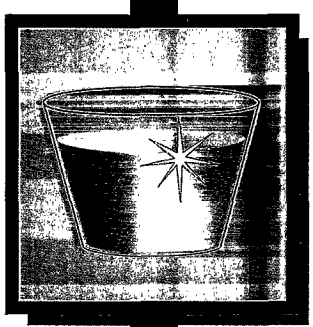

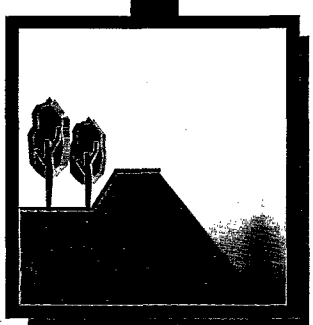

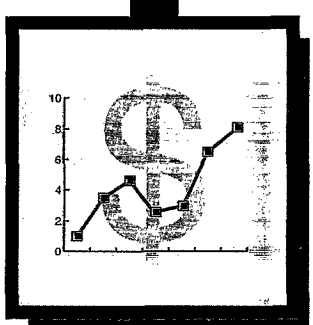

CALFED
BAY-DELTA
PROGRAM

Programmatic Environmental Impact Statement/ Environmental Impact Report

Draft
March 1998

Draft Programmatic Environmental Impact Statement/
Environmental Impact Report
CALFED Bay-Delta Program

Prepared by the CALFED Bay-Delta Program
for the U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, Natural Resources Conservation Service, U.S. Army Corps of Engineers, and the California Resources Agency

This Draft Programmatic Environmental Impact Statement/Environmental Impact Report (Draft Programmatic EIS/EIR) is prepared in compliance with the National Environmental Policy Act (NEPA), the U.S. Bureau of Reclamation (Reclamation) policy and procedures for implementing NEPA, and the California Environmental Quality Act (CEQA).

The CALFED Bay-Delta Program is a cooperative effort by fifteen state and federal agencies with regulatory and management responsibilities in the San Francisco Bay-Sacramento/San Joaquin River Bay-Delta to develop a long-term plan to restore ecosystem health and improve water management for beneficial uses of the Bay-Delta system. The objective of this collaborative planning process is to identify comprehensive solutions to the problems of ecosystem quality, water supply reliability, water quality, and Delta levee and channel integrity.

The Draft Programmatic EIS/EIR identifies twelve alternative methods to achieve this objective and analyzes the environmental impacts of each of those alternatives. Each of these alternatives includes the core programs which address the problem areas of ecosystem quality, water use efficiency, water quality, and Delta levee and channel integrity, water transfers, and watershed management coordination, as well as a range of storage and conveyance options. This is a programmatic-level document to choose a long-term plan, and by its very nature focuses on the interrelated long-term and cumulative consequences of each of the alternatives. Implementation of the plan will follow the approval of a preferred program alternative, and subsequent environmental review for project specific aspects of the program will be required.

For further information regarding this Draft Programmatic EIS/EIR, please contact the CALFED Bay-Delta Program at 1-800-900-3587 or address letters to the CALFED Bay-Delta Program, 1416 Ninth Street, Suite 1155, Sacramento, CA 95814.

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LIST OF ACRONYMS

AFB	Air Force Base
ARB	Air Resources Board
ALs	Action Levels
ARWI	American River Watershed Investigation
ARWRI	American River Water Resource Investigation
AUMs	Animal-unit months
BAT	Best Available Technology
BCDC	Bay Conservation and Development Commission
BDAC	Bay-Delta Advisory Council
BMPs	Best Management Practices
C-FOG	California-Federal Operations Group
CAA	Clean Air Act
Cal-EPA	California Environmental Protection Agency
CCWD	Contra Costa Water District
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
cfs	cubic feet per second
CMARP	Comprehensive Monitoring, Assessment, and Research Plan
CO	carbon monoxide
CORPS	U.S. Army Corps of Engineers
CPFVs	commercial passenger-carrying fishing vessels
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
D/DBPR	Disinfectant/Disinfection By-Products Rule
dB	decibels
dBA	A-weighted decibels
DBCP	dibromochloroproppane
DBP	disinfection by-product
DCC	Delta Cross Channel
DDT	Dichlorodiphenyltrichloroethane
DFG	California Department of Fish and Game
DHS	California Department of Health Services
DOC	California Department of Conservation
DOC	dissolved organic carbon
DPR	Department of Parks and Recreation
DWR	California Department of Water Resources
DWRSIM	Department of Water Resources Simulation Model
EBMUD	East Bay Municipal Utility District
EBRPD	East Bay Regional Park District
EC	electrical conductivity
ECCID	East Contra Costa Irrigation District
EDB	ethylene dibromide

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EDD	California Employment Development Department
EIS/EIR	Environmental Impact Statement/Environmental Impact Report
EPA	Environmental Protection Agency
ERAF	Education Reinvestment Augmentation Fund of 1992
ERP	Ecosystem Restoration Program
ESA	Endangered Species Act
ESWTR	Enhanced Surface Water Treatment Rule
EWMP	Efficient Water Management Practices
FACA	Federal Advisory Committee Act
FEAT	Flood Emergency Action Team
FEMA	Federal Emergency Management Agency
FPPA	Farmland Protection Policy Act
fps	feet per second
FSC	Folsom South Canal
FWCA	Fish and Wildlife Coordination Act
GCID	Glenn Colusa Irrigation District
GIS	Geographic Information System
GWh	gigawatt hours
HCP	Habitat Conservation Plan
I-5	Interstate 5
I-80	Interstate 80
IDT	Interagency Development Team
IEP	Interagency Ecological Program
IID	Imperial Irrigation District
IMPAN	Impact Analysis for Planning
IOCs	inorganic chemicals
ISDP	Interim South Delta Program
KCWA	Kern County Water Agency
KWh	kilowatt hours
LFA	Lead Federal Agency
LTMS	Long-Term Management Strategy
M&I	municipal and industrial
MAD	mosquito abatement district
MAF	million acre-feet
MCLG	Maximum Contaminant Level Goal
MCLs	Maximum Contaminant Levels
MCP	market clearing prices
ìg/L	micrograms per liter
ìmhos/cm	micromhos per centimeter
mg/L	milligrams per liter
mgd	million gallons per day
MH	Maas-Hoffman
MPP	Multi-Purpose Pipeline
MW	megawatt
MWD	Metropolitan Water District
MWh	megawatt hours
NAS	National Academy of Sciences
NBA	North Bay Aqueduct
NCCP	Natural Community Conservation Plan

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NCFCWCD	Napa County Flood Control and Water Conservation District
NDDB	National Diversity Data Base
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NO_X	nitrogen oxide
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NOP	Notice of Preparation
NPDES	National Pollutant Discharge Elimination System
NRA	National Recreation Area
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSDWR	National Secondary Drinking Water Regulations
NWR	National Wildlife Refuge
O_3	ozone
Ops	Operations Coordination
PAHs	polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PCT	Program Coordinating Team
PG&E	Pacific Gas & Electric
PL	Public Law
PM_{10}	inhalable particulate matter
ppm	parts per million
ppt	parts per thousand
RVDs	recreational visitor days
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SBCFCWCD	Santa Barbara County Flood Control and Water Conservation District
SCFCWCD	Solano County Flood Control and Water Conservation District
SCVWD	Santa Clara Valley Water District
SDCWA	San Diego County Water Authority
SDWA	Safe Drinking Water Act
SIP	State Implementation Plan
SO_2	sulfur dioxide
SOCs	synthetic organic chemicals
SR	State Route
SRA	State Recreation Area
SRFCP	Sacramento River Flood Control Project
SWP	State Water Project
SWRCB	State Water Resources Control Board
SWTR	Surface Water Treatment Rule
TAF	thousand acre-feet
TCU	transportation, communications, and utilities
TDS	total dissolved solids
THMs	trihalomethanes
TTHMs	total trihalomethanes
USBR	U.S. Bureau of Reclamation

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USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forestry Service
USFWS	U.S. Fish & Wildlife Service
USGS	U.S. Geological Survey
USTs	underground storage tanks
VAMP	Vernalis Adaptive Management Plan
VMS	Visual Management System
VOCs	volatile organic chemicals
WAPA	Western Area Power Administration
WMA	Wildlife Management Area
WQCP	Water Quality Control Plan

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1 PURPOSE AND NEED

1.1 INTRODUCTION

1.1.1 Background

Fed by runoff from the mountains and foothills surrounding California's Central Valley, the state's two largest rivers, the Sacramento and the San Joaquin, meet just south of the city of Sacramento to form the San Francisco Bay, Sacramento-San Joaquin Delta (Bay-Delta). California's principal source of fresh water, the Delta provides water to two-thirds of the state's 32 million residents and is the foundation of California's agriculture industry, irrigating 45% of the nation's produce. It is also a place of extensive environmental diversity, providing the largest wetland habitat in the western United States and supporting more than 750 plant and animal species. The location of the Sacramento/San Joaquin Delta is illustrated on Figure 1-1.

For decades the region has been the focus of competing interests – economic and ecologic, urban and agricultural. These conflicting demands have resulted in a number of resource threats to the Bay-Delta: declining wildlife habitat; native plant and animal species becoming threatened with extinction; the degradation of the Delta as a reliable source of high quality water; and a Delta levee system faced with an unacceptably high risk of failure.

Even though environmental, urban and agricultural interests have recognized the Delta as a critical resource, for decades they were unable to agree on appropriate management of the Delta resources. Consequently, the numerous "traditional" efforts made to address the Bay-Delta problems, including government decrees, private remediation efforts, and seemingly endless rounds of litigation have failed to reverse the steady decline of the Delta as fish and wildlife habitat or as a reliable source of water. The interrelationship of Bay-Delta problems and solutions are illustrated in the box on page 1-3.

Key Bay-Delta Facts
• 738,000 acres • 750 plant and animal species • Source of drinking water for 22 million Californians • Supplies irrigation water for the 45 % of the nation's produce grown in California

1.1.2 Origin of CALFED Bay-Delta Program

Seeking solutions to the resource problems in the Bay-Delta, state and federal agencies signed a "Framework Agreement" in June of 1994, which provided increased coordination and communication for environmental protection and water supply dependability. The impetus to forge this joint effort came at the state level in December 1992 with the formation of the Water Policy Council. The following year, in September 1993, the Federal Ecosystem Directorate was created at the federal level to coordinate federal resource protection and management decisions for the Bay-Delta. The Framework Agreement laid the foundation for the Bay-Delta Accord and CALFED.

The Bay-Delta Accord, signed on December 15, 1994, by a diverse group of state and federal resource agencies, water agencies, and environmental organizations, detailed interim measures for both environmental protection and regulatory stability in the Bay-Delta. CALFED oversees the coordination and increased communication between federal agencies, state agencies, and stakeholders in three areas outlined in the Framework Agreement. The three areas are:

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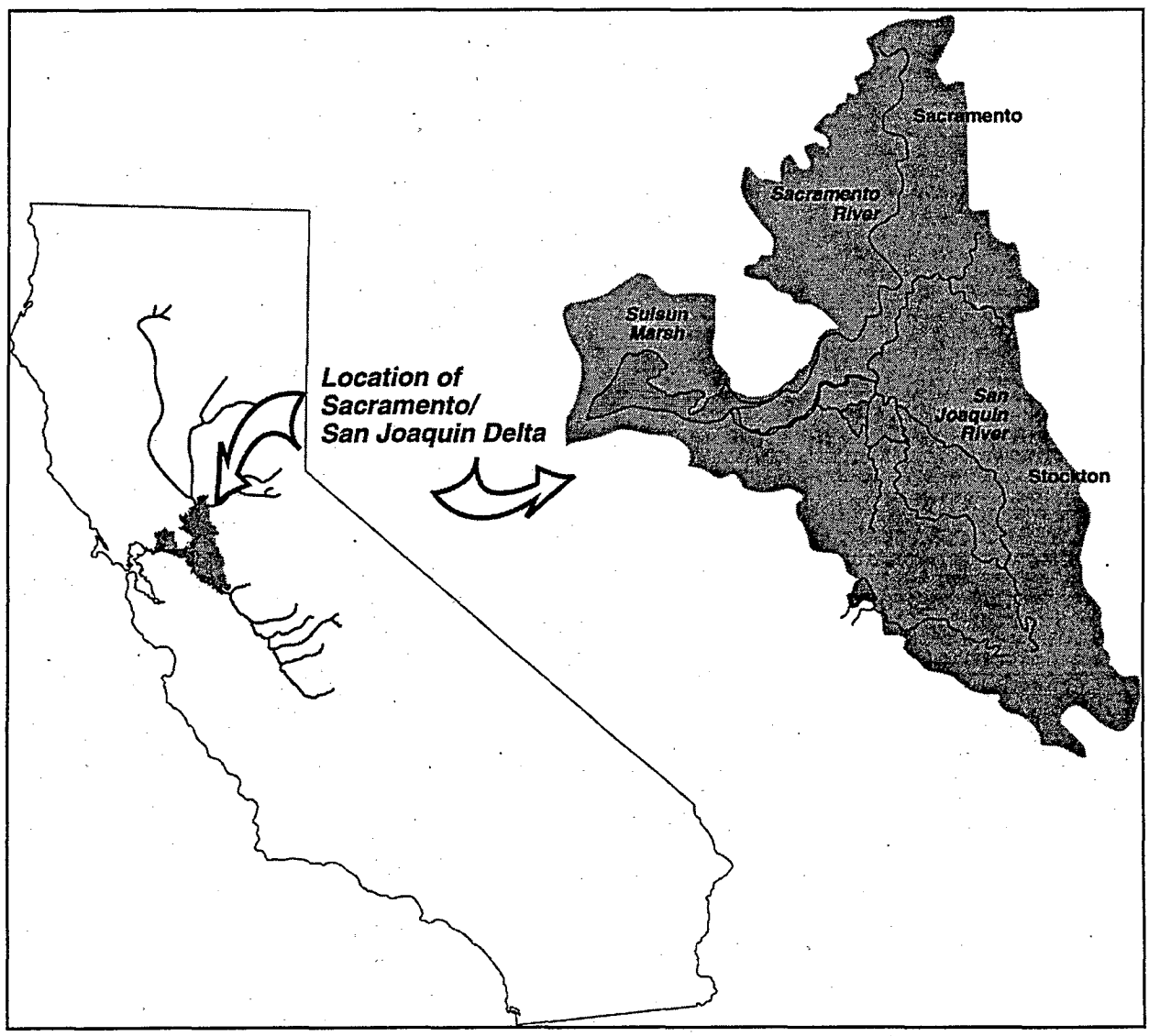

Figure 1-1. Location of Sacramento/San Joaquin Delta

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- Substantive and procedural aspects of water quality standard setting;
- Improved coordination of water supply operations with endangered species protection and water quality standard compliance; and
- Development of a long-term solution to fish and wildlife, water supply reliability, flood control, and water quality problems in the Bay-Delta.

The CALFED Bay-Delta Program (CALFED Program) is charged with responsibility for the third issue identified in the Framework Agreement. This Programmatic Environmental Impact Statement/ Environmental Impact Report (Programmatic EIS/EIR) evaluates this long term program.

The December 1994 Bay-Delta Accord was set to expire on December 15, 1997. In late 1997, the state and federal signatories to the accord extended its effect through December 31, 1998.

1.1.3 Structure of CALFED Program

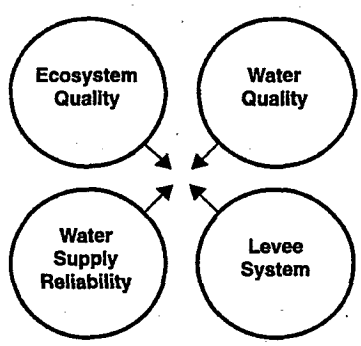
The CALFED Program began in June of 1995 to address the tangle of complex issues that surround the Delta. The CALFED Program is a cooperative, interagency effort involving 15 state and federal agencies with management and regulatory responsibilities in the Bay-Delta. CALFED agencies participating in the CALFED process are shown in the box on the following page.

Bay-Delta stakeholders also contribute to the Program design and to the problem-solving/decision-making process. Public participation and input have been essential throughout the process and have come through the Bay-Delta Advisory Council (BDAC), public participation in workshops, scoping meetings, comment letters, and other public outreach efforts. The BDAC charter is described in the text box on the following page.

Interrelationships of Bay-Delta Problems and Solutions

What are the problems that face the Bay-Delta and why have they occurred? At the simplest level, problems occur when there are conflicting demands over the use of resources from the Bay-Delta system. As California's population increases, we ask more of the system and there is more conflict. Single-purpose efforts to solve problems often fail to address these conflicts. To the extent that these efforts acquire or protect resources for one interest, they may cause impacts on other resources and increase the level of conflict. In the past, most efforts to improve water supply reliability or water quality, improve ecosystem health, or maintain or improve the Delta levees were single-purpose projects. Single-purpose projects have the potential to solve one problem but create other problems, and thereby engender opposition to future actions.

The CALFED Program has taken a different approach, recognizing that many of the problems in the Bay-Delta system are interrelated. Problems in one resource area cannot be solved effectively without addressing problems in all four areas at once. This greatly increases the scope of our efforts, but will ultimately enable us to make progress and move forward to a lasting solution.



The CALFED agencies appointed an Executive Director to oversee the process of developing a long-term comprehensive plan for the Delta. The

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State and Federal Agencies Which are Participating in the CALFED Process

State Agencies

Resources Agency of California
- Department of Water Resources (DWR)
- Department of Fish and Game (DFG)

California Environmental Protection Agency
- State Water Resources Control Board (SWRCB)

California Department of Food and Agriculture

Federal Agencies

U.S. Department of the Interior
- Bureau of Reclamation (BOR)
- Fish and Wildlife Service (USFWS)
- Bureau of Land Management (BLM)
- United States Geological Survey (USGS)

U.S. Army Corps of Engineers (Corps)

U.S. Environmental Protection Agency (EPA)

U.S. Department of Commerce
- National Marine Fisheries Service (NMFS)

U.S. Department of Agriculture
- Natural Resources Conservation Service (NRCS)
- U.S. Forest Service (USFS)

Western Area Power Administration (WAPA)

Executive Director selected staff from the CALFED agencies to carry out the task. In addition, the CALFED agencies and stakeholders worked with the CALFED Program through multi-level technical and policy teams.

The CALFED Program was divided into a three-phase cooperative planning process (Figure 1-2). The process is expected to lead to a determination of the most appropriate strategy and actions necessary to reduce conflicts in the Bay-Delta system. Phase I began in May 1995 with a series of public workshops to define the problems of the Bay-Delta and begin work on developing a range of solution alternatives to the Bay-Delta system problems. The CALFED Program participants worked to clearly define the fundamental problems in the Bay-Delta system: ecosystem quality, water supply, water quality, and levee system vulnerability. This resulted in the creation of a *mission statement* (page 1-6) and objectives for the Program. This also resulted in the development and refinement of an initial group of actions into three preliminary categories of solutions (See Chapter 2) to be considered in Phase II. Phase I was completed in August 1996.

Phase II is ongoing. To comply with CEQA and NEPA, the Program participants prepared this programmatic, or first-tier, EIS/EIR to identify environmental consequences associated with the various program alternatives finalized in Phase II.

Bay-Delta Advisory Committee

BDAC is chartered under the Federal Advisory Committee Act and comprises representatives of stakeholders, including water districts and utilities, environmental organizations, the California Farm Bureau, and sport fishing organizations from throughout California appointed by the administration of Governor Wilson and President Clinton, through Secretary of the Interior Babbitt. The BDAC meets regularly with CALFED agencies and staff to review the status of work on developing the recommended program. Additionally, BDAC has formed several subcommittees, called workgroups, on various issues to provide more focused attention on particularly complex issues. These efforts resulted in several reports (Ecosystem Restoration Program Plan, Implementation Strategy, Water Use Efficiency and Water Transfers) which are technical appendices to the programmatic EIS/EIR. This group of public-advisors helps define problems in the Bay-Delta, helps to assure broad public participation, comments on environmental reports, and offers advice on proposed solutions.

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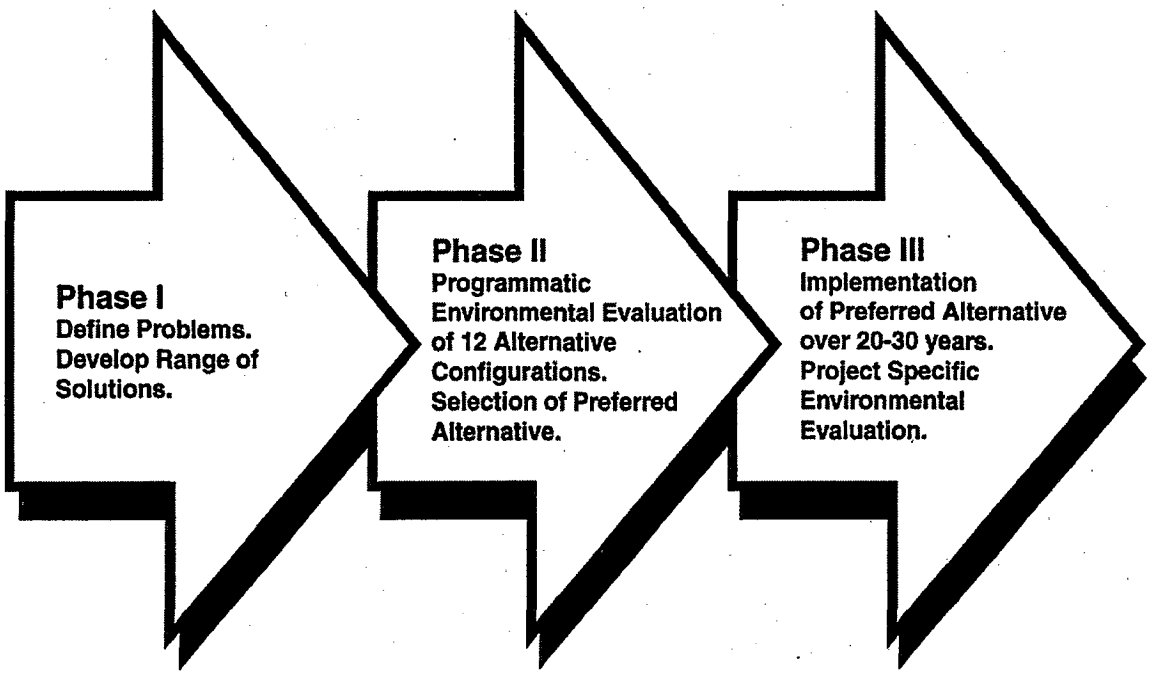

Figure 1-2. Three Phases of the CALFED Process

The Record of Decision/Notice of Determination for this document is expected to be signed in late 1998 and will complete Phase II.

During Phase III, the preferred program alternative will be implemented. This phase will include any necessary studies and site-specific environmental review and permitting. Because of the size and complexity of the program alternatives, implementation is likely to take place over a period of decades. Part of the challenge for Phase II is designing an implementation strategy that acknowledges this long implementation period and keeps all participants committed to the successful completion of all phases of implementation.

1.2 PROGRAM PURPOSE AND NEED

1.2.1 Program Purpose

The purpose of the CALFED Program is to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system. To practicably achieve this program purpose, CALFED will concurrently address problems of the Bay-Delta system within four critical resource categories: ecosystem quality, water quality, water supply reliability, and levee system integrity. Important physical, ecological, and socioeconomic linkages exist between the problems and possible solutions in each of these categories. Accordingly, a solution to problems in one resource category cannot be pursued without addressing problems in the other resource categories.

In achieving the purpose, the Program will address the following goals:

Ecosystem Quality. The goal for ecosystem quality is to improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta system to support sustainable populations of diverse and valuable plant and animal species. This can be accomplished by addressing the objectives which collectively improve and increase aquatic and

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CALFED Bay-Delta Program Mission Statement

The Mission Statement does not stand alone as a single statement of CALFED Program purpose. Rather, the Mission Statement is supported by sets of Primary Objectives and Solution Principles. The Mission Statement is important and reflects the basic intent of the CALFED Program. However, the full expression of the CALFED program mission is reflected in the Mission Statement, Objectives, and Solution Principles read together.

Mission Statement:

> ***The mission of the CALFED Bay-Delta Program is to develop a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta System.***

Primary Objectives of the CALFED Program:

- **Ecosystem Quality.** Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species.
- **Water Supply.** Reduce the mismatch between Bay-Delta water supplies and the current and projected beneficial uses dependent on the Bay-Delta system.
- **Water Quality.** Provide good water quality for all beneficial uses.
- **Vulnerability of Delta Functions.** Reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of Delta levees.

Solution Principles:

The solution principles were developed as a means to achieve the CALFED Program's objectives in the context of a multi-purpose mission and a history of (competing) contentious environmental, political, and institutional influences on the affected resources. The solution principles provide an overall measure of the acceptability of alternatives and guide the design of the institutional part of each alternative. The solution principles are:

- **Reduce Conflicts in the System.** Solutions will reduce major conflicts among beneficial uses of water.
- **Be Equitable.** Solutions will focus on solving problems in all problem areas. Improvement for some problems will not be made without corresponding improvements for other problems.
- **Be Affordable.** Solutions will be implementable and maintainable within the foreseeable resources of the Program and stakeholders.
- **Be Durable.** Solutions will have political and economic staying power and will sustain the resources they were designed to protect and enhance.
- **Be Implementable.** Solutions will have broad public acceptance and legal feasibility, and will be timely and relatively simple to implement compared with other alternatives.
- **Have No Significant Redirected Impacts.** Solutions will not solve problems in the Bay-Delta system by redirecting significant negative impacts, when viewed in their entirety, within the Bay-Delta or to other regions of California.

Further discussion of the CALFED Program objectives is provided in the Program, Goals, and Objectives Appendix.

wetland habitats so that they can support the sustainable production and survival of estuarine and anadromous fish and wildlife species and increase population health and population size to levels that assure sustained survival. The objectives in summary form are:

1. Increase the amount of shallow riverine, shaded riverine, tidal slough, and estuary entrapment/null zone habitats for aquatic species;

2. Improve the in-Delta, upstream, and downstream movement of larval, juvenile, and adult life stages of aquatic species;

3. Reduce water quality degradation;

4. Increase the amount of brackish tidal marsh, freshwater marsh, riparian woodland, waterfowl breeding habitat, wintering range for wildlife, managed permanent pasture and flood plains, and associated riparian habitats for wildlife species; and

5. Contribute to the recovery of threatened or endangered species and species of special concern.

Water Supply Reliability. The goal for water supply reliability is to reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system. This can be accomplished by addressing the objectives, which collectively reduce the conflict among beneficial water users, improve the ability to transport water through the Bay-Delta system, and reduce the uncertainty of supplies from the Bay-Delta system. These objectives in summary form are:

1. Maintain an adequate water supply to meet expected in-Delta beneficial use needs;

2. Improve export water supplies to help meet beneficial use needs;

3. Improve the adequacy of Bay-Delta water to meet Delta outflow needs;

4. Reduce the vulnerability of Bay-Delta levees; and

5. Improve the predictability of the water supply available from the Bay-Delta system for beneficial use needs.

Water Quality. The goal for water quality in the Bay-Delta system is to provide good quality water for all beneficial uses, including drinking water, agricultural uses (both in-Delta and exported), industrial uses, recreational in-Delta uses, and Delta aquatic habitats. This can be accomplished by addressing the objectives which collectively provide for the improvement of water quality for all beneficial uses. The objectives in summary form are:

1. Improve the reliability and quality of raw water for drinking water needs;

2. Reduce constituents in agricultural water which affect operations and crop productivity;

3. Improve the reliability and quality of water for industrial needs;

4. Improve the quality of raw water for recreational uses including consumption of aquatic resources; and

5. Improve the quality of water for environmental needs.

Levee System Integrity. The goal for levee system integrity is to reduce the risk to land uses and associated agricultural and other economic activities, water supply, infrastructure, and the Bay-Delta ecosystem from catastrophic breaching of Delta levees. This can be accomplished by addressing the objectives which collectively provide management of the risk resulting from gradual deterioration of Delta conveyance and catastrophic breaching of the Delta levees. The objectives in summary form are:

1. Reduce the risk to land use from seepage and overtopping of the levees, subsidence of peat soils and catastrophic inundation of Delta islands;

2. Reduce the risk to in-Delta and export water supply from sudden catastrophic island inundation and the resultant salinity intrusion;

3. Reduce the risk to in-Delta and export water supply facilities from sudden catastrophic island inundation; and

4. Reduce the risk to the existing Delta ecosystem from seepage, erosion, and overtopping of levees; from peat soils; and from catastrophic inundation and the resultant salinity intrusion.

1.2.2 Program Need

The Purpose Statement responds to the following needs:

Ecosystem Quality. The health of the Bay-Delta system has declined as a result of a number of factors including degradation and the loss of habitats that support various life stages of aquatic and terrestrial biota. Further, the decline in health has resulted from activities within and upstream, of the Bay-Delta system. One early human-induced event was hydraulic mining in the river drainages along the eastern edge of the Central Valley. The mining degraded habitat in Central Valley streams as channel beds and shallow areas filled with sediment. In addition, the reduced capacity of the sediment-filled channels increased the frequency and extent of periodic flooding, accelerating the need for flood control measures to protect adjacent agricultural, industrial, and urban lands. Levees constructed to protect these lands eliminated fish access to shallow overflow areas, and dredging to construct levees eliminated the tule bed habitat along the river channels.

Since the 1850s, 700,000 acres of overflow and seasonally inundated lands in the Bay-Delta system have been converted to agricultural, industrial, and urban uses. Many of the remaining stream sections have been dredged or channelized to improve navigation and to increase stream conveyance capacity to accommodate flood flows and facilitate water export.

Upstream water development and use, depletion of natural flows by local diverters, and the export of water from the Bay-Delta system, have changed seasonal patterns of the inflow, reduced outflow, and diminished the natural variability of flows into and through the Bay-Delta system. Facilities constructed to support water diversions (upstream, in-Delta, and export) cause straying or direct losses of fish (for example, through unscreened diversions) and can increase exposure of juvenile fish to predation. Entrainment and removal of substantial quantities of food-web organisms, eggs, larvae, and young fish further exacerbate the impacts of overall habitat decline.

Habitat alteration and water diversions are not the only factors that have affected ecosystem health. Water quality degradation caused by pollutants and increased concentrations of substances may also have contributed to the overall decline in the health and productivity of the Bay-Delta system. In addition, undesirable introduced species may compete for available space and food supplies, sometimes to the detriment of native species or economically important introduced species.

Water Supply Reliability. The Bay-Delta system provides the water supply for a wide range of in-stream, riparian, and other beneficial uses such as drinking water for millions of Californians and irrigation water for agricultural land. While some beneficial water uses depend on the Bay-Delta system for a portion of their water needs, others are highly or totally dependent on Bay-Delta water supplies. As water use and competition among uses has increased during the past several decades, conflicts have increased among users of Bay-Delta water. Heightened competition for the water during certain seasons or during water-short years has magnified the conflicts.

Water flow and timing requirements have been established for certain fish and wildlife species with critical life stages dependent on freshwater flows. These requirements have reduced water supplies and flexibility to meet the quantity and timing of water delivered from the Bay-Delta system. Water suppliers and users are concerned that additional restrictions, if needed to protect species, would increase the uncertainty and

further reduce the availability of Bay-Delta system water for agricultural, industrial, and urban purposes.

Delta levees and channels may fail. Water users are concerned that such failures could result in an interruption of water supply for both urban and agricultural purposes and degradation of water quality and aquatic habitats.

Water Quality. Good quality water is required to sustain the high-quality habitat needed in the Bay-Delta system to support a diversity of fish and wildlife populations. In addition, the Bay-Delta system is a source of drinking water for millions of Californians and is critical to the state's agricultural sector. The potential for increasingly stringent drinking water requirements requiring new treatment technologies is spurring water providers to seek higher-quality source waters and to address pollution in source waters. Pollutants enter the Bay-Delta system through a variety of sources, including sewage treatment plants, industrial facilities, forests, farm fields, mines, residential landscaping, urban streets, ships, and natural sources. The pollutants, pathogens, natural organics, and salts in the Bay-Delta system affect, in varying degrees, existing fish and wildlife, as well as human and agricultural uses of these waters. The salts entering the Bay-Delta system from the ocean and from return flows upstream and within the Delta decrease the utility of Bay-Delta system waters for many purposes including the ecosystem, agriculture, and drinking water. The level of natural organics in the water (resulting primarily from the natural process of plant decay on many of the Delta peat soil islands) is of concern because of the way natural organics react with disinfection chemicals commonly used to meet public health requirements in water treatment.

Levee System Integrity. Levees were first constructed in the Sacramento-San Joaquin Delta during the late 1800s, when settlers began to turn tidal marshes into agricultural land. Over time, both natural settling of the levees and shallow subsidence (oxidation which lowers the level of the land over time) of the Delta island soils resulted in a need to increase levee heights to maintain protection. There is a growing concern that this increased height, coupled with poor levee construction and inadequate maintenance, makes Delta levees vulnerable to failure, especially during earthquakes or floods. Failure of Delta levees can result in flooding of Delta farmland and wildlife habitat. If a flooded island is not repaired and drained, the resulting large body of open water can expose adjacent islands to increased wave action and possible levee erosion. Levee failure on specific islands can have impacts on water supply distribution systems such as the Mokelumne Aqueduct. Similarly, levee failure on key Delta islands can draw salty water up into the Delta, as water from downstream rushes to fill the breached island. This would be of particular concern in low-water years when less fresh water would be available to repel the incoming salt water. Such a failure could interrupt the water supply for urban, agricultural, and environmental uses and degrade water quality and aquatic habitats.

1.3 PROGRAMMATIC NATURE AND ACTIONS WHICH WILL BE TAKEN BASED ON THIS DOCUMENT

1.3.1 Programmatic Nature

The analyses presented in this Programmatic EIS/EIR provide information to decision makers and the general public on the range of possible environmental consequences associated with each program alternative. The analyses also present decision makers and the general public an opportunity to understand the proposed sequence for implementing CALFED actions.

The descriptions of consequences are presented at a programmatic level of detail rather than at a site-specific level of detail because the actions being evaluated are not yet precisely defined. Because of the nature of the Program, each program alternative contains water quality actions, ecosystem restoration actions, water use efficiency actions, Delta levee actions, water transfer actions, watershed management

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coordination actions, and three differing approaches to conveying water through the Delta. Further, various combinations of storage and conveyance facilities are a part of many of the alternatives evaluated. Specific construction details and operational plans have not yet been developed. Accordingly, the descriptions of consequences generally include the upper range or most severe effects that are expected to be associated with each alternative. Oftentimes, the evaluations are qualitative in nature based on sound professional judgement. This level of analysis is consistent with the guidance for programmatic documents provided by the Council on Environmental Quality's Regulations for implementing the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) guidelines.

The Phase II Interim Report

There has been a concurrent effort to continue to develop greater detail than what is presented for the alternative configurations analyzed in this document. This detail is presented in the Phase II Interim Report, which is a technical appendix of the Programmatic EIS/EIR. A summary of the Phase II Interim Report is contained in Chapter 4 of this document. The Phase II Report reveals the comparative technical advantages of the alternatives in much greater specificity than what is presented in the description of consequences in this document. The information in the Phase II Interim Report along with information about the 12 alternatives discussed in this document will be used, along with other information, in a public process, to support the selection of a preferred program alternative.

1.3.2 Actions Which Will Be Taken Based On This Document

The analyses presented in this document are intended to support the selection of a preferred program alternative rather than the selection of a specific action. The recommended preferred program alternative will include seven basic elements which together form the basis for each alternative being evaluated. These are water storage and conveyance, ecosystem restoration, water quality program, water use efficiency, levee system integrity, water transfers, and coordinated watershed management.

The recommended preferred program alternative will not, in itself, enact any changes in law, regulation or policy. Instead, the recommended preferred program alternative will describe a set of actions which should be taken by a variety of organizations to move forward on a comprehensive approach to managing Bay-Delta resources. Some of these actions may require new legislation, some may require changes in operation of water supply projects, others may require government acquisition of land or water rights, and still others could require the construction of new facilities.

During Phase III of the CALFED Program, second-tier or site-specific environmental documents will be prepared for individual projects. Second-tier documents will be prepared to concentrate on issues specific to the individual project being implemented and site(s) chosen for the action. In addition to the site-specific analysis, it is possible that further detailed system-wide analysis may be necessary during Phase III to determine the effects of projects with wide -reaching impacts.

1.4 ORGANIZATION OF THE PROGRAMMATIC EIS/EIR

The Programmatic EIS/EIR consists of an executive summary, a main document, 11 technical appendices and numerous supporting documents which are incorporated by reference (Figure 1-3). The appendices expand upon the information summarized in both the Executive Summary and the main document. For example, the description of alternatives in the Alternatives Technical Appendix is condensed in Chapter 2 of the main document. Similarly, a summary of the Phase II Interim Report is included in Chapter 4 of the main document.

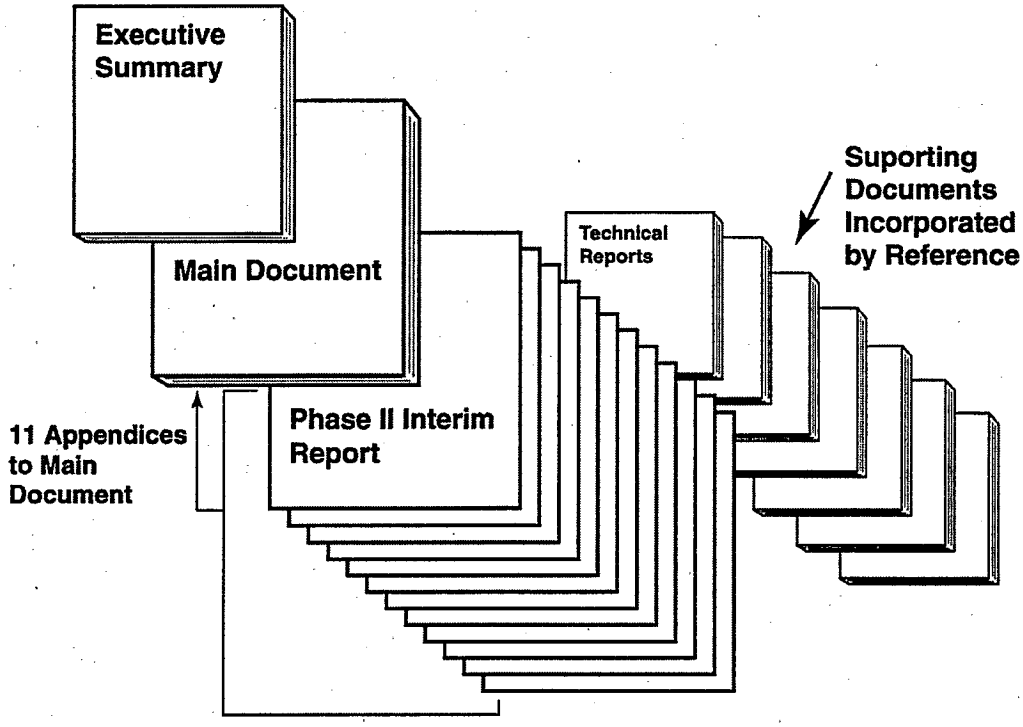

Figure 1-3. Organization of the Programmatic EIS/EIR

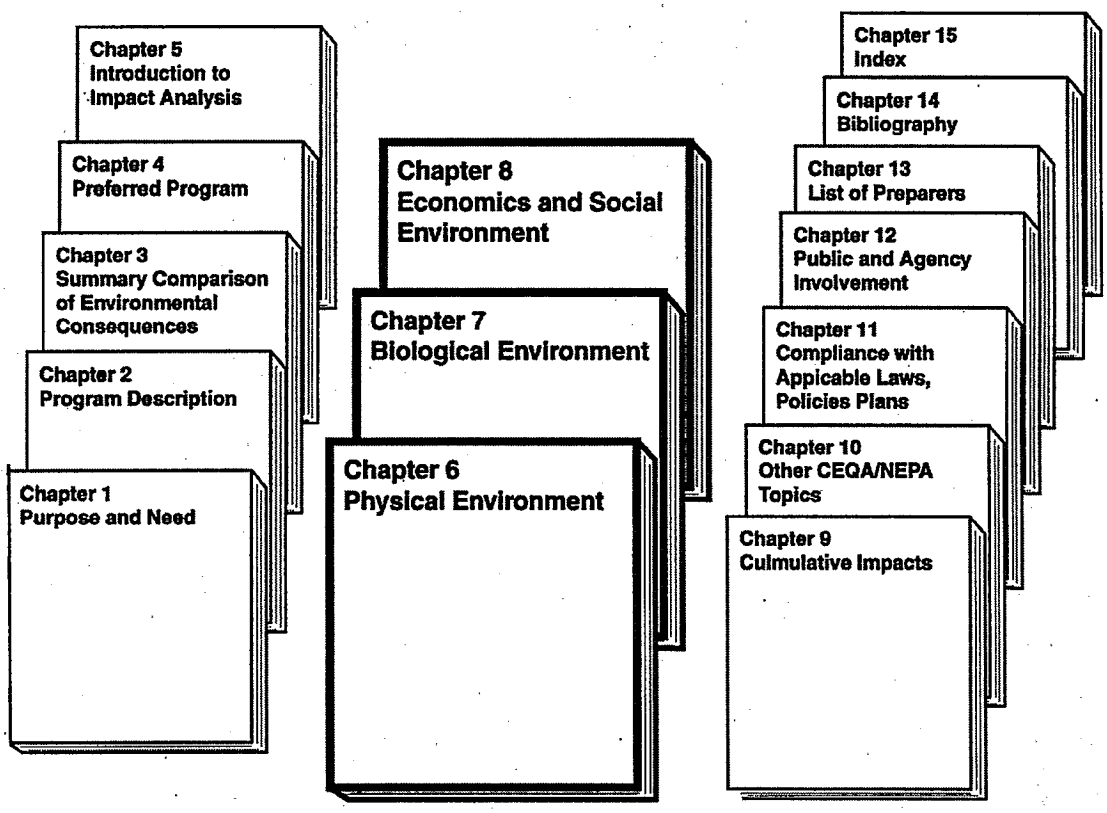

Figure 1-4. Organization of the Main Document

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Executive Summary. The Executive Summary includes a broad overview of the four critical problem areas most heavily impacting the Bay-Delta system, CALFED's efforts and proposed alternatives for resolving these problem areas and a description of the resultant consequences of implementing the various alternatives. The Executive Summary is intended for the reader wishing to get a quick summary before, or instead of, reading the main document and technical appendices.

Main Document. The Main Document contains the required environmental document elements (Figure 1-4). Chapter 1 provides an introduction to the problems of the Delta, the origin of the CALFED Bay-Delta Program and the Program's statement of Purpose and Need for this document. Chapter 2 describes the program alternatives (three alternative approaches with a total of 12 configurations) and the No Action alternative. Chapter 3 provides a summary of the various consequences identified in Chapters 6, 7, and 8. The main document does not contain a draft preferred program alternative; however, it does include a discussion in Chapter 4 of the steps and analysis that have been and will continue to be taken to reach a preferred program alternative. The process of developing a preferred program alternative is expanded upon in the Phase II Interim Report, which is one of the technical appendices to the Programmatic EIS/EIR. Chapter 5 presents a guide to the impact analysis sections and describes land use assumptions associated with program alternatives. This description of potential land use changes is presented in Chapter 5 rather than within the impact analysis chapters to provide the appropriate perspective with regard to potential land use conversion and to avoid considerable repetition in the impact analysis chapters. Chapters 6, 7 and 8 describe the affected environment/existing conditions and environmental consequences to the physical; biological; and land use, economics, and social environments, respectively. As noted above, a guide to their content is presented in Chapter 5. Chapters 9, 10, 11, and 12 cover a variety of issues ranging from cumulative impacts to public involvement. Chapter 13 includes a list of preparers, Chapter 14 includes the bibliography for this document, and Chapter 15 presents an index.

Appendices. Eleven appendices expand upon the information contained in the Executive Summary and the Main Document. These appendices are:

1. *Program Goals and Objectives.* Summary of Program goals and objectives developed in Phase I of the Program.

2. *No Action Alternative.* Describes the No Action Alternative, which is a description of what would be reasonably expected to occur by the year 2020 if the project were not approved.

3. *Program Alternatives.* Summarizes the 12 alternative configurations built around the three basic Program alternative categories..

4. *Ecosystem Restoration Program Plan.* Basis of the Ecosystem Restoration Program included in all alternatives.

5. *Water Quality Program.* Basis of Water Quality Program included in all alternatives.

6. *Water Use Efficiency Program and Water Transfers.* Basis of Water Use Efficiency and Water Transfers Program included in all alternatives.

7. *Long-Term Levee Protection Plan.* Basis of Delta levee improvement program included in all alternatives.

8. *Coordinated Watershed Management.* Basis of Watershed Management Coordination Program included in all alternatives.

9. *Summary of Modeling Assumptions and Results.* Summarizes and references the many modeling reports developed during evaluations for the Programmatic EIS/EIR.

10. *Phase II Interim Report.* Describes the CALFED process, solution alternatives and the fundamental program concepts that have guided their development, and analyses that

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have revealed the comparative technical advantages of each alternative. Finally, this report describes how the CALFED agencies will use the results of additional analysis in a public process to proceed to the selection of a preferred program alternative by December 1998.

11. *Implementation Strategy.* Includes financial and assurance strategies for guiding implementation of the long-term comprehensive plan.

1.5 NEXT STEPS

Work will continue between the Draft and Final Programmatic EIS/EIR on refining and resolving the primary issues of concern that remain in this Programmatic EIS/EIR (Figure 1-5). A series of scientific/peer reviews and additional analyses will be linked through stakeholder collaboration to arrive at recommendations for the preferred alternative and its associated implementation including financing and assurances.

Between this draft and the Final Programmatic EIS/EIR, work will continue toward selecting the preferred program alternative. This effort will include:

- Refining the actions and the implementation strategy for the water storage and conveyance, ecosystem restoration, water quality program, water use efficiency, levee system integrity, water transfers, and coordinated watershed management.
- Conducting technical evaluations to select the method of Delta conveyance, and associated operation criteria.
- Assessing the need and location for new storage.
- Defining the actions and mechanisms including finances, that will be needed to assure that the preferred program alternative will be implemented and operated as agreed to by all parties.

The CALFED Program staff will continue to work with stakeholders over the coming months on technical and implementation issues to develop a truly supportable preferred program alternative that reduces major conflicts in the system, is equitable, affordable, durable, implementable, and will not solve problems in the system by redirecting significant impacts. Concurrently, the CALFED Program will work with CALFED agencies on technical and implementation issues leading to the selection of a preferred program alternative.

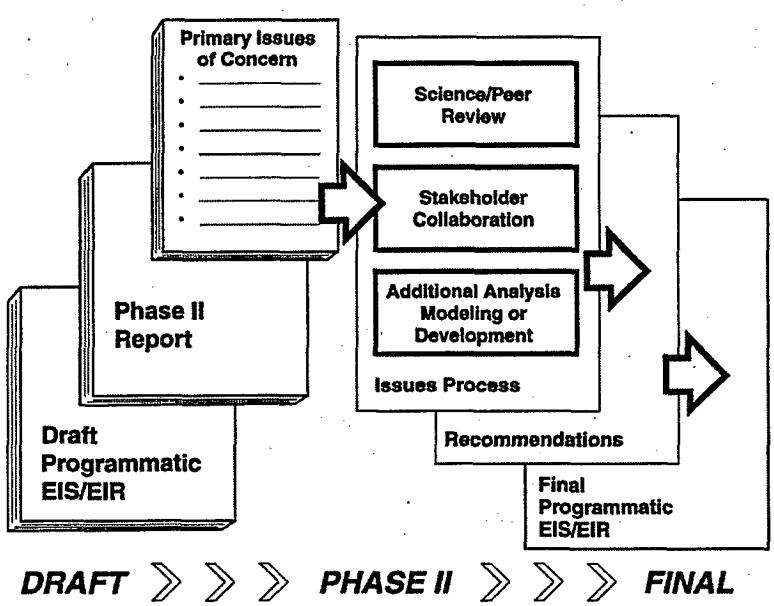

Figure 1-5. CALFED Phase II Process

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2 PROGRAM DESCRIPTION

2.1 PROGRAM STUDY AREA/ GEOGRAPHIC SCOPE

The scope of analysis and action for the CALFED Program that evolved through both technical and public forum discussions is a tiered geographic scope focusing on the Bay-Delta system for purposes of problem definition, while allowing solution generation from a much broader area.

2.1.1 CALFED Problem and Solution Areas

The CALFED Program is addressing problems which are manifested in or closely linked to the Suisun Bay/Suisun Marsh and Delta area (Problem Scope, see Figure 2-1). However, the scope of possible solutions (Solution Scope) to these problems encompass any action which can be implemented by the CALFED agencies or can be influenced by them to address the identified problems, regardless of whether implementation takes place within the Delta/Suisun Bay/Suisun Marsh area.

Any problem currently associated with (1) the management and control of water or (2) the beneficial use of water within the Bay-Delta (including both environmental and economic uses) is within the purview of the CALFED Program if at least part of the problem is manifested within the Bay-Delta or is directly associated with conditions within the Bay-Delta.

In contrast to the Problem Scope, the Solution Scope is quite broad, potentially including any action which could help solve identified problems. Since there is a wide range of actions encompassed within the basic project purposes and solutions, it follows that various actions will affect different geographic areas depending upon the nature and location of the action. Thus, although each action will not affect the entire geographical solution area, certain actions will directly or indirectly affect areas within the Central Valley watershed, southern California water system service area, Suisun Bay, San Pablo Bay, San Francisco Bay, portions of the Pacific Ocean out to the Farallon Islands, and a near-coastal band extending from about Morro Bay to the Oregon border.

An expanded solution scope is necessary because many problems related to the Bay-Delta are caused by factors outside the Bay-Delta. Moreover, an expanded solution scope is desirable from a planning point of view because more benefits may be generated at lower cost if solutions are not limited to the geographic Bay-Delta. For example, the problem of declining salmon populations is linked to the Bay-Delta because of high salmon mortality during salmon migrations. However, the broader problem of declining salmon populations goes far beyond the

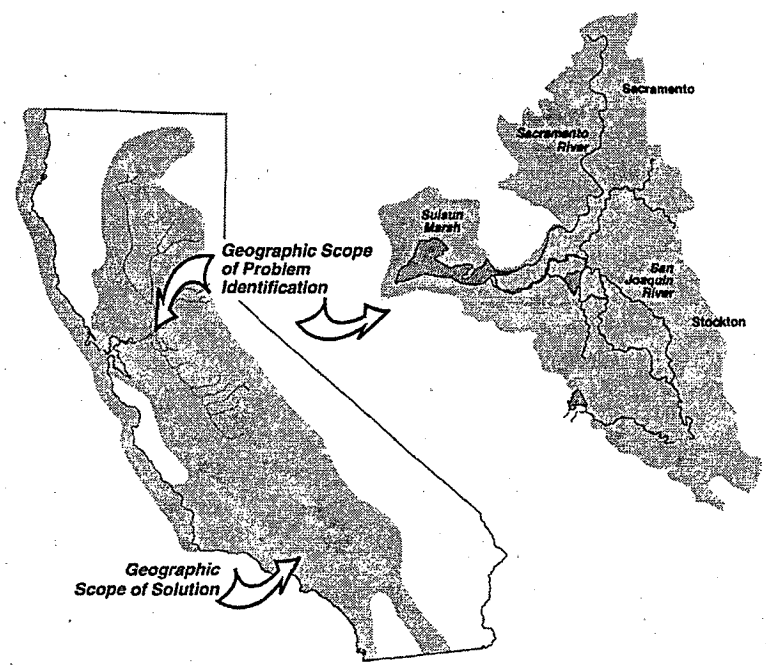

Figure 2-1. Geographic Scope of CALFED Problem and Solution Areas

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Bay-Delta. One solution action might be to reduce salmon mortality during salmon migration through the Bay-Delta. However, it might be less expensive to combine that action with an effort to promote greater salmon protection upstream.

2.1.2 Description of the Study Area

The Program study area includes both the problem and solution areas described above. The Draft Programmatic EIS/EIR study area map, included as a pull out inside the back cover of this report, has been broken down into regions: the Delta Region, the Bay Region (and outer Bay or near-shore area), the Sacramento River Region, the San Joaquin River Region (including the Tulare Lake Basin), and SWP and CVP Service Areas Outside the Central Valley.

Delta Region. The Delta Region is defined as the statutory Delta (in Section 12220 of the California Water Code) and is comprised roughly of lowlands (lands approximately at or below the 5-foot contour) and uplands (lands above the 5-foot contour that are served water by lowland Delta channels). The Delta Region has been carved out of the Sacramento and San Joaquin River watersheds because of its legal status and the program's focus on this region.

Bay Region. The Bay Region includes Suisun Bay and Marsh, San Pablo Bay, and the Bay watershed. In addition, an offshore band, approximately 25 miles wide running from Point Conception to the Oregon border, has been included to cover potential ocean harvest management of anadromous fish along the California coast. Certainly anadromous fish roam beyond this artificial boundary, but the purpose of this boundary is to identify the area where most anadromous fish from the Bay-Delta system exist and cover where harvest management actions would be employed. Though CALFED has not proposed specific harvest management measures, general impacts of harvest management are discussed in the document.

The upper watershed areas of the Bay Region include the unregulated watersheds that drain directly into the San Francisco Bay, and the watershed areas upstream of existing reservoirs and fish migration barriers within the San Francisco Bay area. These areas include the east sloping drainages of San Mateo, San Francisco, and Marin counties; north and west sloping drainages of Contra Costa and Alameda counties; and the east and north sloping drainages of Santa Clara County. The major creeks in the Bay Region include: Miller, Corte Madera, San Rafael, Novato, San Ramon, Walnut, Pacheco, Wildcat, Alameda, Berryessa, Coyote, Guadalupe, Stevens and San Francisquito Creeks.

Sacramento River Region. The Sacramento River Region is essentially bounded by the ridge tops of the Sacramento River watershed or hydrologic region. The Goose Lake watershed, in the northeast corner of California, has been left out of the study area because it rarely contributes to the flow of the Pit and Sacramento Rivers–apparently Goose Lake last spilled very briefly sometime in the 1950s and only a few times between 1869 and the present–and no actions are proposed in the watershed. The Trinity River is connected by a pipeline to the Sacramento River system and contributes to CVP water supply, but because it does not flow naturally into the Sacramento River watershed, and no CALFED Program actions are being proposed for the Trinity River or its watershed, the Trinity River watershed is not included in the CALFED Program study area.

The upper watershed areas of the Sacramento River region can be subdivided into three sub-regions on the north, east, and west sides of the Sacramento Valley. The upper watershed areas on the north side of the valley include all or portions of Shasta, Siskiyou, and Trinity counties. The upper watershed areas on the east side of the valley include all or portions of the following counties: Butte, Lassen, Modoc, Nevada, Placer, Plumas, Sierra, and Yuba. The upper watershed areas on the west side of the valley include all or portions of the following counties: Colusa, Glenn, Lake, Napa, Solano, Tehama, and Yolo.

