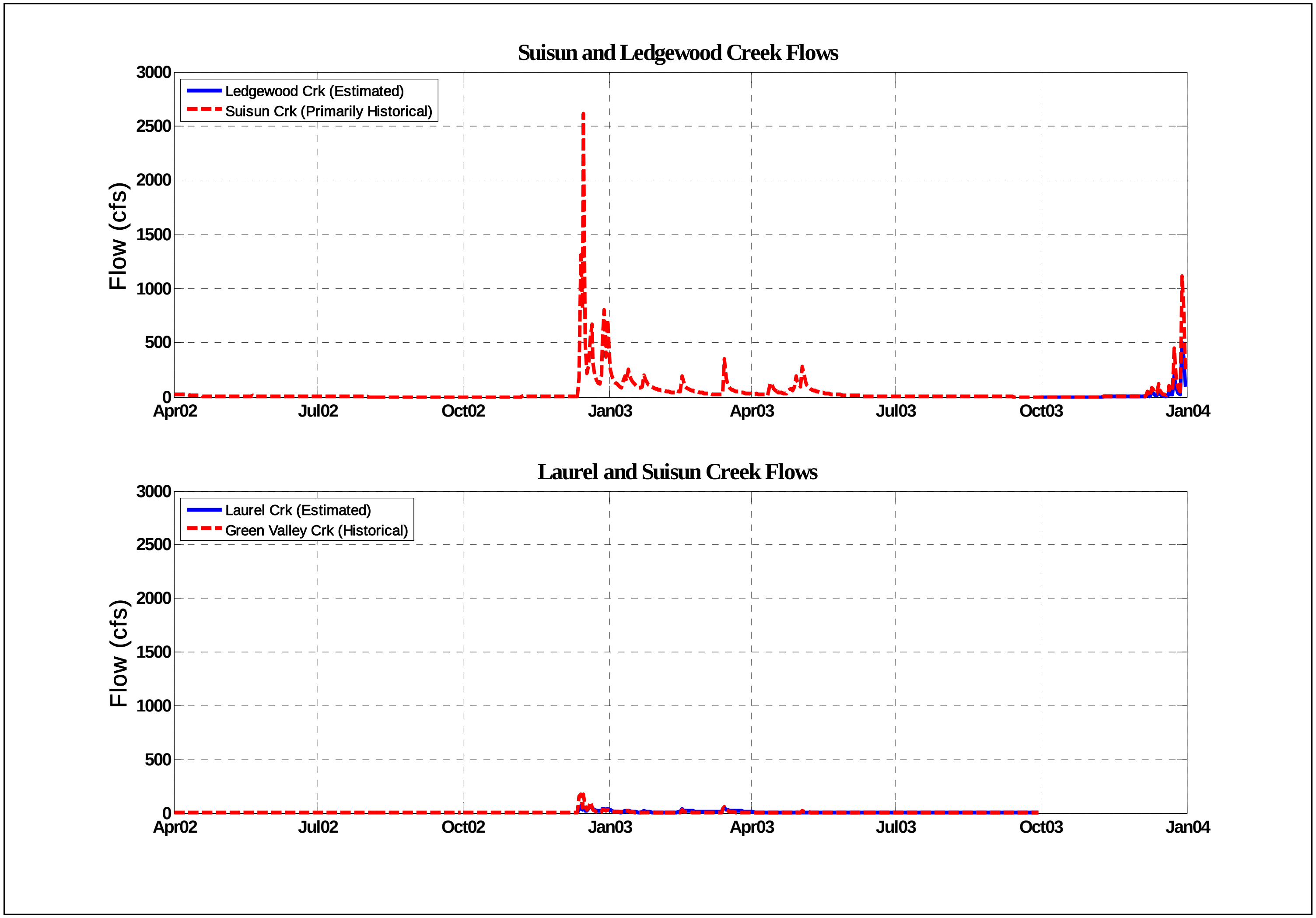


Figure 3-7 Suisun Marsh local creek flows for the 2002-2003 EC calibration/scenario simulation period.

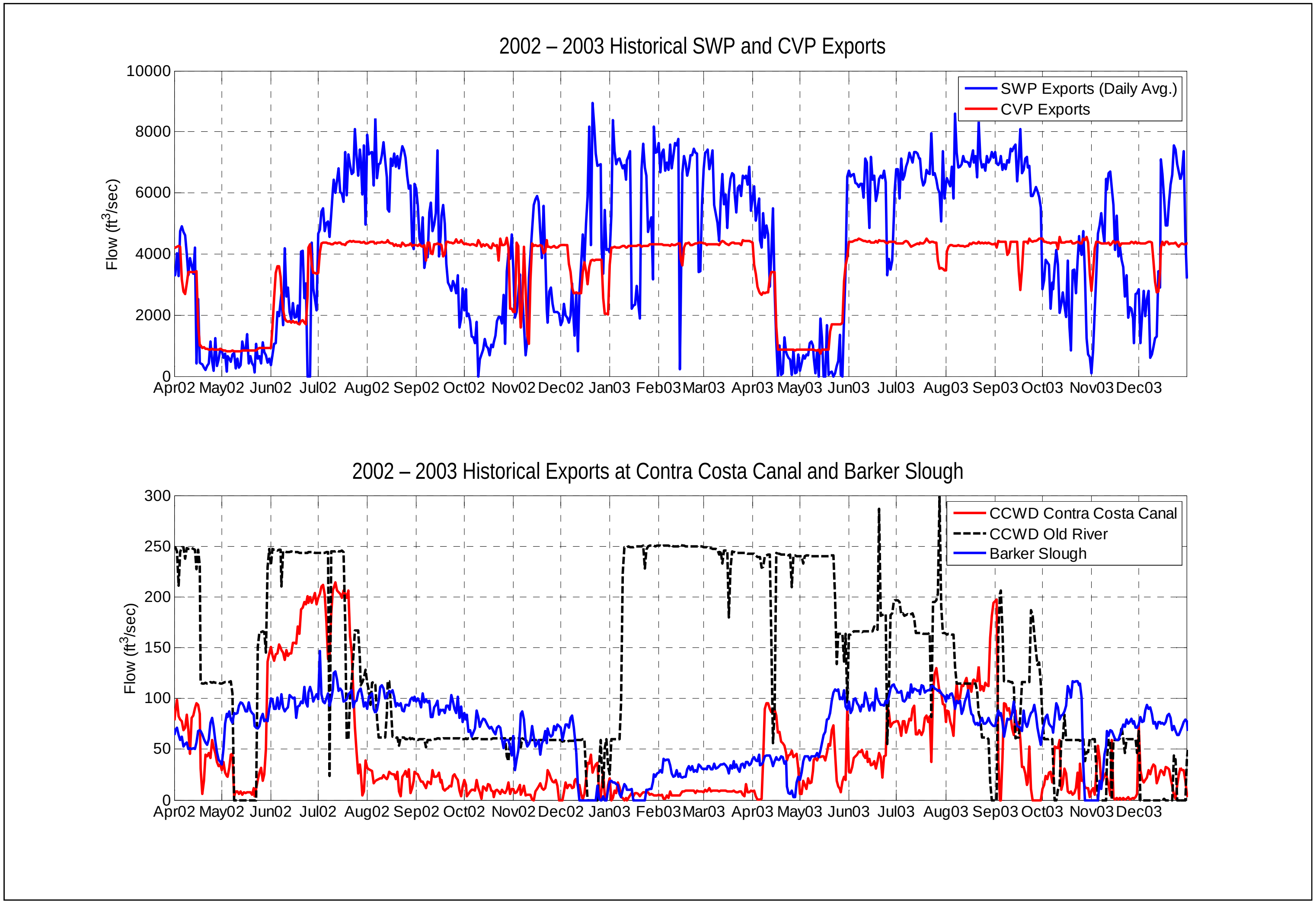


Figure 3-8 Historical exports and diversions used in the model for the 2002-2003 EC calibration/scenario simulation period. Note that daily averaged SWP exports are plotted, however the model uses 15-minute inputs.

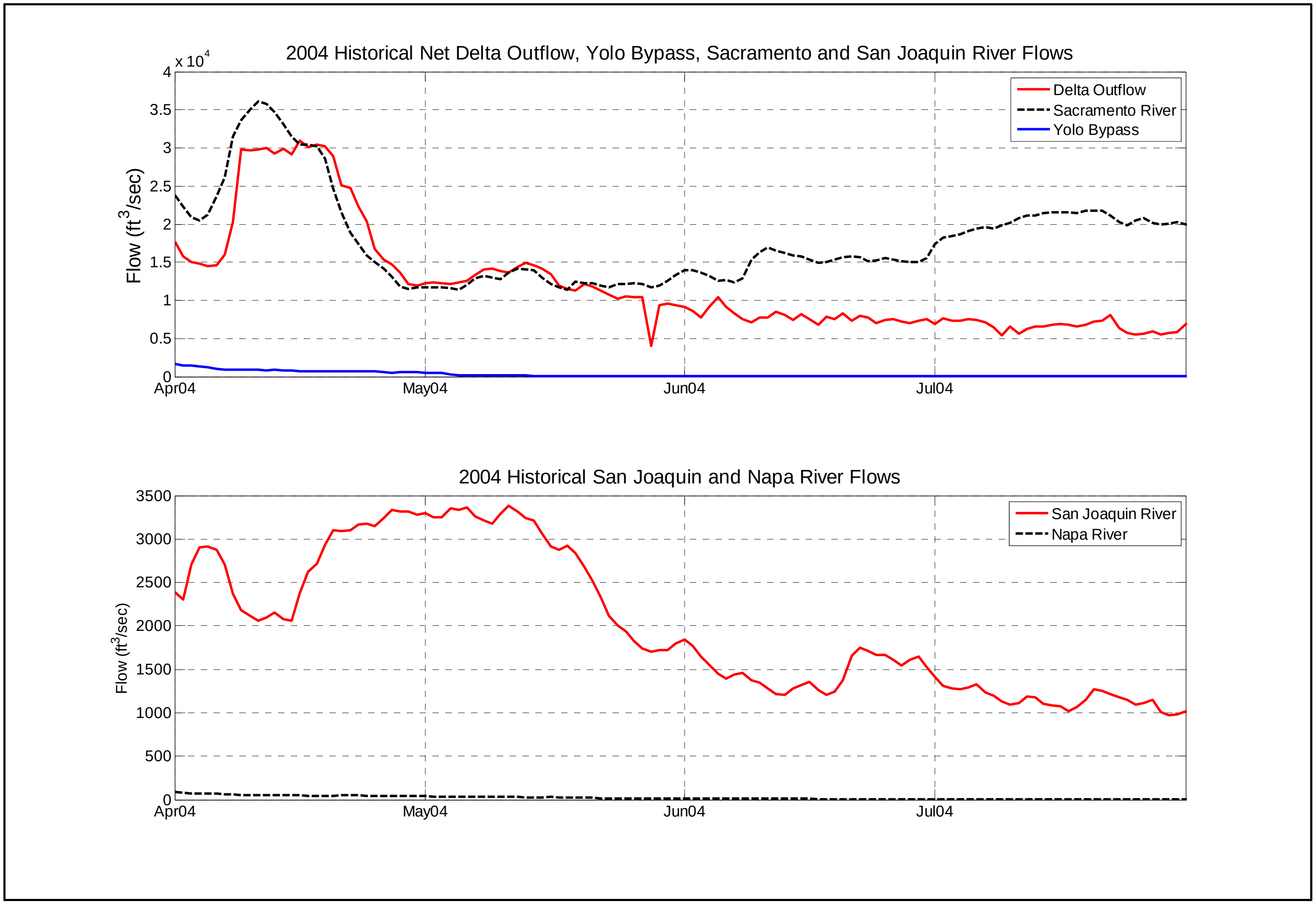


Figure 3-9 Major boundary flows for the 2004 hydrodynamic calibration period.

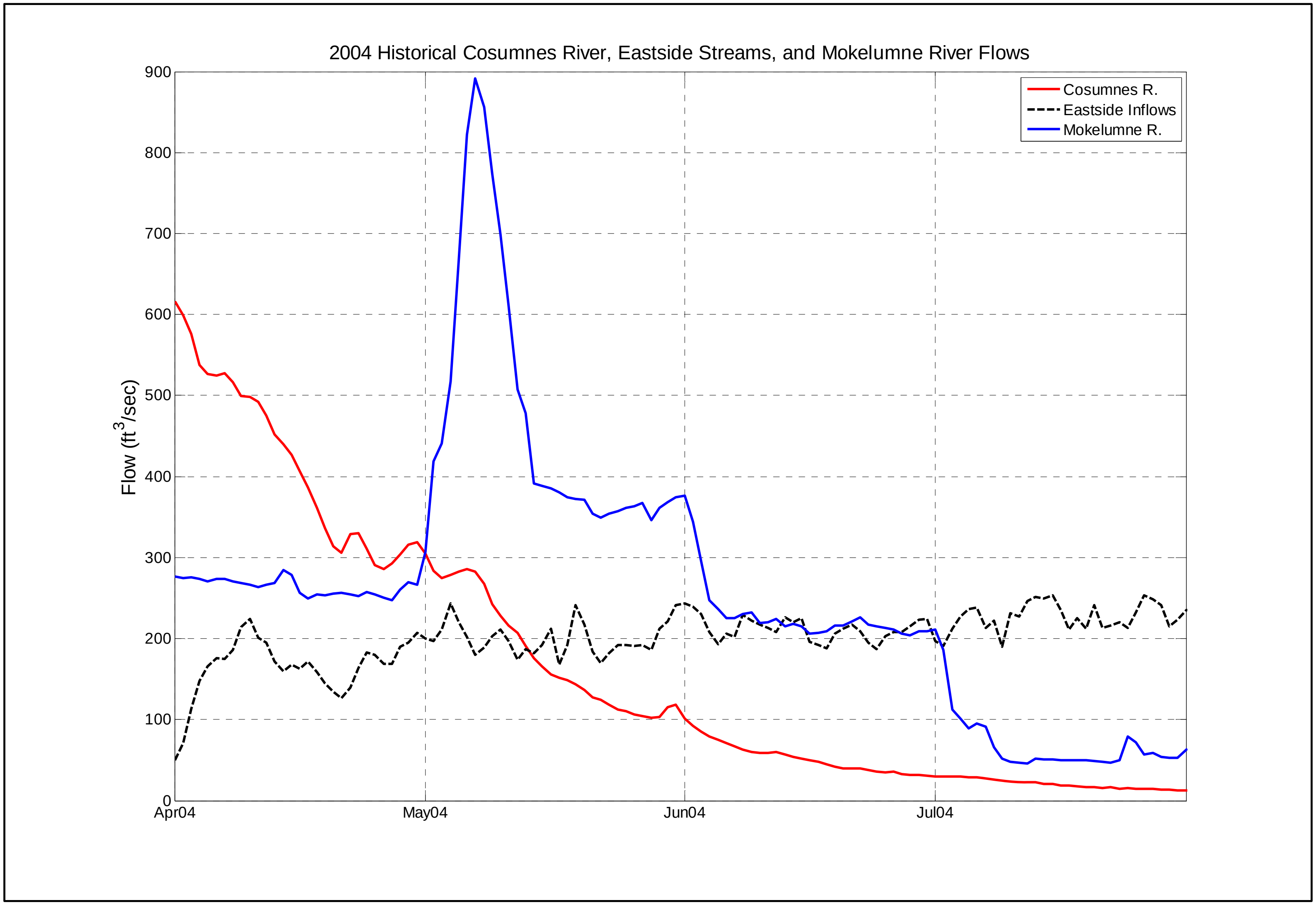


Figure 3-10 Minor boundary flows for the 2004 hydrodynamic calibration period.

Table 3-1 Summary of monthly DICU flows ($ft^3 sec^{-1}$) for the calibration and scenario simulation periods. Negative values indicate Delta withdrawal.

Month	Diversions (-)	Drains (+)	Seeps (-)	Total
EC calibration period				
April 2002	2109.9	1121.8	1006.4	-1994.5
May 2002	3978.0	1710.4	973.4	-3241.0
June 2002	4850.2	1995.6	1006.4	-3860.9
July 2002	4943.0	2011.0	973.4	-3905.4
August 2002	2659.8	1265.9	973.4	-2367.3
September 2002	1231.2	848.4	1006.2	-1389.1
October 2002	875.2	681.1	973.2	-1167.4
November 2002	268.9	576.2	1018.0	-710.8
December 2002	429.2	2318.5	633.9	1255.4
January 2003	2.0	133.4	575.7	755.7
February 2003	62.6	873.8	714.1	97.1
March 2003	314.5	741.1	725.6	-299.0
April 2003	405.9	825.8	701.1	-281.2
May 2003	1438.8	894.3	980.5	-1525.0
June 2003	2929.1	1346.7	1006.2	-2588.6
July 2003	5254.4	2108.3	973.1	-4119.2
August 2003	2569.5	1237.3	985.8	-2318.0
September 2003	1351.0	884.2	1006.2	-1472.9
October 2003	981.1	709.1	973.1	-1245.2
November 2003	272.5	528.7	1027.2	-771.0
December 2003	429.2	1011.2	791.9	-209.9
Hydrodynamic calibration period				
April 2004	1559.5	951.8	1003.9	-1611.6
May 2004	3014.1	1364.0	975.0	-2625.1
June 2004	4018.5	1705.6	1006.3	-3319.2
July 2004	5006.5	2030.6	973.4	-3949.4

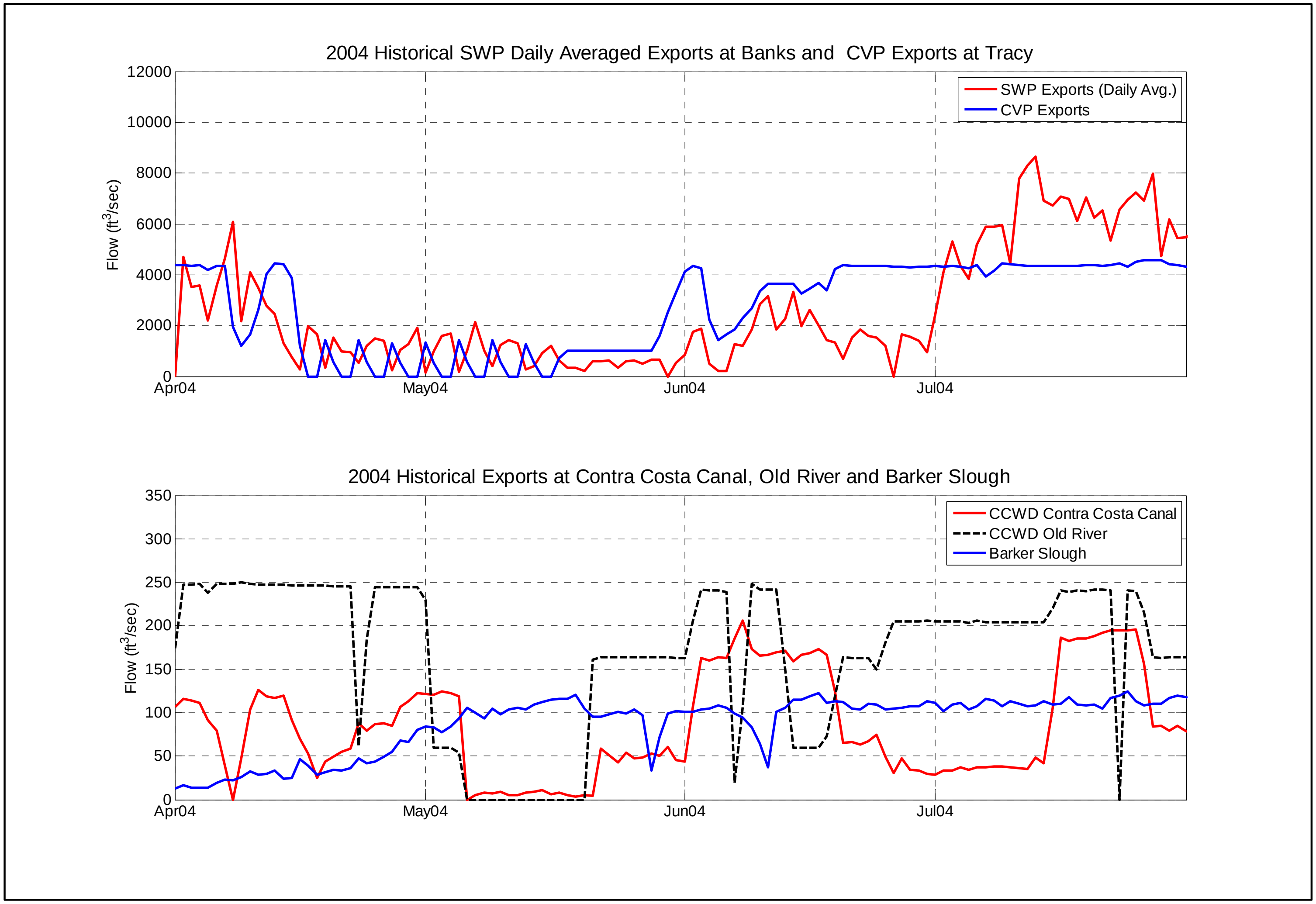


Figure 3-11 Historical exports and diversions used in the model for the 2004 hydrodynamic calibration period. Note that daily averaged SWP exports are plotted, however the model uses 15-minute inputs.

1	Morrow Island managed wetland
2	Green Valley Creek
3	Suisun Creek
4	Suisun Slough
5	Montezuma Slough west managed wetland
6	Boynton Slough tidal marsh
7	Fairfield WWTP
8	Ledgewood Creek
9	Peytonia Slough tidal marsh
10	Hill Slough tidal marsh
11	Laurel Creek
12	First Mallard Slough tidal marsh
13	Cutoff Slough tidal marsh
14	Beldons Landing tidal marsh
15	Montezuma Slough middle managed wetland
16	Nurse Slough managed wetland
17	Montezuma Slough east managed wetland
18	Roaring River managed wetland

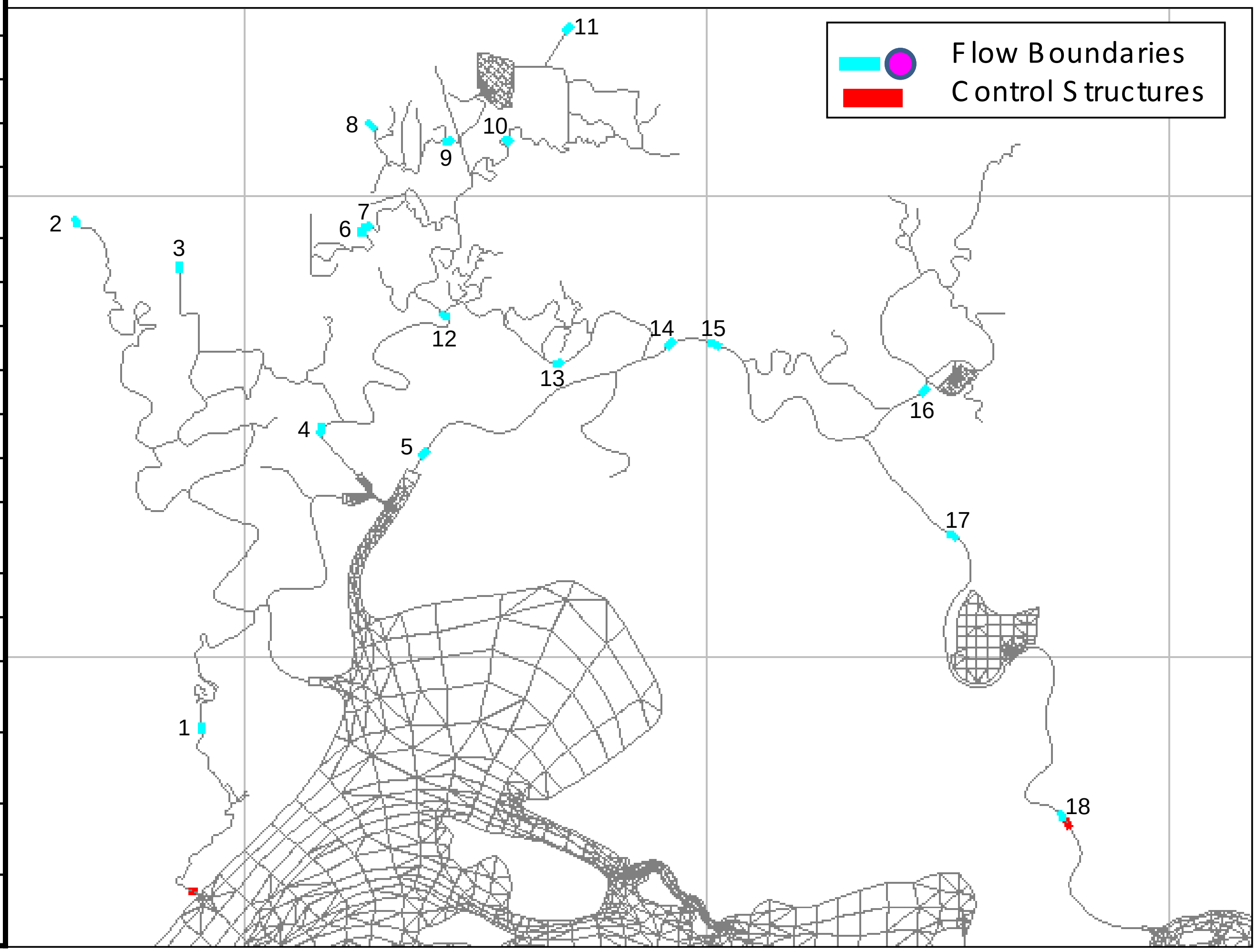


Figure 3-12 Inflow/export locations in Suisun Marsh.

Table 3-2 EC boundary conditions for the EC calibration, Base case and scenarios simulations.

Boundary Location	Value (µmhos cm^{-1})	Data Source
Golden Gate	50,000	Seawater EC
Sacramento River	Time Series	DWR DSM2
Yolo Bypass	Sac. River Time Series	DWR DSM2
San Joaquin River	Time Series	DWR DSM2
DICU	Monthly Time Series	DWR’s DICU model
Cosumnes River	150	Estimated
Mokelumne River	150	Estimated
Misc. Eastside Rivers	750	Estimated
Fairfield WWTP	120	Estimated
Napa River, Green Valley Creek, Suisun Creek, Ledgewood Creek, Laurel Creek	120	Estimated; Napa R. based on measured data
Duck Club Drains: Nurse Slough drain Suisun Slough drain Roaring River drain Montezuma Slough West Montezuma Slough Middle Montezuma Slough East	Estimated Using Source Time Series Data:	 Beldon’s Landing Observed EC Boynton Sl. Observed EC, shifted in time Roaring River Observed EC Hunter Cut Observed EC Beldon’s Landing Observed EC National Steel Observed EC
Tidal Marsh – Boynton Slough Peytonia Slough Hill Slough First Mallard Slough Cutoff Slough	Estimated Using Source Time Series Data:	 Boynton Sl. Observed EC, shifted in time Hill Slough Observed EC Hill Slough Observed EC Beldon’s Landing Observed EC Beldon’s Landing Observed EC

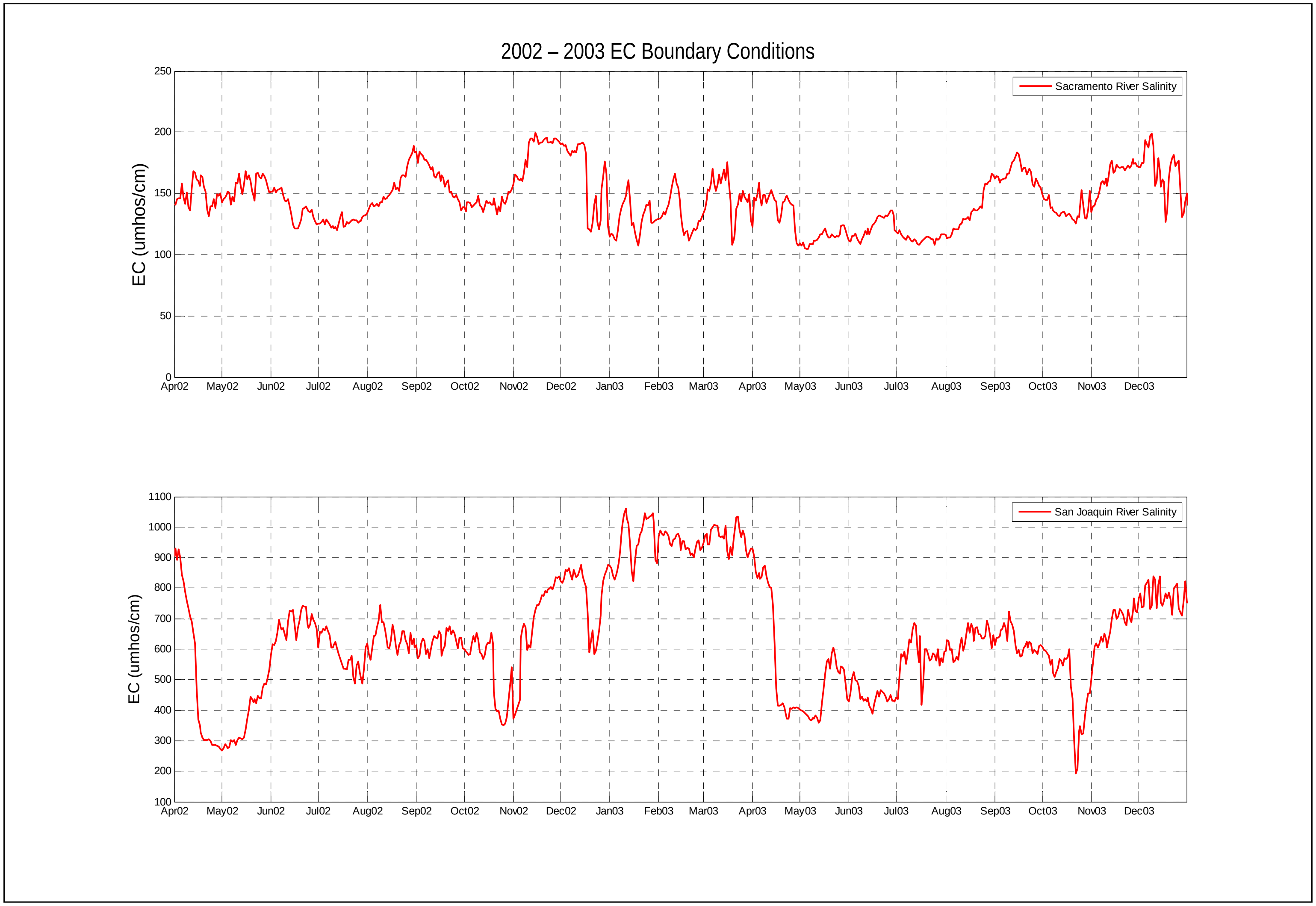


Figure 3-13 Daily EC time series used as boundary conditions for the Sacramento River and Yolo Bypass (upper) and for the San Joaquin River (lower) for the 2002-2003 EC calibration/scenario simulation period.

Figure 3-14 Aerial view of the Suisun Marsh Salinity Control Gates.

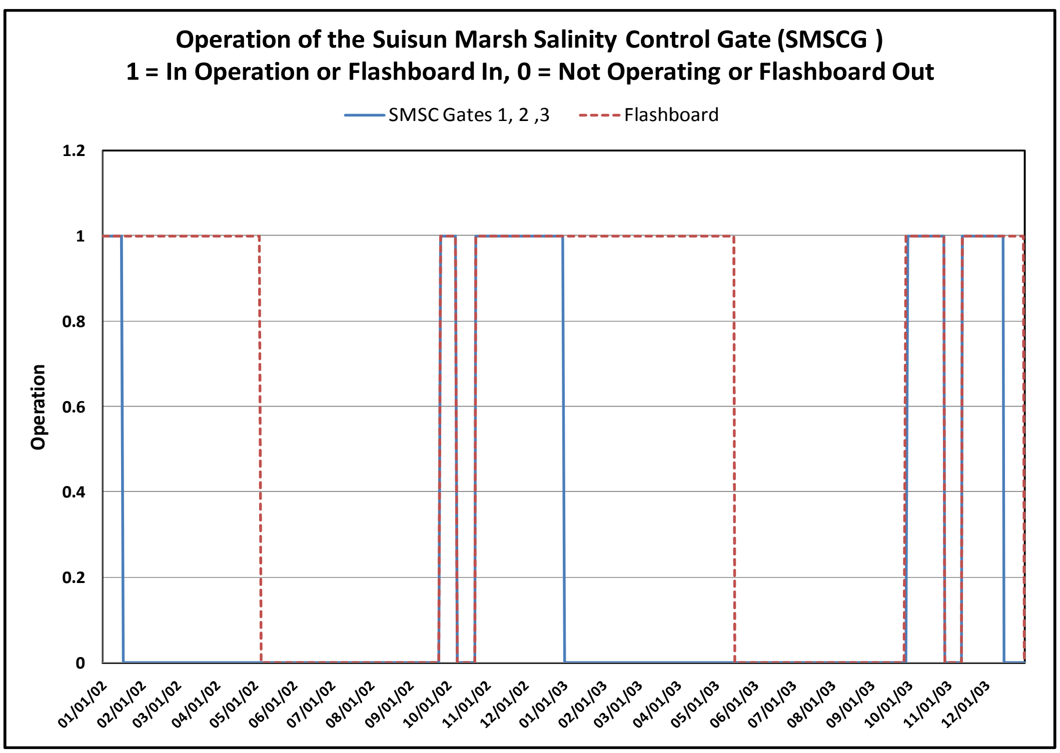


Figure 3-15 Operational schedule for the SMSCG during the 2002-2003 EC calibration/scenario simulation period.

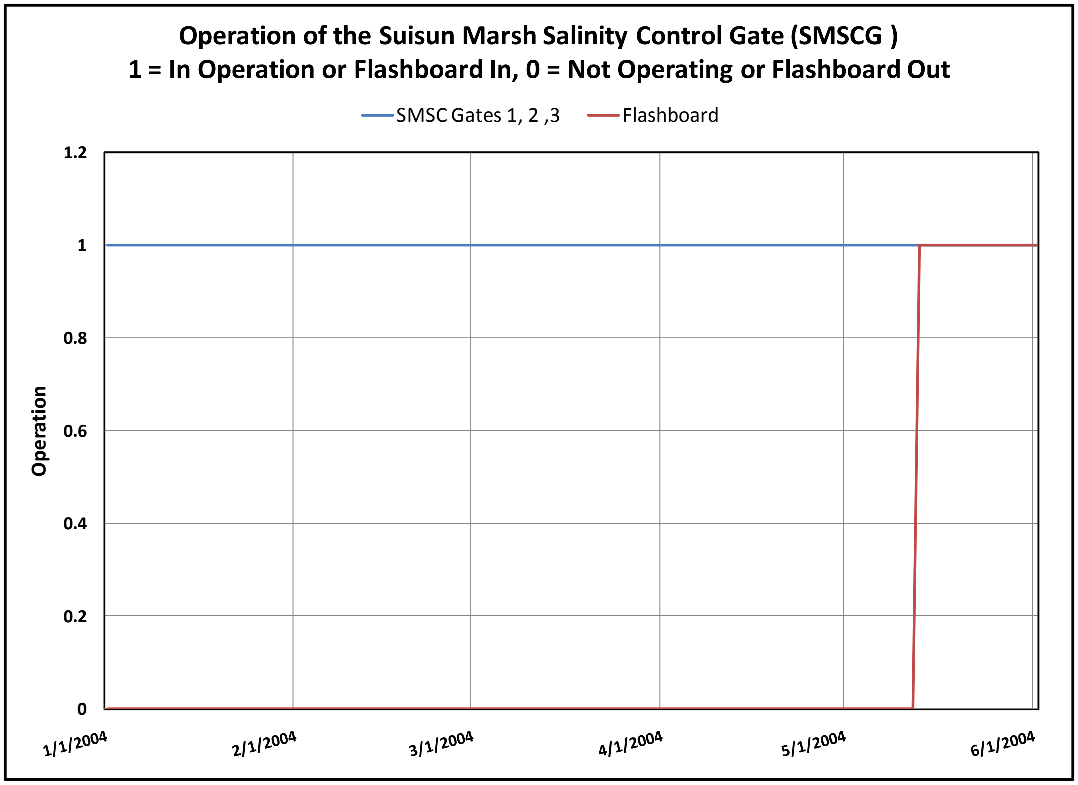


Figure 3-16 Operational schedule for the SMSCG during the 2004 hydrodynamic calibration period.

4. Model Calibration

The objective of the calibration effort was to prepare the model for detailed evaluation of flow and EC effects associated with the four marsh restoration scenarios proposed in the Suisun Marsh study. Understanding and accurately representing the changes in short time scale flow and mixing processes in the model is important in predicting the effects of these scenarios.

A recent calibration of RMA's Bay-Delta model for the Flooded Islands Feasibility Study (RMA, 2005) was used as the starting point for the current effort to improve the representation in Suisun Marsh. There was no recalibration of flow or EC in the Delta.

4.1. Hydrodynamics Calibration

The RMA2 hydrodynamic model calibration covered the period April – July, 2004. The Jones Tract levee break occurred during this period, which is included in the model representation (RMA, 2005). Both the breach event and the subsequent levee repair were explicitly modeled.

In 2004, the DWR field program collected continuous flow data in major channels and dead-end sloughs in Suisun Marsh from April through early August – these data were used for calibrating the hydrodynamic model (DWR 2004a). Figure 4-1 gives the locations of stations in Suisun Marsh providing data for the hydrodynamic calibration. A new LiDAR dataset provided detailed elevation data, shown in Figure 4-2, which was instrumental in improving the model representation and the subsequent calibration in Suisun Marsh along with aerial photographs.

The flow and stage calibration greatly improved the representation of hydrodynamics in the Suisun Marsh region. DWR's continuous monitoring data from Suisun Marsh (Figure 4-1, white boxed labels) for flow and stage was used to guide the calibration, and LiDAR data (DWR, 2007) and aerial photographs were used to help define the extent and elevation of tidal marsh areas. The revised mesh geometry incorporated new marsh channels and off-channel storage to represent marsh overbank. RMA2 was updated to include the ability to represent daily time series of precipitation and evaporation.

4.1.1. Refining Suisun Marsh sloughs

The 2004 DWR field survey included the monitoring of flow and stage at the mouths of a number of dead-end sloughs. These sloughs were Nurse Slough (NS1), Hill Slough (HS1), First Mallard Slough (FM1), Cutoff Slough (C01 and C02), Boynton Slough (B01) and Shelldrake Slough (SH1). The first step of the calibration procedure was to model an individual dead-end slough and refine the network representation until the model flow closely matched the observed flow as recorded at the mouth of the slough. The model slough tidal boundary was driven by the observed stage at the mouth of the slough or from a nearby Suisun Marsh monitoring/compliance station (Figure 4-1). The refined and calibrated dead-end sloughs were then inserted back into the RMA Bay-Delta model for the subsequent calibration of the major Suisun Marsh sloughs and channels, specifically Montezuma (M01, M02, M03 and M04) and Suisun Sloughs (SS1) and Hunter Cut (HC1).

Details of the observed flow and stage records were used to iteratively refine the model representation. LiDAR images and aerial photographs were used to understand the geography, and to estimate the location, extent and elevation of tidal marsh. For example, aerial photographs sometimes helped define areas covered with specific vegetation such as tules, which gives an indication of inundation around Mean Higher High Water (MHHW).

Figure 4-3 illustrates how differences between the observed and computed values for flow as the tidal marsh filled and drained were used to refine the initial estimates of marsh area associated with Boynton Slough. As the water level rises above 3.0 feet (June 16 @ 22:00), the initial slough model (red line) shows an early fall off in flood flow relative the observed flow. Similarly, the initial slough model is low on the following peak ebb flow as the stage begins to fall. The slough model was modified to increase the amount of overbank marsh and the simulation rerun. The green line in Figure 4-3 shows the better fit to observed flow with the revised slough representation.

4.1.2. **Incorporating managed wetlands**

Figure 4-4 presents the tidally averaged observed and computed flow for Boynton (B01) and Hill (HS1) Sloughs and the observed stage at Hill Slough (S-4). The observed tidally averaged flows show a distinct net flow landward during most spring tide periods. This was typical of all observed flow records for the dead-end sloughs for the April – July, 2004 monitoring period. The tidally averaged computed flows show only small fluctuations in the net flows as the average water level rises with the spring tide and falls with the neap tide. The observed flow records show a significantly greater net landward flow during the spring tide periods. The Boynton Slough observed flow also exhibits notable net outward flow around July 5 and July 31.

The differences between the observed and initial computed net flows are most likely related to exchange with the managed wetlands and the wetting and evaporation of the tidal marsh on the spring tide. A trial model simulation was performed for Boynton Slough in which an adjacent managed wetland was added and connected to the slough by open culverts. Evaporation was simulated with a withdrawal from the managed wetlands of 7 cfs in the May 1-27 period and 21 cfs in the May 27 – June 30 period.

The addition of the managed wetland with evaporation significantly improves the fit of the model to the observed net flows. Figure 4-5 compares the new simulation result to the observed record and to a simulation with no evaporation or managed wetland. Figure 4-6 shows the improved fit to the intertidal flow with the managed wetland addition, in particular where the computed flood flow was initially too low. Evaporation from adjacent tidal marsh and the channel water surface is another source of water loss from Boynton Slough and other marsh channels. The 21 cfs rate of water loss modeled for late May and June is equivalent to 1260 ac-ft/month. The open tidal marsh and water surface upstream of the Boynton Slough flow meter is about 230 acres. Thus evaporation from the tidal marsh alone is not sufficient to account for the 1260 ac-ft/month flow loss.

The trial model demonstrated that the addition of managed wetland with evaporation significantly improved intertidal flow. However, simulation of tidal flow through the managed wetlands was not incorporated into the final model simulations.

The observed flow records may also indicate the diversion of flow from Montezuma Slough. Figure 4-7 shows the tidally averaged observed flow for the Montezuma Slough stations M03, south of Nurse Slough, and M04, south of the Suisun Marsh Salinity Control Gates. The curves show more flow into Montezuma Slough at M04 than exiting at M03 for portions of April and May 2004. The net flows at the two stations are roughly equal in June and July. Peak difference is about 500 cfs around May 5, 2004. The stage records inside the managed wetlands at the Roaring River intake location and for Montezuma Slough suggests large diversions occurring at the intake in early May (Figure 4-7).

Except for the trial simulations for the model of only Boynton Slough, diversions to the managed wetlands were not generally part of the 2004 hydrodynamic calibration. There was not sufficient detailed knowledge to attempt to reproduce all the characteristics of the managed wetlands culvert structures and operation within the tidal cycle. The observed flow data suggests the diversions and returns by the managed wetland, and evaporative losses for the tidal marsh. The differences in observed and computed net flows were used to help guide estimates of the wetlands diversions and returns. Further estimation of wetlands diversions/returns and evaporative losses for the channels and marsh were refined in the EC calibration phase.

4.1.3. Results of the hydrodynamic calibration

As described above, the dead-end sloughs were first calibrated in the isolated fashion, and then the revised slough networks were reinserted into the full RMA Bay-Delta model. The model flows and stages presented in this section are for the full Bay-Delta model. The diversions to the managed wetlands were not included in this hydrodynamic calibration and would likely influence both the net and intertidal flows. The estimation of the managed wetlands diversions/returns on a gross basis was performed as part of the EC calibration. The detailed hydraulic properties of the many culvert structures throughout the Suisun Marsh and the operation of these structures on a tidal and daily time scale create a large set of unknown variables. As such, the managed wetlands diversions/returns were not generally included during the hydrodynamic calibration except on an experimental basis.

Flow in dead-end sloughs and stage representations were generally good through-out the marsh. Figure 4-8 through Figure 4-11 give representative results for stage calibration (NGVD29) at three monitoring locations. Timing was slightly retarded in comparison with observed stage. Modeled stage tended to be somewhat low in Montezuma Slough, particularly during neap tides.

Tidal flow results were more variable. Figure 4-12 illustrates the tidal flow calibration at station NS-1 in Nurse Slough , showing that calculated flood tide flow was generally too low at this location. The tidally averaged observed flows for Nurse Slough showed large negative values on average of -400 cfs. There was no attempt to simulate culvert flows to managed wetlands for Nurse Slough, which may have improved the computed vs. observed fit. The computed flow vs. observed for Hill Slough (HS1) is very good, with the computed tidal flow amplitude slightly overestimated (Figure 4-9).

Tidal flow in Cutoff Slough (Figure 4-13) and First Mallard Slough (Figure 4-14) is slightly too large during ebb tide, but otherwise good in phase and magnitude. Tidal flow in Montezuma Slough was generally too low (Figure 4-15 through Figure 4-17), and the differences were significant here although phasing was quite good. Trial simulations were performed which examined incorporating culvert flows into the Roaring River distribution system (just north of the Suisun Marsh Salinity Control Gates). These results suggested that computed tidal flow and net flow for M04 may be somewhat improved by explicit modeling of the culverts to the Roaring River distribution system and to other managed wetlands diversions.

The differences between observed and calculated tidal flow in Suisun Slough and Hunter's Cut are likely related, as Suisun Slough above Hunter Cut is filled by both channels. Figure 4-18 and Figure 4-19 show modeled and observed tidal flows at the mouth of Suisun Slough and in Hunter Cut, respectively. The low values for tidal flow in Hunter Cut may be compensated by larger-than-observed tidal flow through the mouth of Suisun Slough.

Generally, these calibration results showed good agreement between the simulated and measured tidal elevations (stage) and between the simulated and measured tidal flows at many different locations in the marsh during 2004. The model results can be used with confidence to estimate the effect of additional tidal restoration.

Figure 4-1 Locations of stations in Suisun Marsh used for flow and EC calibration. The white boxed labels indicate special continuous monitoring stations implemented during spring 2004.

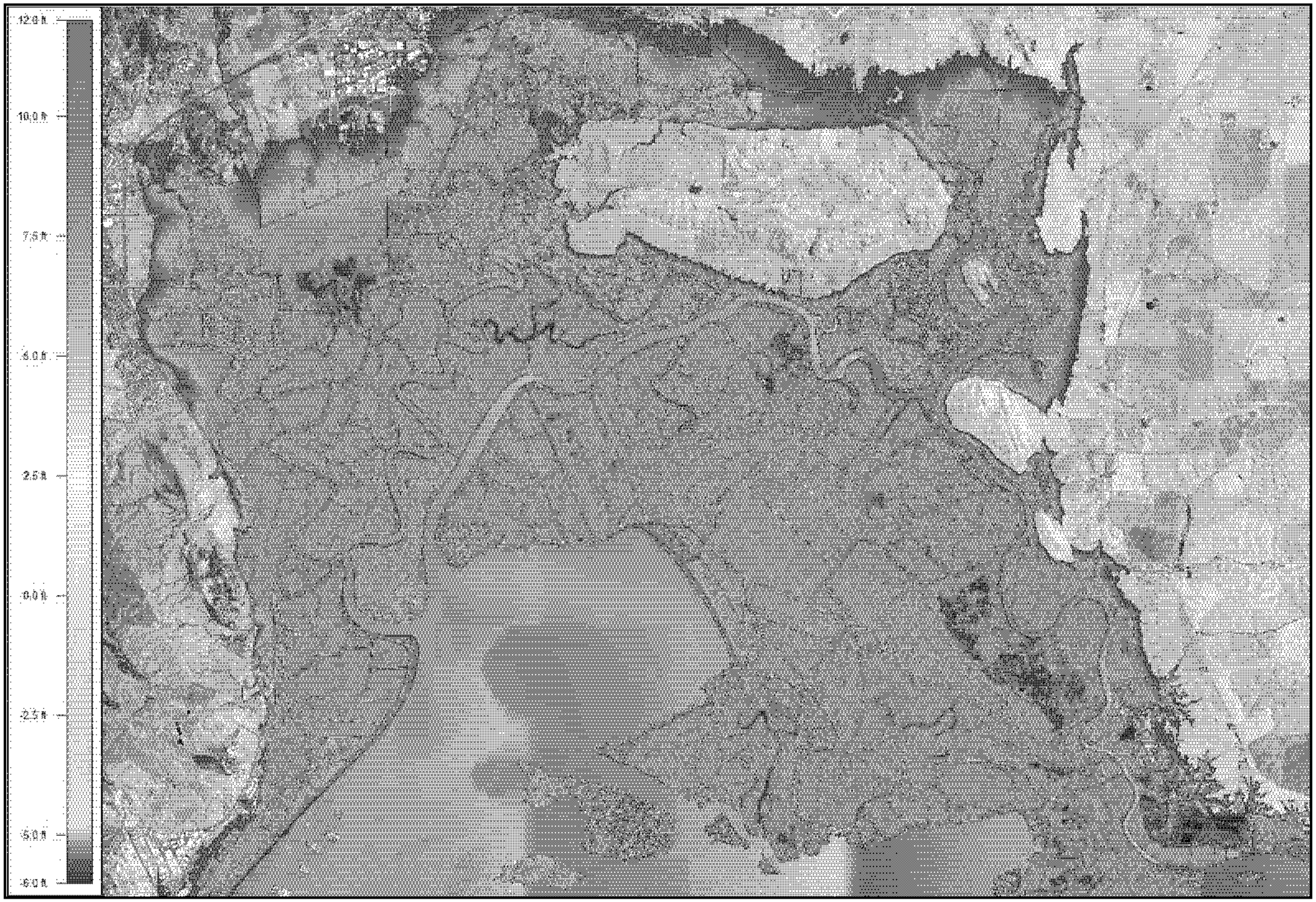


Figure 4-2 Suisun Marsh LiDAR data used in the model calibration – elevations shown in the color scale are in feet (NGVD29).

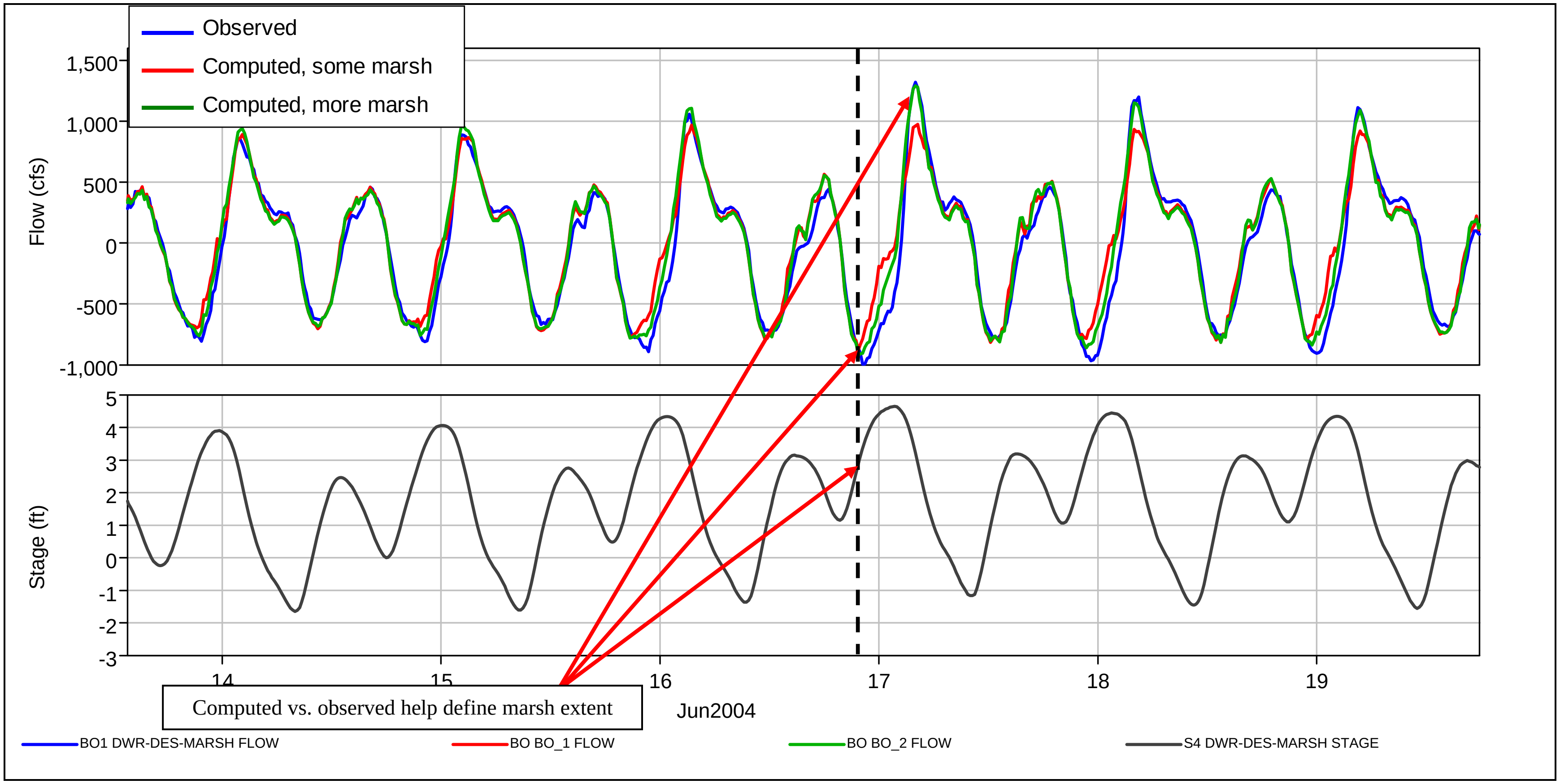


Figure 4-3 Observed and computed flow and stage data in Boynton Slough with two iterations of flow results showing how addition of tidal marsh affects computed flows.