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San Joaquin River Region. The San Joaquin River Region includes both the San Joaquin and Tulare Lake hydrologic basins.

Upper watershed areas of the San Joaquin River region basically encompass the watersheds and major tributaries upstream of the existing reservoirs and fish migration barriers within the San Joaquin River Region. During years of high flood flows it may include the areas of the Kings River drainage upstream of Pine Flat Reservoir. The major rivers of the San Joaquin River Region include: Consumnes River; Mokelumne River upstream of Camanche Reservoir; Calaveras River upstream of New Hogan Lake; the Stanislaus River upstream of Goodwin Dam; the Tuolumne River upstream of La Grange Dam; Merced River upstream of Crocker-Huffman Dam; the San Joaquin River upstream of Friant Dam; Chowchilla River upstream of Buchanan Dam; and Fresno river upstream of Hensley Lake and the Madera Canal.

SWP and CVP Service Areas Outside the Central Valley. The service areas outside the Central Valley include small portions of Santa Cruz, San Benito, and Santa Clara counties outside the Bay watershed, served by the CVP (San Felipe Diversion). The SWP service areas include most of the urbanized areas of Southern California as well as Santa Barbara and San Luis Obispo counties. There are CVP and SWP service areas within the Central Valley, but the Central Valley watersheds cover those areas. In addition, Imperial Irrigation District is included in this region.

The upper watersheds in the SWP and CVP Service Areas Outside the Central Valley are not described in this report because no specific watershed management activities are proposed in these areas.

2.2 CALFED PHASE I ALTERNATIVE DEVELOPMENT PROCESS

2.2.1 CALFED Phase I Process

During Phase I, completed in September 1996, a range of possible alternative solutions were developed and narrowed to three basic alternative approaches.

The Phase I process concluded with three basic alternative approaches to meeting the Program's multiple objectives. Figure 2-2 depicts these basic approaches. Each of these basic approaches includes:

- **Water Use Efficiency:** Promote an increased level of efficiency to meet water supply objectives of all beneficial users.
- **Water Quality:** Provide high-quality water at a reasonable cost by controlling pollutant sources.
- **Levee System Integrity:** Protect farms, habitat, infrastructure, and water quality from floodwaters.
- **Ecosystem Restoration:** Promote restoration of ecosystem functions and the recovery of Bay-Delta species.
- **Water Storage:** Provide opportunities to improve the timing and availability of water for all uses.
- **Water Conveyance:** Provide opportunities to move water across the Delta and improve the performance of the other program elements.

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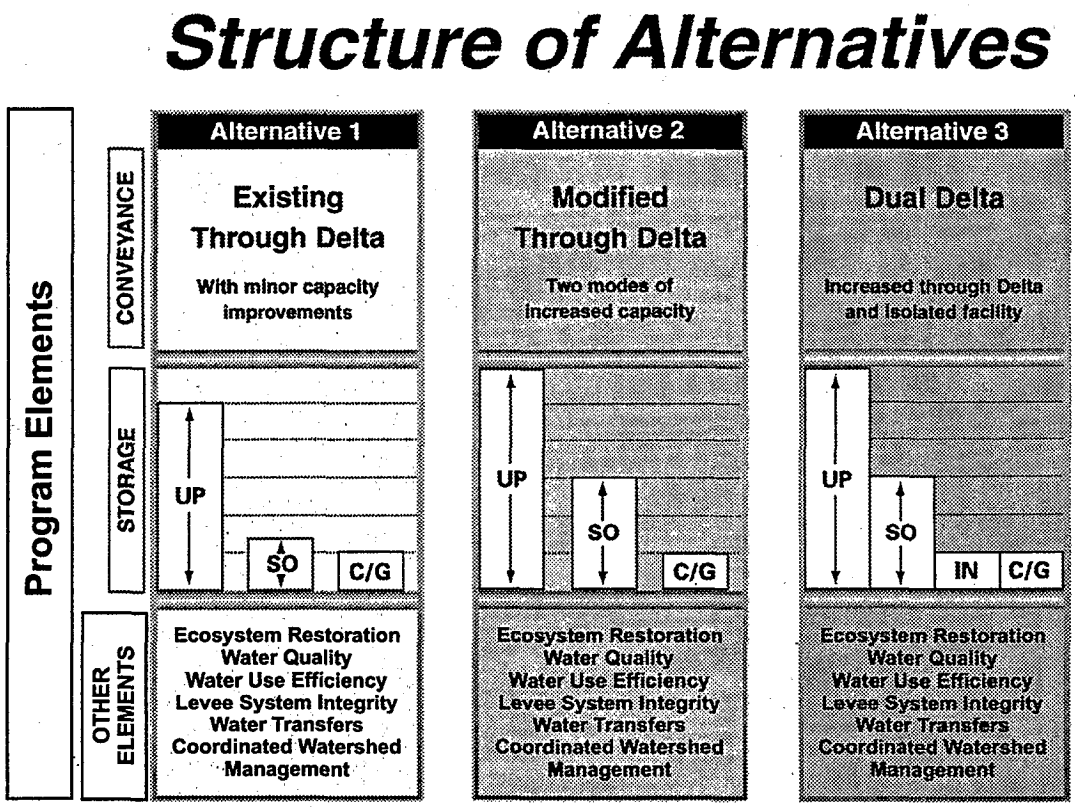

Storage Features

- UP: upstream storage (any on- or offstream storage upstream of the Delta supplied by the Sacramento and San Joaquin rivers or their tributaries)
- SO: south of Delta storage (any offstream storage supplied with water exported south from the Delta)
- IN: In-Delta storage
- C/G: conjunctive use/groundwater banking
- Arrows used to depict range of storage

Conveyance Features

- **Existing Through Delta:** little or no modifications are made to the flow capacity of the existing Delta channels
- **Modified Through Delta:** a variety of modifications to Delta channels could be make to increase the conveyance efficiency
- **Dual System Conveyance:** a combination of improved through Delta conveyance and conveyance isolated from Delta channels

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Figure 2-2. Structure of Alternatives at the end of Phase I

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2.2.2 CALFED Phase II Alternative Development Process

The three basic alternative approaches carried into Phase II of the CALFED Bay-Delta Program were expanded to include several configurations per approach. As a result, 17 configurations of the three basic approaches were identified.

The major alternative development tasks undertaken during Phase II were:

- Refinement of the program elements and actions making up the Phase I alternatives;
- Two additional elements (water transfer and watershed management coordination) were added to each alternative because of their value in helping the Program meet its multiple objectives;
- Development of strategies for implementing the alternatives; and
- Preferred Program Alternative development process (Phase II report) a discussion of this Phase II effort can be found in the Phase II Interim Report Appendix.

Twelve of the 17 configurations are discussed in detail in Section 2.3.3. Section 2.3.3.4 discusses the reasons why five of these alternative configurations were not carried forward for further evaluation in this Programmatic EIS/EIR.

2.3 PHASE II ALTERNATIVES

This section presents a description of alternatives considered in the Programmatic EIS/EIR.

2.3.1 No Action Alternative

The No Action Alternative is used as a basis for comparison of the program alternatives. The purpose of this comparison is to highlight the changes to the environment that would take place as a result of implementing the various alternatives. CALFED is also comparing the project alternatives to Existing Conditions, which are referred to as the Affected Environment in the Programmatic EIS/EIR. Additional information can be found in the No Action Alternative Technical Appendix.

Since water simulation modeling is needed to identify differences between alternatives, many of the operational and regulatory features were identified only to serve as assumptions for this modeling effort. For example, modeling of the No Action Alternative includes the CVP and SWP Delta operational criteria contained in the NMFS and USFWS biological opinions, but does not consider possible changes in the criteria that could result if consultations were reinitiated. Changes in project operations in the No Action Alternative may require reinitiation of the consultations. Rather than try to predict and model the kind of operational changes that are consistent with the existing biological opinions, CALFED has addressed this by comparing the program alternatives to both the No Action Alternative and to the Existing Conditions. Existing Conditions includes known project operations that are consistent with the biological opinions as of June 1995. By comparing the project alternatives to both the existing conditions and the No Action Alternative, the Programmatic EIS/EIR discloses the range of impacts that may result, without having to make an assumption about the specific changes in operations that would require reinitiation of the consultations.

In addition to the modeling assumptions, additional assumptions were made about agreements, operations and regulatory criteria for both Existing Conditions and the No Action Alternative. All of these assumptions are depicted in Table 2-1.

The No Action Alternative also includes physical features that would have been implemented regardless of CALFED's actions. The criteria for inclusion of physical features in the No Action Alternative were: (1) Had the action been approved for implementation? (2) Did the action have funding for implementation? (3) Did the

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Actions	Existing Conditions	No Action Alternative
Interim Re-operation of Folsom Reservoir	400 to 670 TAF flood control reservation	Same as Existing Conditions
Water Conservation	Based on information developed by Department of Water Resources for Bulletin 160-98	Assumes levels per upcoming Bulletin 160-98
Land Retirement	Assume no land retirement	Assumes 45,000 acres retired by 2020 according to Bulletin 160-93
Groundwater Regulations	Assumes existing groundwater regulation policies	Same as Existing Conditions
Power Production	Assumes power produced incidental to other operations	Same as Existing Conditions
Flood Control Policies	Assumes existing policies	Same as Existing Conditions
Population Estimates	CA Dept. of Finance Projections for 1995	CA Dept. of Finance Projections for 2020
Delta Standards	1995 WQCP and delta smelt and winter-run Biological Opinions	Same as Existing Conditions
CVPIA	Dedication of 800,000 AF (assumes B-2 requirements of Act are met) Deliver Level IV water amounts to state and federal refuges	Same as Existing Conditions
Monterey Agreement	In place	Same as Existing Conditions
CVP and SWP Operations	Assumes continued operation pursuant to 1992 CVP operating criteria and procedures and current SWP operating criteria	Same as Existing Conditions
Water Contract Rate Setting	Assumes existing rate setting policies	Same as Existing Conditions
Endangered Species Listings	Assumes current listed species	Same as Existing Conditions
Drinking Water Regulations	Assumes existing regulations	Same as Existing Conditions
Level of Development	1995	2020
CVP Delta Exports	3.3 MAF	3.5 MAF with variations in a few wet years
SWP Delta Exports	2.6 to 3.6 MAF	variable between 3.6 and 4.1 MAF
Coordinating Operations Agreement	Continue with current agreement	Same as Existing Conditions
Tracy Pumping Capacity	Current permitted capacity (4,600 cfs)	Same as Existing Conditions
Sacramento, American, Feather, Stanislaus, Merced, Mokelumne Rivers, etc.	Meet current instream water requirements including Biological Opinion, FERC, SWRCB, CVPIA, DFG, etc.	Same as Existing Conditions
Banks Pumping Capacity	Current permitted capacity (6,680 cfs)	Same as Existing Conditions
Trinity River	Maximum release of 340 TAF	Same as Existing Conditions
Tuolumne and Yuba Rivers	Previous instream flow requirements	New FERC agreements
Vernalis Salinity Standard	Not completely met in all years	Met in all years subject to Vernalis Adaptive Management Plan

Table 2-1. Physical, Regulatory and Operational Assumptions for Existing Conditions and the No Action Alternative Based on their Status as of June 1995

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action have final environmental documents? (4) Did the action have final environmental permits? (5) Was the action excluded from the CALFED Program? and (6) Were the effects of the action identifiable at the level of detail being considered for CALFED analysis? Features meeting all these criteria are: Coastal Aqueduct Branch II; Shasta Temperature Control Device; Kern Water Bank facilities which were completed and operation as of June 1995; Los Vaqueros Reservoir Project; Eastside Reservoir Project; New Melones Conveyance Project; Interim Re-operation of Folsom Reservoir; Sacramento River Flood Control System Evaluation-Phases II and III; Semitropic Water Storage District Groundwater Banking Project; Monterey Agreement; and Stone Lakes National Wildlife Refuge.

The rigorous screening process used by the CALFED Program resulted in relatively few additional physical features beyond those already in place on June of 1995. For example, the interim reoperation of Folsom Reservoir had just been initiated, Los Vaqueros Reservoir, Shasta Temperature Control Device and Eastside Reservoir were under construction and the Kern Water Bank was just completed when the CALFED Program was describing the No Action Alternative. Similarly, as can be seen in Table 2-1, there are relatively few assumptions which differ between the No Action Alternative and Existing Conditions. These similarities between what is depicted for Existing Conditions and what is depicted for the No Action Alternative make it very difficult to identify different consequences when comparing either the No Action Alternative or Existing Conditions to the various program alternatives.

During the development of Phase II of the Program, a change has been made to one of the water simulation modeling assumptions which had been used to depict the No Action Alternative. After the CALFED Program concluded its evaluation of the consequences of the various alternatives, there were new developments related to implementation of Section 3406 (b)(2) of the Central Valley Project Improvement Act. As such, the modeling assumptions used for 3406 (b)(2) in this document differ from those that would be used if the evaluations were made today. These newer assumptions were used for the evaluations that went into the Phase II Report. It is conceivable that other changes might be made in the many assumptions in Table 2-1. For instance, the spring-run salmon could be listed by the Federal Government pursuant to the Endangered Species Act. Should such a listing occur before the Record of Decision and Certification of this Programmatic EIS/EIR, the programmatic consequences of such a listing on the CALFED Program would be addressed in the final Programmatic EIS/EIR.

2.3.2 Overview of Alternative Elements

This section provides a brief overview of the various elements making up all three alternatives and their 12 configurations. The overview is followed by Section 2.3.3, which pulls the elements together into the various alternatives. Section 2.3.3.4 describes alternatives not carried forward for further evaluation. For more detailed information on each of these elements or the alternatives, please see the Alternatives Technical Appendix.

Each of the alternative configurations include Ecosystem Restoration, Water Quality, Water Use Efficiency, Levee System Integrity, Water Transfers and Coordinated Watershed Management elements. The description of each of these elements is very similar among all configurations. Most of the alternatives also include storage and conveyance elements. Generally, the storage element is quite similar for each alternative configuration which has storage, but not all the alternatives include storage. The conveyance element differs the most among the alternatives.

The makeup of the various program elements is still undergoing refinement and development. In order to evaluate consequences and release this document early in 1998, it was necessary to use the alternative configuration descriptions as of early 1997. The technical appendices to this Programmatic EIS/EIR for each of the CALFED

Program elements provide a description of their current status. Similarly, the Phase II Report evaluations reflect a more recent description of the alternatives than those described in this chapter.

> The descriptions of the various elements are, at times, quite specific. For example, the descriptions of Delta conveyance facilities identify islands and channels along the conveyance alignments. The specificity associated with the conveyance facilities and other CALFED program elements as well, were provided as examples of potential options to help the reader better understand what was being contemplated. These alignment descriptions, as noted above, are not current and should not be considered as final. A sizable amount of work will be needed in Phase III before any alignment is selected or any new facility or restoration action is implemented. This work will include substantial site specific environmental analysis including preparation of environmental documents.

2.3.2.1 Water Storage and Conveyance

New storage would provide opportunities for enhanced timing and flow management to more effectively and efficiently satisfy urban, agricultural, and environmental beneficial users. Additional study will be required to determine the need for additional storage, optimal storage sizes considering physical factors, hydrology and hydraulic constraints, economic allocation of costs, and assurances needed for successful long-term multi-benefit operations.

Several options are under consideration for those alternative configurations that include additional storage including enlarging existing facilities, and developing new off-stream and on-stream storage reservoirs. Groundwater storage development will be implemented with demonstration projects in partnership with local agencies with attention to groundwater levels, water quality, local economic impacts, and any other third-party impacts.

Considering storage capacity needs for different purposes, and operational flexibility of the system, a range of facility sizes have been evaluated:

- 3.0 million acre-feet (MAF) surface storage upstream of the Delta (enlargement of existing storage or new off-stream storage) on Sacramento River tributaries;
- 500,000 acre-feet (TAF) surface storage upstream of the Delta (enlargement of existing storage or new off-stream storage) on San Joaquin River tributaries;
- 2.0 MAF surface storage off-aqueduct (South of Delta);
- 200 TAF in-Delta storage;
- 250 TAF groundwater storage in the Sacramento Valley; and
- 500 TAF groundwater storage in the San Joaquin Valley.

(See text box next page.)

Conveyance elements would convey water from north of the Delta to south of the Delta. The various conveyance components in this category range from modifications to existing facilities in the south Delta, to improvements to existing Delta channels, to the construction of an isolated transfer facility.

Existing through Delta facilities include:

- South Delta Modifications intended to result in removal of current regulatory constraints and thus allow the export pumps to operate at their physical capacity.
- State Water Project/Central Valley Project (SWP-CVP) improvements to provide additional operational flexibility.

Modified through-Delta improvements include:

- Physical modification of Delta channels to support continued conveyance through the

Various types of new storage components were evaluated for their potential to contribute to an overall approach to meeting Program objectives. Different types of storage components would provide different kinds of benefits. Storage upstream of the Delta would function differently than storage adjacent to export canals downstream of the Delta. Off-stream surface storage provides different benefits and generally fewer environmental impacts than on-stream surface storage. Groundwater banking and conjunctive use programs could enhance benefits provided by surface storage.

A preliminary evaluation was performed to determine an appropriate range of storage to be examined at a programmatic level. A rough approximation of water supply benefits for various storage volumes was made for both Sacramento River off-stream storage and south of Delta off-aqueduct storage.

This preliminary evaluation indicates that most water supply benefits of Sacramento River off-stream storage are achieved with about 3 MAF of storage, while most water supply benefits of south of Delta off-aqueduct storage are attained with about 2 MAF of storage. Of course, the relationship of water supply benefits to storage volume is highly dependent on operating assumptions. Much more detailed information about specific locations of new storage, potential allocation of storage benefits, and operational goals and constraints would be necessary to determine an optimal volume of storage from a water supply perspective.

Other types of surface storage considered include San Joaquin River tributary storage and in-Delta storage. Relatively smaller volumes of storage are practical for these types of storage facilities due to engineering considerations. Groundwater banking and conjunctive use in the Sacramento and San Joaquin Valleys were also considered. The practical storage capacity available for groundwater storage in these areas will be determined only after detailed study of specific projects and full consideration of local concerns. For study purposes, groundwater storage volumes of 250 TAF in the Sacramento Valley and 500 TAF in the San Joaquin Valley were considered.

Based on this preliminary evaluation of potential water supply benefits and practical consideration of acceptable levels of impacts and total costs, the range of total new storage considered for evaluation was from zero up to about 6 MAF. This amount of new storage was considered a reasonable range for study purposes; much more detailed study and significant interaction with stakeholders will be required before specific locations and sizes of new storage are proposed. A more complete screening process, taking into account potential environmental impacts, engineering feasibility, costs, and benefits, will proceed over the coming months.

Delta from north to south. The through-Delta conveyance capacity could range from use of the existing unaltered channels to channel enlargements by dredging and setback levees. Improvements to north Delta channels could be designed to provide multiple benefits for flood conveyance, habitat restoration, water supply, and south Delta water quality.

- A new screen or unscreened diversion (up to 10,000 cubic feet per second [cfs]) from the Sacramento River along with channel modifications will increase flow capacity and decrease flow velocity.

- The channel improvements include corridors of habitat along selected channels; setback levees to provide restored shaded riverine aquatic habitat; shallow water habitat, as well as increased water conveyance and flood protection; and conversion of islands into tidally influenced habitat.

Dual Delta Conveyance is formed around a combination of improved through-Delta conveyance and new isolated conveyance. It includes:

- A new screened diversion facility on the Sacramento River between Hood and Freeport could supply a new isolated conveyance facility to transport water around the east side of the Delta to the existing south Delta pumping plants. The new screened diversion facility could also supply water for continued through-Delta conveyance.

- The isolated conveyance can be sized and operated to convey from 5,000 to 15,000 cfs to the south Delta export facilities. For some of the smaller isolated conveyance capacities, a buried pipeline concept would be evaluated.

- The through-Delta conveyance capacity could range from use of the existing unaltered channels to channel enlargements by dredging and setback levees. Improvements to north Delta channels could be designed to provide multiple benefits for flood conveyance, habitat restoration, water supply, and south Delta water quality.

2.3.2.2 Ecosystem Restoration Program

The Ecosystem Restoration Program (ERP) focuses on the restoration of ecological processes

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associated with streamflow, stream channels, watersheds, and floodplains. These processes create and maintain habitats essential to the survival of species dependent on the Delta. In addition, the ERP aims to reduce the effects of stressors (such as unscreened diversions and introduced species and toxicity), that inhibit ecological processes, habitats, and species.

The ERP is not designed as mitigation for projects that would improve water supply reliability or bolster the integrity of Delta levees. Improving ecosystem functions and increasing the amount and quality of habitat are equally as important as other program goals related to water supply reliability, water quality, and system integrity.

The difficulties and uncertainties of ecosystem restoration call for a flexible implementation strategy that can accommodate and respond to new information. The foundation of the ERP is adaptive management. Adaptive management is a process of testing alternative ways of meeting objectives, and adapting future management actions according to what is learned. Adaptive management relies on identifying indicators of ecosystem health, comprehensive monitoring of indicators, focused research, and phasing actions.

The ERP will remain relatively unchanged between the alternatives. However, its performance can vary with the other program elements. Storage can improve instream flows, Delta outflows, and modification of timing of diversions. Improved conveyance to the south Delta export pumps can improve timing of diversions to reduce impacts on fish. Conveyance type can reduce adverse Delta flow circulation issues and can also reduce the entrainment effects on fisheries. Water quality improvements through source controls and timing of remaining pollutant releases improves water quality and reduces toxicity for the ecosystem. Improvements of levees and channels for improved system integrity can also incorporate new habitat features. Reduced diversions associated with water use efficiency measures helps reduce diversion effects on fisheries.

Potential benefits of the habitat restoration program include:

- Reversing the decline in ecosystem health by reducing or eliminating factors which degrade habitat, impair ecological functions, or reduce the population size or health of species
- Produces a healthy Bay-Delta ecosystem that provides for the needs of plants, animals, and people using the system
- Supports sustainable production and survival of plant and wildlife species, including resident species as well as migrants such as the waterfowl that use the Pacific Flyway each winter
- Reduces the conflict between fisheries and diversions

Potential concerns of the habitat restoration program include:

- Setback levees along the Sacramento and San Joaquin rivers may remove agricultural land from production.
- Restoration of riparian habitats adjacent to levees may increase the difficulty of maintaining safe and stable levees and may increase risk of levee catastrophic failure.
- Reestablishment of river meander zones may increase sediment loads in the short-term and impact downstream navigation channels; sediment loads may also increase maintenance costs for flood bypass systems.
- The enhancement of fishery populations may require reconsultation pursuant to the Endangered Species Act; (e.g., increased Delta smelt around the North Bay aqueduct).
- Floodway conversions to habitat may increase maintenance costs or impair floodway capacities; there may also be impacts to agricultural acreage.

- Depending on how the program is implemented, actions to address salmon migration at the head of Old River may impact water stages and quality as well as flood stages in the south Delta channels.

- There is uncertainty about implementation level and experience needed to achieve desired results.

- Water supply reliability improvements resulting from ecosystem restoration could take considerable time to achieve.

2.3.2.3 Water Quality Program

The Water Quality Program consists of a series of actions designed to improve water quality in the Bay-Delta system and support all beneficial uses including drinking water supply, recreation, agricultural and industrial water supply, and protection and enhancement of aquatic life. The program includes programmatic actions to reduce water quality degradation from agricultural drainage, urban and industrial runoff, mine drainage, and municipal and industrial wastewater discharges. Most actions involve a reduction in discharge of elements of concern to waterways; others involve changes in timing of wastewater release and relocation of water supply intakes. The actions are organized by geographic region and described in the Water Quality Program Appendix.

It should be noted that the Water Quality Program relies on source control, increased enforcement of existing regulatory programs and provision of incentives for action that goes beyond current regulatory programs. The actions do not involve new regulatory programs.

Water quality parameters of concern are constituents that cause water quality problems by affecting beneficial uses of water, or are indicators of water quality problems. The parameters of concern for the CALFED Water Quality Program were identified with the assistance of technical experts from public agencies, private industry, and public representatives. Collectively, agricultural, urban, environmental, industrial, and recreational interests are represented by this group. The parameters of concern include:

- Metals and trace elements (cadmium, copper, mercury, and zinc);

- Pesticides and other synthetic organic chemicals (carbofuran, chlordane, chlorpyrifos, diazinon, toxaphene, dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyls (PCBs);

- Minerals and nutrients (total dissolved solids, chloride, bromide, nitrates); and

- Physical characteristics (pH, temperature), toxicity, and pathogens (viruses, bacteria, protozoa).

A more complete listing of water quality parameters of concern can be found in Table 6.1.1-1.

The Water Quality Program will remain relatively unchanged between the alternatives but its performance can vary significantly depending on the other program elements. Storage can help timing for release of pollutants remaining after source control efforts. Improved conveyance to south Delta export pumps will improve water quality for those diversions but may decrease quality for in-Delta diversions. Water use efficiency measures can improve water quality entering the Delta by reducing some agricultural drainwater containing pollutants.

Potential benefits of the Water Quality Program include:

- Improves Delta water quality by reducing the volume of urban and agricultural runoff/drainage and concentration of pollutants entering the Delta

- Improves water quality for the ecosystem by reducing toxics as a limiting factor

- Improves drinking water quality and public health benefits

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- Reduces concentration of compounds contributing to trihalomethane formation potential and degradation of drinking water supplies

Potential concerns of the Water Quality Program include:

- Retention of agricultural drainage and changing the timing of releases to the river and Delta will not change the total mass of salts recycled through the San Joaquin Valley irrigation system

- Treatment systems for agricultural drainage may be prohibitively expensive

- Wetland treatment systems may expose wildlife to toxic effects

- Source control actions for agricultural drainage may be prohibitively expensive for some agricultural interests

- Management of urban stormwater runoff may be prohibitively expensive and difficult to implement

- Need to determine impacts or benefits to south Delta stage, circulation, and water quality

2.3.2.4 Water Use Efficiency Program

The CALFED Water Use Efficiency Program approaches water use efficiency from a policy perspective. In contrast to all other program elements, few technical issues are addressed. This approach is necessary and appropriate because implementation of efficiency measures occurs mostly at the local and regional level by local agencies, not by state and federal CALFED agencies. The program's policy toward water use efficiency is a reflection of the California's legal requirements for reasonable and beneficial use of water: existing water supplies must be used efficiently, and any new water supplies that are developed by the program must be used efficiently as well.

The role of CALFED agencies will be twofold. First, they will offer support and incentives through expanded programs to provide planning, technical, and financing assistance. Second, the CALFED agencies will play an important role in providing assurances that cost-effective efficiency measures will be implemented.

Based on a more detailed analysis provided in the Water Use Efficiency Appendix to the Programmatic EIS/EIR, estimates of potential conservation and water recycling are summarized in Table 2-2. Values represent water savings expected to occur for future conditions regardless of the outcome of a CALFED solution (termed no-action) as well as the incremental savings expected from a CALFED solution. Representative values shown in this summary table are all midpoints in value ranges contained in the Water Use Efficiency Appendix .

With respect to urban and agricultural conservation, the Program proposes to rely largely on locally directed processes to provide endorsement or certification of urban and agricultural water suppliers that are properly analyzing conservation measures and are implementing all measures that are cost-effective and feasible. Organizations composed of water suppliers and public interest or environmental groups already exist that may be able to serve this function. Endorsement or certification of water suppliers will enable CALFED agencies to target assistance programs and other measures to assure reasonable and beneficial use.

The Water Use Efficiency Program includes the following programmatic actions.

Conservation-related actions include:

- Work with the California Urban Water Conservation Council and the Agricultural Water Management Council to identify appropriate urban and agricultural water conservation measures, set appropriate levels of effort, and certify or endorse water suppliers that are implementing cost-effective feasible measures.

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	Net Water Savings [1] (1,000 acre-feet annually)		
	Urban Conservation	Agriculture Conservation	Urban Recycling
CALFED No Action (occur as future trends in absence of a Bay-Delta solution)	1,480	230	1,170
CALFED Program (result of CALFED Program actions)	740	160	300
Total	2,220	390	1,470
		Total	4,080

1. "Net water savings" is water available for reallocation to other water supply uses. Reductions in applied water would be greater.

Table 2-2. Representative Net Water Savings From Water Use Efficiency Measures

- Expand state and federal programs in order to provide sharply increased levels of planning, technical, and financing assistance, and develop new ways of providing assistance in the most effective manner.
- Help urban water suppliers comply with the Urban Water Management Planning Act.
- Help water suppliers and water users identify and implement water management measures that can yield multiple benefits including improved water quality and reduced ecosystem impacts.
- Identify and implement practices to improve water management on wildlife refuges.

Water recycling actions include:

- Help local and regional agencies comply with the water recycling provisions in the Urban Water Management Planning Act
- Expand state and federal recycling programs in order to provide sharply increased levels of planning, technical, and financing assistance, and develop new ways of providing assistance in the most effective manner
- Provide regional planning assistance which can increase opportunities for use of recycled water.

Assurances will play a critical role in the Water Use Efficiency Program. The assurance mechanisms are structured to ensure that urban and agricultural water users implement the appropriate efficiency measures. As a prerequisite to obtaining CALFED Program benefits (receiving "new" water, participating as a buyer or seller in a water transfer, or receiving water from a drought water bank) water suppliers will have to show that they are in compliance with the applicable urban or agricultural council agreements and applicable State law. This requirement will result in serious analysis and implementation of conservation measures identified in those agreements. In addition, the Program is considering a requirement that recipients of "new" or transferred water meet water measurement and volumetric pricing requirements developed under the Central Valley Project Improvement Act.

A high level of water use efficiency may also be assured through the concept of linked implementation. Widespread demonstration of efficient use by local water suppliers and irrigation districts could be a prerequisite to

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CALFED implementation of other program actions for water supply reliability.

The Water Use Efficiency Program remains relatively unchanged among the alternatives. However, depending on the alternative, more or less implementation of water use efficiency measures may occur at the local level as water suppliers integrate efficiency measures into their integrated resources planning. The extent of feasible water recycling is affected by efforts to maintain and improve water quality. Source water that is high in salinity may not be suitable for subsequent recycling.

The effectiveness of water use efficiency methods can be enhanced by storage of the saved water for later use. For example, the groundwater banking and conjunctive use programs in Delta export areas such as the San Joaquin Valley and the Tulare Lake Basin and in the Sacramento Valley could be expanded. Improved conveyance to the South Delta export pumps will help move water when it is needed. The opportunity for transfers will be increased, which will provide market incentives for implementation of water use efficiency actions. Conversion of certain drainage-affected agricultural lands to other uses may reduce the pollutant load entering the Delta.

Potential benefits of the Water Use Efficiency Program include:

- Reduces demand for Delta exports and related entrainment effects on fisheries.
- Can help in timing of diversions for reduced entrainment effects on fisheries.
- Could make water available for transfers.
- May delay need (and size) for new water facilities.
- May improve overall Delta and tributary water quality.
- Could reduce the total salt load to the San Joaquin Valley.

Potential concerns of the Water Use Efficiency Program include:

- Average year conservation may produce few critical year benefits unless conserved water can be stored.
- Conservation may adversely affect downstream water reuse.
- As conservation becomes an integral part of water management, it can reduce opportunities for additional water use reductions during shortages, and increase the need for reliability.

2.3.2.5 Levee System Integrity Program

The Levee System Integrity Program has five elements:

- The Delta Levee Base Level Protection Plan strives to increase the stability and structural integrity of Delta project and nonproject levees up to the Corps PL 84-99 standard.
- The Delta Levee Special Improvement Projects provide increased flood protection beyond the Delta Levee Base Level Protection Plan for Delta islands with many public benefits.
- The Delta Island Subsidence Control Plan reduces island subsidence to improve long-term reliability of Delta levees.
- The Delta Levee Emergency Management Plan will build upon existing emergency management resources to protect critical Delta resources during an emergency.
- The Delta Levee Seismic Risk Assessment will identify and increase the understanding of the seismic risks to Delta resources and develop recommendation for increasing Delta levee seismic stability.

The levee plan will remain relatively unchanged between the alternatives. Delta channel modifications for conveyance may require a levee

setback along the alignment or a different levee cross section depending on channel velocities. The levee cross sections in places may vary depending on locations selected for levee-associated habitat. Overall potential benefits of the Levee System Integrity Program include:

- Subsidence reduction helps long-term Delta system integrity
- Ensures suitable funding, equipment and materials availability, and coordination to rapidly respond to levee failures
- Provides funding for continued maintenance of levees to protect Delta functions
- Increases reliability for water supply needs from the Delta and in-Delta water quality
- Increases reliability for in-Delta land use and habitat
- Increases reliability for in-Delta aquatic and wildlife habitat

Potential concerns of the Levee System Integrity Program include:

- Providing increased levee stability and higher levels of flood protection in a staged fashion can expose adjacent islands to higher levels of flood risk until their priority is reached in the staged program
- Attempting to reach a uniform high level of flood protection may be prohibitively expensive
- Creating aquatic habitat as part of levee stabilization work may impact terrestrial habitats and vice versa
- Creating subsidence buffer zones may remove agricultural lands from production and impact terrestrial habitats.
- Improving flood protection may impact both aquatic and terrestrial habitats.
- Without an adequate subsidence control plan, levee stabilization may not be successful over the long term in the peat soil areas of the Delta.
- Sea level rise could eventually jeopardize long-term levee viability, especially in combination with continued land subsidence.

2.3.2.6 Water Transfers

Water transfers are currently an important part of water management in California, and offer the potential to play an even more significant role in the future. An open and active water transfers market will improve the economic efficiency of water use, will provide an incentive for water users to implement cost-effective conservation measures that yield transferable water, and will help ensure realistic evaluation of the cost-effectiveness of any new supply development. The program is addressing water transfers from both a technical and policy perspective. Technical considerations related to conveyance and storage vary among the alternatives. A water transfer policy framework is being established to resolve many of the issues that currently constrain transfers or raise concerns when transfers do occur.

The policy framework is expected to provide an effective means of moving water between users on a voluntary and compensated basis, as well as a means of providing incentives for water users to implement management practices which will improve water use efficiency. Transfers can also provide water for environmental purposes in addition to the minimum instream flow requirements.

Water transfer policy must also provide a means of ensuring that water transfers do not merely improve short-term water supply reliability at the expense of local communities or groundwater resources. Reductions in groundwater can occur when users of surface water transfer this water to others and switch to groundwater instead. Local communities can be affected when agricultural land is taken out of production in order to transfer the water that would have been used for irrigation.

All of those dependent on an agricultural economy -- from farm workers to farm equipment mechanics -- can be adversely affected. Strong mechanisms to avoid or mitigate water transfer impacts to third parties and groundwater resources will be essential elements of a CALFED water transfer policy.

The CALFED water transfer element proposes a policy framework for water transfer rules, baseline data collection, public disclosure, and analysis and monitoring of water transfers, both short and long-term. The element, in its final form, may also identify areas where additional regulation or statutory changes are desirable. Such modifications to existing policy are expected to facilitate the water transfer market, although the annual volume of transfers will still be dependent on locally developed agreements and assurances.

2.3.2.7 Coordinated Watershed Management

The CALFED Bay-Delta Program is developing and implementing a comprehensive plan to address a declining ecosystem, uncertain water supplies, imperiled water quality and decreased levee system integrity. This plan will include an integrated approach to solving these problems and watershed management is one of the components of the approach. Watershed management will be included in each of the alternatives as a means of improving water quality, ecosystem quality, and water yield, and levee system integrity.

The Coordinated Watershed Management Program will include a comprehensive, integrated, ecosystem-wide approach to developing methods for protecting and enhancing beneficial uses of the Bay-Delta system. Management efforts throughout the watersheds will achieve maximum efficiency and effectiveness if they are carried out as part of a coordinated effort and will provide the means to organize existing and new management programs which demonstrate clear linkage to correcting the problems of the Bay-Delta estuary. The Coordinated Watershed Management Program will:

- Utilize the watershed management structure to provide for intergovernmental, interagency, and interwatershed coordination of restoration and management efforts including planning, data collection, implementation, and monitoring of results. A complete inventory of watershed plans, programs, and projects would also be included.

- Implement a planning process which takes advantage of local watershed management councils, Coordinated Resource Management and Planning efforts, and similar stakeholder ongoing processes. The planning process would include participation by CALFED agencies as well to provide technical assistance and identify federal land management agency matching of efforts with state and local actions. The output would be a strategy for achieving coordinated, restored watersheds.

- Provide for long-term coordination, new funding, and prioritization programs for watershed management and restoration through the watershed management structure. These programs should take advantage of existing funding programs which are currently in place. New funding sources developed as part of CALFED and other opportunities will also be identified. CALFED will provide a coordination point for participating CALFED agencies to more effectively coordinate their watershed budget dollars and use them in conjunction with CALFED funds.

- Implement data collection, standardization, monitoring, interpretation, and reporting mechanisms as part of the CALFED adaptive management program. This information would be available for incorporation into CALFED scientific analysis and reporting.

Coordinated watershed management efforts will be carried out in all of the study area regions to ensure an integrated approach to watershed management, and to ensure that no misdirected impacts occur within any of the study regions.

The Water Transfers and Coordinated Watershed Management Programs described in Sections 2.2.3.6 and 2.2.3.7, respectively, would be implemented under each alternative and the descriptions of these two program elements do not change between alternatives. Therefore, neither of these two programs will be noted again in the description of alternatives.

2.3.3 *Alternative Description Summaries*

This section provides a summary description of the 12 configurations analyzed in this Programmatic EIS/EIR. The five configurations not analyzed are discussed in Section 2.3.3.4. An Alternatives Matrix highlighting the major components of the individual alternatives is provided in a pocket on the inside back cover of this document for a quick reference. Tables 2-3, 2-4, and 2-5 show the major components for Alternatives 1, 2, and 3, respectively. The general features of Alternatives 1, 2, and 3 are shown on Figures 2-3, 2-4, and 2-5, which the reader can refer to when reading the following sections.

2.3.3.1 Alternative 1— Existing System Conveyance

The general features of Alternative 1 are shown in Figure 2-3. Three configurations with various south Delta modifications are included in this alternative. One configuration includes new surface and groundwater storage.

Configuration 1A. Configuration 1A combines and integrates the six programs without adding new storage and conveyance facilities to supplement the status quo.

Ecosystem Restoration. The entire ERP would be implemented with the following modifications:

- Operational changes in environmental waterflows would be achieved through purchase of water from willing sellers rather than reliance on regulatory mandates.
- Habitat restoration of tidal emergent wetland and tidal perennial wetland identified for the South Delta area would be relocated to the northern and western Delta. This change would provide for intensive habitat restoration targeting fisheries to

CALFED Alternatives include a variety of South Delta and CVP-SWP Improvements that are components of DWR's Interim South Delta Program. The specific ISDP facilities that are featured in various alternatives include flow control structures (Middle River, Grant Line Canal, Old River) and a fish control structure at the head of Old River. Channel dredging in Old River adjacent to Victoria Island is also derived from the ISDP.

Although the proposed location is the same, the component that does vary between the Programs is the new Clifton Court Forebay Intake Structure. The ISDP concept features a 25,000-30,000 cfs gated structure that is operated in conjunction with the tidal cycle. This design would allow for continuous pumping of 10,300 cfs from the Banks Pumping Plant. CALFED's proposed intake facility consists of a fish-screening complex and a 15,000 cfs pump station that can be continuously operated independent from tidal influence. Further studies are required to support the theory of continuous pumping at a rate of 15,000 cfs, year around, without adversely impacting stages and water quality in south Delta channels. The results of these studies may also indicate that channel enlargement in Old River might not be required at this export flow rate.

CALFED's CVP-SWP Improvements also include a 4,600 cfs channel (intertie) between Clifton Court and the Tracy intake channel, as well as new state-of-the-art fish screens for the existing Tracy Fish Screening Facility. These features are not part of the ISDP. Configurations 2D, 2E, 3H, and 3I include channel improvements in Old River that feature setback levees and habitat. This setback levee concept would preclude the need for the ISDP dredging component on Old River.

Water Storage	Conveyance	Other Program Elements
Varies from no new storage to: 3.0 MAF Upstream (Sac) 1.0 MAF Off-Aqueduct 250 TAF Sac. Valley GW 500 TAF San Joaquin GW	Varies from existing Delta channels with no conveyance modifications to select south Delta modifications	Ecosystem Restoration Water Quality Water Use Efficiency Levee System Integrity Water Transfers Coordinated Watershed Management

Table 2-3. Alternative 1—Existing System Conveyance

Water Storage	Conveyance	Other Program Elements
Varies from no new storage to: 3.0 MAF Upstream (Sac) 500 TAF Upstream (SJ) 2.0 MAF Off-Aqueduct 250 TAF Sac. Valley GW 500 TAF San Joaquin GW	Varies from channel modifications primarily for water conveyance to extensive modifications for water conveyance and habitat restoration	Ecosystem Restoration Water Quality Water Use Efficiency Levee System Integrity Water Transfers Coordinated Watershed Management

Table 2-4. Alternative 2— Modified Through-Delta Conveyance

Water Storage	Conveyance	Other Program Elements
Varies from no new storage to: 3.0 MAF Upstream (Sac) 500 TAF Upstream (SJ) 2.0 MAF Off-Aqueduct 250 TAF Sac. Valley GW 200 TAF In-Delta Storage 500 TAF San Joaquin GW	Through-Delta channel modifications vary from those primarily for water conveyance to those for water conveyance with extensive habitat restoration. Isolated facility varies from small (5000 cfs) to large (15,000 cfs)	Ecosystem Restoration Water Quality Water Use Efficiency Levee System Integrity Water Transfers Coordinated Watershed Management

Table 2-5. Alternative 3— Dual Delta Conveyance

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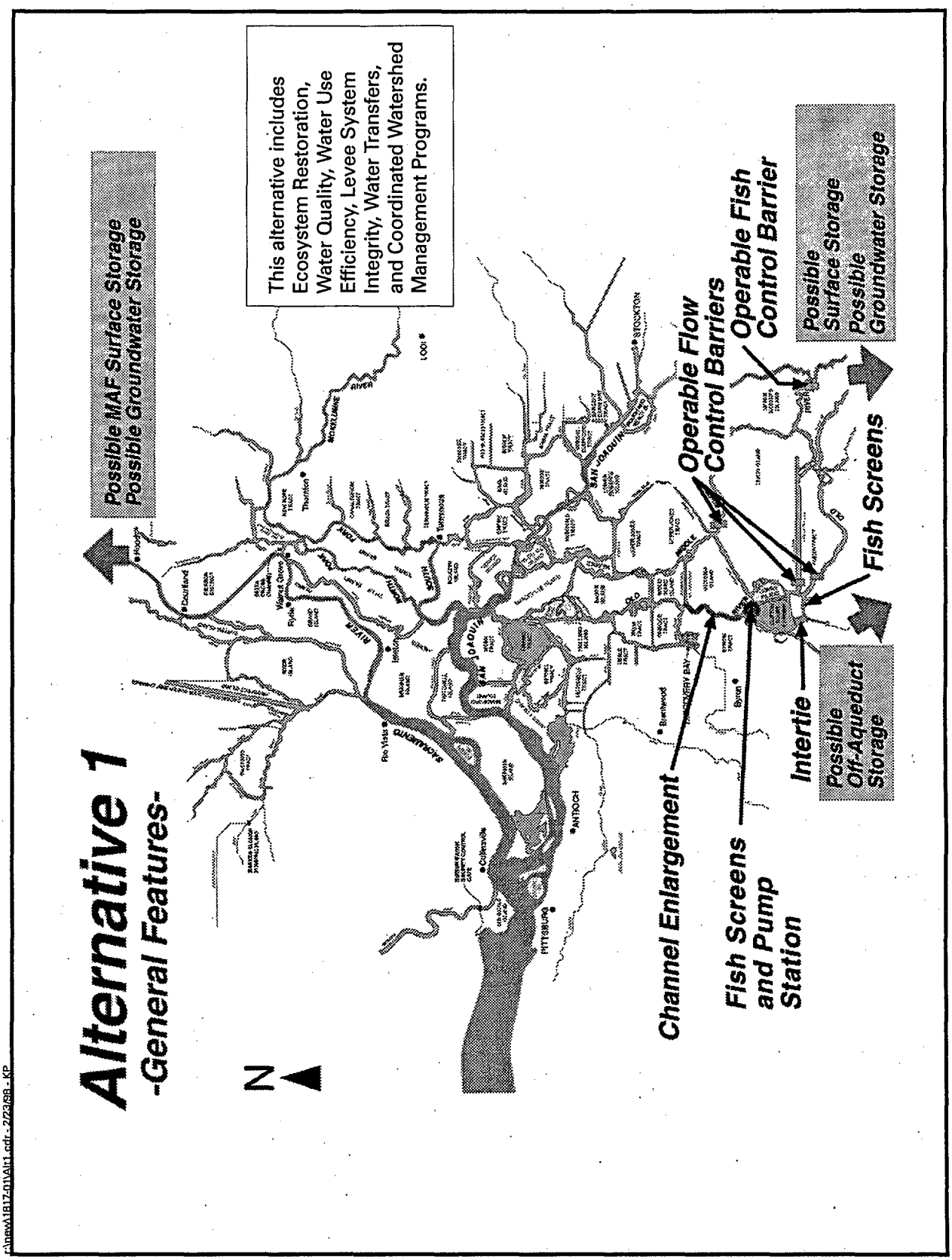

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Figure 2-3. Alternative 1 General Features

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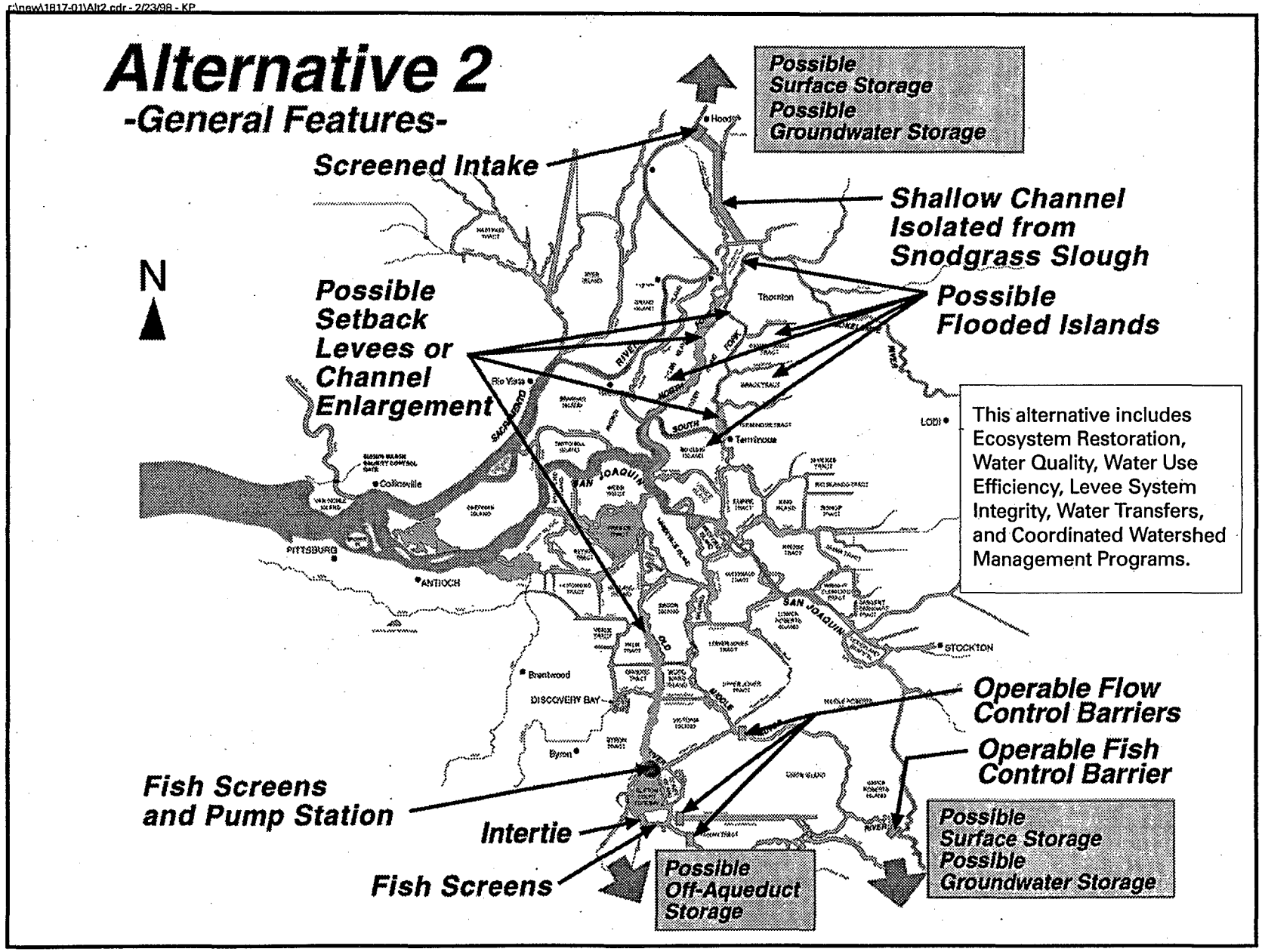

Figure 2-4. Alternative 2 General Features

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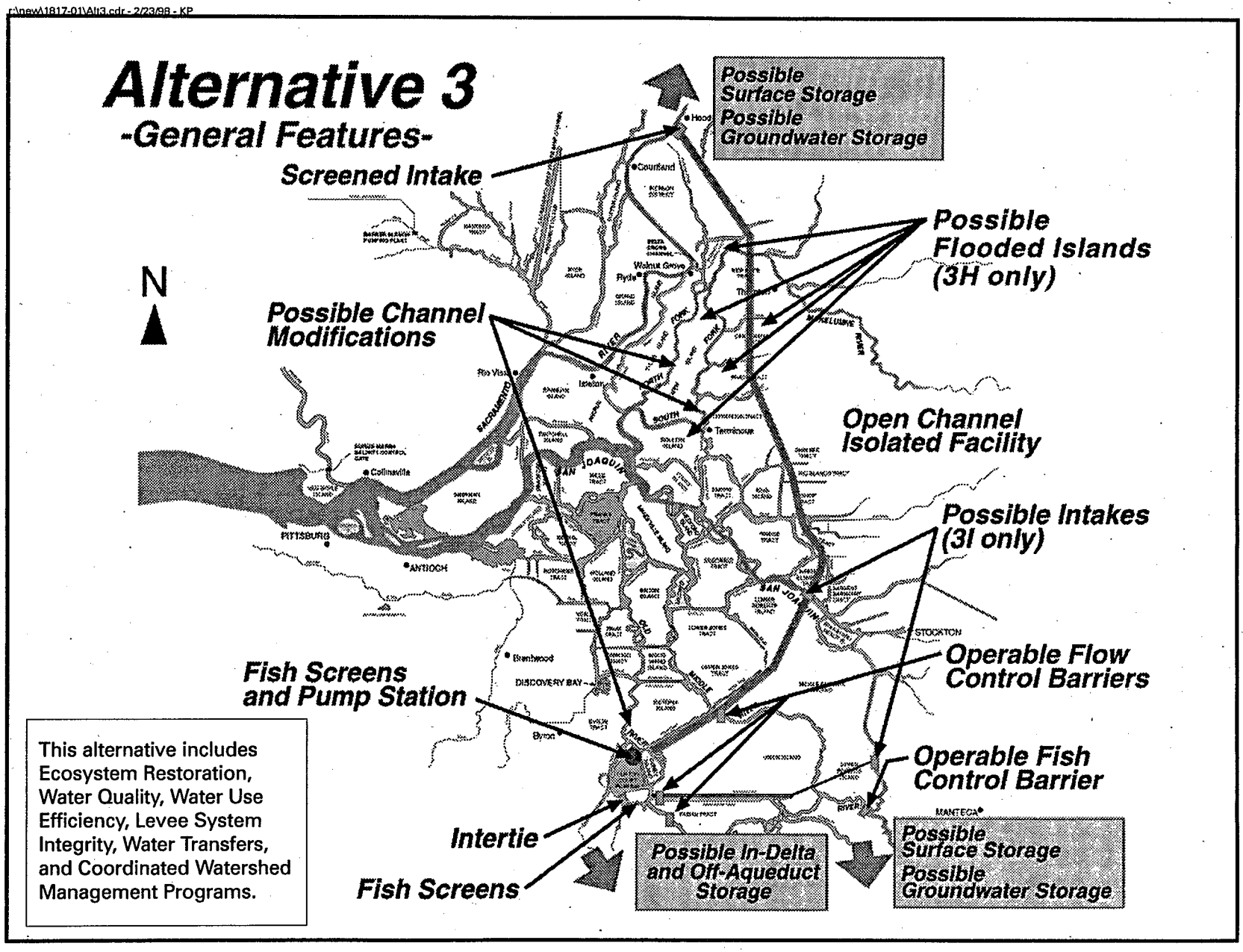

Figure 2-5. Alternative 3 General Features

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be located prudently distant from the South Delta pumping facilities.

Water Quality Program. The entire Water Quality Program would be implemented with the following addition:

- Evaluate relocating water supply intakes (such as North Bay Aqueduct, Tracy, and Contra Costa Water District intakes) to avoid salts and organic carbon that reduce the ability to recycle water and that complicate disinfection and are sources of disinfection by-products.

Water Use Efficiency. The entire Water Use Efficiency Program would be implemented.

Levee System Integrity. The entire Levee System Integrity Program would be implemented.

Storage and Conveyance. No new water storage is proposed. No conveyance improvements are proposed.

Configuration 1B. Configuration 1B combines and integrates the six alternative elements with select south Delta improvements. Configuration 1B builds upon Configuration 1A by adding fish screens at the Banks and Tracy pumping plants and an intertie between the Tracy pumping plant and Clifton Court Forebay. All six alternative elements fit together as they did with Configuration 1A.

Storage and Conveyance. No new water storage is proposed.

Proposed South Delta Modifications include:

- Installation of an operable barrier or equivalent at the head of Old River to maintain a positive flow down the San Joaquin River; and

- Flow and stage control measures on Middle River, Grant Line Canal, and Old River or other methods to control flow, stage, and south Delta salinity.

SWP and CVP improvements include:

- New fish screens at the Skinner Fish facility;

- New fish screens at the Tracy Pumping Plant intake; and

- Intertie between Tracy Pumping Plant and Clifton Court Forebay to provide operational flexibility to minimize fisheries impacts.

Configuration 1C. Configuration 1C builds on Configuration 1B by adding new conveyance to provide for increasing the diversion capacity of existing exports to their full physical capacity and enlarging Delta channels, and includes new surface and groundwater storage facilities throughout the watershed. Except for one minor change in the ERP, all six alternative elements fit together as they did with Configuration 1A.

Ecosystem Restoration. Configuration 1C would implement the entire ERP with the following change from Configuration 1A:

- Some environmental water flows would be met through use of new storage specifically allocated to environmental water supplies.

Storage and Conveyance. A range of facility sizes will be evaluated up to:

- 3.0 MAF surface storage upstream of the Delta (enlargement of existing storage or new off-stream storage) on Sacramento River tributaries;

- 1.0 MAF surface storage off-aqueduct (South of Delta);

- 250 TAF groundwater storage in the Sacramento Valley; and

- 500 TAF groundwater storage in the San Joaquin Valley.