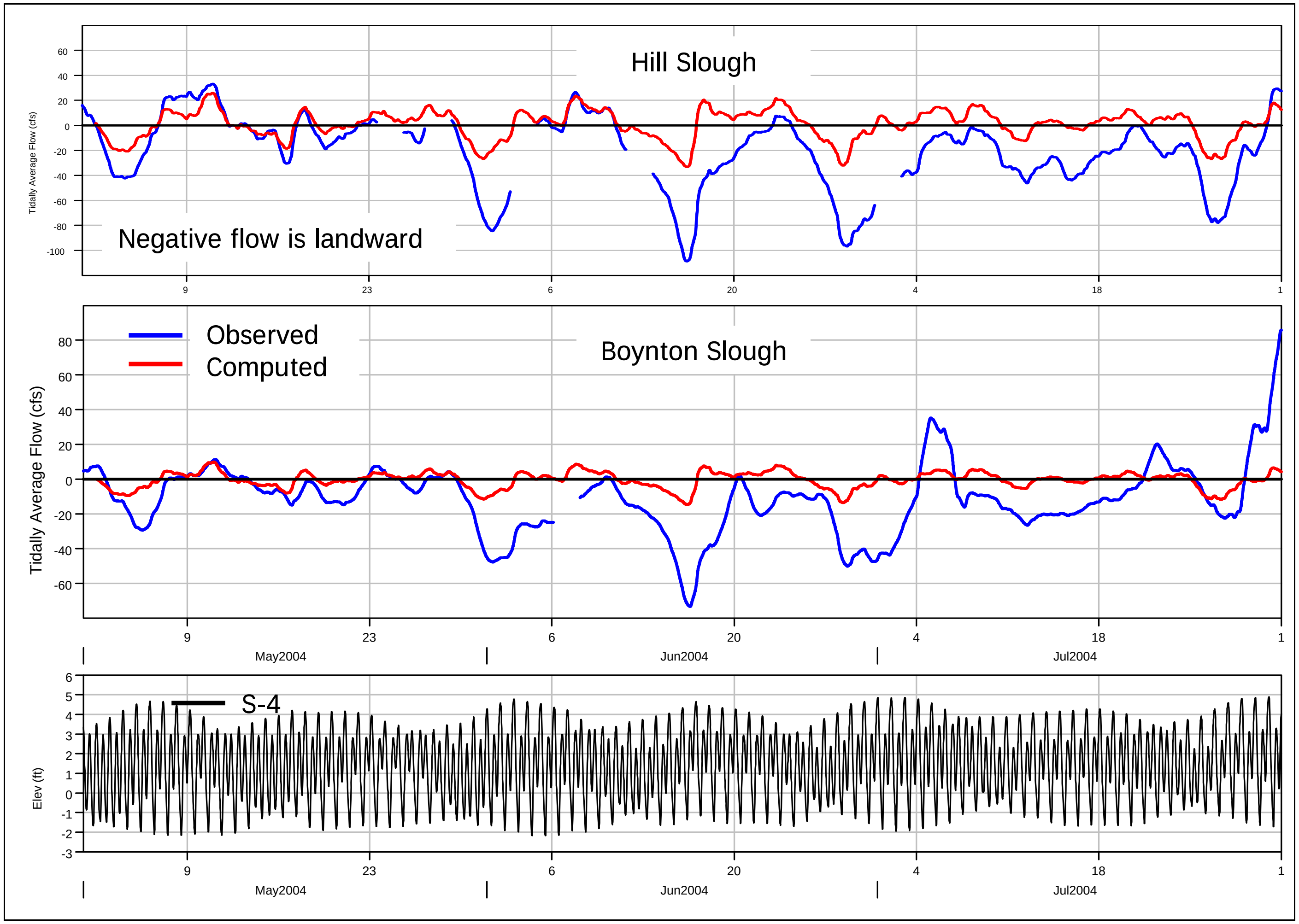


Figure 4-4 Observed and computed tidally averaged flow in Boynton Slough (B01) and Hill Slough (HS1), and observed stage at Hill Slough (S-4).

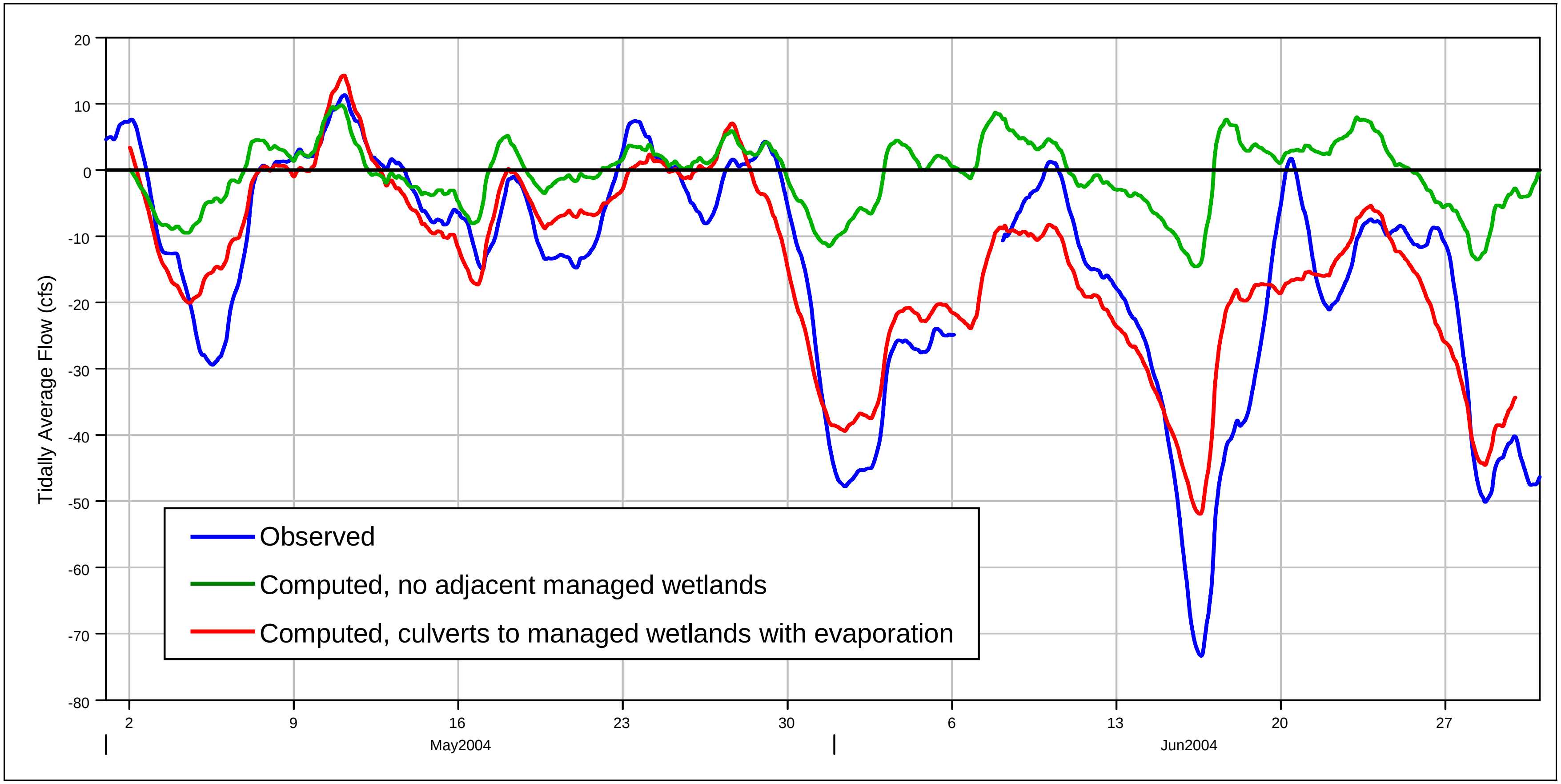


Figure 4-5 Observed and computed tidally averaged flow for Boynton Slough. The red line is the flow for a modeled system with an adjacent managed wetland connected by open culverts to Boynton Slough.

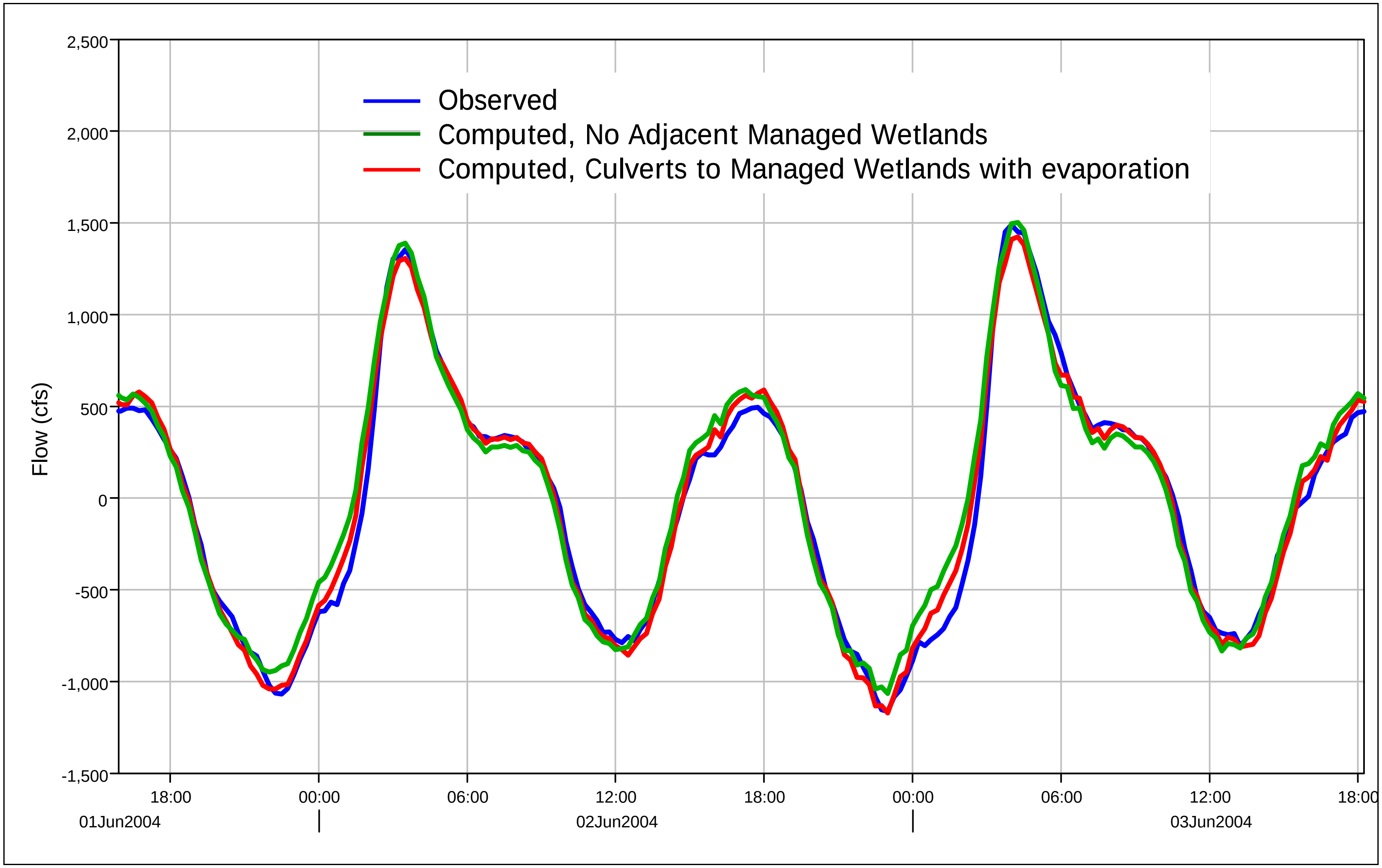


Figure 4-6 Observed and computed flow for Boynton Slough. The red line is the flow for a modeled system with an adjacent managed wetland connected by open culverts to Boynton Slough.

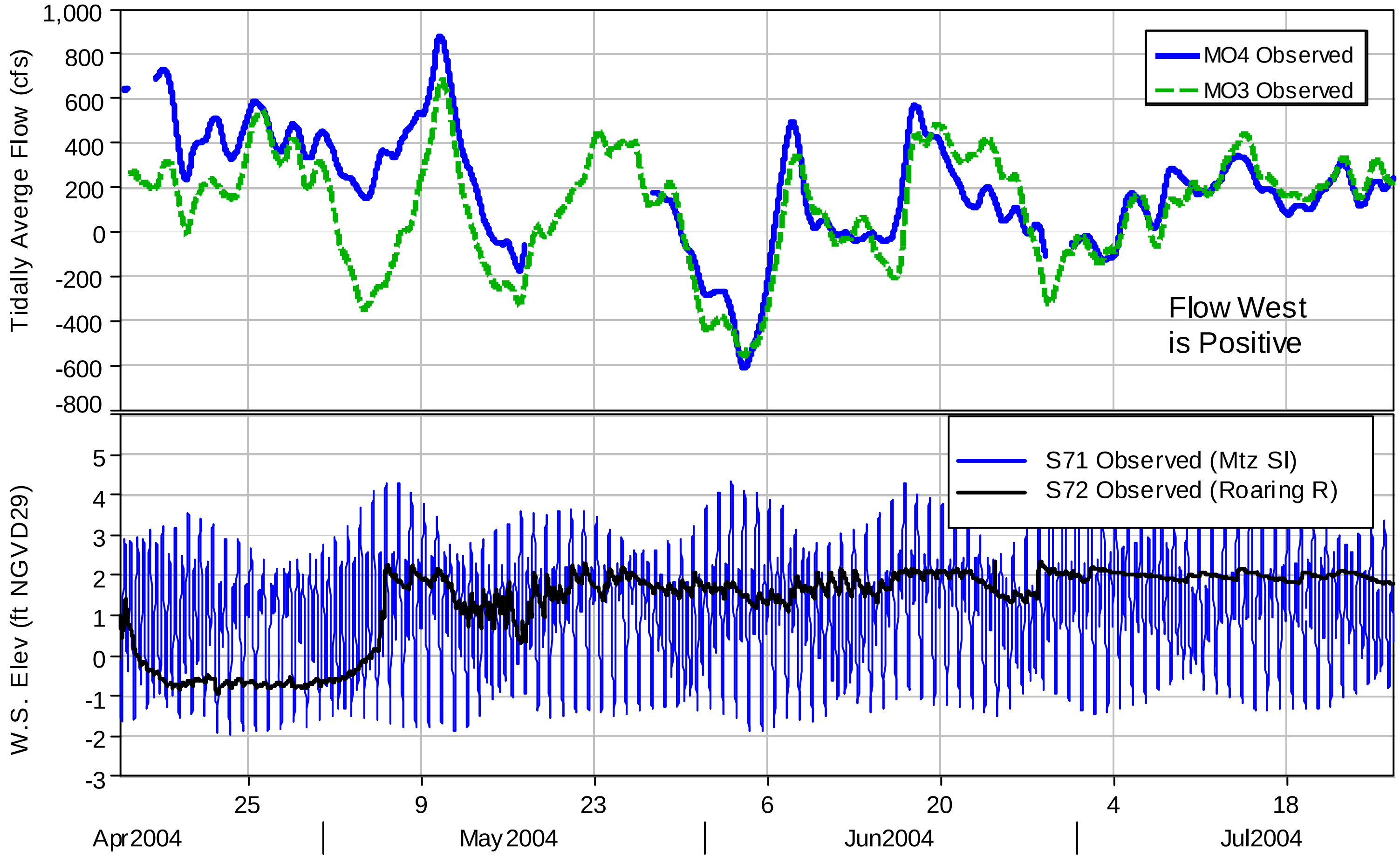


Figure 4-7 Observed tidally averaged flow for the east side Montezuma Slough stations M04 and M03, and the Observed Stage at S71 and S72.

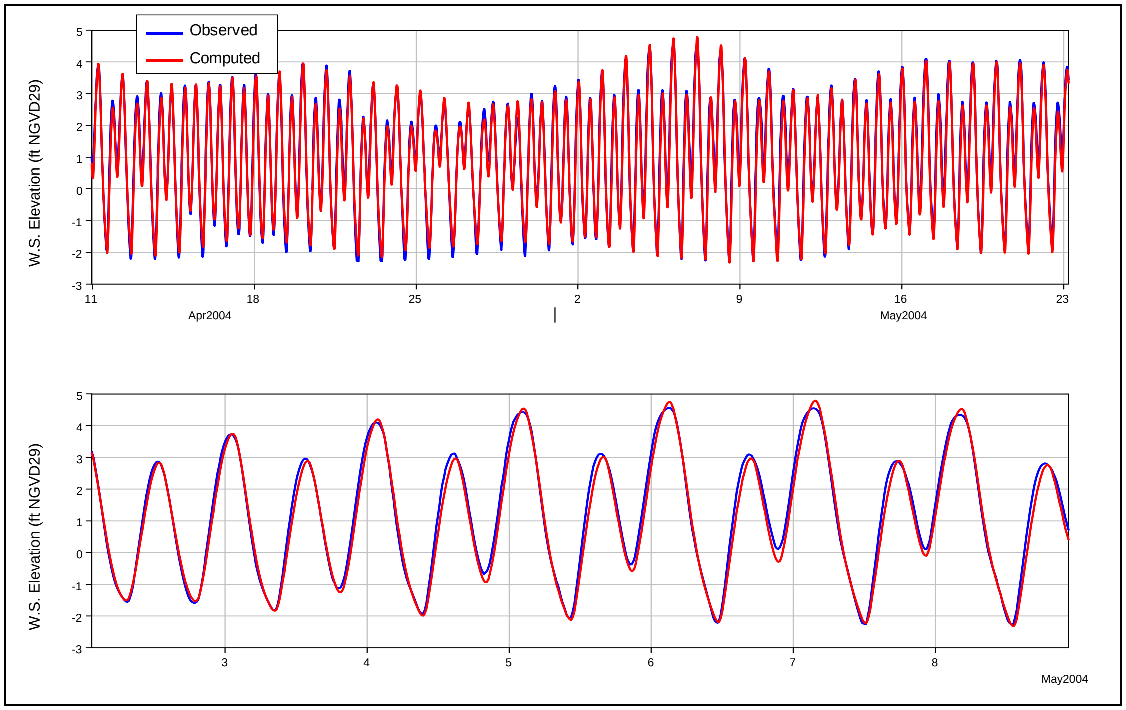


Figure 4-8 Observed and computed stage at monitoring station S-4 in Hill Slough during April – May 2004 (shorter time period shown in lower plot).

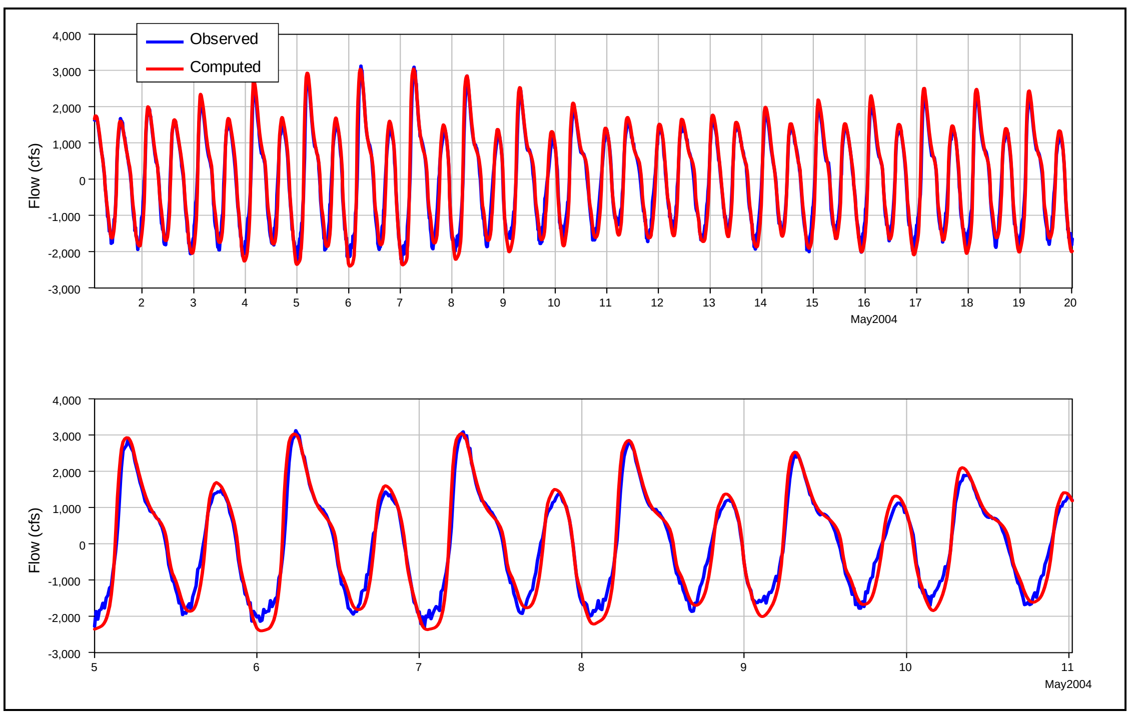


Figure 4-9 Observed and computed flow at Hill Slough, station HS1 during May 2004 (shorter time period shown in lower plot).

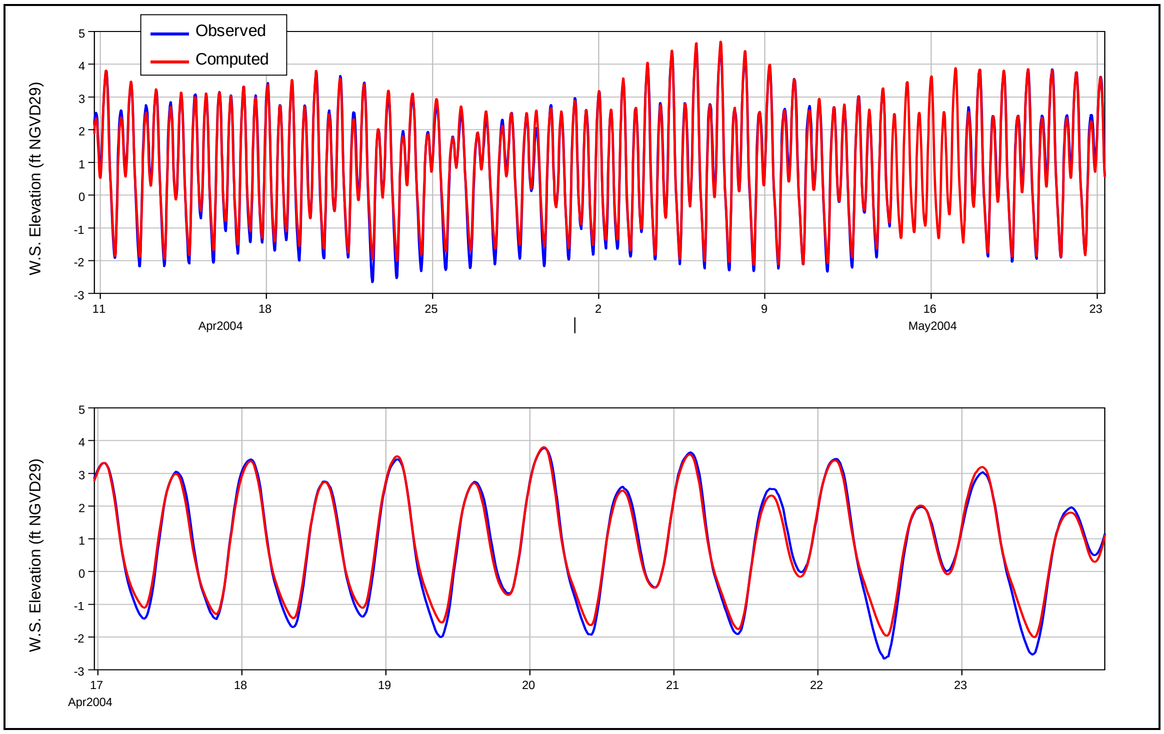


Figure 4-10 Observed and computed stage at monitoring station S-49 at Beldon's Landing on Montezuma Slough during April – May 2004 (shorter time period shown in lower plot).

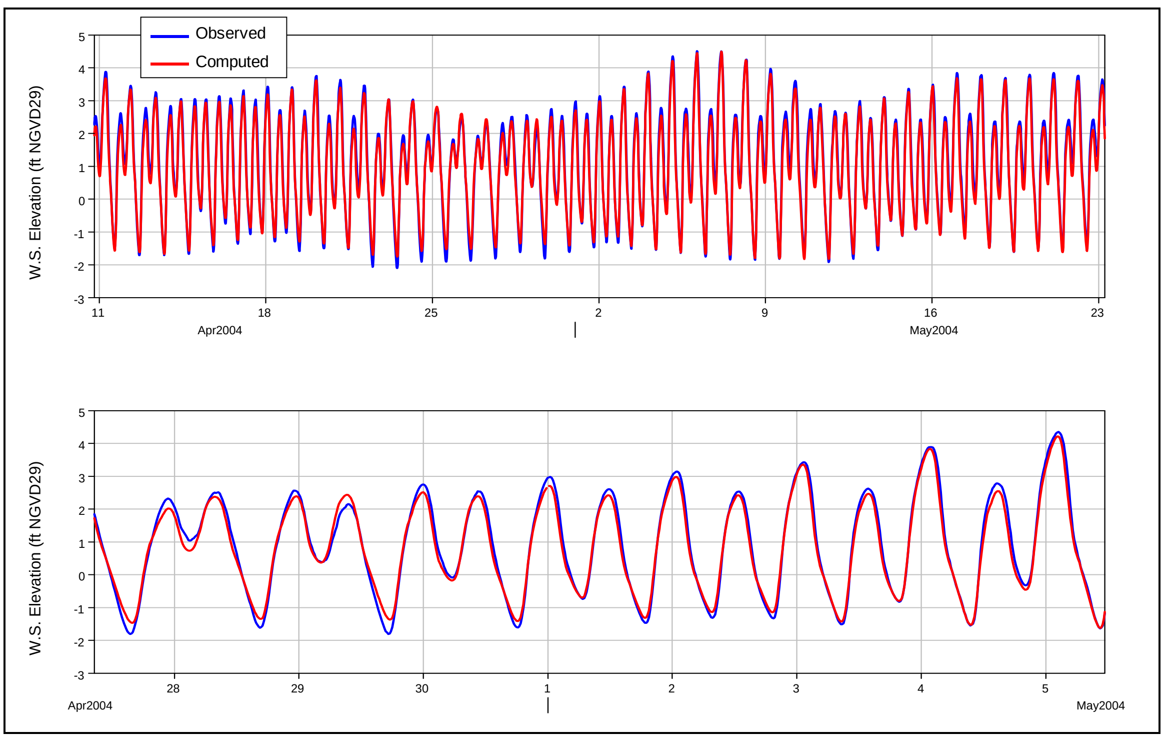


Figure 4-11 Observed and computed stage at monitoring station S-64 at National Steel on Montezuma Slough April – May 2004 (shorter time period shown in lower plot).

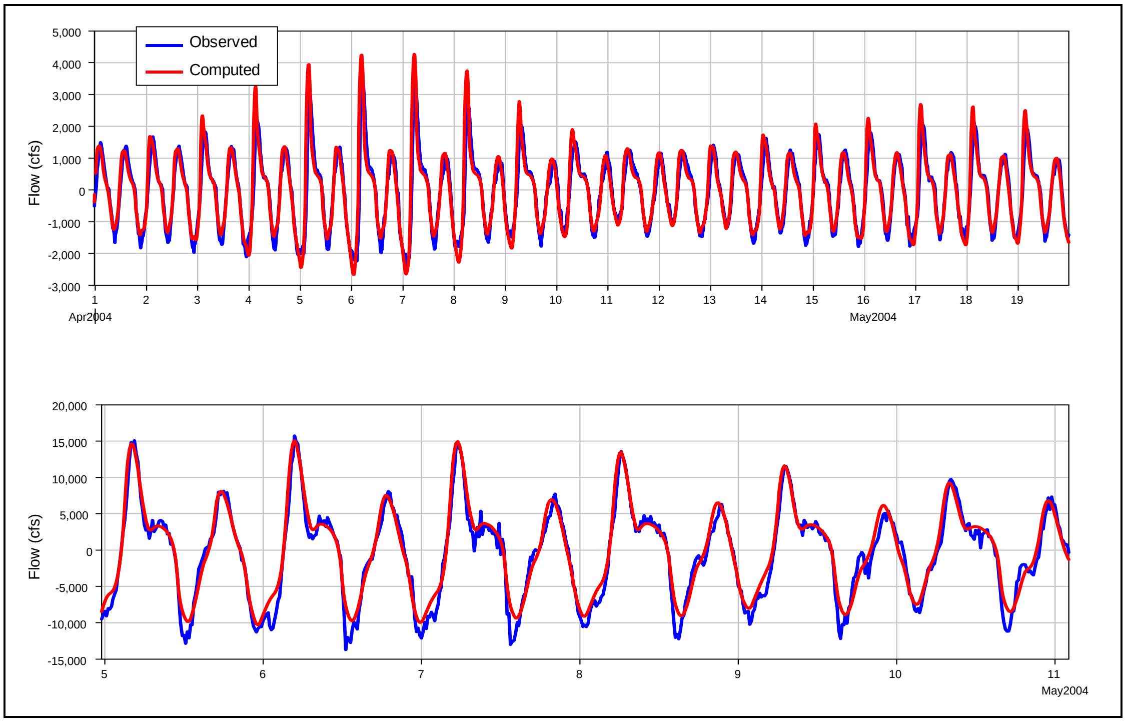


Figure 4-12 Observed and computed flow at the Nurse Slough monitoring station, NS1 May 2004 (shorter time period shown in lower plot).

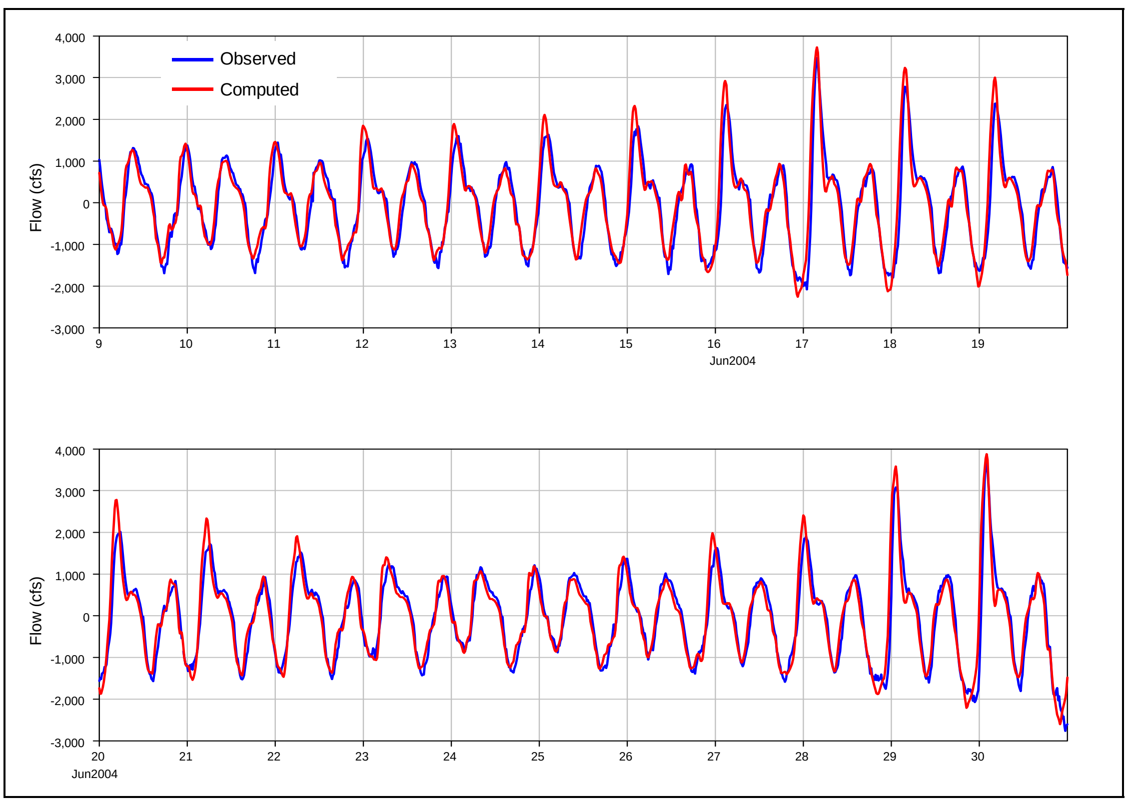


Figure 4-13 Observed and computed flow at the Cutoff Slough monitoring station, CO2 during June 2004.

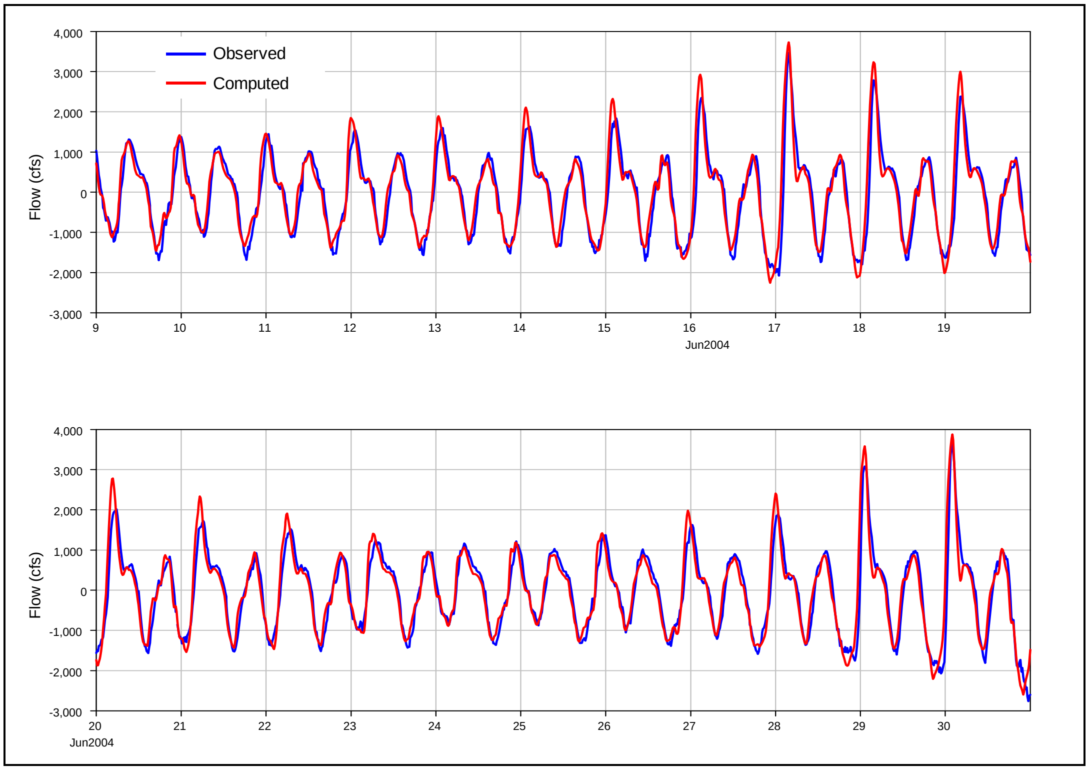


Figure 4-14 Observed and computed flow in First Mallard Slough at station FM1 during June 2004.

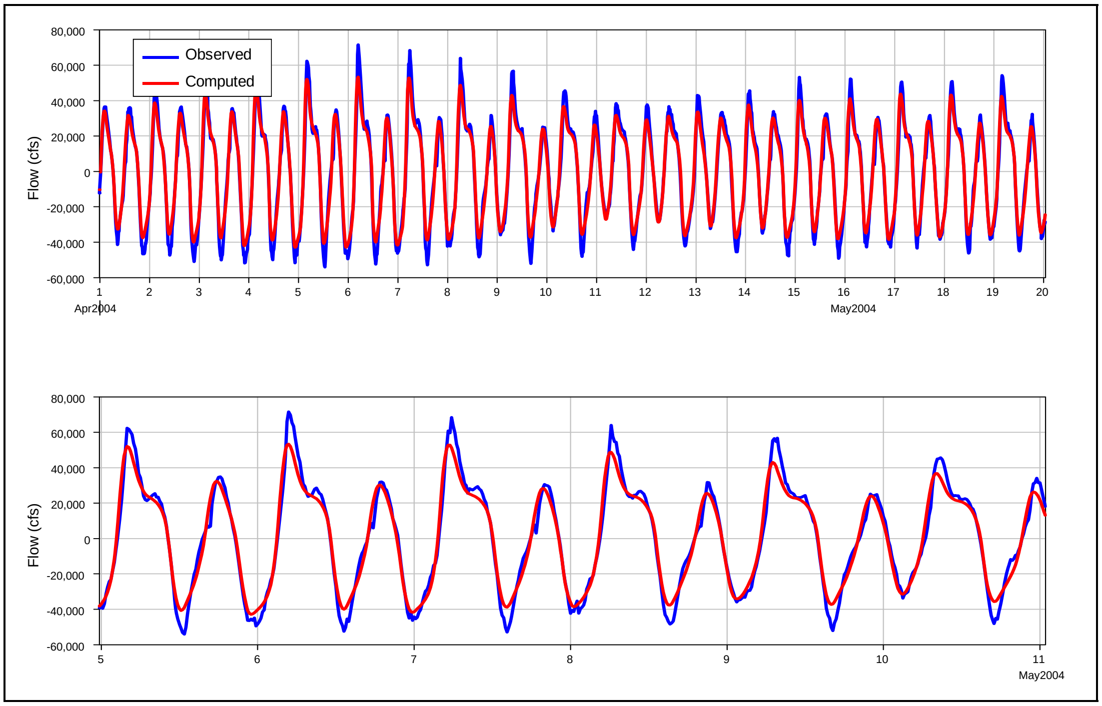


Figure 4-15 Observed and computed flow in Montezuma Slough at station MO1 during May 2004 (shorter time period in lower plot) – positive values indicate flow is eastward.

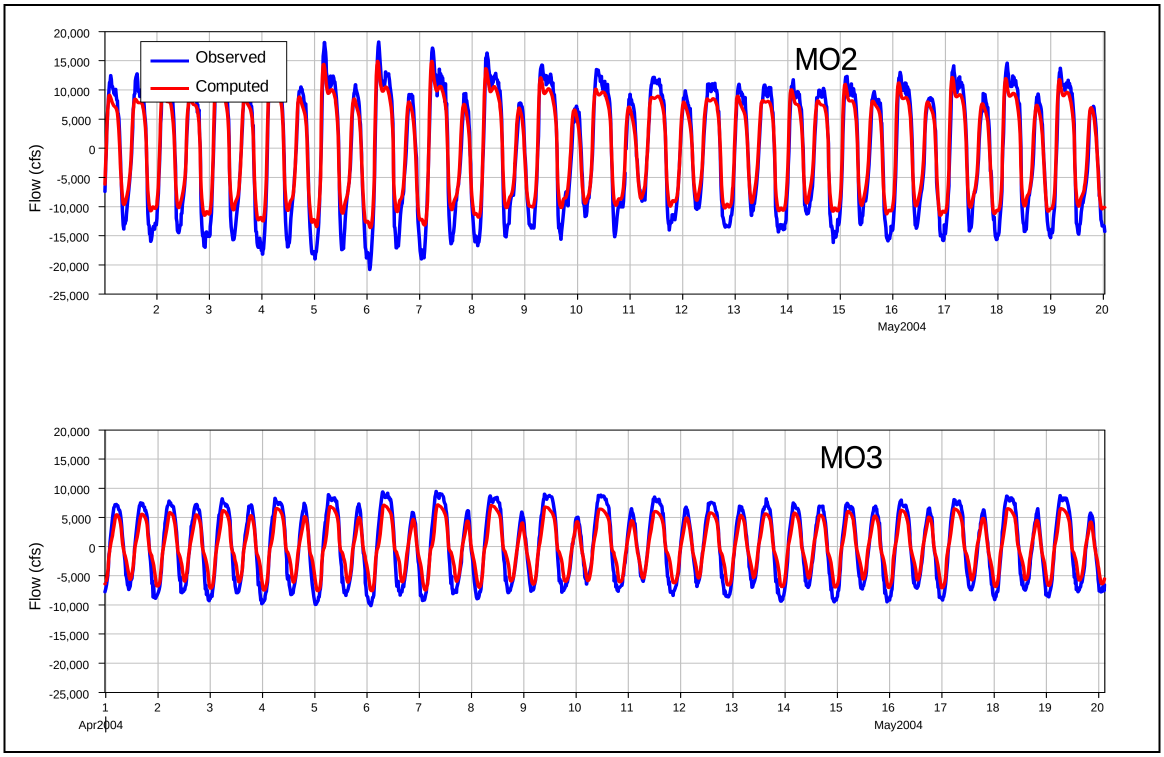


Figure 4-16 Observed and computed flow in Montezuma Slough at monitoring locations MO2 and MO3 – positive values indicate flow is eastward.

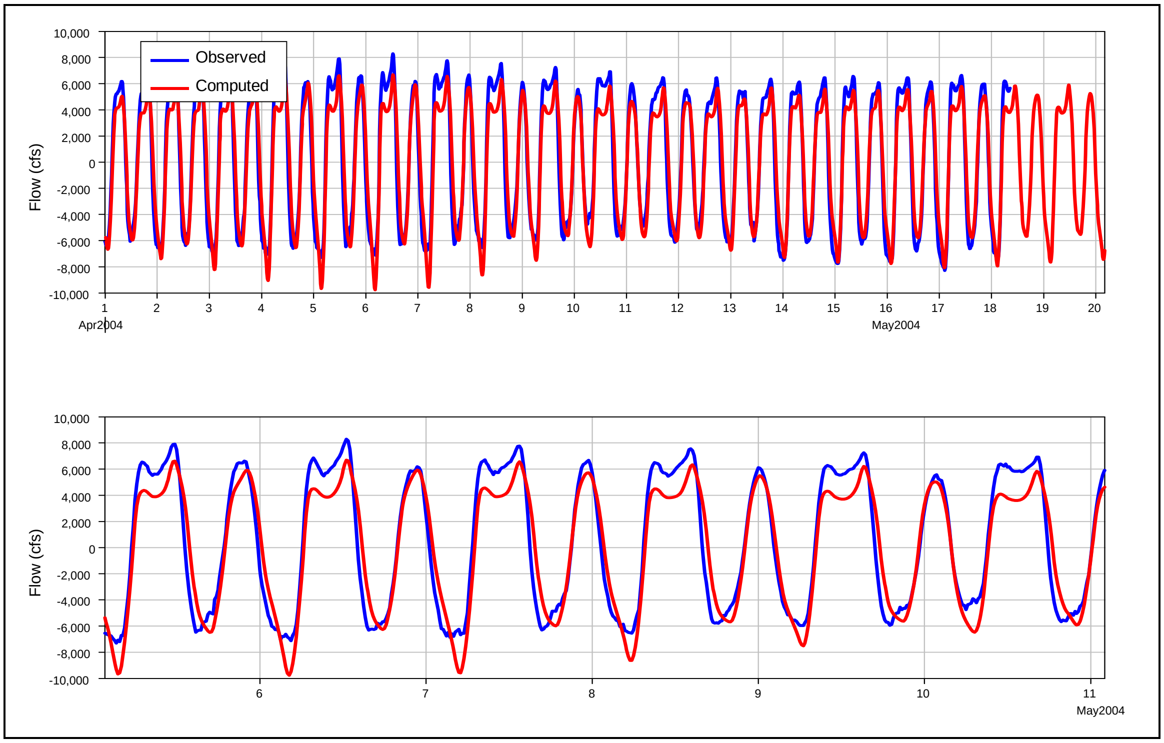


Figure 4-17 Observed and computed flow in Montezuma Slough at monitoring location MO4 (shorter time period shown in lower plot) – positive values indicate flow is eastward.

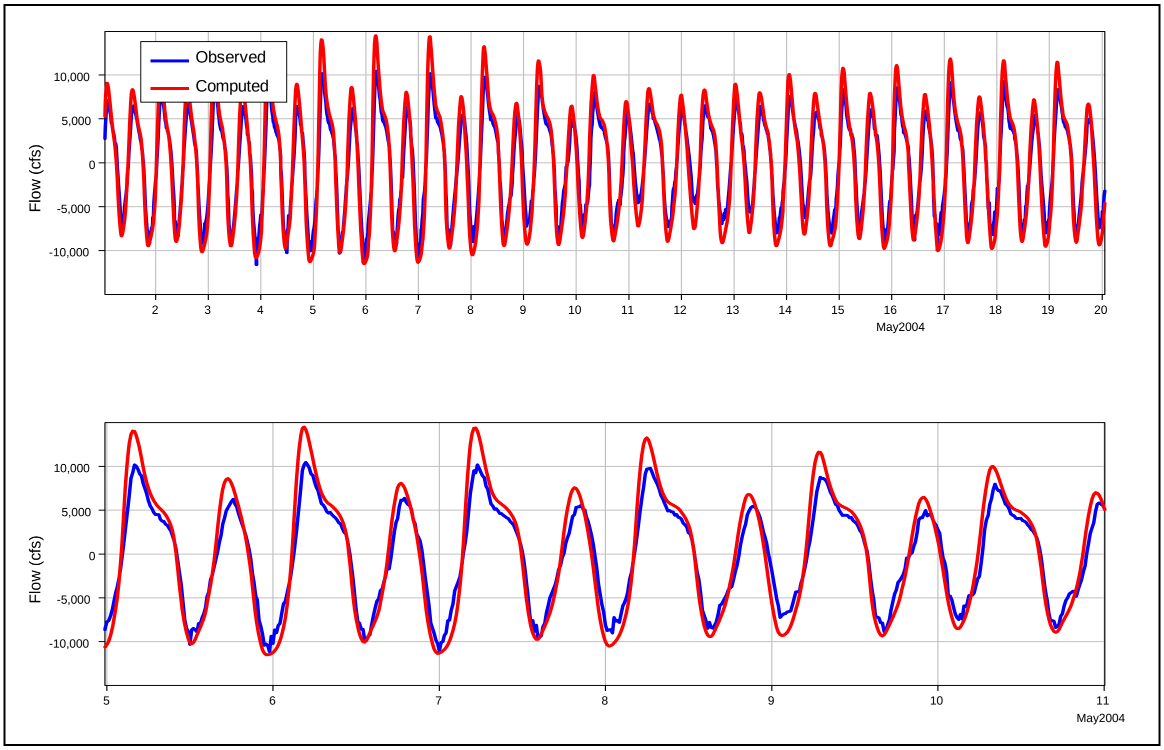


Figure 4-18 Observed and computed flow at the mouth of Suisun Slough, station SS1 (shorter time period shown in lower plot).

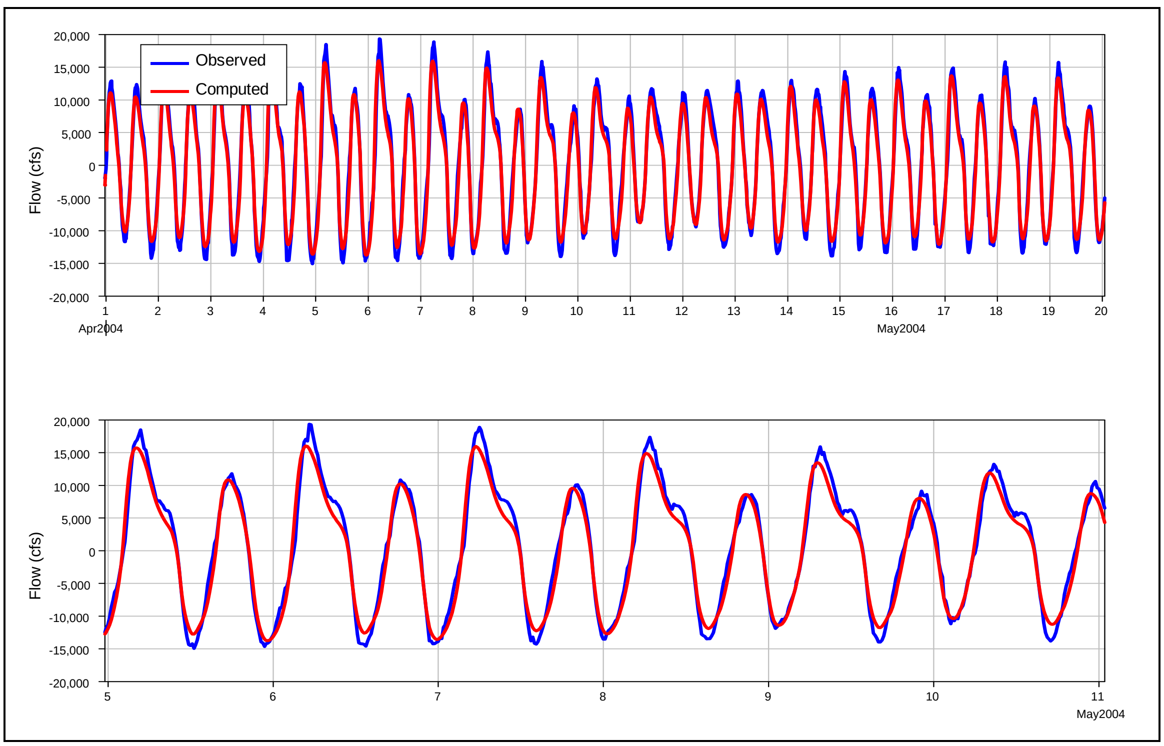


Figure 4-19 Observed and computed flow through Hunter Cut at monitoring station HC1 (shorter time period shown in lower plot).

4.2. Electrical Conductivity (EC) Calibration

4.2.1. Background

The RMA11 EC calibration was performed for the period of April 2002 – December 2003. To calibrate the EC model, computed EC was compared with observed data at the sampling locations shown in Figure 4-2.

Calibration results were hampered by the lack of sufficient model input data, for example the lack of managed wetlands withdrawals and returns and local creek flows, and by approximations to some mechanisms that are intrinsic to the model. Specifically, density stratification cannot be explicitly represented in the depth-averaged model formulation.

Density stratification is particularly important following high flow periods during neap tide, although periods of stratification also occur intermittently during neap tide periods when net Delta outflow is sufficiently low. Periods of higher (> 30,000 cfs) and lower (~ 4,000 cfs) outflow, are illustrated in Figure 4-21 and Figure 4-22, respectively, which show observed top and bottom EC, stage at Martinez, and Delta outflow. In Figure 4-22, during a neap tide in a lower outflow period around August 19, 2003, top and bottom EC data indicate that significant stratification developed at Martinez, which lasted for about five days.

The result of neglecting density stratification in the 2-D model is slow recovery of model EC following high flow periods. In the calibration results, attempts to compensate for the stratification using diffusion coefficients have pushed computed EC too high during the late fall. These problems become evident in the model at the Martinez station and are propagated through Suisun Marsh. Modeled, tidally-averaged EC at Martinez (Figure 4-23) illustrates the effect of the 2-D model approximation in comparison with data. The winter period of low EC accentuates the inability of the model to capture stratification, and the high fall EC shows the effect of the compensating diffusion coefficients.

4.2.2. Results

EC calibration results were geographically and seasonally variable along Montezuma Slough. The inclusion of managed wetlands and evaporation resulted in significant improvements in modeled EC at Beldon’s Landing, S-49 (Figure 4-24), during some periods. The tidally averaged computed EC (Figure 4-25) is a fairly good match with tidally averaged observed data throughout most of the calibration period, except during winter 2003 and late fall 2002 and 2003. This location seems to be near the balancing point between the overestimated EC at Martinez in the fall, and the incorrect net flow balance in Montezuma Slough during the periods when SMSCG is not operating (although flow data are not available specifically for this time and location to confirm this). Intertidal results at this location show slightly less tidal variation in computed EC compared with observed data.

In eastern Montezuma Slough, modeled EC is lower than observed EC year-round. This can be seen at stations S-64 at National Steel, in Figure 4-26, and S-71 at Roaring River, in Figure 4-27. This is due to insufficient propagation of higher EC up Montezuma

Slough from the west, possibly because of incorrect net flows and/or due to insufficient representation of local effects, for example, exchange with Roaring River. Also, the hydrodynamic calibration did not include wetland diversions, while EC calibration did.

Calibration results at Collinsville (Figure 4-29) are relatively good on a tidally averaged basis. Throughout much of the year the tidal signal in the computed EC is dampened compared with the observed data, and at other times, the agreement between computed and observed 15-minute data is quite good. Although it is not always true, the results tend to be best when the SMSCG is operating (Figure 4-30).

The addition of Green Valley Creek, Suisun Creek, Ledgewood Creek and Laurel Creek and WWTP flows in the model representation greatly improved the storm period results in the eastern and northeastern marsh. Figure 4-32 to Figure 4-36 illustrate these effects at S-4 in Hill Slough, S-42 at Volanti in Suisun Slough, and at S-97 in Cordelia Slough at Ibis, respectively. EC results at S-4 and S-42, although very much improved with the addition of creek flows, seem to indicate either missing inflows, or possibly that the shape of the hydrograph is not quite right. Ledgewood and Laurel Creek flows, which contributed to this area of the marsh, were estimated because no data were available, so an excellent match with observed data is not expected.

Results in western Montezuma Slough at S-54, Hunter Cut (Figure 4-28), follow the pattern of EC under- and over-estimation observed at Martinez in Figure 4-23. The results are similar in the south-western areas of the marsh (Figure 4-37 to Figure 4-40), although EC increases are somewhat muted at S-37 in Suisun Slough (Figure 4-38).

4.2.3. Summary

Although the model development and calibration effort improved modeled EC in Suisun Marsh, the improvements were geographically and seasonally variable. The inclusion of managed wetlands and evaporation alone resulted in significant improvements in modeled EC in some areas, such as Beldon’s Landing (Figure 4-24). The addition of creek flows greatly improved the representation of EC in the northern and north-eastern portions of the marsh.

Modeled EC tended to be too low January – June, 2003 in most of Suisun Marsh. Computed EC was generally good in the western and middle portions of Montezuma Slough and in the south-western regions of the marsh. EC was low in the eastern portion of Montezuma Slough, and high in the northern portions of Suisun Slough.