Additional proposed South Delta Modifications include:

- A new Clifton Court Forebay intake structure; and,

- Channel enlargement along a 4.9-mile reach in Old River.

2.3.3.2 Alternative 2— Modified Through-Delta Conveyance

The general features of Alternative 2 are shown in Figure 2-4. Combinations of four potential conveyance options and three new storage options differentiate the four configurations of this alternative.

Configuration 2A

Configuration 2A combines and integrates the six alternative elements with North and South Delta channel modifications designed to improve water conveyance. Configuration 2A is the "minimal" alternative to achieve improved through-Delta conveyance. It provides for more efficient water conveyance from the Sacramento River through Snodgrass Slough, North Fork Mokelumne River, and Old River near Clifton Court Forebay. It also includes the Alternative 1B and 1C conveyance features. The configuration does not provide additional water storage.

Ecosystem Restoration. The entire ERP would be implemented with the following modifications:

- Operational changes in environmental water flows would be achieved through purchase of water from willing sellers rather than reliance on regulatory mandates.

- Habitat restoration identified for the south Delta area would all be located west of the flow and stage control structures on Middle River, Grant Line Canal, and Old River.

- Habitat improvements along the North Fork Mokelumne River would be limited to establishing a riparian habitat corridor associated with setback levees constructed to modify channel conveyance.

- Shallow water habitat identified for the Delta would be located in the eastern Delta by breaching select portions of the east levee along the South Fork Mokelumne River and protecting interior levee slopes.

Water Quality Program. The entire Water Quality Program would be implemented with the following additions:

- Evaluate relocating water supply intakes (such as North Bay Aqueduct, Tracy, and Contra Costa Water District intakes) to avoid salts and organic carbon that reduce the ability to recycle water, complicate disinfection, and are sources of disinfection by-products.

- Relocate Delta island drainage discharges away to channels other than those identified for conveyance modifications.

Water Use Efficiency. The entire Water Use Efficiency Program would be implemented.

Levee System Integrity. The entire Levee System Integrity Program would be implemented with the following modifications:

- The program would be adjusted to accommodate new setback levees for improved water conveyance and flooding of McCormack-Williamson Tract.

Storage and Conveyance. No new water storage is proposed.

A new 10,000-cfs screened intake at Hood would divert water into the improved through-Delta channels from the Sacramento River. This would include:

- A gated intake with pumping plant to open channel;

- Fish screen and bypass system;

- Open channel to Snodgrass Slough with setback levee along east side of channel to McCormack-Williamson Tract;

- Relocation/replacement of existing improvements displaced by the new channel; and

- Breach McCormack-Williamson Tract levee to flood island for shallow water habitat and water conveyance.

North Delta Channel modifications would provide for deepening and widening the Mokelumne River channel to improve water conveyance and flood control in the northern Delta. These modifications include:

- Purchase of 600-foot-wide alignment along Mokelumne River from I-5 to the San Joaquin River;

- Replacement of existing levees on one side of the existing channel with new setback levees approximately 500 feet back from the existing channel;

- Removal of existing levees where they obstruct the new channel and convert remaining portions into channel islands;

- Relocation/replacement of existing improvements displaced by the widened channel; and

- Channel dredging where appropriate.

This configuration includes all of the South Delta Modifications and SWP-CVP improvements mentioned in Configurations 1B and 1C.

Configuration 2B. This configuration is the same as Configuration 2A except that it modifies the ERP and adds new water storage facilities.

Ecosystem Restoration. Configuration 2B would implement the entire ERP with these modifications:

- Changes in environmental water flows would be met through purchase of existing water from willing sellers and use of the new storage allocated to environmental water supplies.

- Habitat restoration identified for the south Delta area would all be located west of the flow and stage control structures on Middle River, Grant Line Canal, and Old River.

- Habitat improvements along the North Fork Mokelumne River would be limited to establishing a riparian habitat corridor associated with setback levees constructed to modify channel conveyance.

- Shallow water habitat identified for the Delta would be located in the eastern Delta by breaching select portions of the east levee along the South Fork Mokelumne River and protecting interior levee slopes.

Storage and Conveyance. A range of facility sizes will be evaluated up to:

- 3.0 MAF surface storage upstream of the Delta (enlargement of existing storage or new off-stream storage) on Sacramento River tributaries;

- 500 TAF surface storage upstream of the Delta (enlargement of existing storage or new off-stream storage) on San Joaquin River tributaries;

- 2.0 MAF surface storage off-aqueduct (South of Delta);

- 250 TAF groundwater storage in the Sacramento Valley; and

- 500 TAF groundwater storage in the San Joaquin Valley.

Configuration 2D. Configuration 2D combines and integrates the six alternative elements with system modifications in the north and south Delta designed to improve water conveyance, to provide habitat restoration integrated with the conveyance improvements, including the Configuration 2A diversion at Hood, and new aqueduct storage south and downstream of the Delta. The

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configuration provides for more efficient water conveyance from the Sacramento River through Snodgrass Slough, South Fork Mokelumne River, and Old River near Clifton Court Forebay. It also includes Alternative 1C conveyance features.

Ecosystem Restoration. The entire ERP would be implemented with these modifications:

- Changes in environmental water flows would be met through purchase of existing water from willing sellers and use of the new storage allocated to environmental water supplies.
- The modification of the Mokelumne River Floodway with setback levees, conversion of Bouldin Island to aquatic habitat, and construction of the East Delta Wetlands Habitat (channel modification along the South Fork Mokelumne River).
- A portion of identified south Delta habitat will be incorporated with the setback levees along Old River.

The Water Quality and Water Use Efficiency programs would fit together as they did for Configuration 2A.

Levee System Integrity. The entire Levee System Integrity Program would be implemented with this modification:

- The program would be adjusted to accommodate new setback levees and the flooding of McCormack-Williamson Tract, Bouldin Island, and tracts along the eastern side of the South Fork Mokelumne River.

Storage and Conveyance. A range of facility sizes will be evaluated up to:

- 2.0 MAF surface storage off-aqueduct (south of Delta).

Mokelumne River Floodway and East Delta Wetlands Habitat (channel modifications along the South Fork Mokelumne River) provide for improved conveyance and associated habitat. Modifications include:

- Construction of setback levees on New Hope Tract about 2,000 feet east of existing alignment from Mokelumne River to Beaver Slough;
- Removal of segments of the eastern levee along South Fork Mokelumne River to provide new flooded habitat, such as Canal Ranch and Brack Tract (protect interior levee slopes);
- Construction of setback levees on Terminous Tract about 2,000 feet east of existing alignment;
- Construction of setback levees on Staten Island, south of Sycamore Slough, about 4,000 feet west of existing alignment;
- Removal of portions of Bouldin Island levee to flood the island for conveyance and habitat. Interior levee slopes will be protected from erosion; and
- Relocation/replacement of key infrastructure such as Highway 12.

This configuration includes all of the South Delta Modifications, SWP-CVP improvements, and a 10,000-cfs screened intake at Hood mentioned in Configurations 1B and 1C.

Configuration 2E. Configuration 2E is the same as 2B with respect to the Ecosystem Restoration Program, Water Quality Program, Water Use Efficiency Program, and Levee System Integrity Program. The conveyance and habitat portions of this configuration are similar to Configuration 2D with the exception of the additional conveyance and setback levee habitat on Tyler Island and the elimination of the 10,000-cfs intake at Hood.

Storage and Conveyance. A range of facility sizes will be evaluated up to:

- 3.0 MAF surface storage upstream of the Delta (enlargement of existing storage or new

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off-stream storage) on Sacramento River tributaries;

- 500 TAF surface storage upstream of the Delta (enlargement of existing storage or new off-stream storage) on San Joaquin River tributaries;
- 2.0 MAF surface storage off-aqueduct (South of Delta);
- 250 TAF groundwater storage in the Sacramento Valley; and
- 500 TAF groundwater storage in the San Joaquin Valley.

Tyler Island Aquatic Habitat provides habitat and flow control into the central Delta. Modifications include:

- Construction of a setback levee, 500 feet west of Georgiana Slough, from the Sacramento River to weir intake into the central Delta;
- Construction of a 600-foot-wide inflatable rubber dam to control weir elevation to control water flow;
- Construction of channel section control in Georgiana Slough to prevent accelerated erosion of channel bottom, armoring with rip-rap or gabion baskets;
- Breaching a 2,000-foot-long section of Tyler Island levee on the northeast side of the island; and
- Ripraping all remaining interior levee slopes.

Mokelumne River Floodway and East Delta Wetlands Habitat (channel modifications along the South Fork Mokelumne River) provide for conveyance and significant expansion of habitat. These modifications include:

- Breaching McCormack-Williamson Tract levee to flood the island for shallow water habitat and water conveyance;
- Construction of setback levees on New Hope Tract about 2,000 feet east of existing alignment from Mokelumne River to Beaver Slough;
- Removal of segments of the eastern levee along South Fork Mokelumne River to provide new flooded habitat, such as Canal Ranch and Brack tracts (protect interior levee slopes);
- Construction of setback levees on Terminous Tract about 2,000 feet east of existing alignment;
- Construction of setback levees on Staten Island, south of Sycamore Slough, about 4,000 feet west of existing alignment; and
- Removal of portions of Bouldin Island levee to flood the island for conveyance and habitat. Protect interior levee slopes.

This configuration includes all of the South Delta Modifications and SWP-CVP improvements mentioned in Configurations 1B and 1C.

2.3.3.3 Alternative 3— Dual Delta Conveyance

The general features of Alternative 3 are shown in Figure 2-5. Combinations of seven potential conveyance options and two new storage options differentiate the five configurations of this alternative.

Configuration 3A. Configuration 3A combines and integrates the six alternative elements with North and South Delta channel modifications designed to improve water conveyance and a small (5,000-cfs) open channel isolated facility. This configuration is considered the "minimal" option for the dual Delta conveyance alternative. It also includes the Alternative 1 conveyance features. The configuration provides no new water storage.

Ecosystem Restoration. The entire ERP would be implemented with the following modifications:

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- Changes in environmental water flows would be met through purchase of existing water from willing sellers;

- Habitat improvements along the North Fork Mokelumne River would be limited to establishing a riparian tree corridor associated with the setback levees for modified channel conveyance;

- Shallow water habitat identified for the Delta would be located in the eastern Delta by breaching select portions the east levee along the South Fork Mokelumne River and protecting interior levee slopes.

Water Quality Program. The entire Water Quality Program would be implemented with the following additions:

- Evaluate relocating water supply intakes (such as North Bay Aqueduct, Tracy, and Contra Costa Water District intakes) to avoid salts and organic carbon that reduce the ability to recycle water, complicate disinfection, and are sources of disinfection by-products; and

- Relocate Delta island drainage discharges away from the channels identified for conveyance modifications.

Water Use Efficiency. The entire Water Use Efficiency Program would be implemented.

Levee System Integrity. The entire Levee System Integrity Program would be implemented.

Storage and Conveyance. No new water storage is proposed.

Conveyance includes all of the South Delta modifications and SWP-CVP improvements listed under Configurations 1B and 1C, as well as the North Delta channel improvements listed under Configuration 2A.

The 5,000-cfs isolated facility would provide for improved operational flexibility for use in conjunction with through-Delta improvements. The isolated facility includes:

- New screened intake at Hood (or alternatively at Freeport);

- Pumping plant to open channel;

- 2,000-foot wide alignment from Hood to Clifton Court Forebay along the eastern side of the Delta;

- 5,000-cfs open channel from the vicinity of Hood (or alternatively Freeport) to Clifton Court Forebay; and

- Relocation/replacement of existing improvements displaced by the new facility.

Configuration 3B. Configuration 3B combines and integrates the six alternative elements with North and South Delta channel modifications designed for water conveyance, a small (5,000-cfs) isolated facility constructed as an open channel, and surface and groundwater storage. The configuration is the same as Configuration 3A except for the new water storage.

A range of facility sizes will be evaluated up to:

- 3.0 MAF surface storage upstream of the Delta (enlargement of existing storage or new off-stream storage) on Sacramento River tributaries;

- 500 TAF surface storage upstream of the Delta (enlargement of existing storage or new off-stream storage) on San Joaquin River tributaries;

- 2.0 MAF surface storage off-aqueduct (South of Delta);

- 200 TAF in-Delta storage;

- 250 TAF groundwater storage in the Sacramento Valley; and

- 500 TAF groundwater storage in the San Joaquin Valley.

Configuration 3E. Configuration 3E combines and integrates the six alternative elements with North Delta channel modifications designed to improve water conveyance, a large (15,000-cfs) isolated facility constructed as an open channel, and surface and groundwater storage. The configuration is the same as Configuration 3A with respect to the Ecosystem Restoration, Water Quality, Water Use Efficiency, and Levee System Integrity programs.

Storage and Conveyance. The storage is the same as Configuration 3B. Conveyance includes all of the SWP-CVP improvements listed under Configurations 1B and 1C, as well as the North Delta channel improvements listed under Configuration 2A.

South Delta Modifications would provide for increasing the permitted capacity of existing export pumps up to their physical capacity. These improvements include:

- A new Clifton Court Forebay intake structure; and
- An operable barrier or equivalent at the head of Old River to maintain a positive flow down the San Joaquin River. Downstream flow/stage control structures would not be constructed.

A 15,000-cfs isolated facility would provide improved operational flexibility for use in conjunction with the through-Delta improvements. The isolated facility includes:

- New screened intake at Hood;
- Pumping plant to open channel;
- 2,000-foot-wide alignment from Hood to Clifton Court Forebay along the eastern side of the Delta;
- 15,000-cfs open channel from Hood to Clifton Court Forebay; and
- Relocation/replacement of existing improvements displaced by the new facility.

Configuration 3H. Configuration 3H combines and integrates the six alternative elements with modified conveyance in the north and south Delta designed for water conveyance and significant habitat restoration with a small (5,000-cfs) isolated facility constructed as an open channel, and surface and groundwater storage. The 5000-cfs facility is the same as the one described for Configuration 3A. The configuration is the same as Configuration 3A with respect to the Water Quality Program and Water Use Efficiency Program. The storage is the same as Configuration 3B, except that it doesn't include in-Delta storage.

Ecosystem Restoration. Configuration 3H would implement the entire ERP with these modifications:

- Changes in environmental water flows would be met through purchase of existing water from willing sellers and use of the new storage allocated to environmental water supplies.
- The modification of the Mokelumne River Floodway with setback levees, conversion of Bouldin Island and Tyler Island to aquatic habitat, and construction of the East Delta Wetlands Habitat.
- Portions of identified south Delta habitat will be incorporated with the setback levees along Old River.

Levee System Integrity. Configuration 3H would implement the entire Levee System Integrity Program with these modifications:

- The program would be adjusted to accommodate the new setback levees and the flooding of McCormack-Williamson Tract, Bouldin Island, Tyler Island, and tracts along the eastern side of the South Fork Mokelumne River.

Storage and Conveyance. Conveyance includes all of the South Delta habitat modifications and SWP-CVP improvements listed under Configurations 1B and 1C.

Tyler Island Aquatic Habitat provides habitat and flow control into the central Delta. Modifications include:

- Construction of setback levee, 500 feet west of Georgiana Slough, from the Sacramento River to weir intake into the central Delta;
- Construction of 600-foot-wide inflatable rubber dam to control weir elevation to control water flow;
- Construction of channel section control in Georgiana Slough to prevent accelerated erosion of channel bottom; armor with riprap or gabion baskets;
- Breaching 2,000-foot-long section of Tyler Island levee on northeast side of island; and
- Ripraping all remaining interior levee slopes.

Mokelumne River Floodway and East Delta Wetlands Habitat (channel modifications along the South Fork Mokelumne River) provide for conveyance and significant expansion of habitat. These modifications include:

- Breaching McCormack-Williamson Tract levee to flood island for shallow water habitat and water conveyance;
- Construction of setback levees on New Hope Tract about 2,000 feet east of existing alignment from Mokelumne River to Beaver Slough;
- Removal of segments of the eastern levee along South Fork Mokelumne River to provide new flooded habitat, such as Canal Ranch and Brack Tracts (protect interior levee slopes);
- Construction of setback levees on Terminous Tract about 2,000 feet east of existing alignment;
- Construction of setback levees on Staten Island, south of Sycamore Slough, about 4,000 feet west of existing alignment; and
- Removal of portions of Bouldin Island levee to flood the island for conveyance and habitat. Protect interior levee slopes.

Configuration 3I. Configuration 3I combines and integrates the six alternative elements with three new diversion locations for Tracy and Banks pumping plants and surface and groundwater storage. The new diversions could be used separately or in combination to provide increased operational flexibility. One new in-Delta water storage facility would receive water from one of these new diversions. The configuration also includes new fish screens at the Tracy and Banks pumping plants, and an intertie between the pumping plants. The Water Quality and Water Use Efficiency programs are the same as Configuration 3A. The storage is the same as Configuration 3H.

Ecosystem Restoration. Configuration 3I would implement the entire ERP with these modifications:

- Changes in environmental water flows would be met through purchase of existing water from willing sellers.
- Shallow water habitat identified for the Delta would be located in the eastern Delta by breaching select portions of the east levee along the South Fork Mokelumne River and protecting interior levee slopes.
- Habitat restoration identified for the south Delta area near the new diversion locations would be relocated to the northern and western Delta.

Levee System Integrity. Configuration 3I would implement the entire Levee System Integrity Program with these modifications:

- The Program would be modified to accommodate the isolated channels, and associated levees, leading from the new diversion locations to Clifton Court Forebay.

- Levees selected for breaching, and the associated flooded land, along the eastern side of the South Fork Mokelumne River would not be improved to reduce flood risk.

Storage and Conveyance. Three isolated conveyance channels would convey water to Clifton Court Forebay and the Tracy Pumps from two locations on the San Joaquin River and one on Old River near Franks Tract. An intake at Hood is also included. The New Diversion Locations would provide the flexibility to divert water from different parts of the Delta depending on need and operating criteria at the time.

The western 15,000-cfs isolated south Delta Intake would include:

- Intake on Holland Tract near the south side of Franks Tract;

- Setback levee, approximately 500 feet from channel, along western side of Old River;

- Isolated conveyance parallel to Old River and connected to Clifton Court Forebay. The conveyance could serve water users along the alignment;

- Isolated conveyance connected to new in-Delta storage on Holland Tract. The intake would be constructed to allow diversion out of the storage (may require pumps) or directly out of the Delta channel; and

- Relocation/replacement of existing improvements displaced by the new facility.

Northern 15,000-cfs isolated south Delta Intake would include:

- Intake from San Joaquin River at northern end of Lower Roberts Island;

- Isolated conveyance to Clifton Court Forebay. The conveyance could serve water users along the alignment; and

- Relocation/replacement of existing improvements displaced by the new facility.

The eastern 5,000-cfs isolated south Delta Intake would include:

- Intake from San Joaquin River at southern end of Upper Roberts Island;

- Isolated conveyance to Clifton Court Forebay. The conveyance could serve water users along the alignment; and

- Relocation/replacement of existing improvements displaced by the new facility.

Northern 15,000-cfs isolated Sacramento River Intake would include:

- Screened Intake from Sacramento River at Hood;

- Isolated conveyance to the diversion on the San Joaquin River;

- Siphon under the San Joaquin River; and

- Relocation/replacement of existing improvements displaced by the new facility.

South Delta Modifications would provide for increasing the diversion capacity of existing export pumps up to their physical capacity. These modifications include:

- A new Clifton Court Forebay intake structure.

This configuration also includes the SWP-CVP improvements listed under Configurations 1B and 1C.

2.3.3.4 Alternatives Not Carried Forward for Further Evaluation

In addition to the 12 configurations considered in this Programmatic EIS/EIR, five others were

considered but eliminated from detailed study, which is consistent with the directions contained in the California Environmental Quality Act Guidelines and the Council of Environmental Quality's Regulations for implementing National Environmental Policy Act.

Alternatives were eliminated based on the results of a narrowing process. The primary focus of the narrowing process was technical deficiencies and the conveyance options used in each alternative. Additionally, if alternatives provided the same conveyance function with similar impacts, the less expensive alternatives were retained. Alternatives with lower costs but higher adverse impacts were eliminated. The following process and recommendations from technical work groups, operational modeling results, engineering prefeasibility studies, preliminary information from impact analysis, preliminary cost estimates, and other information were used in the evaluation:

- Identify and eliminate technical problems not evident when the alternatives were formulated and which severely limit an alternative's success.
- Identify alternatives with engineering/ technical problems which must be resolved for the alternatives to proceed.
- Modify each alternative, if possible, to remove the technical problems.
- If modifications to the alternative cannot solve the problem, the alternative is not practicable and will be eliminated.
- Reduce the number of alternatives that achieve the same Delta conveyance function.
- Identify alternatives that meet Program objectives approximately the same and achieve the same Delta conveyance function.
- Use engineering/technical and cost evaluations to compare the Delta conveyance. Consider adverse impacts of each alternative. If one alternative has significantly higher costs for conveyance and/or greater adverse impacts while achieving similar functions, it is not practicable and will be eliminated from further consideration.

Using the above criteria, five Configurations (2C, 3C, 3D, 3F, and 3G) were eliminated from further analysis.

Configuration 2C. The Multiple Intakes Conveyance Option in Configuration 2C would utilize three isolated conveyance channels to convey water to the Clifton Court Forebay from two diversion locations on the San Joaquin River and one on Old River near Franks Tract.

Configuration 2C was eliminated because the alternative would have to be modified to remove technical problems, but even then it would have been difficult to hydraulically control the three water diversion "arms." Fish screens had to be added to the alternative to control for fish entrainment at the pumps. The screens are costly because they would require elaborate flow structures for the intake facilities. This alternative is very expensive, with a total of $2.281 billion and a monitoring cost of $2.4 million. Configuration 3I includes the same multiple Delta intake option, as well as options that address Configuration 2C's possible impacts to anadromous fish and it allows for more operational flexibility.

Configuration 3C. Configuration 3C utilizes a buried pipeline isolated facility to convey 5,000 cfs from a diversion on the Sacramento River at Hood along the eastern Delta to Clifton Court Forebay. No new storage is included in this alternative.

Configuration 3C was eliminated because Configuration 3A provides the same conveyance function at less cost. The alternatives are identical, except Configuration 3C proposed a pipeline isolated facility while Configuration 3A proposes an open channel. Configuration 3A will cost $857 million, while Configuration 3C will cost $2.067 billion. The consequences of the pipeline are very similar to those of a channel, and therefore the elimination of the pipeline did not result in the loss of an environmentally preferred

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alternative from study. The pipeline portion of Configuration 3C will be evaluated in a "sidebar" analysis.

Configuration 3D. As in Configuration 3C, Configuration 3D utilizes a buried pipeline isolated facility to convey 5,000 cfs from a diversion on the Sacramento River at Hood along the eastern Delta to Clifton Court Forebay. It differs from 3C in that it includes new storage.

Configuration 3D was eliminated because Configuration 3B provides the same conveyance function at less cost. The alternatives are identical, except Configuration 3D proposed a pipeline isolated facility while Configuration 3B proposes an open channel. Configuration 3B will cost $857 million, while Configuration 3D will cost $2.067 billion. The pipeline portion of Configuration 3D will be evaluated in a "sidebar" analysis.

Configuration 3F. Configuration 3F, or "Chain-of-Lakes," utilizes a connected chain of up to eight lakes, created by flooding Delta islands, that would convey water via siphons beneath Delta channels to Clifton Court Forebay.

Configuration 3F was eliminated because of issues related to environmental damage, logistics, and cost. A major drawback of this configuration is the Delta land use conversion it entails. Approximately 37,000 acres of land would be required for the creation of the chain of lakes. This is also an environmental concern because some of this land (primarily on the water side of levees) currently provides aquatic habitat. The land currently in agricultural use has habitat value for terrestrial wildlife species, and some of this land is intended for habitat restoration under the ERP. In addition to the land use conversion concerns, this configuration also creates a logistical concern related to achievement of water quality objectives because the storage of water on Delta peat soils may create total organic carbon problems for urban water users. Finally, this alternative is estimated to cost approximately $2.4 billion compared to a cost of $1.7 billion for Configuration 3E, which provides similar water storage and conveyance functions with fewer associated adverse environmental impacts.

Configuration 3G. Configuration 3G, the Western Delta Isolated Conveyance Facility, utilizes the Deep Water Ship Channel, and a western Delta conveyance pipeline, tunnel, and channel to convey 5,000 cfs from the intake on the Sacramento River near Sacramento to Clifton Court Forebay.

Configuration 3G was eliminated because the cost of Configuration 3G is estimated at $2.3 billion, substantially more than the estimated $0.9 billion for Configuration 3B, which provides very similar water conveyance benefits and has very similar environmental impacts.

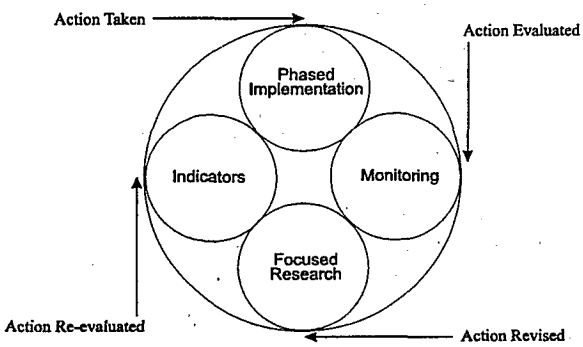
2.3.3.5 Adaptive Management

Adaptive management is the process of adjusting or refining management actions as a process unfolds and results are obtained. It is an interactive approach to decision making that incorporates feedback loops to evaluate actions and inject new information, as it becomes available. Adaptive management begins by implementing the actions most likely to achieve implementation objectives, given today's knowledge. Experimental management is included where improved knowledge is essential. Results are monitored and actions modified as necessary to achieve management goals.

Because of the difficulties and uncertainties involved in the implementation of the CALFED objectives and programs, adaptive management has been suggested and widely adopted as a standard approach. Adaptive management is a key component of the CALFED Program as it provides a decision support system for stakeholders and resources managers. Adaptive management addresses risks and uncertainties by increasing opportunities to redirect management with new information.

To succeed, an adaptive management program should include objectives for key resource indicators, and actions with target implementation levels. Implementation objectives should be well

Adaptive Management



defined, and should not be adjusted in the event success is not achieved. Only targets, specific actions, and the implementation approach should be changed. The Program goals should not change, only the treatment program need be changed to ensure that goals are attained. Targets may change as research and monitoring provide more indication as to the inherent relationships between indicators and key resources. Monitoring data are examined and re-examined with these objectives and targets in mind. In addition, effective adaptive management requires well-defined success criteria, long-term comprehensive monitoring plans, comprehensive research plans, and a coordinating management team.

Adaptive management for CALFED has a dual nature:

- First, adaptive management is a philosophical approach towards restoration that acknowledges that a better understanding of the Bay-Delta watershed is needed if the program is to succeed. It acknowledges that the CALFED Program will proceed using existing information, while additional knowledge is gathered. Although much is known about the resources affecting the Bay-Delta, additional information is needed to successfully restore its health. The adaptive management philosophy accommodates the status of knowledge and provides an avenue to obtain the necessary knowledge (and experience) through the duration of the implementation period.
- Second, adaptive management is a structured decision making process. The process includes important components to identify key system indicators; a program for monitoring indicators; a program for implementing focused research to gather new or additional information; a phased implementation and optimization process; a feedback process to integrate knowledge gained from monitoring and research; and the flexibility to change the program in response to new information. In its practical application, adaptive management must be strongly based on the scientific method and its ultimate success lies in the integration of scientific information and technical evaluations.

Adaptive management provides for flexibility in the CALFED Program. It allows a step-by-step approach where solutions can be implemented in phases for cost or technical reasons. Flexibility comes from an ability to adjust the Program as needed.

2.3.3.6 Implementation Strategy

Due to the complexity of the Bay-Delta system, the scope of the Bay-Delta solution, and the cost associated with implementing the solution, the preferred program alternative will be implemented in stages over a number of years. Staged implementation reflects the different time scales associated with different program components. Certain elements of the Bay-Delta solution, such as potential storage and conveyance facilities, require more time to be designed, environmentally reviewed, and constructed while other program components, such as certain ecosystem restoration or water use efficiency actions, can be implemented sooner. Staged implementation also allows project costs for program components to be spread over time so as to distribute the financial burden.

However, staged implementation also stimulates concern that program components may not be implemented in the future as outlined in the preferred program alternative. There is general concern that program components slated for later

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implementation may suffer from inadequate funding in the future, or key stakeholder groups engaged in the collaborative process may withdraw their support in the future. Such potential future threats could negate the extensive efforts by agency personnel and stakeholders to reach consensus over contentious issues through the CALFED Bay-Delta collaborative process. An assurances package, then, must provide adequate assurance that program components will be implemented as planned.

In August 1996, the Bay Delta Advisory Council Assurances Workgroup was convened to formulate, discuss, analyze, and recommend to the BDAC appropriate mechanisms to assure implementation of the long-term Bay-Delta solution identified by the CALFED process. The BDAC Assurances Workgroup completed five stages of developing assurances. The five stages are:

- Identify assurance needs and issues by program components;
- Identify the assurance concern by stakeholder groups;
- Compile a list of assurance tools and methods;
- Develop guidelines for evaluating assurance tools and methods; and
- Develop a preliminary package of assurances.

Having identified assurance concerns and needs and assessed assurance tools and mechanisms, Program staff and stakeholders began developing preliminary packages of assurances. The preliminary assurance packages include assurance tools and mechanisms that garnered support from agency personnel and stakeholders. For assurance tools and mechanisms that did not attract consensus among agency personnel and stakeholders, the packages present a range of options with accompanying rationale so that decision makers could select the appropriate assurance mechanisms in the future.

The following section describes a preliminary list of tools and methods of assurances available to meet the assurance needs and stakeholders' concerns developed by the BDAC Assurances Workgroup.

- Federal and State constitutional amendments
- Financing mechanisms
- Federal and State statutes
- Bond measures
- State voter referenda
- Market incentives
- Federal and State regulations
- Physical constraints
- Federal and State judicial actions
- Parallel implementation
- President's and Governor's executive order
- Public oversight/public involvement process
- Administrative agency orders
- Contracts
- New institutions
- Memoranda of understanding/agreement
- Multiple species protection plans
- Joint powers agreements
- Programmatic permitting

2.4 RELATIONSHIP WITH OTHER ONGOING PROGRAMS

Due to the extent of the CALFED study area, there are many activities and studies that are currently on-going or planned for the near future that could be affected by the actions of the CALFED program. Related studies and projects that have been conducted recently or are currently being completed are summarized in the following discussion.

Water Rights Process for CVP and SWP State Water Resources Control Board

As a follow-up to adopting the 1995 Water Quality Control Plan in 1995, the SWRCB is evaluating alternatives for implementing that plan. This process may increase the amount of water provided by other water rights holders to meet Bay-Delta Water Quality Standards, and/or it may change Delta export criteria. Therefore, operations of upstream projects may change.

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Because the outcome is not complete, a conservative assumption was used in modeling for the EIS/EIR. It was assumed that the Bay-Delta Plan Accord criteria would be the long-term plan for the Delta. The SWRCB is completing an Environmental Impact Report as part of this process. If instream flows provided by the other water rights holders increases, some portion of the Ecosystem Restoration Program environmental flows could be satisfied by this Water Rights Process. This may reduce the amount of water that the Program needs to acquire from willing sellers. It may also reduce the amount of water that the Program needs to develop or may allow for the developed water to be used more effectively in meeting Program objectives. Any additional demand on water right holders could decrease the amount of water available for transfer.

Central Valley Project Improvement Act
U.S. Bureau of Reclamation

On October 30, 1992, the President signed into law the Reclamation Projects Authorization and Adjustment Act of 1992 (Public Law 102-575) that included Title XXXIV, the Central Valley Project Improvement Act (CVPIA). The CVPIA amends previous authorizations of the Central Valley Project to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses and fish and wildlife enhancement as a project purpose equal to power generation. Four provisions of the Act were included in the No Action Alternative for the EIS/EIR for the CALFED Bay-Delta Program:

- Dedication of 800,000 acre-feet for fish and wildlife purposes;
- Delivery of Level IV water amounts to State and Federal refuges;
- Shasta Temperature Control Device; and
- Restoration Fund and Friant Division Surcharge.

The Ecosystem Restoration Program for CALFED is inclusive of the remaining ecosystem restoration provisions of CVPIA. The CALFED Program seeks to improve overall system reliability. The Program's objective of improving water reliability may help to offset any agricultural water impacts due to dedication of the 800,000 acre-feet.

Place of Use EIR for CVP Water Supplies
U.S. Bureau of Reclamation/SWRCB

Some areas adjacent to the existing CVP service area have been served with CVP water. This process considered the impacts of expanding the SWRCB designated Place of Use for CVP water to include these areas. The SWRCB and U.S. Bureau of Reclamation (USBR) are preparing the EIR as part of the approval process. The modeling for this Draft EIS/EIR assumes that this process will be completed by the year 2020 to include lands currently receiving CVP water. If, it is not completed and approved, water would need to be used within the existing CVP service area. This may marginally increase the reliability of CVP deliveries and thereby marginally increase the overall reliability of the CALFED Program. The SWRCB is considering expanding the CVP Place of Use during its water quality plan implementation process.

Trinity River Studies
U.S. Fish and Wildlife Service

In October 1984, the USFWS began a 12-year study to describe the effectiveness of increased flows and other habitat restoration activities to restore fishery populations in the Trinity River. An EIS/EIR is being prepared under a concurrent program to evaluate alternatives to restore and maintain natural production of anadromous fish in the Trinity River mainstem downstream of Lewiston Dam. Approximately 1 million acre-feet of water annually has been diverted from the Trinity River to the Sacramento River system. While the Trinity River is outside the CALFED study area, a change in the Trinity River flow requirements and a corresponding change in the amount diverted to the Sacramento River system could affect future flows to the Delta and overall water supply reliability as well as carryover storage in Shasta Reservoir and water quality and temperature in the Sacramento River. Trinity

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River actions are being discussed in the cumulative impact section, Chapter 9.

Bulletin 160-98, California Water Plan Update
Department of Water Resources

Bulletin 160, updated every 5 years by the Department of Water Resources, contains estimates of future water demands in the state. Modeling for the CALFED Bay-Delta Program EIS/EIR used the most recent demand estimates (being prepared for 160-98) for year 2020 for the No Action Alternative and the Program alternatives.

Sacramento and San Joaquin River Basins Comprehensive Study
U.S. Army Corps of Engineers

The Federal Government and the State of California have recognized the need for a comprehensive approach to flood plain management as described in reports such as the 1997 Governor's Flood Emergency Action Team (FEAT) Report, Federal Public Law 87-874, and the 1998 Energy and Water Development Appropriations Bill.

The Sacramento and San Joaquin River Basins Comprehensive study is addressing the general objectives of flood damage reduction and ecosystem restoration. The study will ultimately have implementation plans for long-range management of the entire river system. The study will include consideration of the full range of structural and non structural flood damage reduction measures, as well as the diverse, but interrelated, water and land management objectives. The study will be fully coordinated and compatible with other related programs and will contribute directly towards meeting the goals of the CALFED Levee System Integrity Program in the Delta. Phases I and II of this study are part of the No Action Alternative.

Long-Term Management Strategy (LTMS)
U.S. EPA/Corps of Engineers/SWRCB, RWQCB, BCDC

Coastal managers have long expressed concern about environmental threats of disposing large volumes of sediments in ecologically sensitive areas. The LTMS's long range goals are to reduce disposal in the Estuary and to instead find beneficial uses for the dredged material. The Strategy has already resulted in designation of a deep ocean disposal site 50 miles offshore of San Francisco that is an ecologically superior alternative to disposal in the Estuary itself. Since use of the ocean disposal site began in late 1995, over 4 million cubic yards of dredged material have been diverted from disposal in the Bay, and overall Bay disposal has dropped from historic averages of about 6 million cubic yards annually, to approximately 2-½ million cubic yards.

However, this is the short-term approach until beneficial use projects can be initiated. Dredged material can be reused in a variety of ways, including levee maintenance and stabilization, or restoration of habitat such as tidal wetlands. Using clean sediments from dredging projects, the LTMS agencies have participated in pilot levee maintenance projects and have constructed the Sonoma Baylands wetland restoration project. LTMS is now considering other projects, and other ways of beneficially reusing dredged material. A specific policy of the LTMS is to pursue habitat restoration projects that are consistent with habitat goals and plans worked out in other venues, including CALFED. Of particular interest are the cost-sharing opportunities working with the Corps of Engineers and other dredgers who must pay for the dredging in any event. These parties are in a position to provide the clean material to restoration projects much more efficiently than if the restoration project were to acquire the material on its own.

CALFED and LTMS will coordinate during CALFED Program Implementation on potential joint levee construction and habitat restoration projects.

C-005191

C-005191

Vernalis Adaptive Management Plan USBR/USFWS

The May 1995 State Water Resources Control Board's (State Board) Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta Estuary contained water quality and flow objectives pertaining to the San Joaquin River basin. During 1997, the USBR acquired water within the San Joaquin River system to help meet the WQCP's flow objectives. In an effort to refine the science for the flow objective, the San Joaquin River interests collaborated to identify feasible actions to protect the River's fish resources and to implement the State Board's flow objectives. This collaboration led to a proposed scientifically-based adaptive fishery management plan known as the Vernalis Adaptive Management Plan (VAMP). The VAMP will provide protective measures for fall-run chinook salmon and will gather scientific information on survival of salmon smolts through the Delta. The VAMP will be implemented through experimental flows on the San Joaquin River and export pumping rates with a temporary Old River fish barrier during the one-month period each year, from approximately April 15 to May 15. Additional attraction flows are targeted for October.

The VAMP includes proposed water acquisition in the form of a pulse flow at Vernalis during the April and May period and other flows identified to meet anadromous fish flow objectives. VAMP flows should have beneficial effects for Delta smelt. Water will be acquired from willing sellers by the USBR on the San Joaquin River and its tributaries.

The San Joaquin River Group Authority, USBR, and the USFWS will participate in preparation of and EIS/EIR for the VAMP. The draft document should be available for public review in September-October 1998. The VAMP will directly contribute to meeting the restoration goals of the CALFED ERP. The VAMP is included in the No Action Alternative.

Colorado River Board's California 4.4 Plan

The rights of seven states (including California), and Mexico to use Colorado River water is governed by a series of agreements, treaties, laws, and court decisions, collectively referred to as the "Law of the River". California is entitled to 4.4 MAF of water in a normal year. Agriculture has first priority to about 90% of California's entitlement; the balance goes to the Metropolitan Water District of Southern California (MWD) which operates the Colorado River Aqueduct to deliver to urban users.

Historically, California has used more water than its entitlement. California's use above its entitlement has been made possible through a reallocation of unused water from Arizona's and Nevada's entitlements. In 1997, the Colorado River provided about 5.2 million MAF of the 8.4 MAF of water used in southern California. The Secretary of the Interior has directed California to come up with a plan to live within its entitlement of 4.4 million acre-feet of water per year.

The Secretary of the Interior has advised California that, absent a plan on how it can live within its entitlement, he will be less likely beginning in 1999 to make water available to California above its entitlement. If California has an acceptable plan for living within its entitlement, the Secretary could make water available to the state beyond its entitlement through a water surplus declaration.

The Colorado River Board, with assistance from the Director of Water Resources, is responsible for developing the California plan. The board's draft plan (dated August 11, 1997) includes the following major components, all of which are focused on changes in the use, supply, or transfer of Colorado River water. The plan relies first on a variety of intrastate measures which either conserve water or increase water supplies. The plan then relies on measures which would make extra water available to California. These include purchasing water from other states and revising the river's reservoir operations. Adoption of these measures is contingent on preapproval or other

action by the Secretary since other basin states would be affected.

If California were to live within its 4.4 MAF entitlement today, the immediate impact would fall mostly on the MWD because almost all of the allocation to California above its entitlement now goes to urban users serviced by the MWD. Since the draft California plan focuses on changes in use, supply, or transfer of Colorado River water, CALFED has assumed the plan will NOT lead to additional demand on Delta water.

Imperial Irrigation District and San Diego County Water Authority Water Transfer

Depending on local conditions, San Diego County obtains 75 to 95% of its water from MWD which imports water from the Colorado River and northern California. The San Diego County Water Authority (SDCWA) has negotiated and agreement for the long-term transfer of conserved water from the Imperial Irrigation District (IID) to the San Diego region. Under the negotiated contract, IID and its agricultural customers would conserve water and sell it to the Authority for at least 45 years. Either agency may extend the contract for another 30 years beyond the initial term. Deliveries in the first year of the contract would total 20,000 acre-feet and increase annually in 20,000 acre-foot increments until they reach a maximum of 200,000 acre-feet. The two agencies may agree to transfer an additional 100,000 acre-feet per year after year 10. SDCWA has also been negotiating with MWD for use of the Colorado River Aqueduct to deliver the water which would result from a water transfer agreement with IID.

These agreements could play a significant role in helping the Colorado River Board develop a plan that allows California to live within its 4.4 MAF water entitlement from the Colorado River. CALFED has assumed that these agreements will NOT change demand for Delta water.

Category III

In December 15, 1994, the Bay-Delta Accord included a commitment to develop and fund non-flow related ecosystem restoration actions to improve the health of the Bay-Delta ecosystem. This commitment is commonly referred to as Category III. Some of the specific non-flow factors identified to be addressed as part of the Category III commitment include unscreened water diversions, waste discharges and water pollution prevention, fishery impacts due to harvest and poaching, land derived salts, exotic species, fish barriers, channel alternations, loss of riparian wetlands, and other causes of estuarine habitat degradation.

While the details of the preferred alternative are not finalized, Category III actions can be beneficial to the long term program regardless of which alternative is selected. The Category III actions must be consistent with each of the three alternatives and provide early implementation benefits. This implementation will also provide valuable information for use in adaptively managing the system in later years of the program. Category III projects must have appropriate environmental documentation, have no significant adverse cumulative impacts, and must not limit the choice of a reasonable range of alternatives.

Funding sources for near-term restoration activities include $60 million from state Proposition 204 funds (Bay-Delta Agreement Program) and 1997 stakeholder contribution of $10 million to fund the Category III ecosystem restoration commitments in the Bay-Delta Accord, bringing the stakeholder total to more than $30 million. In addition, Congress authorized $430 million for fiscal years 1998, 1999, and 2000 to fund the federal share of Category III and initial implementation of the ERP. In federal fiscal year 1998, $85 million was appropriated for Bay-Delta ecosystem restoration. Proposition 204 also include $390 million for implementation of the ERP, however, this funding will not be available until after the EIS/EIR is final.

CALFED established a two step process to evaluate and select the 1997 Category III proposals. In addition, public input was obtained via the Bay Delta Advisory Council. Thirteen technical review panels, organized by subject, scored and evaluated each of the 332 proposals.

The evaluation sheets were passed onto the Integration Panel, comprised of state, federal, and non-agency representatives, whose task was to select the highest priority proposals based on the benefits to the priority species and habitats. Targeted species include anadromous fish, Delta native fish and migratory birds.

On December 17, 1997, the CALFED Bay-Delta Program announced more than $100 million in funding for 50 ecosystem restoration projects selected from proposals. This included approximately $60 million of CALFED awards using Proposition 204, federal and stakeholder funds, with more than $40 million in cost sharing from project proponents. About three-fourths of the money was devoted to projects that restore ecological health of rivers and riparian forests and for wetlands and marsh restoration. The remainder went to projects such as installing fish screens to keep endangered fish from being pumped out of rivers; preventing the introduction of exotic species into the wild; water quality monitoring and research; educating farmers on how to improve farming practices to lessen reliance on pesticides; and research on endangered species such as delta smelt.

Projects to be funded in 1998 will be developed in three ways. They can be drawn from the remaining proposals submitted in 1997, developed as designated actions to develop and fund a proposal from a specific entity, or they can be implemented as focused grants. Currently, $21.6 million in additional proposals are being approved through the process. Approximately $48.5 million in remaining funds will be used to fund designated actions and to support focused grants. The advertising for the focused grants should begin in March 1998.

For 1999 funding, CALFED will be working to revise and update the priorities to ensure that they are consistent with the ERPP and to build on restoration actions funded to date. These revised priorities will guide development of restoration actions.

3 SUMMARY COMPARISON OF THE ENVIRONMENTAL CONSEQUENCES

The environmental consequences of the three CALFED program alternatives are summarized in Table 3-1, for each environmental resource category included in this Programmatic EIS/EIR. The affected environment and environmental consequences of the program alternatives are described in detail in Chapters 6, 7, and 8. The information in this table provides a brief synopsis and summary comparison of the adverse and beneficial impacts of the No Action Alternative and CALFED Program Alternatives 1, 2, and 3. In general, the impacts to each resource resulting from the storage and conveyance program element would vary by alternative. The impacts resulting from program elements other than storage and conveyance would be less sensitive to the alternative selected. Therefore, in Table 3-1, the impacts associated with storage and conveyance are described separately for each alternative, and the other program elements are not grouped by alternative. For details of how each of the Program elements is affected by the various alternatives, please see Chapters 6, 7, and 8 of this Programmatic EIS/EIR.

Environmental Resource Category	ENVIRONMENTAL CONSEQUENCES OF CALFED BAY-DELTA PROGRAM ALTERNATIVES				
	No Action Alternative	Storage and Conveyance			Other Programs
		Alternative 1	Alternative 2	Alternative 3	
PHYSICAL ENVIRONMENT					
Surface Water Resources					
Bay-Delta Hydrodynamics and Riverine Hydraulics	Minor changes in stream flow in the rivers and Bay-Delta as a result of increased demand.	Small to moderate increases occur in mid-range Sacramento River flows due to increased releases from storage for 1C. Little change in Delta circulation patterns for 1A and 1B for Alternative 1, but increased south Delta pumping in 1C leads to small increases in magnitude of reverse flows in central Delta.	Small to moderate increases occur in mid-range Sacramento River flows due to increased releases from storage for 2B, 2D, and 2E. Potential reduction in through-Delta flow velocities (greater residence time) and reductions in frequency of reverse flows associated with changes in channel geometry and distribution of Delta inflow.	Small to moderate increases occur in mid-range Sacramento River flows due to increased releases from storage for 3B, 3E, 3H, and 3I. Reduction in north Delta inflow, reduced frequency of reverse flows in San Joaquin River, and substantially reduced influence of south Delta pumping on Delta circulation pattern.	Ecosystem Restoration pulse flows and Delta outflow targets result in potentially substantial short term increases in Sacramento River and San Joaquin River flows during selected periods from March to May.
Water Quality	Gradual deterioration in Delta water quality.	Shift in timing of Delta inflow results in some improvements in Delta water quality for 1C. Improvements are offset by increased south Delta pumping. No change in water quality for configurations without storage component.	Reduction in salinity and bromide concentrations due to improved circulation pattern and shift in timing of Delta inflow with storage component. Water temperature may increase in east Delta from channel widening for habitat improvements. Temperature effects partially offset by shading.	Quality of water exported to SWP-CVP Area South of Delta improves substantially with isolated facility because water is taken from Sacramento River instead of Delta. Salinity increases, however, at Rock Slough.	The Ecosystem Restoration and Levee System Integrity programs significantly increase sediment loading and turbidity during construction and initial operation. Substantial potential benefits from source control measures of the Water Quality Program in all regions.

Table 3-1. Summary of Environmental Consequences of CALFED Program Actions (page 1 of 10)

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Environmental Resource Category	ENVIRONMENTAL CONSEQUENCES OF CALFED BAY-DELTA PROGRAM ALTERNATIVES				
	No Action Alternative	Storage and Conveyance			Other Programs
		Alternative 1	Alternative 2	Alternative 3	
Water Supply and Management	Increased demand, no additional supply, and increased allocation to instream flows under results in increased unmet urban and agricultural demand.	Increased availability and reliability with 1C.	Increased availability and reliability with 2B, 2D, and 2E.	Increased availability and reliability for all 3B, 3E, 3H, and 3I. In addition, isolated facility conveyance reduces sensitivity of export's quantity and quality.	Levee System Integrity Program increases water supply reliability
Groundwater Resources	Increased groundwater use and potential adverse impacts.	Additional surface water and groundwater storage which would potentially reduce the significant adverse impacts to groundwater resources throughout all regions as compared to No Action.	Impacts similar to those described under Alternative 1.	Impacts similar to those described under Alternative 1.	Ecosystem Restoration, Water Quality, and Levee System Integrity programs would increase groundwater recharge. The Water Use Efficiency and water transfer program can result in greater reliance on groundwater resources during dry periods, and potential reductions in groundwater recharge, both potentially adversely impacting groundwater resources for 3rd party users.
Geology and Soils	Conditions are expected to be similar in type but of greater magnitude than existing conditions due to continued soil erosion, sediment contamination, subsidence, and channel degradation.	Reduced channel erosion and sedimentation in the Delta Region through channel enlargements. Applied salt loads would be reduced in the Delta and San Joaquin River regions under all alternatives due to increased flows from additional storage facilities.	Reduced potential for erosion of channel, levee, and interior island soils through levee setbacks and shallow flooding of Delta island interiors. Applied salt loads would be reduced in the Delta and San Joaquin River regions under all alternatives due to increased flows from additional storage facilities and Water Use Efficiency.	Impacts similar to those described under Alternative 2.	Ecosystem Restoration is expected to have beneficial long-term effects in all geographic regions except the SWP and CVP Service Areas with respect to soil erosion, geomorphology, and sediment transport. The Water Use Efficiency program is expected to reduce erosion from agricultural lands. Coordinated Watershed Management efforts may have adverse short-term impacts on surface soil and channel erosion in

Table 3-1. Summary of Environmental Consequences of CALFED Program Actions (page 2 of 10)

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C-005197

Environmental Resource Category	ENVIRONMENTAL CONSEQUENCES OF CALFED BAY-DELTA PROGRAM ALTERNATIVES				
	No Action Alternative	Storage and Conveyance			Other Programs
		Alternative 1	Alternative 2	Alternative 3	
Geology and Soils (continued)					the Sacramento San Joaquin watersheds, but are expected to have beneficial long-term impacts on stream geomorphology by reducing sediment inputs from hillslope, bank, and channel erosion.
Noise	Conditions are forecast to be similar to existing conditions.	Construction of storage facilities in 1C is expected to result in overall greater potential noise effects but would not be significant in any region.	Impacts are expected to be similar to Alternative 1 for 2B, 2D, and 2E.	Impacts are expected to be similar to Alternative 1 for 3B, 3E, 3H, and 3I. In addition, construction of the isolated facility would generate noise.	Construction activities associated with the Ecosystem Restoration Program, and Levee System Integrity would not cause significant noise impacts in any region.
Transportation	Conditions are forecast to be similar to existing conditions, but traffic demands and traffic volume on existing roadways are expected to increase.	Significant but mitigable short- and long-term impacts to roads where construction of levee and storage and conveyance improvements may cause re-routing or temporary closure of some traffic routes for 1C.	Impacts similar to those described under Alternative 1, for 2B, 2D, and 2E.	Impacts similar to those described under Alternative 1, for all configurations except 3A.	Construction activities associated with Ecosystem Restoration and Levee System Integrity improvements may cause significant short-term impacts to roadways and traffic routes if detours or road closures occur.
Air Quality	Conditions are forecast to be similar to existing conditions.	Significant but mitigable short-term adverse air quality effects in the Sacramento and San Joaquin River Regions from construction of storage facilities for 1C.	Impacts are expected to be similar to Alternative 1, for 2B, 2D, and 2E. Other short-term impacts would occur as a result of construction of conveyance facilities.	Impacts from construction of storage facilities are expected to be similar to Alternative 2, for 3B, 3E, 3H, and 3I, All configurations would have impacts associated with construction of conveyance facilities.	Construction activities associated with Ecosystem Restoration and Levee System Integrity, improvements are not expected to cause significant air quality impacts in any region.

Table 3-1. Summary of Environmental Consequences of CALFED Program Actions (page 3 of 10)

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C-005198

Environmental Resource Category	ENVIRONMENTAL CONSEQUENCES OF CALFED BAY-DELTA PROGRAM ALTERNATIVES				
	No Action Alternative	Storage and Conveyance			Other Programs
		Alternative 1	Alternative 2	Alternative 3	
BIOLOGICAL ENVIRONMENT					
Fisheries and Aquatic Ecosystems	Conditions would be similar to existing conditions, although increased input of contaminants and increased Delta exports would adversely affect some aquatic organisms.	Adverse impacts, including increased entrainment loss, reduced productivity, and delayed migration of fish species could result from diversion to new off-stream storage (1C) and increased exports. Construction of new storage facilities would have potentially adverse impacts on spawning and rearing habitat.	Impacts would be similar to those for Alternative 1, for 2B, 2D, and 2E. Additional adverse impacts would include increased entrainment, reduced Delta productivity, reduced survival of aquatic outmigrants and habitat loss or degradation. Beneficial impacts would result from Delta flow conditions in the lower San Joaquin river that improve fish migration to the Bay.	Alternative 3 is expected to have greater impacts than Alternative 1 but would have the highest potential for beneficial impacts in the east, central, and south Delta Regions due to reduced entrainment losses, increased productivity and improved aquatic outmigration.	Ecosystem Restoration and Water Quality would improve aquatic habitat and species under all alternatives in all regions except SWP and CVP Service Areas outside the Central Valley. The Water Use Efficiency Program is expected to create ecosystem benefits through reduced diversion entrainment impacts, modifications in flow timing, improved in-stream water quality, and Water Transfers for ecosystem purposes.
Vegetation and Wildlife	Conditions are forecast to be similar to existing conditions.	Minimal adverse impacts on vegetation and wildlife communities, except 1C, which would cause disruption and reduction of habitats from construction and operation of storage facilities.	Greater adverse impacts on vegetation and wildlife for 2B, 2D, and 2E, than 1C, but would provide benefits to some species as a result of the creation of aquatic habitats.	Most adverse impacts on vegetation and wildlife resulting from extensive facility construction; however, the numerous aquatic habitats that are created would benefit numerous species dependent on such areas.	Ecosystem Restoration and Water Quality Program elements would lead to improved habitats under all alternatives. The Water Use Efficiency program may result in adverse impacts to some habitats from reduced surface water runoff. Changes in crop mix as a result of increased efficiencies and Water Transfers may reduce the amount of wildlife friendly crops.

Table 3-1. Summary of Environmental Consequences of CALFED Program Actions (page 4 of 10)

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C-005199

Environmental Resource Category	ENVIRONMENTAL CONSEQUENCES OF CALFED BAY-DELTA PROGRAM ALTERNATIVES				
	No Action Alternative	Storage and Conveyance			Other Programs
		Alternative 1	Alternative 2	Alternative 3	
Land Use, Economics, and Social Environment					
Agricultural Resources					
Agricultural Land and Water Use	Shifts in production from field crops and grains to fruits and vegetables are expected to occur.	Prime and unique farmland and other agricultural lands would be converted to other uses, and potential conflicts between proposed actions and regional land use plans and policies could occur. Storage facilities would potentially increase the amount of water available for agricultural production.	Impacts would be similar but more pronounced than those associated with Alternative 1.	Impacts would be similar but more pronounced than those associated with either Alternative 1 or 2.	Ecosystem Restoration would convert agricultural lands to other uses in the Delta, Sacramento River, and San Joaquin River regions. The Water Quality Program would result in improved water quality of irrigation water, higher crop yields, and greater crop selection flexibility. Retirement of lands in the San Joaquin River region could significantly affect up to 45,000 acres of agricultural land. Levee System Integrity program would convert Delta Region farmland, but provide greater protection to farmland from flooding and salinity intrusion.