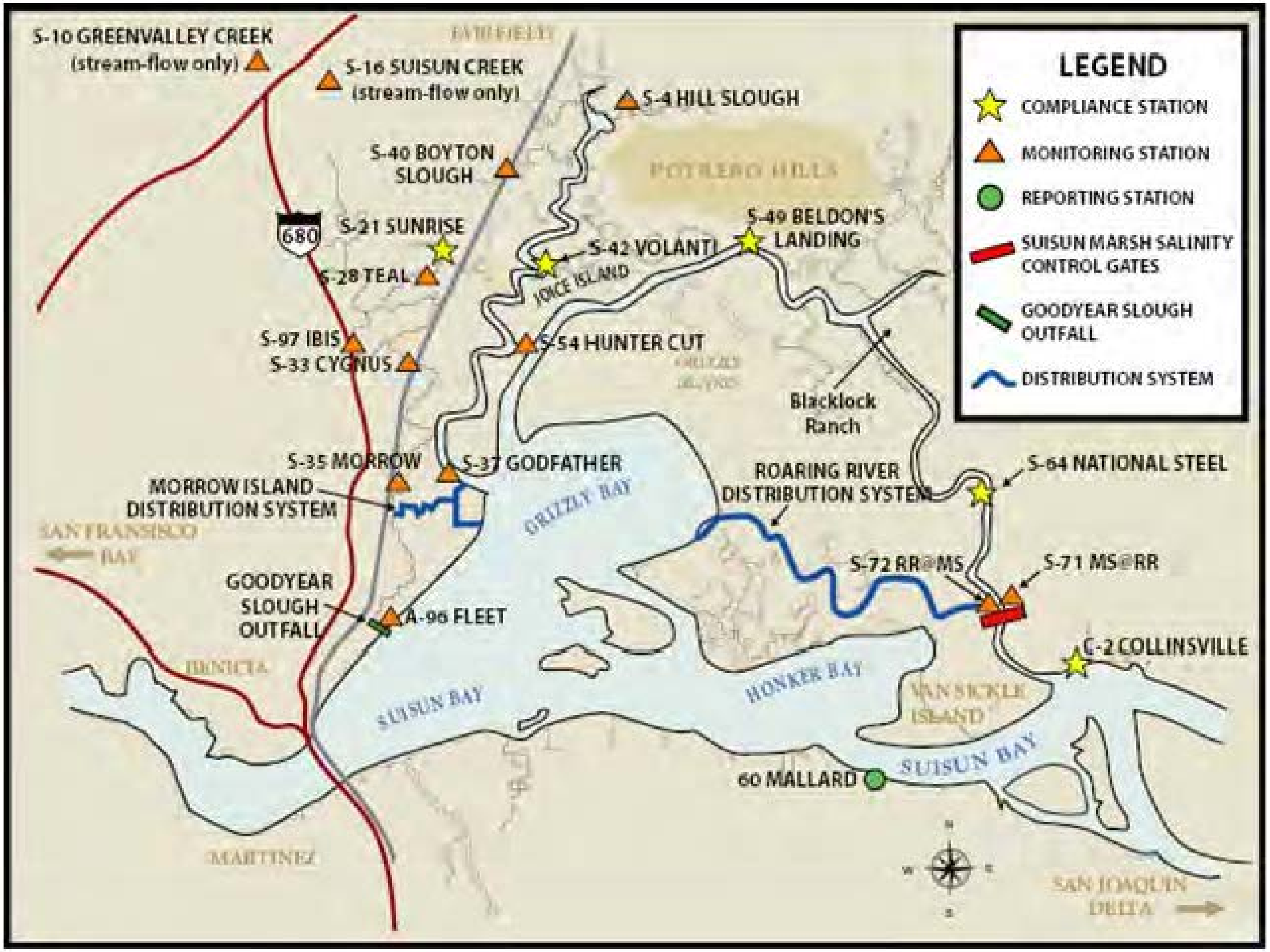


Figure 4-20 Locations of monitoring stations used in EC model calibration.

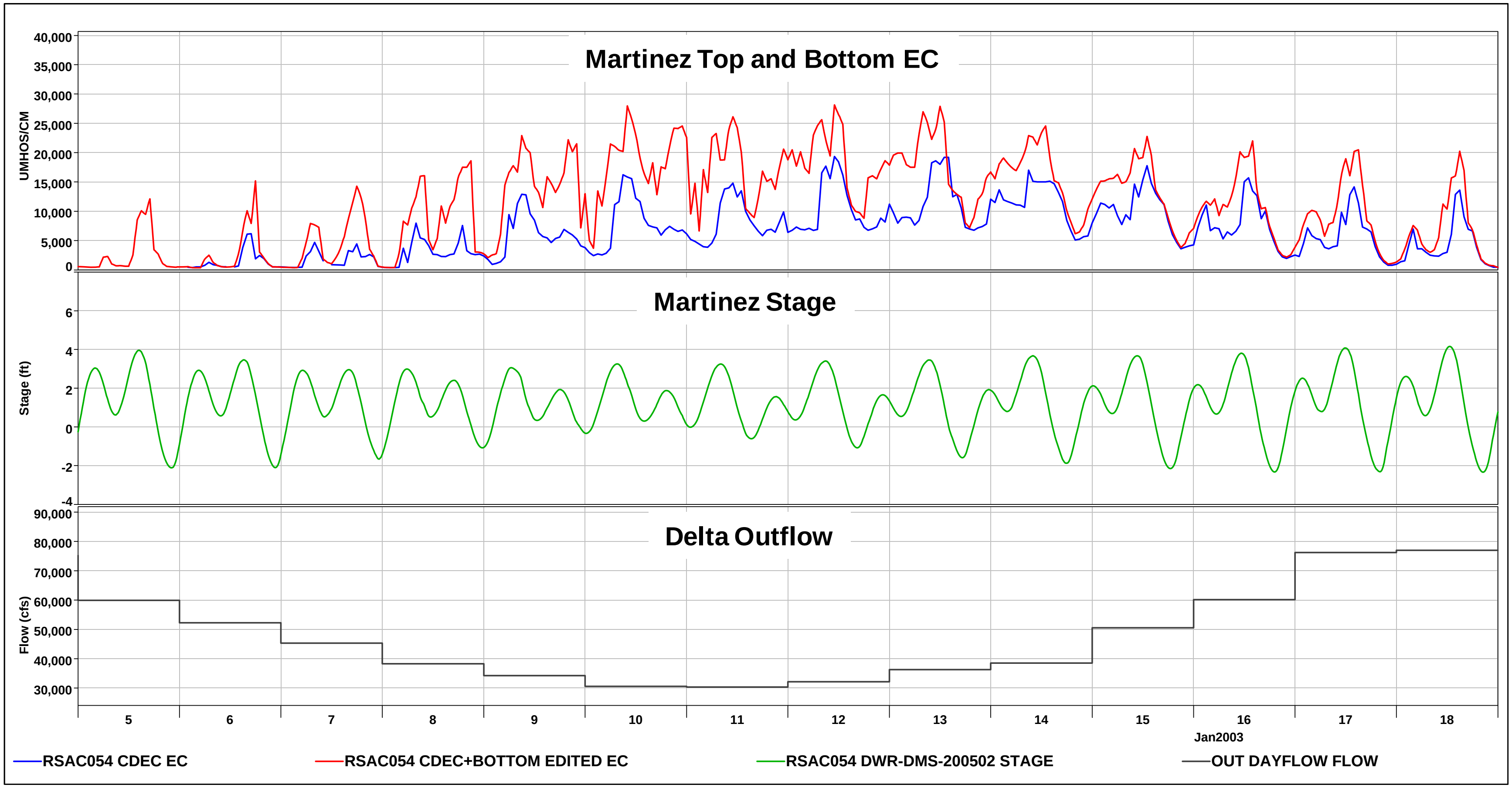


Figure 4-21 Top/bottom EC and stage at Martinez (RSAC054), and Sacramento River flow during a high outflow, neap tide period.

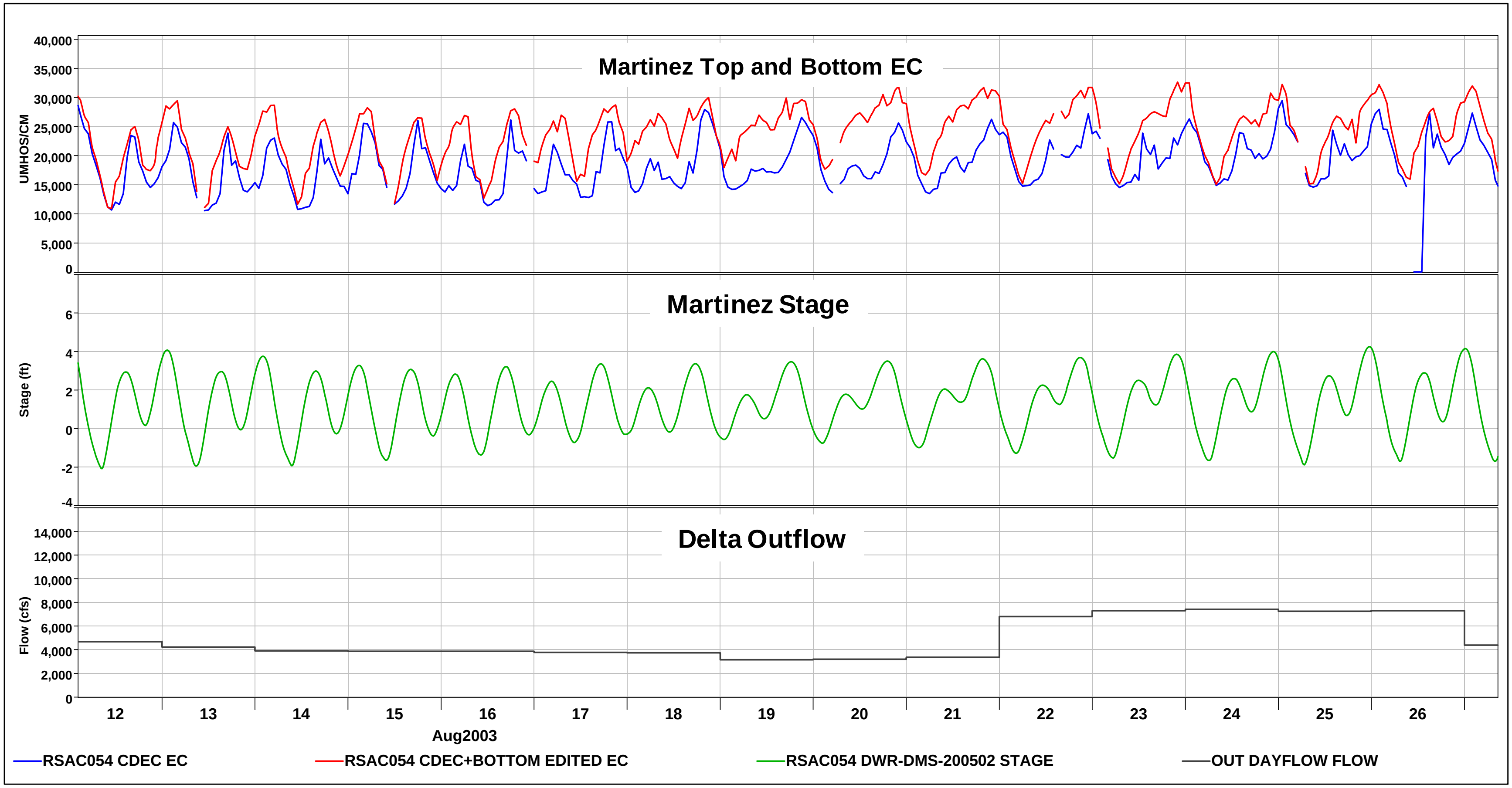


Figure 4-22 Top/bottom EC and stage at Martinez (RSAC054), and Sacramento River flow during a lower outflow period, neap tide period.

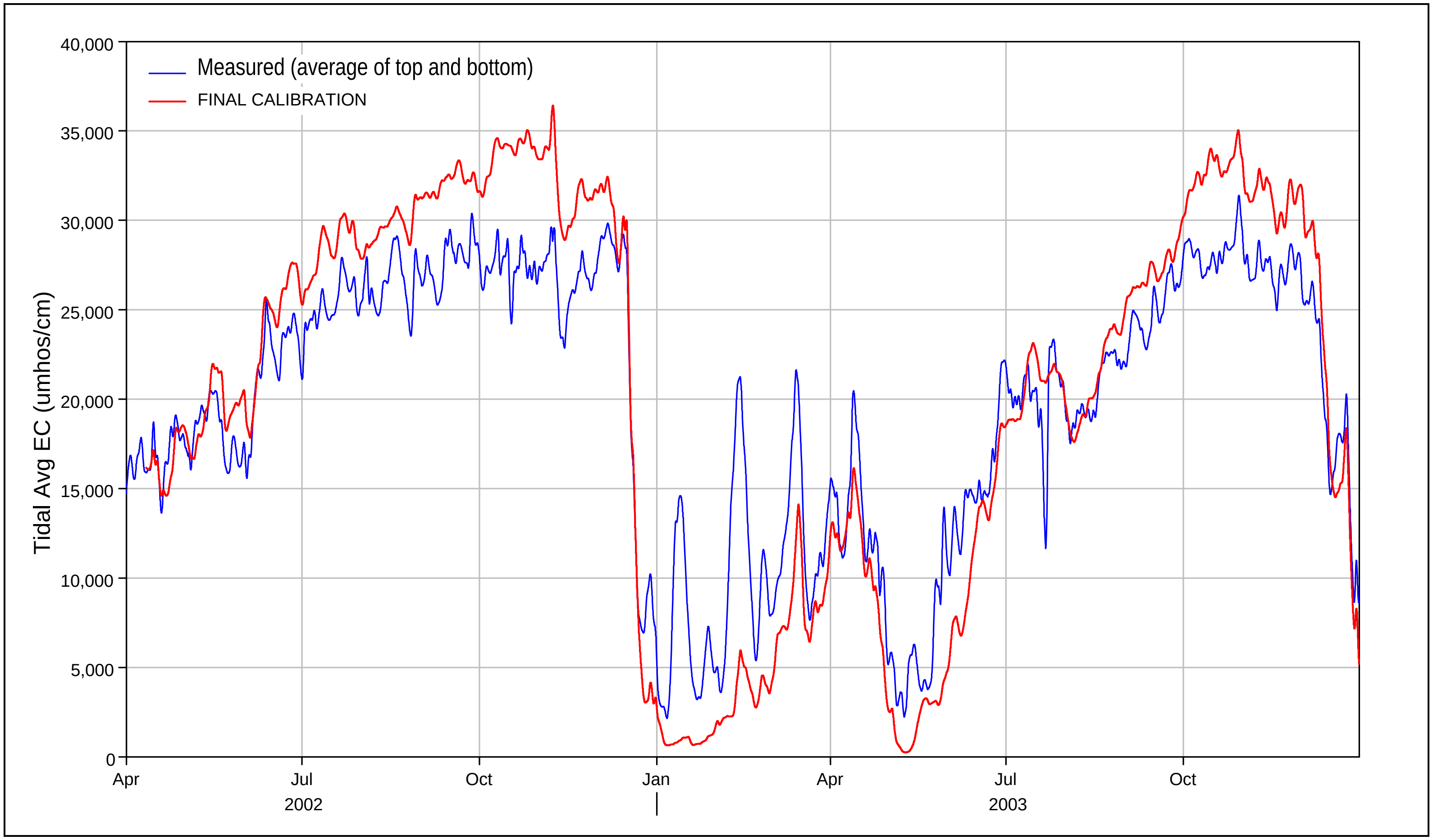


Figure 4-23 Tidally averaged measured (average of top and bottom) and computed EC at Martinez station (RSAC054).

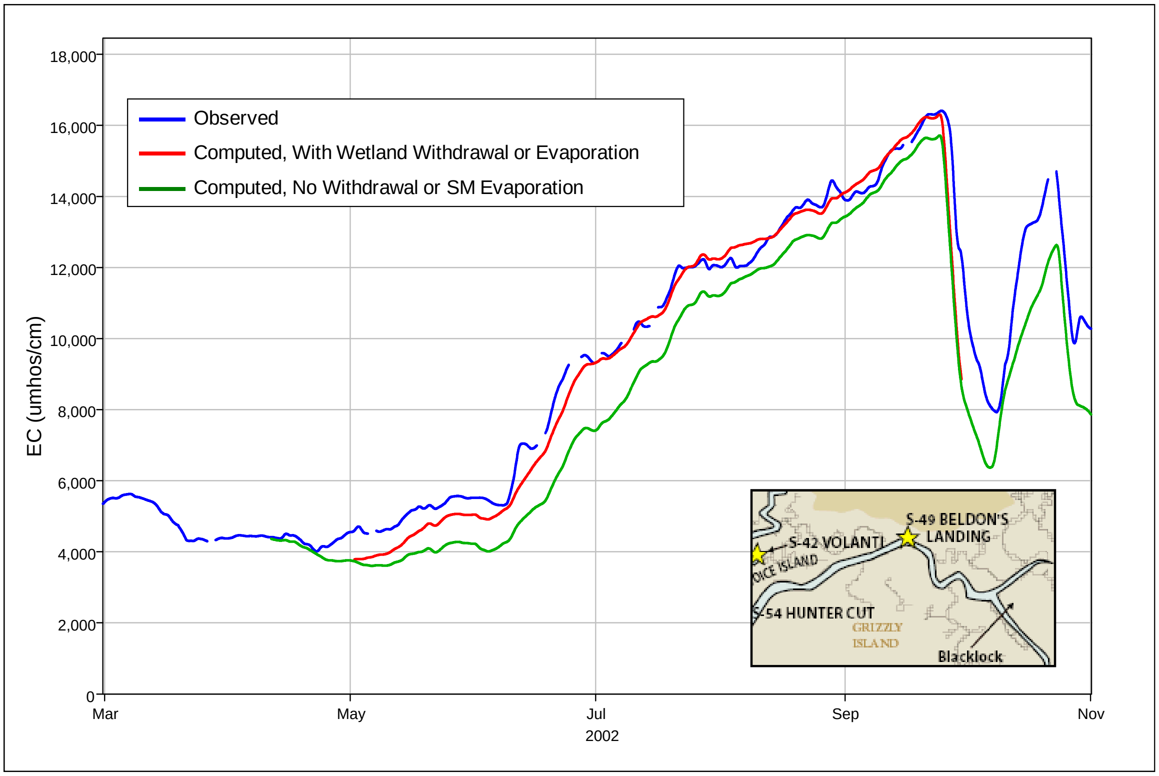


Figure 4-24 Tidally averaged observed and computed EC at S-49, Montezuma Slough at Beldon's Landing. Computed shown with and without duck club withdrawals and evaporation.

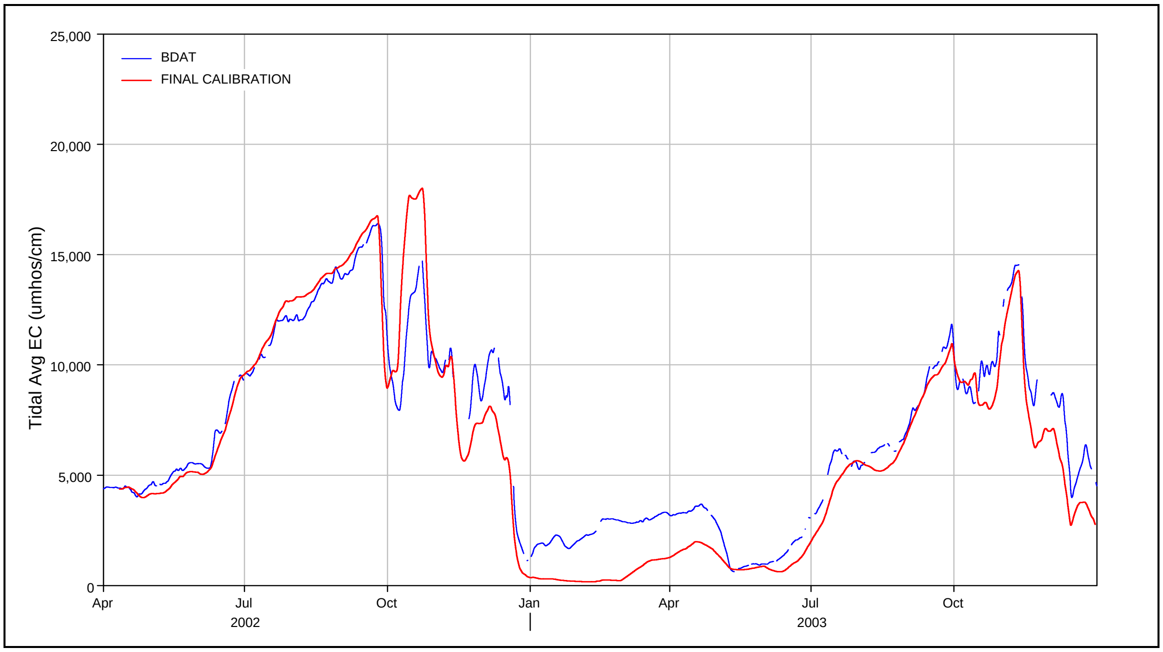


Figure 4-25 Tidally averaged observed and computed EC at station S-49, Beldon's Landing.

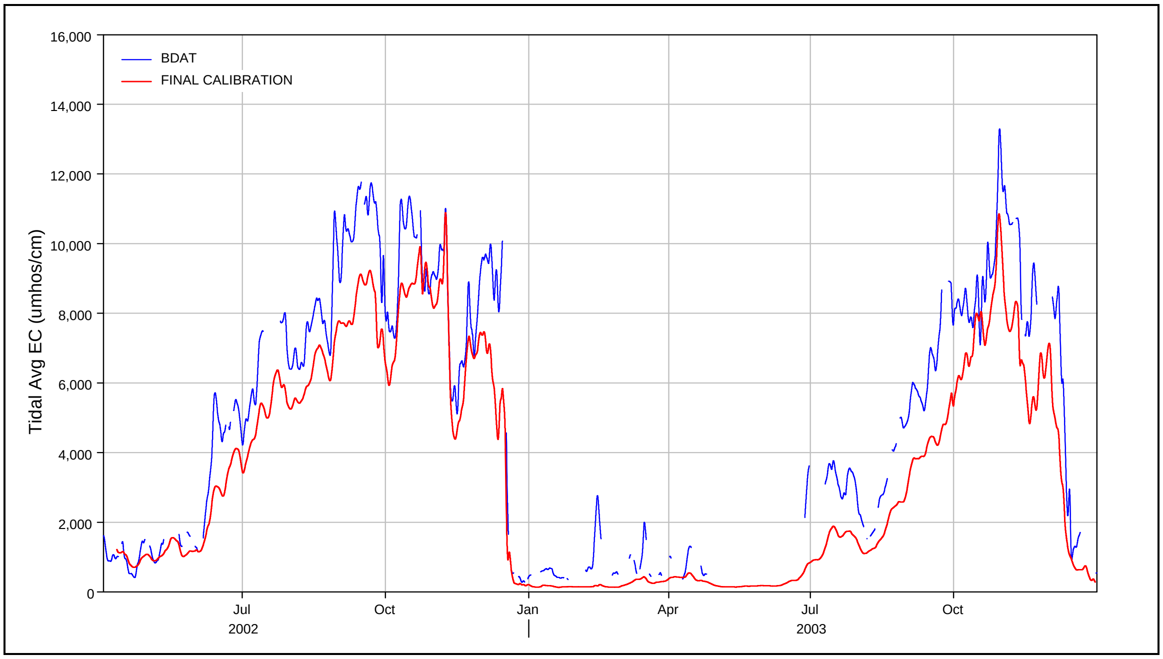


Figure 4-26 Tidally averaged observed and computed EC at station S-64, National Steel in eastern Montezuma Slough.

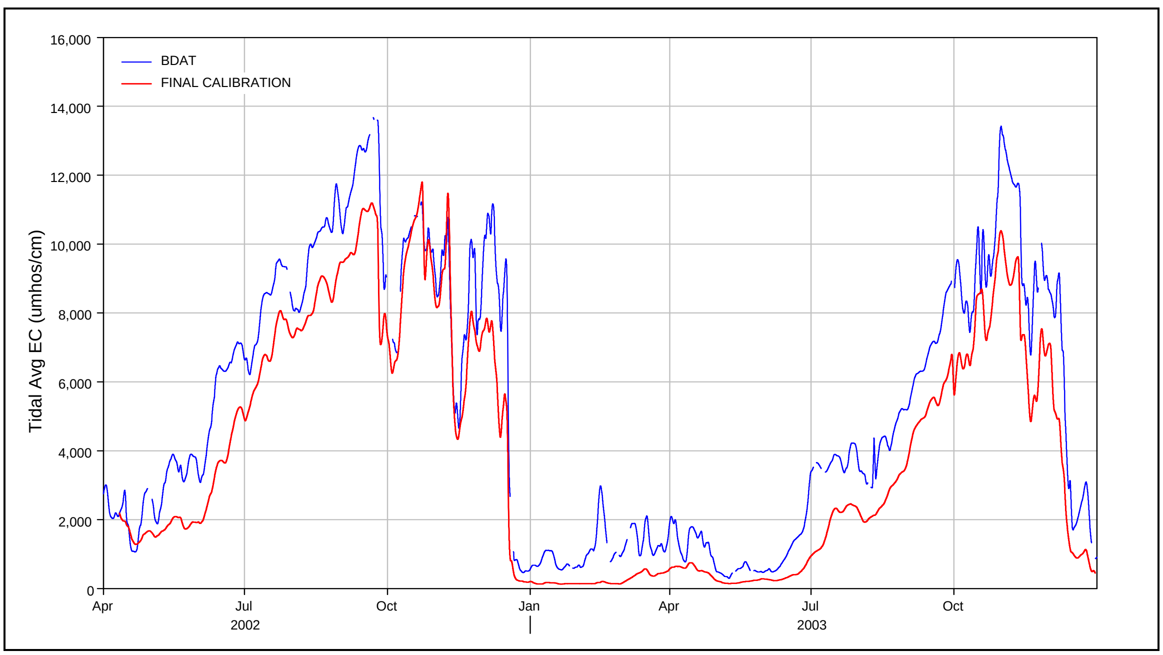


Figure 4-27 Tidally averaged observed and computed EC at station S-71 Roaring River in eastern Montezuma Slough.

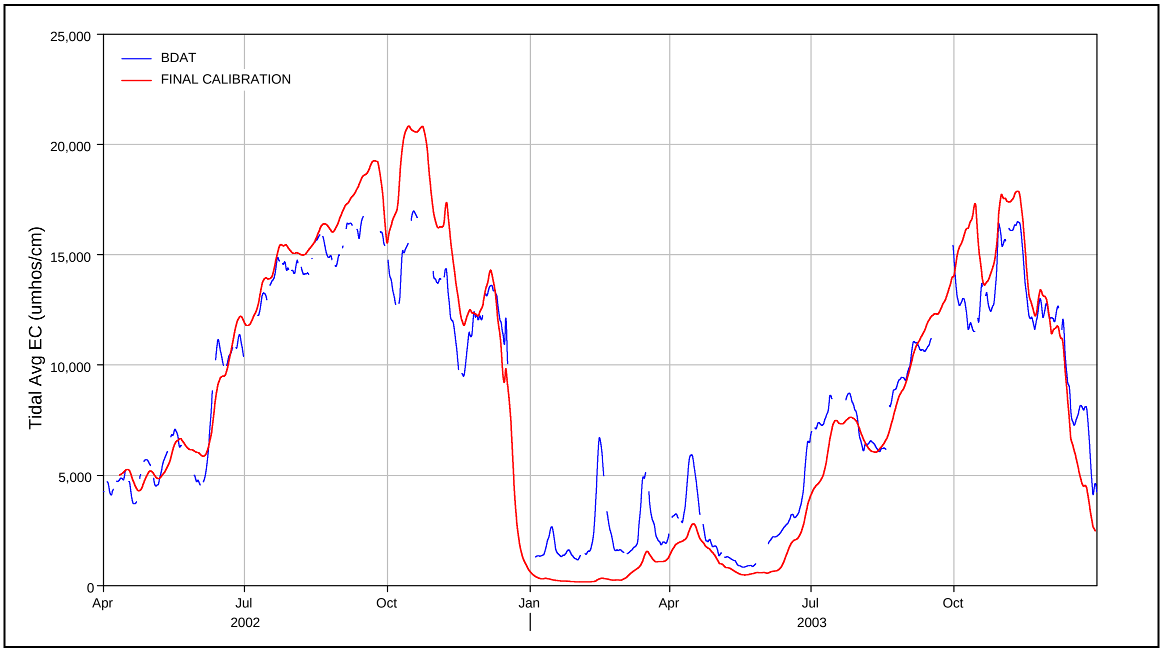


Figure 4-28 Tidally averaged observed and computed EC at station S-54, Hunter Cut.

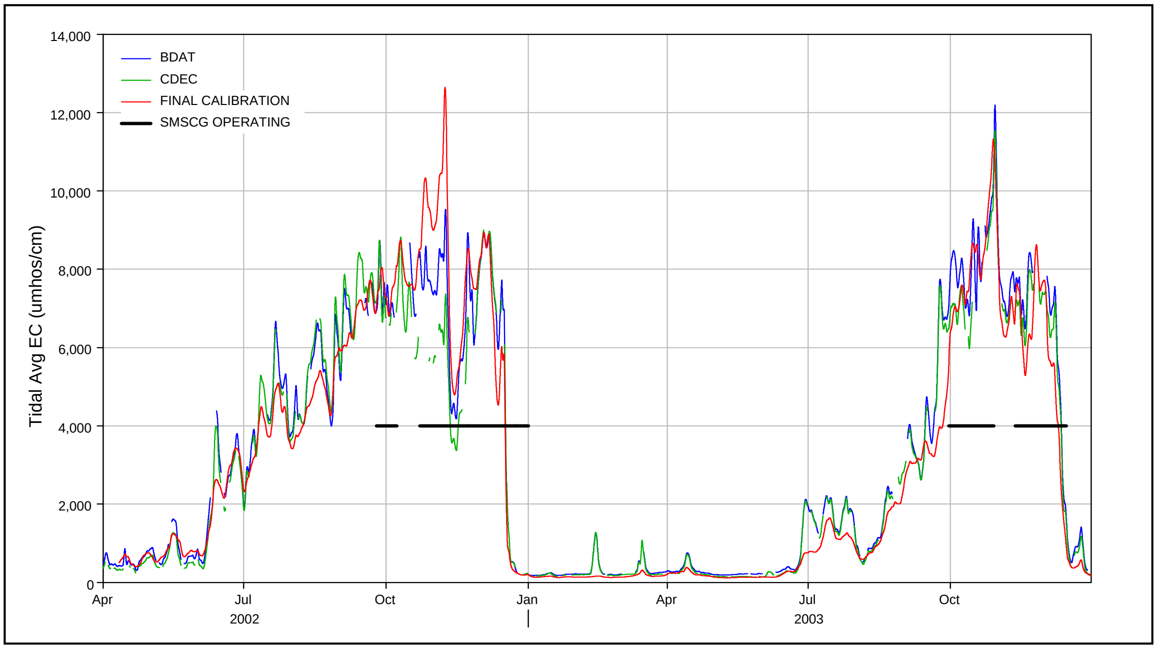


Figure 4-29 Tidally averaged observed and computed EC at Collinsville (RSAC081).

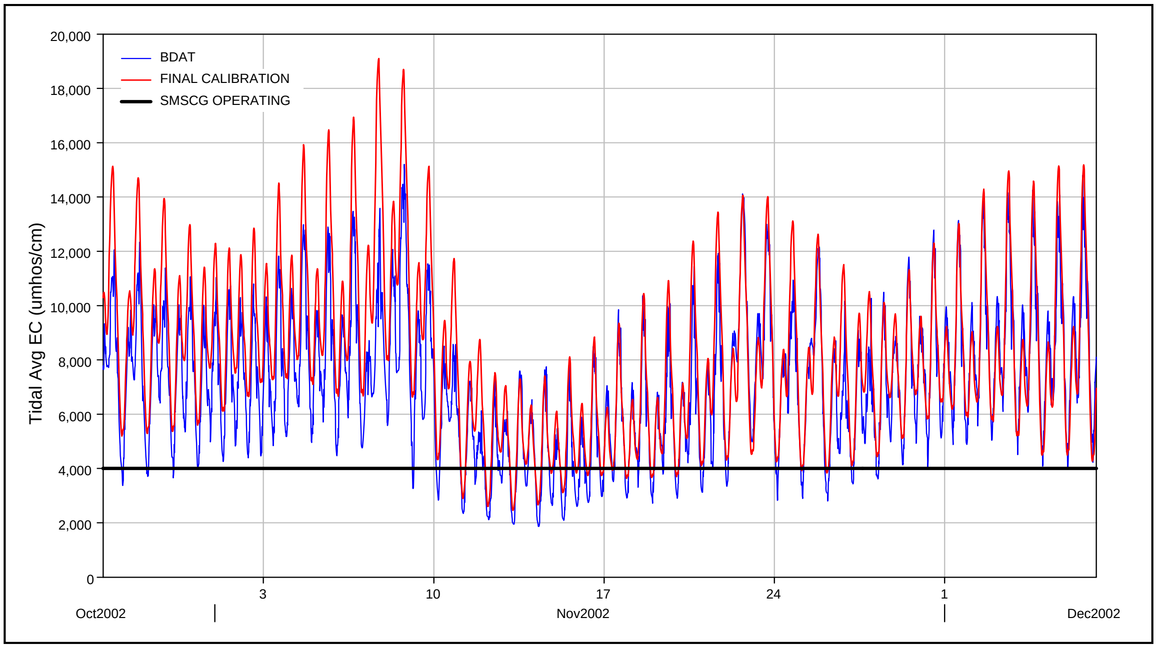


Figure 4-30 Observed and computed EC at Collinsville (RSAC081) during a period of SMSCG operation.

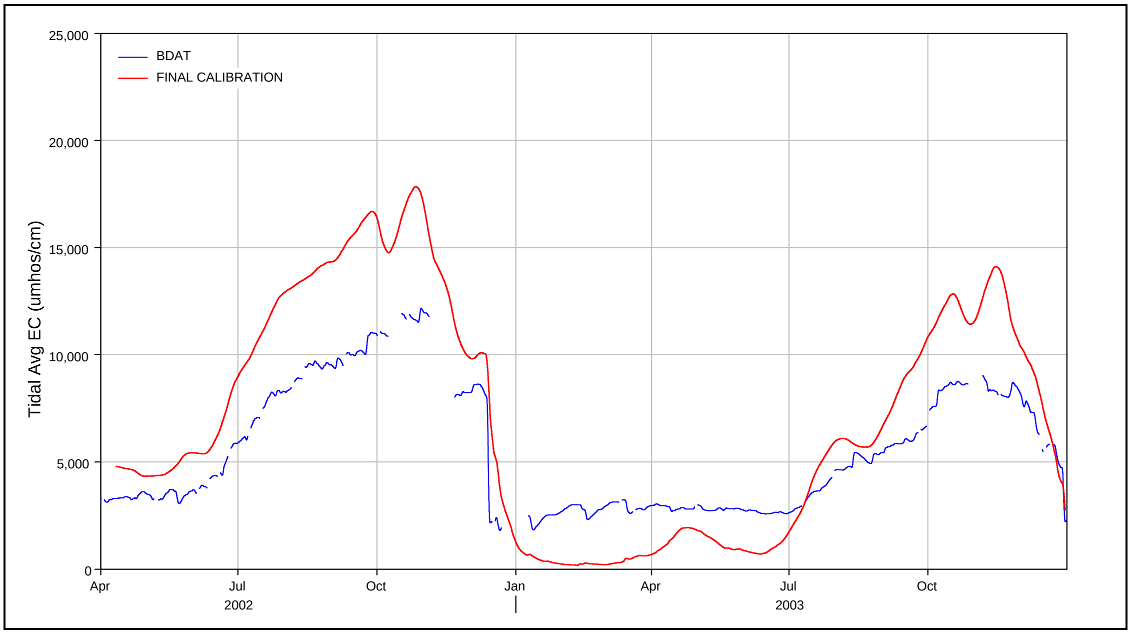


Figure 4-31 Tidally averaged observed and computed EC at station S-4, Hill Slough.

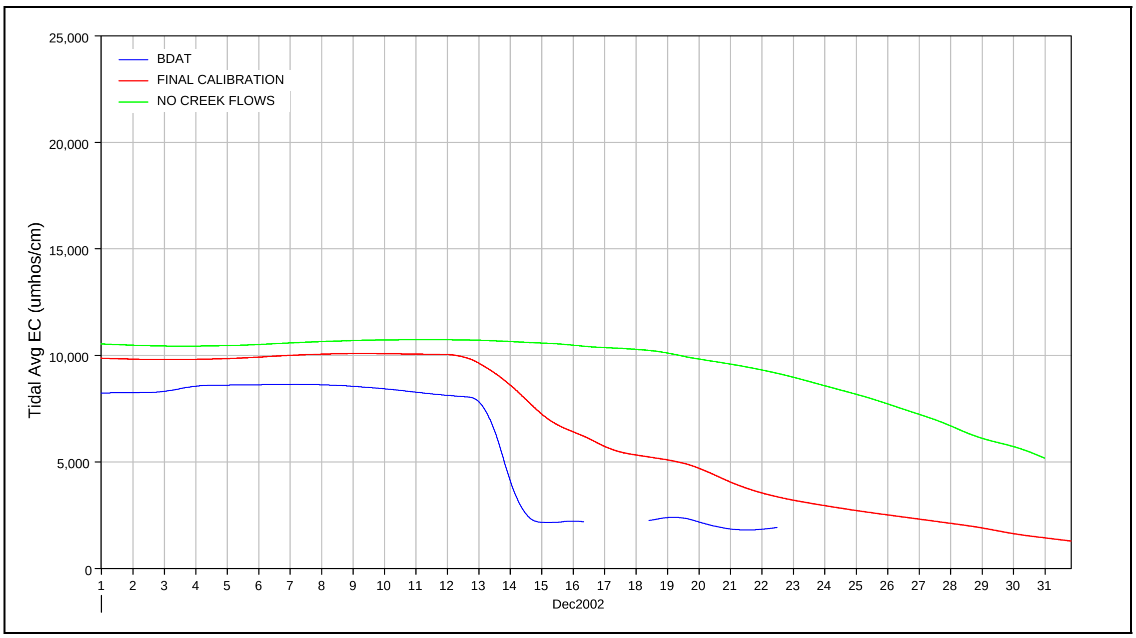


Figure 4-32 Tidally averaged observed and computed EC at station S-4, Hill Slough in December, 2002. Computed results shown with and without local creek flow addition.

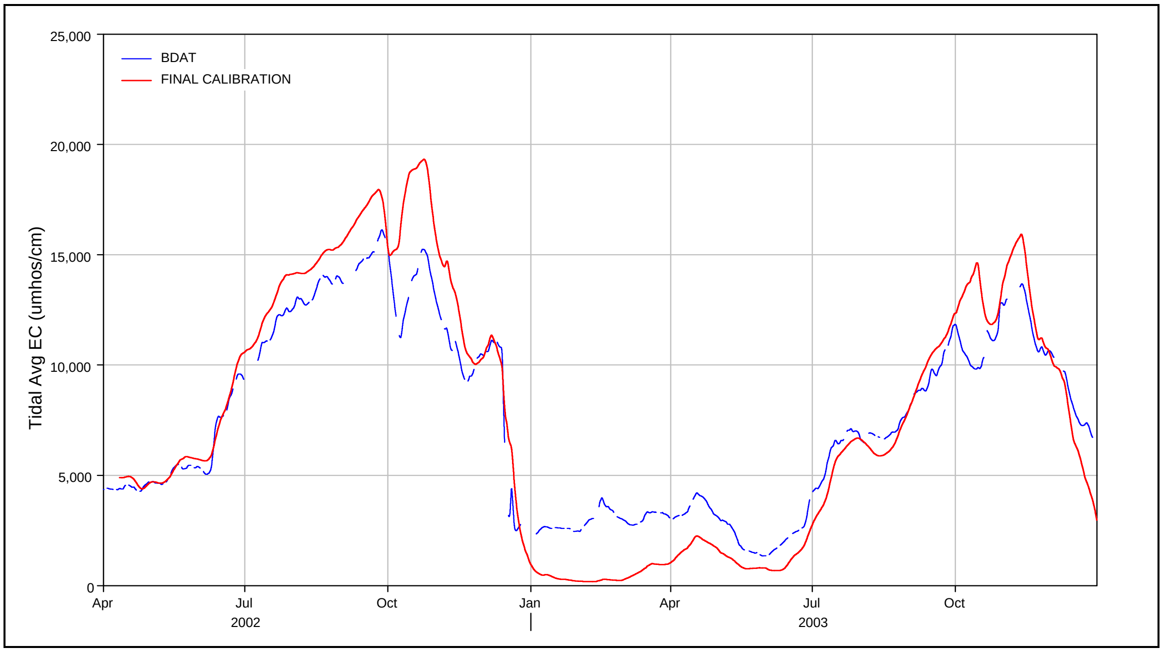


Figure 4-33 Tidally averaged observed and computed EC at station S-42, Volanti.

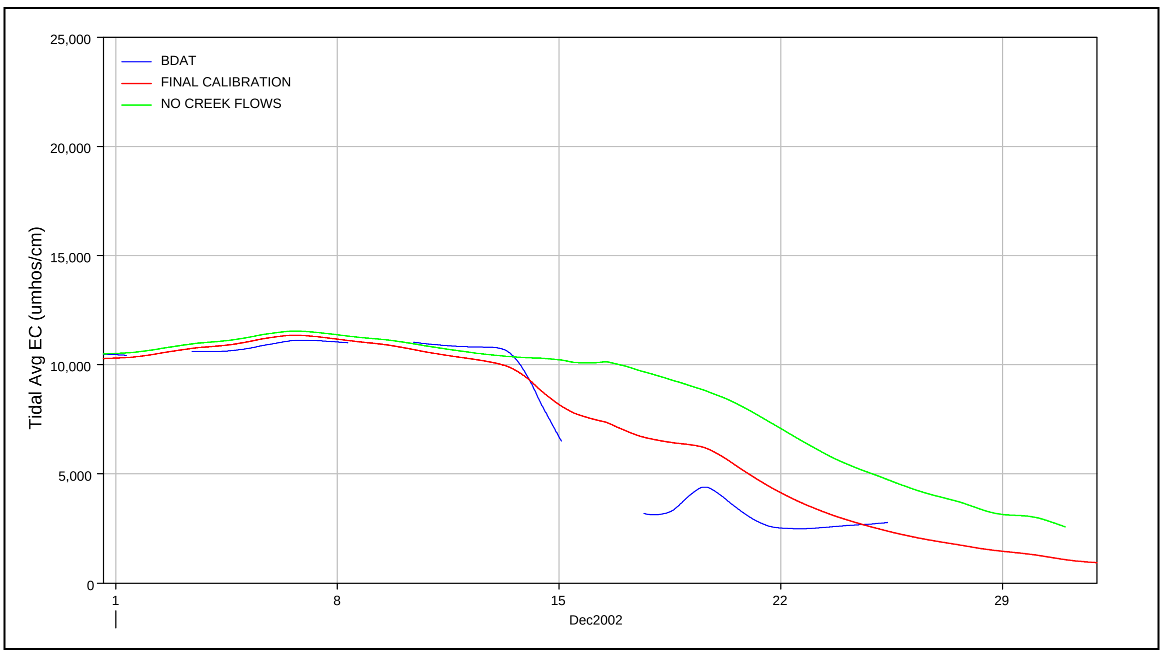


Figure 4-34 Tidally averaged observed and computed EC at station S-42, Volanti in December, 2002. Computed results shown with and without local creek flow addition.

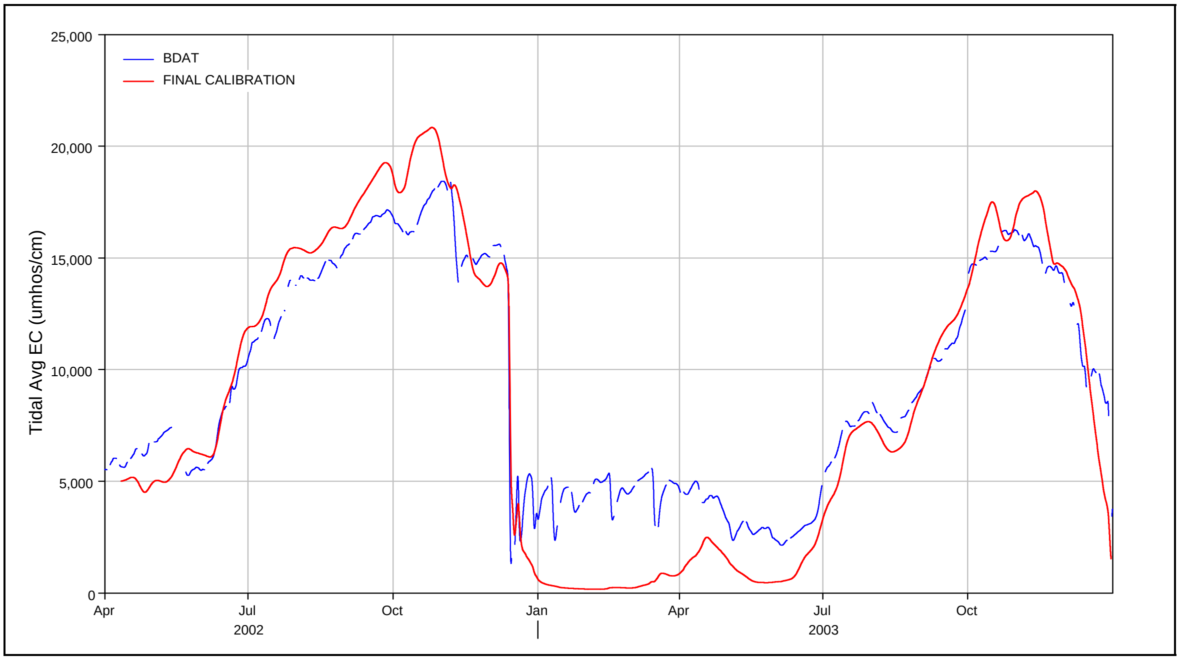


Figure 4-35 Tidally averaged observed and computed EC at station S-97, in Cordelia Slough at Ibis.

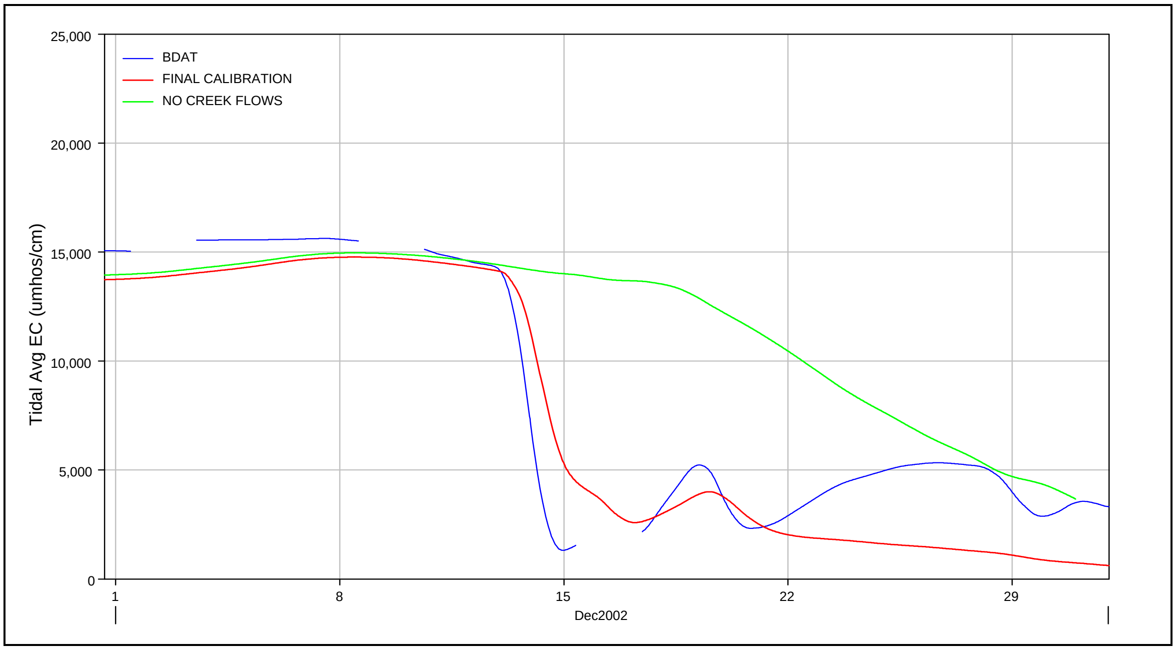


Figure 4-36 Tidally averaged observed and computed EC at station S-97, in Cordelia Slough at Ibis December, 2002. Computed results shown with and without local creek flow addition.

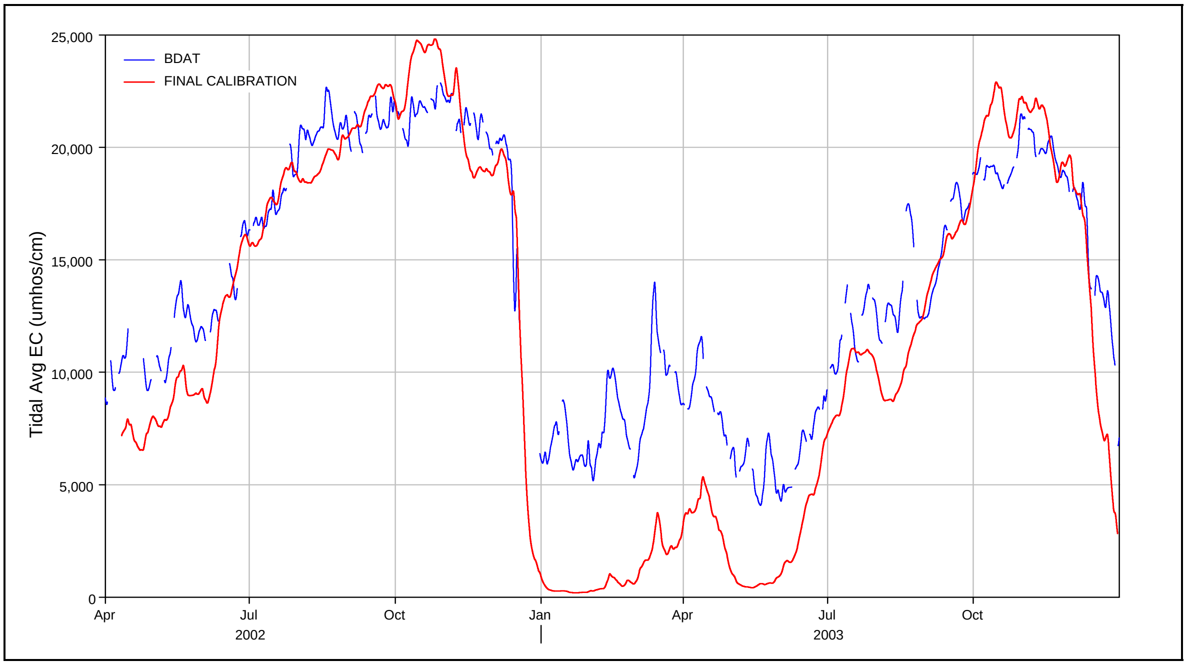


Figure 4-37 Tidally averaged observed and computed EC at station A-96 on Goodyear Slough at Fleet.

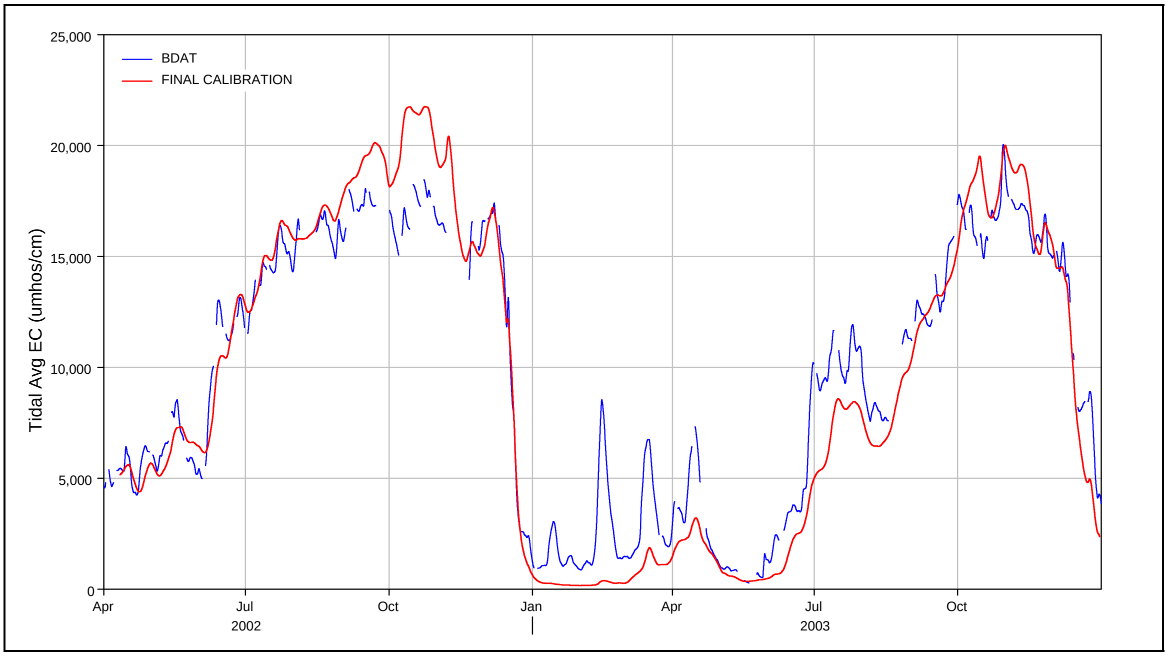


Figure 4-38 Tidally averaged observed and computed EC at station S-37 in Suisun Slough at Godfather.