Table 3-1. Summary of Environmental Consequences of CALFED Program Actions (page 5 of 10)

C-005200

C-005200

Environmental Resource Category	ENVIRONMENTAL CONSEQUENCES OF CALFED BAY-DELTA PROGRAM ALTERNATIVES				
	No Action Alternative	Storage and Conveyance			Other Programs
		Alternative 1	Alternative 2	Alternative 3	
Agricultural Economics	The cost of water is expected to continue to increase.	Conversion of farmland may result in adverse economic impacts.	Similar but more pronounced effects than Alternative 1.	Similar but more pronounced effects than Alternatives 1 or 2.	Ecosystem Restoration and Coordinated Watershed Management efforts could potentially convert agricultural lands from production, resulting in adverse economic impacts to revenue generation, employment, and local spending. The Water Quality Program would reduce long-term production costs and generate higher crop yields. A loss of jobs and economic income in the San Joaquin River region as lands are retired. Levee System Integrity could potentially convert some agricultural land from production but can provide increased protection to farmlands, thereby resulting in short-term adverse impacts for long-term benefits. Water Transfers may result in changes to local economies as a result of the sale of water. The type of impact would be dependant on how revenues from the sale are spent and how local economies are impacted because of the transfer of water into or away from a region. Coordinated Watershed Management would alter land use practices in upper watershed, which may result in forgone economic opportunities.

Table 3-1. Summary of Environmental Consequences of CALFED Program Actions (page 6 of 10)

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C-005201

Environmental Resource Category	ENVIRONMENTAL CONSEQUENCES OF CALFED BAY-DELTA PROGRAM ALTERNATIVES				
	No Action Alternative	Storage and Conveyance			Other Programs
		Alternative 1	Alternative 2	Alternative 3	
Agricultural Social Issues	Conditions are forecast to be similar to existing conditions.	Job losses could occur as agricultural land is converted to other uses.	Jobs loses are expected to be more pronounced than for Alternative 1.	Jobs loses are expected to be more pronounced than for Alternatives 1 or 2.	Ecosystem Restoration could result in a significant loss of jobs due to the conversion of agricultural lands for habitat restoration. The Water Quality Program would result in a loss of jobs in the San Joaquin River region as lands are retired. The Water Use Efficiency Program would result in increased yield for farmers, but may reduce on-farm jobs associated with irrigation activities. Water Transfers may result in the loss of farm worker jobs and other job related impacts in the selling region. The loss of farm worker jobs in the receiving region, if the water is purchased for agricultural use, may be avoided by a transfer.
Urban Resources					
Urban Land Use	Continued development trends would cause displacement of some residents, disruption of some existing communities, local and regional land use plan inconsistencies.	Urban impacts could include displaced residents, disrupting of existing communities, and inconsistencies with local and regional land use plans.	Impacts would be similar to Alternative 1, but potentially more pronounced.	Impacts would be similar to Alternative 1, but potentially more pronounced than either Alternative 1 or 2.	Other prorams are expected to have only negligible effects on urban land uses but could require relocation of major infrastructures.

Table 3-1. Summary of Environmental Consequences of CALFED Program Actions (page 7 of 10)

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C-005202

Environmental Resource Category	ENVIRONMENTAL CONSEQUENCES OF CALFED BAY-DELTA PROGRAM ALTERNATIVES				
	No Action Alternative	Storage and Conveyance			Other Programs
		Alternative 1	Alternative 2	Alternative 3	
Urban Water Supply Economics	Water supply reliability would continue to decline and supply costs would increase.	Water supply costs could increase.	Water supply costs could increase.	Water supply costs could increase.	Other programs are not expected to significantly affect urban economics.
Utilities and Public Services	Demand for utilities and public services is expected to increase significantly.	Alternative 1 is expected to increase the demand for utilities and public services and require the relocation of some utility infrastructure components.	Alternative 2 is expected to have similar but more pronounced effects than Alternative 1.	Alternative 3 is expected to have similar but more pronounced effects than Alternative 2.	Ecosystem Restoration may require the relocation of utility infrastructure components under all alternatives.
Recreational Resources	Continuing increased demand for recreational facilities.	New storage and conveyance facilities under 1C would create new recreational opportunities while displacing some existing opportunities.	New storage and conveyance facilities under 2B, 2D, and 2E would create new recreational opportunities while displacing some existing opportunities.	New storage and conveyance facilities under 3B, 3E, 3H, and 3I would create new recreational opportunities while displacing some existing opportunities.	Ecosystem Restoration could convert existing open space uses in the Delta, Sacramento River, and San Joaquin River regions. Levee System Integrity improvements may result in beneficial impacts by creating beach slopes associated with new levees and reduced exposure to flooding for existing recreational facilities. Some facilities could be closed or relocated depending on the location of the levee improvements.
Flood Control Resources	Property values in the Delta Region would continue to increase, but flood protection levels would slightly decline.	Small potential benefits or costs to flood control in the Sacramento and San Joaquin River regions.	Benefits to flood control in the Delta, Sacramento River, and San Joaquin River regions from channel improvements and additional upstream storage.	Conveyance facilities and channel improvements are expected to provide additional benefits in the Delta. Other impacts are expected to be similar to those described in Alternative 2.	The Levee System Integrity Program is expected to have substantial beneficial impacts on flood control. The Ecosystem Restoration and Water Quality programs will also have flood control benefits.

Table 3-1. Summary of Environmental Consequences of CALFED Program Actions (page 8 of 10)

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C-005203

Environmental Resource Category	ENVIRONMENTAL CONSEQUENCES OF CALFED BAY-DELTA PROGRAM ALTERNATIVES				
	No Action Alternative	Storage and Conveyance			Other Programs
		Alternative 1	Alternative 2	Alternative 3	
Power Production and Energy	No Action Alternative would impact power and energy resources, due to changes in water demand, conveyance and pumping strategies.	Configuration 1C is expected to increase average dry year energy generation and capacity as new hydropower facilities are added. It would increase project energy use as operations change, would decrease the amount of CVP energy available for sale, and would increase the SWP's net energy requirement. Western's composite energy rate would increase significantly under this alternative. DWR's net power costs could also increase.	Configurations 2B and 2E would cause the same types of impacts as 1C.	Configurations 3B, 3E, 3H, and 3I would cause the same types of impacts as 1C.	Other program elements may affect power production and energy but would not significantly impact CVP and SWP hydroelectric generating capacity, power production economics or energy generation.
Regional Economics	No Action conditions are forecast to be similar to existing conditions adjusted for population growth.	Adverse impacts are expected from loss of agricultural production and beneficial effects from increased recreation and water supply and reliability.	Impacts similar to those from Alternative 1, but provide more beneficial recreational impacts.	Impacts similar to those from Alternative 1, but provide more beneficial recreational impacts. In addition, this alternative would provide greater water supply reliability as a result of additional conveyance flexibility.	Other program elements would remove agricultural lands from production, resulting in adverse economic impacts.

Table 3-1. Summary of Environmental Consequences of CALFED Program Actions (page 9 of 10)

C-005204
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Environmental Resource Category	ENVIRONMENTAL CONSEQUENCES OF CALFED BAY-DELTA PROGRAM ALTERNATIVES				
	No Action Alternative	Storage and Conveyance			Other Programs
		Alternative 1	Alternative 2	Alternative 3	
Cultural Resources	Additional development could result in impacts to cultural resources.	Disturbance of some cultural resources within all regions is expected except the SWP and CVP Service Areas.	Impacts would be similar to those associated with Alternative 1.	Impacts would be similar to those associated with Alternative 1.	Ecosystem Restoration could adversely effect cultural resources in all regions except the SWP and CVP Service Areas; the Levee System Integrity Program could adversely effect cultural resources in the Delta.
Public Health and Environmental Hazards	Some adverse impacts on public health and beneficial impacts on environmental hazards are expected.	Some adverse impacts on public health and beneficial impacts on environmental hazards could occur.	Impacts would be similar to those associated with Alternative 1.	Impacts would be similar to those associated with Alternative 1.	Ecosystem Restoration Program, Water Quality Program, and Levee System Integrity Program may increase the amount of mosquito breeding habitat.
Visual Resources	Continued development could result in some visual impacts.	Visual impacts on Delta boaters from channel enlargements and flow control structures, and potential impacts in the Sacramento and San Joaquin River Regions from new storage facilities for 1C.	Potential for significant visual impacts in the Delta from new conveyance facilities, and in the Sacramento River and San Joaquin River Regions from new storage facilities for 2B, 2D, and 2E.	Potential for significant visual impacts in the Delta from new conveyance facilities, and in the Sacramento River and San Joaquin River Regions from new storage facilities for 3B, 3E, 3H, and 3I.	Ecosystem Restoration is expected to have beneficial effects in the Delta and a mix of both beneficial and adverse effects in the Bay, Sacramento River, and San Joaquin River regions. The Levee System Integrity Program could have temporary visual impacts in the Delta.
Environmental Justice	Similar to existing conditions.	Some actions could have a disproportionate impact on minority and low income populations, including migrant workers as agricultural land is converted to other uses.	Alternative 2 would have similar impacts as Alternative 1.	Alternative 3 would have similar impacts as Alternative 1.	Ecosystem Restoration could have a disproportionate impact on minority and low income populations, including migrant workers as agricultural land is converted to other uses.
Indian Trust Assets	No significant impacts identified.	No significant impacts identified.	No significant impacts identified.	No significant impacts identified.	No significant impacts identified.

Table 3-1. Summary of Environmental Consequences of CALFED Program Actions (page 10 of 10)

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Table 3-1. Summary of Environmental Consequences of CALFED Program Actions (page 11 of 10)

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4 MOVING TOWARDS THE PREFERRED PROGRAM

This chapter provides information on the process CALFED is using to develop a consensus on common program elements and on a preferred program alternatives. This is a summary of the information in the Phase II Report Technical Appendix. CALFED has not identified a preferred program alternative but has conducted analyses to help move towards a preferred program alternative.

This chapter will be replaced with a description of the preferred program alternative in the Final Programmatic EIS/EIR.

4.1 INTRODUCTION

The foundation of every CALFED alternative is the common program elements: the ecosystem restoration program, water quality program, water use efficiency program, Delta levee protection plan, water transfer policy, and watershed management coordination program. These common program elements will differ only slightly between alternatives. Each of the individual common program elements is a major program on its own, and each represents a significant investment in and improvement in the Bay-Delta system. For example, the ecosystem restoration plan is the largest, most complex ecosystem rehabilitation effort ever undertaken anywhere.

A significant part of the overall performance of the CALFED Bay-Delta Program is attributable to the common program elements.

During the Phase II process, stakeholders have raised significant questions and issues about different aspects of the common program elements. CALFED recognizes that addressing these questions and issues on common program elements are fundamental to the success of the Program. The Phase II Report Technical Appendix includes sidebar discussions of stakeholder concerns and lays out proposed processes for resolving these critical concerns.

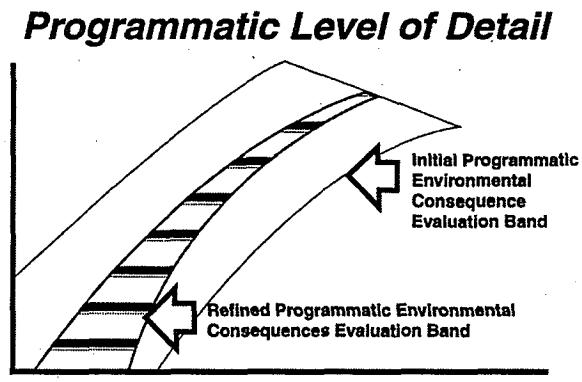

Figure 4-1. Programmatic Level of Detail

The variable Program elements, storage and conveyance, further enhance performance, provide greater operational certainty and Program balance, and reduce potential redirected impacts. The 12 alternative configurations addressed in this Programmatic EIS/EIR differ primarily by how they assemble different components of storage and conveyance.

The 12 alternative configurations cover the broad range of potential consequences of implementing a CALFED solution. This is represented by the Initial Programmatic Environmental Consequences Evaluation band shown in Figure 4-1. As CALFED moves towards a preferred program alternative, the evaluations will become more and more focused as shown in the Refined Programmatic Environmental Consequences Evaluation band in Figure 4-1. Although more specific evaluations may be needed to define the preferred program alternative, the consequences of the preferred program alternative will be contained within the range of consequences described in this Draft Programmatic EIS/EIR.

The CALFED will continue evaluation of the alternatives and, using the input received from the public, will select a preferred program alternative prior to the Final Programmatic EIS/EIR in late 1998.

The remainder of this chapter shows the CALFED progress in moving towards a preferred program alternative. This chapter will be replaced by a description of the preferred program alternative in the Final Programmatic EIS/EIR.

4.2 SUMMARY OF PROCESS

CALFED identified 18 distinguishing characteristics of the alternatives to help show the potential differences between the alternatives. Distinguishing characteristics are those features which help differentiate among the alternatives. The process continued by examining at how each of the 12 alternative variations performed for the distinguishing characteristics. This assessment provided information on where alternatives performed particularly well and where there were significant deficiencies. As a tool in moving towards a preferred program alternative, CALFED agencies used the distinguishing characteristics information and sought to develop the best alternative for each of the three main categories:

- **Alternative 1** (existing system conveyance)
- **Alternative 2** (modified through-Delta conveyance)
- **Alternative 3** (dual Delta conveyance)

The CALFED Program looked for modifications, including operational changes, that would resolve the major deficiencies and enhance the overall performance of alternatives in each of the three categories. A summary of this process is contained in the following sections. More detail on development of the alternatives and the evaluations leading towards the preferred program alternative can be found in the Phase II Interim Report Appendix.

4.3 DISTINGUISHING CHARACTERISTICS

Chapter 4 will be replaced with the description of the preferred program alternative in the Final Programmatic EIS/EIR. Therefore, discussions of distinquishing characteristics are included in this draft only. No specific discussion of distinquishing characteristics is found in other chapters of this

Looking simultaneously at all the information on how well the alternatives meet the Program objectives and how well they satisfy the solution principles would be nearly impossible due to the large amount of information. Furthermore, many aspects of the alternatives do not vary from one alternative to another. They all include common program elements that make significant progress toward meeting program objectives and reducing conflict in the system.

On the other hand, there are aspects that do differ among the alternatives and it is these aspects, or distinguishing characteristics, that helped CALFED move towards a preferred program alternative. These characteristics are important when assessing the performance, impacts and overall merits of each alternative. Following are the 18 identified distinguishing characteristics:

- **In-Delta water quality** - provides a measure of **salinity** and **flow circulation** for four areas of the Delta (north, south, central, west). The measure focuses on water quality for in-Delta agricultural uses.
- **Export water quality** - provides a measure of **salinity, bromide, and total organic carbon** for four export diversion location from the Delta. The measure focuses on municipal/ industrial uses for the North Bay Aqueduct and Contra Costa Intake and for agricultural and municipal/industrial uses for the SWP and CVP export pumps.
- **Diversion Effects on Fisheries** - includes only the **direct effects on fisheries due to the export diversion intake and associated**

fish facilities. These will vary depending on diversion location, size, type, method of handling bypassed fish, and annual volume of water diverted. The effects on flow patterns in the Delta as a result of the diversion are addressed below in the distinguishing characteristic for "Delta Flow Circulation." The loss of fish due to diversion to another route is covered in this effect.

- **Delta Flow Circulation** - includes the **direct and indirect effects of water flow circulation on fisheries due to the export diversions and changes in cross-Delta water conveyance facilities.** These will vary depending on diversion location, size, type, and operation of conveyance facilities, and annual volume of water diverted.

- **Storage and Release of Water** - provides a measure of the environmental benefit or adverse effects of storing water in new Program storage facilities and releasing that water at a later time of need. Storing the water will generally result in some degradation of environmental conditions and will generally result in some environmental benefits.

- **Water Supply Opportunities** - is a measure of the change provided by the alternatives for water supply for the environment and for agricultural and urban uses.

- **Water Transfer Opportunities** - is an estimate of how well each alternative can carry water that may be generated through market sales or trades at different locations in the system.

- **Operational Flexibility** - provides an indication of how well each alternative can shift operations as needed from time to time to provide the greatest benefits to the ecosystem, water quality, and water supply reliability.

- **South Delta Access to Water** - is a measure of how the alternatives affect local access to water due to changes in water levels in the channels.

- **Risk to Export Water Supplies** - is intended to provide a measure of which alternatives best reduce the risk to export water supplies from a catastrophic earthquake.

- **Total Cost** - will include the initial capital costs for the Program as well as annual costs. Initial costs will include study, design, permitting, construction, mitigation, acquisition, and other first costs of the Program. Annual costs will include operation and maintenance, monitoring, reoccurring annual purchases, and other annual costs.
- **Assurances Difficulty** - is an estimate on how hard an assurance package will be to formulate and get consensus among agencies and stakeholders. It is not an assessment on the perceived effectiveness of the assurance package.

- **Habitat Impacts** - is an assessment of the adverse habitat impacts due to implementation of the storage and conveyance facilities.

- **Land Use Changes** - is a measure primarily of the amount of agricultural land that would change to other uses by implementation of the Program.

- **Socio-economic Impacts** - include adverse and beneficial impacts such as commercial and recreational fishing, farm workers, power production, and other third-party impacts.

- **Consistency with Solution Principles** - provides a qualitative measure of how well the alternatives meet the Program solution principles. Alternatives which violate the solution principles are not likely to be practicable or implementable. However, since the solution principles have been used throughout the Program development, it is unlikely at this point that alternatives will violate the solution principles. The solution principles provide insight in considering

More Critical Distinguishing Characteristics	Less Critical Distinguishing Characteristics
• Export water quality	• Storage and release of water
• In-delta water quality	• Water transfer opportunities
• Diversion effects on fisheries	• South Delta access to water
• Delta flow circulation	• Total cost
• Water supply opportunities	• Habitat impacts
• Assurances difficulty	• Land use changes
• Operational flexibility	• Socioeconomic impacts
• Risk to export water supplies	• Ability to phase facilities
• Consistency with the solution principles	• Brackish water habitat

Table 4-1. Critical Distinguishing Characteristics

tradeoffs among the other distinguishing characteristics in a balanced manner.

- **Ability to Phase Facilities** - provides an indication of how easy it will be to phase implementation of storage and conveyance facilities over time.

- **Brackish Water Habitat** - considers the salinity gradient between fresh and salt water in the Bay-Delta system. The western Delta is an area of important aquatic habitat with salinity levels of approximately 2 parts per thousand. The location of this salt concentration, known as X2, is an indicator of changes in brackish water habitat among the alternatives.

The distinguishing characteristics are intended to help the CALFED agencies and members of the public determine the relative performance levels of each alternative. Among these characteristics, some were found through the evaluation process not to vary greatly among the three alternatives, while other characteristics truly allowed CALFED to distinguish differences in performance. These more critical characteristics are the ones in the left column in Table 4-1.

CALFED has not made any determination about how the alternatives perform in terms of the "assurances" or "consistency with solution principles" characteristics. Although extremely critical to the ultimate decision of a preferred program alternative, evaluation of these two characteristics is highly subjective, and CALFED intends to make that evaluation only after considering the comments of the interested public.

4.4 POTENTIAL MODIFICATIONS TO IMPROVE ALTERNATIVE PERFORMANCE

CALFED considered the following modifications to improve performance of the three basic alternatives:

- **Consolidate and Upgrade SWP/CVP Fish Screens** - The inadequacy of the current facilities to prevent fish entrainment in the water project intakes, along with predation that occurs in Clifton Court, are major sources of fish losses in the system. In considering the option of upgrading State Water Project and Central Valley Project intake screen facilities in the south Delta separately or as a single project, technical team and engineering experts agree there are advantages to developing a combined screen facility at the head of Clifton Court to support both projects, including potential cost savings. Another advantage of a combined screen facility is that it utilizes an intertie between the SWP and CVP conveyance channels. This intertie is

generally recognized as a desirable feature to increase operational flexibility, and is included in all three alternatives.

- **Use of Storage to Enable Export Curtailments** - Storage in the Delta, near the Delta, or off-aqueduct south of the Delta (including groundwater storage) offers the potential to maintain water deliveries while diversions from the Delta are temporarily curtailed. Storage from zero up to 6 MAF (including north of Delta storage) was considered a reasonable range for planning purposes for each of the three alternatives. Some of this storage could be in Delta or near Delta. This figure of 6 MAF of new storage represented a maximum volume for planning purposes, not a storage target. CALFED also evaluated these alternatives with zero additional storage.

- **Separate Conveyance Channel from Snodgrass Slough** - The ecology of Snodgrass Slough could be significantly affected by channel modifications. Construction of a separate conveyance channel adjacent to Snodgrass Slough would avoid these impacts and is, therefore, the preferred approach for Alternative 2.

- **Tyler Island Aquatic Habitat and Andrus Island Levee Setback** - This feature would involve removing a major Delta island from agricultural production, and would create a major change in the Delta hydraulic system. However, the physical and biological consequences of this action are uncertain and would be known only after years of operating and evaluating the system. Thus, the value of this investment would be subject to considerable risk. Similar water conveyance and flood control benefits can be obtained through other, better understood alternatives, with reduced impacts on Delta agriculture. The Tyler Island aquatic habitat and Andrus Island levee setback are not included in moving towards a preferred program alternative.

- **Mokelumne River Floodway and Conversion of Bouldin Island to Habitat** - This feature would involve removing a major Delta island from agricultural production, and would create a major change in the Delta hydraulic system, having unknown physical and biological consequences. Similar water conveyance and flood control benefits can be obtained through other, better understood conveyance configurations, with reduced impacts on Delta agriculture. The Mokelumne River floodway and conversion of Bouldin Island to habitat are not included in moving towards a preferred program alternative.

- **Unscreened Intakes on San Joaquin River, East Delta, and West Delta** - The benefits to fisheries associated with the flexibility of intake location that would be provided by multiple unscreened intakes are thought by CALFED fishery experts to be minimal as compared to the in-Delta construction impacts and costs that would be associated with this option. Other alternatives exist to accomplish similar operational objectives. These unscreened intakes are not included in moving towards the preferred program alternative.

The following alternatives were then subjected to additional analysis:

Alternative 1. Alternative 1C with and without additional storage, and with consolidated SWP/CVP fish screen described above.

Alternative 2. Alternative 2B with and without additional storage, with consolidated SWP/CVP fish screen and through-Delta channel separated from Snodgrass Slough.

Alternative 3. Alternative 3B - 5,000-cfs isolated facility, with and without storage and consolidated SWP/CVP fish screen; also considered 10,000 ± cfs isolated facility. Alternative 3E - 15,000-cfs isolated facility, with and without additional storage and consolidated SWP/CVP fish screen.

In recognition of the uncertainty regarding future conditions, CALFED agencies performed a

sensitivity analysis to evaluate the effects of potential changes in operating criteria under the three Program alternatives. While specific assumptions were necessary to conduct model simulations to aid in this evaluation, no specific standards are proposed or endorsed by CALFED through these assumptions.

4.5 COMPARISON OF ALTERNATIVES

The Phase II Report discusses the major differences between the alternatives on the key technical distinguishing characteristics. Based on the assumptions made in these technical evaluations, Alternative 3 appears to have the potential to provide greater performance on these particular characteristics. At the same time, however, Alternative 3 appears to present the most serious challenges in terms of assurances and implementability. Figure 4.2 provides a general comparison of the alternatives according to the eight distinguishing characteristics. Qualitative rankings of high (H), medium (M), and low (L) were used to summarize the three alternatives. For example, in-Delta water quality ranked best for Alternative 2 and the lowest for Alternative 3.

The evaluation depicted graphically here treats each of the key distinguishing characteristics as if they were of equal importance. It is important to understand, however, that it is unlikely that all of the key distinguishing characteristics are of equal importance, and different weighting of these factors could affect the outcome of the analysis. In addition, Table 4-2 does not attempt to standardize the scales for each characteristic. That is, the relative difference between an "L" and an "M" on one characteristic may be totally different than the difference between an "L" and an "M" on another characteristic. Interested parties, the public, and CALFED agencies must collectively determine the importance of each distinguishing characteristic in the overall evaluation of alternatives leading to selection of the preferred alternative.

Two key distinguishing characteristics seem to be particularly important in making a decision on how well the alternatives perform. Export Water Quality and Diversion Effects on Fisheries are both highly dependent on the alternative selected. Therefore, irrespective of whether these two characteristics are the *most important* to selection of the preferred program alternative, they are the characteristics *most dependent* on that decision.

	In-Delta Water Quality	Export Water Quality (South Delta)	Export Water Quality (Contra Costa)	Minimize Diversion Effects on Fisheries	Delta Flow Circulation	Water Supply Opportunities	Operational Flexibility	Minimize Risk to Export Water Supplies
Alternative 1	M	L	L	L	L	L	L	L
Alternative 2	M+	M	M+	L	M	L	M	M
Alternative 3	L	H	L	M+	M+	M	H	H

Figure 4-2. Summary of the Most Significant Distinguishing Characteristics

Issues to Be Addressed
Export Water Quality
Diversion Effects on Fisheries
Program Element Refinement • Water Quality Program • Ecosystem Restoration Plan • Levee Protection Plan • Water Use Efficiency • Watershed Management • Water Transfers • Storage • Conveyance
Assurances and Financial Plan
Additional Concerns • Agricultural Land Impacts • Etc.

4.6 NEXT STEPS

CALFED has not identified a preferred program alternative. A great deal of dialogue will need to take place among elected officials, CALFED agencies, local agencies, interest groups, and the public before a decision can be made. Together, all interests will need to answer questions such as:

- Are the assumptions and technical evaluations performed by CALFED valid?
- Are the common program elements contained in each alternative adequate to ensure overall Program success?
- How well does each alternative meet the CALFED solution principles? Is any one alternative clearly superior to others?
- Is the construction of water facilities (such as an isolated conveyance facility) acceptable to the public?
- Are beneficiaries willing to pay for a comprehensive Bay-Delta solution?
- Can we devise an adequate assurance package of actions and mechanisms to assure that the program will be implemented and operated as agreed?

During the process of developing the program elements and evaluating the alternatives, many issues and concerns were identified. Some of these issues must be addressed in order to facilitate selection of a preferred program alternative. These issues, as shown in the text box above, vary in their potential significance in selecting an alternative and in the implementation approach to be taken. As shown in Figure 4-3, some issues may require independent scientific review, focused stakeholder collaboration, or simply additional analysis and development.

Between the Public Draft Programmatic EIS/EIR and the Final Programmatic EIS/EIR work will continue on resolving the issues of concern as well as defining and selecting the preferred program alternative. The CALFED agencies will work with elected officials, local agencies, interests groups and the public over the coming months to develop a preferred program alternative which reduces major conflicts in the system, is equitable, affordable, durable, implementable and will not solve problems in the system by re-directing impacts.

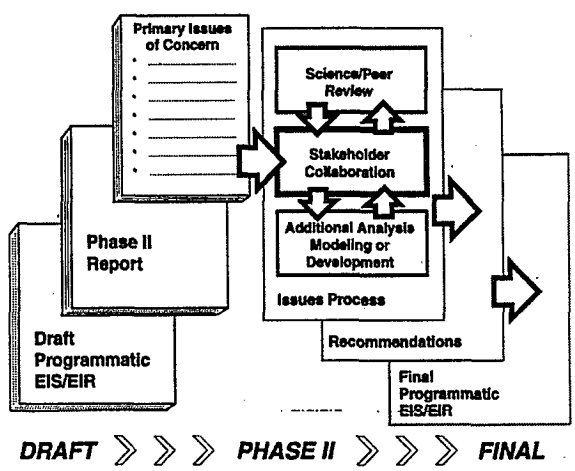

Figure 4-3. Phase II Process

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5 GUIDE TO IMPACT ANALYSIS AND DESCRIPTION OF LAND USE ASSUMPTIONS

This chapter provides a guide to the impact analysis presented in Chapters 6, 7, and 8. It also presents estimates of potential land use changes which could occur as a result of the CALFED Program. As noted in Chapter 2, the alternatives are being refined as Phase II of the CALFED process continues. Although more specific program evaluations may be needed to define the preferred program alternative, the consequences of the preferred alternative will be contained within the range of consequences described in this Draft Programmatic EIS/EIR. The CALFED staff and agencies will continue evaluation of the alternatives and, with the help of the public, will select a preferred program alternative prior to the Final Programmatic EIS/EIR in late 1998. The regulatory framework that is part of the existing conditions can be found in Chapter 11, Section 2.

5.1 GUIDE TO IMPACT ANALYSIS

Technical reports were prepared for each resource area and form the basis for the affected environment and environmental consequences descriptions in Chapters 6, 7, and 8. Each individual technical report analyzes and describes programmatic changes that could result from implementing the CALFED Program alternatives. The technical reports also describe methodologies used for models and other analytical tools. References used to prepare the technical documents are included within each individual technical document and are not duplicated within the Bibliography section of this document (Chapter 14). These technical reports are incorporated by reference and are available for review at the CALFED offices or in the various libraries throughout California that serve as repositories for state and federal documents.

This section explains the organization of a typical environmental resource discussion as an orientation for the reader. Resources evaluated in the Programmatic EIS/EIR have been grouped into three main categories:

- Physical Environment
- Biological Environment
- Land Use, Economic, and Social Issues

These resources are illustrated in Table 5.1-1.

The organization of a typical resource discussion is depicted graphically in Figure 5-1. Each resource discussion begins with a summary of consequences and includes an introductory summary block. The Introduction includes a text box which summarizes the impacts of each alternative configuration. The text box provides an overview of the potentially significant impacts for the resource. This information is provided in brief text bullets for each affected program element. Information presented in the summary boxes is used as the basis for the summary comparison of impacts presented in Chapter 3.

The matrix provides a graphical overview of the environmental consequences of each alternative configuration. The impacts of the program are classified into the following categories for a number of specific issues related to each resource:

- **Significant and unavoidable** – Adverse environmental consequences have been identified that have the potential to be significant with respect to the criteria identified for the resource area even after mitigation strategies are applied. This is represented by a "●" in the matrix.
- **Significant but mitigable** – Adverse environmental consequences have been identified that have the potential to be significant, but which can be reduced to less

Chapter 6 Physical Environment	Chapter 8 Land Use, Economics and Social Issues
Surface Water Resources • Bay-Delta Hydrodynamics and Riverine Hydraulics • Water Quality • Water Supply and Water Management Groundwater Resources Geology and Soils Noise Transportation Air Quality	Agricultural Resources • Land/Water Use • Agricultural Economics • Social Issues Urban Resources • Land Use • Economics • Utilities and Public Services Recreational Resources • Land Use • Opportunities and Economics • Social Issues Flood Control System Power Production and Energy Regional Economics Cultural Resources Public Health and Environmental Hazards Visual Resources Environmental Justice Indian Trust Assets
Chapter 7 Biological Environment	
Fisheries and Aquatic Ecosystems Vegetation and Wildlife	

Table 5-1. Resource Categories Evaluated in Each Region in the EIS/EIR Study Area

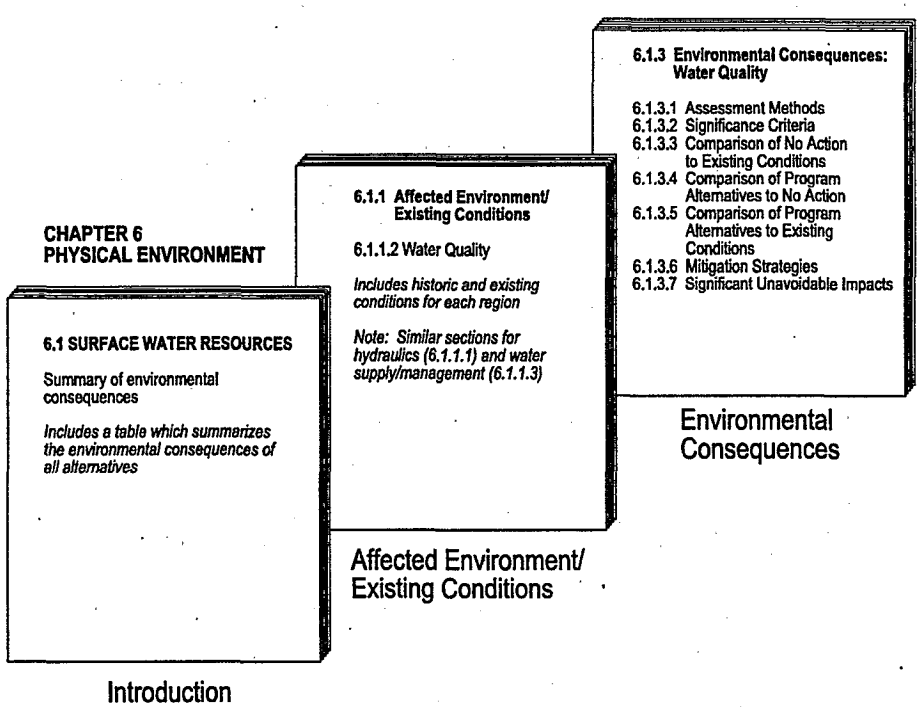


Figure 5-1. Organization of a Typical Environmental Resource Discussion

than significant through the application of identified mitigation strategies. This is represented by a "◑" in the matrix.

- **Less than significant** – Some adverse environmental consequences have been identified; however, they do not exceed the significance criteria identified for the given resource. This is represented by an "o" in the matrix.

- **No impact** – No adverse environmental consequences have been identified for the given resource element, or the consequences are negligible or undetectable. This is represented by a "□" in the matrix.

- **Beneficial** – The environmental consequences would have a positive effect on the given resource element. This is represented by a "+" in the matrix.

- **Unknown** – At this stage of the planning process the environmental consequences within a specific resource element cannot be adequately characterized. This is represented by a "U" in the matrix.

Since detailed project designs have not been prepared at this stage of the planning process, the characterizations represent potential impacts of the alternative configurations.

Within the summary matrices, different symbols have been used to classify the significance of impacts within each specific resource issue area. In some cases the same symbol may be used for many or all alternative configurations for a given resource issue area. The impacts to a given resource area may be significant for all alternative configurations; however, the degree to which the resource area is affected may vary considerably. This variation is not shown on the matrices. For example, the amount of land area disturbance could vary from one configuration to another, and thus, the degree to which each configuration would affect the environment would vary. The summary matrices indicate whether an effect would be considered significant, but do not show the degree of significance or difference between configurations. Details on the degree to which the resource area may be affected are provided in the supporting text. Therefore, it is not appropriate to attempt to score individual effects or to add the number of symbols in each significance category to develop an overall score for an alternative configuration, based on the symbols shown on summary matrices.

The summary introduction is followed by a discussion of the affected environment/existing conditions. These discussions provide an historical perspective of the resource and an overview of the current conditions. The discussions are organized by region, as follows:

- Delta Region
- Bay Region
- Sacramento River Region
- San Joaquin River Region
- SWP and CVP Service Areas Outside the Central Valley

Upper watershed descriptions for each resource are discussed, where appropriate, within the various regions.

The affected environment/existing conditions description is followed by an environmental consequences section, which begins with an overview of assessment methods. Descriptions of assessment methods are resource specific and provide the approach used to identify and assess environmental consequences. Analytical models used in the evaluation are also described.

The assessment method descriptions are followed by discussions of significance criteria. The significance of an activity varies depending on the environmental setting in which the activity occurs. The general nature of the planning process and the broad range of settings and impacts involved with the Phase II Program dictate the use of qualitative thresholds of significance at this programmatic stage.

Significance criteria are generally phrased in qualitative terms indicating potential changes from existing conditions or future conditions under the No Action Alternative. These comparisons provide indications of the potential for significant impacts for use in the Programmatic EIS/EIR. These qualitative and general criteria provide the basis for the establishment of more specific or qualitative thresholds to be used in the project-specific environmental documents. When specific actions have been identified in Phase III, significance criteria may be expressed in quantitative terms based on site-specific data.

The discussions of environmental consequences begin with a comparison of the No Action Alternative to existing conditions.

Evaluation of the 12 alternative configurations consists of a two-part process. Program alternatives are first evaluated in comparison to the No Action Alternative baseline. The analysis presented in the environmental consequences section consists primarily of this evaluation.

Program alternatives were also evaluated relative to existing conditions. This was done to ensure that all potentially significant impacts are identified. In many cases the conditions present under the existing conditions baseline are similar to those found with the No Action Alternative. In these situations differences between existing conditions and No Action Alternative cannot be distinguished at the programmatic level and the results of comparison to both the No Action Alternative and existing conditions are the same. Where there are potential differences between the existing conditions and No Action Alternative the analysis focuses on the following questions:

- Are all significant adverse impacts identified when comparing program alternatives to the No Action Alternative still significant when program alternatives are compared to existing conditions?

- Are there any additional significant adverse impacts identified when program alternatives are compared to existing conditions as compared to the No Action Alternative, or is the magnitude of the impact greater?

- Are all beneficial effects identified when comparing program alternatives to the No Action Alternative still beneficial when the program alternatives are compared to existing conditions?

Where differences are identified between the comparison of program alternatives to the No Action Alternative and comparison of program alternatives to existing conditions, the additional analysis is provided within the appropriate resource section.

Within each regional discussion, impacts are discussed by CALFED program elements, such as storage and conveyance and ecosystem restoration. If an element does not result in an impact in a given region, it is not mentioned.

The information is displayed by CALFED program elements to provide a sense of the consequences of each element in each region. To understand the regional consequences of an alternative, all the elements of an alternative need to be considered. To understand the consequences of an alternative systemwide, all the elements of an alternative in all five regions need to be considered.

Since this Programmatic EIS/EIR does not evaluate site-specific actions, no action-specific mitigation measures or monitoring plans are presented. Rather, general mitigation strategies are identified. These strategies are expected to be further developed in subsequent project-specific environmental documents. This Programmatic EIS/EIR would be used to assist in the implementation and review of subsequent actions and is expected to be particularly useful in evaluating system-wide benefits and consequences of large multiple action programs. However, it is possible that further detailed system-wide analysis may be necessary during Phase III to determine the effects of specifications with wide-ranging impacts.

Finally, potentially significant, unavoidable impacts are identified for each resource area, consistent with the significance criteria described for that resource.

> In some cases, specific descriptions of actions are noted in the environmental consequences sections of Chapters 6, 7 and 8. For example, specific islands and channels are mentioned along conveyance alignments. These descriptions are intended as examples of the type of structures, restoration activities, and alignments which are possible if CALFED Program alternatives are implemented. The CALFED Program has not selected any particular conveyance alignment or the location of any other structure or action depicted in any impact discussions. These selections would not occur until Phase III and would involve extensive study and interaction with all interested parties.

5.2 ESTIMATION OF LAND USE CHANGES DUE TO THE CALFED PROGRAM

Because the extent and specific locations of CALFED actions have not yet been defined, it is necessary to make a rough estimate of the area of land that would be disturbed by CALFED actions. It is likely that the majority of lands that would be affected by the CALFED Program are currently being used for agricultural purposes.

The maximum acreage that could potentially be affected by the various CALFED Program elements has been identified to provide the decision makers and the public a sense of the potential magnitude of land use impact that could be brought about by the CALFED Program, even though it could be considerably less, depending on the specific action implemented. Estimates of other types of changes that might occur because of the CALFED Program can be found in Chapters 6, 7, and 8.

As a program-level planning document, this plan does not include reductions in the land use changes based on measures that would be put into place to avoid, minimize, or mitigate these changes. However, because the ecosystem restoration element actions have the potential to affect the largest land area, particularly agricultural lands, information is offered to illustrate what would be done during Phase III, particularly in the Delta – to avoid, minimize, or mitigate the extent of lands impacted by the CALFED Program.

Estimated land use changes are presented here rather than within the various impact analysis chapters to provide the appropriate perspective with regard to potential land use conversions and to avoid repetition in the document. Whenever a discussion about land use changes occurs in Chapters 6, 7, or 8, the reader will be referred back to the tables in this section.

Estimates of the land area that could potentially be affected by the following program elements:

- Ecosystem restoration
- Water Quality Program
- Restoration of levees
- Construction of new storage facilities or enhancements to existing storage facilities
- Water conveyance through the Delta

Water Use Efficiency measures are not expected to directly impact current land uses therefore, no estimates of land changes relative to this program are presented.

CALFED Program activities have the potential to impact lands designated as prime farmland, unique farmland and farmland of statewide importance. Table 5-2 provides a summary of the acreages of each of these types of farmland that could potentially be affected by the CALFED Program. The acreage estimates assume that all

Alternative	Region	ERP			Levees			Storage			Conveyance			Water Quality[1]	Total
		P	S	U	P	S	U	P	S	U	P	S	U	0	
Alt 1	Delta	93,000-105,000	3,500-6,500	1,500-3,500	31,000	2,500-3,000	500-1,000	0	0	0	0-300	0-100	0	0	132,000-150,400
	Sacramento River	17,000-22,000	2,500-3,000	500-1,000	0	0	0	0	0	0	0	0	0	0	26,000-34,000
	San Joaquin River	8,200-9,500	800-1,000	300-500	0	0	0	0	0	0	0	0	0	35,000-45,000	44,300-[2] 56,000
Alt 2	Delta	93,000-105,000	3,500-6,500	1,500-3,500	31,000	2,500-3,000	500-1,000	0	0	0	3,500-24,500	100-3,000	400-1,500	0	136,000-179,000
	Sacramento River	17,000-22,000	2,500-3,000	500-1,000	0	0	0	0	0	0	0	0	0	0	26,000-34,000
	San Joaquin River	8,200-9,500	800-1,000	300-500	0	0	0	0	0	0	0	0	0	35,000-45,000	44,300-[2] 56,000
Alt 3	Delta	93,000-105,000	3,500-6,500	1,500-3,500	31,000	2,500-3,000	500-1,000	0-14,000	0-2,000	0	3,500-27,000	200-5,000	300-1,500	0	136,000-199,500
	Sacramento River	17,000-22,000	2,500-3,000	500-1,000	0	0	0	0	0	0	0	0	0	0	26,000-34,000
	San Joaquin River	8,200-9,500	800-1,000	300-500	0	0	0	0	0	0	0	0	0	35,000-45,000	44,300-[2] 56,000

Types of Farmland
- **Prime (P) - Land with the best combination of physical and chemical features for the production of agricultural crops**
- **Statewide Importance (S) - Land with a good combination of physical and chemical features for the production of agricultural crops**
- **Unique (U) - Land of lesser quality soils used for the production of the State's leading agricultural cash crops**

[1]Estimated acreages of important farmlands cannot be attained at this time because mapping has not been completed in the San Joaquin Region. It is possible that Important Farmlands will be affected by the Water Quality Program in the Grasslands subarea of the San Joaquin River Region.
[2]Total includes lands potentially affected by Water Quality Program.

Table 5-2. Estimated Acreages of Important Farmland Impacted by Program Actions

C-005219
C-005219

CALFED Program activities would occur on these three types of farmland.

In addition to the long-term land use changes, it is expected that construction activities would temporarily increase land use changes 10 to 15%.

5.2.1 Ecosystem Restoration

Table 5-3 provides a menu of the actions that are currently contemplated, along with estimates of the land area that could potentially be affected by each action.

The CALFED Program would take a variety of steps to reduce effects on farmland, including:

- Habitat restoration efforts would focus on developing habitat on public land first.
- Absent public lands, restoration efforts would occur on lands acquired from willing sellers where at least part of the reason to sell is an economic hardship. That is, land floods frequently or levees are too expensive to maintain.
- Where small parcels of land are needed for waterside habitat, acquisition efforts will seek out points of land on islands where the ratio of levee miles to acres farmed is high.
- The CALFED Program would obtain easements on existing farmlands which would allow for minor changes in agricultural practices, thus increasing the value of the crops to wildlife.
- Where practicable, floodplain restoration efforts would include provisions for continued agricultural practices on an annual basis.
- Conversion of land would occur over an extended time period of many years. The conversion process would include extensive community, land owner, and stakeholder involvement.

5.2.2 Water Quality

Facilities to control and treat various discharge effluents would have a direct impact on current land uses. The extent and locations of these facilities are unknown at this time and the acreage that could be affected is not included in this document.

The drainage management problem areas on the westside of the San Joaquin Valley are part of the No Action Alternative. That is, retirement of lands in this area was to have taken place even if the CALFED Program did not proceed. The CALFED Program is looking to move this effort along as part of the Water Quality element. Specifically, land would be retired within the Grasslands Subarea as a means of improving water quality in the San Joaquin River. This action could potentially impact up to 45,000 acres.

5.2.3 Levee System Integrity

Restoration of levees would cause both temporary and permanent disturbance of land adjacent to existing levees. Land disturbed temporarily during construction would be restored through revegetation and would return to pre-construction conditions at different rates. These temporary losses are estimated at between 1,000 and 1,500 acres. Other land would be permanently affected by the larger footprint of the new levees.

Levee reconstruction would require approximately 15,000 acres. Approximately 625 of the 1,100 miles of Delta levees would be upgraded. A 200-foot-wide piece of land would be acquired for approximately 625 levee miles. In addition, it was assumed that 100 miles of setback levees would be constructed, affecting an area 500 feet in width.

Subsidence control would affect about 14,000 acres.

Habitat Type*	Bay Region	Delta Region	Sacramento River Region	San Joaquin River Region
Tidal perennial aquatic	2,500	7,000		
Tidal perennial aquatic (shoals)		500		
Nontidal perennial aquatic	500	2,600		1,000
Tidal sloughs	600-1,500	600-1,200		
Midchannel islands		200-800		
Fresh emergent wetland (tidal)		30,000-45,000		
Fresh emergent wetland (nontidal)		20,000		
Seasonal wetland	5,800-6,400	30,000		
Riparian	100	1,000-1,500	6,500-7,000	6,000-6,900
Saline emergent wetland (tidal)	7,500-12,000			
Stream meander corridor			19,500-27,000	1,500-1,800
Floodplain/levees				800-1,500
Perennial grassland	22,000-28,000	6,000		
TOTAL ACRES	**22,000-28,000**	**98,000-115,000**	**26,000-34,000**	**9,300-11,000**

* NOTE: The table does not include agricultural land which will be cooperatively managed for the benefit of waterfowl. The acreage is approximately 40,000-70,000 acres for the Delta Region, 300,000 acres for the Sacramento River Region, and 15,000 acres for the San Joaquin River Region. The cooperatively managed lands will have minimal impact on agricultural lands.

Table 5-3. Possible Land Area Affected by Ecosystem Restoration

Based on these estimates, the total land area permanently affected by the levee would be between 34,000 and 35,000 acres. The estimates of land affected by levee system improvements are considered to be the upper range of the possible area that could be affected. These estimates will continue to be refined as the CALFED process continues.

5.2.4 Storage

Land areas permanently affected by construction or modification of storage facilities would vary with the CALFED alternative and configuration selected. Additional groundwater storage is also included in several of the CALFED alternative configurations. Table 5-4 shows some preliminary calculations of the land area that could be affected by new storage facilities. Several representative storage sites were examined to provide a better perspective on the potential magnitude of land use changes as well as other storage related consequences. The following sites were investigated as examples for analysis in this Programmatic EIS/EIR:

- Sites/Colusa and Thomes-Newville candidate reservoir sites were selected as representative examples for surface storage on Sacramento River tributaries. Assuming a storage capacity of 3 MAF, the potential land affected by a new reservoir could range of 16,700 acres (from Thomes-Newville) to 29,600 acres (from Sites/Colusa). This range is included in the Sacramento River Region areas shown in Table 5-4.

- The Montgomery candidate reservoir site was selected as a representative example for surface storage on San Joaquin River tributaries. Assuming a storage capacity of 500 TAF, the potential land affected by a new reservoir at this site was estimated to be 8,050 acres. This value is included in the San Joaquin River Region areas shown in Table 5-4.

- Groundwater storage in the Sacramento River region, was assumed to require 1,500 acres of total surface area disturbance. This value is included in the Sacramento River Region areas shown in Table 5-4.

- Likewise, groundwater storage in the San Joaquin Valley, was assumed to require 1,500 acres of total surface area disturbance. This value is included in the San Joaquin River Region areas shown in Table 5-4.

- A Los Vaqueros reservoir candidate site was used as the example for the surface storage off-aqueduct option. Assuming a storage capacity of 1 MAF, the potential land affected by the enlargement of the existing reservoir was estimated to be 7,000 acres. This value is included in the San Joaquin River Region areas shown in Table 5-4.

- Victoria, Bacon, and Woodward Islands were used as the example sites for in-Delta storage for Configurations 3B and 3E. The sites have an area of 14,000 to 15,000 acres. Holland tract, with an area of 4,000-4,500 acres, was used as an example site for Configuration 3I.

These values are shown for the Delta Region in Table 5-4.

5.2.5 Conveyance

Changes to water conveyance through the Delta are included in all configurations except Configuration 1A. The estimated land areas that would be affected by conveyance are shown in Table 5.2-2. The various components that make up these changes include:

- **Configuration 1A.** No modifications

- **Configuration 1B.** Old River barrier

- **Configuration 1C.** Old River barrier, channel enlargement along Old River

- **Configuration 2A.** Old River barrier, channel enlargement along Old River, intake at Hood and North Delta channel modifications

- **Configuration 2B.** Old River barrier, channel enlargement along Old River, intake at Hood and North Delta channel modifications

- **Configuration 2D.** Old River barrier, intake at Hood and North Delta channel modifications, South Delta improvements plus habitat, Mokelumne River Floodway and east Delta Habitat

- **Configuration 2E.** Old River barrier, South Delta improvements plus habitat, flooding of McCormack-Williamson tract, flooding of Tyler Island and east Delta Habitat

- **Configuration 3A.** Old River barrier, channel enlargement along Old River, isolated open channel

- **Configuration 3B.** Old River barrier, channel enlargement along Old River, isolated open channel

- **Configuration 3E.** Old River barrier, isolated open channel

		DELTA REGION		SACRAMENTO RIVER REGION	SAN JOAQUIN RIVER REGION	ALL REGIONS
Alternatives		Storage	Conveyance	Storage	Storage	Total
Alt 1	A	0	0	0	0	0
	B	0	100	0	0	100
	C	0	400	18,000-32,000	8,500	26,900-40,900
Alt 2	A	0	4,000-4,500	0	0	4,000-4,500
	B	0	4,000-4,500	18,000-32,000	16,600	38,600-53,100
	D	0	18,000-20,500	0	8,500	26,500-29,000
	E	0	25,200-28,000	18,000-32,000	16,600	59,800-76,600
Alt 3	A	0	4,500-6,000	0	0	4,500-6,000
	B	14,000-15,000	4,500-6,000	18,000-32,000	16,600	53,100-69,600
	E	14,000-15,000	5,000-5,500	18,000-32,000	16,600	53,600-69,100
	H	0	29,000-33,500	18,000-32,000	16,600	63,600-82,100
	I	4,000-4,500	7,000-9,000	18,000-32,000	16,600	45,600-62,100

Table 5-4. Possible Land Area Affected by CALFED Storage and Conveyance (in Acres)

- **Configuration 3H.** Old River barrier, South Delta improvements plus habitat, flooding of McCormack-Williamson tract, isolated open channel, flooding of Tyler Island and east Delta habitat

- **Configuration 3I.** Old River barrier, isolated open channel, western isolated facility, eastern isolated facility

For each configuration, the estimate of land area associated with conveyance changes is based on the following:

- Operable Old River barrier - 100 acres

- Channel enlargement along Old River - 300 acres

- Screened intake at Hood and North Delta channel modifications - 3,500-4,000 acres

- South Delta improvements + habitat - 2,000-2,200 acres

- Mokelumne River Floodway and east Delta Habitat - 12,500-14,000 acres

Flooding of Tyler Island and east Delta Habitat - 21,500-24,000 acres

- Flooding of McCormack-Williamson Tract - 1,600-1,700 acres

- Isolated open channel (45 miles in length and 1000 ft in width) - 4,000-5,500 acres
- Eastern isolated facility (12 miles in length and 1000 ft in width) - 1,400-1,600 acres

6 PHYSICAL ENVIRONMENT

6.1 SURFACE WATER RESOURCES

Summary

Program-induced effects on surface water resources may occur as changes in the timing, direction, and magnitude of flows, changes in water quality, and changes in the amount of water available to meet future water demand. A summary of Program-induced effects is provided in Table 6.1-1.

Assessmant Methods

Hydraulic and Hydrodynamic Analysis. Changes in stream flow (hydraulics) and tidally influenced Bay and Delta channel flows (hydrodynamics) have significance with respect to their effects on a variety of resources. An understanding of these changes is one tool in evaluating the potential impacts of the CALFED Program, both beneficial and adverse.

These changes were estimated using the Department of Water Resources planning simulation model DWRSIM, and the Bay-Delta hydrodynamic models DWRDSM1 and DWRDSM2. DWRSIM was modified to reflect the way in which water would be routed through the storage and conveyance network for each CALFED alternative configuration, as well as for the No Action Alternative and existing conditions. The input to the model was the same for each simulation—the historic 73-year record of runoff in the watershed of the Delta. The output of the model provides a quantitative basis for comparing the effects of the alternatives. The results of the modeling simulation are subject to the limitations of the assumptions of the model, including the range of operating rules that determine the timing and magnitude of diversions and releases. For this reason, CALFED is conducting a validation process to fully evaluate the capabilities and limitations of the models currently being applied to the Bay-Delta system. This process and the technical analysis will be presented in the Summary of Modeling Assumptions and Results appendix for the Final Programmatic EIS/EIR.

Delta inflow for the No Action Alternative was used as the input to the Bay-Delta hydrodynamic models DWRDSM1 and DWRDSM2, which simulate the routing of freshwater inflows and

Changes in Stream Flow and Bay-Delta Hydrodynamics

- The **No Action Alternative** would result in minor changes in stream flow in the rivers and Bay-Delta as a result of increased demand.
- **Storage and Conveyance**

  Small to moderate increases occur in mid-range Sacramento River flows due to increased releases from storage for configurations that include new storage.
- Little change in Delta circulation patterns for Configurations 1A and 1B for **Alternative 1**, but increased south Delta pumping in Configuration 1C leads to small increases in magnitude of reverse flows in central Delta.
- Potential reduction in through-Delta flow velocities (greater residence time) and reductions in frequency of reverse flows associated with changes in channel geometry and distribution of Delta inflow in **Alternative 2** configurations.
- Reduction in north Delta inflow, reduced frequency of reverse flows in San Joaquin River, and substantially reduced influence of south Delta pumping on Delta circulation pattern under **Alternative 3.**
- **Ecosystem Restoration** pulse flows and Delta outflow targets result in potentially substantial short term increases in Sacramento River and San Joaquin River flows during selected periods from March to May.

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Surface Water Quality												
Construction - local turbidity, sediment, pollutants from disturbing sediments or accidental release of contaninants during construction	○	○	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Pollutant Loading - point and non point pollutant throughout solution area reduced by Water Quality Program	+	+	+	+	+	+	+	+	+	+	+	+
Salinity and Bromides - spatial and temporal distribution of salinity and bromide constituents in the Delta affected by habitat and Delta channels changes, new facilities, system storage and operations. Salinity and bromides reduced in most Delta areas for Alt. 2 and impacted south Delta salinity with Alt. 3.	○	○	◗/+	○/+	○/+	○/+	○/+	◗/+	◗/+	◗/+	◗/+	◗/+
Total Organic Carbon - potential increase of total organic carbon due to Ecosystem Restoration and channel enlargement.	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Temperature Changes - potential temperature increases due to creation of shallow, slow-moving waterbodies for habitat under Ecosystem Restoration and localized temperature decreases due to creation of more shaded riverine aquatic habitat.	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Surface Water Supply and Management												
Transfers, Water Use Efficiency, & Ecosystem Restoration - improve water supply from water use efficiency and water transfers programs. Increase environmental flows and habitat consumptive use, impacting water supply.	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Storage - increase water supply through additional storage capacity.	□	□	+	□	+	+	+	□	+	+	+	+

Table 6.1-1. Summary of Environmental Impacts Related to Surface Water Resources (page 1 of 8)

C-005226

C-005226

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Facility/Greater Export Capacity - potential increase or decrease of water supply due to operational criteria for existing and new Delta facilities or changing conveyance.	o	o	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+
Levee Integrity Program - increase reliability of Delta conveyances system through levee program.	+	+	+	+	+	+	+	+	+	+	+	+
Drinking Water Quality												
Water Quality and Ecosytem Program - Delta inflow pollutant loading reduced by Water Quality Program. Potential TOC, taste, odor of Delta water increase by Ecosystem Restoration.	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Delta Configuration/New Facilities - Alternatives 2 and 3 both beneficially affect drinking water quality for CVP, SWP, CCWD export facilities. Alternative 3 has greatest potential for improving export water quality, including bromide, salinity and TOC. Shifting export patterns can improve aggregate export water quality.	◗	◗	◗/+	+	+	◗/+	◗/+	+	+	+	◗/+	+
Bay Region												
Surface Water Quality												
Construction-- No significant construction activities are planned for the Bay Region. Contaminants from upstream areas not expected to reach Bay Region in significant concentrations.	o	o	o	o	o	o	o	o	o	o	o	o
Pollutant Loadings - point and non point pollutant throughout solution area reduced by Water Quality Program	+	+	+	+	+	+	+	+	+	+	+	+

Table 6.1-1. Summary of Environmental Impacts Related to Surface Water Resources (page 2 of 8)

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Salinity, Bromide - could increase marginally due to increased export and reduced outflows, primarily in periods of moderate to high inflow to Bay. Direct effects on Bay water quality expected to be minimal. Refer to other portions of document for discussion of biological effects.	o	o	o	o	o	o	o	o	o	o	o	o
Total Organic Carbon - potential increase of total organic carbon in localized areas due to Ecosystem Restoration.	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+
Temperature Changes - no mechanism for effect on Bay water temperatures has been postulated.	□	□	□	□	□	□	□	□	□	□	□	□
Surface Water Supply and Management												
Transfers, Water Use Efficiency, & Ecosystem Restoration - improve water supply from water use efficicency and water transfers programs. Increase environmental flows and habitat consumptive use, impacting water supply.	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Storage - increasing water supply through additional storage.	□	□	+	□	+	+	+	□	+	+	+	+
Delta Facility/Greater Export Capacity - potential increase or decrease of water supply due to operational criteria for existing and new Delta facilities or changing conveyance.	o	o	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+
Levee Integrity Program - increase reliability of Delta conveyances system through levee program.	+	+	+	+	+	+	+	+	+	+	+	+

Table 6.1-1. Summary of Environmental Impacts Related to Surface Water Resources (page 3 of 8)

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Drinking Water Quality												
Water Quality and Ecosytem Program - Delta inflow pollutant loading reduced by Water Quality Program. Potential TOC, taste, odor of Delta export water increase by Ecosytem Restoration.	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Delta Configuration/New Facilities - Alternatives 2 and 3 both beneficially affect drinking water quality for CVP, SWP, CCWD export facilities. Alternative 3 has greatest potential for improving export water quality, including bromide, salinity and TOC. Shifting export patterns can improve aggregate export water quality.	◗	◗	◗/+	+	+	◗/+	◗/+	+	+	+	◗/+	+
Sacramento River Region												
Surface Water Quality												
Construction--Potential increases in turbidity, sediment, and pollutants from disturbing sediments or mine wastes or accidental release of contaminants from construction activities for storage and conveyance facilities or habitat creation activities.	○	○	◗	○	◗	○	◗	○	◗	◗	◗	◗
Pollutant Loading - point and non point pollutant throughout solution area reduced by Water Quality Program.	+	+	+	+	+	+	+	+	+	+	+	+
Salinity, Bromides, and TOC-- No significant effect on this region.	□	□	□	□	□	□	□	□	□	□	□	□
Temperature Changes-- Potential beneficial effects due to increased on-stream storage or reduced diversions from streamflow associated with off-stream storage. Potential impacts due to discharge from off-stream storage to Sacramento River.	○/+	○/+	◗/+	○/+	◗/+	○/+	◗/+	○/+	◗/+	◗/+	◗/+	◗/+

Table 6.1-1. Summary of Environmental Impacts Related to Surface Water Resources (page 4 of 8)

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Surface Water Supply and Management												
Transfers, Water Use Efficiency, & Ecosystem Restoration - improve water supply from water use efficicency and water transfers programs. Increase environmental flows and habitat consumptive use, impacting water supply.	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Storage -Increased surface storage can increase water supply. Potential operational criteria for new and existing facilities could increase or decrease water supply.	□	□	+	□	+	+	+	□	+	+	+	+
Delta Facility/Greater Export Capacity - potential increase or decrease of water supply due to operational criteria for existing and new Delta facilities or changing conveyance.	o	o	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+
Levee Integrity Program - increase reliability of Delta conveyances system through levee program.	+	+	+	+	+	+	+	+	+	+	+	+
Drinking Water Quality												
Water Quality Program - Water Quality Program can reduce pollutant loadings.	+	+	+	+	+	+	+	+	+	+	+	+
San Joaquin River Region												
Surface Water Quality												
Construction--potential increases in local turbidity, sediment, and pollutants from disturbing sediments or mine wastes or accidental release of contaminants from construction activities for storage and conveyance facilities or habitat creation activities.	o	o	◗	o	◗	o	◗	o	◗	◗	◗	◗

Table 6.1-1. Summary of Environmental Impacts Related to Surface Water Resources (page 5 of 8)

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Pollutant Loadings - point and non point pollutant throughout solution area reduced by Water Quality Program. Potential regional benefit due to retirement of certain lands under Water Quality Program.	+	+	+	+	+	+	+	+	+	+	+	+
Salinity, Bromides - Potential benefits associated with improved source water quality associated with new storage and conveyance facilities, resulting in improved tailwater quality.	o	o	+	+	+	+	+	+	+	+	+	+
Temperature Changes-- Potential beneficial effects due to increased on-stream storage or reduced diversions from streamflow associated with off-stream storage. Potential impacts due to discharge from off-stream storage to San Joaquin River. Potential benefits in localized areas due to increased Shaded Riverine Aquatic habitat created under Ecosystem Restoration. Reduced temperatures assumed to be beneficial.	□/+	□/+	□/+	□/+	◗/+	□/+	◗/+	□/+	◗/+	◗/+	◗/+	◗/+
Surface Water Supply and Management												
Transfers, Water Use Efficiency, & Ecosystem Restoration - improve water supply from water use efficicency and water transfers programs. Increase environmental flows and habitat consumptive use, impacting water supply.	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Storage - increasing water supply through additional storage.	□	□	+	□	+	+	+	□	+	+	+	+
Delta Facility/Greater Export Capacity - potential increase or decrease of water supply due to operational criteria for existing and new Delta facilities or changing conveyance.	o	o	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+

Table 6.1-1. Summary of Environmental Impacts Related to Surface Water Resources (page 6 of 8)

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Levee Integrity Program - increase reliability of Delta conveyances system through levee program.	+	+	+	+	+	+	+	+	+	+	+	+
Drinking Water Quality												
Water Quality and Ecosytem Program - Water Quality Program can reduce pollutant loadings in watershed and in water imported from Delta. Potential TOC, taste, odor of Delta water increase by Ecosytem Restoration.	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Delta Configuration/New Facilities - Alternatives 2 and 3 both beneficially affect drinking water quality for CVP, SWP, CCWD export facilities. Alternative 3 has greatest potential for improving export water quality, including bromide, salinity and TOC. Shifting export patterns can improve aggregate export water quality.	◗	◗	◗/+	— +	+	◗/+	◗/+	+	+	+	◗/+	+
SWP and CVP Service Areas Outside the Central Valley												
Surface Water Quality												
All categories - no significant effect on receiving waters.	o	o	o	o	o	o	o	o	o	o	o	o
Surface Water Supply and Management												
Transfers, Water Use Efficiency, & Ecosystem Restoration - improve water supply from water use efficicency and water transfers programs. Increase environmental flows and habitat consumptive use, impacting water supply.	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Storage - increasing water supply through additional storage.	□	□	+	□	+	+	+	□	+	+	+	+
Delta Facility/Greater Export Capacity - potential increase or decrease of water supply due to operational criteria for existing and new Delta facilities or changing conveyance.	o	o	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+	o/+

Table 6.1-1. Summary of Environmental Impacts Related to Surface Water Resources (page 7 of 8)

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Levee Integrity Program - increase reliability of Delta conveyances system through levee program.	+	+	+	+	+	+	+	+	+	+	+	+
Drinking Water Quality												
Water Quality and Ecosytem Program - Delta inflow pollutant loading reduced by Water Quality Program. Potential TOC, taste, odor of Delta water increase by Ecosystem Restoration.	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Delta Configuration/New Facilities - Alternatives 2 and 3 both beneficially affect drinking water quality for CVP, SWP, CCWD export facilities. Alternative 3 has greatest potential for improving export water quality, including bromide, salinity and TOC. Shifting export patterns can improve aggregate export water quality.	◗	◗	◗/+	+	+	◗/+	◗/+	+	+	+	◗/+	+

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:

Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
o	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 6.1-1. Summary of Environmental Impacts Related to Surface Water Resources (page 8 of 8)

tidal flows through Delta channels. The hydrologic input was the same for the simulation of each configuration using DWRDSM1, so that the hydrodynamic effects in the model simulation from in-Delta modifications, including changes in south Delta pumping, channel geometry, and diversions from the Sacramento River at Hood intake, would be readily discernable. Subsequent simulations using DWRDSM2 incorporated both system operation changes associated with new storage as well as changes in the Delta channels and facilities. The results of both sets of simulations yielded similar trends.

Water Quality Analysis. Water quality effects were evaluated both quantitatively and qualitatively. Effects on salinity concentrations were estimated by both DWRDSM1 and DWRDSM2.

Program-induced effects on water supply were also estimated by computer simulations of the alternative configurations. Water supply benefits are reflected in estimates of South of Delta SWP and CVP water deliveries, where meeting prescribed environmental in-stream flows and Delta outflow requirements is made a minimum requirement of the model.

Changes in water quality are considered to be adverse and significant if they have the potential to reduce the beneficial uses of the water, exceed an existing regulatory standard, or have an undesirable effect on public health or environmental receptors. Program effects are considered to be beneficial if the reverse of these conditions occurs.

Water Supply and Management Analysis. Changes in water supply are considered to be adverse and significant if they result in a reduction in the amount of water that can be delivered to meet an established demand for water. Both the water demand and supply are generally specified in terms of quantity, location, and timing.

Summary of Program Impacts

Table 6.1-1 presents a summary of the significance of the effects of each of the alternative configurations relative to the No Action condition. Changes in flows and flow-related variables are not presented in Table 6.1-1 because meaningful significance criteria cannot be assigned to these changes without reference to some environmental resource that may be affected by changes in flows, such as fisheries, recreation, or water quality and water supply. However, hydraulic or hydrodynamic changes are discussed below.

No Action Alternative. In general, hydraulic variables forecasted for the No Action Alternative

Impacts on Water Quality

- Gradual deterioration in Delta water quality under the **No Action Alternative.**
- **Storage and Conveyance**

  Shift in timing of Delta inflow results in sporadic improvements in Delta water quality for **Alternative 1** Configuration 1C. Improvements are offset by increased south Delta pumping. No change in water quality for configurations without storage component.

  Reduction in salinity and bromide concentrations due to improved circulation pattern and shift in timing of Delta inflow under **Alternative 2** configurations with storage component. Water temperature may increase in east Delta from channel widening for habitat improvements. Temperature effects partially offset by shading.

  Quality of water exported to SWP-CVP Area South of Delta improves substantially with isolated facility in **Alternative 3** because water is taken from Sacramento River instead of Delta. Salinity increases, however, at Rock Slough.
- The **Ecosystem Restoration** and **Levee System Integrity Programs** significantly increase sediment loading and turbidity during construction and initial operation.
- Substantial potential benefits from source control measures of the **Water Quality Program** in all regions.

are similar to those for existing conditions, with maximum variations being less than a few percent and less than significant.

The No Action Alternative could have significant adverse impacts on water quality. Because of anticipated demand at the export facilities in 2020, the No Action Alternative may result in further seawater intrusion and increases in salinity. Significant increases in bromide concentrations could occur during October through January at Clifton Court Forebay and the Contra Costa Canal Intake. These effects would be conveyed to the SWP-CVP service areas outside the Central Valley, the Bay Region, and the San Joaquin River Region. A growing mismatch between demand and supply that is expected to result from the No Action Alternative may require substitution of poor quality water in all regions, resulting in potentially significant local water quality impacts.

Based on the Delta inflow modeling studies performed using DWRSIM, no substantial change in inflow to the Delta is expected for the No Action Alternative relative to existing conditions. Long term average annual deliveries to the SWP-CVP Service Areas under the No Action Alternative would increase by about 400 TAF (about 7%) per year compared to existing conditions. These additional deliveries take place primarily in above normal and wet years, when surplus flows are available in the Delta. There would be very little increase in deliveries during critical water years, similar to the drought period from May 1928 to October 1934.

Storage and Conveyance

Alternative 1. Alternative 1 would cause small to negligible incremental changes in Bay-Delta hydrodynamics and riverine hydraulics.

Significant mitigable adverse impacts on surface water quality could occur due to contaminant spills and erosion of sediments during construction of storage facilities. These impacts are generally expected to be less than significant at off-stream storage sites. Local adverse impacts of operation and maintenance of reservoirs would depend on local geology, hydrology, and water chemistry but could include increases in concentrations of minerals, natural organic matter, metals, and nutrients. Stream water quality downstream of reservoirs, including dissolved and suspended constituents and water temperature, may be changed by seepage and reservoir releases.

Alternative configurations 1A and 1B would cause small to negligible effects on water supply compared with the No Action Alternative. Configuration 1C could increase export water supply. Less than significant decreases in Delta outflow may occur due to improved export conveyance capacity in Alternative 1 but would be partially offset by increased storage. The addition of storage in Configuration 1C would provide additional high-quality water to supplement releases during low-flow periods, which is expected to periodically enhance water quality in the Delta. These effects would be beneficial and would be conveyed to all regions that receive the additional stored water. No significant adverse effects on salinity or other water quality indicators are expected in the Bay-Delta system.

Impacts on Water Supply and Management

- Increased demand, no additional supply, and increased allocation to instream flows under CVPIA results in increased unmet urban and agricultural demand under **No Action**.
- **Storage and Conveyance**

  Similar range of water supply benefits occurs under **Alternatives 1,2, and 3.**

  Negligible to moderate benefits from configurations without a storage component. Benefits of delivery capacity and reliability increase with amount of storage.

  Isolated facility conveyance in **Alternative 3** reduces sensitivity of export's quantity and quality, Delta inflow, and Delta water quality, increasing water supply reliability.
- **Levee System Integrity Program** increases water supply reliability.

Alternative 2. For Alternative 2, in-Delta modifications and increased diversions substantially increase through Delta flows and reduce reverse flows in the west Delta. Flows in the rivers would be similar to No Action for Configuration 2A, while low flows in the summer months would tend to increase for other configurations which include new storage facilities.

A range of water quality effects may occur under Alternative 2, depending on the size of the storage component. Channel modifications in the north and east Delta provide a means of introducing more of the freshwater inflow from the Sacramento River into the central Delta. Although a decrease in water quality could occur in selected areas in the Delta (for example, at Emmaton) as more freshwater flows are shifted to the central Delta, the net effect on water quality in the Delta is expected to be beneficial. Water quality is expected to be significantly improved at the southern export facilities in the Delta (Contra Costa Canal Intake and Clifton Court Forebay), at other locations in the central Delta (such as Prisoners Point and San Andreas Landing), and in the west Delta (such as Jersey Point and Antioch). Improved water quality is expected at Delta export pumping locations. Short-term impacts, including increased sediment, nutrient, and possible toxic contaminant loading, could occur during construction of the proposed Delta channel modifications.

Storage components of Configurations 2B, 2D, and 2E would produce localized changes in water quality similar to those described under Alternative 1.

Configuration 2A would have water supply benefits greater than Configuration 1B due to the increased permitted Delta export capacity. Configuration 2B and 2E would have water supply benefits similar to Configuration 1C because of the storage component. Configuration 2D would be more beneficial than Configuration 2A, but less beneficial than Configuration 2B.

Alternative 3. Configuration 3A includes an isolated facility intake on the Sacramento River at Hood and no additional storage capacity. Diverting water at a rate of up to 15,000 cfs from the Sacramento River to the Clifton Court Forebay would reduce inflow to the north Delta. The rate of pumping from the south Delta to Clifton Court Forebay would be reduced by an equivalent amount. Thus, the pattern of flow through the Delta would be altered. The through-Delta (north to south) component of flow would be reduced or eliminated, and the Delta flow pattern would more closely resemble the natural (pre-development) pattern.

Whether the changes in Delta hydraulics are interpreted as beneficial or adverse would depend on the evaluation criteria used. (Effects on aquatic biota, for example, are discussed in another chapter.) Delta hydrodynamic simulation studies suggest that under the assumed operating rules, reverse flows in the San Joaquin River would be reduced. The change in flow pattern would result in a change in the distribution of salinity concentrations. Although Sacramento River inflow and exports to the CVP-SWP service areas would be adjusted to ensure that X2 standards continue to be met, salinity increases could occur in the south Delta, due to the reduced component of Sacramento River flows through the Delta. Delta modeling results suggest that Alternative 3 could have a significant impact on salinity in the south Delta east of the Clifton Court Forebay, but would generally improve salinity in the south central and southwest Delta, in the vicinity of Rock Slough, Clifton Court, and Prisoners Point. Salinity in exported water would be greatly reduced and would remain relatively constant since much of the export water would come from the Sacramento River at Hood instead of from the Delta.

Storage capacity provided as part of Configurations 3B, 3E, 3H, and 3I would increase the flexibility of water managers to meet export demands and to increase in-stream flows during critical periods. The configurations represent a range of storage and conveyance capacities as well as intake locations that would increase operational flexibility.

Impacts of the in-Delta storage component of Alternative 3 would depend on the specific location and design of the project. Short-term effects are expected due to construction of syphons, levee improvements, and screened intake facilities. Long-term effects are possible as a result of operation of new screened intakes for in-Delta storage.

Configurations of Alternative 3 that include a storage component would result in the largest beneficial impacts on water supply reliability of all the alternatives.

Storage components of Alternative 3 would produce localized changes in water quality similar to those described under Alternative 1.

Ecosystem Restoration

Implementation of Ecosystem Restoration Program would have a beneficial effect on the flows within both of the tributary rivers and the Delta. During dry and below normal year types, flows would be increased to meet minimum flow targets. This could result in a long-term beneficial effect on stream water quality within both the Sacramento and San Joaquin rivers and the Delta. Short-term adverse impacts could be created by increased sediment loading during construction activities. Conversion of cultivated land to wetlands could significantly increase evaporative losses. Also, reduction in stream velocity in some Delta reaches that are widened to encourage meanders could result in increases in water temperature. During dry years, ecosystem restoration would increase instream use and reduce water supplies available for diversion from rivers and the Delta, resulting in potentially significant impacts on off-stream beneficial uses.

Water Quality

In general, the CALFED Water Quality Program would rely on source reduction and treatment. Agricultural or municipal source control measures could have a beneficial impact on Delta water quality but would probably not significantly affect channel flows or water supply in the Delta.

Coordinated Watershed Management

The impacts of most watershed improvement projects on flows in the Delta and rivers would probably be less than significant, although the potential exists for significant improvements in watershed storage through better watershed management. The effects in the Delta would be moderated by operation of major reservoirs that are present on most large tributaries between the upper watershed and the valley floor.

Upper watershed management activities that involve construction could create short-term and local increases in sediment loadings. The long-term impacts on surface water quality of most upper watershed activities are expected to be beneficial, consistent with their objectives.

Levee System Integrity

Channel improvements, including levee construction, dredging, and channel widening and deepening, would result in local reduced stream velocities and the potential for increased sediment deposition. Because levee system integrity focuses on levee improvements within the Delta, adverse impacts on channel hydraulics outside the Delta are expected to be minor.

Short-term adverse impacts could be created by increased sediment loading during construction activities. Levee system integrity would have little effect on water quality under normal conditions. It would reduce the risk of catastrophic failure of levees and consequently increase the reliability of water supplies.

Levee system improvements, including levee construction and localized channel dredging, would not significantly affect water supplies. However, to the extent that levee failures are reduced, water supply reliability would be improved.

Water Use Efficiency

Water use efficiency can generate significant water savings (see Chapter 2 for anticipated levels

of water savings) This can have both beneficial and adverse impacts to surface water management. Water may become available for allocation to other beneficial uses, including meeting existing shortages and groundwater overdraft locally or elsewhere, meeting future increased demands, and meeting ecosystem needs. These savings may also provide water quality improvements and potentially modify reservoir releases and instream flow timing. The Program could adversely impact beneficial uses that exist on current inefficiencies, such as riparian habitat that is dependent on agricultural return flows.

Water Transfers

From the perspective of hydraulics, increased transfers could result in changes in stream flow through diversions and releases from storage. Since conveyance capacity represents the upper limit on the volume of transfers, the impacts of increased transfers on river hydraulics would probably not be substantial.

Water Transfers would affect water quality primarily through changes to river flow and water temperatures. In addition, the source of water for a transfer, the timing, magnitude, and pathway of each transfer would affect the potential for significant impacts. Potential beneficial water quality impacts are a function of the ability of transfers to decrease the concentrations of various contaminants through both increased streamflow and the potential for obtaining higher quality water from several transfer sources. Because transfers can invoke both beneficial and adverse impacts, at times on the same resource, net environmental effects of a water transfer within and between resources must be considered on a case by case basis.

With regard to water supply, water transfers can result in either adverse or beneficial impacts, depending on the location, amount, timing, and type of transfer. To date, questions about who owns the water, how to assign costs to the transferred water, and how to evaluate equitability or to compare the benefits derived from different water users or uses at different locations remain unresolved.

Generally, it is expected that water transfers would result in more efficient distribution of water resources among water users during low flow periods, increasing the reliability of supplies for areas experiencing water supply shortages. The environment is included as a potential beneficiary of water transfers either directly through environmental water transfers or indirectly by timing transfers to provide ecosystem benefits.

6.1.1 Affected Environment/ Existing Conditions

This section discusses historic and existing conditions for riverine hydraulics and hydrodynamics, water quality and water supply management. Figure 6.1.1-1 shows the location of some of the major surface water project facilities in the CALFED study area.

6.1.1.1 Delta Region

Surface water resources in the Delta are influenced by the interaction of tributary inflows, tides, Delta geometry, and diversions and transfers. The Delta receives runoff from a watershed that includes more than 40% of the state's land area. Tributaries that directly discharge into the Delta include the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras rivers.

Historical Perspective. Existing surface water conditions in the Delta are the result of the many changes that have occurred as the Delta Region has developed over the past 150 years.

Bay-Delta Hydrodynamics and Riverine Hydraulics. During the mid-1800s, the Delta, an area of nearly 750,000 acres, was mostly undeveloped tidal marsh. The Delta was inundated each year by winter and spring runoff. During this early period prior to development, Delta channel geometry changed in response to the forces of floods and tides.

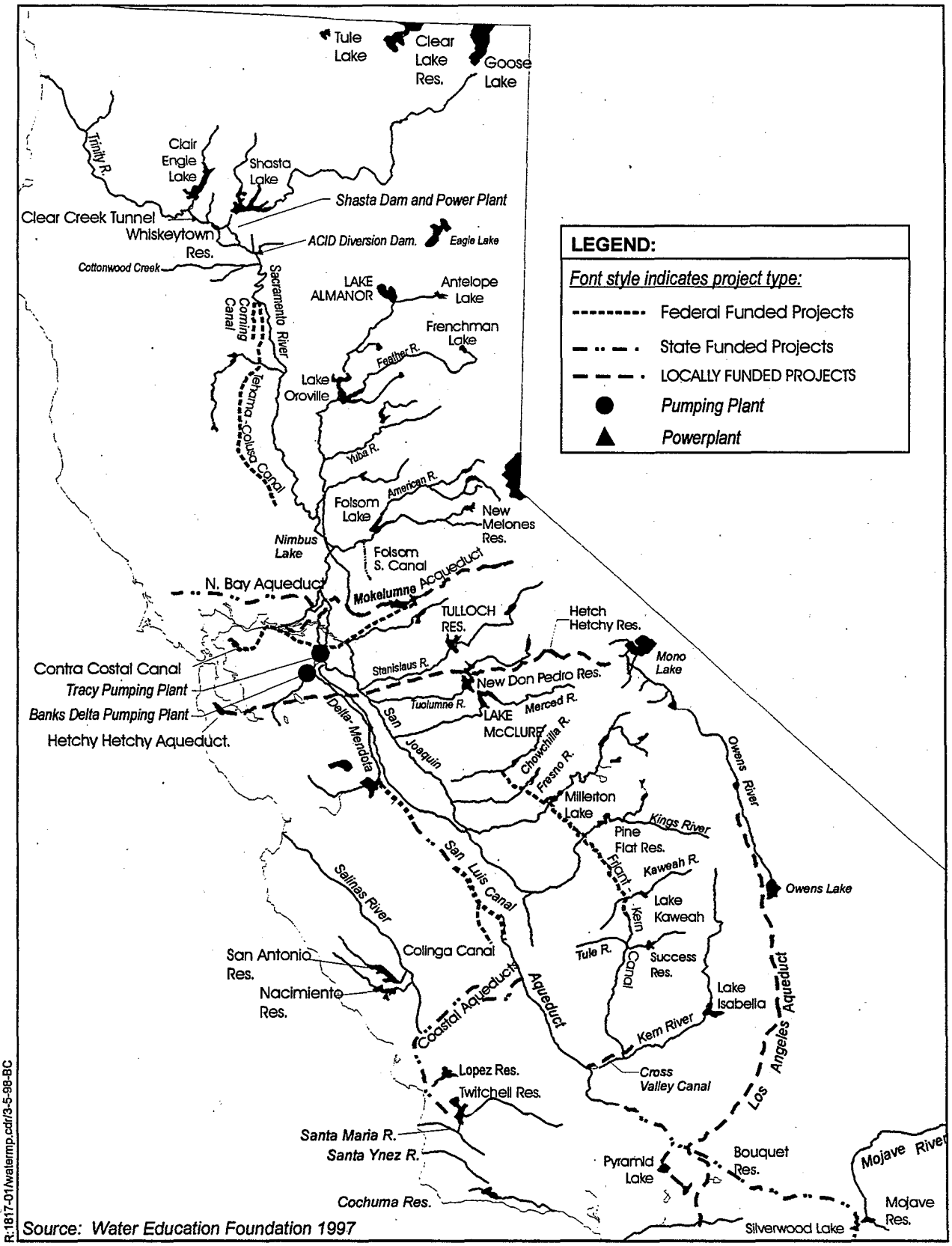


Figure 6.1.1-1. Surface Water Features Location Map

Salton Sea

By 1930, nearly all Delta marshland had been reclaimed for agriculture, peat production, and urban and industrial uses. Delta channels and islands became more permanently established. New linear channels were dredged, replacing natural meandering channels. These new channels were constructed for navigation, to improve circulation, and to provide the material needed for levee construction. Examples of new channels include Grant Line Canal, Victoria Canal, Empire Cut, Columbia Cut, and the Delta Cross Channel. The two major navigation waterways include the Stockton Deep Water Channel, completed in 1933 (along the San Joaquin River), and the Sacramento Deep Water Channel, completed in 1963.

Water exports from the Delta began in 1940, following completion of the Contra Costa Canal, a unit of the CVP. In 1951, the Tracy Pumping Plant began supplying water to the Delta-Mendota Canal. The SWP began exporting water through the South Bay Aqueduct in 1962 (through an interim connection to the CVP's Delta-Mendota Canal). Due to increased water demand, the SWP began pumping from the south Delta in 1967 (supplying the California Aqueduct) and from the north Delta in late 1987 (supplying the North Bay Aqueduct).

To facilitate movement of Sacramento River water to pumping facilities in the south Delta, the U.S. Bureau of Reclamation completed the Delta Cross Channel in 1951. This channel connects the Sacramento River to Snodgrass Slough and the Mokelumne River system. The flow from the Sacramento River is controlled by two 60-foot gates on the Sacramento River near Walnut Grove. Downstream from the Delta Cross Channel, Georgiana Slough also connects the Sacramento River to the Mokelumne River system, allowing Sacramento River water to enter the central Delta.

Twice-daily tides move water from San Francisco Bay into the Delta. The average incoming and outgoing Delta tidal flow is about 170,000 cfs at Chipps Island. By comparison, the current permitted SWP and CVP combined export capacity is about 11,000 cfs. Historically, during extremely low runoff periods in the summer, salt from tidal flows intruded into the Delta as far as Hood. During the winter and spring, freshwater from heavy rains pushed the saltwater back, well into the Bay, and sometimes beyond. Saltwater intrusion into the Delta during the summer is controlled by tides, freshwater inflows from reservoir releases, and Delta pumping. Reservoir storage and releases have resulted in increased summer and fall flows and dampened peak winter and spring flows. In very wet years, such as 1969, 1982, 1983, and 1986, reservoirs are unable to control runoff, and salinity in the Bay is nearly reduced to freshwater levels.

Average net Delta outflow measured at Chipps Island is about 30,000 cfs or about 21 million acre-feet (MAF) per year. Average natural freshwater in-flow to the Delta varies by a factor of more than 10 between the highest month in winter or spring and the lowest month in fall. During the summer months of critically dry years, net Delta outflow can fall as low as 3,000 cfs.

The three major sources of freshwater to the Delta are the Sacramento River, the San Joaquin River, and eastside streams. The Sacramento River (including the Yolo Bypass) contributes about 77 to 85% of the freshwater flows to the Delta. The San Joaquin River contributes roughly 10 to 15%. Streams on the east side, including the Mokelumne River, provide the remainder of the Delta inflow. On average, about 10% of the Delta inflow is withdrawn for local use, 30% is withdrawn for export by the CVP and SWP, 20% is needed for salinity control, and the remaining 40% is Delta surplus, the outflow in excess of minimum identified requirements. However, it provides benefits to the Bay ecosystem. Delta surplus is negligible during most dry seasons.

During dry periods, water is released from upstream reservoirs to establish a hydraulic barrier to reduce intrusion of saline water from intruding into the Delta and to protect municipal and agricultural water supplies. The hydraulic barrier, where freshwater gradually mixes with saline water, is generally maintained near Chipps Island. During high flows, the mixing zone moves downstream into the Bay.

The location of the mixing zone between fresh water from the Delta and saline water from the Bay varies with the amount of Delta outflow, as well as tides. It is pushed bayward during periods of high Delta outflow and can move up into the Delta if Delta outflow is low or during spring neap tides. In order to track and regulate this movement, a standard has been developed, called X2, which represents the mean distance in kilometers from the Golden Gate Bridge, where the salinity concentration is two parts per thousand and the electrical conductivity is 2,640 micro siemens per centimeter (μs/cm). The X2 position approximates the location of the entrapment zone, an area of high biological productivity. The Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta defines requirements for maintaining X2 at Chipps Island and at Port Chicago.

Water Quality. Historically, concerns over water quality have grown in proportion to the increasing demand for Delta water for drinking water supply and agricultural use. Hydraulic and hard-rock mining for gold in the late 1800s produced the first significant impacts to water quality. Vast amounts of sediment, containing high levels of heavy metals (cadmium, copper, zinc, and mercury) were washed from the hillsides and carried downstream to be deposited in river beds, Delta tidal marshes, and mudflats. These metals are still considered to be contaminants of concern because of their continuing potential to cause adverse effects on beneficial uses in the Delta. Sampling in the Sacramento River from 1987 to 1992 indicates that about 75% of the mass of these metals found in sediments can be traced to past mining activities.

The growth of agriculture, enabled by the diversion of irrigation water from the rivers and Delta during this century has also led to water quality concerns. The application of fertilizers and pesticides on 500,000 acres of farmland within the Delta and another 4.5 million acres in the San Joaquin and Central Valley has resulted in adverse effects on the beneficial uses of water for drinking, fishery resources, recreation, and agricultural uses.

Water quality in the San Joaquin River and the south Delta has been affected by salts, which are concentrated in shallow groundwater on the west side of the San Joaquin Valley, that must be pumped in order to drain agricultural lands. Responses to the problem have included curtailment of discharges of drain water to the river, reduction in applied irrigation, and retirement of some irrigated land.

Over the past 50 years, water exports from the Delta to the state and federal water projects have increased ten-fold. Average annual exports now total approximately 18% of the average annual inflow to the Delta. Saltwater intrusion into the Delta is intensified by diversion of freshwater and the corresponding decrease of freshwater outflow from the Delta. As a result, the western Delta often experiences increased salinity during spring and summer. High salinity adversely affects the quality of drinking and irrigation water.

More recently, urban development and population growth within the Delta have intensified adverse impacts to water quality and, at the same time, have increased demand for better water quality. Industrial and sewage treatment plant discharges are strictly regulated to prevent adverse water quality impacts, but runoff from urban and agricultural areas is much more difficult to control. Runoff, containing oil, grease, metals, pesticides, fertilizers, and many other pollutants, contributes significantly to the pollution of Delta and Bay waters.

In conjunction with urban growth, the demand for high quality drinking water also increases. Chlorination to treat water for domestic consumption produces several undesirable by-products, including trihalomethanes.

Water Supply and Water Management. Historically, the entire discharge from the combined Sacramento/San Joaquin River system flowed to San Francisco Bay via the Delta region. The range of annual Delta unimpaired flow is quite large, reflecting the extreme climatic and hydrologic variability that characterizes the Central Valley watersheds. The average annual unimpaired Delta inflow is about 27.8 MAF but

ranges from less than 7 MAF to greater than 70 MAF.

In the years from 1967 through 1991, following completion of the H.O. Banks pumping plant, average Delta inflow was 25 MAF and exports averaged 5 MAF. The average annual Delta outflow to the Bay was about 20 MAF.

Historically, there have been several months each year when Delta inflow exceeded the flows necessary to satisfy the estimated minimum Delta outflow, supply in-Delta diversions, and provide all needed export pumping. This unallocated discharge provided additional water quality and ecological benefits to the Delta and downstream.

Existing Conditions. Today the Delta consists of about 740,000 acres, including approximately 500,000 acres of rich farmland, interlaced with hundreds of miles of waterways that divide the Delta into islands. Some of the island interiors are as much as 25 feet below sea level. Therefore, the Delta relies on about 1,100 miles of levees for flood protection.

Hydrodynamics and Hydraulics. Delta hydrodynamic conditions are primarily determined by inflow to the Delta from tributary streams, daily tidal inflow and outflow through the Bay, and pumping from the south Delta through the Banks and Tracy pumping plants. Since tidal inflows are about equal to tidal outflows during each daily tidal cycle, tributary inflows and export pumping are the principal variables that define the range of hydrodynamic conditions in the Delta.

As discussed in Section 6.1.2.3, existing conditions were not simulated in time for inclusion in this evaluation. Instead, the No Action Alternative was modeled, and differences between no action and existing conditions are described qualitatively. Results of the no action simulation are discussed later in this section.

Water Quality. Water quality is affected by many constituents and characteristics. Concentrations and loadings of metals, salts, organic compounds and pathogens plus measures of other parameters of concern, such as turbidity, temperature, pH, and dissolved oxygen all affect the quality and thus the beneficial uses of water.

Specific beneficial uses of Delta water have been identified by San Francisco Regional Water Quality Control Board, and specific water quality objectives have been developed to protect these uses. Similar lists of beneficial uses have been developed for surface water in other regions. The beneficial uses fall within five general classes: environmental, urban, agricultural, recreational, and industrial.

Although there are many urban uses of water, the most important use is drinking water. Drinking water standards are often, but not always, the most conservative standards, since they are designed to be protective of human health or to maintain aesthetic qualities of taste, color, and odor. Some of the standards to protect environmental beneficial uses are more conservative than drinking water standards. One of the most important distinctions between drinking water standards and environmental standards may be the point at which the standards apply. Environmental standards are typically in-stream standards, while drinking water standards apply at the point of use. Thus, poor quality water may be stored and treated to meet drinking water standards. Treatment of raw water containing dissolved natural organic carbon components (DOC) or bromide can result in the formation of hazardous by-products. As a result, DOC and bromide are undesirable in raw water. Some of the water quality parameters that are very important for agriculture or industry are less important for drinking water. For example, temperature, boron, and sodium absorption ratio (SAR) are not very important drinking water concerns but are very important agricultural concerns. Similarly, alkalinity is an important industrial water quality concern but is less important in drinking water. Recreational beneficial uses may include in-stream uses. Water quality standards may be designed to reduce hazards associated with contact with contaminated water, or to prevent bioconcentration of contaminants in fish and wildlife, or to prevent degradation of aesthetic qualities, such as water clarity.

Water quality in the Delta not only impacts the Delta, it also affects each of the regions to which Delta water is exported. Although this discussion of water quality falls within the Delta Region section, the discussion can be applied to the CVP and SWP service areas generally. Water quality parameters of concern to each of the general classes of beneficial uses of water are listed in Table 6.1.1-1.

Varying hydrologic conditions (such as rainfall and water storage releases), seasonal demands for water diversion, and changing agricultural drainage flows produce large fluctuation in Delta water quality. The concentrations of parameters of concern are closely linked to present and historical land uses in the Delta upstream and downstream watersheds. Principal sources include:

- Drainage from inactive and abandoned mines of metals such as cadmium, copper, zinc, and mercury;
- Stormwater inflows and urban runoff contribute metals, turbidity, pathogens, organic carbon, nutrients, pesticides, petroleum, and other chemical residues;
- Municipal and industrial waste water discharges contribute salts, metals, trace elements, nutrients, pathogens, oil and grease, and turbidity;
- Surface agricultural and grazing land return flows, and nonpoint discharges contribute salts, nutrients, pesticide residues, pathogens, and turbidity;
- Subsurface agricultural drainage contributes salts, selenium, nutrients, and some pesticide residues;
- Water-based recreational activities (such as boating) contribute hydrocarbon compounds, some pesticides, nutrients, turbidity and pathogens; and
- Atmospheric deposition contributes metals, pesticides, and some organic chemicals, and may lower pH.

The current water quality conditions within the Delta vary, not only by season but also by distance from the various sources or activities described above. The significant water quality issues in the Delta region considered for this analysis have been summarized as follows:

- High-salinity water from Suisun and San Francisco bays intrudes eastward into the Delta during periods of low Delta outflow. Elevated salinity may adversely affect all beneficial uses. Bromides are a particular problem for municipal water supply.
- Synthetic chemicals (such as pesticides and herbicides) and natural contaminants (heavy metals) have accumulated in sediments in the Delta and can accumulate in aquatic organisms. For example, mercury and DDT, which bioaccumulate through the foodweb, in fish and shellfish can exceed acceptable limits for human consumption. Disturbance of contaminated sediments can release these constituents into the water column.
- Agricultural drainage to the Delta contains high levels of nutrients, suspended solids, dissolved organic carbon, salinity, selenium, boron, and chemical residues. All of these constituents may have adverse impacts on beneficial uses of Delta water.
- Heavy metals, including cadmium, chromium, copper, mercury, and zinc, continue to enter the Delta. Sources of these metals include runoff from abandoned mine sites, tailings deposits, downstream sediments, where the metals have been deposited over the past 150 years, and urban runoff. High metals concentrations have the greatest potential for adverse effects on drinking water supply and environmental and recreational uses.

Environment	Urban	Agriculture	Recreation	Industrial
Metals & Toxic Elements	**Disinfection By-product Precursors**	**Other**	**Metals**	**Other**
Cadmium	Bromide	Boron	Mercury	Salinity
Copper	DOC	Chloride	**Organics/Pesticides**	pH
Mercury	Chloride	Nutrients (Nitrate)	PCBs	Alkalinity
Selenium	**Other**	pH (Alkalinity)	DDT	Phosphates
Zinc	Pathogens	Salinity (TDS, EC)	**Other**	Ammonia
Organics/Pesticides	Turbidity	SAR	Pathogens	
Carbofuran	Salinity (TDS)	Turbidity	Nutrients	
Chlordane	Nutrients (Nitrate)	Temperature		
Chlorpyrifos	pH			
DDT				
Diazinon				
PCBs				
Toxaphene				
Other				
Ammonia				
Dissolved Oxygen				
Salinity (TDS, EC)				
Temperature				
Turbidity				
Unknown Toxicity[a]				

NOTE:

[a] Unknown toxicity refers to observed toxicity to aquatic organisms, the source of which is unknown.

Table 6.1.1-1. Water Quality Parameters of Concern to Beneficial Uses

- The estuarine salinity gradient and its associated entrapment zone (where biological productivity is relatively high because of the mixing dynamics and accumulation of suspended materials) affect the quality and extent of habitat for some estuarine species. The entrapment zone and adjacent habitats support fish food production in the Delta. The location of the entrapment zone and its extent, controlled by Delta outflow, directly affect environmental and dependent recreational beneficial uses.

Actual concentrations and loadings of parameters of concern are not easily quantified. Water quality is continually changing over time and space. Monitoring stations, where concentrations of pollutants are measured, are spread widely throughout the Delta and contiguous waterways, and measurements are generally recorded only at discrete intervals, ranging from daily to a few times a year. However, estimates of current parameter concentrations and loadings are necessary to provide not only a measure of the quality of Delta and tributary waters, but also the potential impacts of the proposed alternatives and actions.

Present and future pollutant load estimates are based on limited data and many assumptions. The approaches and methods used to estimate contaminant loads within each region are explained in the Water Quality Technical Appendix. In brief, existing contaminant loads are estimated by multiplying measured concentrations in some discharge or receiving waters by the mean flows at or near monitoring locations. Flows and contaminant concentrations vary from year to year, between seasons, and as a result of rainfall in the upper watershed or at the monitoring location. Thus, data from different years and different seasons, representing different meteorological conditions were combined to produce single annual load estimates to better approximate typical conditions. For each parameter of concern, the average daily load (in

pounds per day) is equal to the average daily concentration multiplied by average daily flow. The average annual load (in pounds per year) is equal to the sum of the average daily loads for the year divided by the number of days per year.

Estimated loadings of parameters of concern have been calculated where data have been available, for the Delta, the Bay, the San Joaquin River, and the Sacramento River. The Sacramento River Region estimates were further divided into loads generated above and below the three major dams, Shasta, Oroville, and Nimbus. A summary of the estimated average annual loads for constituents of concern, for which data are available, is provided in the Water Quality supporting document.

Water Supply and Water Management. Average flows in the Delta are about 22 MAF, with a range of less than 8 MAF to more than 68 MAF (in very dry and very wet years, respectively). The required Delta outflows under the 1995 WQCP objectives average 5.5 MAF, with a range of less than 4 MAF to about 8 MAF. The simulated in-Delta net channel depletions are about 1.2 MAF. Total exports average 6.4 MAF, with a range of from less than 3 MAF to about 8 MAF. Average annual deliveries to the SWP-CVP Service areas are about 5.5 MAF. For critically dry hydrologic conditions, the period from May 1928 through October 1934, average annual deliveries have been estimated to be about 4 MAF.

Simulated unallocated annual Delta outflow (to the Bay) ranges from less than 0.1 MAF to more than 50 MAF, with an average of 8.7 MAF. Delivery deficits can occur during dry years due to lack of available water. Exports also can be limited by pump capacity, permitted pumping limits, lack of aqueduct demands, and lack of off-aqueduct reservoir storage.

At the 1995 level of demand, approximately 46 % of water use during average water years in California goes to environmental purposes. This percentage is expected to remain constant through the year 2020. The distribution of the remaining water between urban and agricultural uses is expected to shift, however, toward urban uses, with urban use increasing from about 11 % to 15 % during the 25-year period and agricultural use decreasing from about 43 % to 39 % (DWR 1997). This change is primarily a result of a predicted decline in irrigated acreage. More detailed information about the distribution of water demand is included in other sections of this report.

6.1.1.2 Bay Region

The San Francisco Bay system includes the Suisun, San Pablo, and South bays. The Golden Gate, the outlet of San Francisco Bay, is located 85 miles from Chipps Island, the outlet of the Delta to Suisun Bay. To the north of Suisun Bay and east of Carquinez Strait lies the Suisun Marsh, an extensive mosaic of variably-controlled tidal marshlands. Tributaries to San Pablo Bay include the Napa, Sonoma, and Petaluma rivers. The principal tributary to the South Bay is Coyote Creek. There are numerous lesser streams that collectively drain the Bay Region.

Historical Perspective. The rapid influx of new settlers following the discovery of gold in 1848 resulted in almost immediate changes to the Bay Region. Marshland around the Bay was filled to provide more land for homes and industry.

Levees were constructed to convert formerly flooded marshlands to arable islands. Valley lands were drained for farming, and Central Valley streams were dammed for water supply. Hydraulic mining for gold in the Sierra foothills washed large amounts of sediment into streams and channels leading to the Bay. All of these activities caused changes in the quantity and quality of water reaching the Bay. Additionally, untreated municipal and industrial wastes were discharged directly into the Bay.

Increased urban growth has resulted in severe point and nonpoint loading to the Bay. Metals and persistent organic compounds were routinely discharged to the Bay and have resulted in severe impacts on the food web through sediment loading. Discharges of untreated sewage have been addressed in recent years through upgrading municipal wastewater treatment facilities. Development of water quality standards based on

loading of toxic chemicals, particularly certain metals, has resulted in increased scrutiny of industrial wastewater discharges and development of treatment technologies. Many streams are channelized through urban areas for flood protection, and most streams are intermittent. In most areas, municipal and industrial water is imported and stored locally in reservoirs near urban areas. Activities in the watershed of these reservoirs are restricted to protect public water supplies.

Existing Conditions. San Francisco Bay currently has a surface area of about 400 square miles at mean tide level. Most of the Bay's shoreline has a mild slope, which creates a relatively large intertidal zone. The volume of water in the Bay changes by about 21% from mean higher-high tide to mean lower-low tide. The overall average depth of the Bay is only about 20 feet, with the Central Bay averaging 43 feet and the South Bay averaging 15 feet. San Francisco Bay is surrounded by about 130 square miles of tidal flats and marshes.

In addition to Delta outflow, San Francisco Bay receives freshwater inflow from the Napa, Petaluma, and Guadalupe rivers and from Alameda, Coyote, Walnut, and Sonoma creeks and the lesser streams. The total average inflow of these tributaries (excluding the Delta) is about 350 thousand acre-feet (TAF). Stream flow is highly seasonal, with more than 90% of the annual runoff occurring during November through April.

Suisun Bay and the adjacent 80,000-acre Suisun Marsh are located near the downstream end of the Delta. Suisun Bay is the area where the effects of mixing freshwater and saltwater are most pronounced most of the time.

Downstream of Carquinez Strait are the San Pablo and central San Francisco Bays. Carquinez Strait separates these bays from Suisun Bay and the Delta and allows such oceanic conditions as tides to play a leading role in their salinity and circulation. These embayments can become quite fresh, especially at the surface, during extremely high freshwater flows, such as happened during February 1986. During these high flows, the entrapment zone can be temporarily relocated downstream to San Pablo Bay. During periods of low freshwater flows and high tides, these embayments are quite saline.

South Bay is different from the other parts of the system. This area is not in the main path of Delta outflows, and water quality is not significantly affected by Delta outflow, except during sustained high outflow periods. During low Delta outflow periods, evaporation, combined with limited tidal flushing, can cause salinity levels to be higher in the South Bay than in the ocean outside the Golden Gate. Large level tracts of the South Bay are still used as evaporation ponds for salt production.

The Bay Region receives unallocated and minimum required out-flows from the Delta Region. These can range from the minimum required flows of less than 4 MAF to nearly 60 MAF, depending on precipitation and diversions. This water is used in the Bay Region primarily for ecological and water quality maintenance purposes.

6.1.1.3 Sacramento River Region

The Sacramento River Region contains the entire drainage area of the Sacramento River and its tributaries and extends almost 300 miles from Collinsville in the Sacramento-San Joaquin Delta north to the Oregon border. The total land area within the region is 26,960 square miles. Average annual precipitation is 36 inches, and average annual runoff is approximately 22.4 million acre-feet.

Historical Perspective. For more than 100 years the flows in the Sacramento River have been subject to some regulation as the result of construction and operation of storage facilities. By 1900, storage capacity on the Yuba River, a tributary of the Sacramento River, already exceeded 30,000 acre-feet.

Hydrodynamics and Hydraulics. Construction of larger reservoirs began in the 1920s and continued through the 1960s. Some key milestones for the Sacramento River region included construction of

Lake Shasta as part of the CVP, and Oroville Dam and Reservoir on the Feather River as part of the SWP. The 4.55 million acre-feet capacity Lake Shasta began storage in 1943 and is the largest man-made reservoir in California. Lake Oroville has a capacity of 3.54 million acre-feet and began storage in 1967.

The Sacramento River enters the Delta at Freeport. The drainage area upstream of the gaging station at Freeport (USGS Station 11447650) is listed as "indeterminate," but the drainage area of the Sacramento River above Sacramento, 11 miles to the north, is 23,502 square miles. The historical average annual flow is 16.7 million acre-feet at Freeport, which is more than twice the average annual flow measured in the Sacramento River above the confluence with the Feather River. The maximum mean monthly discharge at Freeport measured for the period of record was 71,340 cfs (March 1986); the minimum mean monthly discharge was 4,494 cfs (October 1977).

The flow data for this station do not account for the upstream flood overflows that bypass the Sacramento River, at Freeport through the Yolo Bypass. Most of the flood flows that come from the upper Sacramento River, Feather River, and Sutter Bypass are also diverted to the west of the Sacramento area by spilling over the Fremont Weir at Verona into the Yolo Bypass. Overflows occur at this point when Sacramento River flows, as measured at Verona (USGS Station 11425500), exceed 55,000 cfs. Sacramento River overflows also may enter the Yolo Bypass just north of Sacramento when the Sacramento Weir gates are open.

Water Quality. Past mining practices, particularly hydraulic mining from the late 1800s until the 1920s, resulted in the discharge of huge quantities of sediment into major tributaries in gold-producing areas. Mining operations continued to be a major source of toxic chemical loading to streams in some areas, including the Clear Creek watershed and local watersheds of the Sierra Nevada. Logging operations have resulted in increased erosion and reduced retention over widespread areas of upper watersheds of the Sierra Nevada and Cascade Ranges. With regard to other water quality issues, the discussion of the historical water quality in the Preceding section under Delta Region: Historical Perspective also applies to the Sacramento River.

Water Supply and Water Management. The Sacramento River region contributes the majority of Delta inflows. Combined historic, unimpaired flows from the major rivers of the Sacramento system (Sacramento, Feather, Yuba, and American rivers) averaged about 17 MAF and ranged from 5 MAF to 38 MAF during the 1969-1991 period. Of this, the Sacramento River (at Red Bluff) averaged 8 MAF (including Trinity River imports, described below), the Feather River averaged 4.3 MAF, the Yuba River averaged 2.3 MAF, and the American River averaged 2.6 MAF. Overall "excess" (unallocated) flows from the Sacramento River (including Trinity River diversions) at the Delta have averaged 5.4 MAF, and ranged from about 0.64 MAF to nearly 20 MAF.

Since 1900, numerous reservoirs have been constructed in or have affected this region. These include Shasta Lake, Lake Oroville, Clair Engle Lake, and Folsom Reservoir, as well as numerous smaller reservoirs. Total reservoir capacity in or affecting the Sacramento Region is approximately 15.25 MAF, or nearly one year of average system discharge. Historically, these reservoirs have been operated to provide agricultural and domestic water supplies, flood control capacity and, more recently, recreation and ecological flows.

Historic instream flow requirements for the Sacramento River below Shasta Dam have been about 2.9 MAF, and average pre-1980 diversions (these diversions were halted in 1980) have been about 1 MAF. Average Shasta Lake storage was about 2.8 MAF. Historic Feather River allocations have been about 0.87 MAF for instream flows and 0.79 MAF for diversions. Average annual carryover storage in Oroville Reservoir has been about 2.2 MAF. Historic Feather River allocations have been 0.23 MAF of instream flows, with direct water uses of about 0.43 MAF. Folsom Lake had an average annual

carryover storage of 0.56 MAF. In 1962, Clair Engle Lake was constructed on the Trinity River, allowing water from that river to be diverted to the Sacramento River system via the Clear Creek Tunnel Diversion. An average of about 1.3 MAF of runoff occurs in the Trinity River watershed, with a range of 0.2 MAF to 3 MAF. An average of about 1 MAF has been diverted annually from Trinity River to the Sacramento River (1962 through 1991).

The population of Sierra foothill upper watershed areas boomed in the mid-late 1800s, then declined but over the past 20 years has once again increased dramatically, increasing water demand for municipal use. Dams have been constructed on nearly every tributary to increase storage and operational flexibility. Many upper watershed streams contain multiple reservoirs that control flows, store water, produce power, and provide recreation.

Existing Conditions. The two major tributaries to the Sacramento River along its lower reach are the Feather River (which also includes flows from the Yuba River) and the American River. The combined flows of the Feather River and Sutter Bypass enter the river near Verona. The American River joins the Sacramento River north of downtown Sacramento. Smaller contributions are made by the Natomas Cross Canal, draining the area between the Bear River and American River drainages, and the Colusa Basin Drain, which drains the west side of the Sacramento Valley from about Willows south to Knights Landing.