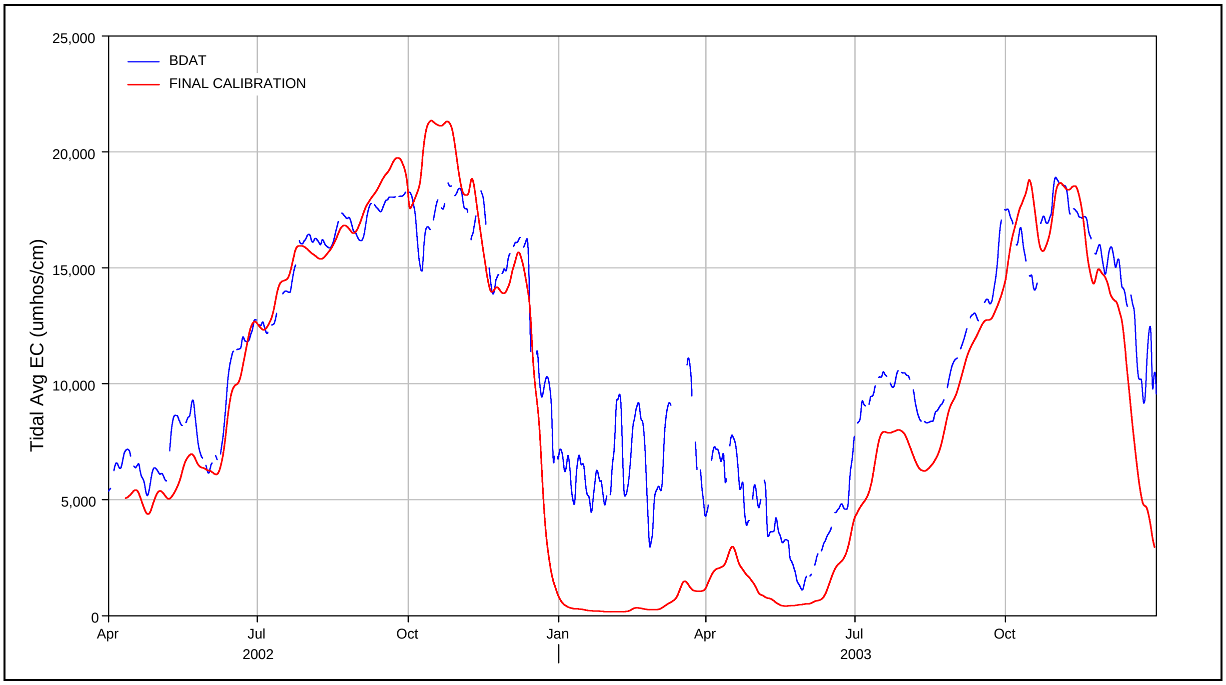


Figure 4-39 Tidally averaged observed and computed EC at station S-35 at Morrow Island.

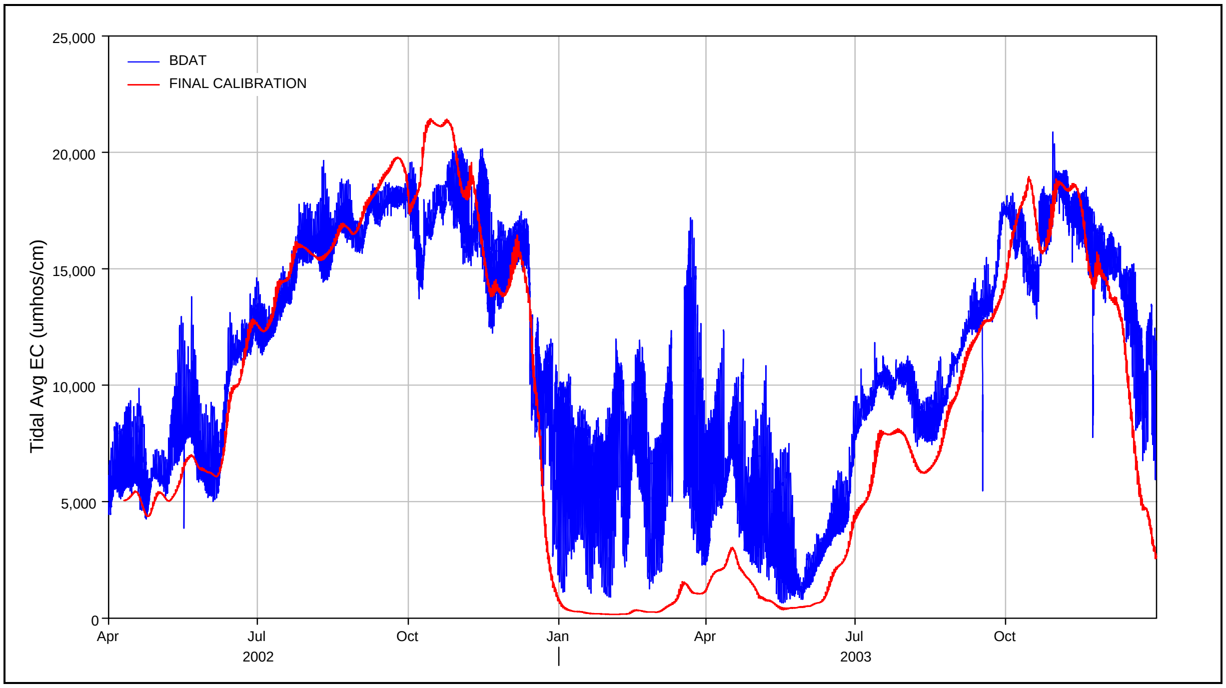


Figure 4-40 Intertidal observed and computed EC at station S-35 at Morrow Island.

4.3. Summary of Unresolved Calibration Issues

Although the model additions and improvements, and the hydrodynamic and EC calibration efforts greatly improved the representation of flows and EC in Suisun Marsh, there are several issues that may influence the representation of scenario results. One modification to the model that could potentially improve calibration results would be to include a formulation for gravitational circulation to improve the representation of salinity stratification effects.

There was insufficient data in some critical areas of the model, such as insufficient data to represent local inflows and withdrawals in Suisun Marsh. Although modeled stage representation was generally good, some of the flows in major sloughs had substantial error, such as in Montezuma and Suisun Sloughs, which may bias EC model results in the scenarios. In the periphery areas of Suisun Marsh, much of the difference between modeled and measured EC and flow may be due to estimation of local creek flows and managed wetland diversions and returns.

5. Tidal Restoration Scenario Simulations

Each of the Suisun Marsh restoration scenarios (Figure 1-1) was modeled to evaluate its effect on tidal range, scour, tidal prism and EC in Suisun Marsh and EC in the Delta. A Base case scenario was also modeled. In cases where 1-D sections of the Base case mesh were extended to 2-D for the scenarios, the comparison between the cross-sectionally averaged 1-D Base case mesh results and depth-averaged 2-D scenario mesh results is not necessarily direct. However, comparison plots are still used to get a general idea of the potential magnitude of the differences.

Zone 1 has one breached levee near the mouth of Suisun Slough and another on Goodyear Slough. This restored area is incorporated in Set 2, which also has two restored areas with breaches on or near Honker Bay, an area off of Montezuma Slough, and two areas on smaller sloughs in the interior of the northeastern area of Suisun Marsh. Zone 4 has two breach locations on Montezuma Slough. Set 1 includes the Zone 4 area, as well as areas in the interior of the marsh, with breaches on smaller sloughs in the northeastern and northwestern corners of the marsh.

5.1. Boundary Conditions

Boundary conditions for the four scenarios were in large part the same as those for the Base case, with the primary difference in filling and draining of the duck club ponds to accommodate changes in geometry. The fill and drain flow rates of the duck ponds were reduced by eliminating the flooded area from the volume calculation.

5.2. Simulation Period

The simulation period for the Base case and four scenarios extends from April 10, 2002 through December 31, 2003.

5.3. Mesh

LiDAR data (DWR, 2007) and aerial photographs were used to guide the elevation and extent of the breached and flooded areas incorporated in each of the scenarios.

5.3.1. Base

The Base case model differs slightly from the calibration model. It was assumed that the Meins Landing and Hill Slough marsh restoration projects, although not currently complete, would be in place by the time any of the scenarios would be implemented. Therefore, these areas were included in the Base case and in each of the scenarios. Figure 5-1 and Figure 5-2 illustrate the grid and bottom elevation, respectively, in the Suisun Marsh region for the Base case.

5.3.2. Set 2 and Zone 1

The total restoration area for Set 2 is approximately 7529 acres (not including Meins Landing, Hill Slough or Blacklock). Figure 5-3 and Figure 5-4 illustrate the grid and bottom elevation, respectively, in the Suisun Marsh region for Set 2.

Set 2 scenario geometry incorporates the Zone 1 (see Figure 1-1) marsh restoration which occurs at Morrow Island with breaches off of Suisun Slough and Goodyear Slough. The flooded area is approximately 2003 acres. The remainder of the restoration area for Set 2 consists of breaches flooding approximately 2107 acres north of Suisun Slough at Cutoff Slough, north and south of Cross Slough, and between Nurse Slough and Luco Slough. Two additional breaches off of Suisun Bay flood approximately 3419 acres of Simmons, Dutton and Wheeler Islands.

5.3.3. Set 1 and Zone 4

Total restoration area for Set 1 is approximately 7821 acres (not including Meins Landing, Hill Slough or Blacklock). Figure 5-5 and Figure 5-6 illustrate the grid and bottom elevation, respectively, in the Suisun Marsh region for Set 1.

Set 1 scenario geometry incorporates Zone 4 (see Figure 1-1), as well as the breached area between Nurse Slough and Luco Slough (approximately 582 acres), and several breached areas in western Suisun Marsh totaling approximately 3895 acres. Zone 4 scenario geometry includes proposed tidal marsh restoration area south of Suisun Slough at Frost Slough, with two breaches off of Suisun Slough. The flooded area is approximately 3344 acres.

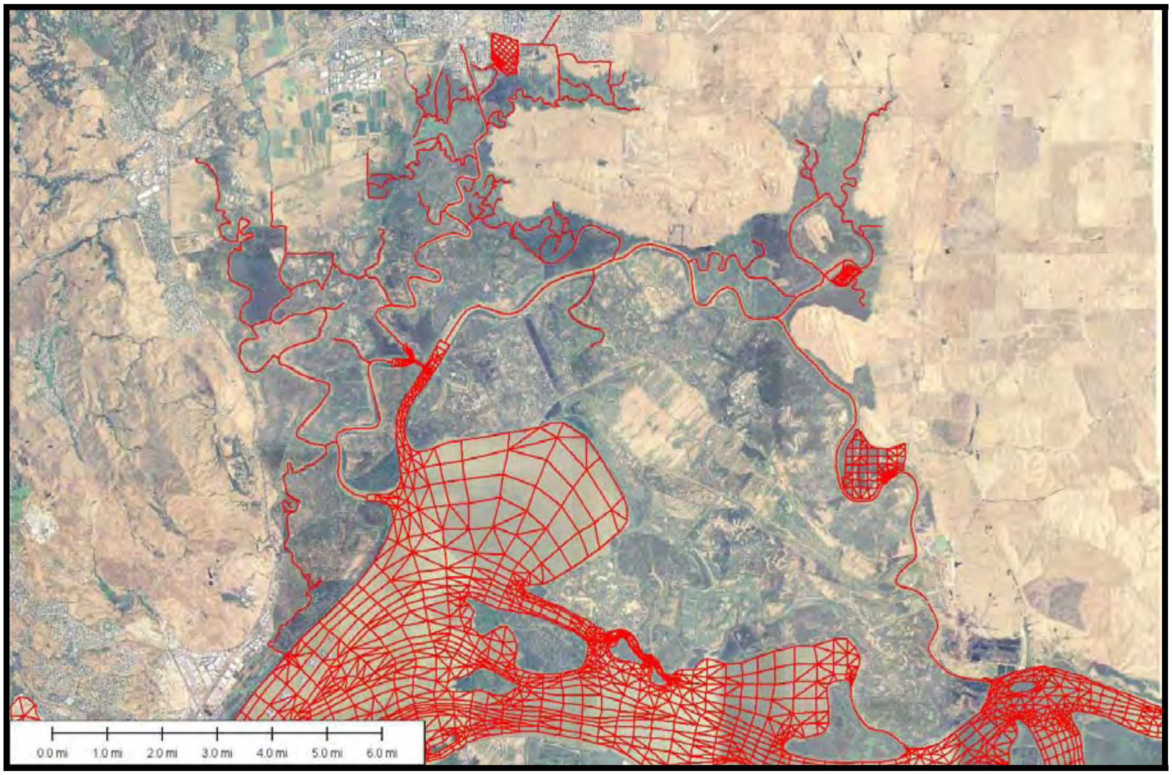


Figure 5-1 Base case grid in Suisun Marsh.

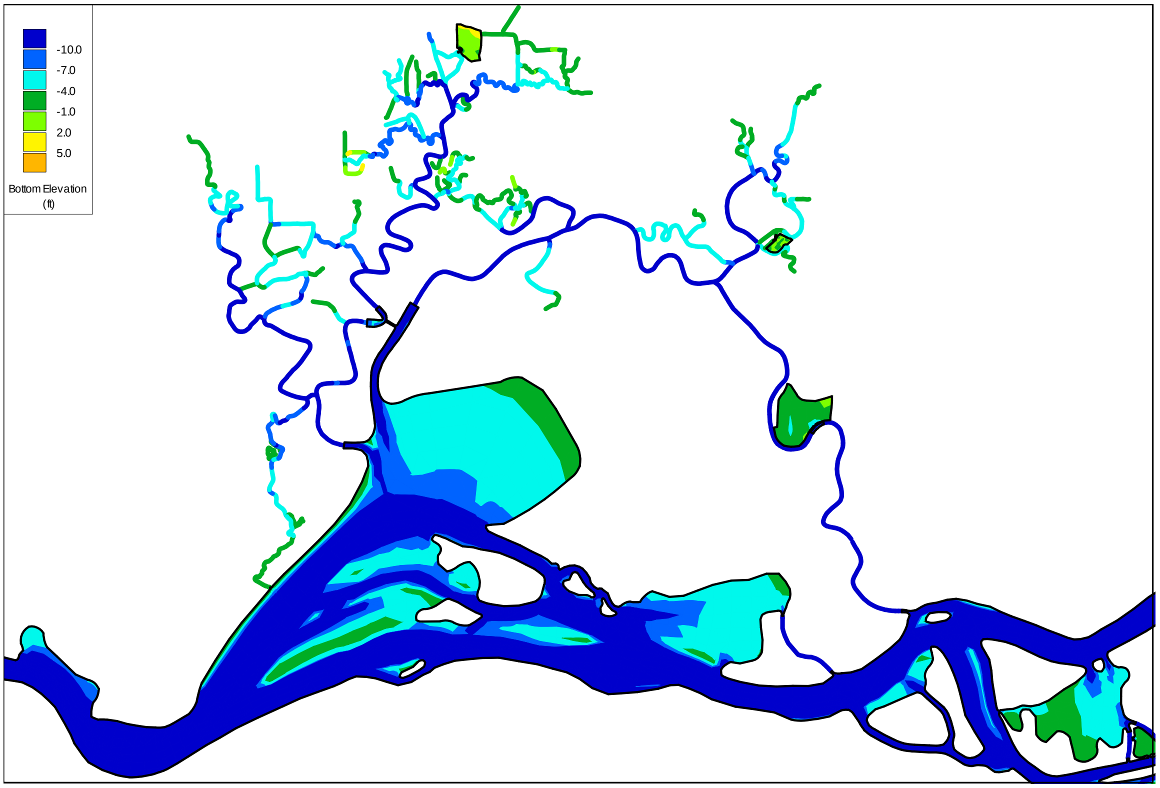


Figure 5-2 Bottom elevation for the Base case grid.

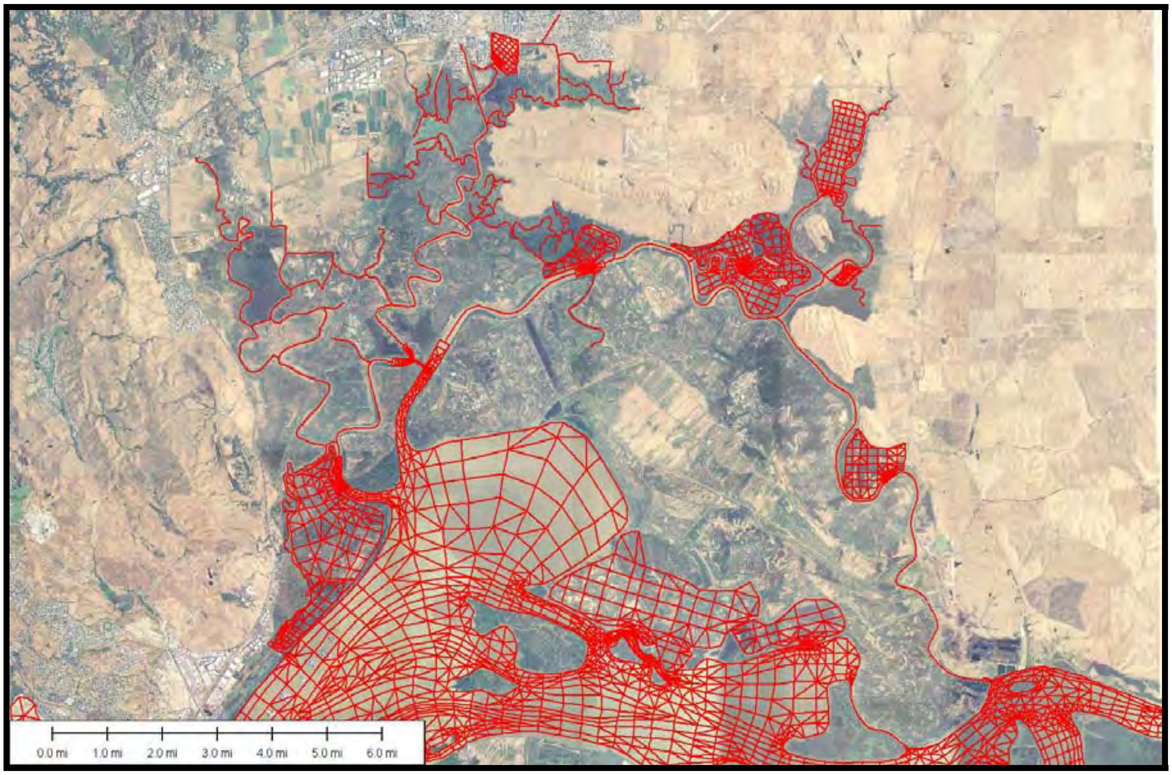


Figure 5-3 Set 2 grid in Suisun Marsh.

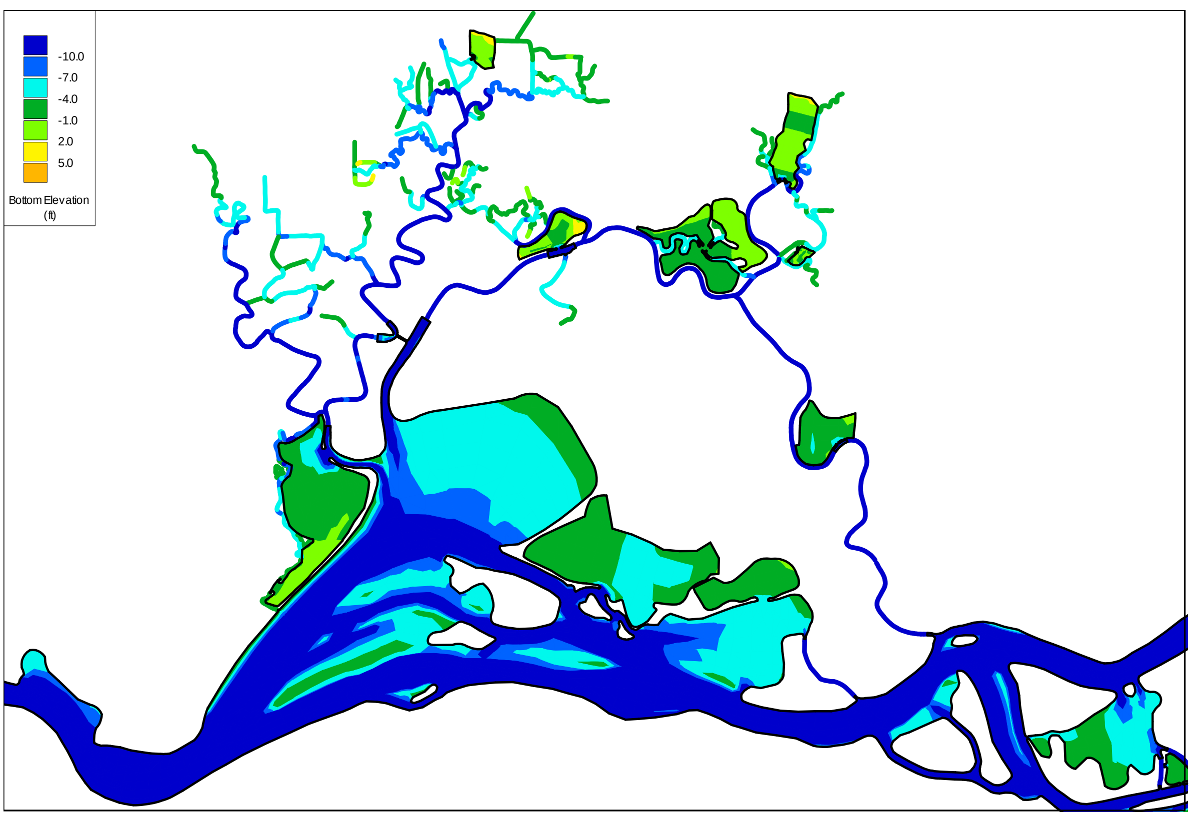


Figure 5-4 Bottom elevation for the Set 2 grid.

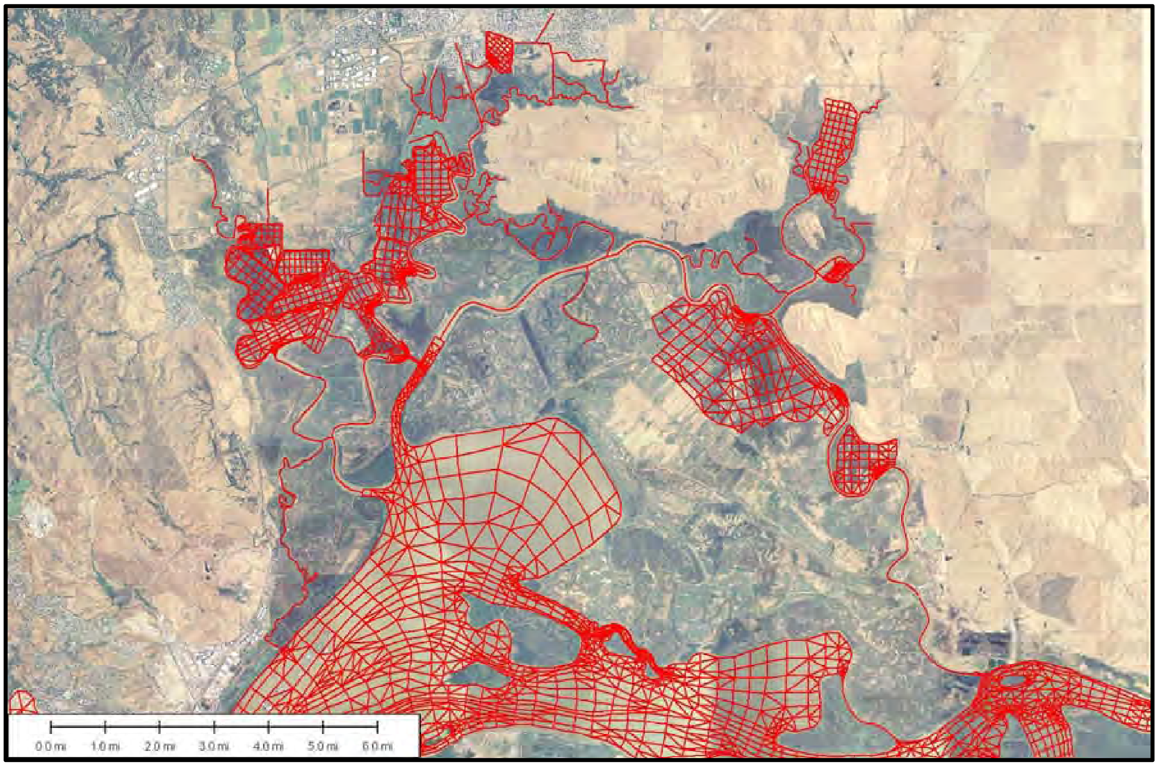


Figure 5-5 Set 1 grid in Suisun Marsh

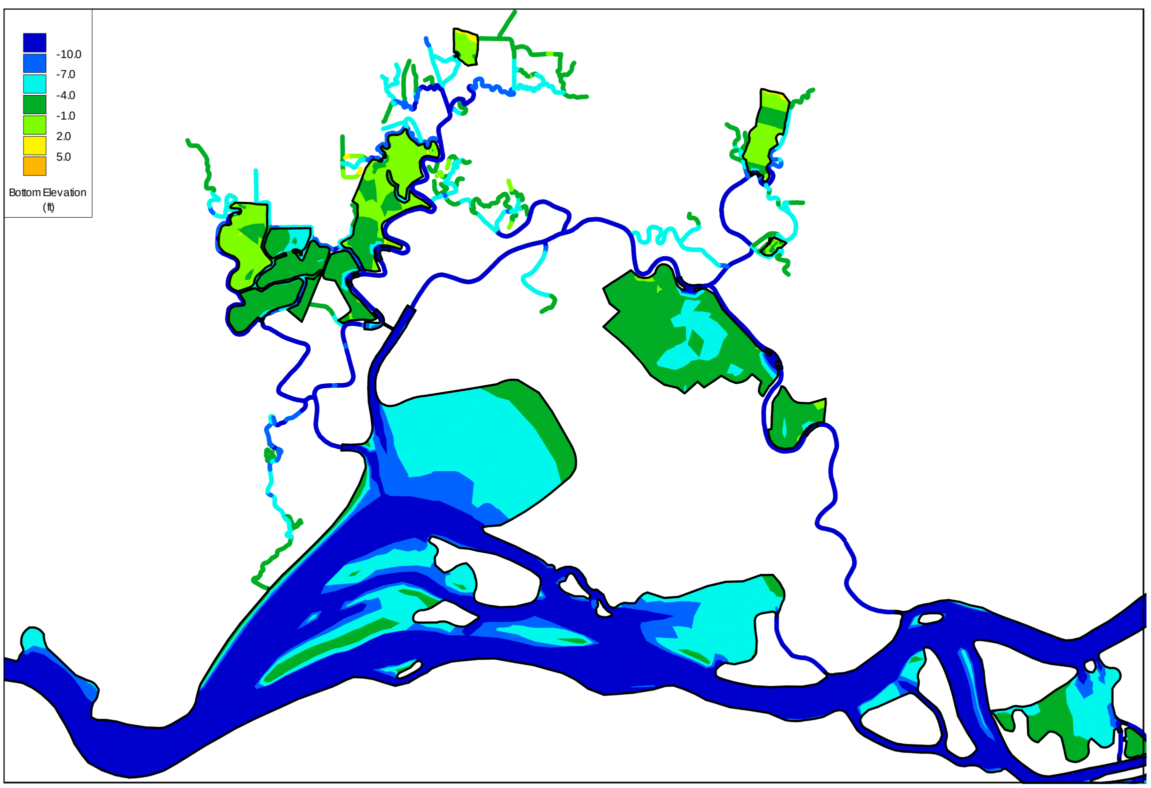


Figure 5-6 Bottom elevation for the Set 1 grid.

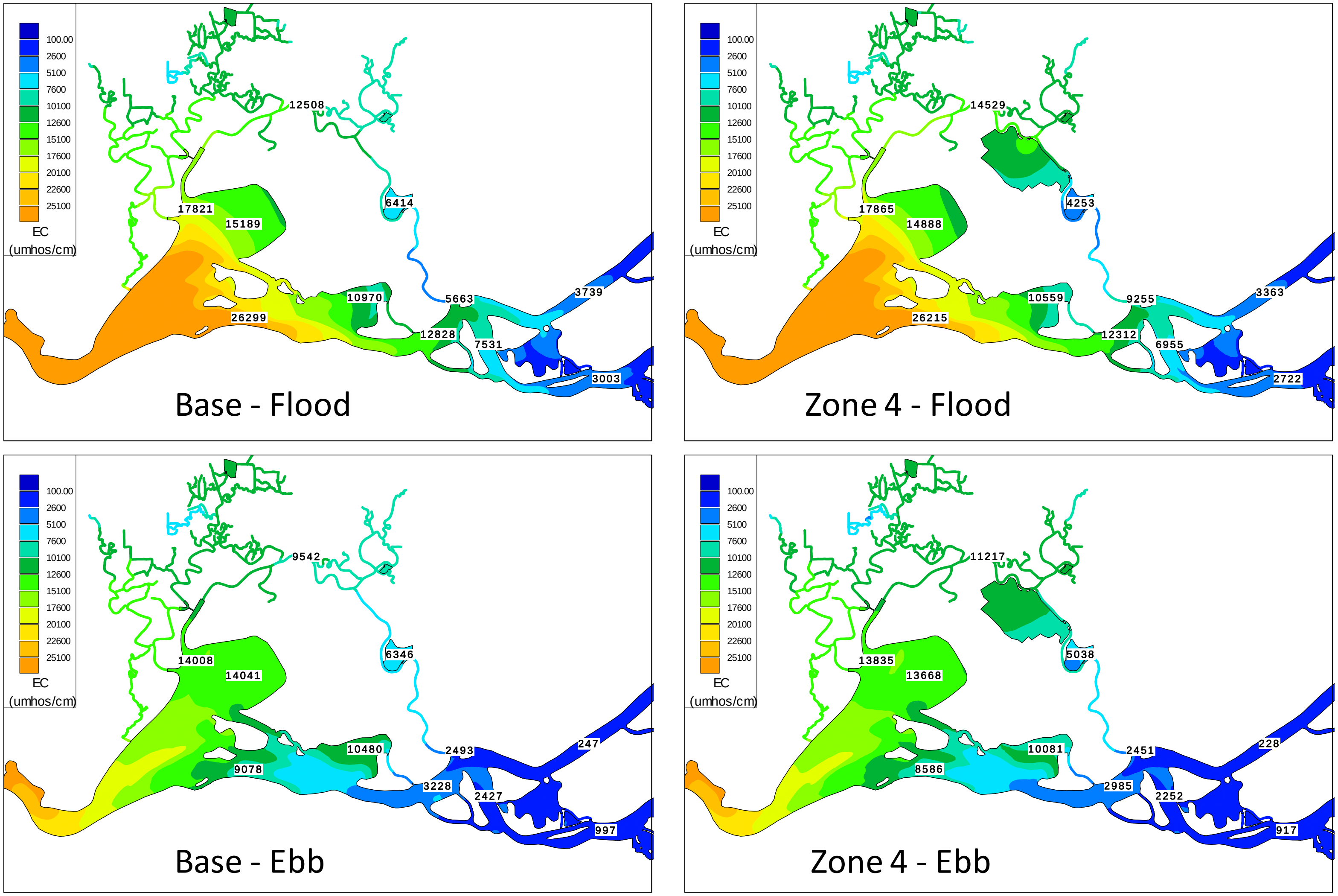


Figure 5-40 Color contour plots of EC for the Base case (left) and Zone 4 scenario (right) at the same timing on a flood tide (upper) and ebb tide (lower).

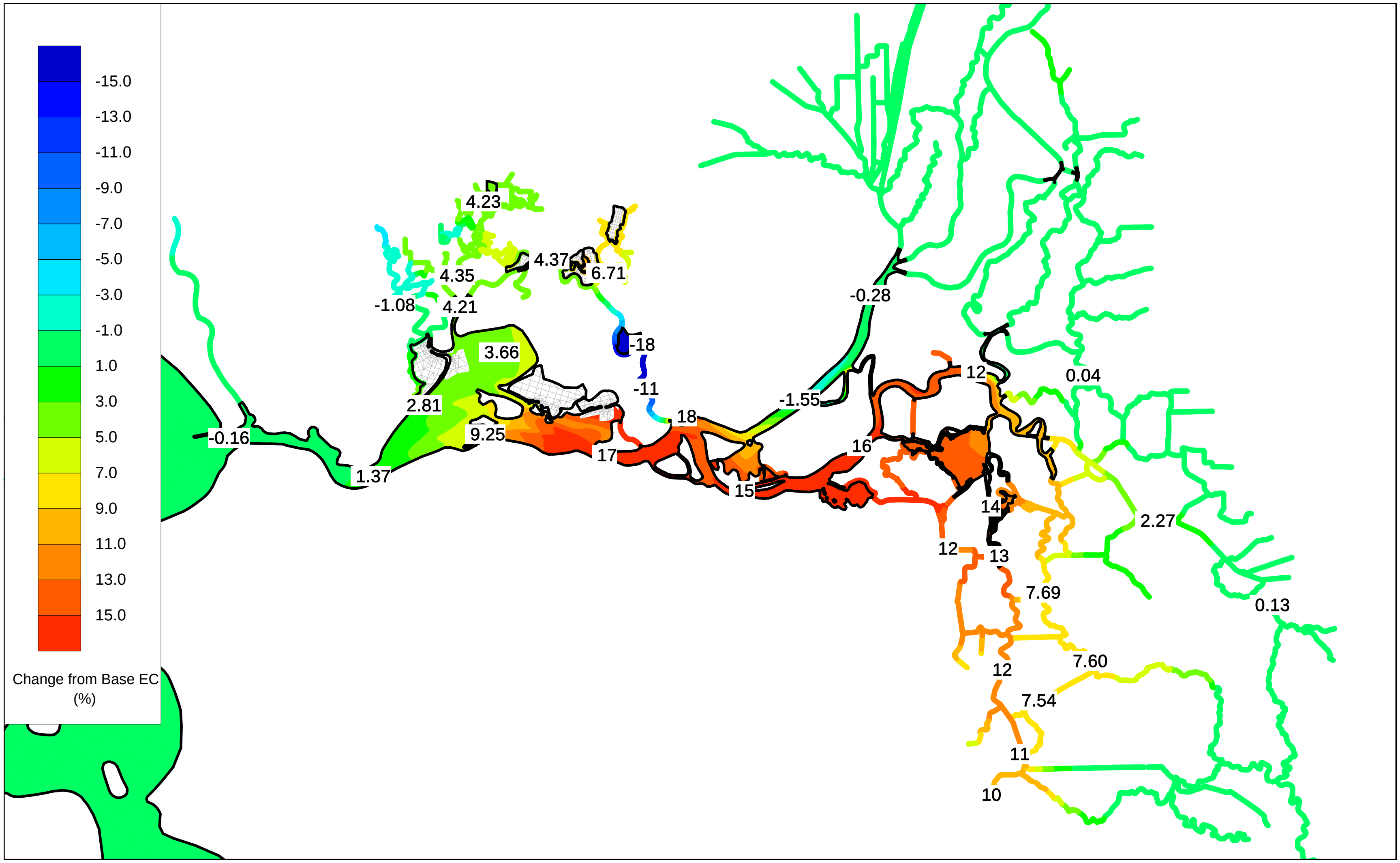


Figure 5-41 Set 2 EC % change from Base case – August 1, 2002.

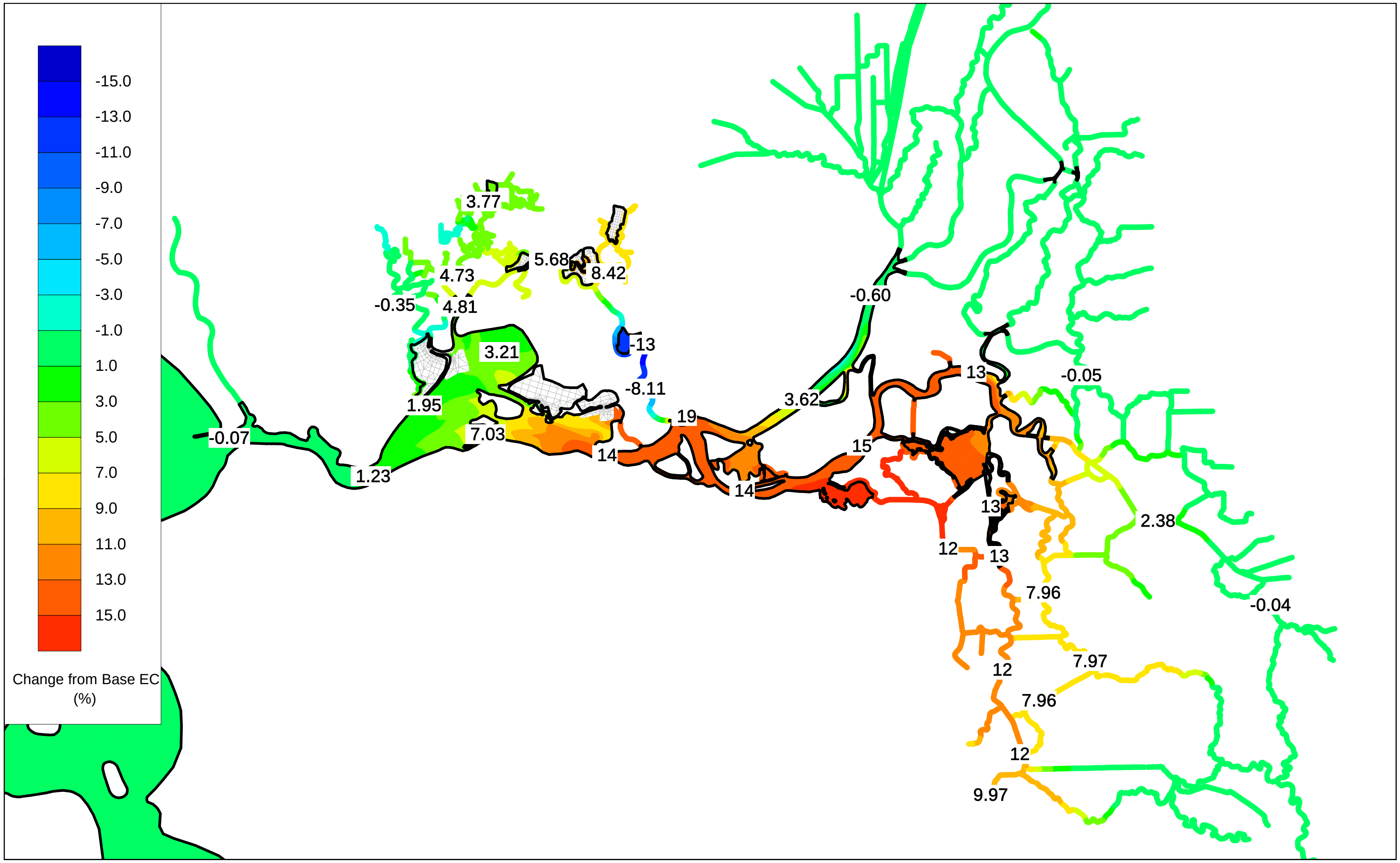


Figure 5-42 Set 2 EC % change from Base case – September 1, 2002.

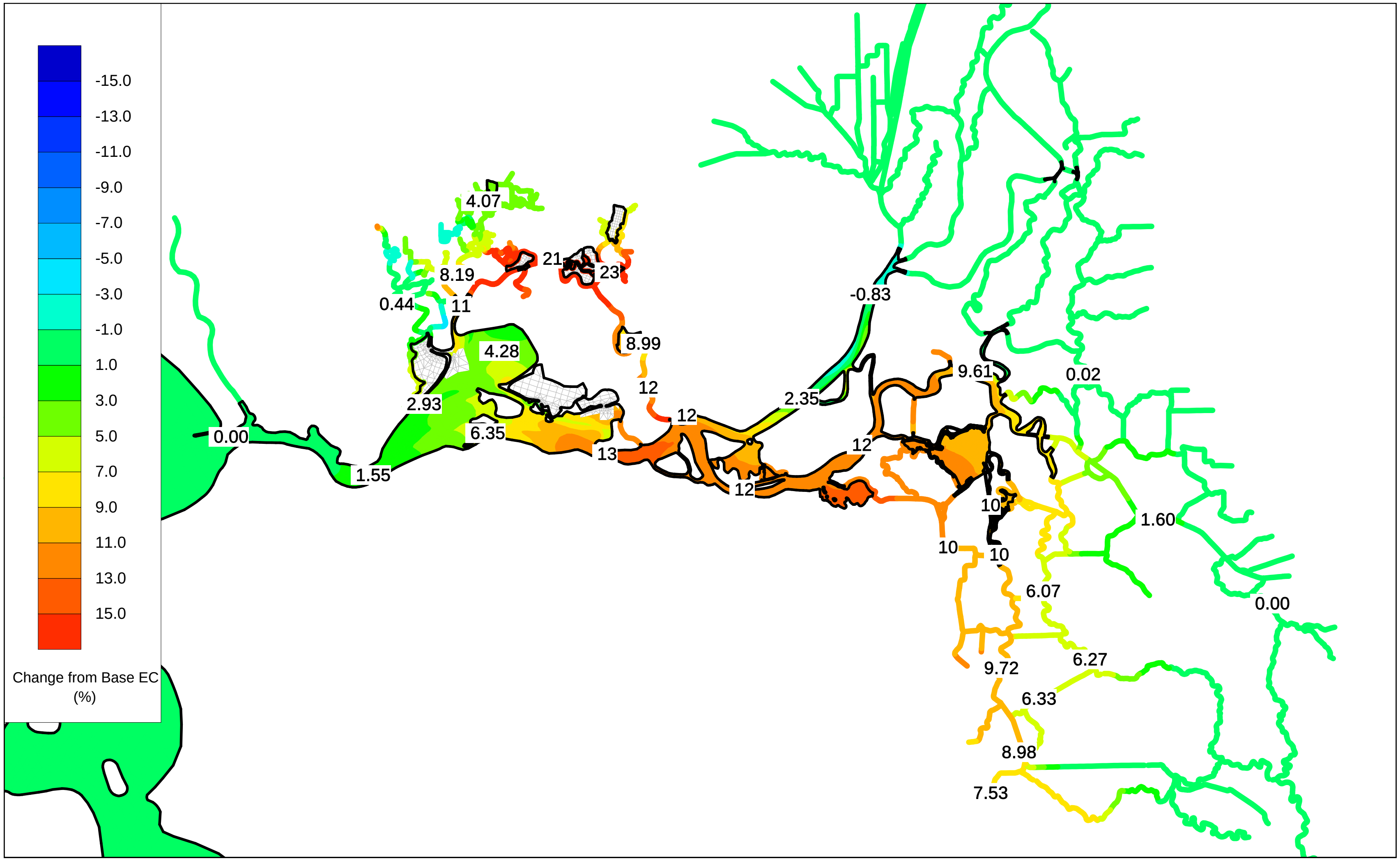


Figure 5-43 Set 2 EC % change from Base case – October 1, 2002.

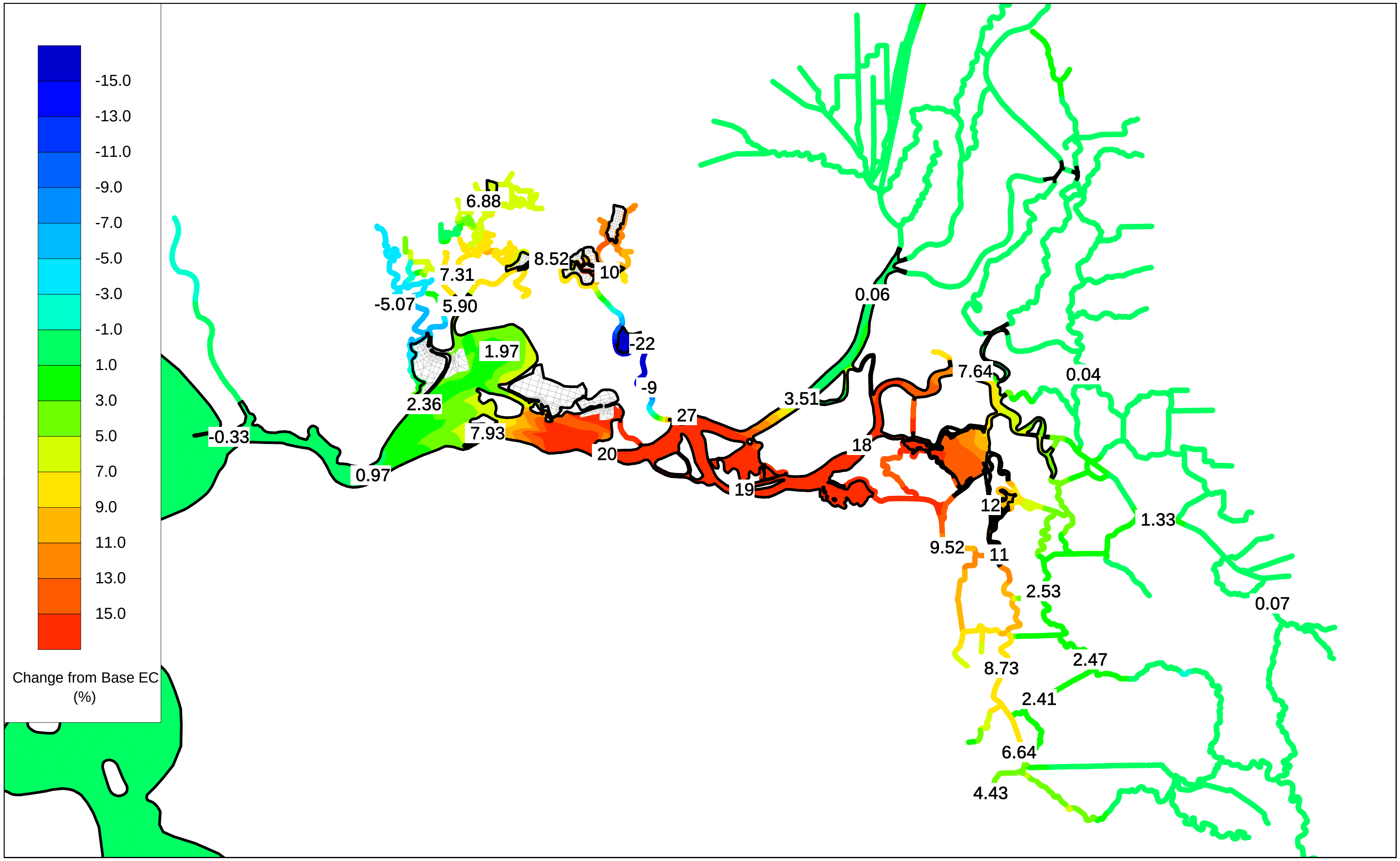


Figure 5-44 Set 2 EC % change from Base case – September 1, 2003.

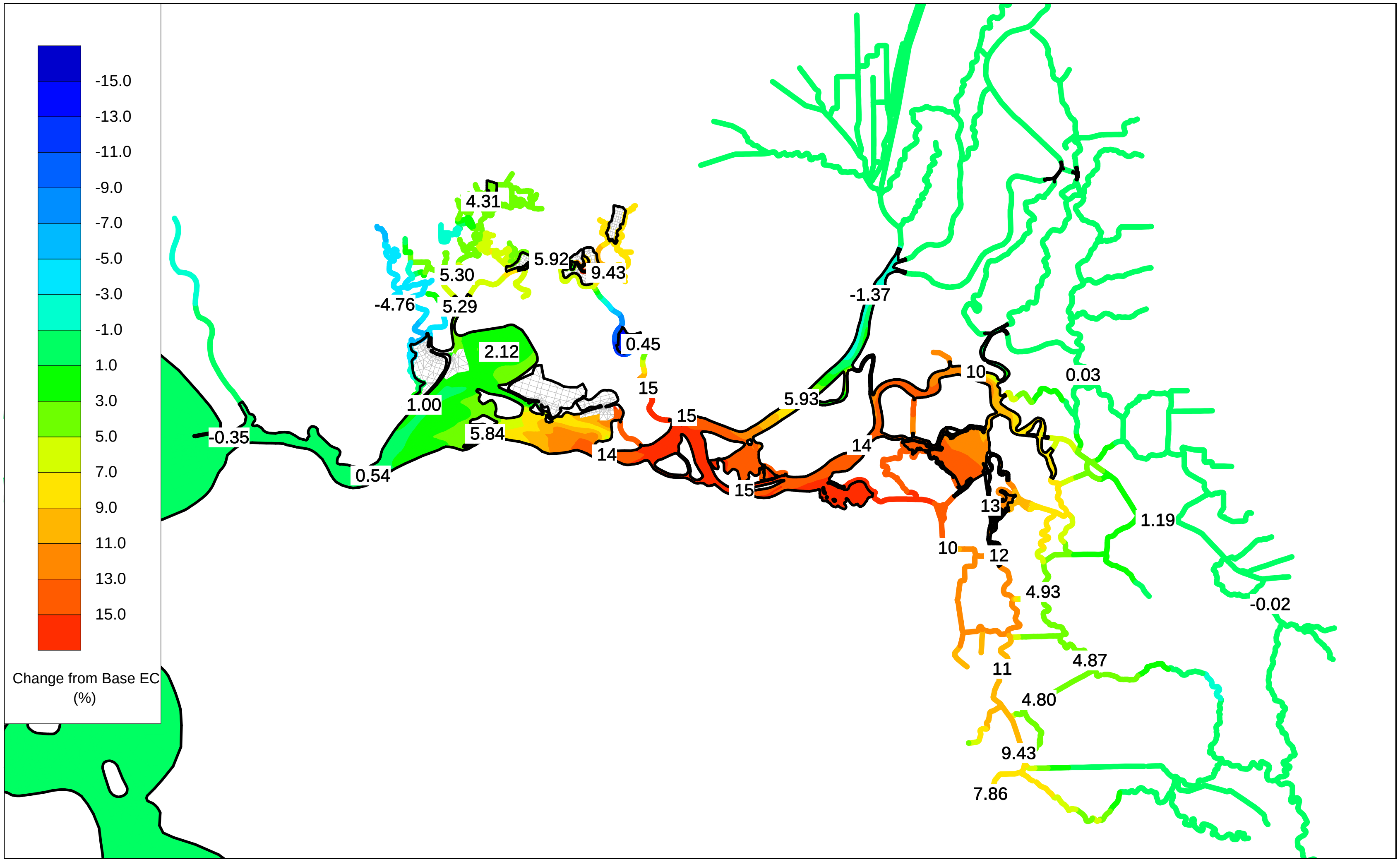


Figure 5-45 Set 2 EC % change from Base case – October 1, 2003.

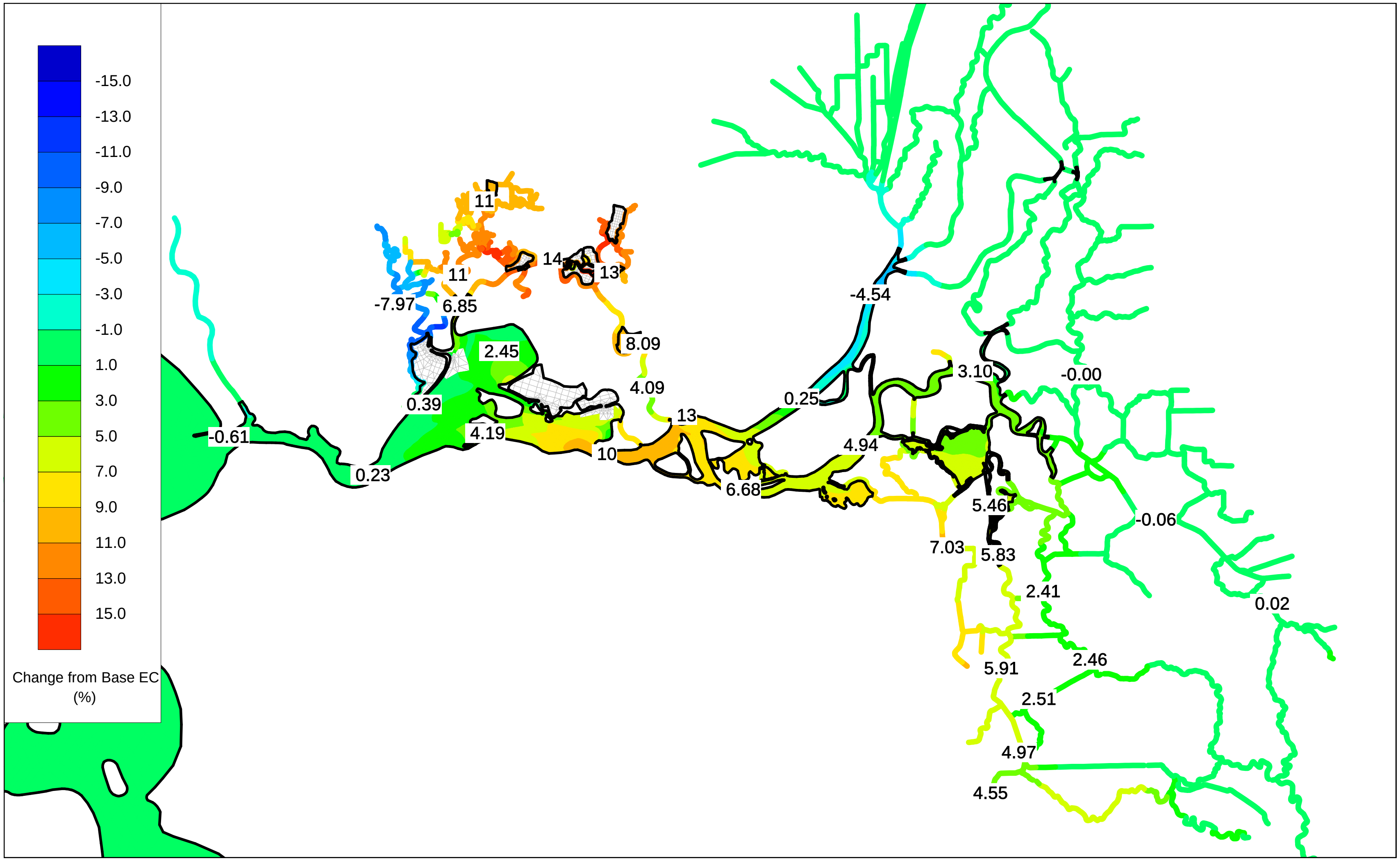


Figure 5-46 Set 2 EC % change from Base case – November 1, 2003.

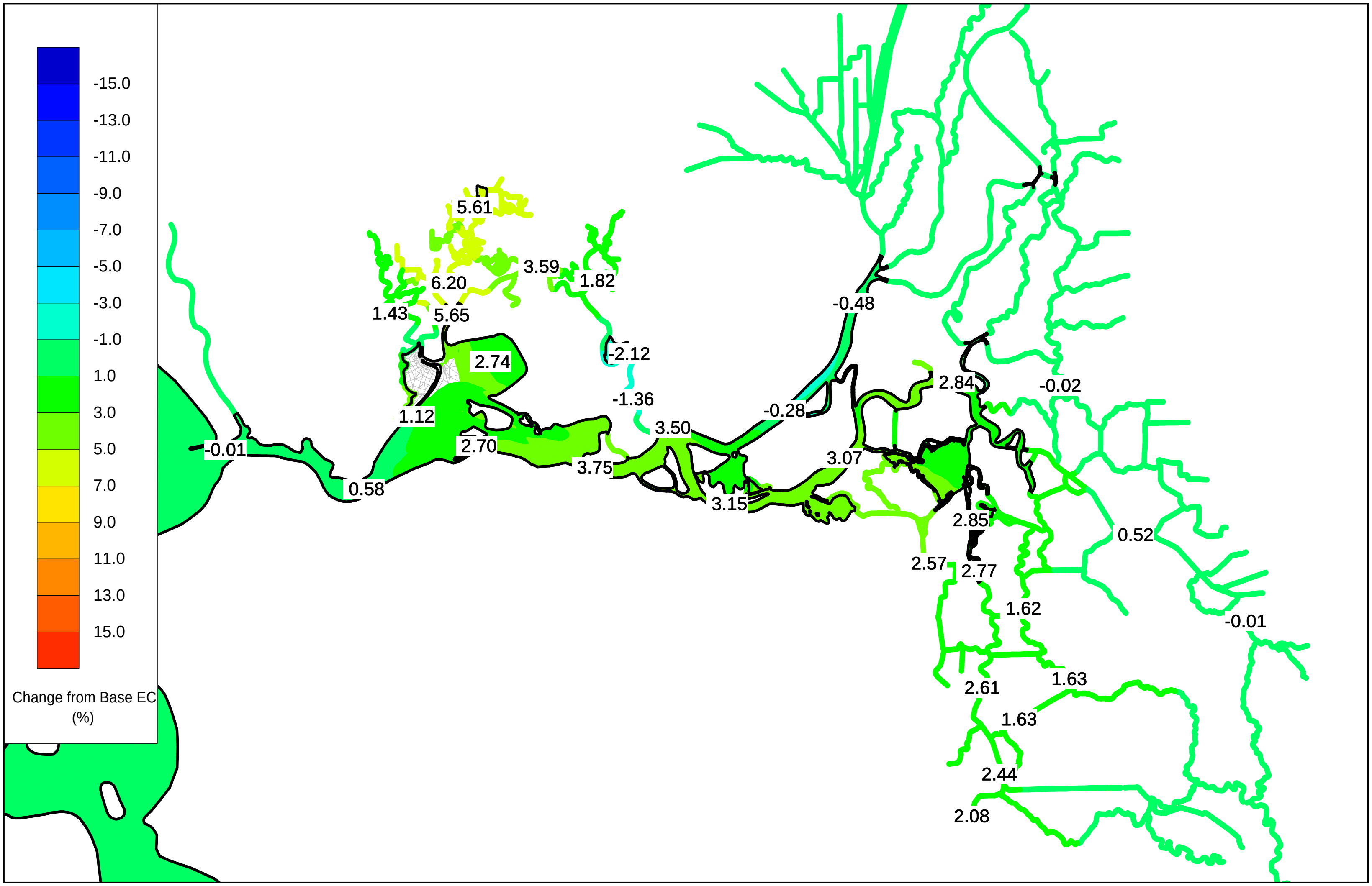


Figure 5-47 Zone 1 EC % change from Base case – September 1, 2002.

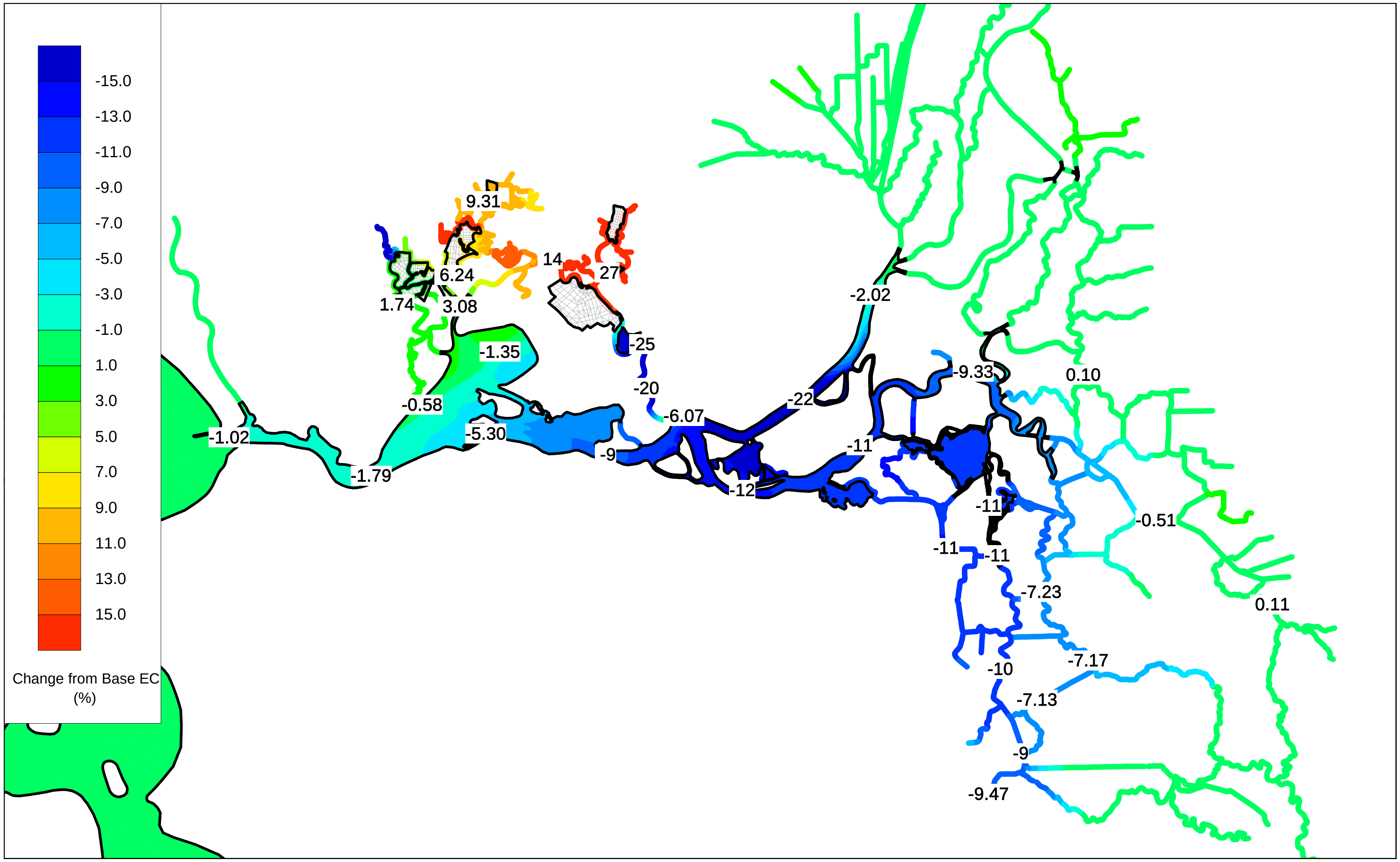


Figure 5-48 Set 1 EC % change from Base case – August 1, 2002.

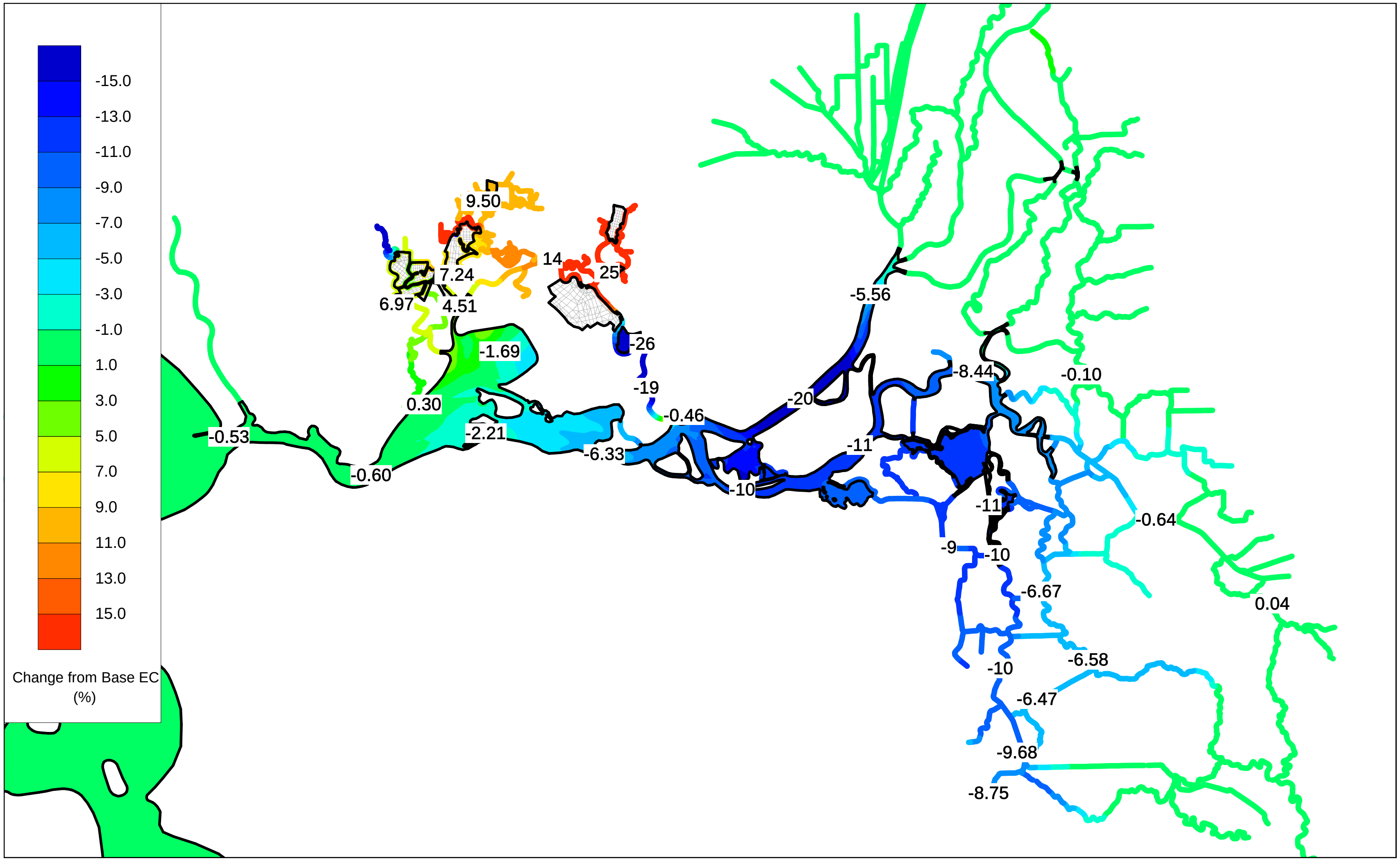


Figure 5-49 Set 1 EC % change from Base case – September 1, 2002.

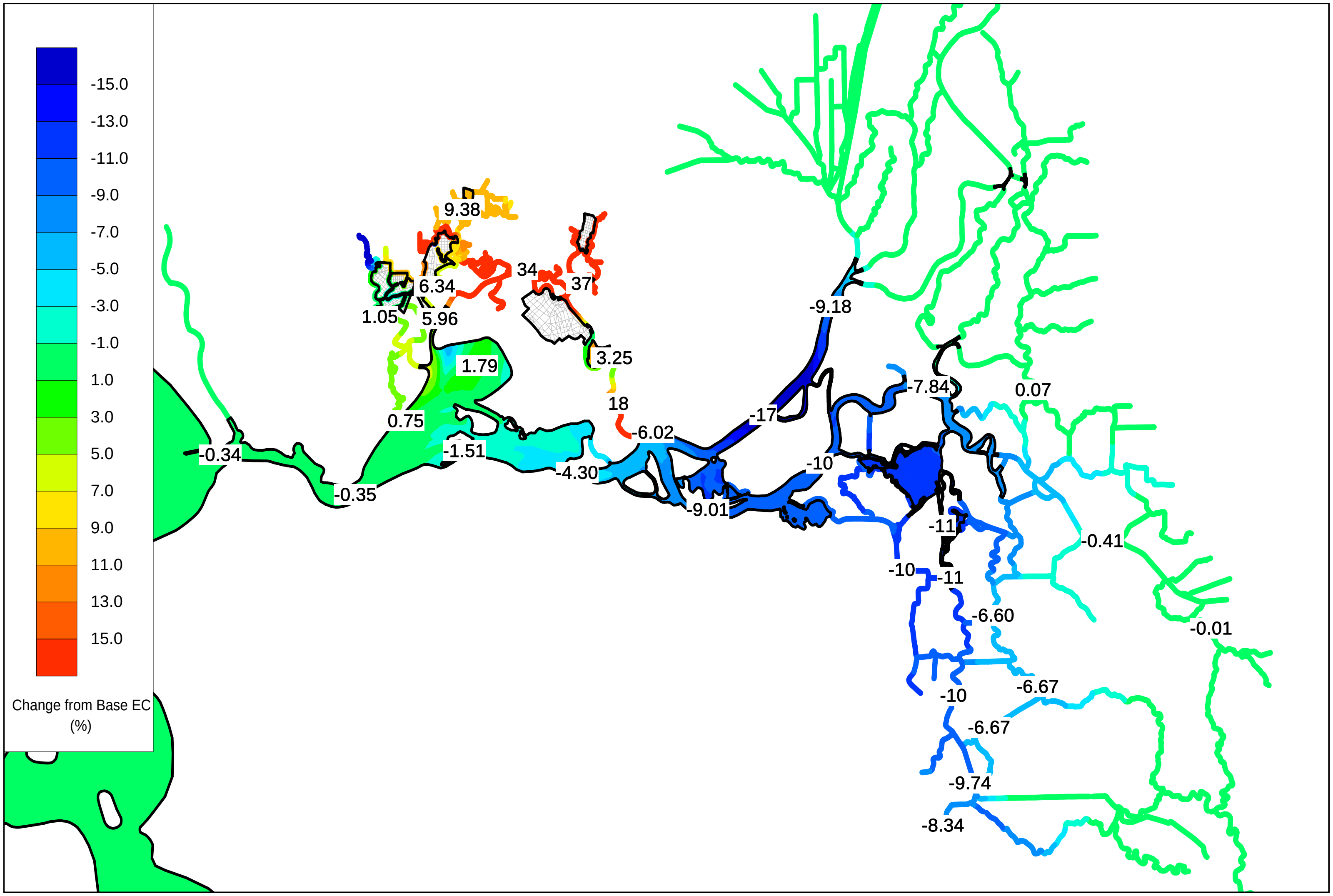


Figure 5-50 Set 1 EC % change from Base case – October 1, 2002.

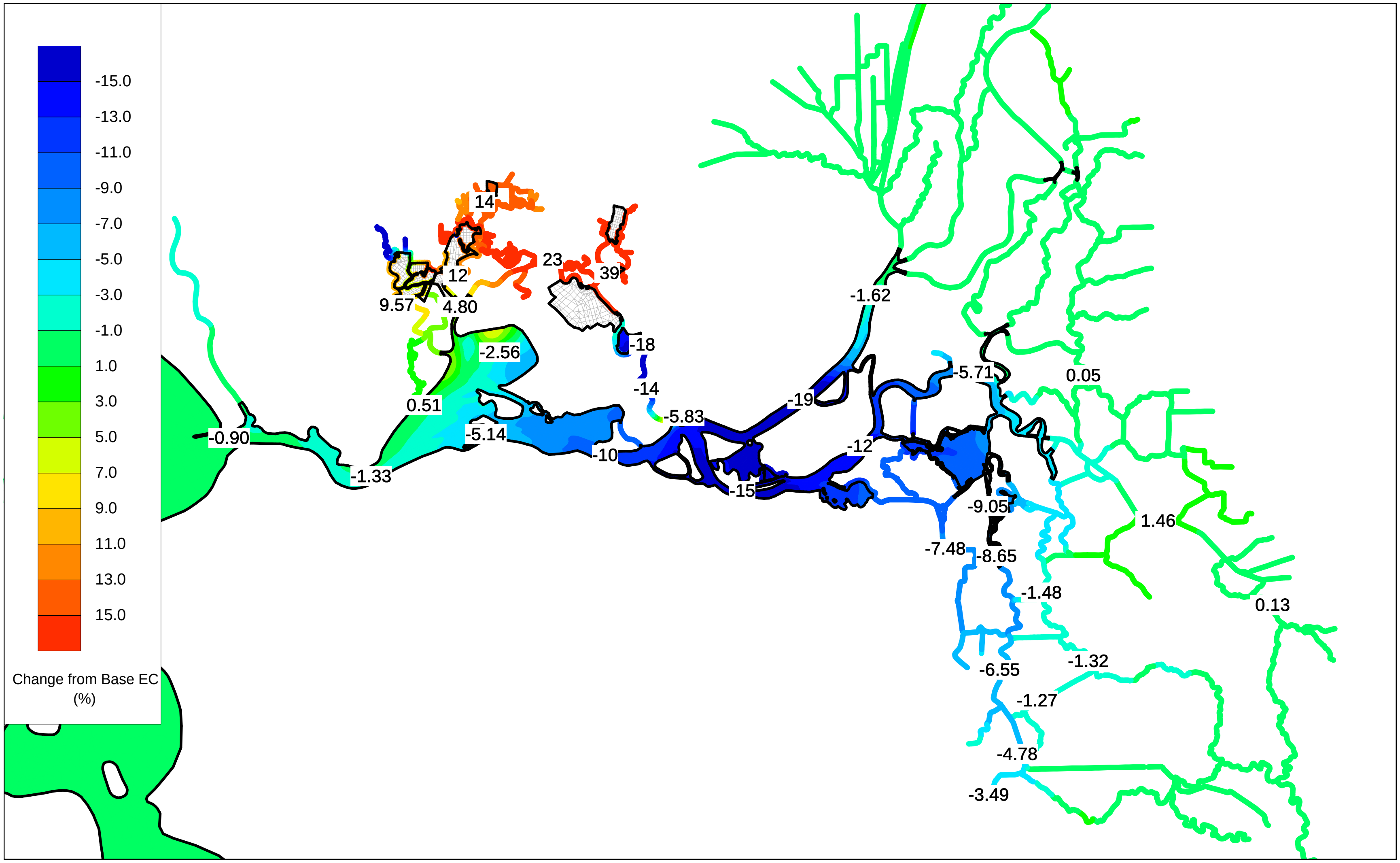


Figure 5-51 Set 1 EC % change from Base case – September 1, 2003.

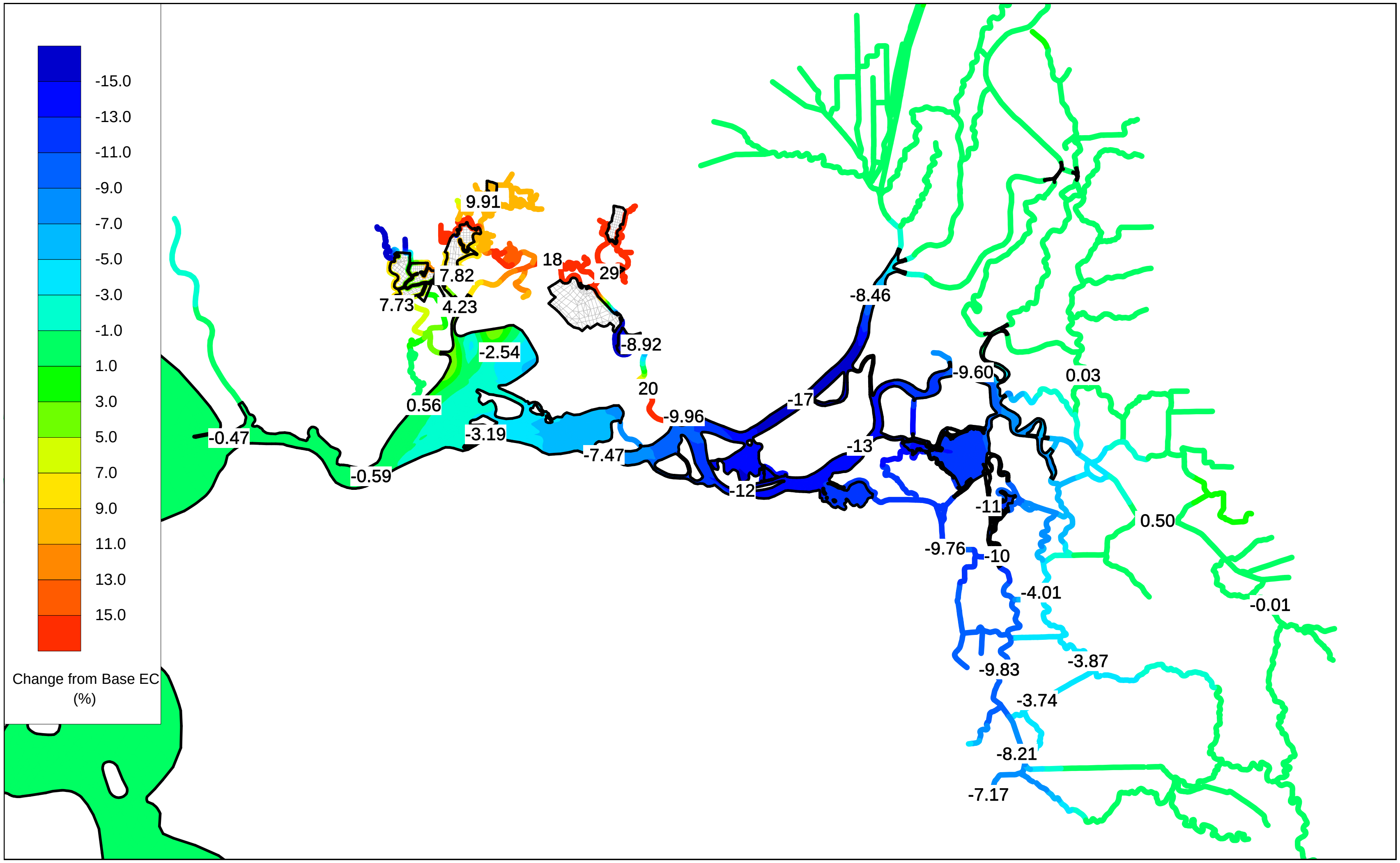


Figure 5-52 Set 1 EC % change from Base case – October 1, 2003.

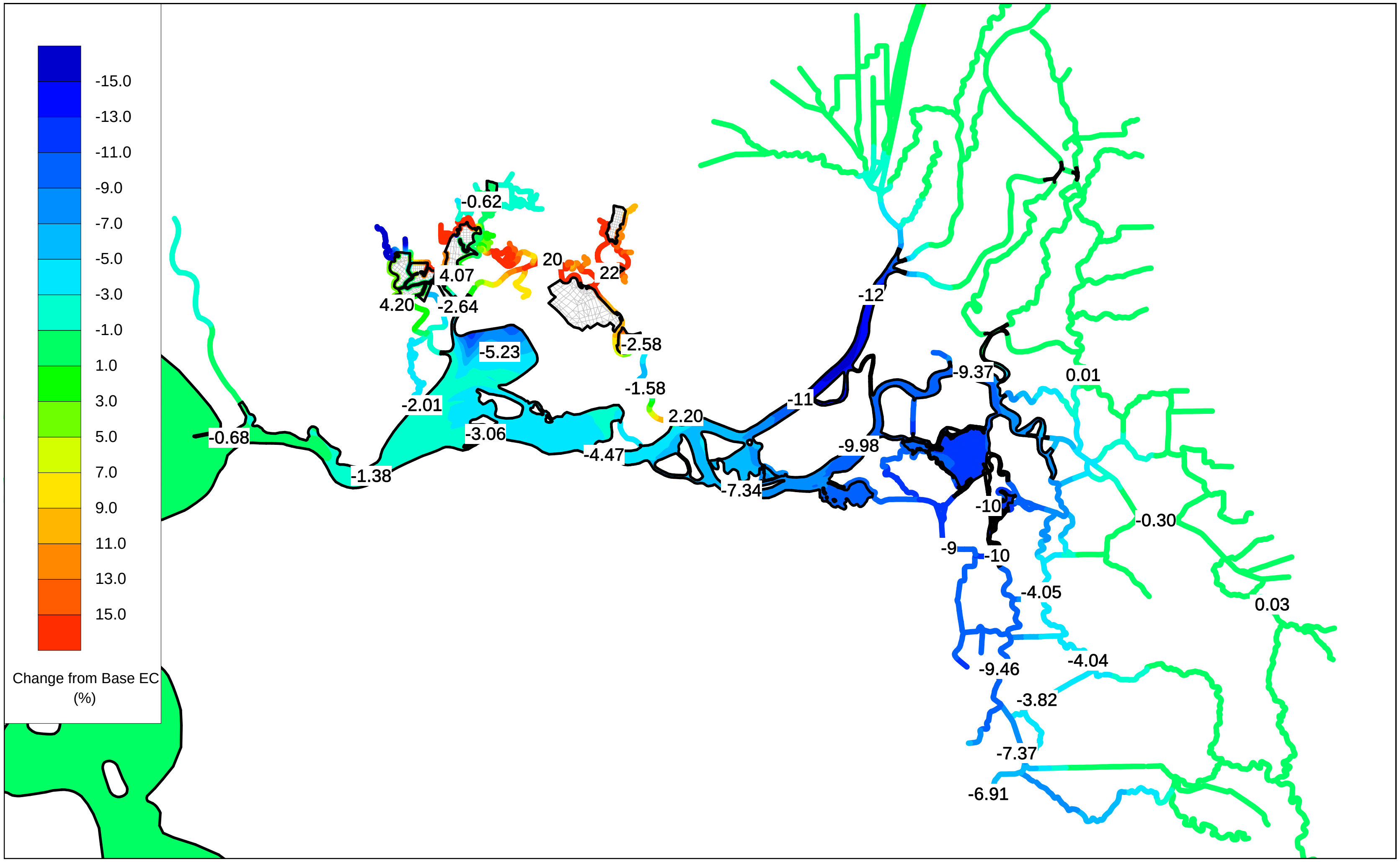


Figure 5-53 Set 1 EC % change from Base case – November 1, 2003.

5.7. Velocity Results – Scour Potential

5.7.1. Background

The creation of tidal marsh in restoration areas increased the volume of water flowing through downstream channels in Suisun Marsh each tidal cycle without a change in channel capacity. The result was an increase in velocity in some channels and sloughs and the potential for scour in channels and on banks and subsequent risk of levee failure.

The potential for channel scour and levee failure was evaluated using modeled velocity. Problem locations were identified as places where modeled velocity in the scenarios increased substantially with respect to the Base case during the July 2002 model period, in particular where velocity magnitude exceeded 2.0 ft/sec in the scenario but not in the Base case. Figure 5-54 gives location names for the six areas where potential scour problems were identified. Velocity changes in comparison with the Base case were generally small elsewhere.

Potential effects were assessed using exceedance plots of velocity distribution and magnitude. The velocity distribution plots show velocity versus the percent of time during July 2002 that each velocity was exceeded. Time series plots are also shown at some locations. Specific locations where results were assessed are indicated on velocity contour plots.

Although comparison locations for one and two-dimensional grids were selected at comparable geographical co-ordinates, comparisons between depth-averaged velocity at 2-dimensional *vs.* cross-sectionally averaged velocity at 1-dimensional grid locations should be interpreted with caution.

5.7.2. Scouring potential for the scenarios

Six locations were identified where the potential for scouring increased due to the incorporation of restoration area for the scenarios. Four of the six locations where large changes in velocity were identified occurred in channels adjacent to newly flooded areas. The maximum velocity at a given location did not occur at the same time or in the same tidal cycle in each scenario, partly due to shifts in stage timing. Velocity profiles at some problem locations exhibited a large asymmetry in velocity, e.g., the magnitude of the velocity on the incoming tide (negative velocity) increased substantially in comparison to increases on the outgoing tide.

The Set 1 and Set 2 scenarios each had the most extensive flooded areas, but the Zone 4 scenario resulted in the largest increases in channel velocity; it also reduced velocities at some locations in comparison with the Base case.

Figure 5-55 illustrates the magnitude and frequency of velocity changes at Beldon's Landing in Montezuma Slough for the scenarios. The velocity distributions for the scenarios vary in timing, as the percent of time with negative velocities (incoming tide) ranged from 47 to 49% in July, 2002. The Zone 4 restoration area has the greatest potential to influence sediment movement in Montezuma Slough, as both the Set 1 and

Zone 4 scenario velocities are nearly double the Base case values on both incoming (negative values) and outgoing (positive values) tides. Set 1 and Zone 4 velocity magnitudes were greater than 2.0 ft/sec ~ 25% of the time on both the incoming tide and outgoing tides, and were nearly symmetric with respect to tidal direction. These scenarios also produced the greatest tidal flow in Montezuma Slough (Figure 5-13).

Two points were examined at Hunter Cut: Point 1 at the bank (edge of the grid) and Point 2 in a mid-channel location (Figure 5-56). The Set 1 scenario (Figure 5-58) has the largest velocity effect mid-channel in Hunter Cut, which occurs on the outgoing tide. The large amount of restored area in the western marsh for Set 1 means that Suisun Slough and Hunter Cut contribute heavily to the channel conveyance for filling and draining the large volume of water in that restored area. Zone 1 contributes the greatest potential for scour on the levee bank in Set 2 with a large velocity magnitude on the incoming tide. The Zone 4 restoration area reduced tidal flow through Hunter Cut (Figure 5-13), as well as velocity in comparison with the Base case (Figure 5-58).

The other locations where velocity increases might result in scouring were all at the entrance to breaches at restoration areas within the marsh. Near the breach at Morrow Island (Figure 5-59), velocities are much higher for Set 2 and Zone 1 than the other scenarios (Figure 5-61). Velocities peak on the incoming tide, with the Zone 1 area contributing the majority of the velocity increase. Near the breach location at Meins Landing (Figure 5-62), the Zone 4 and Set 1 scenarios have similar velocity profiles (Figure 5-65), as both incorporate the Zone 4 region off of Montezuma Slough. Velocities on the bank (Point 1) and in mid-channel (Point 2) are very similar, while Point 3 near the entrance to the northern breach for the zone has an asymmetry profile which peaks on the incoming tide (negative velocity).

In the region near the Cross Slough (Figure 5-66), only the Set 2 scenario exhibits scour potential in comparison with the Base case. There are large velocity asymmetries in all three Set 2 points, with the mid-channel point showing the greatest potential for scour (lower right plot, Figure 5-66). Near the breach for the Duck Clubs restoration, the Set 1 scenario (Figure 5-68) has complex velocity profiles (Figure 5-69, lower plot). The modeled velocity profiles at the five points in Set 1 (Figure 5-70 and Figure 5-71) indicate that there is a high potential for scour in the channels and possibly to the levee banks, in some cases on the incoming tide (Points B and C, negative) and in others on the outgoing tide (Point B, positive).

5.7.3. **Summary**

Of the six locations identified as problematic for scouring, only two (Beldon's Landing and Hunter Cut) were located away from breach locations. The other four locations were located directly upstream of the breach. The grid development for channels near breach locations conforms to the existing channel configuration, and breaches were opened at the width of the channel at the location of the breach. Depending on the location in this channel, the increase in velocity magnitude could indicate potential problems with scour leading to failure on a levee bank (i.e., at the edge of the 2-dimensional grid) or scouring of the channel.

Changes to the channels such as deepening or widening could be modeled to assess the ability reduce scour potential both on levees and on levee banks.

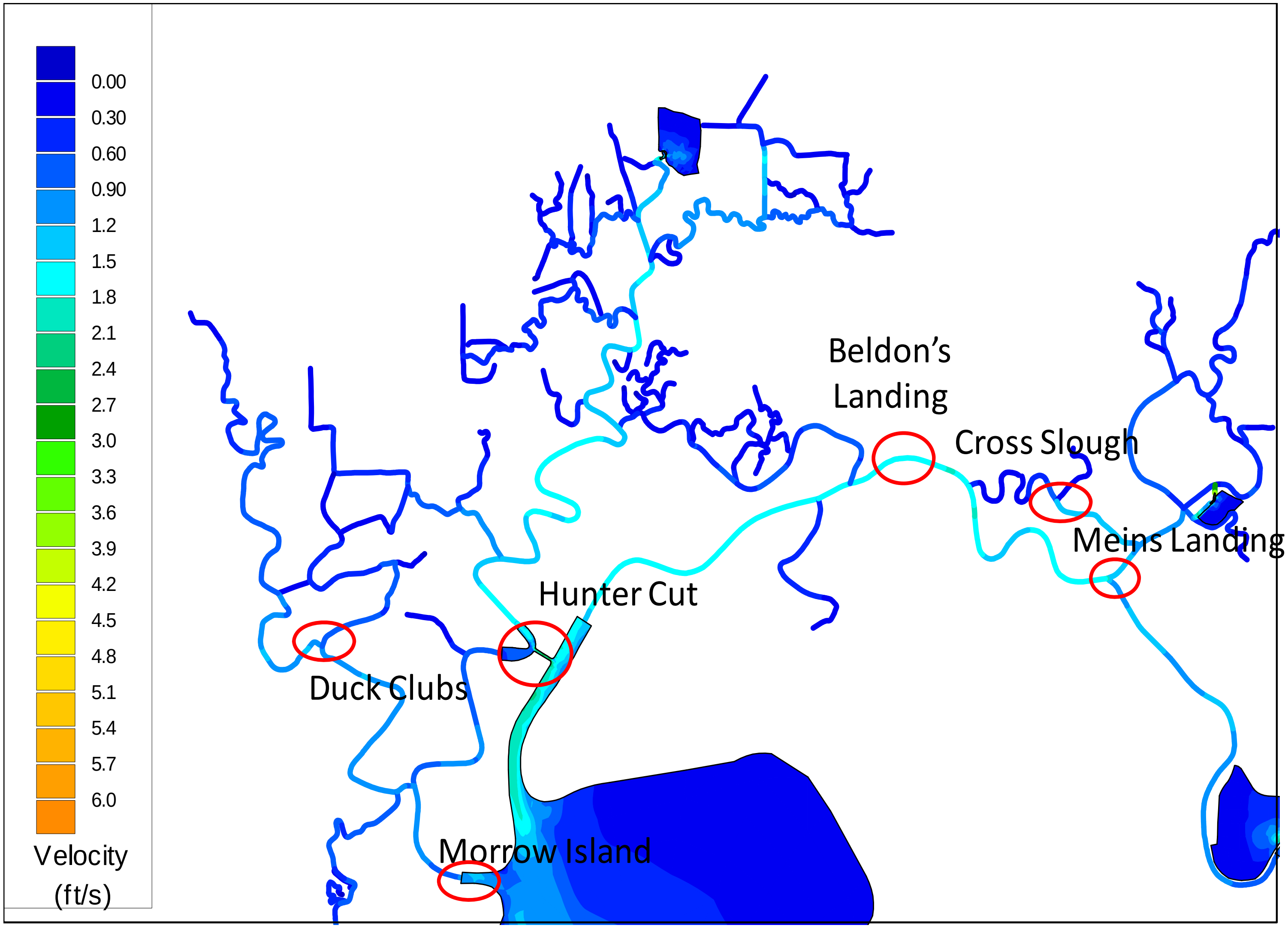


Figure 5-54 Location names for the areas examined for scouring potential.

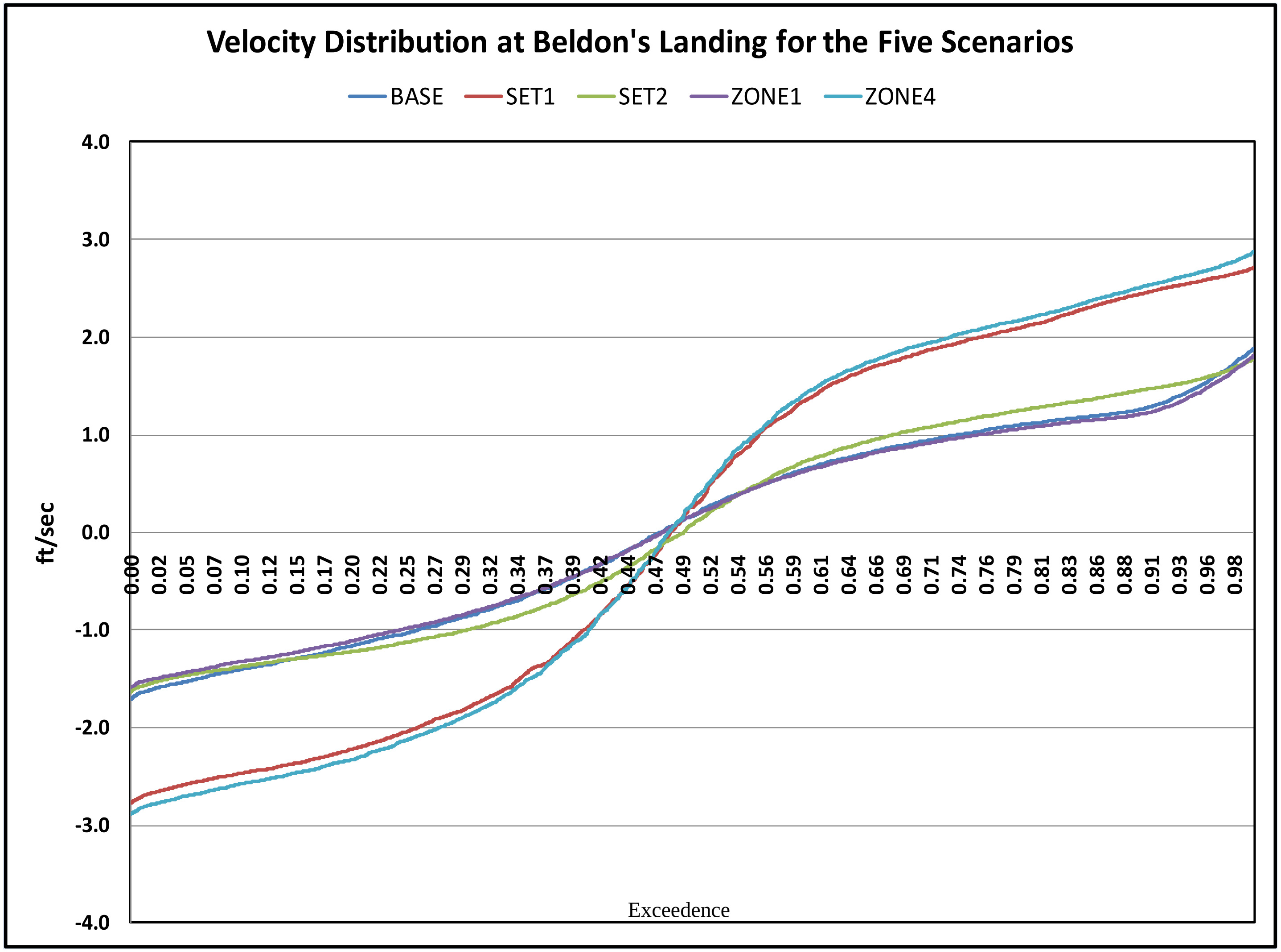


Figure 5-55 Velocity distributions for the five scenarios at Beldon's Landing, July 2002.

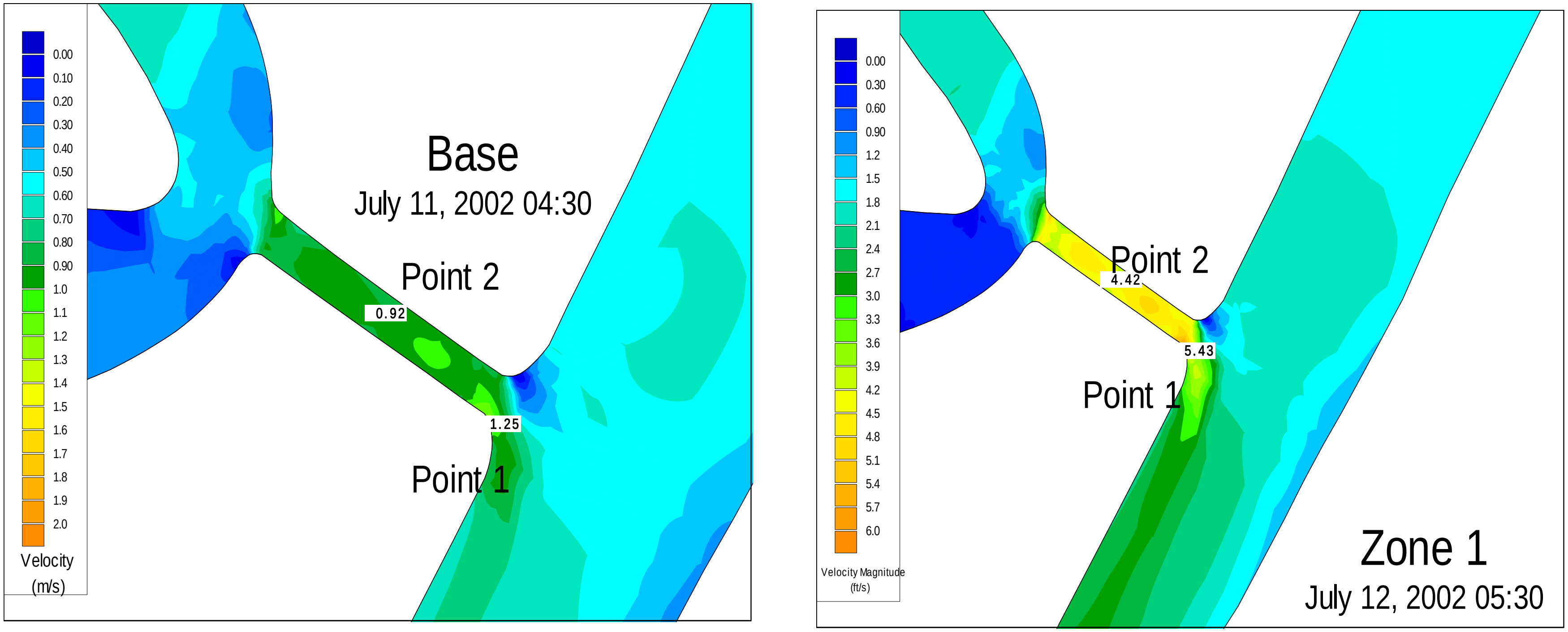


Figure 5-56 Color contour plots of velocity for Base case and Zone 1 at Hunter Cut in July 2002. Points analyzed: Point 1 on bank Point 2 mid-channel.

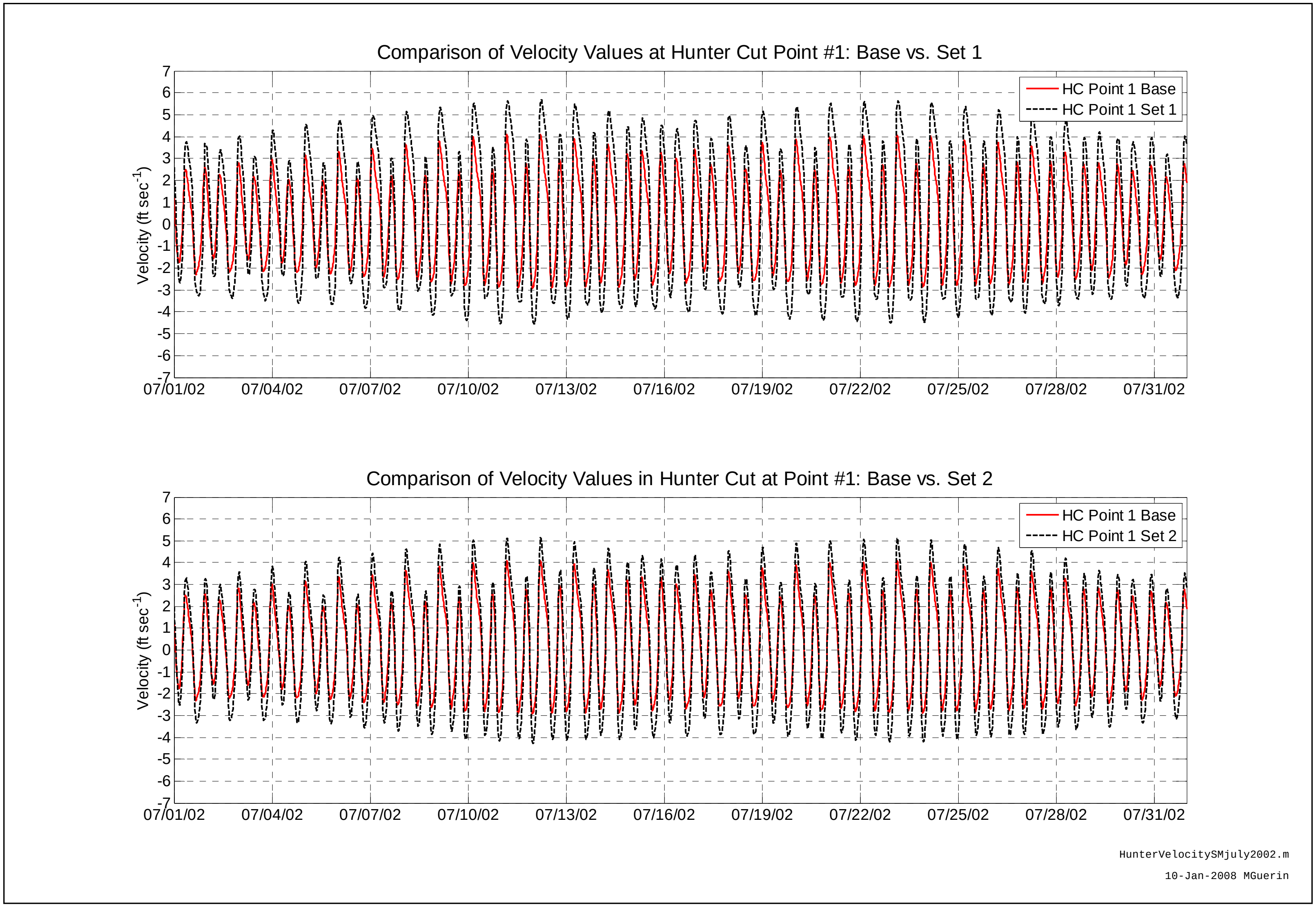


Figure 5-57 Hunter Cut velocity at Point 1 for Sets 1 and 2 in comparison with the Base case.

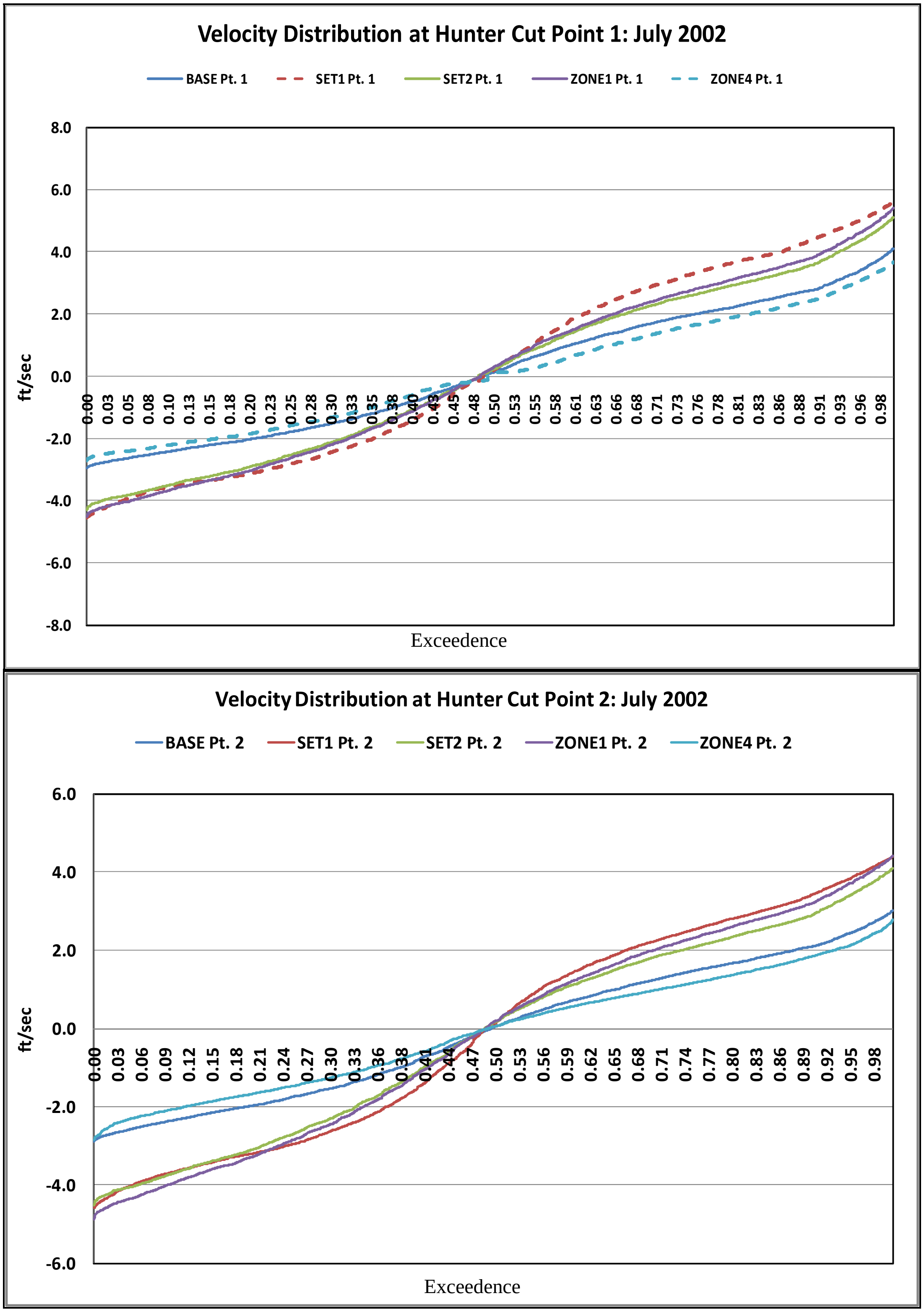


Figure 5-58 Velocity distributions for points 1 (bank) and 2 (mid-channel) at Hunter Cut.

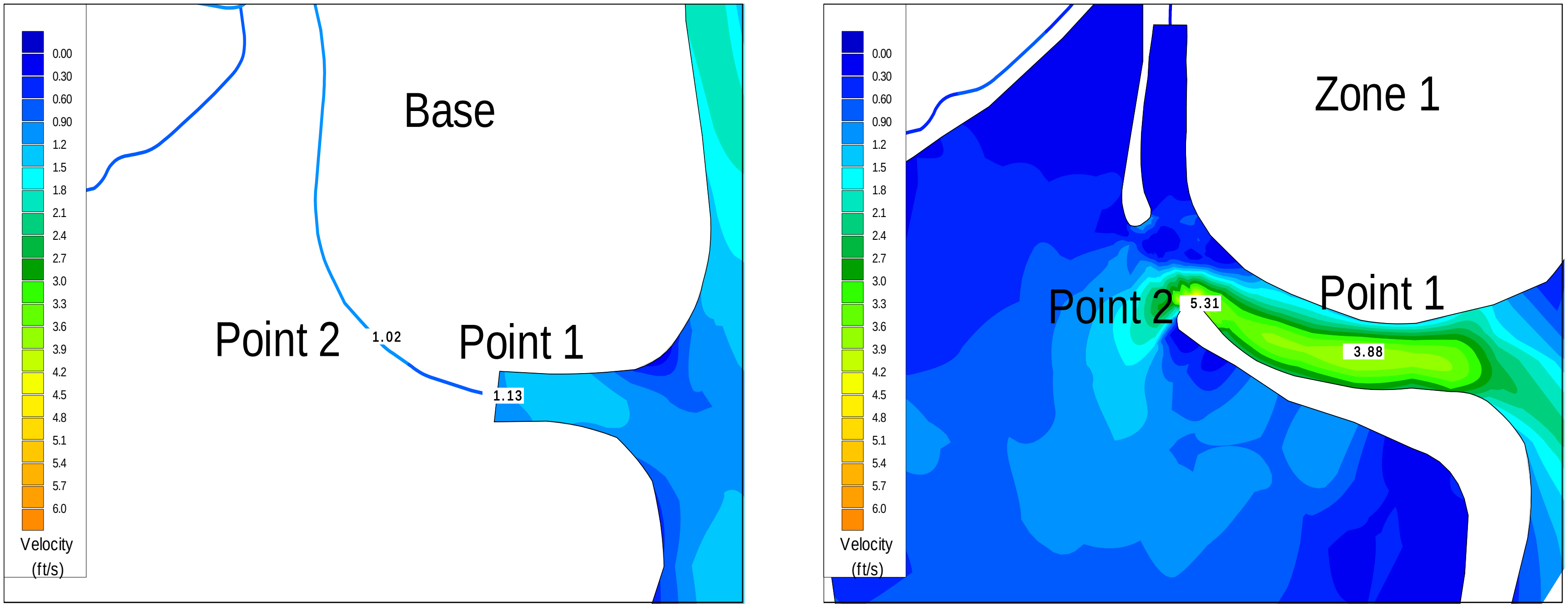


Figure 5-59 Color contour plots of velocity for Base case and Zone 1 near Morrow Island on July 12, 2002 14:00. Points analyzed: channel (Point 1) and bank (Point 2).