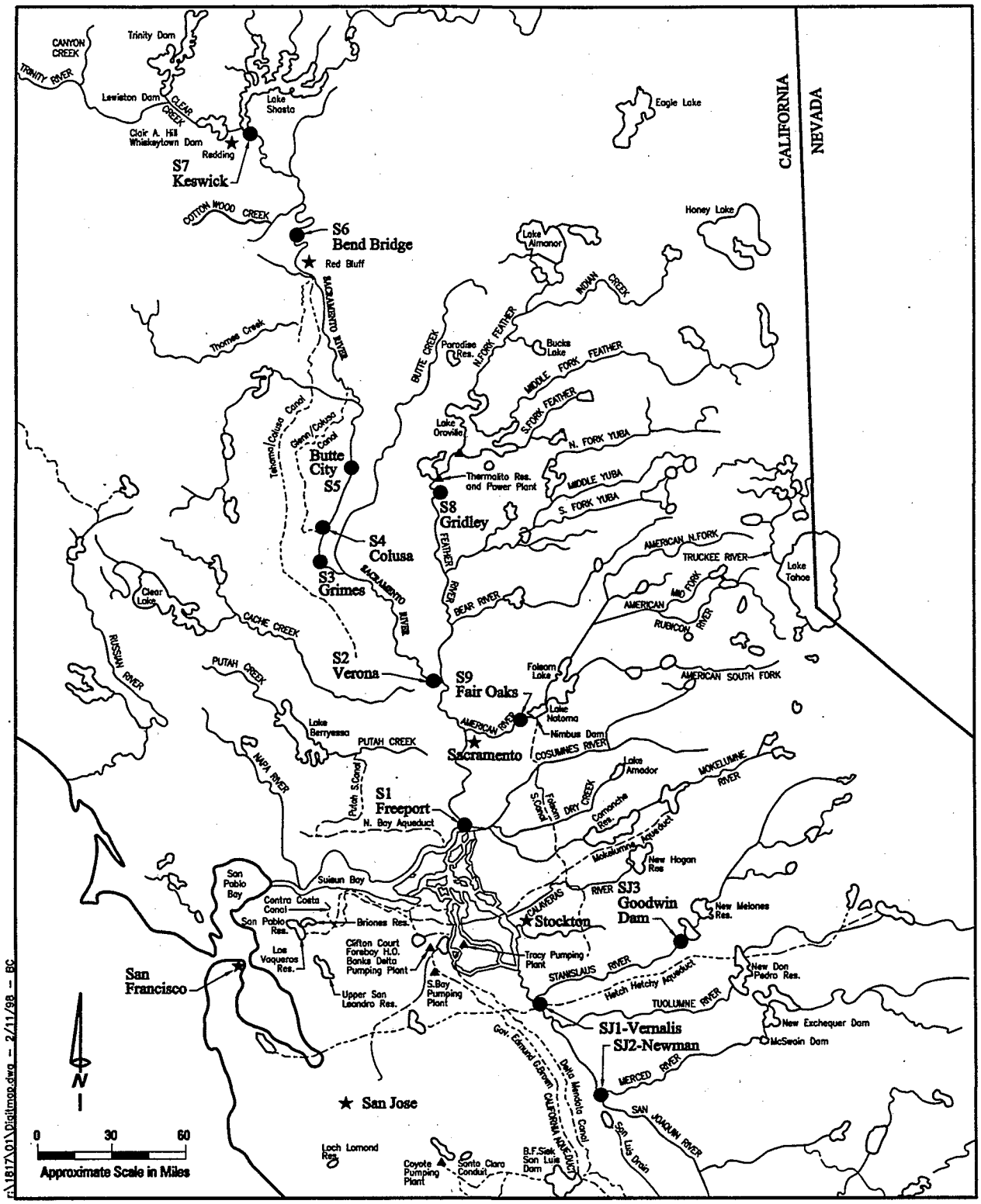
Hydrodynamics and Hydraulics. Nine locations have been selected as the focal points for analyzing current hydraulic conditions in the Sacramento River Region (Figure 6.1.1-2). The locations were selected based on their proximity to principal hydraulic features in the region and include stations on both the Feather and American rivers.

The DWRSIM model was used to simulate monthly flows. Flow simulations illustrate how the current storage and conveyance facility configurations would respond to the 73-year record of hydrologic input data from water year 1922 through water year 1994. Hydraulic geometry equations were derived from recent USGS gaging station data. These equations were used to estimate the mean velocity, stream width, and mean depth corresponding to the simulated average monthly discharges at each study location.

The results of the flow simulations for existing conditions for February and September are presented in Table 6.1.1-2. The maximum, minimum, and average values of hydraulic parameters for February and September are shown in the table. February was selected to represent wet season flows because average flows are highest in that month. September represents dry season flows because average flows are lowest during that month.

The values shown in the table are estimates for comparison purposes. They depend on local stream channel geometry at the measurement points. It should also be noted that average velocities are calculated from the average monthly discharge divided by the cross-sectional area of the stream channel. Stream velocities at any point are greater in the center of the channel and lower at the margins and near the channel bottom due to friction. In addition, flow conditions may vary considerably over a month, particularly during the wet season.

Figure 6.1.1-3 shows the distribution of the simulated average monthly flows at Freeport using the 73-year hydrologic record. The Freeport station is used to represent the point at which the Sacramento River enters the Delta. In Figure 6.1.1-3, the heights of the bars correspond to the rate of discharge that is exceeded with the frequency shown in the table below. The exceedence frequencies are based on the %ile ranking of the discharge values for the month. The %ile is calculated by ranking the values from smallest to largest. Since DWRSIM calculates the average monthly discharge for each month of the 73-year simulation period, there are 73 discharge values associated with each month.



LEGEND:

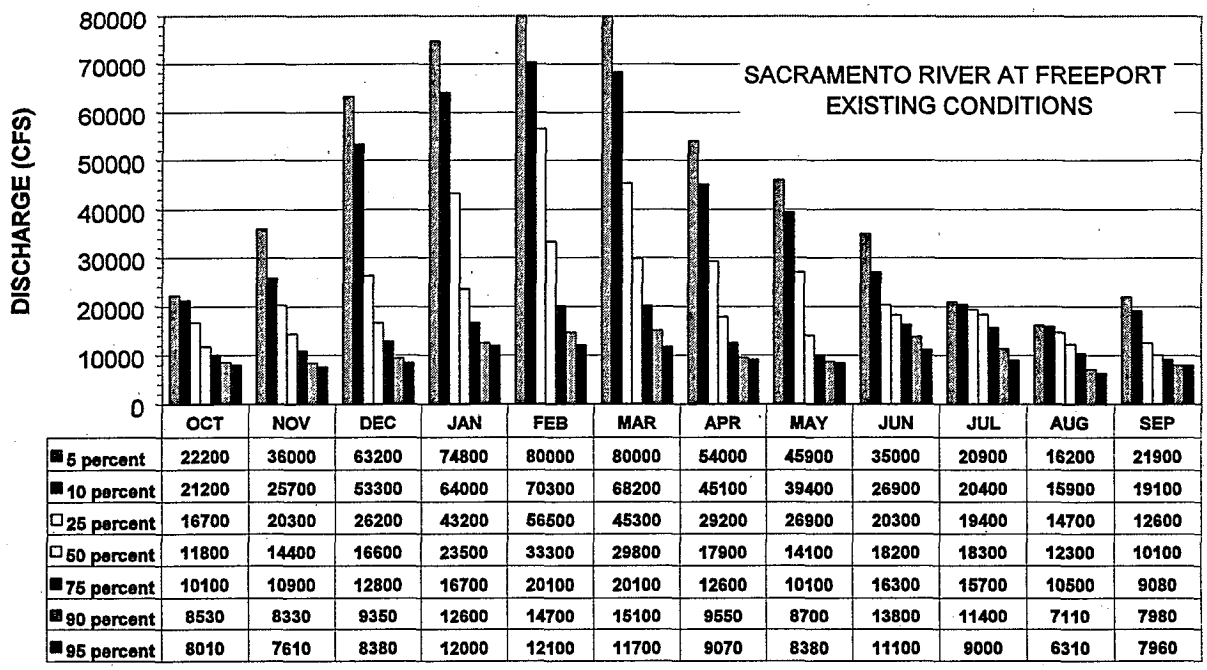
● Station locations

------- Aqueduct/canal

Figure 6.1.1-2. River Hydraulics Study Location Map

FLOW CONDITIONS BASED ON 73-YEAR HYDROLOGIC RECORD.	CP#137, GS4476.5, SAC. R @ FREEPORT	CP#61, GS4255, SAC. R. @ VERONA	CP#61, GS3905, SAC. R. BLW WILKINS SLOUGH NR. GRIMES	CP#120, GS3890, SAC. R. @ BUTTE CITY	CD#120, SAC. R. @ COLUSA	CD#73, SAC. R. ABV. BEND BRIDGE	CP#62, GS3705, SAC R. @ KESWICK	CP#9, GS 4465, AM. R. @ FAIR OAKS	CP#106, GS4071.5, FEA. R. NR. GRIDLEY
Location Map Station >	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
FEBRUARY									
Discharge (cfs)									
Maximum	95090	107874	107874	78056	78056	53694	46186	33005	24884
Minimum	11632	3997	3997	4808	4808	3619	3241	504	900
Average	38605	25227	25227	20257	20257	13198	10966	5168	6194
Mean Velocity (fps)									
Maximum	4.26	4.48	5.81	6.13	4.86	6.24	7.25	6.04	4.24
Minimum	1.34	1.67	2.25	1.42	2.26	4.16	1.94	0.70	0.34
Average	2.60	3.02	3.82	3.02	3.35	5.06	3.63	2.32	1.84
Top Width (feet)									
Maximum	621	839	375	509	389	569	629	462	317
Minimum	564	460	213	459	269	335	429	260	275
Average	596	536	292	484	326	382	516	358	299
Mean Depth (feet)									
Maximum	36.2	30.6	49.7	25.5	40.1	14.7	10.1	12.2	9.9
Minimum	16.2	5.2	8.3	7.4	7.9	2.6	3.9	2.7	9.1
Average	25.6	15.5	22.6	14.0	18.5	7.0	5.8	6.3	9.3
SEPTEMBER									
Discharge (cfs)									
Maximum	27494	14638	14638	14621	14621	13327	13041	4790	6420
Minimum	7999	4437	4437	6016	6016	6117	6000	504	756
Average	12722	6689	6689	7630	7630	7159	6974	1865	1613
Mean Velocity (fps)									
Maximum	2.15	2.54	3.27	2.54	3.07	5.06	3.96	2.23	1.90
Minimum	1.09	1.73	2.32	1.59	2.40	4.50	2.66	0.70	0.29
Average	1.41	1.97	2.61	1.81	2.56	4.61	2.87	1.37	0.57
Top Width (feet)									
Maximum	587	512	266	478	312	382	530	354	299
Minimum	555	464	217	463	278	353	471	260	273
Average	567	480	233	467	286	359	482	311	282
Mean Depth (feet)									
Maximum	22.5	11.2	16.8	12.1	15.4	7.0	6.1	6.1	9.3
Minimum	14.0	5.5	8.8	8.2	9.1	3.8	4.7	2.7	9.1
Average	16.8	7.1	11.0	9.1	10.5	4.3	5.0	4.4	9.2

Table 6.1.1-2 Range of Existing Hydraulic Conditions at Selected Stations in the Sacramento River Region



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
5 percent	22200	36000	63200	74800	80000	80000	54000	45900	35000	20900	16200	21900
10 percent	21200	25700	53300	64000	70300	68200	45100	39400	26900	20400	15900	19100
25 percent	16700	20300	26200	43200	56500	45300	29200	26900	20300	19400	14700	12600
50 percent	11800	14400	16600	23500	33300	29800	17900	14100	18200	18300	12300	10100
75 percent	10100	10900	12800	16700	20100	20100	12600	10100	16300	15700	10500	9080
90 percent	8530	8330	9350	12600	14700	15100	9550	8700	13800	11400	7110	7980
95 percent	8010	7610	8380	12000	12100	11700	9070	8380	11100	9000	6310	7960

MONTH

Figure 6.1.1-3. Flow Frequencies, Sacramento River at Freeport, Existing Conditions

The maximum simulated discharge at Freeport in the month of February is 95,486 cfs; the minimum is 11,002 cfs, and the average is 38,893 cfs. Figure 6.1.1-2 provides more information about the distribution of values between the extremes. Under the column representing the month of February in Figure 6.1.1-3, the first value corresponds to the highest bar in the chart above it and is 80,000 cfs. This is the discharge that would be exceeded in 5 out of 100 years in February at Freeport. Therefore, this discharge has a 5% probability of being exceeded.

Water Quality. The discussion of current water quality conditions in the corresponding subsection in the preceding section under Delta Region: Existing Conditions also applies to the Sacramento River Region. Summaries of loadings of the major contaminants of concern are provided in the water quality supporting document.

Water Supply and Water Management. Total flows on the Sacramento River system above the Delta region average approximately 19.9 MAF annually. Average total diversions are about 6.1 MAF.

Based on historical conditions, total average annual runoff in the Sacramento River Basin upstream of the Feather River is approximately 11 MAF, of which approximately 5.9 MAF per year on average flows into Shasta Reservoir. The average instream flow requirement on the Sacramento River, just upstream of the Feather River, is approximately 3.6 MAF. Average total diversions between Shasta Lake and the Feather River are about 3.2 MAF. The average historic unallocated flow on the Sacramento River above the confluence with the Feather River is about 4.2 MAF.

Combined Feather/Yuba/Bear River flows are about 6.3 MAF. Of these, about 2.5 MAF are diverted on these rivers. Instream flow requirements are about 0.85 MAF.

Annual inflows on the American River (at Folsom Reservoir) average about 2.6 MAF. Direct uses for instream flow requirements average 1.5 MAF, and diversions average about 0.4 MAF.

The most intensive runoff occurs in the upper watershed of the Sacramento River above Shasta Reservoir and on the rivers originating on the west slope of the Sierra Nevada. These watersheds produce an annual average of 1,000 to more than 2,000 acre-feet (AF) of runoff per square mile annually.

6.1.1.4 San Joaquin River Region

The San Joaquin River Region includes the Central Valley south of the watershed of the American River. It is generally drier than the Sacramento Valley, and flows into the Delta from the San Joaquin River are considerably lower than those from the Sacramento River. The region is also subject to extreme variations in flow, as exemplified by flooding that occurred during January 1997.

Historical Perspective. The drainage area of the San Joaquin River above Vernalis, the point at which the river enters the Delta, is 13,356 square miles, including 2,100 square miles of drainage contributed by James Bypass. Inflows from the Merced (farthest upstream), Tuolumne, and Stanislaus rivers historically contribute more than 60% of the flows in the San Joaquin River, as measured at Vernalis. Vernalis lies just inside the legal boundary of the Delta, but it is widely used as monitoring points for Delta inflows and standards.

The USGS has operated a gaging station on the San Joaquin River near Vernalis (Station 11303500) since 1922, although complete records are available only back to 1930. The instantaneous maximum recorded at the station was 79,000 cfs, observed on December 9, 1950. The lowest daily mean flow was 19 cfs, on August 10, 1961. The maximum mean monthly discharge was 40,040 cfs (March), and the minimum mean monthly discharge was 804 cfs (April).

Historically, the major rivers of the San Joaquin system have contributed an average of about 5.5 MAF to Delta flows, with an annual range of from 1.1 MAF to 15 MAF. Historic unimpaired flows on the Stanislaus, Tuolumne, Merced, and San Joaquin rivers averaged a total of 5.6 MAF. Numerous dams and diversions have been constructed on these rivers and other rivers in this system.

On the Stanislaus River, approximately 0.52 MAF have been diverted and 0.2 MAF have been allocated for instream flows. These total 64% of the river's average flows of 1.1 MAF. Prior to construction of the New Melones Reservoir in 1980, an average of 25% of these uses were supplied by reservoir releases. The Tuolumne River has average unimpaired flows of about 1.8 MAF. Over 2.5 MAF of storage capacity has been constructed on this river. Historical water allocations have been approximately 13% for instream flows and 58% for diversions. About 28% of historical water uses were supplied from reservoir releases. The Merced River has average unimpaired flows of about 1 MAF. Over 1 MAF of storage capacity has been constructed on this river. Historical water allocations have been approximately 4% for instream flows and 54% for diversions. About 40% of historical water uses were supplied from reservoir releases. The upper San Joaquin River has average unimpaired flows of about 1.7 MAF. Approximately 0.6 MAF of storage capacity has been constructed on this reach of the river. Historically, approximately 70% of the river's runoff has been diverted to the Friant-Kern and Madera canals, primarily for agricultural uses. About 20% of historical water uses were supplied from reservoir releases.

The upper watershed of the San Joaquin River Region has historically been less developed than that of the Sacramento Region, although the same general process of development has occurred, including mining, logging, housing construction, industrial development, and dam construction. As in the Sacramento River Region the upper watershed contains major parks and wilderness areas. Most development has occurred in the lower foothills, near or below the snow line.

Existing Conditions. Three locations have been selected to represent the range of hydraulic conditions in the San Joaquin River Region. The most important of these is the San Joaquin River at Vernalis because of its location near the Delta. The San Joaquin River at Newman was chosen to characterize the upstream portion of the river. The Stanislaus River below Goodwin Dam was also selected.

Hydrodynamics and Hydraulics. Table 6.1.1-3 presents the estimated range in discharge, average stream velocities, top width, and mean depth for February (high-flow period) and August (low-flow period).

Figure 6.1.1-4 shows the frequency distribution of flows for the San Joaquin River at Vernalis, the point at which the river flows into the Delta. The data are plotted at the same scale used to plot the data for Sacramento River stations to illustrate the relative contributions in flows to the Delta from each river. As described for Sacramento River stations, the results indicate that the average winter flows are skewed by infrequent elevated flows. The medians in the low flow months of July through November, are nearly the same and stay within a narrow range reflecting the effects of reservoir operations during these months.

Water Quality. The current water quality conditions discussed in the corresponding subsection of a preceding section under Delta Region: Existing Conditions also apply to the San Joaquin River Region. Summaries of loadings of the major contaminants of concern are provided in the Water Quality Technical Report.

Water Supply and Water Management. Of the 5.5 MAF of unimpaired flows, a total of 3.5 MAF are diverted from the major rivers of the San Joaquin system. An average of about 3 MAF annually reaches Vernalis and contributes to Delta inflows.

Total flows on the Stanislaus River currently average approximately 1.2 MAF annually. About 0.2 MAF are allocated for instream flows, and about 0.7 MAF are diverted.

Tuolumne River flows are simulated to be about 1.55 MAF at New Don Pedro Reservoir. Of this, about 0.9 MAF (58%) are used for average annual diversions and 0.2 MAF (13%) are for instream flows.

Merced River flows are simulated to be about 0.9 MAF at McClure Reservoir. Of this, about 0.525 MAF are used for diversions and 0.043 MAF are for instream flows.

Annual inflows on the upper San Joaquin River (at Millerton Reservoir) average about 1.67 MAF. An annual average of about 0.234 MAF are not diverted or otherwise allocated.

Most of the inflow to the San Joaquin River region originates from the upper watershed tributary streams between the Mokelumne River and the San Joaquin River, on the west slope of the Sierra Nevada. Runoff intensity averages less than 1,000 AF/square mile in this region. For a detailed description of the upper watersheds of the San Joaquin River Region, see the supporting document for Surface Water Resources.

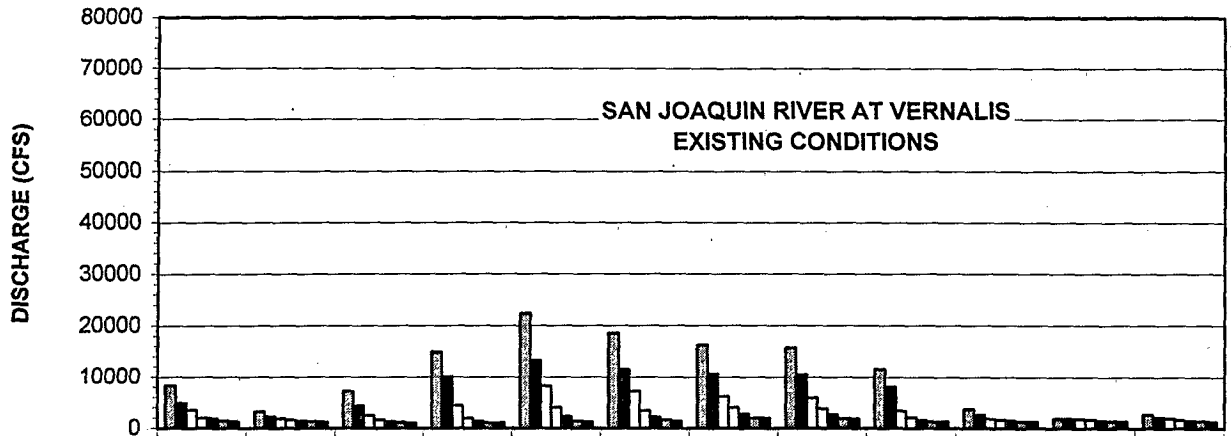
6.1.1.5 SWP and CVP Service Areas Outside Central Valley

Hydrodynamics and Hydraulics. Surface water flows in SWP and CVP service areas outside the Central Valley are not directly affected by the CALFED project.

Water Quality. Because exported water is pumped from the Delta, the quality of water delivered to the SWP and CVP service areas is similar to that found within the Delta. Source control measures instituted under the Water Quality Program would affect Delta water quality and therefore would indirectly benefit the quality of water delivered to the SWP and CVP service areas.

FLOW CONDITIONS BASED ON 72-YEAR HYDROLOGIC RECORD	CP#682, GS3035, SAN. JOAQ. R @ VERNALIS	CP#695, GS2740, SAN. JOAQ. R. NR. NEWMAN	CP#675, GS3020, SAN. JOAQ. R. BLW. GOODWIN DAM, NEAR KNIGHTS LANDING
Location Map Station >	**SJ1**	**SJ2**	**SJ3**
FEBRUARY			
Discharge (cfs)			
Maximum	36534	21409	5078
Minimum	972	306	216
Average	6410	2917	738
Mean Velocity (fps)			
Maximum	3.17	3.64	4.27
Minimum	1.42	0.89	1.12
Average	2.15	1.88	2.01
Top Width (feet)			
Maximum	512	261	151
Minimum	247	140	88
Average	294	195	105
Mean Depth (feet)			
Maximum	20.8	25.4	7.9
Minimum	2.8	2.4	2.2
Average	9.7	8.4	3.5
AUGUST			
Discharge (cfs)			
Maximum	1919	683	960
Minimum	1106	342	732
Average	1626	520	878
Mean Velocity (fps)			
Maximum	1.65	1.16	2.27
Minimum	1.46	0.92	2.00
Average	1.59	1.06	2.18
Top Width (feet)			
Maximum	263	157	109
Minimum	250	142	105
Average	259	151	108
Mean Depth (feet)			
Maximum	4.3	3.8	3.9
Minimum	3.0	2.6	3.5
Average	3.9	3.3	3.7

Table 6.1.1-3. Range of Existing Hydraulic Conditions at Selected Stations in the San Joaquin River Region



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
5 percent	8330	3250	7220	14900	22400	18500	16200	15700	11600	3670	1890	2670
10 percent	4900	2330	4350	10100	13300	11500	10700	10600	8150	2650	1870	2200
25 percent	3550	1850	2520	4370	8260	7240	6200	5940	3430	1870	1810	1950
50 percent	2000	1630	1690	2020	4000	3420	3980	3820	2130	1680	1680	1700
75 percent	1920	1410	1320	1350	2290	2280	2810	2680	1560	1450	1500	1480
90 percent	1520	1290	1170	1150	1430	1670	1980	1890	1330	1310	1370	1360
95 percent	1330	1240	1140	1130	1260	1370	1980	1870	1300	1280	1290	1290

FIGURE 6.1.1-4 FLOW FREQUENCIES, SAN JOAQUIN RIVER AT VERNALIS, EXISTING CONDITONS

Water Supply and Water Management. The SWP includes 20 dams and 662 miles of aqueduct. Conveyance facilities serving the area outside the Central Valley include the North Bay Aqueduct (serving parts of Napa and Solano Counties), the South Bay Aqueduct (serving Santa Clara County), the Coastal Branch Aqueduct (serving San Luis Obispo and Santa Barbara counties), and the California Aqueduct (which serves the South Coast Region). The capacity of the California Aqueduct at the Delta is 10,300 cfs. South of the Tehachapi Mountains at the southern end of the Central Valley, the capacity of the aqueduct is 4,480 cfs. The major SWP reservoirs outside the Central Valley include Pyramid Lake and Castaic Lake, which receive water via the west Branch of the California Aqueduct, and Silverwood Lake and Lake Perris, which receive water via the East Branch of the California Aqueduct. Of the initial project contracts for annual delivery of 4.2 MAF, about 2.5 MAF was allotted to southern California, about 1.3 MAF to the San Joaquin Valley, and about 0.4 MAF was allotted to San Francisco Bay, Central Coast, and Feather River areas. Since about 1980, the southern California area has received about 60 percent of its full entitlement, while the San Joaquin valley has received nearly all of its entitlement. It has been estimated that SWP facilities have about a 65 percent chance of making full deliveries at the existing (1995) level of demand.

The U.S. Bureau of Reclamation's Central Valley Project supplies water to more than 250 long-term water contractors in its service area. Most of the service area is inside the Central Valley. Outside the Central Valley the service area includes part of Santa Clara County, northwest San Benito County, a small region along both sides of the Santa Cruz/Monterey County line, and northeastern Contra Costa County. About 90

percent of the south-of-Delta contractual delivery is for agricultural users.

6.1.2 Environmental Consequences: Bay-Delta Hydrodynamics and Riverine Hydraulics

6.1.2.1 Assessment Methods

The potential impacts resulting from the implementation of CALFED alternatives were analyzed using the Department of Water Resources' operations planning model (DWRSIM) and Bay-Delta hydrodynamic model (DWRDSM1 and DWRDSM2).

Approach

Statewide. DWRSIM is a planning simulation model which is used to simulate the Central Valley Project (CVP) and the State Water Project (SWP) system of reservoirs and conveyance facilities. The model calculates flows on a monthly time step using 73 years of historic hydrology. The historic hydrology, for example runoff records, have been updated to reflect present and future land use.

DWRSIM is designed to simulate operation of the SWP and CVP system for the purposes of water supply, flood control, recreation, instream flows, power generation and Sacramento-San Joaquin Delta water quality and associated outflow requirements. The model is used to analyze the potential effects of proposed new features, such as additional reservoir storage or Delta export conveyance, as well as any changes to criteria controlling project operations.

In conducting these studies, expansion of the SWP and CVP facilities and/or water demands were often used as surrogates to analyze the potential effects of the various configurations under consideration. Model results provide information on expected reservoir storages, river flow, Delta inflows, Delta outflow exports, and water deliveries. In addition, spreadsheet models and other analytical tools were used for the alternatives analyses.

The monthly flows calculated by DWRSIM for the Sacramento River and for the San Joaquin River are used as input for Delta hydrodynamic/water quality modeling.

Delta. Hydrodynamic models DWRDSM1 and more recently DWRDSM2 are used to simulate the channel flows, tidal effects, and water quality of the Bay-Delta estuary. DWRDSM2 uses a 60-second time step in simulating Delta hydrodynamics and a 15-minute time step in calculating water quality, while simulation results are generally presented as daily values. The model was used to simulate 16 years of record from October 1975 to September 1991. This period was selected to cover a broad range of inflow and Delta export values, including high inflow, low inflow/high pumping, and low inflow/low pumping.

The most fundamental hydraulic variable is streamflow discharge, which is often expressed in cubic feet per second (cfs), and sometimes referred to simply as flow or flow rate. Channel geometry and slope affect stream velocity, width, and depth. For a given rate of flow, average stream velocity and depth increase as a channel narrows and decrease as a channel broadens. The ability of a stream to transport sediment is mainly a function of its velocity. Therefore, changes in channel shape and slope as well as flow can affect the sediment-carrying capacity of a stream. Broad, shallow streams with gentle slopes expose more water surface area to ambient temperature conditions, which can have an effect on the water temperature during summer months.

A greater number of variables are needed to describe flows in the Delta. The Delta is a network of interconnected channels. The water flowing in these channels is acted upon by a number of competing forces from different directions. Freshwater enters the Delta from tributary streams, primarily the Sacramento River but also the Mokelumne River, the Calaveras River, the San Joaquin River, and several smaller streams. During much of the year, these

tributaries to the Delta are largely controlled by operation of upstream reservoirs.

Prior to development, Delta inflow flowed through the Delta and discharged in the Bay. But now some of the inflow is captured by pumping facilities or used for local irrigation of agricultural lands within the Delta. The largest of these are the Banks and Tracy pumping plants located in the south Delta. Additional pumping is done by the Contra Costa Water District at its intakes at the Contra Costa Canal and at Rock Slough in the southwest Delta. Some north Delta water is pumped to the North Bay Aqueduct. This Delta pumping not only draws freshwater toward the pumps, it also draws in salt water from the Bay.

The third and most regular influence on the flow of water in Delta channels is tidal action. Tidal inflows move water into portions of the Delta where freshwater outflows and channel geometry offers the least resistance. The relatively large freshwater inflows from the Sacramento River have the capacity to resist tidal inflows more than the small inflows from the San Joaquin River. Combined with pumping in the south Delta, saline Bay water tends to move further into the South Delta than it does into the north Delta. The pattern of flows is in a continual dynamic state of change as a result of these competing forces, making it difficult to describe the dominant patterns.

A number of methods have been developed to define and characterize the hydrodynamic conditions of the Delta. For example, the Delta may be divided into general regions, north, south, central, and west. Each of these regions may be dominated by a different pattern during any given period of time. In the west Delta, for example, tidal influences are strong, and reverse flows occur frequently. The north Delta is more dominated by Sacramento River and Mokelumne River inflows. The south Delta is affected by both San Joaquin River inflows and pumping. The central Delta is the region in which the different regimes intersect. Evaluating the dominant flow pattern in each of these compartments tends to be a qualitative approach.

Delta hydrodynamic modeling enables the analyst to "inject" a tracer at some point in the model network, for example at Vernalis on the San Joaquin River, and track the movement and spread of the tracer in the Delta. Also, average flows (in both direction and magnitude) can be calculated at selected locations. Sacramento River is generally described by the flow at Rio Vista. Cross Delta flow is flow diverted to the east central Delta from the Sacramento River through the Delta Cross Channel and Georgian Slough or into the Mokelumne River from the Sacramento River, and thus into the central Delta (as in Alternative 2).

Another measure of dominant hydrodynamic conditions in the Delta is salinity. Salinity in the Delta is primarily a result of seawater intrusion, although upstream sources, such as agricultural drainage from the San Joaquin Valley, contributes to Delta salinity. X2 is the distance upstream from the Golden Gate Bridge, at which the mixing of freshwater from the Delta inflow and saltwater from the Bay results in a salinity of 2,000 parts per million total dissolved solids. Changes in each of these variables is used in this report to describe the effects of Program actions on hydrodynamic conditions in the Delta.

CALFED has continued to upgrade and refine the assumptions of the simulation models used to represent the configurations of the Program alternatives. Initial modeling efforts focused on evaluating the feasibility of proposed storage and conveyance components and on narrowing the list of alternatives. Subsequent modeling efforts focused on evaluating the impacts of the alternatives with respect to their major distinguishing characteristics.

Thus the modeling effort has continued to advance with the alternative refinement process and is expected to continue as Program elements are further refined. At any point in time within this process, the modeling results are only as accurate a predictor of real-world conditions as the assumptions on which the modeling is based.

A number of modeling studies were used in the analysis presented in this report. Early studies, discussed in the surface water technical support

document, were later supplemented by additional, more detailed, studies. The conclusions of the earlier studies generally supply an adequate level of detail to support a Program level analysis. But, where appropriate, the results of more recent studies are discussed to further support the conclusions presented in this report.

Modeling Assumptions

Initial Statewide Modeling. Initial DWRSIM modeling studies used in preparation of this report included:

- A study representing existing conditions;
- A No Action benchmark study representing the effects of increased water demand for the year 2020;
- Three studies that added, progressively, south Delta improvements, north and south Delta surface storage (representing basic components of Alternatives 1 and 2);
- Two studies that included a 5,000 cfs isolated facility representing Alternative 3 with and without surface storage, respectively; and
- One study that included a 15,000 cfs isolated facility representing Alternative 3 without storage.

These studies provided a basic framework for comparison of the major features affecting hydraulics and water supply.

Refined Statewide Modeling. Subsequent simulation studies were performed to more accurately relect the alternative configurations analyzed in this Programmatic EIS/EIR. For example, the DWRSIM study representing No Action was modified to reflect the implementation of additional instream and Delta outflow requirements of the CVPIA, which were not included in the initial benchmark study.

The CVPIA assumptions consist of three additions to the benchmark study: exports are restricted during the low runoff period of April and May X2 requirements are extended in May and June, and the Delta Cross Channel is closed for an additional period from November through June. These assumptions are believed to be sufficient to meet the CVPIA flow objective for protection of anadromous fish.

Also, the hydrologic data used as input to the DWRSIM model were updated to better reflect expectations of 2020 demand, land use, watershed inflows, and other variables. This upgraded 2020 hydrology was used in all of the subsequent simulations of Program alternative configurations, as well.

The modeling assumptions of the Program alternative configurations were modified to include environmental restoration flow targets. Among the assumptions of the Ecosystem Restoration Program component of the new DWRSIM simulations is that the Ecosystem Restoration Program flow targets would have no impact on SWP-CVP deliveries and would be met either from new storage or from additional future water purchases from willing sellers.

The assumptions for Alternative 3 were modified to include operation of an intake for an isolated conveyance facility at Hood. Two diversion capacities, 5,000 and 15,000 cfs, were evaluated. The isolated facility was assumed to be operated to maximize isolated conveyance and minimize exports from south Delta channels, consistent with the need to meet in-Delta water quality objectives. This type of operation is expected to maximize both fishery protection and export water quality benefits.

Minimum monthly exports from south Delta channels were set at 1,000 cfs in July through March, and zero cfs in April through June. These minimum south Delta exports are intended to provide flow circulation and maintain south Delta water quality. After providing these minimum south Delta exports, diversions through the isolated facility were assumed to be maximized, consistent with other Bay-Delta standards, prior to taking additional exports from the south Delta. For example, when evaluating a 5,000 cfs isolated facility in the month of July, the first 1,000 cfs of

exports would be diverted from south Delta channels, while the second 5,000 cfs of exports would be diverted through the isolated facility. Additional diversions from south Delta channels would only be allowed after using thefull 5,000 cfs capacity of the isolated facility.

The maximum total new surface and groundwater storage was set at 6.25 MAF.

Delta Modeling. Delta hydrodynamic simulation studies using the DWRDSM1 model were performed using a fixed Delta inflow hydrology representing the Delta inflow determined from the DWRSIM No Action benchmark study combined with south Delta improvements (Study 472B). Although, the Delta inflow and outflow hydrology was fixed, the DWRDSM1 model was modified to represent different Delta geometries and export diversion locations to evaluate the flow of water within the Delta. The DWRDSM1 studies include the effects of and average tide on Delta flows and also include routines to calculate salinities and to track the pattern of water migration from pre-selected points throughout the Delta (so-called "particle" or "mass fate" tracking).

The DWRDSM1 model runs simulated flows corresponding to the 16-year period from October of water year 1976 to September 1991. The Delta simulations which used DWRSIM Study 472B included:

- A study in which Delta Channel geometry was not changed (no action);
- A study in which south Delta improvements were added;
- Three studies in which channels in the north and south Delta were modified to reflect Configurations 2B, 2D, and 2E;
- A study reflecting the effects of a 15,000 cfs diversion of Delta inflow from the Sacramento River at Hood, through an isolated facility to Clifton Court, bypassing the Delta, and representing the higher capacity of Configuration 3E; and
- A study reflecting a 5,000 cfs isolated facility representing Configurations 3A and 3B.

Two of the configurations, those representing 2B and 2D, included a 10,000 cfs diversion from the Sacramento River at Hood to the North Fork of the Mokelumne River through Snodgrass Slough.

6.1.2.2 Significance Criteria

Although Program-induced changes in hydraulic parameters, including flow, velocity, stage, and related variables, such as X2 position, salinity, or sediment transport, are described in this section, their significance or environmental implications of these changes are not. The significance of these changes is discussed in other sections of this report in the context of each of the resources affected by the changes.

6.1.2.3 Comparison of No Action Alternative to Existing Conditions

The forecasted flows for the No Action Alternative differ from the existing condition flows primarily as a result of anticipated future demands for water.

Separate DWRDSM1 modeling studies of existing conditions in the Delta were not performed. However, DWRSIM studies show that Delta outflow would decrease slightly under no action as a result of meeting additional year 2020 demand.

In order to evaluate the hydrodynamic effects, high inflow and low inflow conditions were evaluated separately. Low inflow conditions were further evaluated to isolate the effects of pumping. The three resulting inflow and pumping conditions evaluated are high inflow, low inflow/high pumping, and low inflow/low pumping. The results of modeling of these conditions, which has been performed by the California Department of Water Resources using the DWRDSM1 computer model, are presented in this report. (Subsequent refinements of this modeling have been completed using DWRDSM2 model. These results are generally

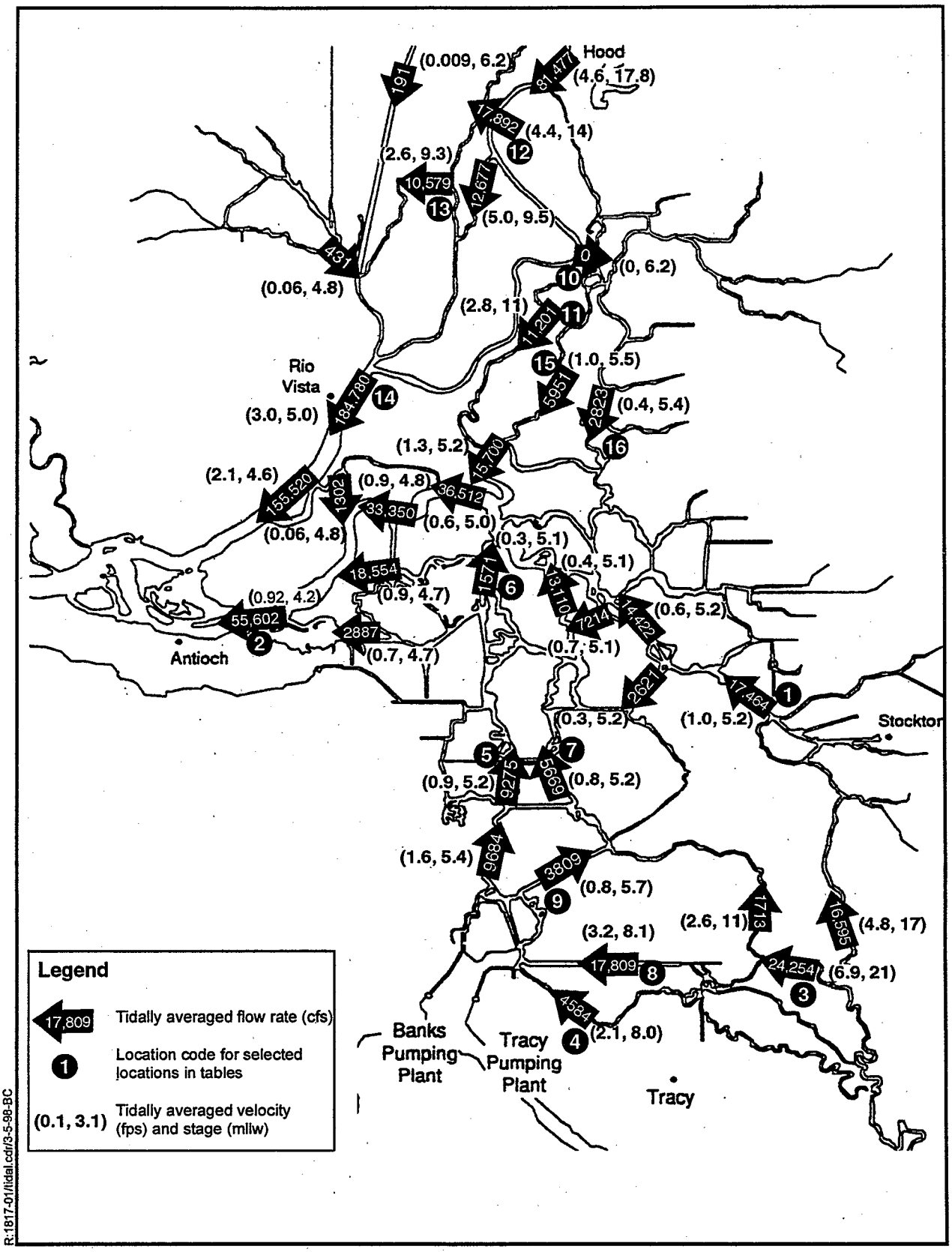


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Figure 6.1.2-1. Average Tidal Flow Rates, Velocities, and Stages for High Flow, No Action Alternative

Location		No Action Alternative			Configuration 1A				Configuration 1C			
High Inflow Condition	**Loc. Key**	**Avg.**	**Max. Sea-ward**	**Max. Land-ward**	**Avg.**	**Max. Sea-ward**	**Max. Land-ward**	**% Diff***	**Avg.**	**Max. Sea-ward**	**Max. Land-ward**	**% Diff***
S.J. River at Fourteen Mile Slough	1	17,500	21,600	11,400	17,900	22,000	11,800	2%	17,800	21,900	11,800	2%
San Joaquin River at Antioch	2	55,600	170,000	110,000	56,500	170,400	109,100	2%	56,700	169,000	108,000	2%
Old River at Mossdale	3	24,300	24,300	24,200	23,800	23,800	23,800	-2%	23,900	24,000	23,800	-1%
Old River at Fabian Tract	4	4,580	4,840	4,140	4,500	4,740	4,020	-2%	4,850	5,100	4,370	6%
Old River at Woodward Island	5	9,280	15,000	1,120	9,720	15,300	402	5%	10,100	17,800	3,790	9%
Old River at Franks Tract	6	1,570	5,250	4,010	1,620	5,250	3,980	3%	1,590	5,130	3,930	1%
Middle River at Woodward Island	7	5,670	10,000	2,180	5,990	10,200	1,630	6%	5,750	11,400	4,210	1%
Grant Line Canal	8	16,000	16,500	14,700	15,700	16,300	14,400	-2%	15,500	16,100	14,200	-3%
Victoria Canal	9	-3,810	-57	5,910	-4,110	-518	6,140	8%	-3,280	1,200	5,780	-14%
Delta Cross Channel	10	0	114	283	0	114	283	NA	0	110	279	NA
Georgiana Slough	11	11,200	11,700	10,800	11,200	11,700	10,800	0%	11,200	11,700	10,800	0%
Sutter/Steamboat Sl. Diversion	12	17,900	18,200	17,400	17,900	18,200	17,400	0%	17,900	18,200	17,400	0%
Miner Slough	13	10,580	11,100	9,760	10,600	11,100	9,760	0%	10,600	11,100	9,750	0%
Sacramento River at Rio Vista	14	185,000	219,000	132,600	185,000	219,000	133,000	0%	185,000	219,000	132,000	0%
Mokelumne River, North Fork	15	5,950	7,690	2,370	5,950	7,680	2,370	0%	5,940	7,620	2,390	0%
Mokelumne River, South Fork	16	2,820	5,800	3,850	2,820	5,800	3,870	0%	2,820	5,700	3,850	0%
Low Inflow/High Pumping Condition												
S.J. River at Fourteen Mile Slough	1	-34	6,030	6,380	-51	6,050	6,370	50%	1,270	7,490	5,060	3629%
San Joaquin River at Antioch	2	-1,550	148,000	155,000	-1,520	147,000	155,000	-2%	-1,500	146,000	154,000	-3%
Old River at Mossdale	3	1,290	1,650	213	1,310	1,610	868	1%	0	88	104	-100%
Old River at Fabian Tract	4	158	763	1,020	160	742	466	1%	-294	158	771	86%
Old River at Woodward Island	5	-4,560	5,890	13,200	-4,530	6,380	14,800	-1%	-5,540	8,210	18,200	21%
Old River at Franks Tract	6	-295	4,480	3,400	-305	4,020	3,980	3%	-385	3,640	4,180	31%
Middle River at Woodward Island	7	-3,150	4,190	9,920	-3,140	4,620	10,800	0%	-3,400	5,600	12,000	8%
Grant Line Canal	8	1,080	3,630	3,810	1,100	3,700	1,580	2%	340	3,590	3,160	-69%
Victoria Canal	9	2,360	5,940	1,050	2,360	6,050	1,160	0%	2,220	6,310	2,090	-6%
Delta Cross Channel	10	3,860	7,760	597	3,870	7,740	755	0%	3,880	7,680	863	0%
Georgiana Slough	11	2,240	3,950	903	2,240	3,940	990	0%	2,250	3,910	1,040	0%
Sutter/Steamboat Sl. Diversion	12	1,880	5,050	3,420	1,880	5,020	3,420	0%	1,880	5,010	3,420	0%
Miner Slough	13	1,110	4,280	3,390	1,110	4,270	3,390	0%	1,110	4,270	3,340	0%
Sacramento River at Rio Vista	14	6,160	91,100	82,700	6,140	91,300	83,000	0%	6,140	91,500	83,400	0%
Mokelumne River, North Fork	15	3,020	4,400	1,400	3,020	4,440	1,370	0%	3,020	4,530	1,270	0%
Mokelumne River, South Fork	16	829	4,790	4,410	836	4,880	4,430	1%	845	4,940	4,500	2%
Low Inflow/Low Pumping Condition												
S.J. River at Fourteen Mile Slough	1	99	5,950	6,340	69	6,070	6,360	-30%	412	6,280	5,850	316%
San Joaquin River at Antioch	2	950	149,000	152,000	680	148,000	152,000	-28%	652	147,000	152,000	-31%
Old River at Mossdale	3	862	1,600	749	892	1,550	452	3%	554	1,400	401	-36%
Old River at Fabian Tract	4	32	993	1,110	49	875	888	53%	113	963	750	253%
Old River at Woodward Island	5	-981	8,470	11,300	-1,330	8,410	11,300	36%	-1,570	9,400	13,300	60%
Old River at Franks Tract	6	25	4,630	4,030	-11	4,300	4,030	-56%	4	4,100	4,200	-84%
Middle River at Woodward Island	7	-848	6,080	8,380	-1,090	6,050	8,390	29%	-1,220	6,490	9,110	44%
Grant Line Canal	8	525	3,920	3,940	509	3,850	4,020	-3%	190	3,560	3,240	-64%
Victoria Canal	9	429	3,210	2,080	624	4,260	2,210	45%	569	4,340	2,490	33%
Delta Cross Channel	10	2,680	6,190	528	2,880	6,400	313	7%	2,870	6,400	213	7%
Georgiana Slough	11	1,630	3,230	443	1,730	3,340	540	6%	1,730	3,340	523	6%
Sutter/Steamboat Sl. Diversion	12	1,130	4,660	4,290	1,230	4,700	4,180	9%	1,230	4,680	4,190	8%
Miner Slough	13	653	4,080	3,830	710	4,110	3,770	9%	710	4,100	3,770	9%
Sacramento River at Rio Vista	14	2,900	87,300	86,500	3,250	87,700	86,300	12%	3,250	87,700	86,300	12%
Mokelumne River, North Fork	15	2,050	3,650	385	2,190	3,820	593	7%	2,190	3,870	541	7%
Mokelumne River, South Fork	16	297	4,460	4,600	351	4,610	4,590	18%	347	4,610	4,520	17%

*Represents the percent difference between the average value of the alternative and the average value of the No Action Alternative.

Note: A negative flow or velocity indicates landward direction.

Table 6.1.2-1. Average, Maximum, and Percent Change in Delta Channel Flows, Compared to No Action, at Selected Stations for Three Inflow/Pumping Conditions (page 1 of 3)

Location		Configuration 2B				Configuration 2D				Configuration 2E			
High Inflow Condition	**Loc. Key**	**Avg.**	**Max. Sea-ward**	**Max. Land-ward**	**% Diff***	**Avg.**	**Max. Sea-ward**	**Max. Land-ward**	**% Diff***	**Avg.**	**Max. Sea-ward**	**Max. Land-ward**	**% Diff***
S.J. River at Fourteen Mile Slough	1	17,700	21,800	11,900	1%	17,700	20,600	13,100	1%	17,600	20,200	13,600	0%
San Joaquin River at Antioch	2	61,500	170,000	101,000	11%	62,300	164,000	94,600	12%	77,600	171,000	72,400	39%
Old River at Mossdale	3	23,900	24,000	23,800	-1%	24,000	24,000	23,900	-1%	24,000	24,100	23,900	-1%
Old River at Fabian Tract	4	4,840	5,080	4,360	5%	4,540	4,780	4,170	-1%	4,530	4,750	4,130	-1%
Old River at Woodward Island	5	10,100	17,400	3,570	9%	8,320	15,400	5,250	-10%	8,390	14,900	5,210	-10%
Old River at Franks Tract	6	1,620	5,060	3,970	3%	1,660	6,380	5,470	5%	1,900	6,460	5,600	21%
Middle River at Woodward Island	7	5,670	11,000	4,140	0%	4,130	9,540	7,230	-27%	3,810	8,940	7,500	-33%
Grant Line Canal	8	15,500	16,000	14,200	-3%	15,700	16,300	14,700	-2%	15,700	16,300	14,700	-2%
Victoria Canal	9	-3,260	1,170	5,630	-14%	-1,310	1,840	2,720	-66%	-1,200	1,990	2,560	-68%
Delta Cross Channel	10	0	46	108	NA	0	23	59	NA	0	172	185	NA
Georgiana Slough	11	10,200	10,600	9,860	-9%	10,100	10,600	9,740	-10%	39,800	47,300	35,300	256%
Sutter/Steamboat Sl. Diversion	12	16,100	16,500	15,600	-10%	16,200	16,500	15,600	-10%	14,060	14,700	13,200	-21%
Miner Slough	13	9,460	10,100	8,560	-11%	9,470	10,100	8,570	-10%	8,050	8,790	6,960	-24%
Sacramento River at Rio Vista	14	177,900	213,000	125,000	-4%	178,000	217,000	125,000	-4%	156,000	192,000	98,300	-16%
Mokelumne River, North Fork	15	7,390	10,500	1,020	24%	7,680	8,890	5,540	29%	2,960	4,150	1,090	-50%
Mokelumne River, South Fork	16	3,010	5,890	2,880	7%	2,690	6,000	3,660	-5%	2,630	8,660	9,830	-7%
Low Inflow/High Pumping Condition													
S.J. River at Fourteen Mile Slough	1	1,270	7,360	5,040	3635%	1,290	6,170	3,940	3691%	1,270	6,200	3,960	3635%
San Joaquin River at Antioch	2	1,310	144,000	151,000	-16%	1,340	138,000	147,000	-14%	712	137,000	147,000	-54%
Old River at Mossdale	3	0	87	103	-100%	0	99	79	-100%	0	97	78	-100%
Old River at Fabian Tract	4	-292	154	738	85%	-11	809	735	-93%	-11	786	698	-93%
Old River at Woodward Island	5	-5,500	7,820	17,700	21%	-4,860	8,040	17,500	6%	-4,840	7,780	17,000	6%
Old River at Franks Tract	6	-370	3,560	4,060	25%	-537	4,730	5,160	82%	-499	4,610	5,000	69%
Middle River at Woodward Island	7	-3,430	5,220	11,500	9%	-2,440	6,420	11,100	-23%	-2,450	6,230	10,700	-22%
Grant Line Canal	8	340	3,460	3,050	-69%	-47	3,080	2,930	-96%	-49	2,990	2,810	-95%
Victoria Canal	9	2,220	6,110	1,990	-6%	1,120	38,000	1,670	-49%	1,200	3,660	1,620	-49%
Delta Cross Channel	10	0	88	130	-100%	0	63	105	-100%	0	194	191	-100%
Georgiana Slough	11	903	3,350	1,640	-60%	781	3,890	2,550	-65%	9,020	26,000	4,650	302%
Sutter/Steamboat Sl. Diversion	12	783	3,850	3,930	-58%	827	3,770	3,960	-56%	1,260	5,220	4,750	-33%
Miner Slough	13	447	3,780	3,810	-60%	476	3,780	3,770	-57%	752	3,900	3,860	-32%
Sacramento River at Rio Vista	14	2,430	90,100	89,400	-61%	2,640	93,800	92,900	-57%	3,250	84,000	84,900	-47%
Mokelumne River, North Fork	15	4,280	8,970	4,730	42%	5,000	6,940	1,780	66%	-41	3,080	3,800	-99%
Mokelumne River, South Fork	16	1,330	5,420	4,120	60%	1,260	6,170	5,110	52%	136	10,300	12,100	-84%
Low Inflow/Low Pumping Condition													
S.J. River at Fourteen Mile Slough	1	394	6,090	5,670	298%	127	4,930	5,180	28%	122	4,930	5,090	23%
San Joaquin River at Antioch	2	986	145,000	151,000	4%	1,320	138,000	146,000	39%	2,240	139,000	146,000	135%
Old River at Mossdale	3	573	1,390	315	-34%	846	1,580	490	-2%	843	1,560	418	-2%
Old River at Fabian Tract	4	115	942	696	259%	40	746	714	25%	39	731	699	22%
Old River at Woodward Island	5	-1,560	9,150	12,600	59%	-1,120	9,580	13,800	14%	-1,120	9,260	13,400	14%
Old River at Franks Tract	6	-10	4,040	4,200	-60%	-126	5,110	5,050	404%	-93	4,990	5,000	272%
Middle River at Woodward Island	7	-1,200	6,310	8,520	41%	-821	8,170	9,430	-3%	-851	7,830	9,070	0%
Grant Line Canal	8	203	3,440	3,000	-61%	480	3,020	3,020	-9%	474	2,940	2,940	-10%
Victoria Canal	9	564	4,100	2,480	31%	269	2,840	2,100	-37%	282	2,730	2,010	-34%
Delta Cross Channel	10	996	7,680	5,010	-63%	1,610	7,960	3,600	-40%	1,350	5,790	2,750	-50%
Georgiana Slough	11	1,710	3,160	99	5%	1,350	3,340	1,070	-18%	5,270	18,900	5,390	222%
Sutter/Steamboat Sl. Diversion	12	1,020	4,440	4,500	-10%	995	4,220	4,500	-12%	700	5,040	5,330	-38%
Miner Slough	13	589	3,880	3,890	-10%	576	3,720	3,850	-12%	408	3,760	4,150	-38%
Sacramento River at Rio Vista	14	2,830	85,500	85,600	-2%	2,660	89,700	89,700	-8%	1,240	80,100	86,300	-57%
Mokelumne River, North Fork	15	1,580	6,410	5,410	-23%	2,260	3,640	548	10%	375	2,380	2,200	-82%
Mokelumne River, South Fork	16	272	4,430	5,430	-8%	448	5,780	5,600	51%	1	10,400	12,100	-100%

*Represents the percent difference between the average value of the alternative and the average value of the No Action Alternative.

Note: A negative flow or velocity indicates landward direction.

Table 6.1.2-1. Average, Maximum, and Percent Change in Delta Channel Flows, Compared to No Action, at Selected Stations for Three Inflow/Pumping Conditions (page 2 of 3)

Location		Configuration 3E			
High Inflow Condition	**Loc. Key**	**Avg.**	**Max. Seaward**	**Max. Landward**	**% Diff***
S.J. River at Fourteen Mile Slough	1	17,700	21,500	12,000	1%
San Joaquin River at Antioch	2	60,700	172,000	103,000	9%
Old River at Mossdale	3	23,900	24,000	23,900	-1%
Old River at Fabian Tract	4	4,620	4,900	4,300	1%
Old River at Woodward Island	5	13,500	18,000	5,130	46%
Old River at Franks Tract	6	2,000	4,900	3,600	25%
Middle River at Woodward Island	7	8,930	12,300	3,060	58%
Grant Line Canal	8	15,700	16,300	14,800	-2%
Victoria Canal	9	-6,530	-3,230	7,520	71%
Delta Cross Channel	10	0	121	301	NA
Georgiana Slough	11	10,300	10,800	9,920	-8%
Sutter/Steamboat Sl. Diversion	12	16,400	16,700	15,900	-9%
Miner Slough	13	9,600	10,200	8,710	-9%
Sacramento River at Rio Vista	14	179,000	213,000	126,000	-3%
Mokelumne River, North Fork	15	3,960	6,570	2,080	-33%
Mokelumne River, South Fork	16	1,740	5,030	4,970	-38%
Low Inflow/High Pumping Condition					
S.J. River at Fourteen Mile Slough	1	1,270	6,830	4,760	3629%
San Joaquin River at Antioch	2	912	147,000	152,000	-41%
Old River at Mossdale	3	0	114	134	-100%
Old River at Fabian Tract	4	-17	969	1,020	-89%
Old River at Woodward Island	5	-650	9,350	11,300	-86%
Old River at Franks Tract	6	62	4,070	3,870	-79%
Middle River at Woodward Island	7	-582	6,680	8,090	-82%
Grant Line Canal	8	-54	3,520	4,050	-95%
Victoria Canal	9	383	4,630	2,500	-84%
Delta Cross Channel	10	0	243	233	-100%
Georgiana Slough	11	1,360	3,740	989	-39%
Sutter/Steamboat Sl. Diversion	12	936	4,050	3,830	-50%
Miner Slough	13	539	3,860	3,730	-52%
Sacramento River at Rio Vista	14	2,970	90,300	88,400	-52%
Mokelumne River, North Fork	15	13	4,620	5,000	-100%
Mokelumne River, South Fork	16	-26	5,000	4,820	-97%
Low Inflow/Low Pumping Condition					
S.J. River at Fourteen Mile Slough	1	131	5,760	6,180	32%
San Joaquin River at Antioch	2	1,220	148,000	152,000	28%
Old River at Mossdale	3	830	1,540	528	-4%
Old River at Fabian Tract	4	31	917	910	-3%
Old River at Woodward Island	5	-686	9,070	11,600	-30%
Old River at Franks Tract	6	27	4,080	3,910	8%
Middle River at Woodward Island	7	-632	6,490	8,380	-25%
Grant Line Canal	8	443	3,670	3,910	-16%
Victoria Canal	9	277	4,630	2,430	-35%
Delta Cross Channel	10	2,470	6,590	1,840	-8%
Georgiana Slough	11	1,640	3,250	493	0%
Sutter/Steamboat Sl. Diversion	12	1,030	4,590	4,330	-9%
Miner Slough	13	590	4,050	3,870	-10%
Sacramento River at Rio Vista	14	2,530	86,900	87,400	-13%
Mokelumne River, North Fork	15	1,040	4,070	2,370	-50%
Mokelumne River, South Fork	16	309	4,950	4,590	4%

*Represents the percent difference between the average value of the alternative and the average value of the No Action Alternative.

Note: A negative flow or velocity indicates landward direction.

Table 6.1.2-1. Average, Maximum, and Percent Change in Delta Channel Flows, Compared to No Action, at Selected Stations for Three Inflow/Pumping Conditions (page 3 of 3)

consistent with the DWRDSM1 results and are not presented in this document.)

The high inflow simulation, shown in Figure 6.1.2-1 for selected points in the Delta, depicts an extreme flood event based on monthly simulated inflow hydrology for March 1993. Average flows, velocities, and stages are shown on Figure 6.1.2-1. For each location shown on Figure 6.1.2-1, Table 6.1.2-1 presents corrsponding flow data for high inflow conditions for No Action and other alternatives. Table 6.1.2-1 also shows corresponding data for low inflow/high pumping and low inflow/low pumping conditions for each location for each alternative configuration. In the table, negative flows indicate that the direction of flow is landward. The ranges of flows are expressed as maximum seaward and maximum landward flows. Landward flows occur as a result of tidal inflows from the Bay. When tidal inflows exceed downstream flows, the net flow is landward. This occurs frequently near the Bay and less frequently further upstream in the Delta.

During periods of high tributary inflow, the Delta Cross Channel is closed for Delta flood protection. During these periods, higher flows are observed in locations along the Sacramento River and in the north Delta, while flows in the south Delta are generally lower. Average simulated flow rates shown in Table 6.1.2-1 range from 0 to 185,000 cfs for high inflow conditions, 30 to 6,200 cfs in low inflow/high pumping conditions and 30 to 2,900 cfs for low inflow/low pumping conditions.

Flow velocities in the Delta corresponding to these flows are generally well below the nominal scour velocity of approximately 3 feet per second (fps), except at a few locations in high inflow conditions. These locations include the Old River at Mossdale, Grant Line Canal, the diversion to Sutter and Steamboat sloughs, and the Sacramento River at Rio Vista. Since DWRDSM1 provides only cross-sectionally averaged velocity, these results should be considered as indices for comparative purposes.

High Inflow Conditions. For high inflow conditions, approximately 40% of the inflow from the Sacramento River at Hood is diverted to Steamboat and Sutter sloughs, and 15% travels down Georgiana Slough. The remainder continues down the Sacramento River toward the Bay.

In the south Delta, about 60% of the San Joaquin River inflow at Vernalis is diverted to Old River near Mossdale and 40% remains in the San Joaquin River channel and flows past Stockton. Of the flow diverted to Old River, approximately 5% travels down Middle River toward the Bay, 75% is carried by the Grant Line Canal, and 20% is carried by Old River toward the pumping plants.

Water from the central Delta flows out through the San Joaquin River and through Franks Tract and connecting channels (False River and Dutch Slough). Central Delta water includes inflows from the San Joaquin River and east-side streams, as well as Sacramento River flow diverted through Georgiana Slough. False River carries about 35% of the central Delta outflow, and Dutch Slough carries about 5%. About 60% of the total central Delta outflow remains in the main channel of the San Joaquin River.

Low Inflow/High Pumping Conditions. For low inflow/high pumping conditions, approximately 20% of the inflow from the Sacramento River at Hood is diverted to Steamboat and Sutter sloughs, 30% is diverted to the Delta Cross Channel, and 20% travels down Georgiana Slough. The remainder continues down the Sacramento River toward the Bay.

In the south Delta, the San Joaquin River experiences reverse flows. Of the flow in Old River at Mossdale, approximately 85% is carried by the Grant Line Canal and 10% is carried by Old River toward the pumping plants. Water in Victoria Canal, Old River north of Victoria Island, and Middle River travels south toward the state/federal project export locations at the Banks and Tracy pumping plants.

Water in the central Delta tends to flow south toward the pumping plants when they are operating. Central Delta water enters Old and Middle river channels at their mouths and flows through Turner, Empire, and Columbia cuts, which connect the upper San Joaquin River with Middle River. Central Delta water includes inflows from the San Joaquin River and

east-side streams, as well as Sacramento River flow diverted through the Delta Cross Channel and Georgiana Slough. False River, Dutch Slough, and the San Joaquin River carry water west from the central Delta into the west Delta.

Low Inflow/Low Pumping Conditions. For low inflow/low pumping conditions, approximately 20% of the inflow from the Sacramento River at Hood is diverted to Steamboat and Sutter sloughs, 35% is diverted to the Delta Cross Channel, and 25% travels down Georgiana Slough. The remainder continues down the Sacramento River toward the Bay.

In the south Delta, about 80% of the San Joaquin River inflow at Vernalis is diverted to Old River near Mossdale, and 20% remains in the San Joaquin River channel and flows past Stockton. Of the flow diverted to Old River, approximately 5% travels down Middle River toward the Bay, while 60% is carried by the Grant Line Canal and 5% is carried by Old River toward the pumping plants. Water in Victoria Canal, Old River north of Victoria Island, and Middle River travels south toward the SWP-CVP Project export locations at the Banks and Tracy pumping plants.

Water in the central Delta tends to flow westward through the west Delta, toward the Bay. Central Delta water enters the Old and Middle River channels at their mouths and flows through Turner, Empire, and Columbia cuts, which connect the upper San Joaquin River with Middle River. Central Delta water includes inflows from the San Joaquin River and east-side streams, as well as Sacramento River flow diverted through the Delta Cross Channel and Georgiana Slough. False River, Dutch Slough, and the San Joaquin River carry water west toward the Bay.

The average modeled QWEST flow for the 16-year inflow hydrology from 1975 to 1991 was negative (eastward) during the months June through January, as would be expected under existing conditions. QWEST was positive, in the range of 3,000 to 9,000 cfs during the period from February to May.

Additional reservoir releases needed to meet the higher demand results in slightly higher flows in Sacramento River Region streams. The %age increases of in-stream flows are largest in reaches below major dams, such as Shasta and Oroville. Also, both Delta inflow and outflow would increase to meet CVPIA AFRP requirements.

Delta salinity would probably not change much under the No Action Alternative compared to existing conditions either, although this was not confirmed by Delta modeling. Under the No Action Alternative, modeling studies indicate that average salinity in the Delta varies widely depending on the location and the time of year. For example, expressed as electrical conductivity (EC), it ranges from a high of nearly 2,500 μs/cm in late fall and early winter to generally less than 500 μs/cm between February and May at Emmaton and Jersey Point in the west Delta. It ranges between about 300 and just over 1,000 μs/cm at Rock Slough on the Old River. It ranges between about 400 and 800 μs/cm in the south Delta.

Under the No Action Alternative, Delta modeling results indicate that the average X2 position over the 16-year period would range from a maximum seaward position of about 70 km (which is about 10 km west of Collinsville and within Suisun Bay) in May to a maximum landward position in September of about 85 km (which is 5 km east of Collinsville and just inside the Delta). X2 position is a regulatory standard, so system operations would be modified, as needed, to ensure that the standard is met.

No substantial changes in flows are expected in the San Joaquin River relative to existing conditions as a result of the No Action Alternative; however, riverine hydraulics outside the SWP and CVP service areas are not expected to be directly affected by any CALFED alternatives. Changes in stream flows in these service areas would be the result of local interagency operations and were not evaluated by CALFED and are not further discussed in this report.

6.1.2.4 Comparison of Program Alternatives to No Action Alternative

Changes to hydraulic flow conditions resulting from the storage and conveyance Program element will vary by alternative. Changes resulting from other

Program elements such as ecosystem restoration will be less sensitive to the alternative selected. Therefore, the discussions of the effects of storage and conveyance are grouped by Program alternative and each of the other Program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a regions, the program element is not discussed.

Delta Region

Storage and Conveyance

Alternative 1. Alternative 1 causes small to negligible changes in hydrodynamic parameters in the Delta Region.

Table 6.1.2-2 summarizes the changes in hydrodynamic and hydraulic variables associated with all Programmatic alternatives for low Delta inflow conditions with high south of Delta exports. The low inflow/high (export) pumping condition is typical of the combination of conditions with the greatest potential for adverse effects. As shown in Table 6.1.2-2, Alternative 1 causes negligible adverse impacts in the north Delta region, small to negligible adverse impacts in the central Delta region, and negligible and beneficial impacts in the south Delta with regard to flow and mass fate.

In the south Delta Region, flow circulation patterns would be improved as a result of the south Delta improvements in Configuration 1C. The south Delta improvements would, at times, not allow San Joaquin River water to flow directly to the export pumps via Old River; therefore, upstream flows in the San Joaquin River between Prisoners Point and the head of Old River could be virtually eliminated. However, Delta channel flows toward the export pumps in lower Old River and Middle River could increase.

Configuration 1C would, at times, reduce net Delta outflow and would probably increase reverse flows in the central and south Delta a small %age of the time. The increase in exports and the corresponding changes in net and central Delta outflow would occur mostly during the fall, when unallocated water is available. All Delta standards would continue to be met.

Alternative 2. Alternative 2 would alter flows in the north, central, and south Delta regions (Table 6.1.2-2). In-Delta modifications and increased north Delta inflows would reduce reverse flows in the central Delta. A strong through-Delta flow pattern toward the export pumps would continue to exist because of (increased) south Delta pumping and increase cross Delta flow. However, mostly beneficial impacts would occur due to extra freshwater inflows from the Sacramento River.

Configurations 2A and 2B include south Delta flow and stage control measures, which would eliminate net upstream flows in a portion of the San Joaquin River and, at times, reduce the draw of water out of the San Joaquin River channel at the head of Old River. The purpose of these features is to improve flow conditions favored by migratory fish species. These effects would vary with the operation of the flow and fish control structures.

Configuration 2D would improve circulation and reduce reverse flows in the Delta with a Mokelumne River Floodway and East Delta improvements. All configurations except 2E include a 10,000 cfs intake on the Sacramento River at Hood that diverts water to the East Delta. Configuration 2E is similar to 2D except that it would include a Tyler Island weir structure in place of a new Hood intake. Like Configuration 2D, 2E would also reduce reverse flows in the Delta.

Alternative 2 would cause a small reduction in net Delta outflow (Table 6.1.2-2). Alternative 2 reduces net Delta outflow during the fall and early winter a small %age of the time. The increase in exports and corresponding changes in net Delta outflow occur when surplus water is available in excess of the defined flow requirements. All Delta standards would be met by this alternative.

Alternative 3. Configurations 3A and 3B use a combination of through-Delta conveyance and a 5,000 cfs isolated facility to move water from the Sacramento River in the north Delta to the pumping plants in the south Delta. The hydrodynamic effects on the Delta of Configurations 3A and 3B will be

Category	Alternative 1	
	1A and 1B	1C
Flow, Velocity, and Stage	1. No substantial effects	• Reduces reverse flows in San Joaquin River between Vernalis and Disappointment Slough • Changes in stage and velocity in areas near flow control structures
Mass Fate	• No substantial effects	• No substantial effects
Net Delta Outflow	• No substantial effects	• Decreases outflow in late summer, fall, and winter about 25% of the time. No change in spring and summer. • Increases the frequency of flows in the 4,000 to 6,500 cfs range. No change in the 3,000 to 4,000 cfs range.
Central Delta Outflow	• No substantial effects	• No change in the frequency of reverse flows. However, increases magnitude of reverse flows and decreases magnitude of downstream flows.
X2 Position	• No substantial effects	• Moves the average seaward location 1 to 5 kilometers upstream in late summer and fall about 25% of the time.
Salinity	• No substantial effects	• No change at Jersey Point and Emmaton. • Increases salinity at Rock Slough in the spring about 75% of the time. • Increases salinity at Clifton Court Forebay throughout the year about 50% of the time.

Table 6.1.2-2. Summary of Changes in Delta Hydrodynamic Variables Based on DWRDSM1 and DWRSIM Model Simulations (page 1 of 5)

Category	Alternative 2	
	2A	2B
Flow, Velocity, and Stage	• Similar to 2B	• Improves circulation of flows • Reduces reverse flows in San Joaquin River • Increases flows in Mokelumne River and Old River near Woodward Island • Changes in stage and velocity in areas near flow control structures
Mass Fate	• Similar to 2B with reduced mass reaching exports	• For lower flow conditions, no significant effects except at low pumping conditions where more mass injected at Vernalis becomes trapped on Delta islands and less reaches the exports. • For higher flow conditions, substantially more mass injected in north Delta remained in the Delta after 60 days.
Net Delta Outflow	• Decreases outflow in late summer and fall about 25% of the time. No change in spring and summer. • Increases the frequency of flows in the 4,000 cfs to 6,500 cfs range. No change in the 3,000 to 4,000 cfs range.	• Similar to 1C
Central Delta Outflow	• Similar to 2B	• Substantially reduces the frequency and magnitude of reverse flows. • Reverse flows remain in July and August about 25% of the time.
X2 Position	• Moves the average seaward location 1 to 3 kilometers upstream in late summer and fall about 25% of the time.	• Similar to 1C
Salinity	• Similar to 2B	• Substantially reduces salinity at Jersey Point throughout the year. • Increases salinity at Emmaton in the summer and fall about 75% of the time. • Small increase in Rock Slough in spring salinity but large decreases during summer and fall when salinities are typically higher. • Substantial improvements in CCFB salinity under most circumstances when salinities are high.

Table 6.1.2-2. Summary of Changes in Delta Hydrodynamic Variables Based on DWRDSM1 and DWRSIM Model Simulations (page 2 of 5)

Category	Alternative 2	
	2D	2E
Flow, Velocity, and Stage	• Improves circulation of flows • Reduces reverse flows in San Joaquin River • Increases flows in Mokelumne River • More flow carried by Old River due to channel improvements • Decreased velocity and increased minimum stage in channels with setback levees • Changes in stage and velocity in areas near flow control structures	• No substantial effects
Mass Fate	• For lower flow conditions, mass injected at Freeport and Terminous remains in the Delta longer before reaching the endpoints • For higher flow conditions, substantially more mass injected in north remained in Delta after 60 days	• For lower flow conditions, mass injected at Freeport and Terminous remains in the Delta longer before reaching the endpoints • For higher flow conditions, no substantial effects
Net Delta Outflow	• Decreases outflow in late summer, fall and winter about 25% of the time. No change in spring and summer. • Increases the frequency of flows in the 4,000 cfs to 6,500 cfs range. No change in the 3,000 to 4,000 cfs range.	• Similar to 2B
Central Delta Outflow	• Substantially reduces the frequency and magnitude of reverse flows. • Reverse flows remain in July and August about 25% of the time.	• Substantially reduces the frequency and magnitude of reverse flows. • Reverse flows remain in July and August only about 10% of the time.
X2 Position	• Moves the average seaward location 1 to 3 kilometers upstream in late summer and fall about 25% of the time.	• Similar to 2B
Salinity	• Substantially reduces salinity at Jersey Point throughout the year. • Increases salinity at Emmaton in the summer and fall about 75% of the time. • Increases salinity at Rock Slough similar to 2B. • Increases salinity at Clifton Court Forebay similar to 2B.	• Substantially reduces salinity at Jersey Point throughout the year. • Increases salinity at Emmaton in the summer about 75% of the time. • Small increase in Rock Slough in spring salinity but large decreases during summer and fall when salinities are typically higher. • Increases salinity at Clifton Court Forebay similar to 2B.

Table 6.1.2-1. Summary of Changes in Delta Hydrodynamic Variables Based on DWRDSM1 and DWRSIM Model Simulations (page 3 of 5)

Category	Alternative 3	
	3A	3B
Flow, Velocity, and Stage	• Similar to 3E but flows through Delta reduced to a lesser degree	• Similar to 3E but flows through Delta reduced to a lesser degree
Mass Fate	• Similar to 3E	• Similar to 3E
Net Delta Outflow	• Decreases outflow in late summer and fall about 25% of the time. Decreases outflow in the spring about 25% of the time (April and May). No change in July and August. • Increases the frequency of flows in the 4,000 cfs to 6,500 cfs range. Negligible change in the 3,000 to 4,000 cfs range.	• Decreases outflow in the late summer, fall, and winter about 25% of the time. Decreases outflow in the spring about 25% of the time. No change in July and August. • Increases number of months with flows in the 4,000 cfs to 5,000 cfs range. Negligible change in the 3,000 to 4,000 cfs range.
Central Delta Outflow	• Similar to 3E	• Similar to 3E
X2 Position	• Moves the average seaward location 1 to 4 kilometers upstream in late summer and fall about 25% of the time. Moves the average landward location 1 to 3 kilometers upstream in winter and spring.	• Moves the average seaward location 1 to 7 kilometers upstream in late summer and fall about 40% of the time. Moves the average landward location 1 to 5 kilometers upstream in winter and spring about 40% of the time.
Salinity	• Similar to 3E	• Similar to 3E

Table 6.1.2-2. Summary of Changes in Delta Hydrodynamic Variables Based on DWRDSM1 and DWRSIM Model Simulations (page 4 of 5)

Category	Alternative 3		
	3E	3H	3I
Flow, Velocity, and Stage	• Less flow down Sacramento River at Rio Vista and through Delta toward pumps • Reduces reverse flows in San Joaquin River • Decreased velocity in channels with setback levees • Changes in stage and velocity in areas near flow control structures	• Similar to 2E with reduced flows through Delta	• Similar to 2C with reduced flows through Delta
Mass Fate	• Reduces mass reaching exports from all locations except Freeport • For low flow conditions, increases travel time through Delta for mass injected in south and central Delta	• Similar to 2E except isolated facility reduces mass reaching exports from all locations except Freeport	• Similar to 2C except isolated facility reduces mass reaching exports from all locations except Freeport
Net Delta Outflow	• Similar to 3B	• Similar to 2D	• Similar to 3B
Central Delta Outflow	• Reverse flows are not observed.	• Similar to 3E	• unknown
X2 Position	• Similar to 3B	• Similar to 2D	• Similar to 3B
Salinity	• Increases salinity at Jersey Point in the winter and spring about 50% of the time. Reduces salinity at Jersey Point during the remaining times of year. • Substantially increases salinity at Emmaton throughout the year about 50% of the time, more so in summer and fall. • Substantially increases salinity at Rock Slough throughout the year. Rock Slough salinities increase in winter and spring about 90% of the time. • Substantially reduces salinity at Clifton Court Forebay.	• Similar to 3E	• unknown.

Table 6.1.2-2. Summary of Changes in Delta Hydrodynamic Variables Based on DWRDSM1 and DWRSIM Model Simulations (page 5 of 5)

similar to the effects of Configuration 3E, except the flows through the Delta will be reduced to a lesser degree than for Configuration 3E. This is due to the fact that the isolated facility for Configurations 3A and 3B has a smaller capacity than the isolated facility for Configuration 3E. Configuration 3E introduces additional flexibility compared to Configuration 3B by providing an alternative Delta intake. The intake capacity is 15,000 cfs, instead of only 5,000 cfs in Configurations 3A and 3B. Configuration 3B includes an in-Delta storage facility, as well as north and south of Delta storage.

Configuration 3H is similar to Configuration 2E, except that it has an east Delta isolated facility. The hydrodynamic effects of Configuration 3H will be similar to the effects of Configuration 2E, except that the isolated facility increases the flexibility of the system by providing an alternative intake diversion point. When flow is diverted to the isolated facility, inflows to the Delta would be reduced.

Configuration 3I is similar to Configuration 3E, except that it further increases pumping flexibility by including three new in-Delta diversion locations. The new intakes allow pumping to occur where water quality is highest and at locations where fish entrainment would be least. The new diversion facilities include a 15,000-cfs screened intake in the western Delta to divert water to an in-Delta storage facility, a 15,000-cfs unscreened intake on the San Joaquin River at the north end of Lower Roberts Island, and a 5,000-cfs unscreened intake on the San Joaquin River near the south end of Upper Roberts Island.

In general, for alternative 3E, due to greatly reduced pumping from the Delta at the Banks and Tracy pumping plants there would be a substantial decrease in through-Delta flow from the Sacramento River to the south Delta, resulting in a circulation pattern more like the pre-development circulation pattern. This is generally considered beneficial to anadromous fish (see Chapter 7). Simulation studies show that if a tracer is released into the Delta it would remain in Delta channels longer under Alternative 3 than under the No Action Alternative. In the central Delta, the isolated facility would reduce the frequency of reverse flows.

Operation of an isolated facility could reduce Sacramento River flows downstream of the diversion and cause an increase in salinity at Emmaton throughout the year. The isolated facility also results in substantially reduced cross-Delta freshwater flows and could cause an increase in salinity in the south Delta at many times during the year.

Alternative 3 would frequently reduce net Delta outflow during the fall, winter, and spring. The increase in exports and corresponding changes in net Delta outflow occur when surplus water is available in excess of the defined flow requirements. Unlike the other alternatives, Alternative 3 allows increased exports and reduces net Delta outflow during the spring.

Configuration 3E was used as the basis of the modeling simulation, as shown in Table 6.1.2-2, for low inflow, high pumping conditions. For Configuration 3E, the isolated facility will allow flexibility in the system by providing an alternative intake diversion point.

Channel geometry under Configuration 3I is the same as under the No Action Alternative; therefore, hydrodynamic effects in the north Delta should be minor. Elsewhere, hydrodynamic effects are likely to be localized in the areas of the export pump intakes. Operation of the intakes (timing and rate) would depend on both hydrologic conditions and timing of fish migration. Pumping can be more distributed, rather than concentrated in one part of the Delta, which could help to reduce adverse effects on salinity. Effects on net Delta outflow and X2 position would be similar to Configuration 3E.

Ecosystem Restoration. Average monthly Delta outflow is estimated to be less than the Ecosystem Restoration Program 10-day flow target of 20,000 cfs for April in about 60% of water years. For May, Delta outflow is less than the Ecosystem Restoration Program 10-day flow target in nearly 70% of water years. In April in about 15% of water years (about the %age of critical years), average monthly Delta outflow is less than 9,000 cfs. In May in about 15% of water years, it is less than 6,000 cfs. Tributary flows to the Delta would need to be increased in about 45 to 55% of water years (relative to no action conditions) during late April and early May during

dry years, in order to meet the Ecosystem Restoration Program targets.

Similarly, under the No Action Alternative, Delta outflow in March would be less than the Ecosystem Restoration Program dry year flow target of 20,000 cfs in nearly 40% of the water years. It would be less than the "below normal" year flow target of 30,000 cfs in a little more than 50% of water years. The base Delta outflow in the lowest 15% of water years (about the %age of critical years) is estimated to be about 11,000 cfs.

Table 6.1.2-3 shows estimated total Delta inflows that would be needed in order to meet 30-day Ecosystem Restoration Program Delta outflow targets, assuming that diversions remain the same as under the No Action Alternative. The estimates of additional Delta outflow required to meet Ecosystem Restoration Program requirements are based on the frequency distribution for Delta outflow. The estimates of Ecosystem Restoration Sacramento tributary flows are based on comparison of the Ecosystem Restoration Program May flow target to the frequency distributions for the Sacramento River at Freeport. The estimate of Delta inflow due to additional Ecosystem Restoration Program flows on tributaries of the San Joaquin River was made by subtracting total Ecosystem Restoration Program flow targets from San Joaquin River flows at Vernalis based on the frequency distribution of flows. Probabilities of water year types used to estimate flows under the No Action Alternative are based on historical frequencies, as follows: critical (16% of historical water years), dry (15%), below normal (17%), above normal (13%), and wet (39%).

The last column in Table 6.1.2-3 shows the estimated increase of Sacramento River flow at Freeport that would be needed to meet the Ecosystem Restoration Program Delta outflow targets if exports are not reduced. The results suggest that the Ecosystem Restoration Program delta outflow targets could have a substantial effect on stream flows and/or on exports.

Levee System Integrity. Channel geometry may be altered by creating setback levees, dredging channels for levee construction material, or increasing the height of levees. Increased levee height, channel widening and deepening, and bank stabilization could result in increased channel capacity. Channel widening would result in reduced stream velocities and the potential for more sediment deposition. Levee system integrity focuses on levee improvements and modifications within the Delta. Therefore, adverse impacts on channel hydraulics outside the Delta are expected to be minor.

Water Use Efficiency. Water use efficiency could affect Delta hydrodynamics by changing the timing and reducing the amount of water diverted for agricultural, municipal, industrial, and ecosystem purposes (see Chapter 2 for anticipated levels of water savings).

Bay Region

Storage and Conveyance. CALFED Program actions are not expected to result in measurable changes in Bay hydraulic variables for two reasons: the effect of net Delta outflow on Bay hydrodynamics would be small in comparison to tidal influences, and only small changes were predicted in the position of X2.

Sacramento River and San Joaquin River Regions

Storage and Conveyance

Alternative 1. Short- and long-term river hydraulic impacts in both the Sacramento River Region and in the San Joaquin River Region are expected to be negligible. Alternative 1 does not appear to cause any adverse flood or navigational impacts in either region.

Stream flows would be increased slightly when water is released from storage to meet additional demand, including additional urban and agricultural demand and additional ecological flows. The capacity to increase Delta exports from the south Delta is limited in part by conveyance capacity in the south Delta and storage capacity south of the Delta. DWRSIM operations model simulations of Configurations 1A and 1B show very little change in exports and very little change in Sacramento River flows compared to the No Action Alternative.

Water Year Type	Delta Outflow (No Action)	Delta Outflow Target[1]	Inflow from ERP Tributary Flows (Sacramento River Region)	Inflow from ERP Tributary Flows (SJR) San Joaquin River Region	ERP Delta Outflow Shortage	Shortage as %age of Sacramento River Base Flow (No Action)
Dry (April)	9,000-11,000	20,000	0	1,000-2,000	5,000-9,000	50-70%
Dry (May)	6,000-8,000	20,000	1,000-4,000	1,000-2,000	4,000-11,000	44-100%
Below Normal (April)	11,000-16,000	30,000	0	5,000-6,000	8,000-14,000	60-75%
Below Normal (May)	8,000-11,000	30,000	0-1,000	5,000-6,000	12,000-17,000	110-120%
Above Normal (April)	16,000-20,000	40,000	0	4,000-5,000	15,000-20,000	80-85%
Above Normal (May)	11,000-15,000	40,000	0	4,000-5,000	20,000-25,000	110-125%

NOTES:
[1] 30-day flow target.
[2] 10-day pulse flow target

Table 6.1.2-3 Estimated Stream Flows to Meet April/May ERP Delta Outflow Targets (cfs)

The addition of north of Delta storage under Configuration 1C would cause slight increases in Sacramento River flows when water is released from storage, and slight reductions in flow when water is diverted to storage. Timing and size of the increased releases and diversion depend on a complex set of decision criteria built into the operations model. Over the long term the effect of Configuration 1C can be seen as an increase or decrease in the frequency of flows exceeding any given value. Low flows would tend to increase, and high flows would tend to decrease. But the amount of change as a %age of the flows under the No Action Alternative would be small.

Diversions to new storage would occur when unallocated flows are available, which tends to occur during periods of higher runoff.

Stream flows in the Sacramento River or other streams may decrease below the point at which water is diverted to storage. If stream velocity is reduced, some of the sediment load of the stream may be deposited in the trunk stream channel. This could result in accumulation of sediment below the diversion point. When sediment accumulates on gravels used by anadromous fish for spawning, it can have an adverse effect on fish population. This topic is discussed further in Chapter 7. The magnitude and frequency of decreased flows are not expected to be large enough to significantly change the sediment deposition pattern relative to the conditions under the No Action Alternative.

Each region contains a number of potential surface storage sites that may be further investigated at the project specific level as candidates for implementing the storage components of the alternatives. While detailed impact analysis is not possible until specific sites are identified, general types of impacts may be identified at the program level.

In general, construction of off-stream storage facilities would not interfere with drainage on local stream, due to the intermittent nature of channels the streams in the vicinity of the potential storage facility sites and because any runoff that does occur would be routed through the construction zone.

Infiltration and underflow from the new storage facilities after filling may occur. This could raise water tables enough to cause groundwater discharge

to springs or stream channels below the storage facilities. These effects are dependent on site-specific geohydrologic conditions and are not more likely in any one region.

Alternative 2. Alternative 2 causes small changes in river hydraulics in the Sacramento River Region and negligible changes in river hydraulic variables in San Joaquin River Region (Tables 6.1.2-4 and 6.1.2-5). Effects of diversions to the new surface storage facilities on stream geomorphology would be similar to those described for Configuration 1C.

Local effects of storage facilities would be same as described for Alternative 1.

Alternative 3. Alternative 3 would cause small changes in river hydraulic variables in the Sacramento River Region and negligible changes in river hydraulic variables in the San Joaquin River Region (Tables 6.1.2-4 and 6.1.2-5). Other hydraulic effects of program actions would be the same as described for Alternative 1.

Re-operation enhances the value of water by changing the timing of when it can be stored and used later for beneficial purposes. Under Alternative 3, substantially less water is released upstream of the Delta and exported in July and August, while more water flows down the Sacramento River and is exported in the fall. North Delta storage reduces Sacramento River flows during the winter and increases flows during the fall to supply the increased exports. Re-operation would create a similar effect as those described for Alternative 1; however, the isolated facility has such a large effect on Delta hydrodynamics that any potential impacts from storage and re-operation are rendered negligible.

Ecosystem Restoration. It is expected that meeting Ecosystem Restoration Program upstream flow targets would usually be sufficient to meet Ecosystem Restoration Program Delta outflow targets, so that no additional water would need to be added upstream to meet the Delta outflow targets. Ecosystem Restoration Program targets need not be met when inflows to reservoirs are inadequate to support Ecosystem Restoration Program releases. Therefore, depending upon hydrologic conditions in the upper watersheds, Ecosystem Restoration Program targets for some stream reaches may not be met in some years. For the case in which no new water is available from willing sellers or from storage, the Ecosystem Restoration Program flow targets could represent the lower limit of in-stream flows during dry and below normal water years (most Ecosystem Restoration Program flow targets do not apply to critical water years so in-stream flows could fall below the Ecosystem Restoration Program targets during those years).

Under the No Action Alternative, nearly 50% of the average flows at Freeport during the month of May would be below the Ecosystem Restoration Program flow target of 13,000 cfs. In about 15% of the years (the approximate %age of critical water years) flows are less than 9,000 cfs. In about 30% of the years, (the approximate %age of critical and dry years combined) flows are less than 12,000 cfs. Based on these observations, implementation of the Ecosystem Restoration Program flow target at Freeport would increase flows at Freeport in May about 35% of the time, with increases as a %age of the No Action Alternative base flow of up to about 45%. The effects would occur primarily during dry and below normal water years, which represent about one-third of all water years. The Ecosystem Restoration Program flow targets could result in a significant change in Sacramento River flows for these time periods. The increases would come from additional upstream storage releases. The contributions to the increased flows from the major tributaries would vary, so that larger %age increases could occur on some tributaries.

In order to meet Ecosystem Restoration Program targets for Delta outflow in March, Sacramento River inflows to the Delta in March would need to be increased about 25 to 35% of the time, with increases of up to 80% relative to base flows in dry years. The increase in Sacramento River and tributary stream flows due to meeting March Ecosystem Restoration Program flow targets is therefore expected to be significant.

The effects of the Ecosystem Restoration Program on the San Joaquin River Region would primarily result from pulse flows during late April and early May. Ecosystem Restoration Program targets for the

FLOW CONDITIONS BASED ON 72-YEAR HYDROLOGIC RECORD	EXISTING CONDITIONS	ALTERNATIVE CONFIGURATIONS											
		NO ACTION, 1A, 1B		1C, 2B, 2E		2A		2D		3A		3B, 3E,3H, 3I	
	Value	Value	% Diff*	Value	% Diff**	Value	% Diff**	Value	% Diff**	Value	% Diff**	Value	% Diff*
FEBRUARY													
Discharge (cfs)													
Maximum	95500	95100	-0.41%	111000	16.68%	91700	-3.56%	101000	6.61%	90100	-5.21%	110000	15.83%
Minimum	11000	11600	5.73%	11800	1.08%	11600	-0.31%	10700	-7.89%	10500	-9.75%	10900	-6.04%
Average	38900	38600	-0.74%	37700	-2.43%	38600	SC	38700	0.33%	38600	0.09%	38100	-1.31%
Mean Velocity (fps)													
Maximum	4.25	4.24	-0.23%	4.76	12.45%	4.29	1.26%	4.53	7.00%	4.25	0.31%	4.59	8.43%
Minimum	1.29	1.33	3.11%	1.39	4.03%	1.38	3.23%	1.32	-1.16%	1.30	-2.26%	1.29	-3.37%
Average	2.59	2.58	-0.41%	2.63	1.96%	2.67	3.35%	2.67	3.53%	2.67	3.40%	2.56	-0.72%
Top Width (feet)													
Maximum	620	620	-0.02%	628	1.31%	622	0.43%	625	0.89%	622	0.35%	624	0.67%
Minimum	562	563	0.25%	566	0.52%	566	0.45%	564	0.09%	563	SC	562	-0.28%
Average	595	595	-0.03%	598	0.43%	598	0.54%	598	0.56%	598	0.54%	595	-0.06%
Mean Depth (feet)													
Maximum	36.8	36.8	-0.16%	38.5	4.68%	35.8	-2.69%	37.2	1.12%	35.6	-3.33%	38.9	5.77%
Minimum	16.1	16.5	2.15%	16.3	-1.19%	16.2	-1.71%	15.7	-4.65%	15.6	-5.39%	16.1	-2.35%
Average	26.1	26.1	-0.28%	25.5	-2.37%	25.7	-1.44%	25.7	-1.32%	25.7	-1.41%	25.9	-0.50%
SEPTEMBER													
Discharge (cfs)													
Maximum	27500	27500	SC	27400	-0.37%	27500	SC	27500	SC	27500	SC	27400	-0.37%
Minimum	7610	8000	5.08%	8000	SC	8020	0.21%	8070	0.84%	7550	-6.93%	7680	-3.99%
Average	12000	12700	6.17%	12800	0.53%	12500	-1.59%	12800	0.40%	12700	-0.26%	12700	-0.40%
Mean Velocity (fps)													
Maximum	2.14	2.14	SC	2.21	3.16%	2.21	3.37%	2.21	3.37%	2.21	3.37%	2.14	-0.20%
Minimum	1.06	1.08	2.76%	1.12	3.43%	1.12	3.55%	1.13	3.91%	1.08	-0.58%	1.06	-2.22%
Average	1.35	1.40	3.35%	1.45	3.71%	1.43	2.50%	1.45	3.63%	1.45	3.26%	1.40	-0.22%
Top Width (feet)													
Maximum	586	586	SC	589	0.50%	589	0.52%	589	0.52%	589	0.52%	586	-0.02%
Minimum	553	554	0.23%	556	0.45%	556	0.45%	557	0.48%	555	0.11%	553	-0.18%
Average	564	566	0.27%	569	0.50%	568	0.40%	569	0.49%	568	0.46%	566	-0.02%
Mean Depth (feet)													
Maximum	22.9	22.9	SC	22.5	-1.62%	22.6	-1.49%	22.6	-1.49%	22.6	-1.49%	22.9	-0.14%
Minimum	14.0	14.3	1.91%	14.1	-1.64%	14.1	-1.57%	14.1	-1.33%	13.7	-4.31%	14.1	-1.54%
Average	16.7	17.1	2.31%	16.8	-1.39%	16.7	-2.19%	16.8	-1.44%	16.8	-1.68%	17.0	-0.15%

*Percent Difference Compared to Existing Conditions. **Percent Difference Compared to No Action. SC=Small Change (magnitude of difference less than 0.01 percent. NA=Simulation data not available.

Table 6.1.2-4. Range of Hydraulic Effects of Program Actions, Sacramento River at Freeport

C-005276

C-005276

FLOW CONDITIONS BASED ON 72-YEAR HYDROLOGIC RECORD	EXISTING CONDITIONS	ALTERNATIVE CONFIGURATIONS											
		NO ACTION, 1A, 1B		1C, 2B, 2E		2A		2D		3A		3B, 3E, 3H, 3I	
	Value	Value	% Diff*	Value	% Diff**	Value	% Diff**	Value	% Diff**	Value	% Diff**	Value	% Diff*
FEBRUARY													
Discharge (cfs)													
Maximum	36500	36500	SC	36500	SC	36500	SC	36500	SC	36500	SC	36500	SC
Minimum	1150	972	-15.63%	972	SC	972	SC	972	SC	972	SC	972	SC
Average	6430	6410	-0.28%	6410	SC	6430	0.28%	6410	SC	6430	0.28%	6430	0.28%
Mean Velocity (fps)													
Maximum	3.17	3.17	SC	3.17	SC	3.17	SC	3.17	SC	3.17	SC	3.17	SC
Minimum	1.47	1.42	-3.71%	1.42	SC	1.42	SC	1.42	SC	1.42	SC	1.42	SC
Average	2.16	2.15	-0.06%	2.15	SC	2.16	0.06%	2.15	SC	2.16	0.06%	2.16	0.06%
Top Width (feet)													
Maximum	512	512	SC	512	SC	512	SC	512	SC	512	SC	512	SC
Minimum	251	247	-1.55%	247	SC	247	SC	247	SC	247	SC	247	SC
Average	294	294	-0.03%	294	SC	294	0.03%	294	SC	294	0.03%	294	0.03%
Mean Depth (feet)													
Maximum	20.8	20.8	SC	20.8	SC	20.8	SC	20.8	SC	20.8	SC	20.8	SC
Minimum	3.1	2.8	-10.71%	2.8	SC	2.8	SC	2.8	SC	2.8	SC	2.8	SC
Average	9.7	9.7	-0.19%	9.7	SC	9.7	0.19%	9.7	SC	9.7	0.19%	9.7	0.19%
SEPTEMBER													
Discharge (cfs)													
Maximum	1920	1920	SC	1920	SC	1920	SC	1920	SC	1920	SC	1920	SC
Minimum	1160	1110	-4.23%	1110	SC	1110	SC	1110	SC	1110	SC	1110	SC
Average	1640	1630	-0.99%	1630	SC	1630	SC	1630	SC	1630	SC	1630	SC
Mean Velocity (fps)													
Maximum	1.65	1.65	SC	1.65	SC	1.65	SC	1.65	SC	1.65	SC	1.65	SC
Minimum	1.47	1.46	-0.96%	1.46	SC	1.46	SC	1.46	SC	1.46	SC	1.46	SC
Average	1.59	1.59	-0.22%	1.59	SC	1.59	SC	1.59	SC	1.59	SC	1.59	SC
Top Width (feet)													
Maximum	263	263	SC	263	SC	263	SC	263	SC	263	SC	263	SC
Minimum	251	250	-0.40%	250	SC	250	SC	250	SC	250	SC	250	SC
Average	259	259	-0.09%	259	SC	259	SC	259	SC	259	SC	259	SC
Mean Depth (feet)													
Maximum	4.3	4.3	SC	4.3	SC	4.3	SC	4.3	SC	4.3	SC	4.3	SC
Minimum	3.1	3.0	-2.84%	3.0	SC	3.0	SC	3.0	SC	3.0	SC	3.0	SC
Average	3.9	3.9	-0.66%	3.9	SC	3.9	SC	3.9	SC	3.9	SC	3.9	SC

*Percent Difference Compared to Existing Conditions. **Percent Difference Compared to No Action. SC=Small Change (magnitude of difference less than 0.01 percent.
NA=Simulation data not available.

Table 6.1.2.5. Range of Hydraulic Effects of Program Actions, San Joaquin River at Vernalis

C-005277

C-005277

main tributaries of the San Joaquin River total about 4,000 cfs in dry years (about 15% of water years), about 9,000 cfs in below-normal and above-normal water years (about 30% of water years), and about 13,000 cfs in wet years (about 40% of water years). The lowest 15% of average monthly flows in the San Joaquin River at Vernalis (corresponding to the %age of critical years when Ecosystem Restoration Program targets do not apply) are estimated to be less than about 2,200 cfs in April and May under the No Action Alternative. Flows increase to about 4,000 cfs in above-normal water years, and nearly 90% of the monthly average wet year flows are less than about 13,000 cfs. Based on these observations, Ecosystem Restoration Program pulse flows would be more than double the average monthly flows in the San Joaquin River at Vernalis during dry, below normal, and above normal years and would be substantially larger than average monthly flows during most wet years.

Water Quality. Improved water quality would not directly affect channel hydraulics or hydrodynamics, although it might lead to small changes in stream flows where timed releases are made to dilute constituent loadings.

Coordinated Watershed Management. Coordinated Watershed Management could have a variety of impacts on channel hydraulics. Changes in flow in trunk streams downstream of most watershed improvement projects would generally be less than significant. The effects would be moderated by operation of major reservoirs that are present on most large tributaries between the upper watershed and the valley floor.

The various possible watershed projects could alter flow regimes both in the upper watersheds and downstream. Depending on the size and scale of the projects, effects could range from very limited changes in flows in nearby stream reaches, to large-scale changes in flow regimes. Vegetation and habitat restoration projects might increase retention of surface water in the watershed, resulting in reduced extremes in runoff (reduced peak flows and increased base flows in streams).

Improvements in timber harvesting practices could substantially reduce peak flows and total runoff from the forested areas. Maintained or reforested tree stands would increase evapotranspiration, interception, and infiltration of precipitation, all of which reduce runoff. In areas where snowmelt plays an important role in the flow regime, reducing the effects of timber harvesting would increase shading which tends to reduce direct evaporation of snow packs and maintains the snow packs longer. Range improvement activities could increase vegetation cover and reestablish riparian habitat, both of which would tend to reduce runoff velocities and increase water retention in watersheds.

Erosion control efforts could result in reductions in runoff and sediment input to tributaries and reservoirs. Because many erosion control efforts are expected to be local and small-scale, this would slightly reduce peak flows but would not substantially alter timing of those flows. Large-scale watershed improvements, such as revegetation of large tracts in steep watersheds, would result in more substantial beneficial impacts. During construction of erosion control projects, short-term adverse impacts could be locally significant but would not significantly affect basin areas. Implementation of standard erosion control techniques during construction would further reduce these effects.

Stream restoration projects, such as removal of logs and debris from stream channels to promote fish migration, could result in increased flow velocities and erosion as the stream gradient is reestablished to a new equilibrium. The impacts would decrease with time and distance downstream and would generally be negligible in basin areas. Mitigation measures could include placement of engineered flow control structures, revegetation of stream channels and banks, or widening and/or lengthening channels.

Water Use Efficiency. Water use efficiency could affect riverine hydraulics by potentially changing the timing and reducing the amount of water diverted for agricultural, municipal, industrial, and ecosystem purposes (see Chapter 2 for anticipated levels of water savings). Reductions in agricultural demands could result in fewer and/or smaller diversions and could result in redistribution of reservoir releases. Increased conservation and water recycling in the

urban sector could reduce or eliminate the need for increased diversions as populations increase and demand grows. Beneficial impacts to stream flows could occur as a result of these changes.

Water Transfers. Water transfers can increase streamflows by increasing the amount of water transferred through stream channels. The timing and magnitude of the changes in flows would be constrained by conveyance capacity, such as the capacity of the SWP and CVP pumps and canals south of the Delta and by system operating rules.

6.1.2.5 Comparison of Program Elements to Existing Conditions

The forecasted flows for the No Action Alternative differ from the existing condition flows as a result of forecasted future demands for water. In most cases, forecasted hydraulic variables for the No Action Alternative are similar to those for existing conditions, with maximum variations of less than a few %. Therefore, the conclusions regarding the magnitude of hydrodynamic effects on the Delta would be the same if they are compared to existing conditions as compared to the No Action Alternative.

6.1.2.6 Mitigation Strategies

The potential impacts discussed in this document are based on computer model simulations of programmatic alternatives. As the planning process progresses, the model simulations will be refined. As site-specific alternatives emerge, even more detailed design and analysis information will become available. For example, if Alternative 3 is selected for further analysis and design, it may be possible to develop specific mitigation strategies to avoid potentially significant low flow and associated salinity problems in the south Delta. In general, it is suggested that mitigation include revised operating rules to reduce flow-related problems that may occur during low flow conditions.

6.1.2.7 Potentially Significant Unavoidable Impacts

Discussion of significant impacts resulting from changes in flow-related variables is presented in the sections describing affected resources elsewhere in this report.

6.1.3 Environmental Consequences: Water Quality

6.1.3.1 Assessment Methods

The potential impacts resulting from the implementation of CALFED alternatives were analyzed using the Department of Water Resources operations planning model (DWRSIM) and the Bay-Delta hydrodynamic model (DWRDSM1). DWRDSM1 was used to simulate the effects of the alternatives on salinity, dissolved organic carbon (DOC), and bromide concentrations in Delta waters.

Each of these three constituents is also useful as a surrogate for evaluating other water quality effects of alternatives on the Delta. Salinity concentration often measured as electrical conductivity is largely a result of the balance between freshwater inflows from rivers and intrusion of brackish water from San Francisco Bay. Bromide concentration is another indicator of intrusion of Bay waters, as the Bay is the primary source of bromide in the Delta. DOC levels indicate the extent to which circulation patterns are able to effectively dilute and remove DOC and other constituents that enter Delta waters from urban runoff, agricultural drains, and other sources.

The effects of the alternatives on concentrations of other constituents of concern were evaluated qualitatively.

6.1.3.2 Significance Criteria

The significance of both adverse and beneficial effects was assessed with respect to the degree to which the model studies and programmatic analyses suggest that various water quality parameters of concern could be affected by program alternatives. Changes in the concentrations or loadings of these

water quality parameters have been categorized as negligible, minor, or moderate. A moderate change in concentration is designated as potentially significant.

6.1.3.3 Comparison of No Action Alternative to Existing Conditions

Under the No Action Alternative, the waters of the Bay-Delta system would be managed substantially as they are today but would be modified as necessary to comply with the Central Valley Project Improvement Act. Water storage or conveyance facilities currently under construction would be completed, but no new facilities would be built. Total annual water withdrawals from the Delta would increase from the current 5.9 to 6.9 MAF to 7.1 to 7.6 MAF in 2020. Wastewater treatment facilities would be expanded to meet the needs of a growing population but the treatment provided would remain at current levels or change with new regulations. Levees would be maintained in accordance with current practices but no major rehabilitation would be undertaken. Non-project levees would continue to be maintained under SB-34 and SB-1390 (see Section 4.2).

There would be few direct short-term adverse environmental effects from the No Action Alternative. For the long term, water quality in the Delta would gradually deteriorate as water diversions from the Delta and urban wastewater and stormwater pollutant loadings from point and non point sources in the Central Valley increase. By 2020, water diversions are expected to increase by 15%, while pollutant loads from municipal wastewater treatment plants and urban runoff are expected to increase by 60%. The salinity of water at the CVP and SWP pumps could increase by 10% to 20% or more in dry periods. This represents a significant but mitigable adverse impact.

Levees could continue to deteriorate, increasing the risk of failure. Depending on the extent of the flooding caused by levee failure, water quality at the CVP and SWP pumps and at other water supply intakes could be degraded by sediment loading, and by a variety of chemicals and wastes used or stored in areas protected by levees. Water could become temporarily unusable for municipal and agricultural supply. This would be a significant adverse impact.

Declining water quality in the Delta could cause cities and agriculturalists to seek other sources of water. Development of other sources may adversely affect surface water quality at other locations. This is a potentially significant impact.

6.1.3.4 Comparison of Program Alternatives to No Action Alternative

The impacts to surface water quality resulting from the storage and conveyance program element will vary by alternatives, as discussed below. Impacts to surface water quality resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternatives. In those cases where no environmental impacts have been associated with a program element within a region, the program element is not discussed.

Delta Region

Storage and Conveyance

The DWRSIM, DWRDSM1, and DWRDSM2 models were used to simulate the effects of the Alternative Configurations on water quality in the Delta. DWRDSM2 modeling was conducted as part of the ongoing alternative refinement process. Results of this modeling are not discussed in this report but are presented in the Phase 2 report. Delta modeling for the alternatives used the same hydrology from study 472B.

Alternative 1. Construction activities (primarily dredging and filling) associated with building storage facilities and relocating water supply intakes may have short-term impacts on water quality through the resuspension of sediment. Turbidity plumes may result and the release of chemicals associated with those sediments may occur. Either occurrence could expose aquatic species to short-term increases in toxicity.

Table 6.1-1 summarizes the effects of Alternative 1 on the modeled parameters compared to the No Action Alternative. Alternative 1 would not improve source water quality protection in the Delta.

Salinity and bromide concentrations could increase significantly in the south Delta, especially in dry years, as a result of increased Delta export pumping capacity in Alternative 1. Increases in salinity on the order of 10 % or more are projected. This is a potentially significant impact.

The 4-75-MAF-capacity additional storage component of Configuration 1C is expected to have beneficial impacts on water quality for export. Releases from storage could reduce salinity at the Contra Costa Canal Intake during dry years. Salinity concentrations at Clifton Court Forebay would likely also be reduced. The increases in salinity and bromide concentrations in the south Delta in dry years as a result of the increased export pumping capacity would be offset to an unknown degree by the inflow of high-quality water to the Delta from storage. Delta hydrodynamic modeling results suggest that salinity concentration would increase in the southeast Delta. Changes in average salinity, based on the 16-year modeling period 1975 to 1991, for two selected locations are shown in Figure 6.1.3-1 and 6.1.3-2 for each configuration and for the No Action Alternative. The figure show total dissolved solids (TDS) concentrations in parts per million (ppm). TDS includes dissolved substances that contribute to salinity. Another measure of salinity is electrical conductivity. Salinity in seawater consists predominantly of sodium chloride, but includes a number of other dissolved salts. The TDS of seawater is approximately 35,000 ppm, while brackish water ranges from about 1,000 to 10,000 ppm. TDS, electrical conductivity, and salinity are all approximately proportional. Electrical conductivity is measured in micro Siemens per centimeter (μs/cm), is approximately three times the value of TDS in ppm. Salinity (in ppm) is approximately equivalent to TDS where TDS results mainly from seawater intrusion.

Figure 6.1.3-1 shows simulated monthly average TDS concentrations for Old River at Rock Slough for the hydrology of 1975 to 1991.

TDS for Configuration 1C ranges from about 500 ppm in December to less than 200 ppm from March through June. There is almost no change relative to No Action.

Figure 6.1.3-2 shows TDS concentrations evaluated at Prisoners Point in the central Delta for the same period. For Configuration 1C, TDS ranges from about 200 ppm in December to about 100 to 150 ppm in the period from March through June. This is almost identical to the TDS under No Action.

Alternative 2. Alternative 2 would involve large-scale construction activities. Most of the construction is associated with conveyance structures.

Most of the potential impacts of construction on water quality are associated with ground disturbance and will consist of increases in erosion and subsequent sedimentation loads to adjacent water bodies. The extent of ground disturbance will depend on the dimensions and shape of the canals and the need for construction of new roads to access the construction sites. Excess sediment could be discharged directly to streams as a result of construction activities and as a result of precipitation falling on exposed soils. Increased sediment loading and turbidity can be expected immediately downstream of the construction sites. In addition, disturbed soils may contain residual farm chemicals and nutrients that may affect water quality.

Alternative 2 would have similar beneficial impacts on export water quality to those described under Alternative 1. The benefits result in part from a change in the pattern of flow through the Delta during drier months, and in part on increased freshwater inflows from additional storage releases made possible by increased storage facilities. Configuration 2A, which does not include any new storage, would have the least-beneficial impact.

Estimated effects on salinity in the southwest and central Delta are shown in Figure 6.1.3-1 and 6.1.3-2. At the Contra Costa Water District turnout at Rock Slough, TDS concentrations under three of the Alternative 2 configurations (2B, 2D and 2E) are nearly identical, and fall within a narrow range near 200 ppm. This represents an improvement relative to No Action in the period from July through March.