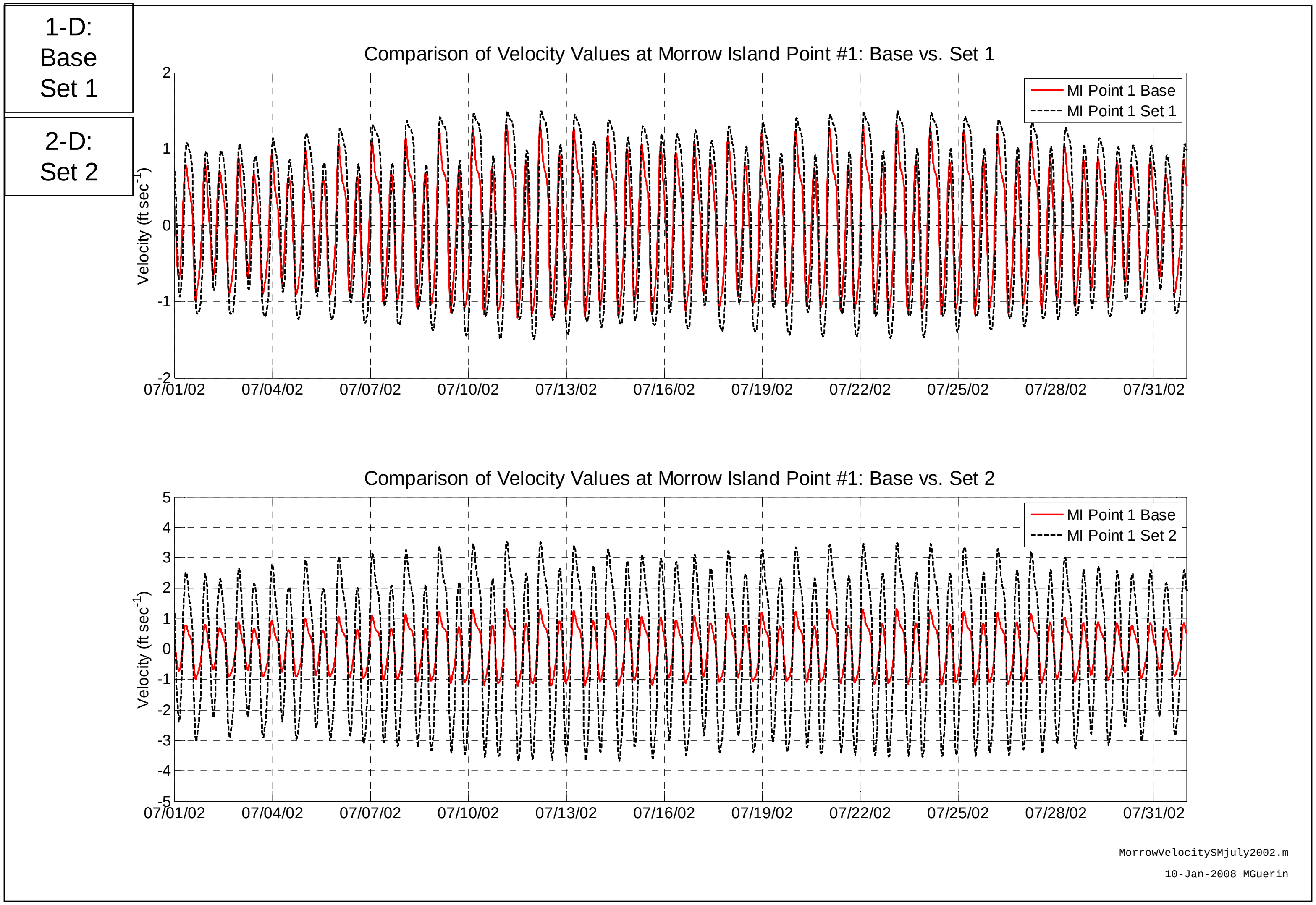


Figure 5-60 Morrow Island velocity at Point 1 for Sets 1 and 2 in comparison with the Base case.

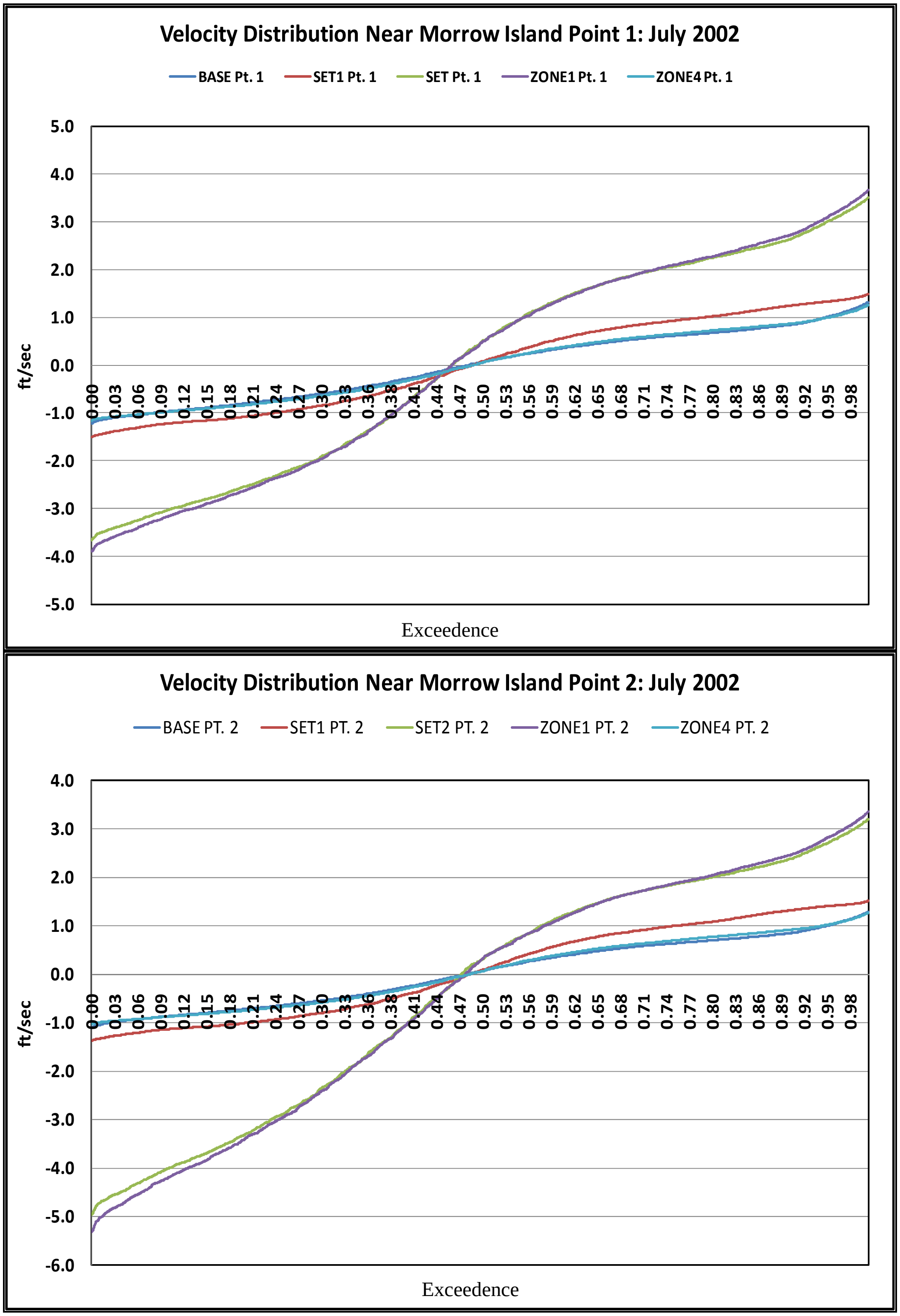


Figure 5-61 Velocity distributions for points analyzed near Morrow Island: point 1 (channel) and point 2 (bank).

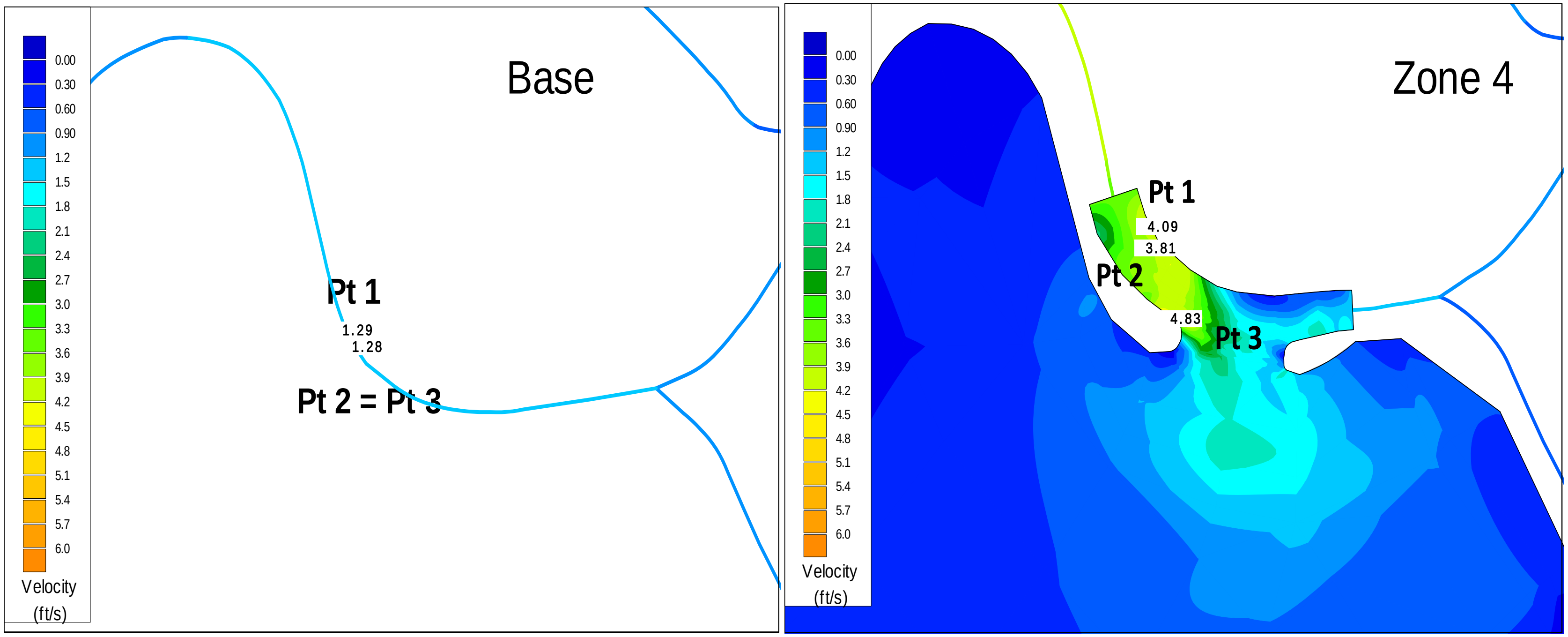


Figure 5-62 Color contour plots of velocity for Base case and Zone 4 near Meins Landing on July 17, 2002 1915. Points analyzed: points 1 and 3 (bank) and point 2 (mid-channel).

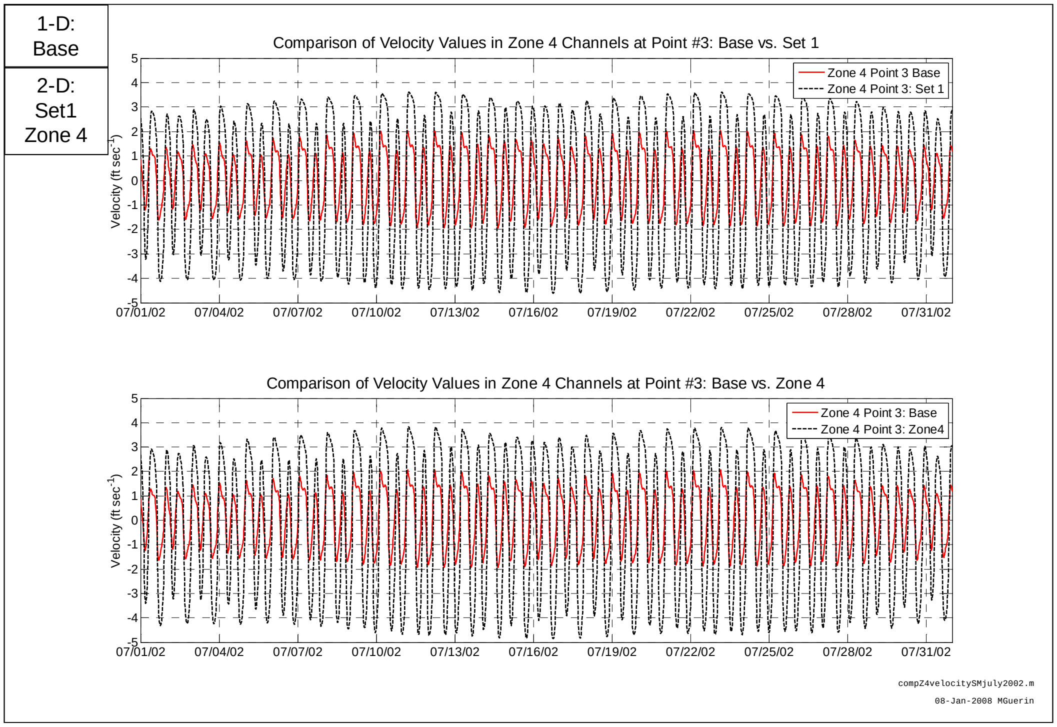


Figure 5-63 Meins Landing velocity at Point 2 for Set 1 and Zone 4 in comparison with the Base case.

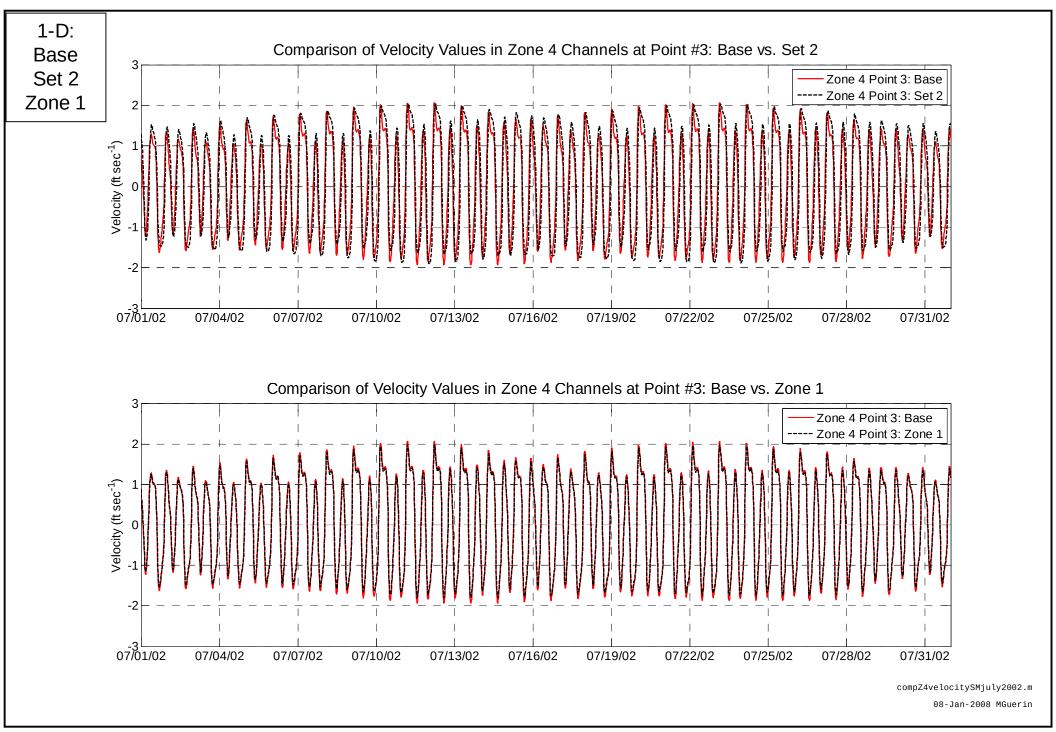


Figure 5-64 Meins Landing velocity at Point 2 for Set 2 and Zone 1 in comparison with the Base case.

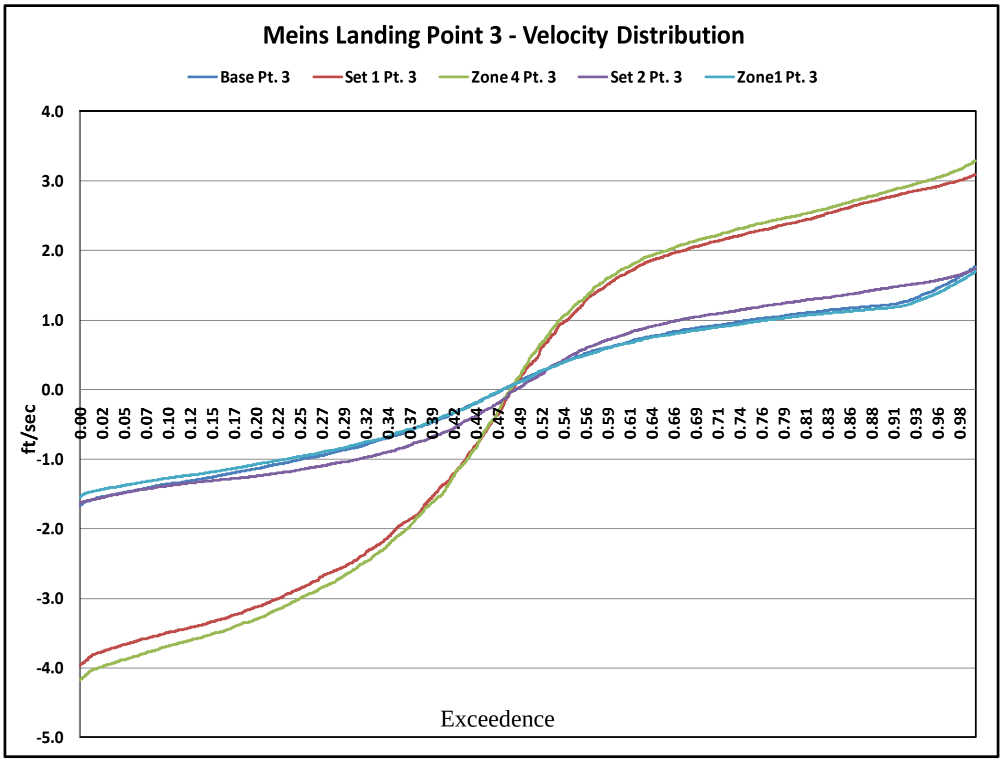


Figure 5-65 Velocity distributions for Point 3 (bank) analyzed near Meins Landing.

Exceedence

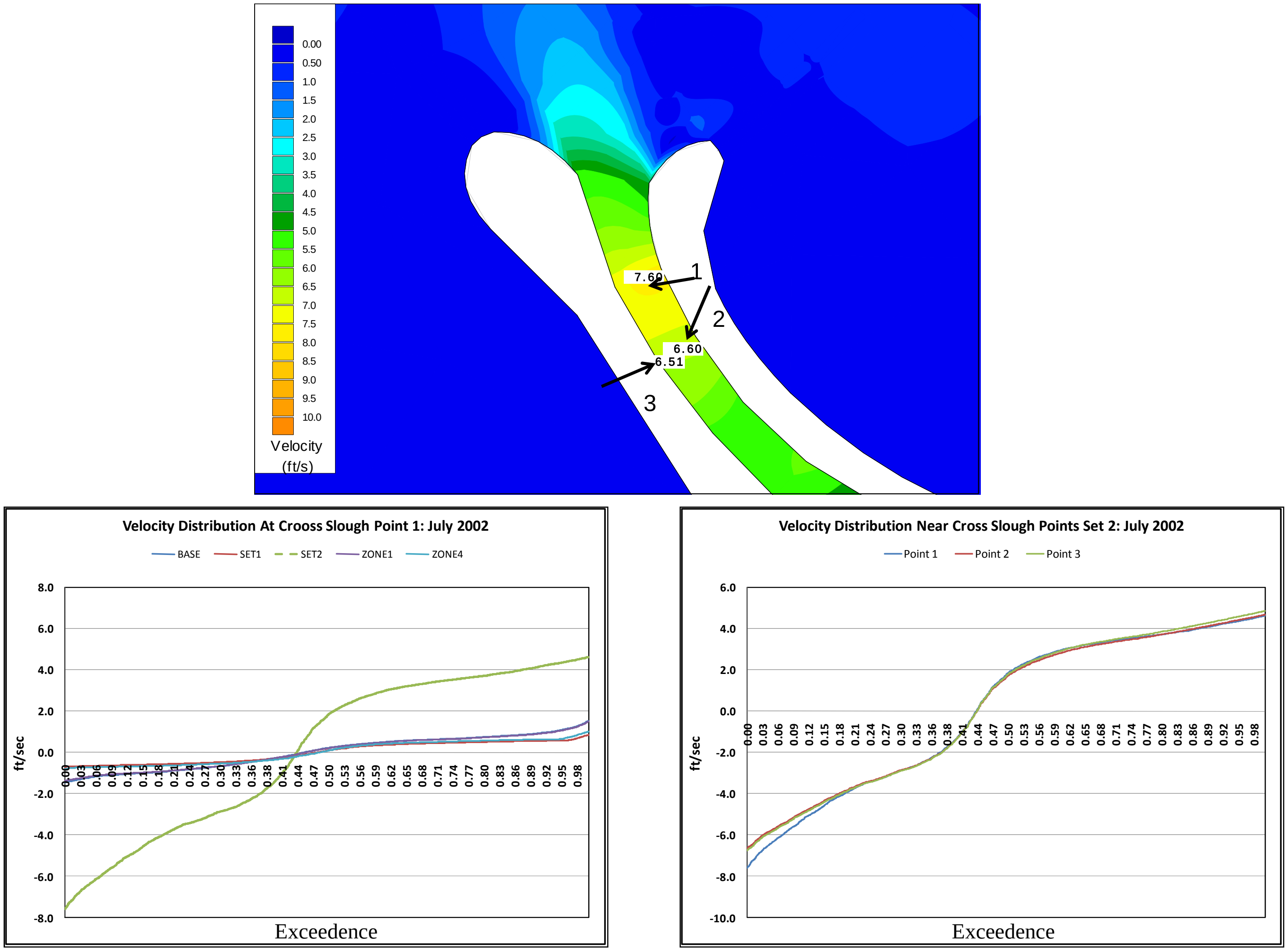


Figure 5-66 (Above) Color contour plot of Set 2 velocity near Cross Slough on July 19, 2002 23:15. (Below) Velocity distributions in Cross Slough. Points analyzed: points 1 and 2 mid-channel.

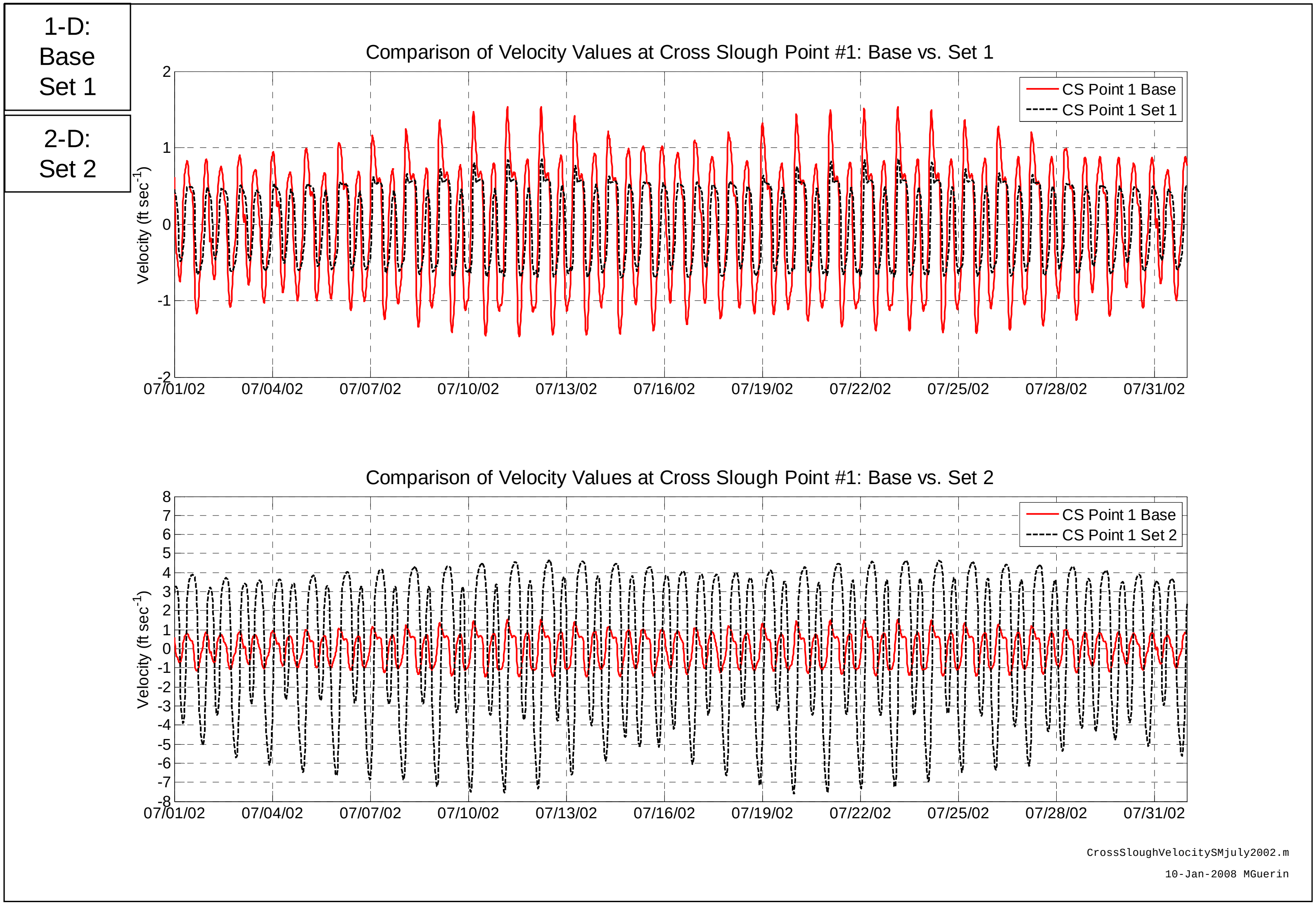


Figure 5-67 Cross Slough velocity at Point 1 for Set 1 and Set 2 in comparison with the Base case.

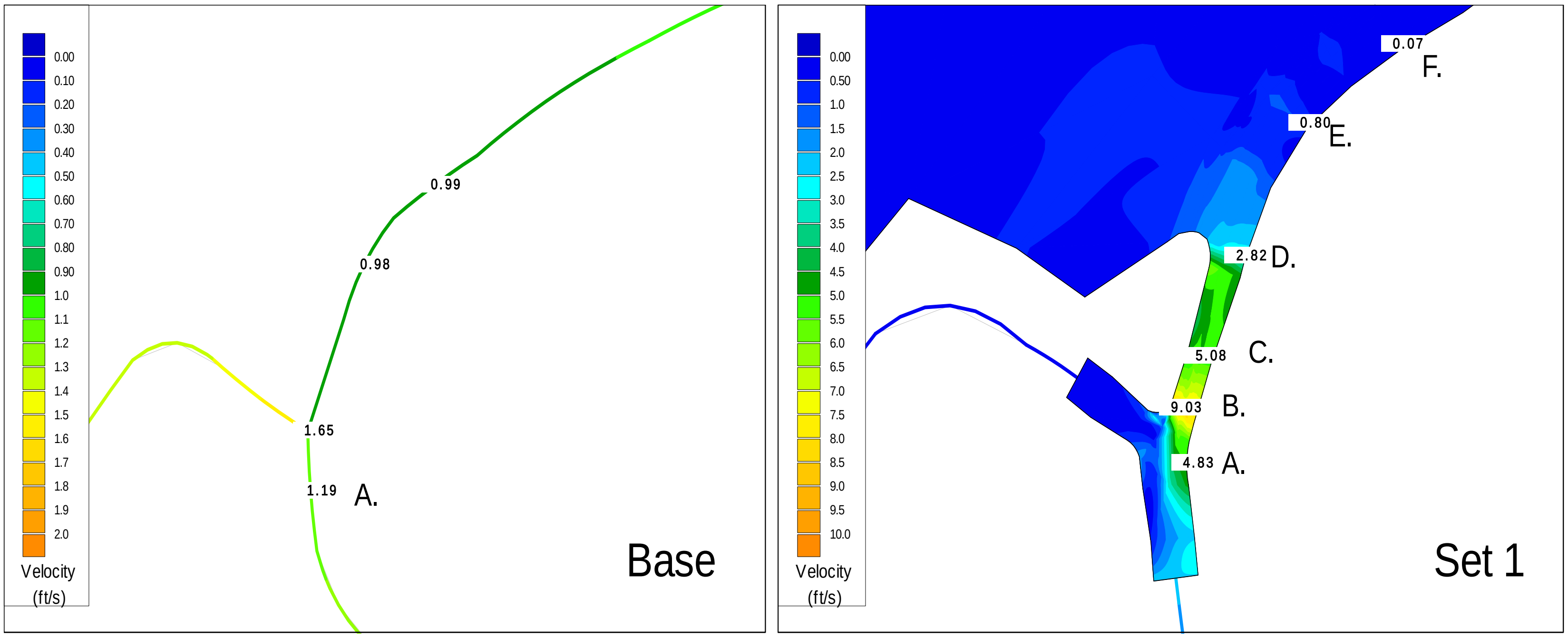
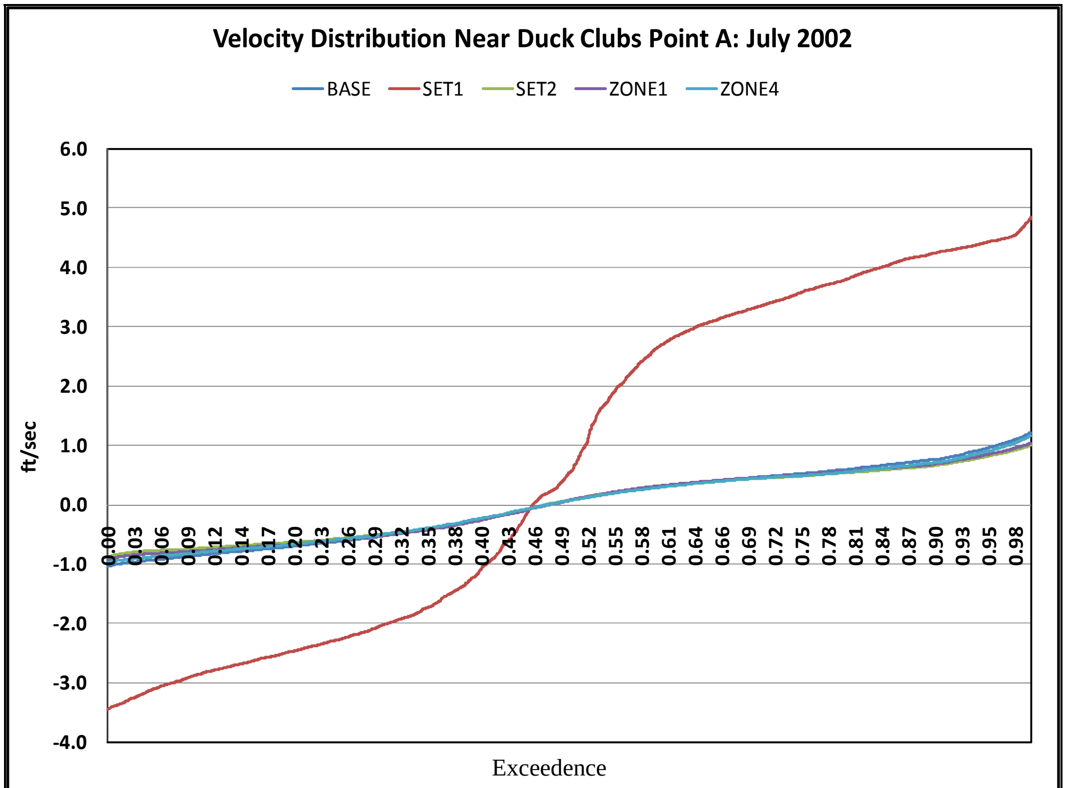


Figure 5-68 Color contour plots of velocity for the Base case and set 1 scenario on July 11, 2002 04:45 (note scale differences on contour plots). Points analyzed near the Duck Club location are indicated.



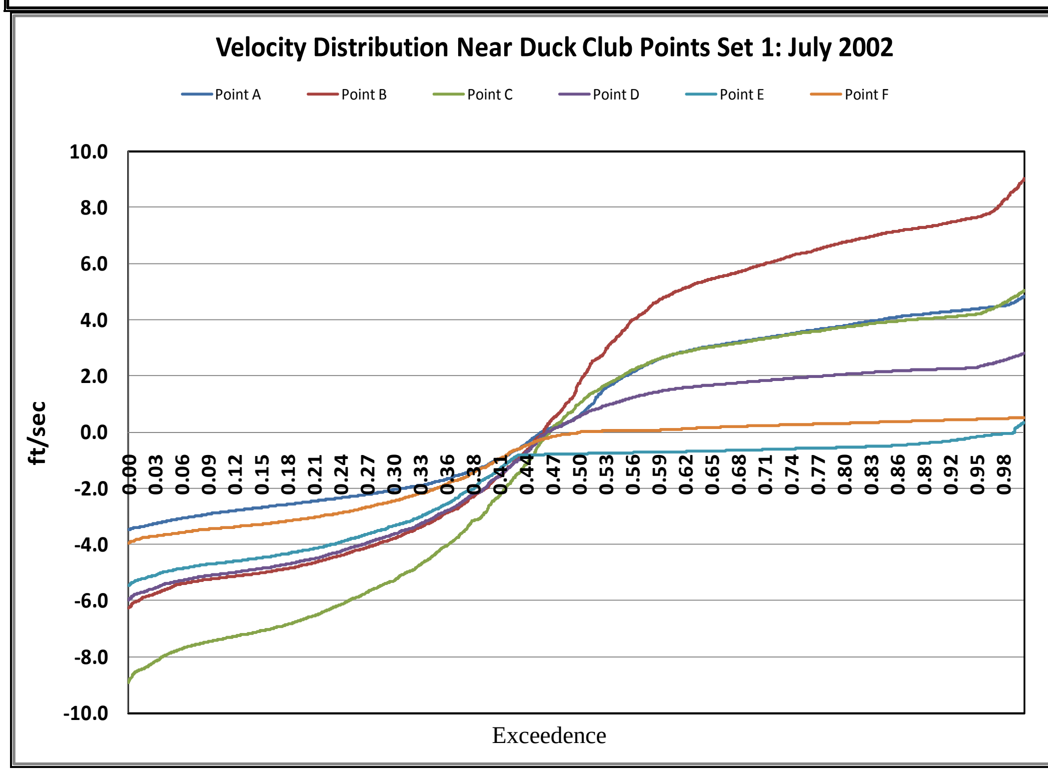


Figure 5-69 Velocity distributions for points analyzed near the Duck Club location. Lower plot shows velocity distributions for Set 1 at six points.

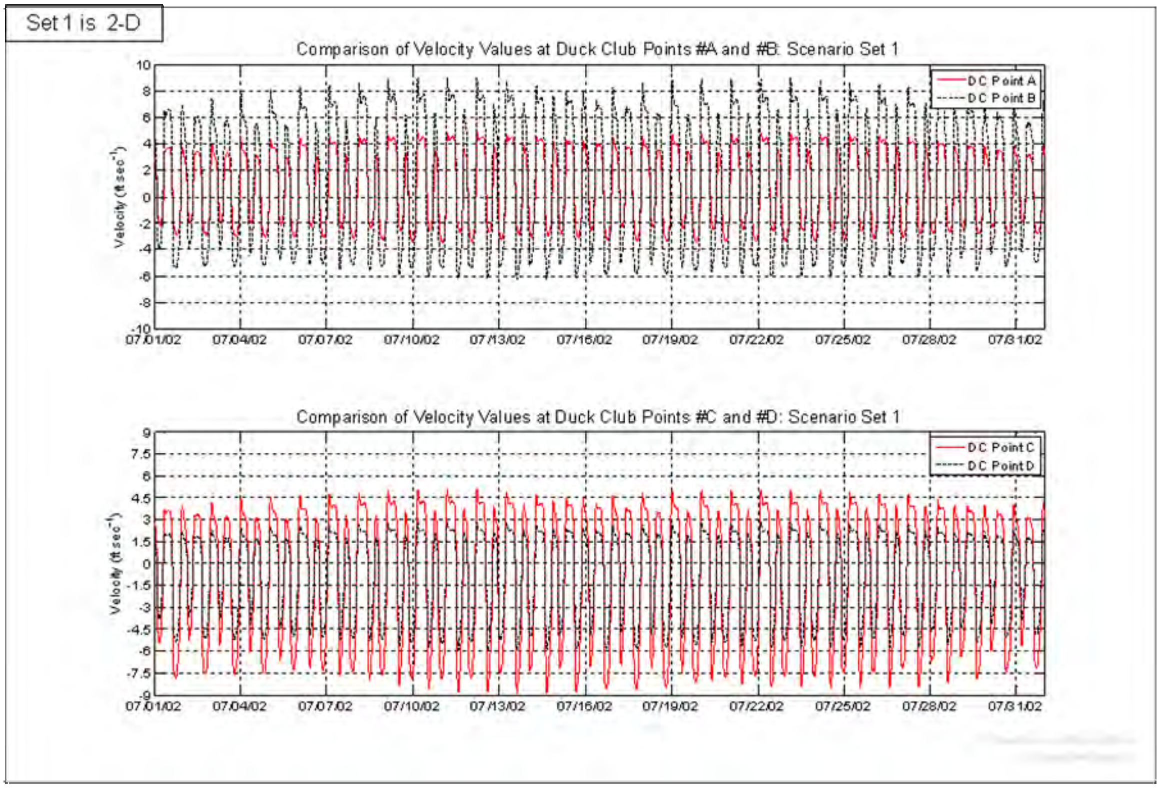


Figure 5-70 Velocity time series for points A - D analyzed near the Duck Club location.

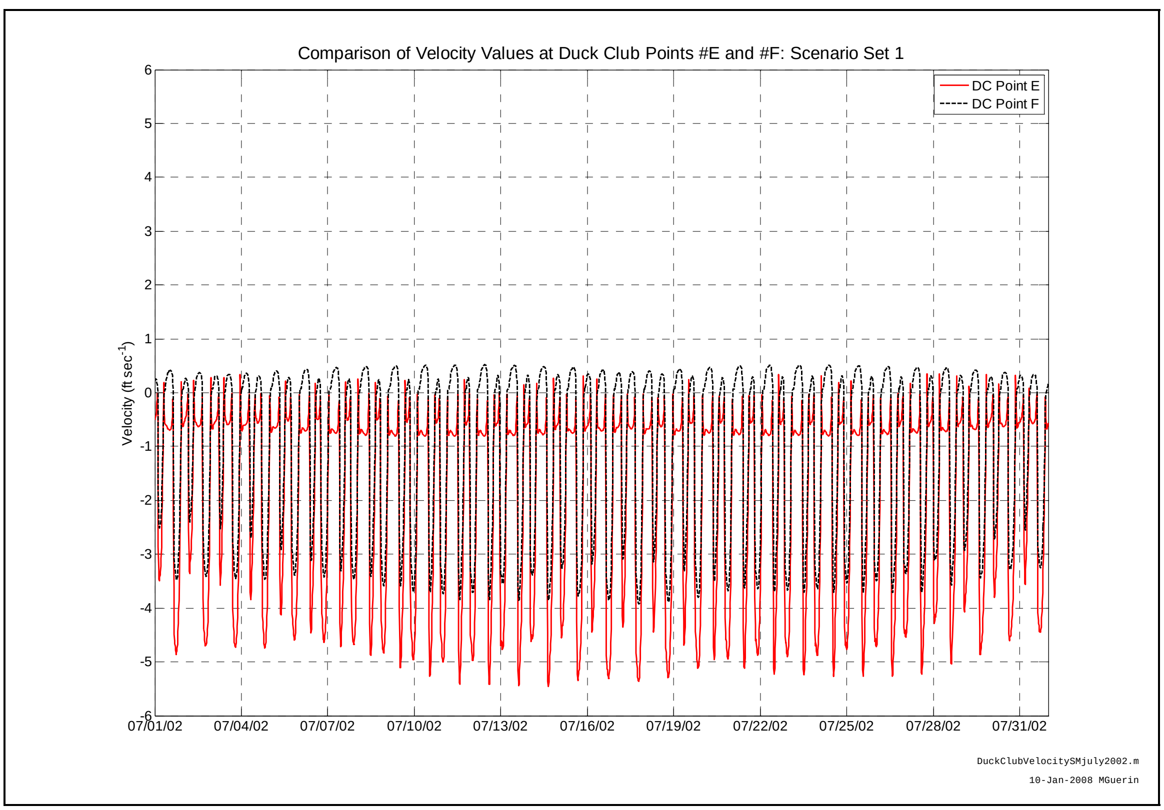


Figure 5-71 Velocity time series for points E and F analyzed near the Duck Club location.

6. Discussion/Summary/Conclusions

The representation of the Suisun Marsh area in RMA's current numerical model of the San Francisco Bay and Sacramento-San Joaquin Delta system was refined to simulate the current hydrodynamics and EC of the Suisun Marsh as well as the changes to this regime under a set of four marsh restoration scenarios.

Refinement in the Suisun Marsh area involved addition of increased detail to represent off-channel storage in overbank/fringe marsh regions, a better representation of precipitation and evaporation, estimation of local creek flows, inflows and withdrawals within the Suisun Marsh, and an overall refinement of the mesh. These additions generally improved the representation of tidal dynamics and EC in Suisun Marsh.

Stage calibration was generally good in Suisun Marsh. Flows in the smaller sloughs were greatly improved by the increased detail and refinement of the grid, the addition of off-channel storage, withdrawals for managed wetlands, and representation of evaporation in the tidal marsh areas. Flow through Montezuma Slough was low in comparison with measured data, and low flows through Hunter Cut were compensated by higher flows through Suisun Slough. These results have the potential of biasing modeled EC in the marsh restoration scenarios.

EC calibration results were variable, with some areas showing good correspondence with measured data, while other areas suffered from the lack of sufficient data or from approximations intrinsic to the model. In general, EC was low everywhere in the marsh in winter 2003. EC was low year-round in the eastern end of Montezuma Slough. Problems with flow calibration in Montezuma Slough or with insufficient representation of local effects are potential causes.

Density stratification is not explicitly represented in the 2-dimensional depth-averaged formulation used in the Bay-Delta model, leading to variations in the representation of EC. In the current model, diffusion coefficients are used to approximate effects due to density stratification. The use of diffusion coefficients to improve the representation of EC during high flow periods tends to bias modeled EC when outflow is low. As a consequence, modeled EC at Martinez is low winter through spring and high summer through fall. This bias in modeled EC at Martinez propagates through western Suisun Marsh.

Using the calibrated model, four marsh restoration scenarios - Zone 1, Zone 4, Set 1 and Set 2 - were simulated and compared to a Base case. Analysis of the results indicated that each of the scenarios increased the tidal prism, but muted the tidal range and shifted stage timing throughout the marsh in comparison with the Base case. Average tidal flow generally increased in the larger sloughs and decreased in smaller sloughs in the interior regions of Suisun Marsh. Tidal flow downstream of the restoration areas will likely increase, but reduced tidal range will reduce tidal flow at the sloughs upstream of the restored areas. The peak velocity increased in sloughs near the breaches of the flooded areas, with the largest changes localized at and near the mouths of the breached levees.

This increases the potential for failure on the banks of some of the affected levees or for scouring in some of the channels.

Water quality model results for the marsh restoration scenarios indicated that Delta EC decreased during July through December for the Zone 4 and Set 1 scenarios where the breached areas were located in channels further from Suisun Bay. The Set 2 scenario resulted in EC increase in the Delta due to tidal trapping in the breached area adjacent to Suisun Bay. Tidal trapping with the Zone 1 scenario caused only minor increases in Delta EC.

Scenarios that decreased Delta EC tended to increase EC in Suisun Marsh, although changes in the details of the EC profile for each scenario depended on the particular location examined, the operation of the Suisun Marsh Salinity Control Gate (SMSCG), and the season. The Zone 1 scenario was again most similar to the Base case, with little or no EC change in the eastern marsh but some increase in the west. The Zone 4 scenario decreased EC in most of the marsh whenever the SMSCG was operating, except in eastern Montezuma Slough where it increased EC. The Set 1 scenario generally resulted in the highest EC conditions in the Marsh, except upstream of the Zone 4 breaches on Montezuma Slough.

In comparison with the Base case:

- Each of the Alternatives resulted in increased EC in Montezuma Slough at Beldon's landing either because of pulling more water from the west, as in the cases of Zone 4 and Set 1, or because of increases in EC at the west end of Montezuma Slough, as in the cases or Zone 1 and Set 2.
- Zone 1 showed little difference in EC compared with the Base case in the eastern Marsh and at Morrow Island, but resulted in at least some EC increase in the western marsh and a small increase in Montezuma Slough at Beldon's Landing. The salinity increases are due in part to large volumes of higher salinity water being pulled into the marsh through Suisun Slough and Hunter Cut.
- When the SMSCG is open, Set 1 tends to have the most pronounced EC increase of all the scenarios in all areas of the Marsh except eastern Montezuma Slough, where Set 1 has greatest EC decrease. This is because of the locations and extent of the Set 1 restoration areas result in large volumes of (higher velocity) water being pumped through the main channels and sloughs in the marsh on both incoming and outgoing tides.
- When the SMSCG is operating, Zone 4 resulted in the greatest EC reduction throughout the western and northern Marsh, and increased EC at Beldon's Landing and eastward in the Marsh. The increases occur because the fresher water from Collinsville is entering the Zone 4 area rather than moving westward and northward in the marsh. With the gates open, EC was decreased in eastern Montezuma Slough and increased in Nurse Slough and at Beldon's Landing. Locations east of the breach benefit from the additional inflow of fresher water from the east, whereas less of the fresher water makes it past the breach to the west and north. Effects elsewhere were minor.

- At most locations, Set 2 increased EC when the gates were operating and otherwise resulted in increased EC or little change, in general. In the western marsh at Ibis, Cygnus and Morrow, very small decreases occurred when the SMSCG were operating. EC decreased only in eastern Montezuma Slough when the gates were open, due to increased flow of lower EC water from the east.

7. References

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5.4. Stage Results

5.4.1. Background

Tidal damping can occur if channels are not large enough to convey the full tidal prism of the restored areas. This effect will persist until channel scour (or levee breaches) increase the capacity of the channels feeding the upstream marshes. Velocity results indicate that some channels (Montezuma Slough, Hunter Cut) will be subject to scouring and tidal damping until sufficient conveyance is established.

5.4.2. Results

Each scenario resulted in reduced tidal amplitude throughout Suisun Marsh, and a shift in timing. These changes were generally the most pronounced in Set 1 and Set 2 scenarios, and varied depending on location in the marsh (Figure 5-7). Time series plot of stage at Beldon’s Landing, S-49, during October 2003 (Figure 5-8, duck clubs filling) shows that the Set 1 and Zone 4 scenarios have the most prominent effect at this location, while the Zone 1 scenario has very little effect.

The significant dampening effect for the Set 1 scenario can be seen in plots of MHHW and MLLW for April and October 2003, shown in Figure 5-9 and Figure 5-10, respectively. During these months, MHHW was reduced by as much as 0.8 ft and MLLW increased by as much as 1.2 ft. Greater differences are seen in the immediate vicinity of the breaches in the western marsh.

Although the restriction of Set 1 restoration area to Zone 4 (not shown) had less effect in the western marsh, with no breaches there, in the eastern portion, MHHW was reduced by as much as 0.6 ft and MLLW increased by as much as 1.1 ft.

Set 2 restoration areas resulted in MHHW reduced by up to 0.3 ft and an increase in MLLW of up to 0.2 ft (Figure 5-11). Restriction of Set 2 restoration area to Zone 1 (not shown) demonstrated this area had minimal effect on stage throughout Suisun Marsh. The tidal dampening effect was generally less than 0.1 ft overall.

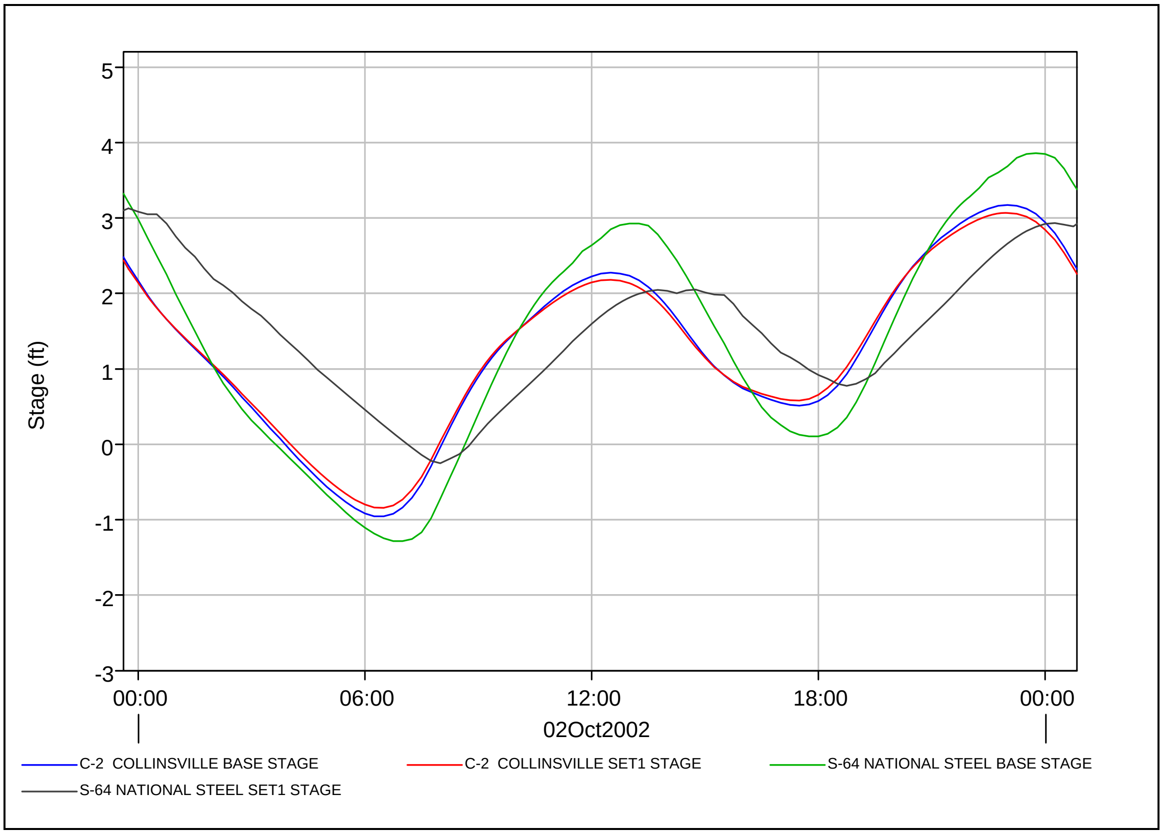


Figure 5-7 Stage time series showing stage shifts at Collinsville monitoring station C-2 and National Steel monitoring location S-64 for Base and Set 1 Scenarios.

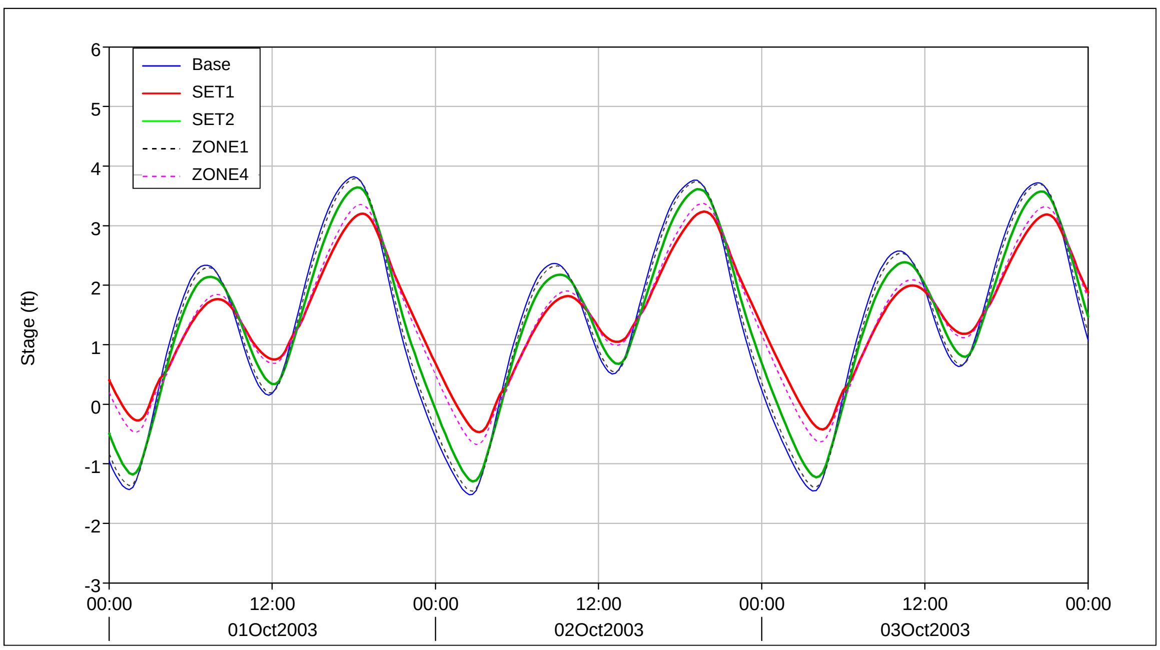


Figure 5-8 Stage time series at monitoring station S-49 at Beldon's Landing when Duck Clubs in the Suisun Marsh region are filling in the fall.

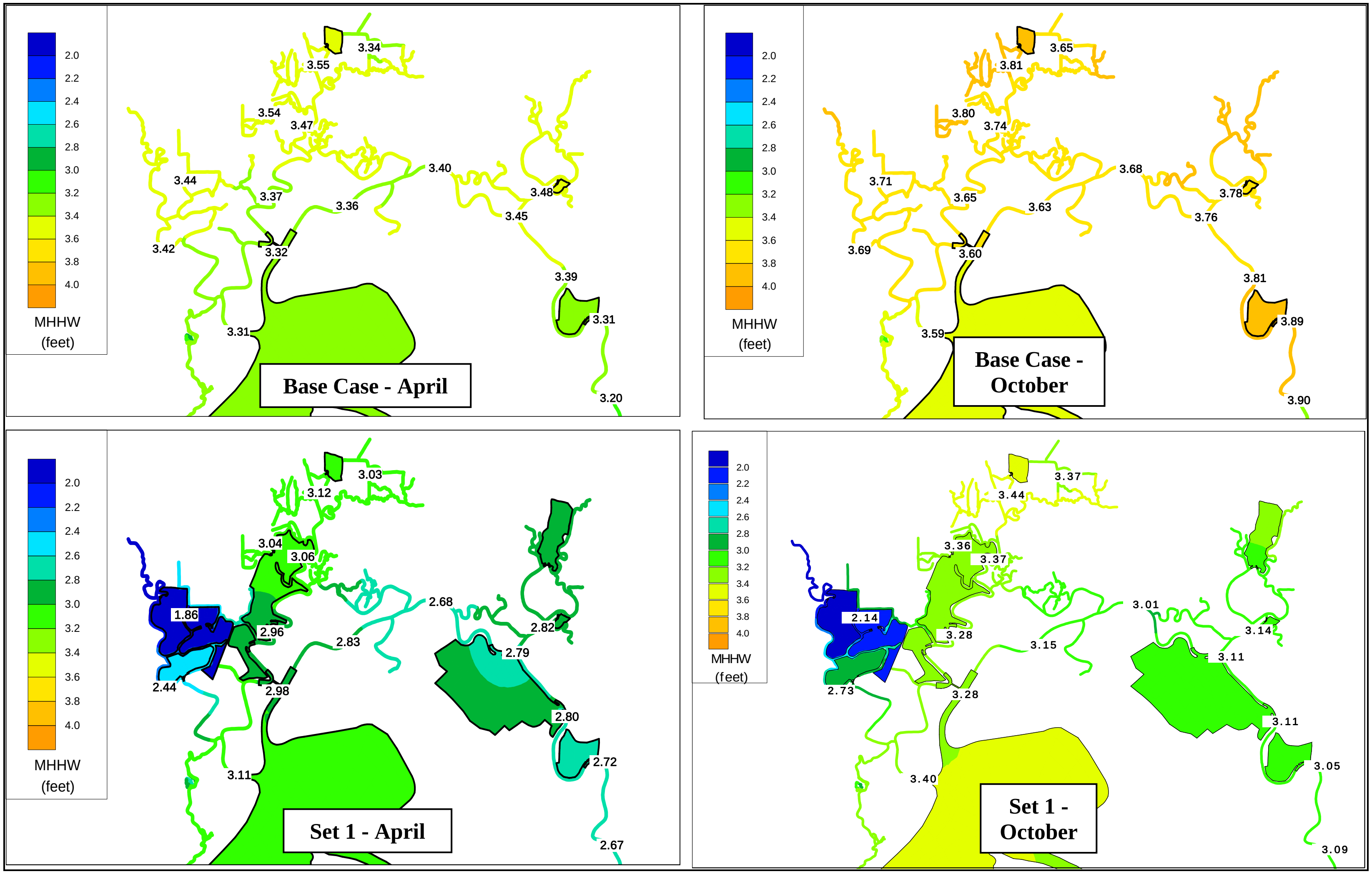


Figure 5-9 Color contour plots of Base case (upper) and Set 1 (lower) MHHW elevations for April (left) and October (right) 2003.

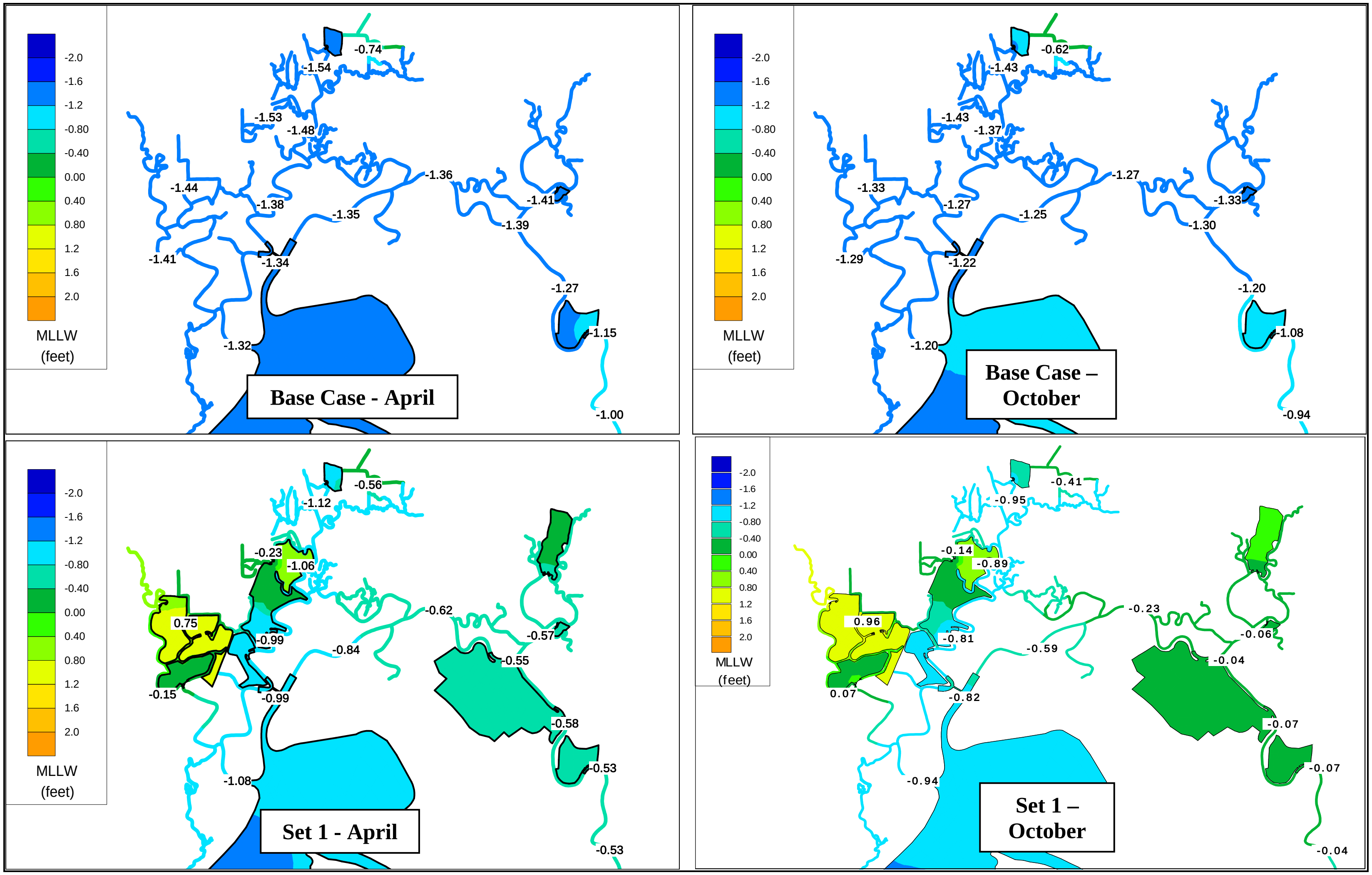


Figure 5-10 Color contour plots of Base case (upper) and Set 1 (lower) MLLW elevations for April (left) and October (right) 2003.

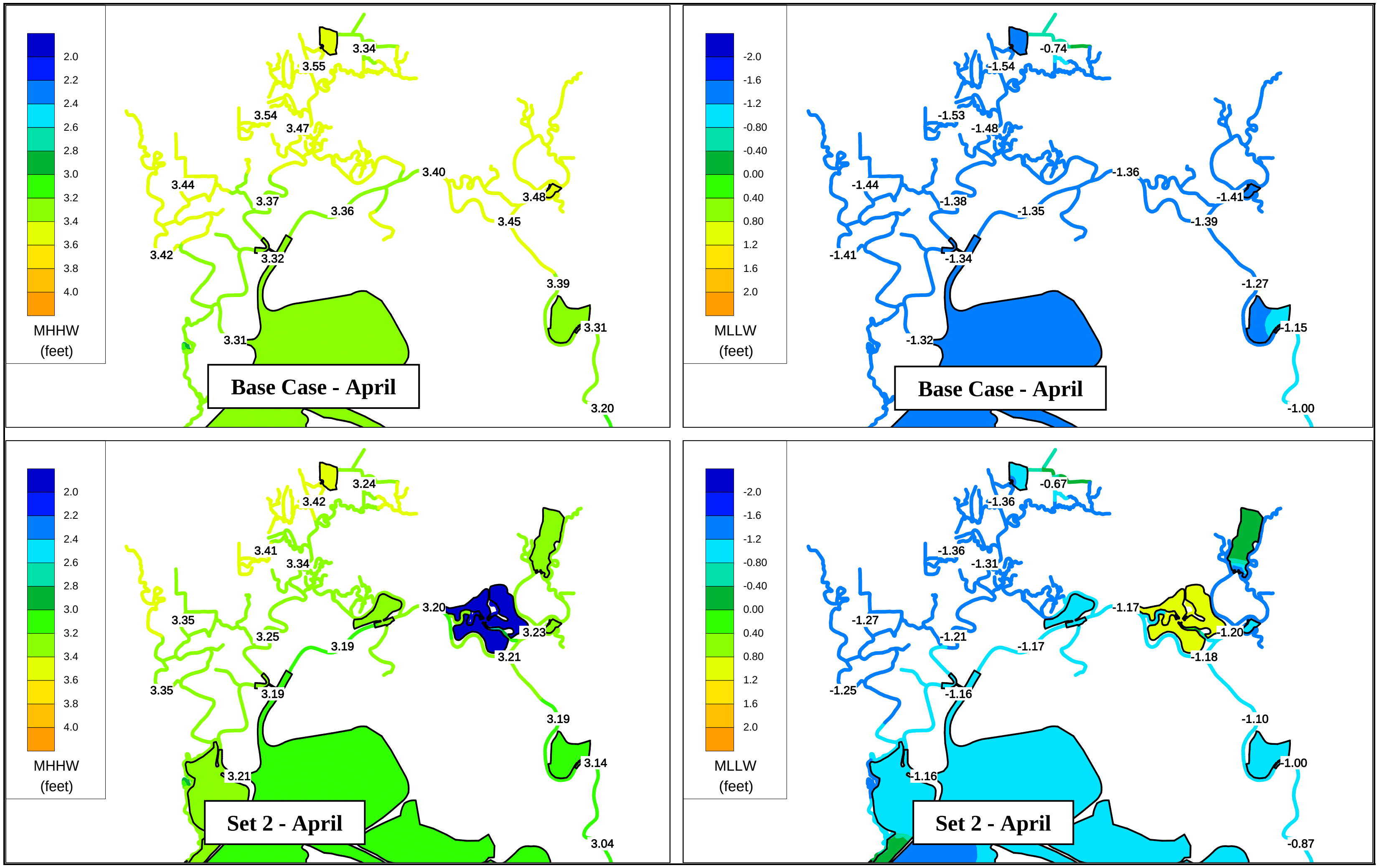


Figure 5-11 Color contour plots of Base case (upper) and Set 2 (lower) MHHW (left) and MLLW (right) elevations for April 2003 (note scale differences for MHHW and MLLW).

5.5. Tidal Prism Results

5.5.1. **General observations**

As expected, each of the scenarios increased the tidal prism, i.e., the volume of water exchanged in the Suisun Marsh area, in comparison with the Base case. Figure 5-12 shows locations where net tidal flow results are presented for July 2003. Values for tidal flow were calculated by accumulating ebb and flood (tidal) flow in ac-ft/day and averaging over the month. The results are grouped by general location in Suisun Marsh and by range of tidal flow.

The Set 1 scenario increased tidal flow everywhere except the boundary sloughs of the Marsh (e.g. Hill Slough) as flow increased through both ends of Montezuma Slough, and through Suisun Slough and Hunter Cut. Tidal flows in boundary sloughs decrease when tidal marsh restoration occurs at downstream locations because not as much of the tidal prism makes it past these new areas. For the Set 2 scenario, the increased flow in Suisun Slough and western Montezuma Slough increased tidal flow in the larger sloughs and adjacent sloughs, but decreased flow to the boundary areas of the Marsh and through the eastern end of Montezuma Slough. Zone 4 resulted in increased flow through Montezuma Slough and through the northern-central portion in the Marsh interior through Suisun Slough, but decreased tidal flow in the north eastern and western regions of the Marsh. Zone 1 decreased tidal flow everywhere, except in areas in the immediate vicinity (e.g., Hunter Cut) of the breached area.

5.5.2. **Central Marsh**

The increase in tidal flow through the largest sloughs in the central portion of the Marsh depended on the location of the breached area. Set 1 and Zone 4 increased average tidal flow through both ends of Montezuma Slough to fill the Zone 4 breached area. At the western end of Montezuma Slough, tidal flow increased ~ 24% for the Zone 4 scenario and ~ 48% for the Set 1 scenario in comparison with the base, and at the eastern end ~ 60% for both Zone 4 and Set 1. Zone 4 filled through the breaches at both ends, with the timing of the filling and draining of the eastern breach delayed for a short while in comparison with the western end.

Set 2 and Zone 1 also increased tidal flow through the western end of Montezuma Slough, but decreased tidal flow through the eastern end.

Changes in the Set 2 and Zone 1 scenarios were very similar, as tidal flow through the mouth of Suisun Slough to fill the Zone 1 breached area increased substantially, while the tidal flow increases were more moderate through Hunter Cut. Zone 1 flows were higher than Set 2 flows by ~ 7% in Hunter Cut, and by ~ 2 % at the mouth of Suisun Slough. Set 1 also increased flows in these two locations, except that the flow increase through Hunter Cut was larger than in Suisun Slough to fill the breached areas northeast of the Cut.

5.5.3. **North Interior Marsh**

The tidal flow in the northern region of the Marsh decreased as distance from Montezuma Slough increased, and all scenarios were less than the Base case at the four northernmost interior locations (Figure 5-14 and Figure 5-15) because of the downstream restoration areas.

5.5.4. **Western Interior Marsh**

Filling and draining of the Zone 1 breached area decreased the tidal flow in interior locations of the western Marsh, west and north of the breached area. Zone 1 and Set 2 tidal flows increased through Hunter Cut and the mouth of Suisun Slough (Figure 5-13), and decreased at the interior Suisun Slough locations(Figure 5-15). Flow through Goodyear Slough only increased at the southern end (Figure 5-16), and then only for the Zone 1 and Set 2 scenarios.

The Set 1 scenario increased flow through Hunter Cut and through portions of Suisun Slough south of the Cut to fill the breached areas in the western Marsh, partly through Cordelia Slough. For Zone 4, there were minor increases in tidal flows through Suisun Slough downstream of Hunter Cut, but decreases in Hunter Cut and in Suisun Slough upstream of Hunter Cut.

5.5.5. **Comparison of flood flow for the scenarios**

Figure 5-17 and Figure 5-18 illustrate the magnitude of flows ($ft^3\,sec^{-1}$) near peak flood tide for the Set 1 and Set 2 scenarios on July 11, 2003 22:00. These results are also shown in Table 5-1 Flow magnitude (cfs) at four locations near peak flood tide (July 11, 2003 22:00)., below. The plots give the magnitude vectors at key locations in Suisun Marsh for the Base case and the two restoration configurations. The flow arrows are scaled by flow magnitude, which is indicated on each plot for the downstream openings at Suisun Slough, Montezuma Slough and Hunter Cut. The color scale gives water surface elevation (ft).

The plots show that when the area on Morrow Island is restored (Set 2, Figure 5-17), Hunter Cut provides almost all of the flow for Suisun Slough above the junction with Cordelia Slough. When filling the Zone 4 breached area in Set 1, most of the flow comes through the mouth of Montezuma Slough (Set 1, Figure 5-18). The red arrows in these figures give the direction and magnitude of the indicated flows.

Table 5-1 Flow magnitude (cfs) at four locations near peak flood tide (July 11, 2003 22:00).

	Base	**Set1**	**Set2**
Suisun Sl. @ Mouth	10,900 cfs	17,400 cfs	20,050 cfs
Montezuma Sl. - west	39,200 cfs	62.300 cfs	44,800 cfs
Hunter Cut	10,600 cfs	19,600 cfs	15,600 cfs
Montezuma Sl. - east	3,440 cfs	1,500 cfs	5,820 cfs

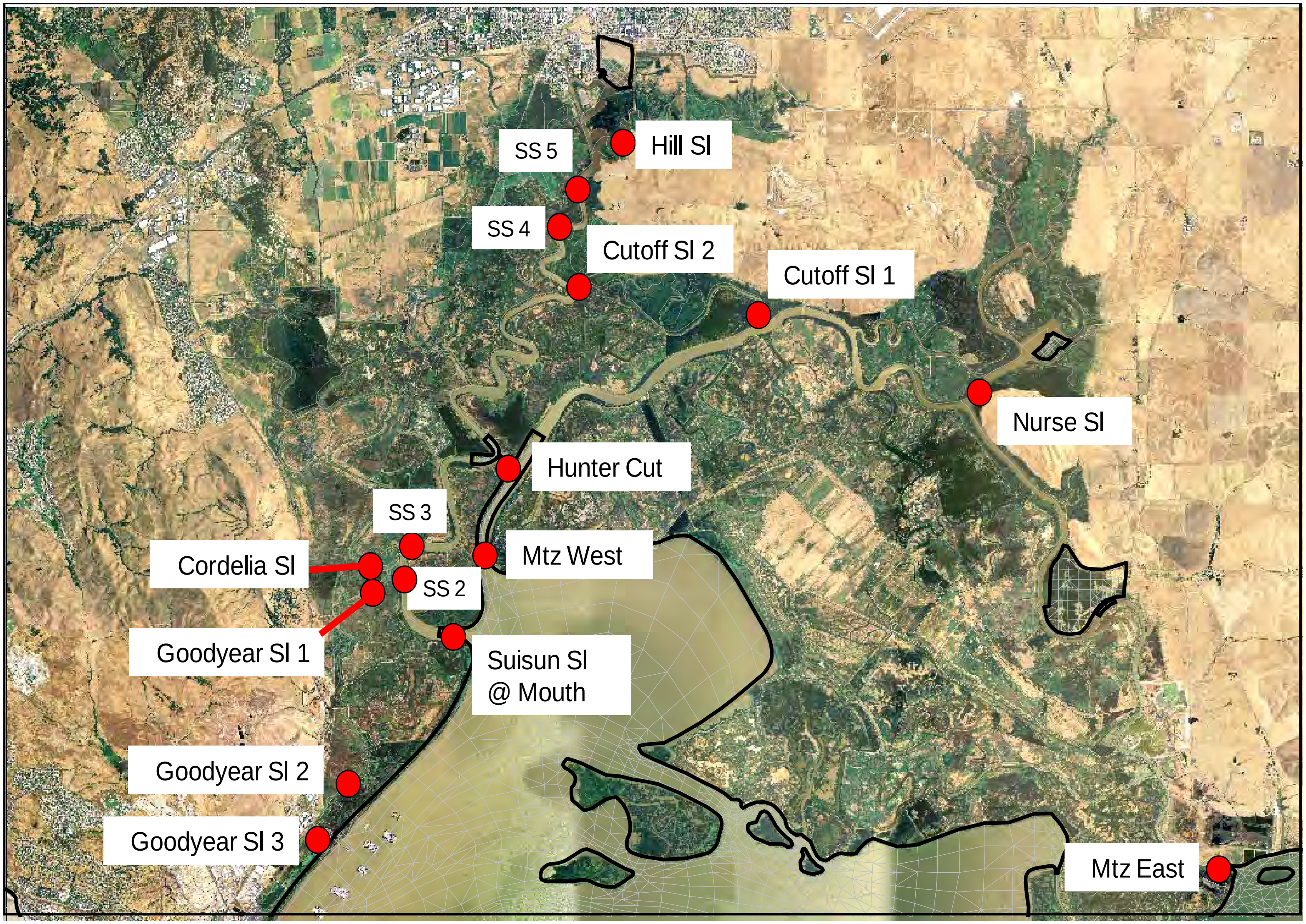


Figure 5-12 Locations where tidal flow was calculated (Base case grid).

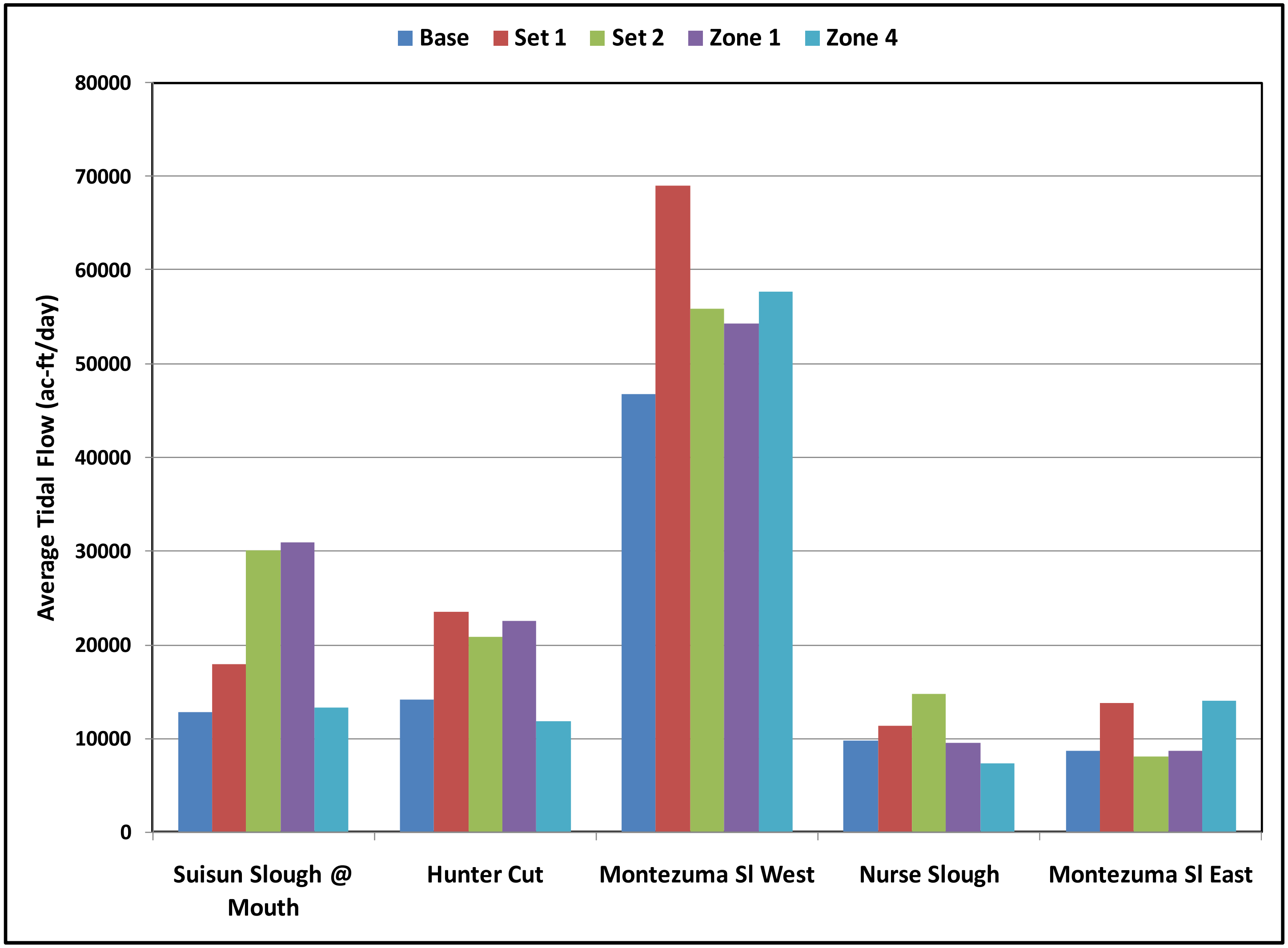


Figure 5-13 Average modeled tidal flow in the larger sloughs in central Suisun Marsh.

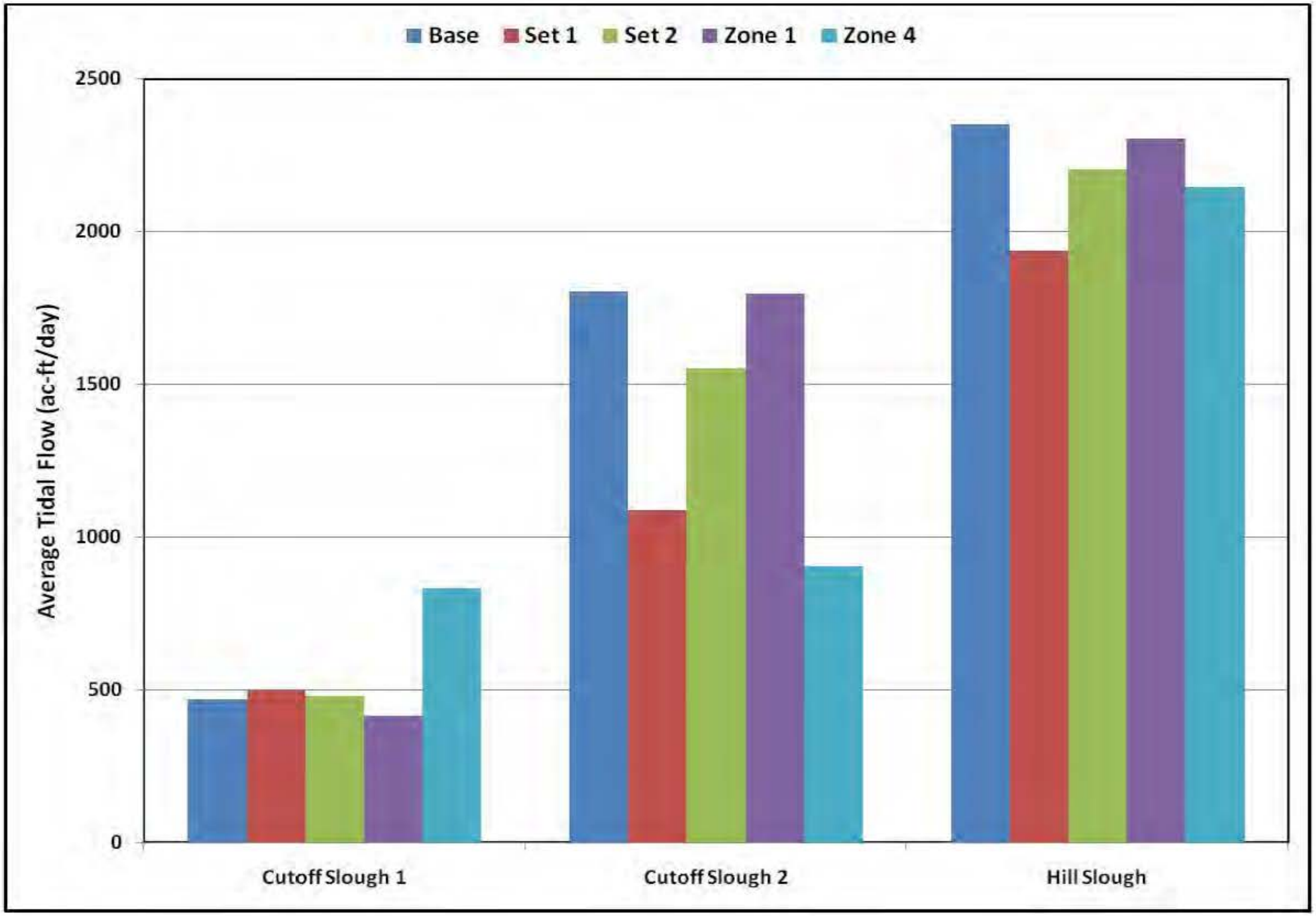


Figure 5-14 Average modeled tidal flow in the smaller sloughs in the northern interior region of Suisun Marsh.

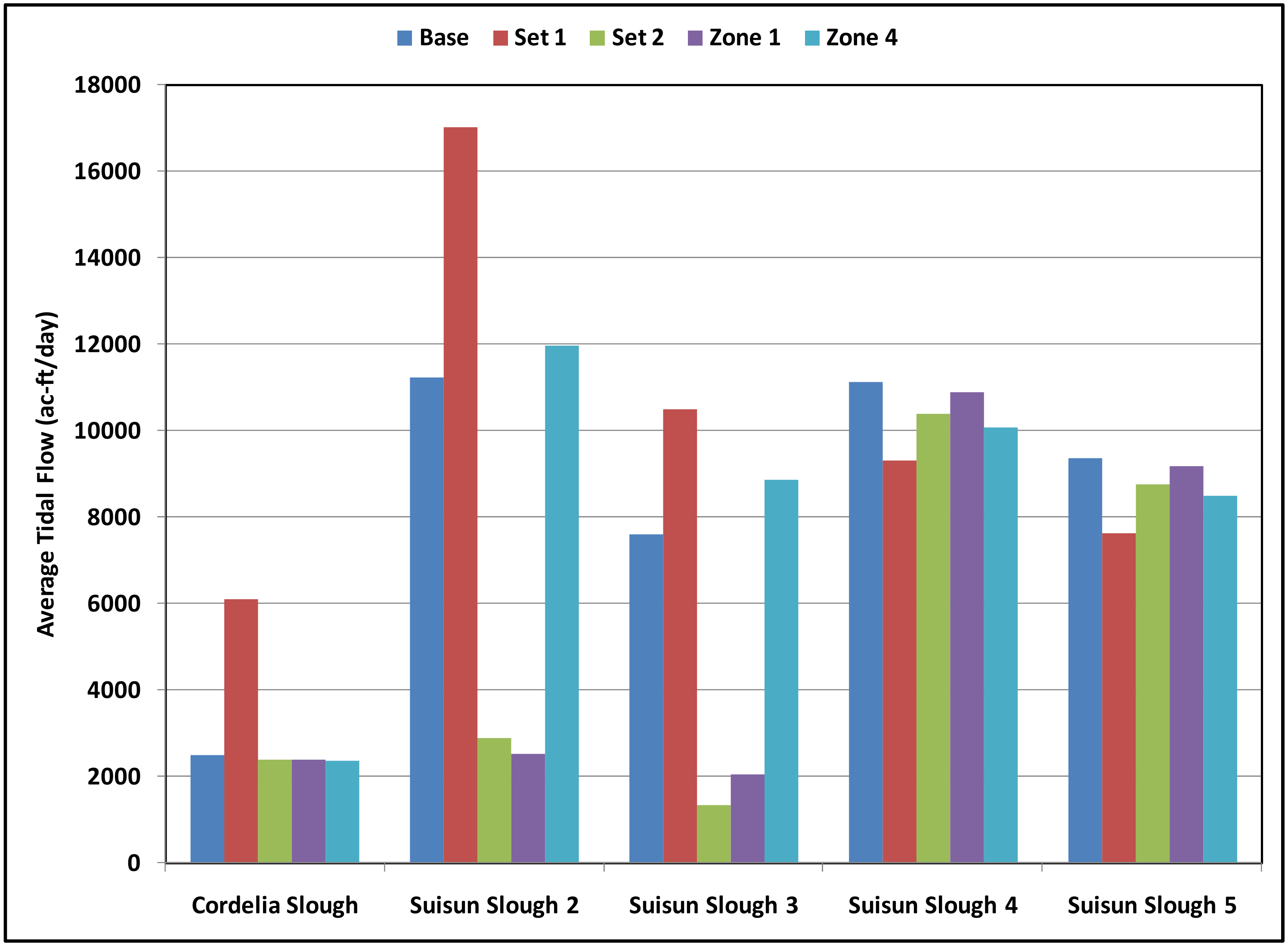


Figure 5-15 Average modeled tidal flow in the sloughs west and north of the Zone 1 area.

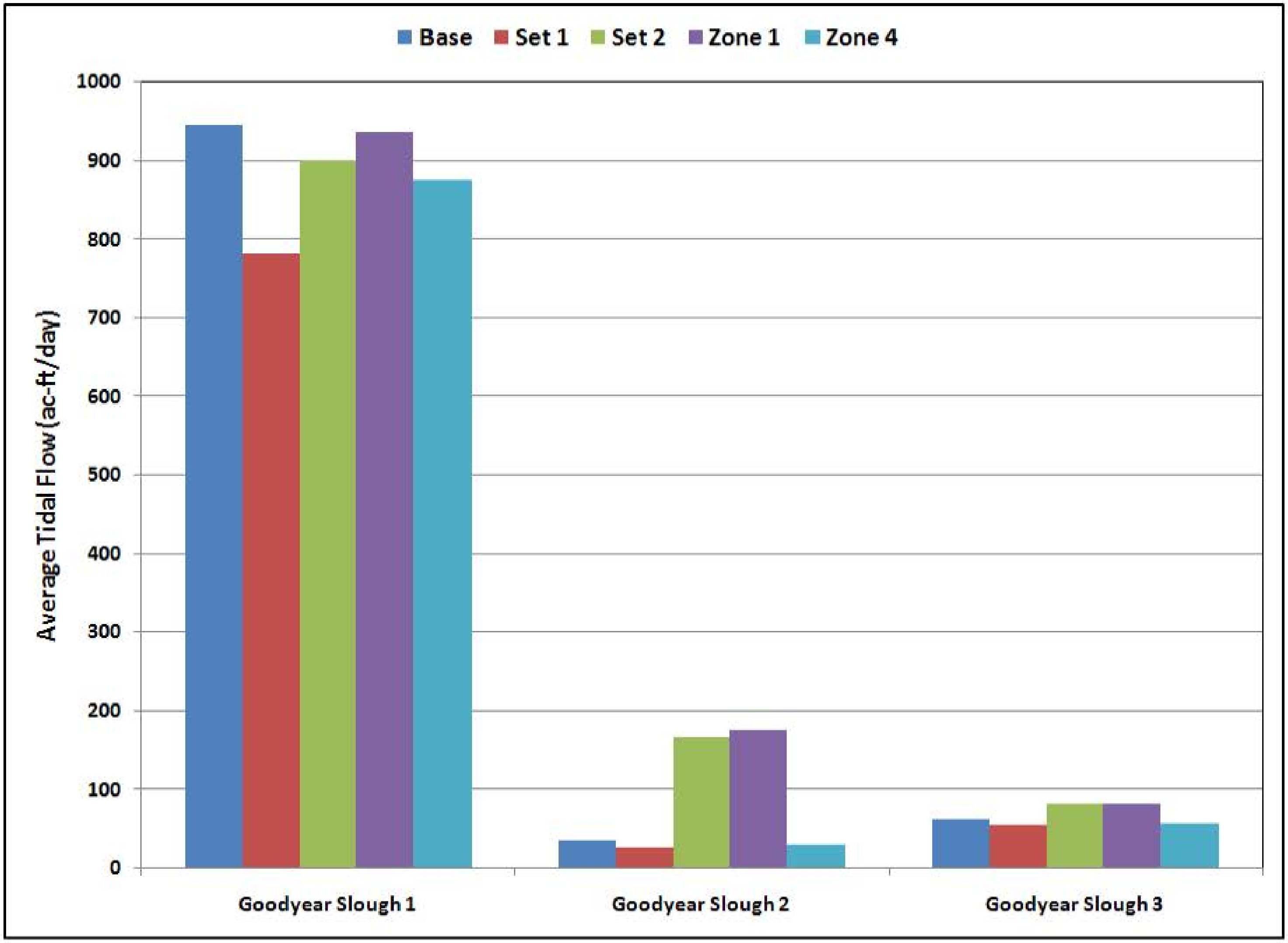


Figure 5-16 Average modeled tidal flow in Goodyear Slough.

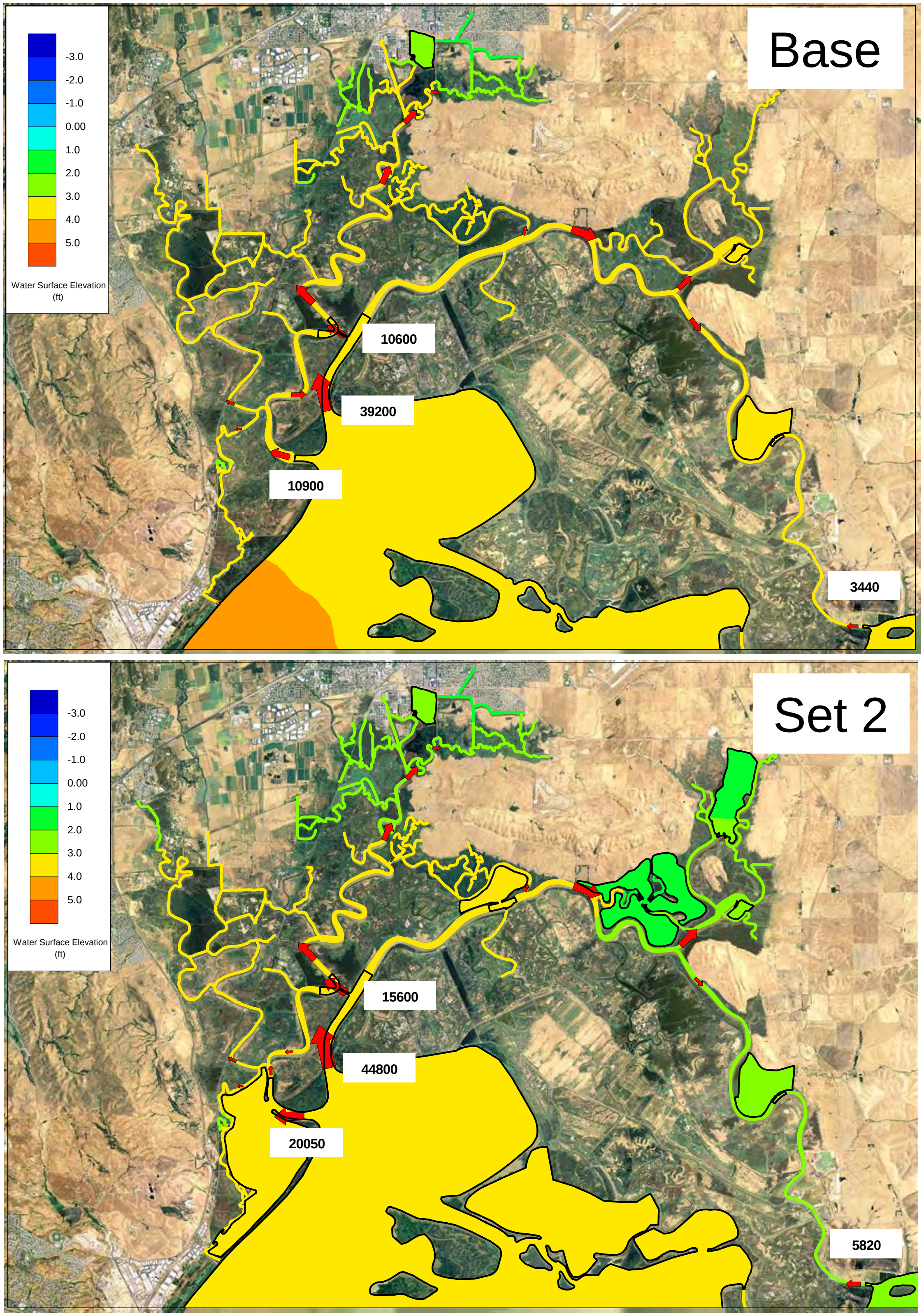


Figure 5-17 Red arrows illustrate flow magnitude (cfs) near peak flood tide (July 11, 2003 22:00) for Base case in comparison with Set 2. Color Scale is water surface elevation.

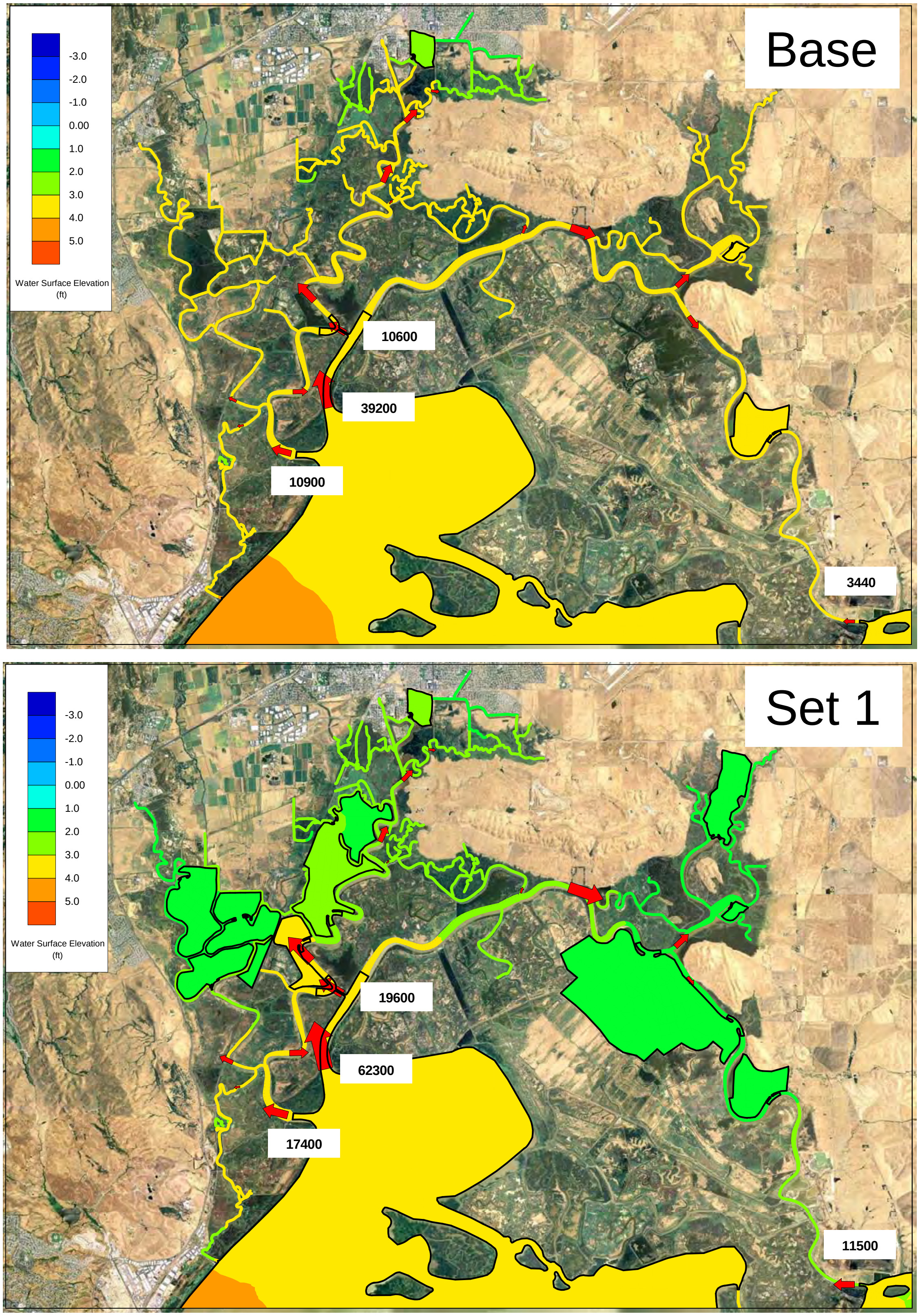


Figure 5-18 Red arrows illustrate flow magnitude (cfs) near peak flood tide (July 11, 2003 22:00) for Base case in comparison with Set 1. Color Scale is water surface elevation.

5.6. EC Results

To present a clear picture of the effects of the scenarios on EC in Suisun Marsh and in the Delta, several types of plots are provided. These include time series plots of the scenario EC at selected locations in Suisun Marsh and the Delta; color contour plots of percent change from base; comparison plots of Base case and scenario EC in Suisun Marsh; and comparison plots of Base case and scenario EC in the Delta. For all of the scenarios, large percent changes calculated in the winter are due to very low values, i.e. relatively small increases in modeled EC can translate to large percent increases. Therefore, contour plots of % change during the winter are not provided.

5.6.1. **Martinez to Collinsville**

Tidally averaged EC at Martinez (Figure 5-19) is relatively uniform between scenarios. However, upstream at Chipps and Collinsville, Figure 5-20 and Figure 5-21 respectively, the effect of the Set 2 tidal restoration with breaches between Honker and Grizzly Bays is seen as a pronounced increase in EC throughout the year.

5.6.2. **Suisun Marsh**

Changes in the details of the EC profile for each scenario depended on the particular location examined, the operation of the SMSCG, and the season. Each of the scenarios resulted in EC increases in Montezuma Slough at Beldon's Landing. Tidally averaged EC for the Base case and the four restoration scenarios are plotted in Figure 5-22 through Figure 5-34 for locations throughout Suisun Marsh.

The Set 1 scenario produced the greatest increases in EC throughout much of Suisun Marsh, as most of the tidal marsh restoration occurs in the interior portions of the marsh and off of Montezuma Slough. See for example, stations S-49 at Beldon's Landing, S-40 at Boynton Slough, and S-97 at Ibis in Figure 5-22 through Figure 5-24. At Beldon's Landing, the Zone 4 breaches pull high salinity water in from western Montezuma Slough increasing EC there year-round. The Set 1 breaches in north-western Suisun Marsh increase EC near those locations, again through the increased volume of higher salinity moving up western Montezuma Slough.

Effects from Set 1 restoration in the western portions of the marsh primarily result from the breaches in that area, as can be seen when comparing results with the Zone 4 scenario results at station S-97, Figure 5-24. Zone 4 had very little effect on EC in the western and northern marsh when the SMSCG was open and decreased EC when SMSCG was operating, as illustrated in Figure 5-24 through Figure 5-31.

Zone 4 increased EC at Beldon's landing regardless of the SMSCG status. In eastern Montezuma Slough at National Steel (Figure 5-33) and Roaring River (Figure 5-34), EC decreased when SMSCG was open and increased when the gates were operating.

In eastern Montezuma Slough, Set 1 reduced EC when the SMSCG was open (see station S-64 at National Steel, Figure 5-33 and station S-71 at Roaring River, Figure 5-34). The

Zone 4 breaches on Montezuma Slough pull high EC water into the marsh from the west during flood tide. Ebb flows on the upstream side of the breaches pull additional lower EC Sacramento River water into the eastern end of Montezuma Slough. This is illustrated in Figure 5-40, which shows color contours of EC for the Base case and Zone 4 scenario at the same timing on a flood tide and on an ebb tide.

The Zone 1 restoration increased EC throughout much of the marsh. As shown in the color contour plot of percent change in EC in Figure 5-47, % EC in Grizzly Bay at the mouth of Montezuma Slough is about 4.5% higher than the Base case with similar increases at the mouth of Suisun Slough. The flows that progress up Suisun Slough past the Zone 1 breach are smaller than in the Base case due to the breach, and the marsh is being filled with higher EC water from the mouth of Montezuma Slough in the west.

The Zone 1 scenario EC results were the most similar to the Base case, showing little difference from the Base case in the eastern Marsh (station S-64 at National Steel and station S-71 at Roaring River) and at Morrow Island (station S-35, Figure 5-26), but resulted in at least some EC increase in the western Marsh (for example, S-42 in Volanti Slough, Figure 5-27 and S-21 on Sunrise Slough, Figure 5-25) and in Montezuma Slough near Beldon's Landing.

The Set 2 scenario, which incorporates Zone 1, increased EC when the SMSCG was operating. In the western and central marsh (for example S-21 and S-49), EC was increased throughout the simulation, but at Morrow Island, Set 2 resulted in little change when the SMSCG was not operating. When the SMSCG was not operating, EC decreased appreciably only in eastern Montezuma Slough at S-64 and S-71.

Operation of the SMSCG acts to decrease EC in comparison to the Base case. Specific locations on Montezuma Slough illustrate the effect of SMSCG operation and changes in tidal flow due to the breaches.

- S-49 – Beldon's Landing (Figure 5-22): For the Set 2 scenario, the breaches north of Montezuma Slough only affect EC at Beldon's Landing when the SMSCG is operating. This can be seen because Set 2 and Zone 1 EC are nearly the same at this location when the gates are open.
- S-64 – National Steel (Figure 5-33): In general, all of the scenarios decrease EC at S-64 when the SMSCG is open because they decrease the flood tide flow of higher EC water to this location. When the gate is operating, EC increases for Set 2 because EC at the eastern end of Montezuma Slough near Collinsville is higher due to the breaches in Suisun Bay. On ebb tide, this higher EC water flows past S-64. For the Zone 1 scenario, the same thing occurs only the effect is much smaller. For the Set 1 and Zone 4 scenarios, the increase in EC is the result of a change in phasing. The breaches off of Montezuma Slough changed the tidal phasing and amplitude so that flow from Collinsville into Montezuma Slough occurs at high tide, when EC at Collinsville is highest.

5.6.3. Delta

Scenarios that tended to increase EC in Suisun Marsh tended to decreased Delta EC. Delta EC was similar to the Base case in all of the scenarios during early winter through spring, but changed in relation to the Base case during summer through fall. This can be seen in plots of tidally averaged EC for the Base case and four marsh restoration scenarios at several Delta stations in Figure 5-35 through Figure 5-39, and in contour plots of % change from base in Figure 5-41 to Figure 5-53.

The two scenarios incorporating Zone 4 (Zone 4 and Set 1) resulted in a decrease in Delta EC, while the two scenarios incorporating Zone 1 (Zone 1 and Set 2) resulted in an increase in summer through fall Delta EC. This is seen at locations from Jersey Point, Figure 5-35, to various locations in the central and south Delta - at Old River near Rock Slough (5-36), in Victoria Canal (5-37) and at the CVP (Figure 5-38) and SWP (Figure 5-39) export locations.

The Set 2 scenario causes the greatest increase in Delta EC, as shown in Figure 5-41 through Figure 5-46 for the months with the highest EC changes. An example is seen in the color contour plot of percent change from Base case EC for the Set 2 scenario on September 1, 2002 in Figure 5-42. At this time, EC at the SWP is 12% greater than Base and at the CVP, it is 10% greater than Base. These changes are due to tidal mixing in the breaches off of Suisun Bay, which causes increased EC there, and later in the year increased EC up the San Joaquin River into Franks Tract and the western Delta. A similar plot for the Zone 1 scenario, in Figure 5-47, shows that it has minimal change to Delta EC, as the largest increases at the export locations are approximately 2% during the at this time.

The Set 1 and Zone 4 scenarios generally reduce EC at the export locations and in the western Delta summer through fall, as shown in Figure 5-48 through Figure 5-53. The Set 1 scenario produces the largest reductions – approximately 10% near the export locations on September 1, 2002, as shown in the color contour plot in Figure 5-49, while the Zone 4 restoration area alone reduces EC by 5 – 6% near the exports (not shown).

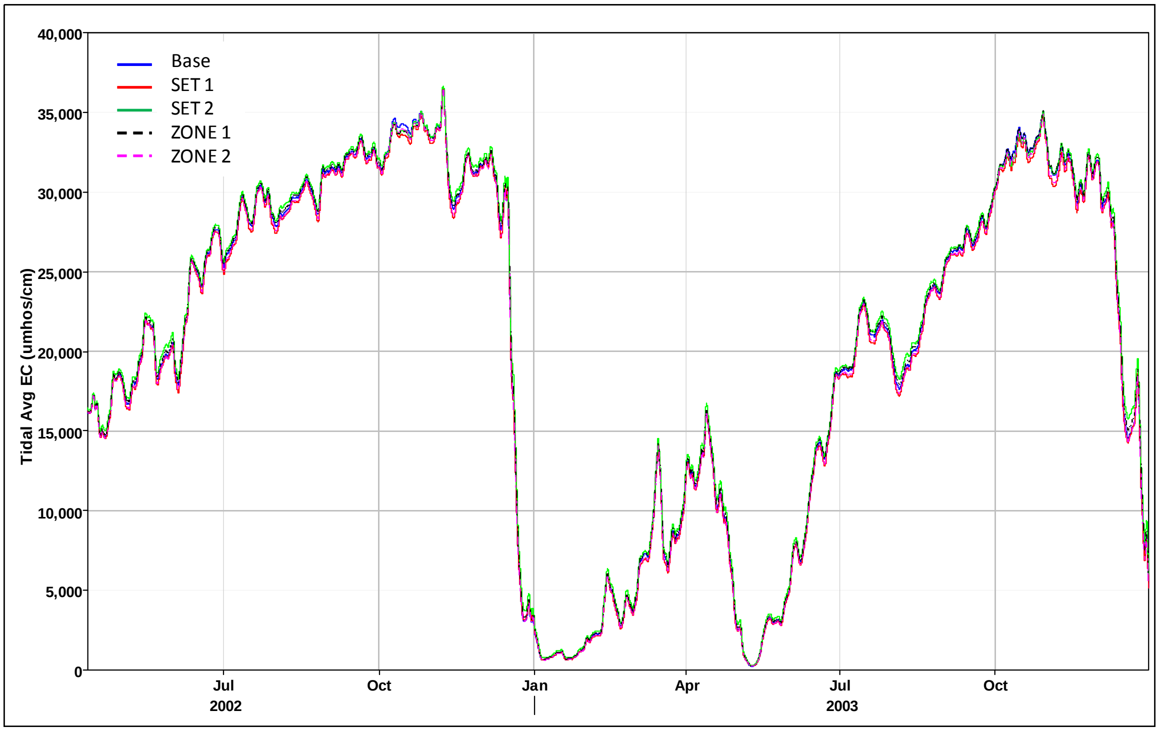


Figure 5-19 Tidally averaged computed EC at Martinez.

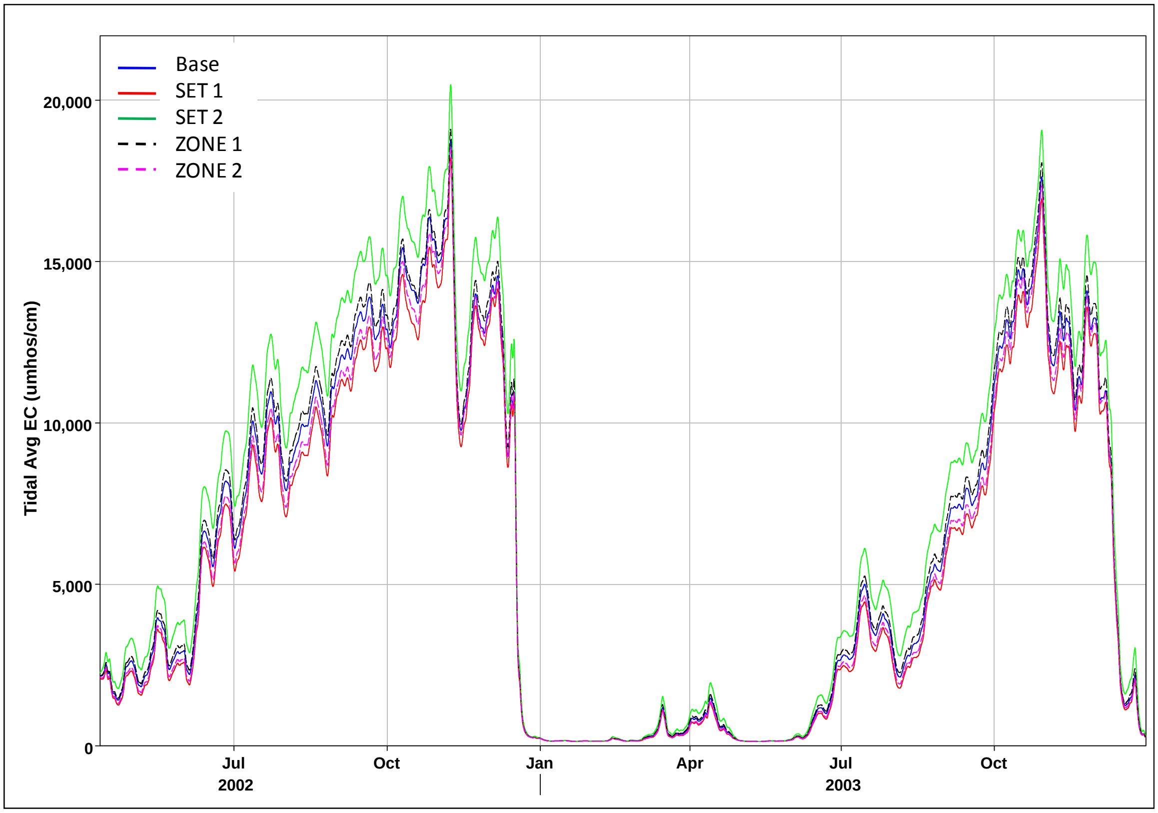


Figure 5-20 Tidally averaged computed EC at Chipps.

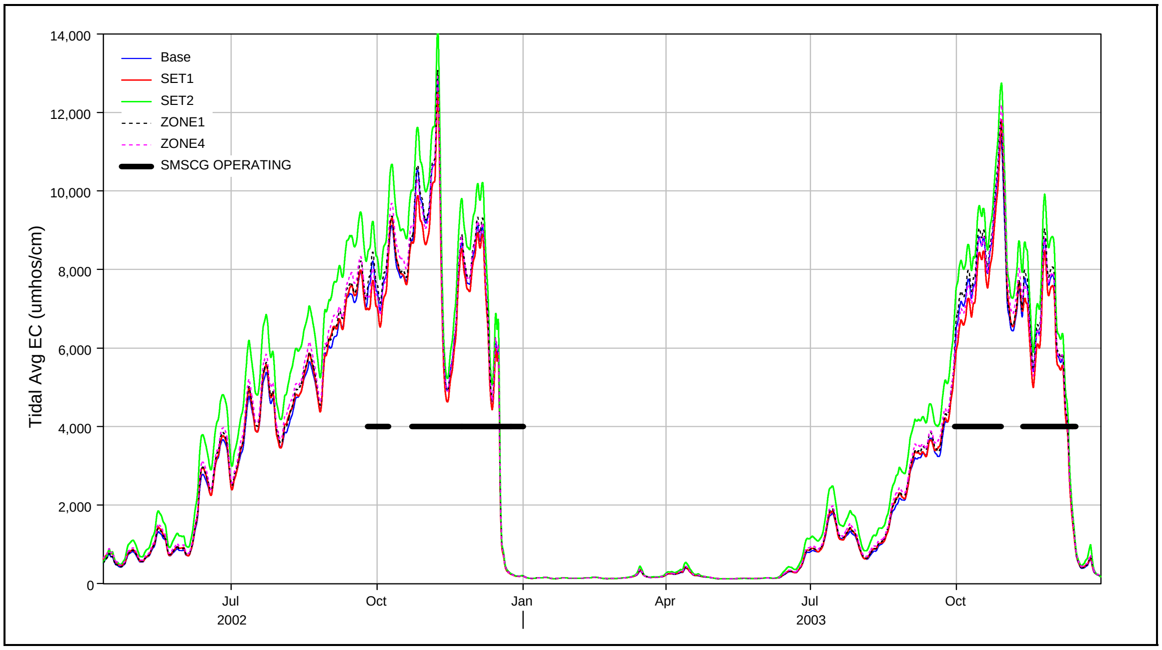


Figure 5-21 Tidally averaged observed and computed EC at Collinsville.

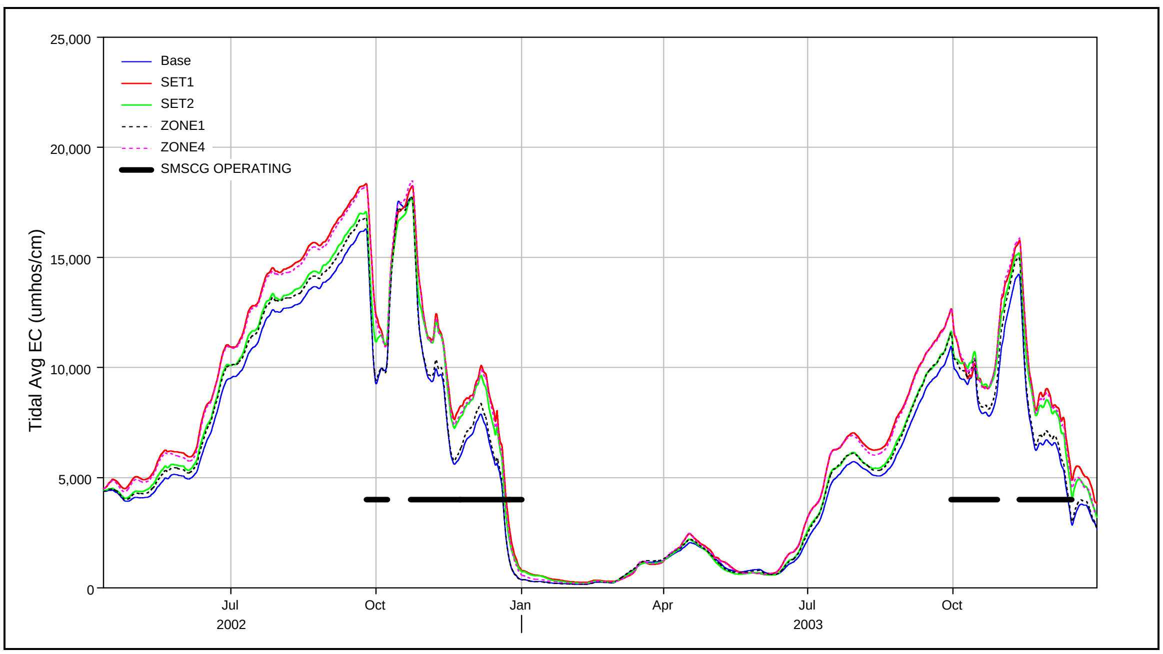


Figure 5-22 Tidally averaged computed EC at Beldon's Landing at monitoring station S-49 in Montezuma Slough.

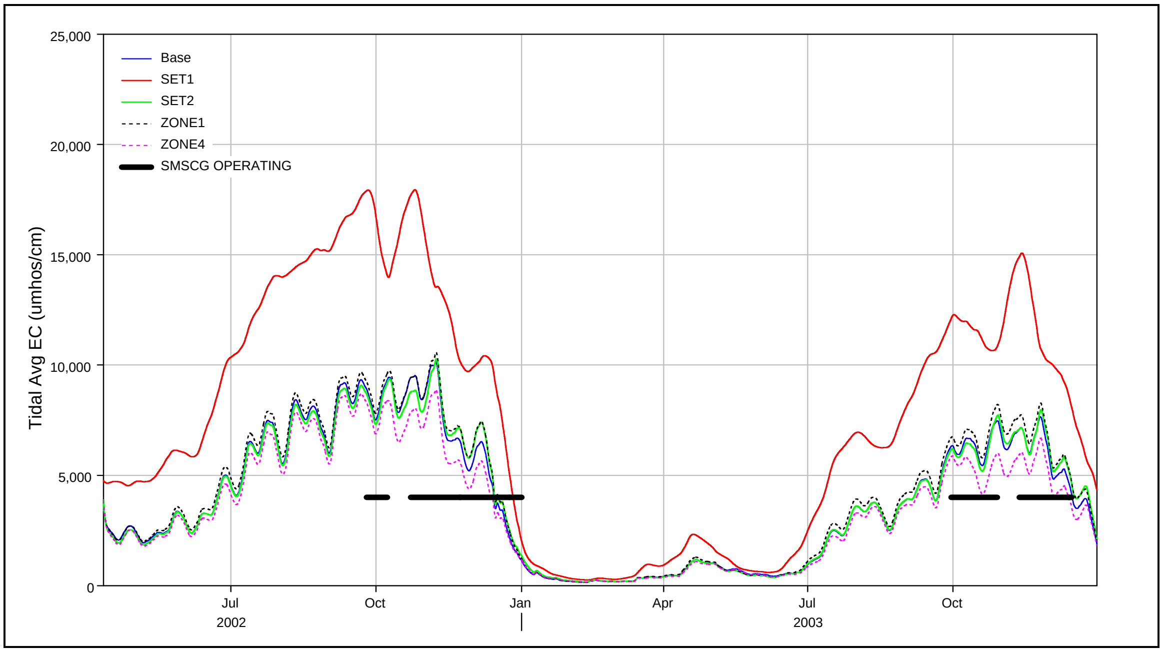


Figure 5-23 Tidally averaged computed EC at station S-40 on Boynton Slough.

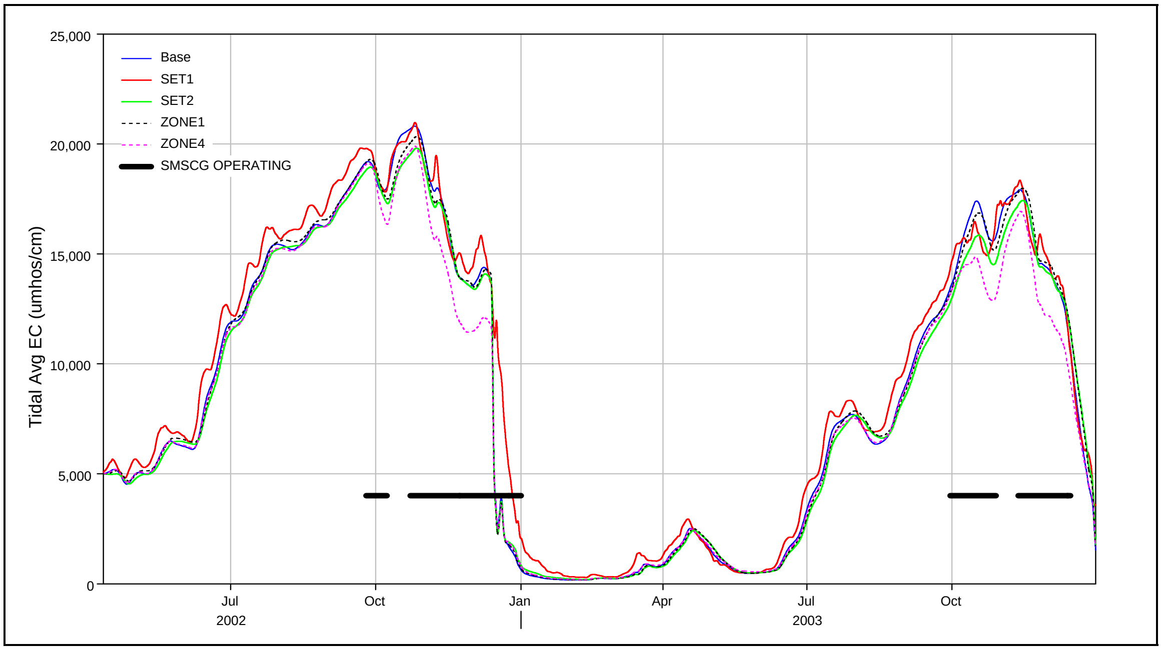


Figure 5-24 Tidally averaged computed EC at station S-97 on Ibis Slough.

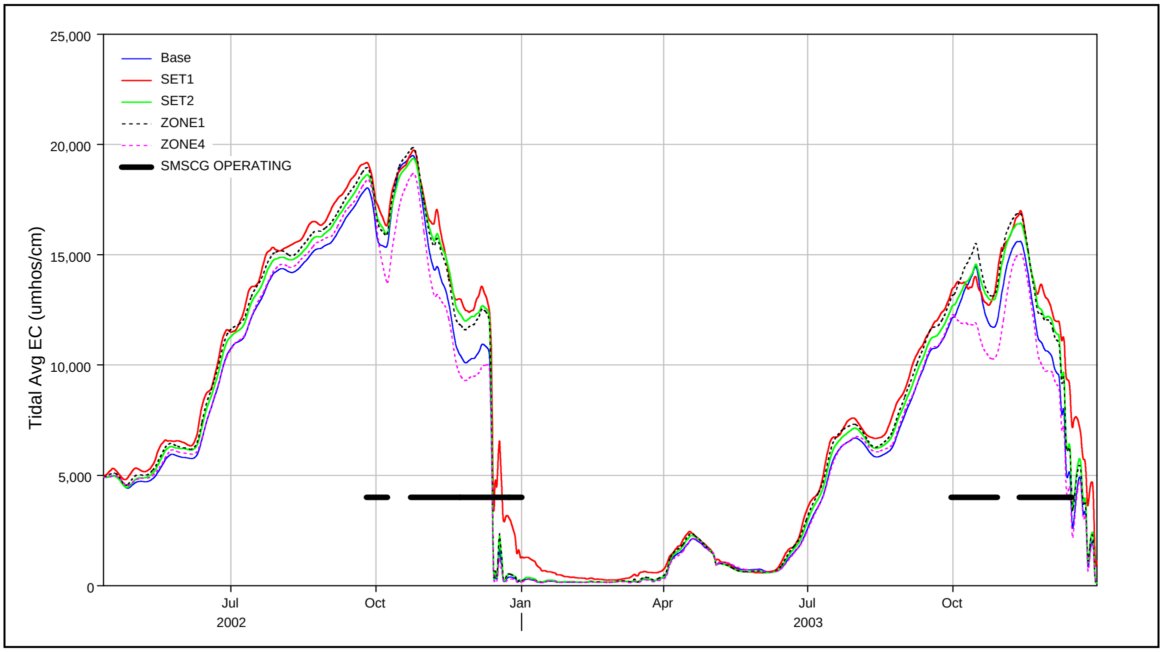


Figure 5-25 Tidally averaged computed EC at station S-21 in Sunrise Slough.

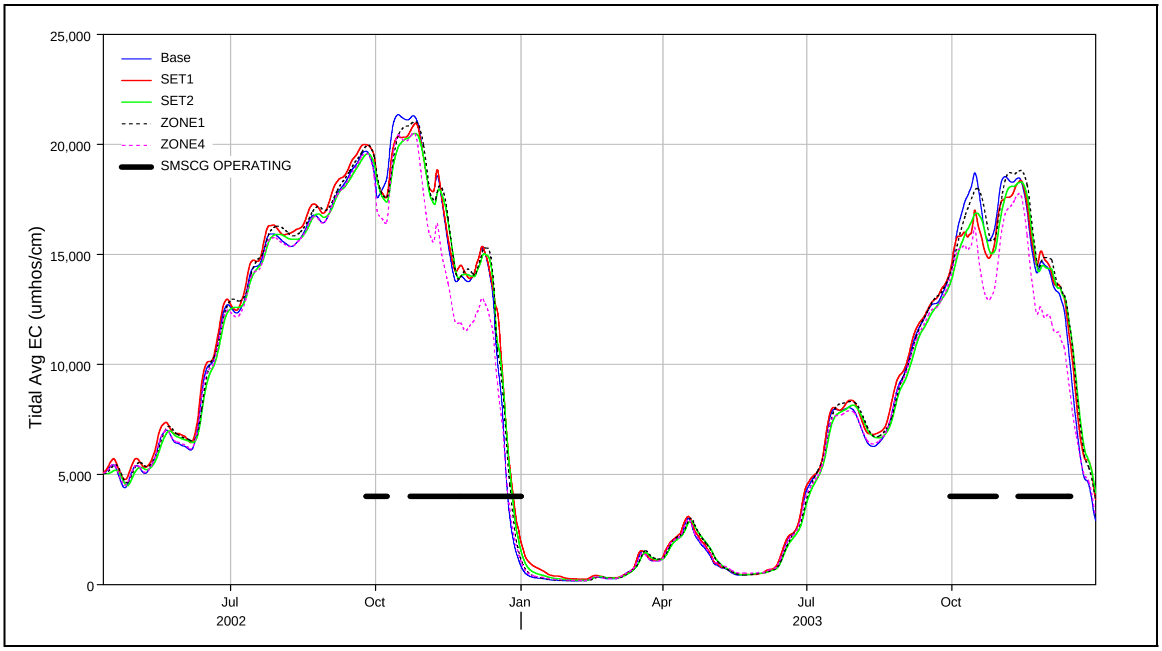


Figure 5-26 Tidally averaged computed EC at station S-35 at Morrow Island.

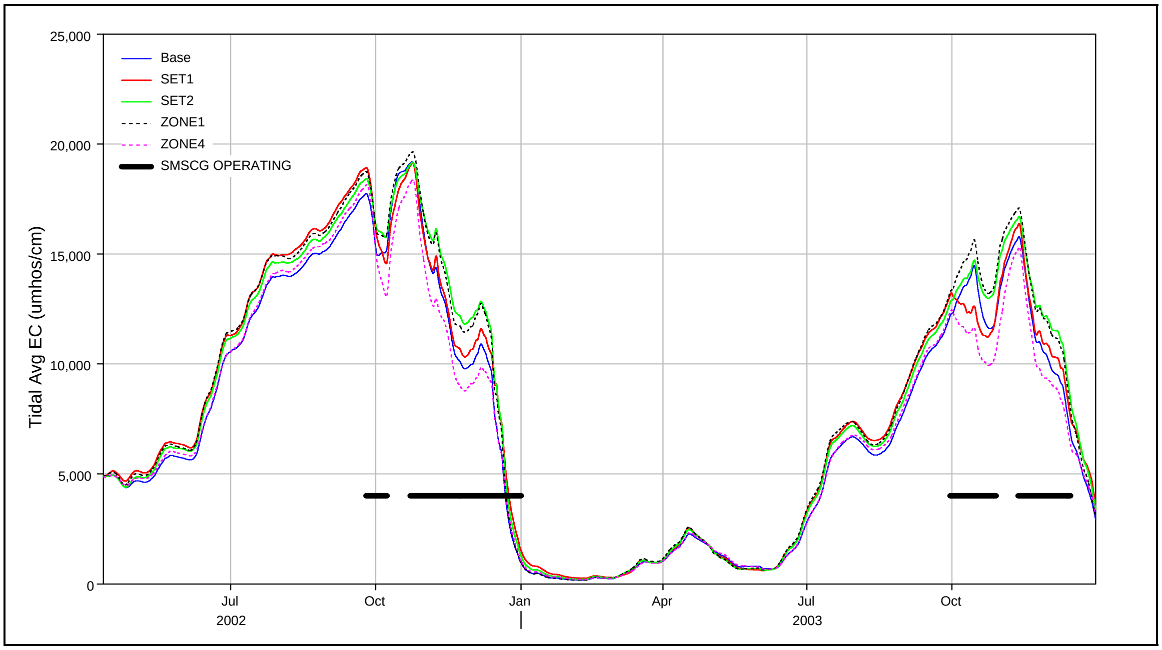


Figure 5-27 Tidally averaged computed EC at station S-42 on Volanti Slough.

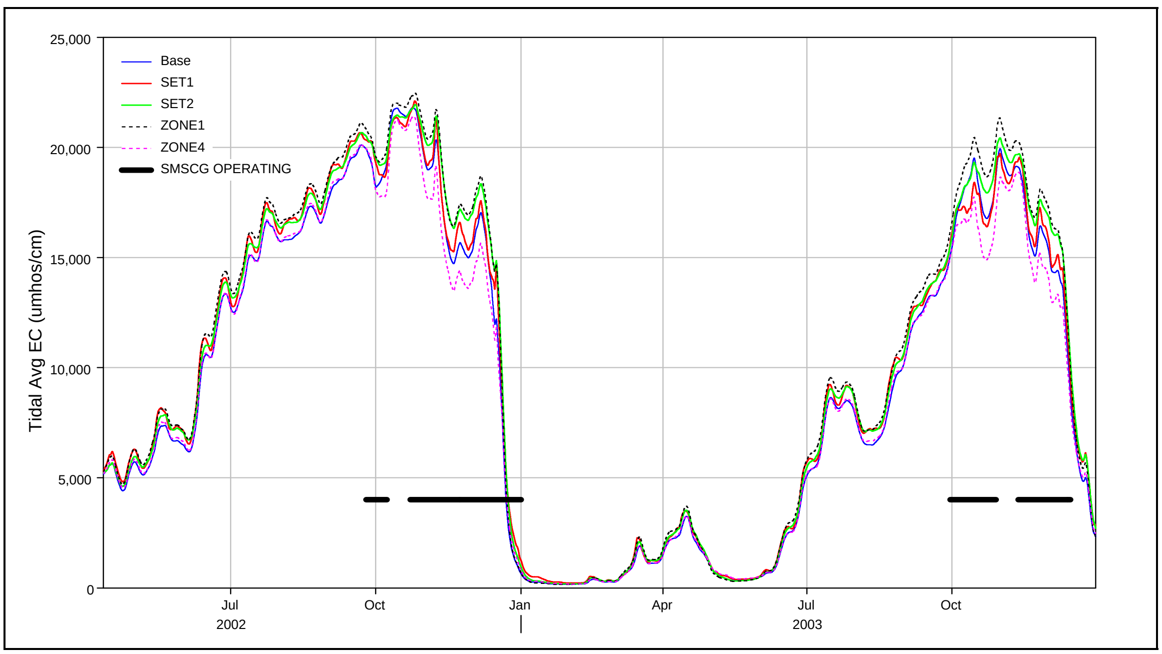


Figure 5-28 Tidally averaged observed and computed EC at station S-37 on Godfather Slough.

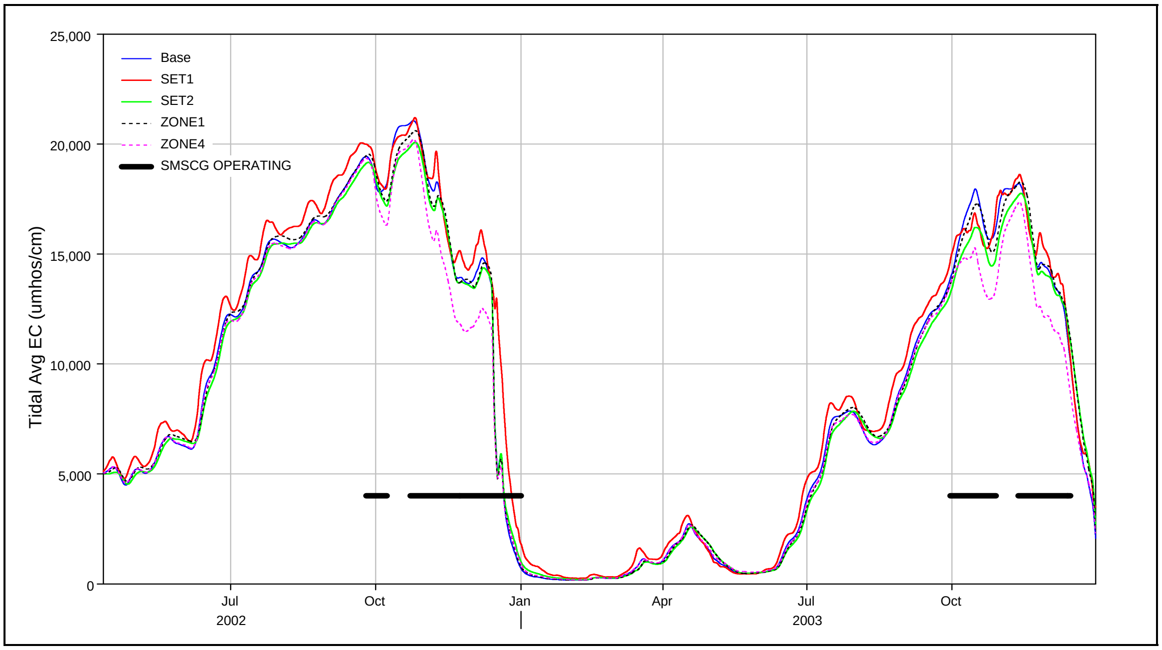


Figure 5-29 Tidally averaged observed and computed EC at station S-33 on Cygnus Slough.

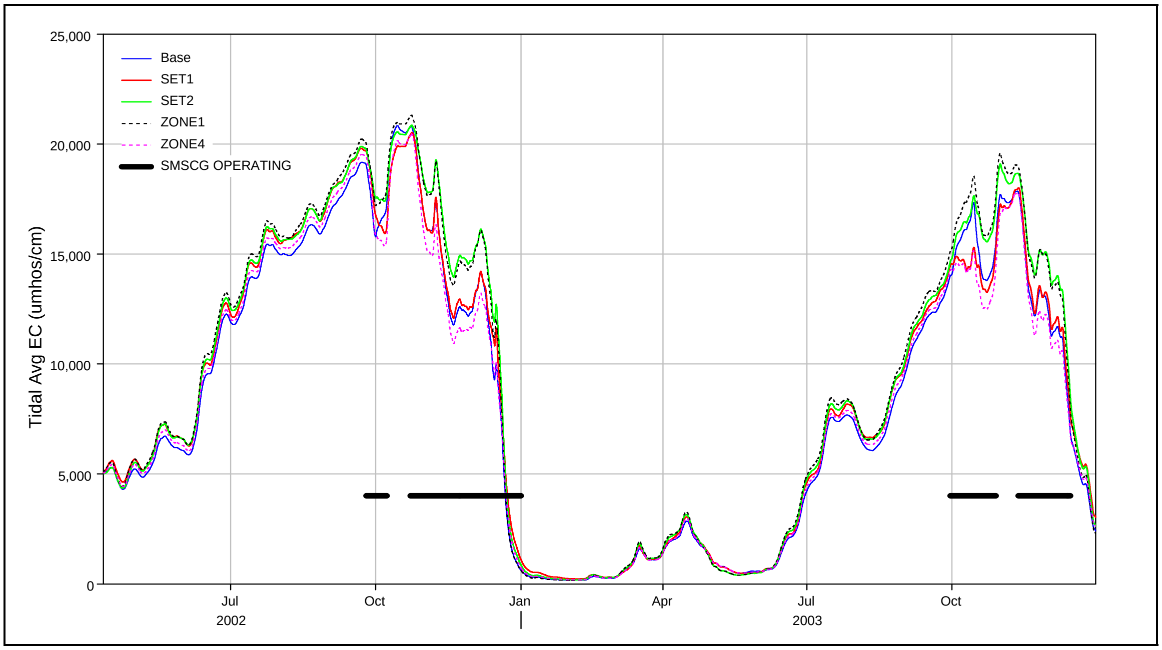


Figure 5-30 Tidally averaged observed and computed EC at station S-54 on Hunter Cut.

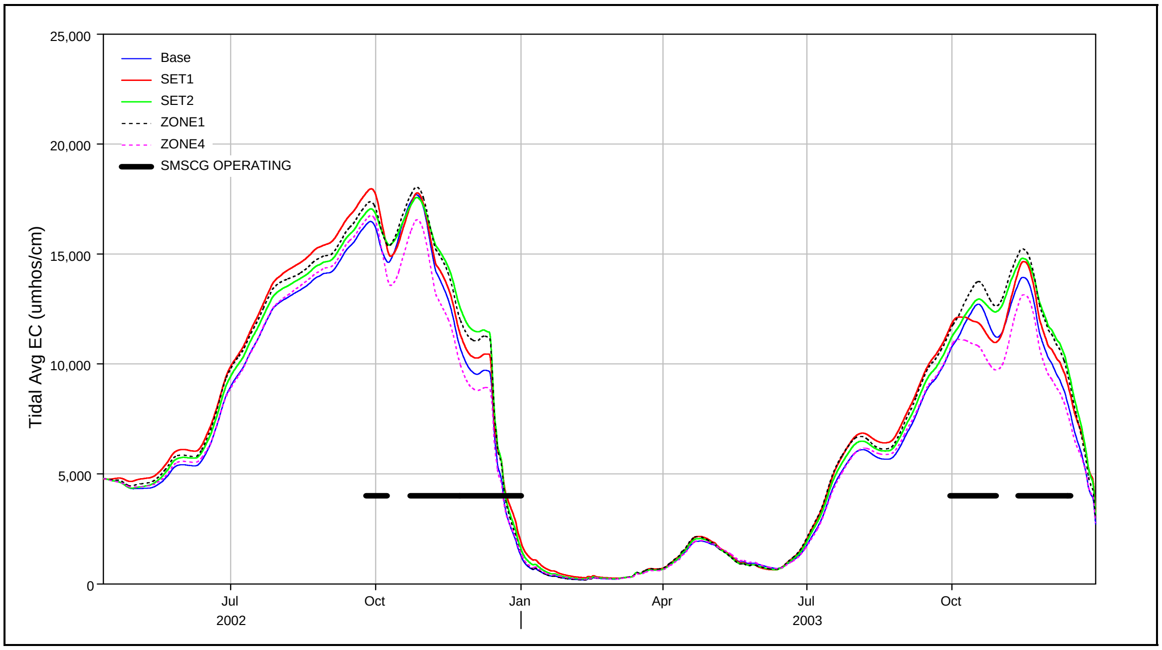


Figure 5-31 Tidally averaged observed and computed EC at station S-4 on Hill Slough.

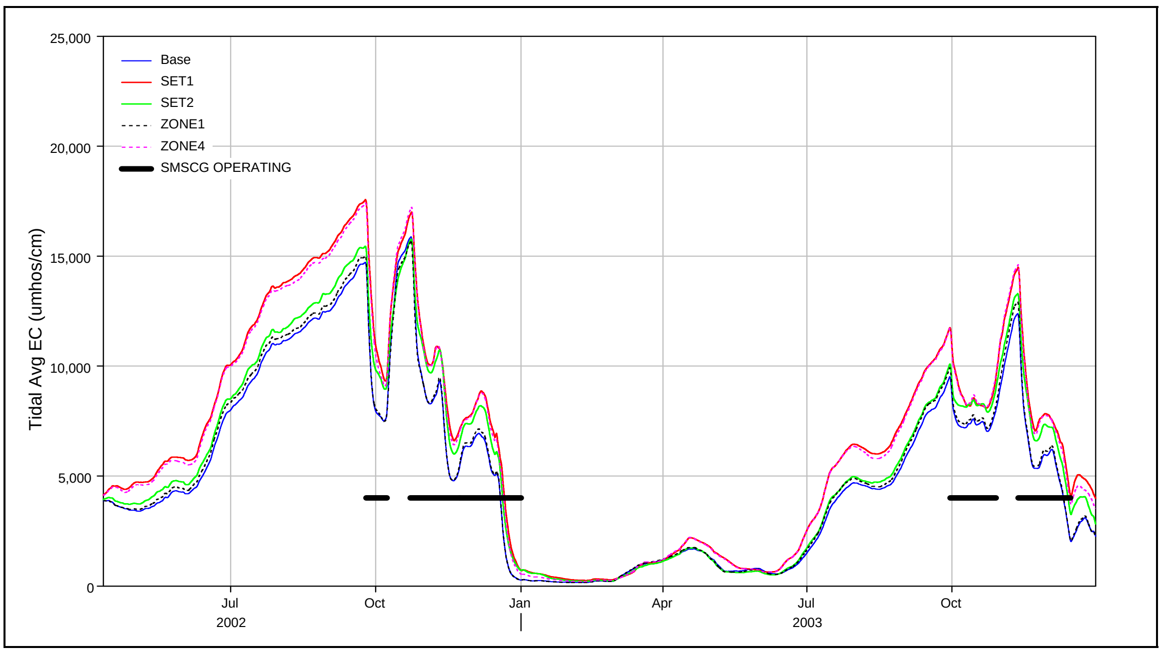


Figure 5-32 Tidally averaged observed and computed EC at station NS-1 on Nurse Slough.

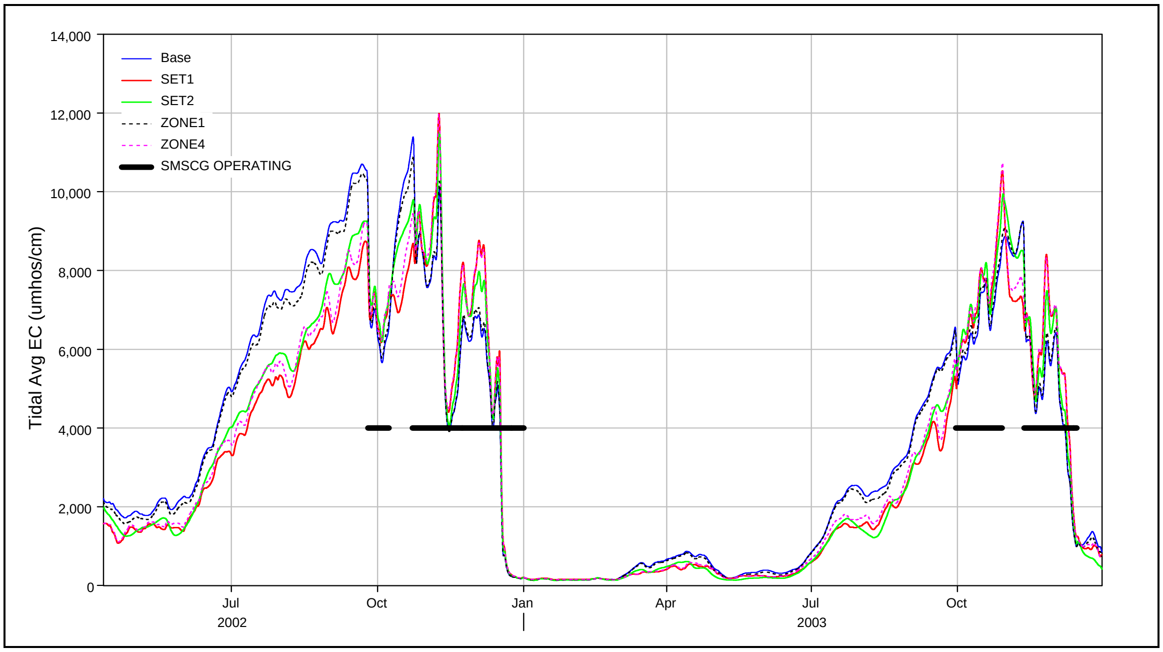


Figure 5-33 Tidally averaged computed EC at the S-64 monitoring location near National Steel on Montezuma Slough.

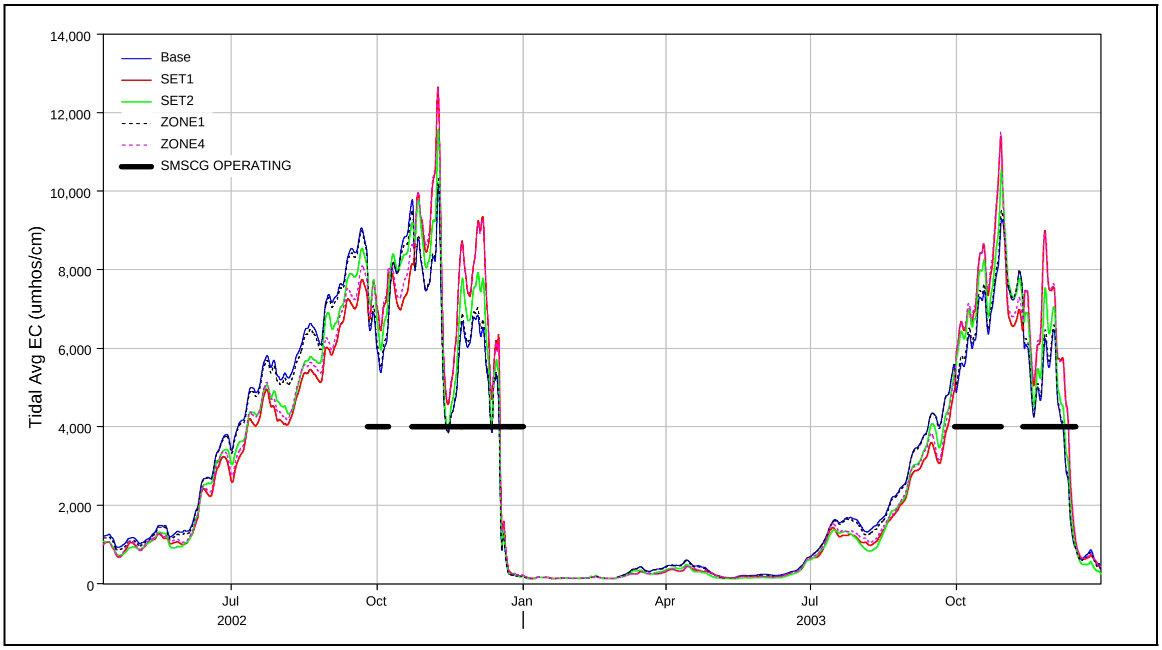


Figure 5-34 Tidally averaged computed EC at the S-71 monitoring location at Roaring River on Montezuma Slough.

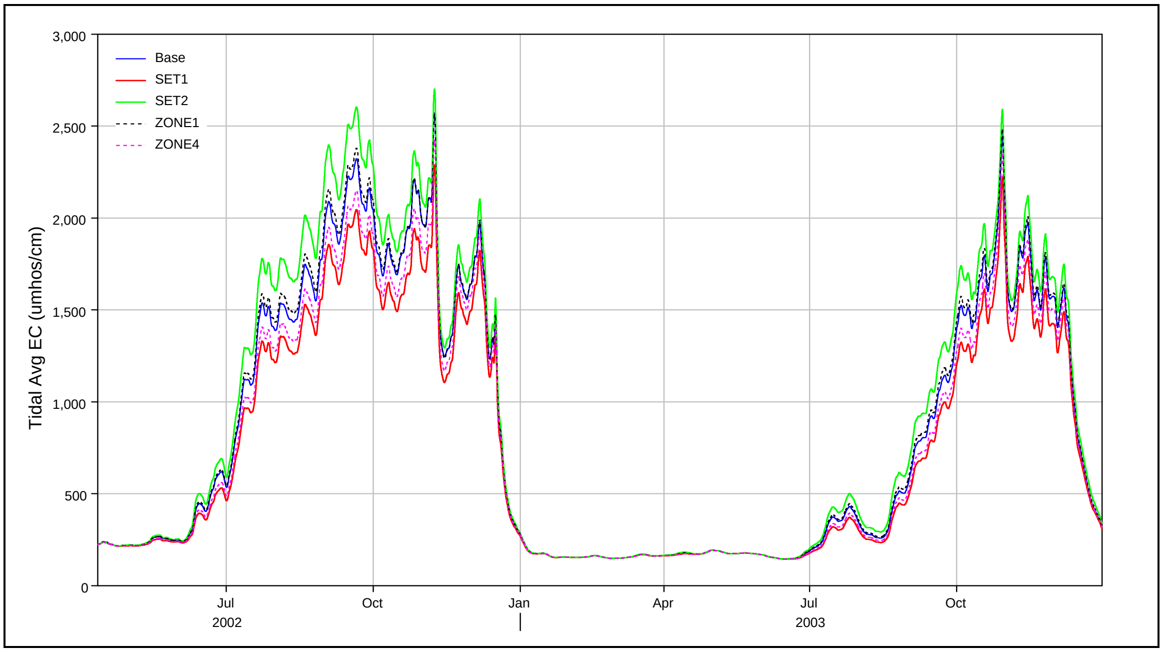
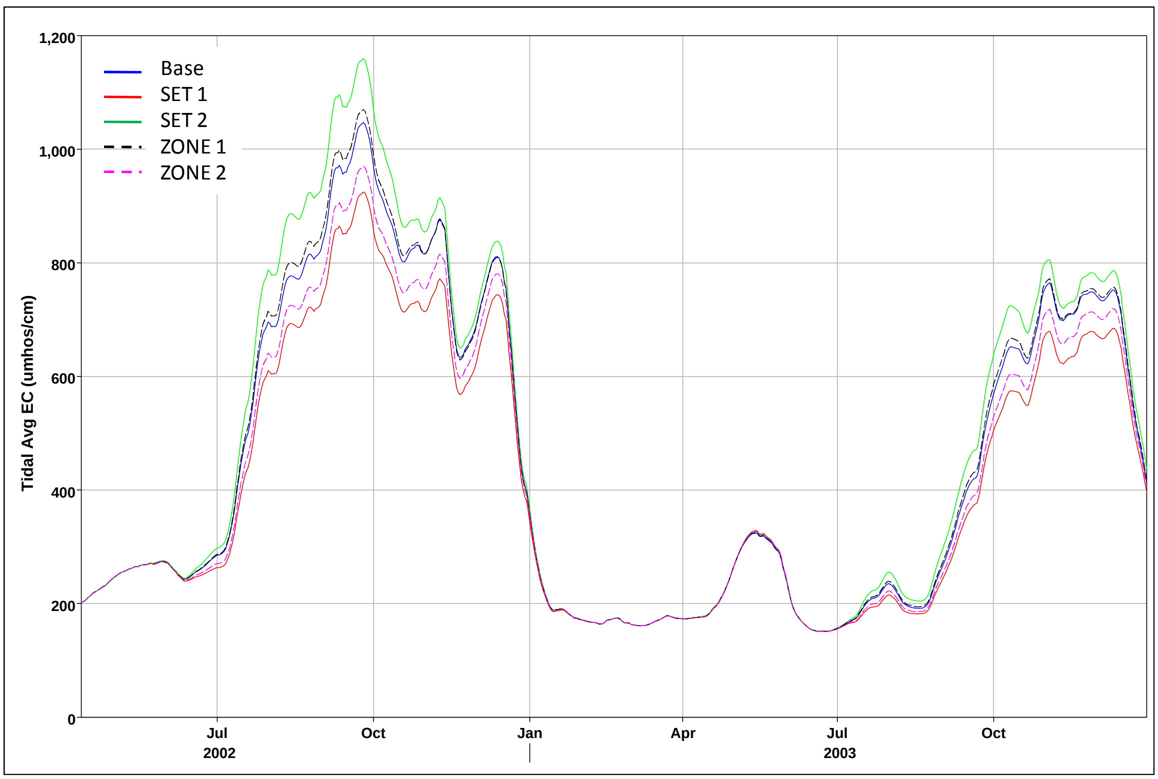
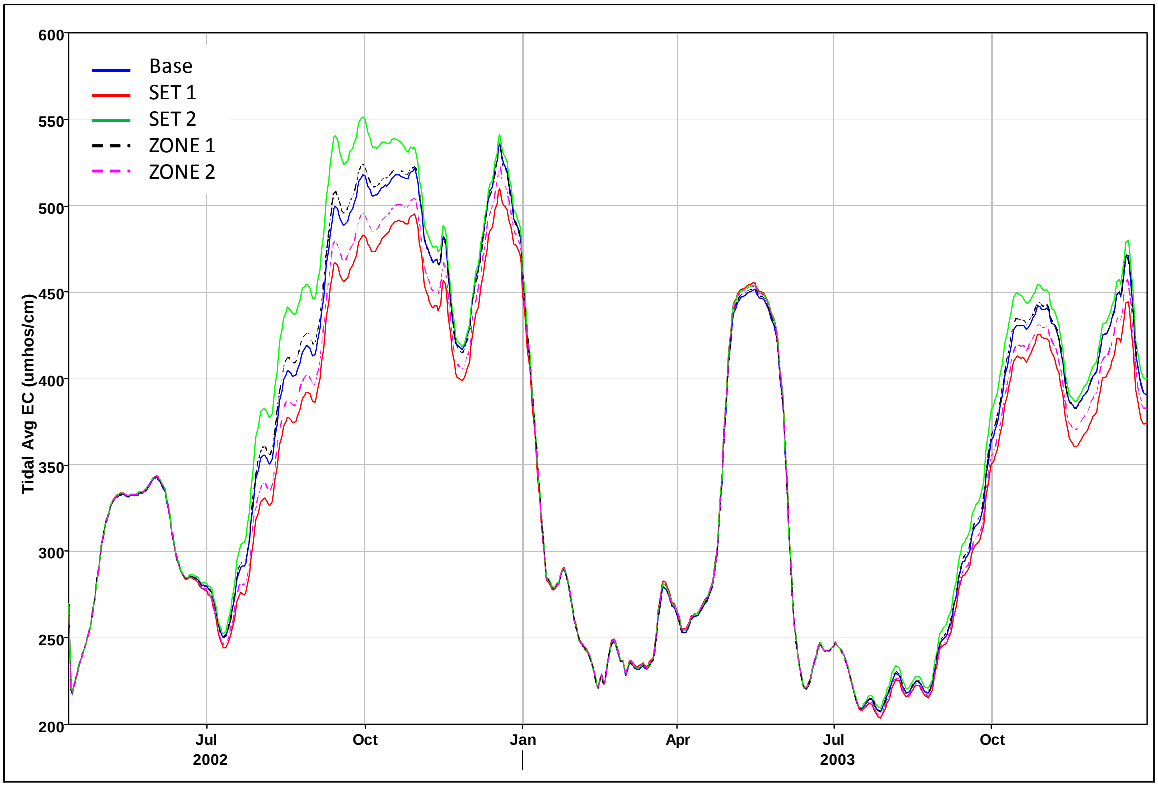


Figure 5-35 Tidally averaged computed EC time series at Jersey Point.



5-36 Tidally averaged computed EC time series at Old River at Rock Slough.



5-37 Tidally averaged computed EC time series at the CCWD Victoria Canal export location for Los Vaqueros.

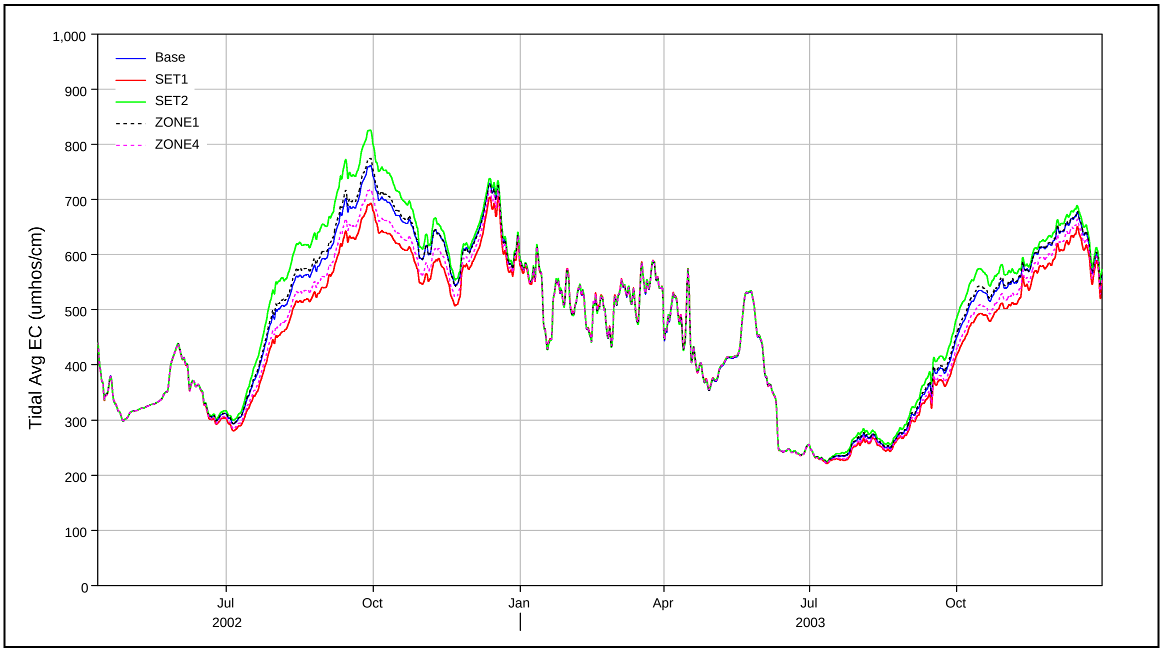


Figure 5-38 Tidally averaged computed EC time series at the CVP export location.

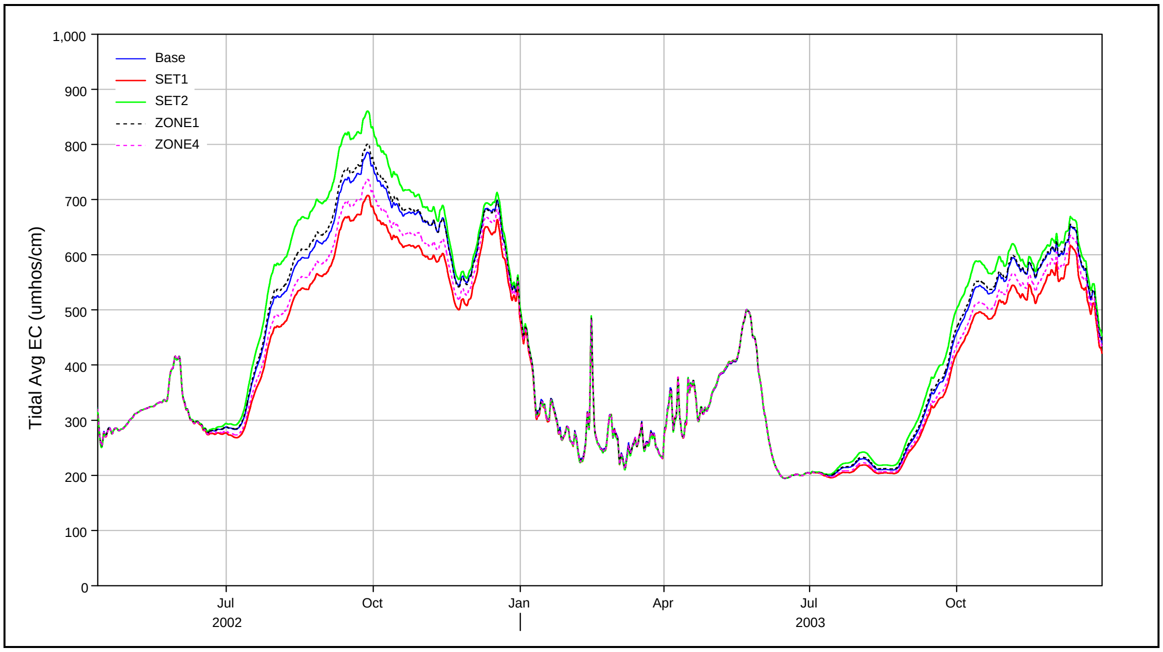


Figure 5-39 Tidally averaged computed EC time series at the SWP export location.