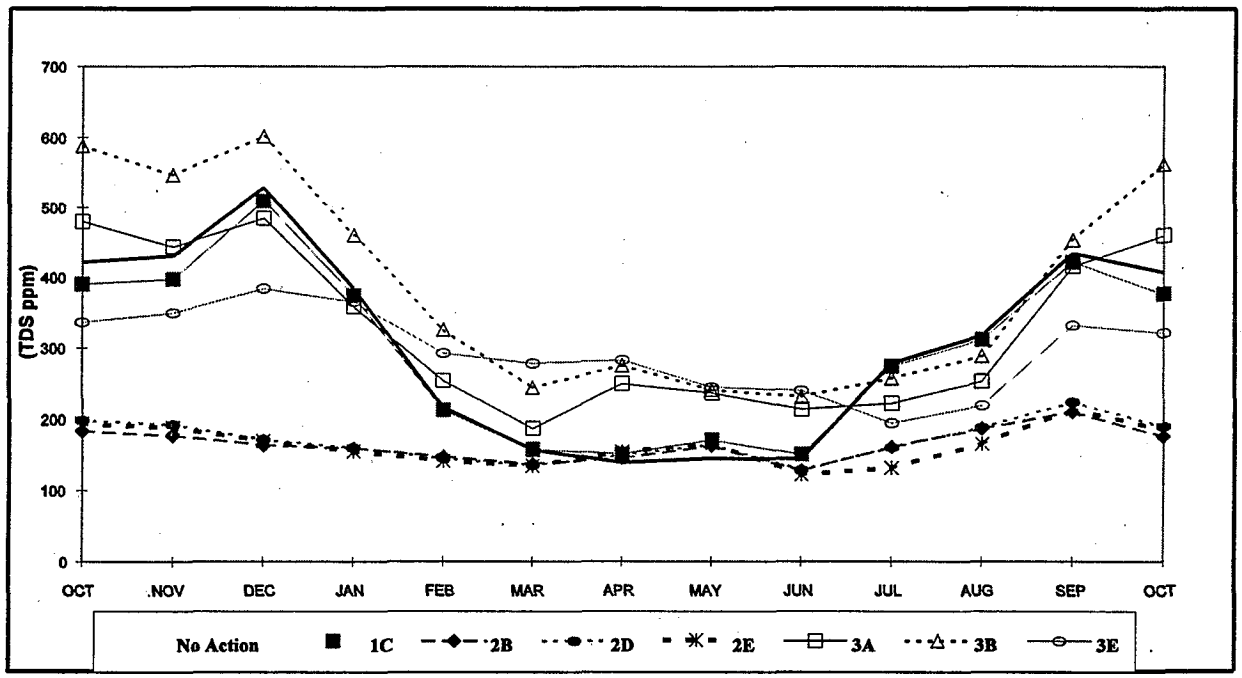

Figure 6.1.3-1 End of Month Salinity (TDS in ppm), Old River at Rock Slough near CCWD Intake, 1976 to1991

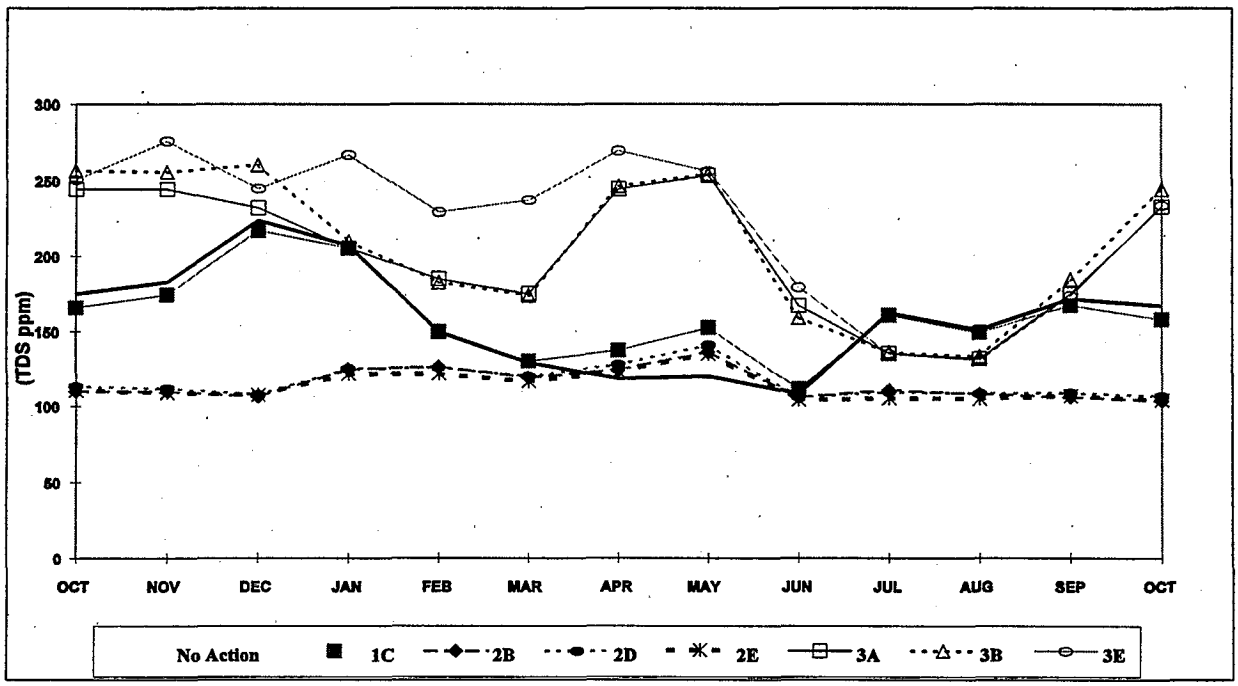

Figure 6.1.3-2. End of Month Salinity (TDS in ppm), Prisoner's Point, 1976 to 1991

Similar improvements relative to already low salinities under No Action are expected in the central Delta, represented by Prisoners Point in Figure 6.1.3-2.

Table 6.1-1 summarizes the effects of Configurations 2B, 2D, and 2E compared to the No Action Alternative. All of the configurations would result in reductions in salinity at Clifton Court Forebay and at the Contra Costa Canal intake and reductions in salinity and bromide concentrations at the Contra Costa Canal intake during some months of dry years.

DOC concentrations would not differ substantially from No Action under any of the modeled configurations at any of the diversion points.

Alternative 3. All configurations of Alternative 3 would involve large-scale construction activities in the Delta. Although some of the construction would occur in or near channels, most would be on land. The impacts of conveyance construction would be similar to those described for Alternative 2 but are expected to be much less significant because of the relatively smaller in-channel exposure. Configuration 3I includes the greatest number of channel crossings and intake facilities and thus would have the largest construction impacts.

Impacts associated with the in-Delta storage facility included in Configurations 3B, 3E, and 3I are construction-related. During construction of the pumping plant and siphon on Clifton Forebay, increased turbidity, contaminants and nutrients due to sediment disturbance could impact water quality. Spills of petroleum products or other chemicals associated with construction equipment and materials may occur. Flooding of a Delta island has the potential to place residual pesticides, nutrients, and other constituents in soils into suspension or solution in the stored water. This impact would occur during early operation of the storage facility. Long-term water quality of water stored in Victoria Island would be similar to that in Clifton Court Forebay. Therefore, no significant long-term water quality impacts are expected.

Alternative 3 would result in major reductions in salinity, DOC, and bromide in export water. This would produce significant benefits for some municipal and agricultural water users outside the Delta. Alternative 3 is also projected to improve salinity in the central Delta, have small impacts on salinity in the southwest Delta, and increase salinity in the south Delta.

Figure 6.1.3-1 shows that salinity would be generally highest for Configuration 3B and lowest for Configuration 3E. Increases would occur at Rock Slough between February and June. The increases would be small. The impacts are expected to be less than significant at Rock Slough.

Figure 6.1.3-2 shows similar relative changes in salinities in the central Delta, but the average salinity concentrations are all less than 300 ppm.

DOC concentrations at the Contra Costa Canal Intake and in the south Delta could increase. Increased salinity in the south Delta could adversely affect agricultural use of the Delta water.

The significance of the increase in salinity in the south Delta is not well established. Under no action conditions, salinity would fluctuate over a wider range than under alternatives that incorporate an isolated facility plus storage. Potential adverse impacts on the south Delta are determined to be significant because increases in salinity at Rock Slough are potentially as much as 100 to 200% relative to the No Action Alternative. In the central Delta, the combination of reduced pumping and reduced freshwater inflows results in a small adverse impact on central Delta salinity.

The general effects of Configurations 3B and 3H on water quality would be very similar to those described above in Alternative 3. Releases from storage during the dry season would not have as much beneficial impact on water quality as in Alternative 2 because the additional water would be captured by the isolated facilities before it reaches the Delta.

Salinities at Emmaton on the Sacramento River are projected to increase with Alternative 3. Effects on salinity in export water should be generally beneficial due to increased flexibility that allows pumping to occur in portions of the Delta with the

highest water quality. Effects on the distribution of salinity should also be beneficial because the various intake locations increase flexibility. The differences in potential adverse effects on Delta water quality among Configurations 3B, 3E, and 3H are primarily the result of the different capacities of the isolated facilities.

Configuration 3I includes three intakes within the Delta. The increased flexibility allows water managers to distribute pumping throughout the Delta or to pump from the Sacramento River. This capability could be used to prevent salinity intrusion into the north Delta during low Sacramento River flows. However, if used to accomplish other objectives, pumping from the in-Delta intakes would probably result in impacts similar to Configurations 1C, 2B, 2D, and 2E.

Ecosystem Restoration. Ecosystem Restoration Program involves restoration of terrestrial and aquatic wildlife habitat.

Habitat restoration would involve large-scale construction operations affecting considerable areas of land and water. Construction activities in waterways could greatly increase local turbidity and, depending on the source of the material used for levee construction, could add nutrients to the water body.

Construction in dry conditions would make similar substances available for washoff into waterways during storms and high flows. Even assuming that construction methods would be chosen to minimize adverse environmental impacts and that conventional mitigation measures would be integrated into construction activities, temporary adverse changes in water quality in the immediate vicinity of construction sites can be expected. Regional water quality and beneficial uses would not be affected by construction activities.

Ecosystem Restoration Program would alter water quality in a number of other ways. The conversion of land from agricultural cropland to wildlife habitat would reduce the emission of soil particles, nutrients, and pesticides to the waters of the Bay-Delta system with a consequent beneficial effect on in-stream water quality. The emission of salts would remain constant, although salt concentrations in Delta channels and other waterways would increase due to increased evaporation rates.

Restoration of riparian corridors and emergent wetlands would increase shading of water surface. Water temperatures in small tributary streams would be lower. However, any decrease in water temperatures due to increased shading in Delta channels and large rivers may be offset by solar heating of a larger water surface area flowing more slowly.

The only potential long-term adverse water quality impact of Ecosystem Restoration Program is an increase in water salinity attributable to increased evaporation. The potential magnitude of this impact cannot be predicted with certainty.

Long-term water quality benefits could result from decreased discharges of nutrients and pesticides.

If the conversion of agricultural land into aquatic habitat resulted in an increase in DOC content of Delta waters, then their suitability as a drinking water source would be reduced and the cost of water treatment would increase. Any adverse effects could be mitigated by locating at least some of the aquatic habitat restoration projects in areas where any increase in DOC emission would not affect drinking water diversions, by capping or sealing peat soils to reduce DOC emissions, or by DOC removal from the island drainage.

Water Quality. Water quality would probably benefit from reduced point and nonpoint source discharges.

Levee System Integrity. Levee rehabilitation would involve large-scale construction operations affecting considerable areas of land and water. Construction activities in or immediately adjacent to waterways could temporarily increase local water turbidity and, depending on the source of the material used for levee construction, could cause the release of nutrients, natural organic matter, and toxicants into the water column. The significance of the impacts would depend on the scale and rate of construction activities. The water quality impacts are expected to be mitigable.

Levee rehabilitation would result in minor beneficial changes in water quality in adjacent waterways due to conversion of agricultural land to levees and reduced levee erosion.

The primary water quality benefit of levee system integrity is that it would reduce the risk of levee failure and the potential for increased sediment loading and dispersal of contaminants (hazardous materials or wastes, for example) that might occur if land protected by levees is flooded. It would also reduce the risk of massive contamination caused by salinity intrusion of levee failure occurred during a low outflow period.

Water Use Efficiency. Impacts of water use efficiency are anticipated to be mostly beneficial. However, in some regions, adverse impacts to surface water may also occur. The significance of beneficial impacts cannot be assessed because the direct relationship between improved irrigation, both agricultural and urban, on contaminant loading in surface runoff is not known. However, it is generally anticipated that the reduced runoff from fields and urban landscapes will reduce the introduction of degrading contaminants into surface waters in and around the Delta. To the extent that reduction is surface runoff from efficiency improvements also reduce the introduction of organic carbons into Delta waterways, water quality benefits will be derived. Water use efficiency improvements may also be derived through recycling of wastewater if additional treatment requirements result in less urban contaminant loading.

Implementation of water use efficiency could involve a wide range of construction activities. Short-term impacts of construction may cause local water quality impacts, but are not expected to be significant.

Water Transfers. Water Transfers would affect water quality primarily through changes to river flow and water temperatures. In addition, the source of water for a transfer, the timing, magnitude, and pathway of each transfer will have a tremendous effect on the potential for significant impacts. Potential beneficial water quality impacts are a function of the ability of transfers to decrease the concentrations of various contaminants through both increased streamflow and the potential for obtaining higher quality water from several transfer sources. Because transfers can invoke both beneficial and adverse impacts, at times on the same resource, net environmental effects of a water transfer within and between resources must be considered on a case by case basis.

Bay Region

Storage and Conveyance

Alternative 1. Configuration 1A will have no water quality impact on the Bay Region. Configuration 1B would probably have a negligible impact resulting from the small increase in pumping capacity from the Delta.

Configuration 1C may have a small beneficial impact on Bay water quality due to increased releases from storage that may result in slightly greater increased Delta outflows during low flow periods.

Alternative 2. Configuration 2A includes no additional storage and is not expected to significantly change Delta outflow. The water quality impacts would be similar to Configuration 1B.

Configurations 2B, 2D, and 2E include additional storage, and their impacts would be similar to those of Configuration 1C.

Alternative 3. Configuration 3A includes no additional storage, but the isolated facility could allow an increase in Delta exports, resulting in a decrease in Delta outflow and consequent potential impacts on Bay water quality. DWRSIM modeling suggests that the X2 position could move eastward 1 to 4 kilometers. This is not expected to result in a significant impact on water quality in the Bay. The daily tidal range in the position of X2 is roughly 10 to 20 km in the Bay (maximum excursion of 60 to 80 km from the Golden Gate).

The isolated facilities differ in capacity, but Delta inflow would not necessarily change because water intended for export would be captured before it reaches the Delta. The Bay Region would benefit from improved quality of water exported through the isolated facilities. The quality of water in the in-

Delta storage facility (Configurations 3B, 3E, and 3I) would also be relatively good since this facility could be filled when Delta water quality is best.

Configuration 3I includes three intakes within the Delta, which would enable water managers to vary pumping patterns and reduce impacts associated with concentrated pumping (such as salinity intrusion into the north Delta). Pumping from within the Delta could require some additional inflows from the Sacramento River to ensure attainment of X2 standards.

Ecosystem Restoration. Under the Ecosystem Restoration Program the acreage of shallow water aquatic habitat and saline emergent wetlands will be increased adjacent to Suisun Bay and Marsh, San Pablo Bay, the Napa and Petaluma rivers, and Sonoma Creek. The land to be converted is currently used for agriculture.

Creation of aquatic habitat will involve construction activities similar to those described for the Delta. Construction impacts would also be similar.

Conversion of land from agriculture to aquatic or riparian habitat in the Bay will change the rates of DOC emission. However, changes in DOC emissions are of little water quality significance here because bay waters are generally too saline for use as drinking water supplies. DOC could produce ecological benefits by increasing the amount of available nutrient energy at the base of the food chain.

Currently, fertilizers and pesticides are used sparingly on the agricultural lands adjacent to the Bay. Conversion of agricultural lands to aquatic habitat will eliminate the use of fertilizers and pesticides on the lands subject to this action and thus modestly reduce the discharge of nutrients and pesticide-containing agricultural drainage water.

Conversion of agricultural land to shallow water aquatic habitat and saline emergent wetlands will have little effect on the emission of salts. The increase in evaporation on the fringes of the North Bay is unlikely to have much effect on the salinity of Bay waters because the area involved in the land conversion is small relative to the surface area of the Bay.

The restoration of riparian vegetation corridors will increase shading of stream waters. The only water quality parameter directly affected will be temperature. Although it does not cool the water, shading helps to prevent the sun's radiation from warming stream water. Water temperature in small streams could be reduced by several degrees relative to no action conditions if a dense canopy can be restored to shade much of the water surface for thousands of feet. Water temperatures in broader streams or locations where the riparian canopy is fragmented will be reduced by lesser amounts. Decreased water temperature will also result in increased dissolved oxygen concentrations.

Water Quality. Beneficial impacts related to implementation of source control measures water quality would be similar to those described for the Delta. Reduction of metals emissions to the Bay from abandoned mercury (cinnabar) mines in t he Guadalupe River watershed may be accomplished by sealing mines, removing and capping tailings, and by removing contaminated sediments from streambeds. Temporary increases in metal discharges may occur due to disruption of tailings piles and exposure of new surfaces to weathering.

Water Use Efficiency. Impacts to water quality in the Bay Region are expected to primarily be beneficial as a result of reduced urban runoff and increased conservation. These actions would decrease the introduction of degrading contaminants into surface waters. Salinity levels in recycled water supplies may create adverse impacts as more water is repeatedly recycled in the local system.

Sacramento River Region

Storage and Conveyance

Alternative 1. Impacts on surface water quality in the Sacramento River Region would result from changes in stream flow due to releases from and diversions to storage and from construction, operation and maintenance of new storage facilities.

Configuration 1A is not expected to result in water quality impacts in the region. Increased export pumping capacity in the Delta under Configuration 1B could result in slightly greater releases from storage and higher stream flows. However, the increases are not expected to be large enough to have a significant impact on water quality.

Additional releases of high-quality water from storage with Configuration 1C could result in increased flows on the order of 5% to 10% during low-flow periods. These increases could result in dilution of constituents carried by the streams. In general this would be a beneficial impact. The increases are too small to result in significant changes in channel scouring. Therefore, suspended sediment concentrations would probably be reduced.

Temperature effects (most likely an increase in temperature in the Sacramento River due to inflow of warmer water from a new off-tributary reservoir) may occur. Surface water releases for Sacramento Tributary storage may be confined to consumptive use in the adjacent service area to prevent the introduction of warmer water into the Sacramento main stream. For example, inflow of water 5 degrees warmer than the water in the trunk stream, at a rate equal to 10% of the flow in the trunk stream, could increase the average temperature of the trunk stream by about half a degree. However, inflows to streams from off-tributary reservoirs would be uncommon. More frequently, stored water would be delivered to water users via canals, in exchange for reduced in-stream diversions.

Construction, operation, and maintenance impacts related to proposed surface storage facilities in the Sacramento River Region would be similar to those described for the Delta Region. Potential off-tributary reservoir sites are located on the west side of the Sacramento Valley where precipitation is low. Water quality impacts of a reservoir in this area are expected to be minor.

Alternative 2. Configuration 2A does not include additional storage and is not expected to impact surface water in the Sacramento River Region.

Configurations 2B, 2D, and 2E each include similar amounts of new storage. Impacts on surface water quality would be similar to impacts described for Configuration 1C.

Alternative 3. Configuration 3A does not include new storage, but the isolated facility provides increased conveyance capacity relative to No Action Alternative conditions. Increased exports would require increased releases from existing reservoirs, under some conditions, to meet Delta outflow and X2 requirements. In-stream water quality may be improved as a result of these releases.

Ecosystem Restoration. Some of the riparian habitat would be created by constructing new levees behind the existing levees. Because levee construction would generally occur outside active stream channels rather than within waterways, adverse effects on water quality would be relatively minor. Minor and localized increases in water turbidity can be expected when the new levees are first exposed to water. Depending on the source of the construction materials, there could also be minor, localized increases in salinity.

Construction materials, including imported soils, will be tested prior to use to ensure that toxic substances are not introduced. Construction material, including imported soils, will be tested in accordance with permit requirements to ensure little or no toxic substances are present. These impacts are expected to be similar to construction-related impacts described for the Delta.

Stockpiling gravel at locations where it would be carried into stream channels would have little effect on water quality, provided the gravel is washed to remove fine sands and silts. Exposing existing sources of gravel on islands, bars, and banks where it is likely to contain a silt component would have a greater but still localized effect on stream turbidity.

The removal or alteration of existing dams could result in increased discharge of sediments that have accumulated behind them. The sediment could impair water quality by increasing water turbidity. Depending on the location and age of the dam, the sediments could contain elevated concentrations of toxic compounds; metals from past mining activities, or agricultural pesticides, including now-prohibited substance such as DDT, that are resistant to chemical

or biological degradation in the environment. The impacts would probably be less than significant because control measures would be required as a condition of obtaining the permit to remove a dam.

To restore floodplains and meanders, stream channels would likely be recontoured and regraded in dry conditions using earthmoving equipment. No discharge of sediment would occur during construction, but some increases in suspended solids concentrations and turbidity would occur when the new channels are exposed to stream flow.

The action includes three activities (improving growth of riparian vegetation, planting vegetation, and acquiring conservation easements) that could potentially affect concentrations of constituents of concern. Changes in emission rates of metals and trace elements are expected to be negligible.

The maintenance of water temperature is largely dependent upon the quantity and density of shade-producing vegetation. Planting and improving the conditions for growth of riparian vegetation would create more shade-producing vegetation and lower water temperatures. Lowered water temperatures would be most apparent within stream reaches with restored riparian canopies.

The solubility of oxygen in water increases proportionately to water temperature. Water temperatures will decrease when shade-producing riparian vegetation is established and, as a result, the dissolved oxygen concentrations will increase. The increase in dissolved oxygen due to temperature reduction may be offset somewhat by consumption of dissolved oxygen by decomposition of organic matter emitted from the riparian zone.

It is assumed that some of the conservation easements would involve conversion of agricultural land adjacent to stream channels to riparian habitat. Conversion of land from agriculture to riparian would change the rate and type of organic matter inputs into stream channels from that derived primarily from soils and crop residues to organic matter derived from trees, terrestrial herbaceous vegetation and aquatic herbaceous vegetation within the riparian zone. Initially, organic matter inputs from the riparian zone would be less than the existing inputs from the agricultural land, but as riparian biomass increases greater amounts of organic matter would be emitted. It is not known whether the emission of organic matter from mature riparian zones would exceed that of the agriculture lands they will replace.

Conversion of agricultural lands to riparian habitat would eliminate the use of pesticides on the lands subject to this action and thus further reduce the discharge of pesticides to streams and rivers.

Reductions in numbers of domestic animals and livestock using riparian areas and streams will reduce the direct release of animal fecal matter into streams and the discharge of runoff contaminated with fecal matter. This would produce a reduction in concentrations of organic matter and pathogenic organisms in stream waters, improve in-stream water quality, and increase its suitability for municipal water supply, aquatic habitat, and water-contact recreation.

The downstream movement of gravel would increase in rivers and streams. Downstream movement of finer materials would likely also increase, resulting in higher water turbidities, particularly during high flows. This is believed to trigger desirable behavior in aquatic organisms. However, additional treatment is required to provide good drinking water quality.

Water Quality. There are not expected to be significant adverse impacts to surface water quality, although short-term impacts related to source remediation activities may occur. Long-term benefits should accrue compared to no action.

Drainage from inactive and abandoned mines has been identified as an important source of cadmium, copper, and zinc in the Sacramento River drainage. Impacts related to implementation of source remediation activities will be similar to those described for the Bay Region.

Table 6.1.3-1 presents estimates of metals loadings to the waters of the Sacramento Valley below the major reservoirs from all sources. Inactive mines are the predominant source of cadmium, copper, and zinc in the region.

Source	Cadmium	Copper	Zinc
Agriculture	0.60	41	110
Mine Drainage	5.9	550	5500
Municipal and Industrial Watsewater	0.093	2.9	29
Urban Runoff	0.060	21	161
Totals	7,193	614.9	5800

NSL: Source does not contribute significant load of contaminant in this watershed.
Source: CALFED Water Quality Action Team. 1997. CALFED Water Quality, Loading Analysis prepared for CALFED Bay-Delta Program, January 1998.

Table 6.1.3-1. Estimated Loads of Selected Metals in Sacramento Valley Rivers Below Major Reservoirs (thousands of pounds/year)

Metals concentrations in water and sediment could be expected to decline in the streams immediately downstream of the inactive mines. Because the behavior of dissolved and particulate metals in natural aquatic systems is complex, however, it is difficult to predict the consequences further downstream. Although high loads of metals enter the Sacramento River system from inactive mines, only a fraction of the total load appears to enter the Delta.

The CALFED Water Quality Program will work within the confines of the existing National Pollutant Discharge Elimination System (NPDES) permit process to identify opportunities to reduce point and nonpoint pollutant discharges. Contaminants of concern found at elevated levels in urban stormwater runoff include cadmium, copper, zinc, nitrate, pathogenic microbes, and diazinon. Reductions in these contaminants and in loadings contributed by wastewater treatment plants would be considered beneficial impacts.

Agricultural runoff also affects water quality. The Clean Water Act addresses agricultural runoff but does not call for a permitting program for agricultural runoff comparable to the urban runoff program. It does include provisions for establishing a framework for voluntary controls for nonpoint sources of pollution.

Pesticide discharges in agricultural runoff are regulated by the state of California. The Central Valley Regional Water Quality Control Plan prohibits the discharge of irrigation return flow containing certain pesticides (including carbofuran, one of the constituents of concern) unless management practices approved by the Regional Water Quality Control Board are followed.

The effects of reductions in contaminant discharges in agricultural runoff are difficult to assess. If the volume of agricultural wastewater discharged to streams were to remain the same while contaminant concentrations decrease, then water quality would be improved. On the other hand, if the measures taken to reduce pollutant emissions also reduce the volume of agricultural wastewater discharge, then the concentrations of contaminants in receiving waters may increase.

The effects of the reduction in contaminant discharge in agricultural runoff would be to improve water quality in drainage channels and streams. Because about 12% of the land in the Sacramento Valley Region is irrigated, the potential for reduction in contaminant loading to surface water is substantial.

Coordinated Watershed Management. Impacts of upper Coordinated Watershed Management should be beneficial overall because implementability of

programs would be improved. Potentially significant short-term impacts should be mitigable.

Range improvement projects could have beneficial impacts on surface water quality by reducing surface water turbidity, nutrient overloading, and biological oxygen demand. The magnitude of the beneficial impacts would depend on the scale of the project and the existing condition of the range land.

Water Use Efficiency. Impacts of water use efficiency would be similar to those described for the Delta Region.

Many agricultural water users in the Sacramento Valley obtain their water from irrigation canals and discharge surface runoff into surface streams. If water is used more efficiently on farms, then the volume of surface runoff (tailwater) would decrease. This could have either beneficial or adverse impacts depending on the specific situation. In general, though, beneficial impacts to surface water quality are expected. If the surface runoff was introducing contaminants (sediments, residual chemicals, nutrients), reducing the runoff will reduce the introduction of these contaminants into the surface water. This would benefit instream quality. In cases where the runoff provided a significant majority of the summertime stream flow and served to dilute contaminants in the stream, the water quality of the remaining stream flow may be further degraded and concentrations of contaminants may increase.

Increased municipal recycling may result in increased concentrations of contaminants in the wastewater flow that is still discharged. This could deteriorate stream flows.

San Joaquin River Region

Storage and Conveyance. Impacts of storage and conveyance options on water quality are expected to be similar to those described for the Sacramento River Region.

Ecosystem Restoration. The impacts from ecosystems restoration would be similar to those described for the Sacramento River Region.

Water Quality. Impacts to water quality in the San Joaquin River Region should be similar to those expected in the Sacramento River Region.

Drainage from inactive and abandoned mines has been identified as an important source of cadmium, copper, and zinc in the San Joaquin River drainages. Impacts related to implementation of source remediation activities also would be similar to those described for the Sacramento River Region.

Table 6.1.3-2 shows available estimates of metals loadings to the San Joaquin Basin. Mine drainage contributes a considerable proportion of total zinc emissions in the basin.

Agricultural land conversion in the San Joaquin River Region is included in the CALFED alternatives as a potential measure to improve water quality by reducing discharges of agricultural drainage water laden with selenium. Farmers may choose to change cropping patterns, temporarily let land go fallow, or permanently take land out of agricultural production in areas with poor drainage in which selenium is present in groundwater at elevated concentrations.

Coordinated Watershed Management. Impacts of upper watershed activities would be similar to those described for the Sacramento River Region. Construction-related impacts may be significant but would be mitigable.

Water Use Efficiency. Impacts of water use efficiency would be similar to those described for the Delta.

In addition, reduced application of export water to agricultural lands would reduce the amount of salt added into the soil profile. With less salt being introduced into the soil from irrigation water, the amount of salt that must be leeched out of the soil will also be less. This, in turn, will reduce the amount of leaching necessary to remove salts from the soil and may result in reduced volume and loads of subsurface drainage and salts into the San Joaquin River (although concentrations may not decrease). To the extent that these discharges contribute to San Joaquin River flow and ultimately Delta inflow, salinity concentrations and loads entering the south Delta may be reduced. This may also reduce the salt

Source	Cadmium	Copper	Zinc
Agriculture	ND	ND	ND
Mine Drainage	0.01	0.20	ND
Municipal and Industrial Watsewater	0.02	0.80	4.5
Urban Runoff	0.20	7	53
Totals	0.226	8	57.5

ND - Not Detected
Source: CALFED Water Quality Action Team. 1997. CALFED Water Quality, Loading Analysis prepared for CALFED Bay-Delta Program, January 1998.

Table 6.1.3-2. Estimated Loads of Selected Metal in San Joaquin Valley Rivers Below Major Reservoirs (thousands of pounds/year)

load of water exported again to the export region (circulation benefit). However, any water quality benefits associated with salinity will be limited by the salt present in the irrigation water and the need to maintain a safe balance in the soil. Reduced applications of exported water may increase some salinity if irrigation water quality is not improved.

SWP-CVP Service Areas Outside the Central Valley. Water quality impacts of alternatives in the SWP-CVP Service Areas outside the Central Valley are expected to be beneficial. Improved quality and/or quantity of exported water, as described for the Delta Region, will result in beneficial impacts.

Ecosystem Restoration, Water Quality, and Levee System Integrity Programs may affect the SWP-CVP Service Areas Outside the Central Valley with a mixture of benefits and adverse consequences. Water use efficiency and water transfers would probably result in indirect benefits in the SWP and CVP service areas.

6.1.3.5 Comparison of Program Elements to Existing Conditions

Comparison of Program elements to existing conditions indicates:

- All potentially significant adverse impacts that were identified when compared to the No Action Alternative would still be considered significant when compared to Existing Conditions.
- No additional significant environmental consequences have been identified when program effects are compared to existing conditions as opposed to No Action.
- The beneficial effects of the program would still be beneficial when compared to Existing Conditions. Many of the beneficial effects would be related to long-term improvements to a number of water quality parameters. These effects are beneficial compared to existing conditions and are even more beneficial when considered with respect to future demands on surface water.

In summary, the conclusions regarding the significance of project effects on surface water quality when compared to existing conditions would be similar to those compared to No Action.

6.1.3.6 Mitigation Strategies

As discussed in the introduction to this summary, mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

If construction methods are chosen to minimize adverse environmental impacts and conventional construction mitigation measures are adopted, adverse changes in water quality associated with construction of conveyance and storage facilities, including the habitat improvements of Alternatives 2 and 3 and Ecosystem Restoration Program elements, could be reduced to less than significant levels because the impacts would be temporary, reversible, and of limited extent. Mitigation strategies could include erosion control measures, soil sampling and removal of toxic constituents if present, isolation of construction components from runoff and channel wash, preparation of spill prevention control and countermeasures plans, and water quality monitoring.

During construction, all known hazardous materials, including underground fuel storage tanks, farm chemicals, and landfills or waste disposal sites within the reservoir inundation area, would be removed. Soil sampling will be performed to determine if residual pesticide concentrations are present in soils from past agricultural practices, and appropriate action (removal or in-place remediation) will be performed if needed. No solid waste landfills or hazardous waste disposal sites are known to exist within the project area; however, the possibility exists that unknown sites may be present. A thorough investigation, including interviews, and a ground reconnaissance will be conducted to identify and remediate any potential waste disposal sites.

Preventive measures to address soil erosion and significant sedimentation impacts could include scheduling of critical activities during the dry season, construction of sedimentation basins, placement of surface covers (gravel, plastic, vegetation) to protect erosive surfaces, and developing fire prevention and response plans.

6.1.3.7 Potentially Significant Unavoidable Impacts

All of the significant impacts described in this section are believed to be avoidable.

6.1.4 Environmental Consequences: Water Supply And Water Management

6.1.4.1 Assessment Methods

Water supply reliability was assessed relative to the degree and frequency at which the alternatives are able to meet future water demands. These demands include municipal, industrial, agricultural, environmental, power production, aesthetic, and recreational water needs. At the program level, only changes in water available to meet offstream and instream water uses are compared.

South of Delta SWP and CVP water deliveries have been estimated for existing conditions, no action, and the three refined program alternatives using the system operations model DWRSIM. Deliveries to the SWP and CVP service areas represent the combined offstream water users, including agricultural and municipal/industrial water users.

Existing Bay-Delta Water Quality Control Plan (WQCP) standards were used as the basis for DWRSIM modeling. Long-term conditions are represented by the historical precipitation and runoff record for the watershed of the Delta for the 73-year period from October 1921 to September 1994. Critically dry conditions are represented by the hydrologic record for the period between May 1928 and October 1934.

6.1.4.2 Significance Criteria

The significance of effects of program actions on surface water supply is evaluated with respect to the CALFED primary water supply objective of reducing the mismatch between Bay-Delta water supplies and the current and projected beneficial uses dependent on the Bay-Delta system. Alternatives that would increase this mismatch by reducing the quantity or reliability of water that can be delivered to meet all beneficial uses are deemed to have a significant adverse impact on water supply.

6.1.4.3 Comparison of No Action Alternative to Existing Conditions

The forecasted flows for the No Action Alternative differ from the existing condition flows as a result of anticipated future demands for water.

Based on the Delta inflow modeling studies performed using DWRSIM, no substantial change in inflow to the Delta is expected for the No Action Alternative relative to existing conditions. Long term average annual deliveries to the SWP-CVP Service Areas under the No Action Alternative would increase by about 400 TAF (about 7 %) per year compared to Existing Conditions (Figure 6.1.4-1). These additional deliveries take place primarily in above normal and wet years, when surplus flows are available in the Delta. Figure 6.1.4-2 shows that there would be very little increase in deliveries during critical water years, similar to the drought period from May 1928 to October 1934.

6.1.4.4 Comparison of Program Alternatives to No Action Alternative

The impacts to surface water resources resulting from the storage and conveyance program element will vary by alternative, as discussed below. Impacts to surface water resources resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternatives. In those cases where no environmental impacts have been associated with a program element within a region, the program element is not discussed.

Delta Region

Storage and Conveyance

Alternative 1. No change in water supply for beneficial uses in the Delta is expected under Configurations 1A and 1B relative to the No Action Alternative. Impacts and benefits on water supply due to Configuration 1C would probably be less than significant.

Configuration 1C, which includes additional storage facilities, increases Delta exports slightly and decreases Delta outflow slightly. Most of the outflow reductions would occur during the wettest months. During the driest months (July through October), Configuration 1C would cause a slight reduction in average Delta outflows compared with the No Action Alternative.

Alternative 2. Configuration 2A would result in less than significant changes in water supply for beneficial use in the Delta. Configurations 2B, 2D and 2E would probably have less than significant impacts or benefits on water supply relative to the No Action Alternative. Some benefits may result from reduced salinity in the southwest Delta, for example at Rock Slough.

Potential water quality reductions due to possible increases in DOC or turbidity, would probably not significantly impact water supply opportunities relative to the No Action Alternative.

Alternative 3. Operation of the isolated facility in Alternative 3 configurations would often reduce Delta inflow to the minimum necessary to meet in-stream flow requirements and Delta standards in the driest months (July through October). Increased predictability and reduced variability in Delta water quality conditions that result from operation of the isolated facility will probably reduce Delta surplus, thus reducing unallocated flows through the Delta. This would have the effect of reducing water supply in the Delta without necessarily resulting in a significant impact, since the unallocated water is not used for a defined beneficial use. This impact is considered less than significant.

Ecosystem Restoration. Estimates of the effects of meeting Ecosystem Restoration Program in-stream flow targets on Delta inflow are presented in Section 6.1.2 (Bay-Delta Hydrodynamics and Riverine Hydraulics). Qualitatively, it can be seen that these flow targets must be met through additional releases from storage and that without additional storage, the targets will be met less frequently than with additional storage. To obtain a more precise estimate of the effects of Ecosystem Restoration Program additional simulation modeling is needed.

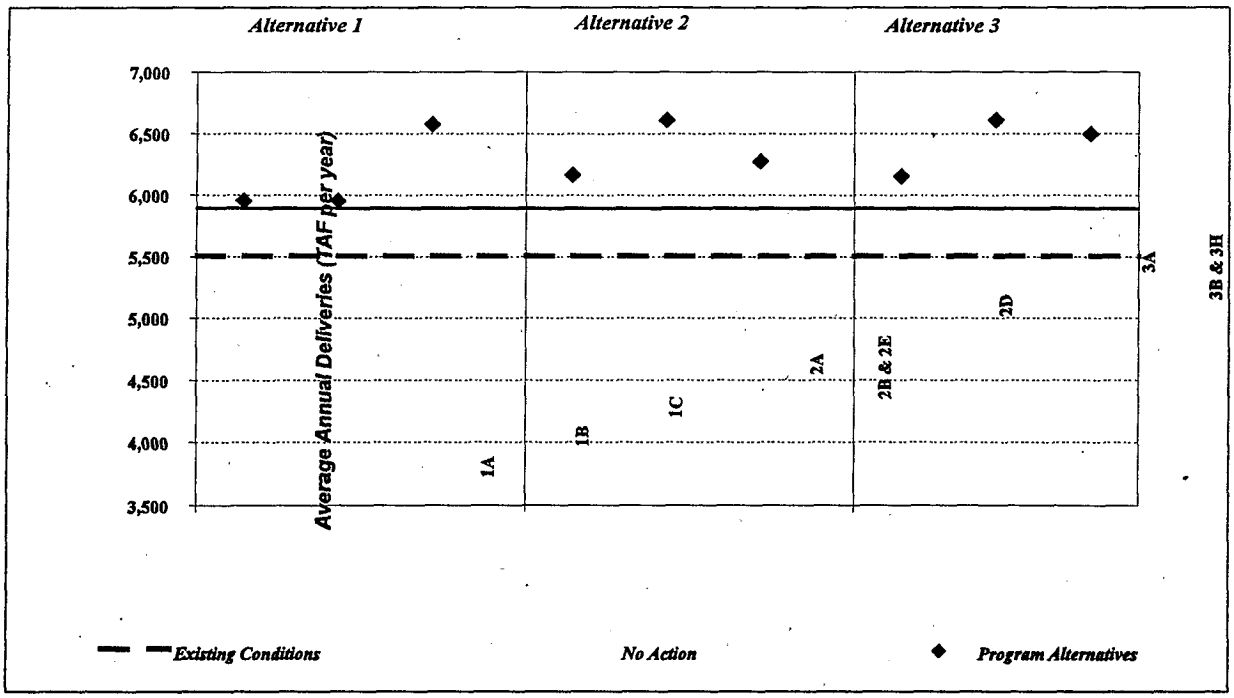

Figure 6.1.4-1. Average Annual SWP and CVP Deliveries South of Delta, Long Term (73 yr)

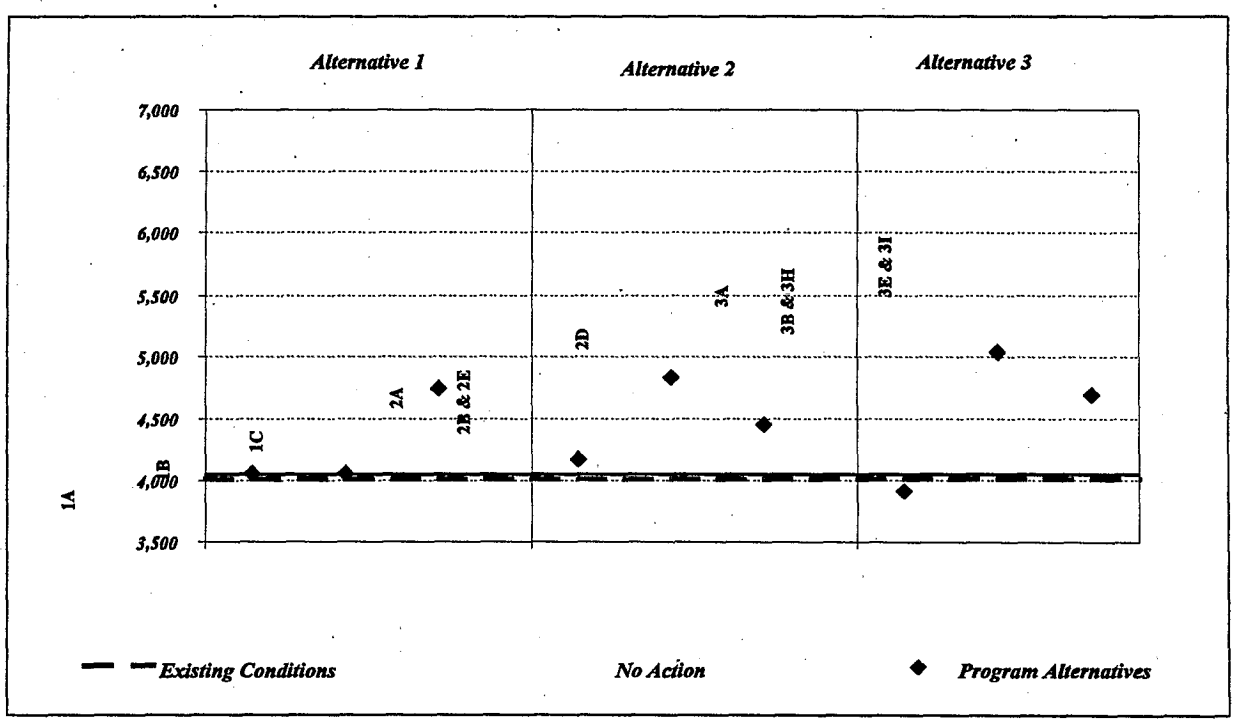

Figure 6.1.4-2. Average Annual SWP and CVP Deliveries South of Delta, Critical Period

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Water Quality. The primary water quality constraints on use of water from the Delta for municipal, industrial, and agricultural purposes are salinity, bromide, dissolved organic carbon (DOC) and pathogens (dangerous microbes). Reductions in Delta water quality can reduce the amount of water available for some beneficial uses. This is discussed in Section 6.2 Improving water quality could lead to reductions in discharge of nutrients and pathogens that degrade Delta water quality, although it would not address salinity. The impacts on water supply would be beneficial.

Levee System Integrity. Improving levee system integrity would reduce the risk of levee failure that could disrupt the distribution of water from the Delta. Although levee failure would most likely occur during the winter or spring, when dependence on Delta exports is lowest, disruption of Delta pumping could have significant effects on water supplies in areas that receive Delta exports. The isolated facilities would be the least vulnerable to effects of levee failure.

Water Use Efficiency. Water use efficiency can allow water managers to keep more water in storage for a longer time during dry periods. This would increase water supply reliability during very low flow periods, which would be a beneficial impact.

Increased water use efficiency has effects similar to reducing water demand, which would have a beneficial effect on water supply.

Reductions in existing or future demand levels could enable more water to be placed in storage, increasing the volume available during low-runoff years for all beneficial uses and increasing the reliability of water supplies during critically dry periods. Water use efficiency could also allow for modifications to be made in the seasonal timing of upstream reservoir releases.

Water Transfers. Water transfers can result in more efficient distribution of water resources among water users during low flow periods, increasing the reliability of supplies for areas experiencing water supply shortages. The environment is included as a potential beneficiary of water transfers either directly through environmental water transfers or indirectly by timing transfers to provide ecosystem benefits.

Bay Region

Storage and Conveyance

Alternative 1. Surface water supply in the Bay Region derives from several sources, including exports from the Delta as well as other sources that are not managed by CALFED. The effects of the alternatives on Delta exports described for the Delta Region would impact a portion of the water supply of the Bay Region. The impacts would generally be beneficial.

Alternative 2. The impacts of Alternative 2 on the Bay Region would derive from the increased Delta exports described for the Delta Region. The impacts would be beneficial.

Alternative 3. The impacts of Alternative 3 would be similar to those described under Alternative 2, but are expected to be greater relative to exports from the Clifton Court Forebay. However, as noted in Section 6.1.3, salinity would increase in the Delta at Rock Slough, the intake for the Contra Costa Water District. This could somewhat reduce the net water supply benefit to the Bay Region of Alternative 3.

Ecosystem Restoration. The indirect impacts of ecosystem restoration on the Bay Region could include improved water quality at Rock Slough during low flow periods and reduced deliveries through Clifton Court Forebay under configurations that do not include additional storage.

Water Use Efficiency. Increased water could result in reduced water demands during dry periods and increased opportunities for storage. However, water saved through conservation measures is anticipated to be used locally to offset current or future unmet demands. During periods of low flow, efficiency measures allow reduced supplies to be spread across more demand with potentially less impact felt by the users. Increased levels of wastewater recycling can further improve local water supply reliability by generating a water supply that is nominally affected by drought conditions. Water use efficiency could marginally reduce the volume of wastewater

generated, but is not expected to cause local reduction in water supplies to water users who supplement their water supplies with reclaimed water.

Water Transfers. Increased ability to transfer water could result in more voluntary and beneficial redistribution of water resources among water users. The degree which this would occur cannot accurately be estimated.

Sacramento River Region

Storage and Conveyance

Alternative 1. Water supply impacts in the Sacramento River Region are expected to be small. Due to existing constraints of conveyance and storage, impacts of configurations that do not include additional storage would be negligible, as indicated by changes in tributary stream flows and Delta exports. Addition of new storage in the region would increase the water supply, which would be diverted to storage during relatively high flow periods. The increased storage would increase flexibility to supply water needs within the region or outside the region during dry periods, which would probably represent a beneficial impact on water supply relative to the No Action Alternative.

Construction of surface water storage facilities may have local construction, operation, and maintenance impacts on surface water supply and management. Specific local construction-related adverse impacts would depend on the reservoir site selected for enhanced capacity. However, in general, adverse construction related impacts on water supply are not expected. Site-specific impacts would be identified in a project-level analysis.

Conveyance of water from new water storage areas could result in a substantial increase in discharge in local stream channels. Infiltration from the new storage sites is also likely to occur and could result in elevated water tables and increased groundwater discharge to springs below the reservoirs. Increased spring discharge would drain into the intermittent stream channels below the dams. This is not likely to significantly affect beneficial uses of the overall system water supplies.

Assuming that a reservoir were constructed off-stream on the west side of the Sacramento Valley, few local adverse water supply impacts would be expected. Local beneficial impacts could include increased reliability of agricultural and domestic water supplies and more reliable water supplies for wildlife areas on the valley floor.

Alternative 2. As described for Alternative 1, the storage component of Alternative 2 would probably result in small beneficial impacts on water supply in the Sacramento River Region. Slight adverse impacts on water supply allocation to the region would probably occur for Configuration 2A, which does not include storage.

Alternative 3. As described for Alternative 1 and 2, the storage components of Alternative 3 would probably result in small net beneficial impacts to the water supply reliability of the region. Configuration 3A would probably see small adverse impacts.

Ecosystem Restoration. A description of the effects on stream flows in the Sacramento Region of Ecosystem Restoration Program in-stream flow targets is presented in Section 6.1.2. The impacts on water supply reliability would be similar to those described for the Delta, above.

Coordinated Watershed Management. The downstream impacts of most watershed improvement projects on water supply would be moderated by operation of major reservoirs that are present on most large tributaries between the upper watershed and the basin.

The various possible watershed projects could alter flow regimes both in the upper watersheds and downstream. Depending on the size and scale of the projects, effects could range from very limited quantity and temporal changes in flows in nearby stream reaches, to large-scale alterations in flow regimes. Vegetation and habitat restoration projects may increase retention of surface water in the watershed, resulting in reduced extremes in runoff (reduced peak flows and increased base flows in streams).

Alteration of timber harvesting practices could change total runoff quantities if implemented over

large areas. Reduced clear-cutting and overall reductions in logging could substantially reduce runoff from the forested areas. Maintained or reforested tree stands would increase evapotranspiration, interception, and infiltration of precipitation, all of which reduce runoff. In areas where snowmelt plays an important role in the flow regime, reducing the effects of timber harvesting would increase shading which tends to reduce direct evaporation of snow pack and maintains the snow pack longer. Range improvement activities could increase vegetation cover and reestablish riparian habitat, both of which would tend to increase water retention in watersheds. The net effect of all of these potentially offsetting activities on water supply is unknown.

Water Use Efficiency. The impacts of water use efficiency program on water supply reliability would be similar to those discussed for the Delta Region. Additionally, water use efficiency improvements may allow for modifications to be made in the timing and amount of reservoir releases made for agricultural or urban uses. Timing changes would benefit fish and aquatic ecosystems.

San Joaquin River Region

Storage and Conveyance

Water supply benefits from increased deliveries to the SWP service areas would generally occur under all configurations. The benefits would be greatest for configurations that include storage. The benefits would depend on the location and volume of storage, which would also affect transfer feasibility to some extent. Also, the benefits of conjunctive use of groundwater are not easily predicted. However, assuming that physical and administrative barriers to transfers are minimal, the water supply benefits of storage configurations would be similar to those described for the SWP-CVP Service Areas Outside the Central Valley, described in the following section.

Alternative 1. No change in water supply conditions is expected for Configurations 1A and 1B relative to the No Action Alternative.

The San Joaquin River Region would generally receive water from the Delta (and the Sacramento Region) and would experience a net increase in water supplies under Configuration 1C.

Alternative 2. The impacts on water supply in the San Joaquin Region of configurations in Alternative 2 that include a storage component would probably be similar to those described for Configuration 1C, above. With no storage component, as in Configuration 2A, water supply impacts would be negligible relative to the No Action Alternative.

Alternative 3. The water supply impacts of Configuration 3A would be similar to those of Configuration 2A, except that the increased capacity of the isolated facility would enable slightly larger exports to the region.

Impacts of configurations that include a storage component would be similar to those described for Alternative 1C, above.

One of the water supply benefits of the isolated facility in Alternative 3, that distinguishes it from the other alternatives, is an improvement in the quality of water delivered from the south Delta pumping facilities. Improved water quality may reduce the total amount of water needed to achieve a given benefit. For example, higher quality water requires less blending, there are fewer losses due to treatment, and it can be applied to more beneficial uses than poorer quality water.

Impacts of the Ecosystem Restoration Program, Water Quality Program, and the Water Use Efficiency Program would be similar to those described in the Sacramento River Region.

SWP and CVP Service Areas Outside the Central Valley. The water supply impacts outside the Central Valley would generally be beneficial for all alternatives.

The magnitude of the benefit depends on the amount of storage, as well as on the operating rules applied to the system. The following analysis applies to the entire SWP-CVP service area served by the Delta-Mendota Canal and the California Aqueduct. Distribution of deliveries between service areas

inside and outside the Central Valley has not been evaluated. However, similar %age changes are expected to apply to all service areas.

Figure 6.1.4-1 illustrates the predicted long term average annual deliveries to the SWP-CVP service areas for each alternative configuration based on DWRSIM modeling. For example, deliveries under Configuration 1A would average about 5,900 TAF per year.

Figure 6.1.4-2 is based on a subset of the same data represented in Figure 6.1.4-1 and shows estimated water deliveries for critically dry conditions. The hydrology of the period from May 1928 to October 1934 is represented. As can be seen, deliveries would be reduced relative to long-term averages.

Alternative 1. Figures 6.1.4-1 and 6.1.4-2 show the predicted deliveries for Configurations 1A and 1B. Configurations 1A and 1B result in nearly identical deliveries. Both would result in a small increase in long term average deliveries (water supply benefit) relative to the No Action Alternative.

Configurations 1A and 1B provide no noticeable benefit compared to No Action during critically dry periods.

Figures 6.1.4-1 and 6.1.4-2 show that for both the long term average and critically dry periods, the addition of storage, as in Configuration 1C, enables deliveries to be increased by about 800 TAF per year. This represents a substantial water supply benefit compared to the No Action Alternative.

Alternative 2. Configuration 2A would result in similar water supply benefits as described above for Configurations 1A and 1B. Deliveries would increase slightly relative to No Action.

Configuration 2B, which includes storage, would result in water supply benefits similar to those described above for Configuration 1C. This is because the primary factor controlling water supply reliability in Alternatives 1 and 2 is the amount of water that can be released from storage during dry periods. Configurations 2B and 2E differ from Configuration 1C primarily with respect to North Delta channel modifications and habitat improvements which do not substantially affect deliveries. Deliveries are expected to be similar under Configurations 2B and 2E.

Configuration 2D includes one-third the amount of storage as Configurations 2B and 2E. The channel modifications should have some synergistic effects on water supply. For both the long term and critically dry periods, deliveries are predicted to be slightly higher under Configuration 2D than under Configuration 2A, but the smaller amount of storage prevents this configuration from performing as well as Configurations 2B and 2E.

Alternative 3. Configuration 3A slightly increases average long term Delta exports compared to the No Action Alternative and slightly decreases critically dry period exports compared to No Action. Configuration 3A does not include additional storage, but it does include an isolated conveyance facility that increases the efficiency of transferring water from the Sacramento River to the CVP-SWP service area. The increase in Delta exports represents a beneficial impact to water users in the SWP-CVP service area.

As shown in Figure 6.1.4-1, long term average annual deliveries are expected to increase to a level similar to those predicted under Configuration 2D. As shown in Figure 6.1.4-2, there would be a slight decrease in water supply during critically dry periods relative to the No Action Alternative. This small decrease in supplies is primarily due to the assumption that, whenever possible, exports would be diverted through the isolated conveyance facility as opposed to south Delta channels to maximize fishery protection and export water quality benefits. This assumed priority for location of divisions results in a need for additional Delta outflow to maintain adequate flow in the lower Sacramento River, and a small decrease in SWP-CVP water supply.

Figure 6.1.4-1 shows that Configurations 3B and 3H (which both include 5,000 cfs capacity conveyances) and Configurations 3E and 3I (which both include 15,000 cfs capacity conveyances) perform about as well as Configuration 1C and Configurations 2B/2E over the long term. This illustrates that the addition of storage and not conveyance capacity is the

principal factor governing the performance of these configurations.

Figure 6.1.4-2 shows that the combination of storage and an isolated facility greatly increases deliveries during critically dry periods.

Figure 6.1.4-1 also shows that average annual deliveries with a 5,000 cfs capacity isolated facility are predicted to be slightly higher than with a 15,000 cfs capacity isolated facility. As described above, this is due to the assumed priority of diversions through the isolated facility compared to diversions from south Delta channels. Under this assumption, the larger capacity isolated facility results in an increased need for releases from upstream reservoirs to maintain adequate flow in the lower Sacramento River.

6.1.4.5 Comparison of Program Elements to Existing Conditions

Comparison of Program elements to existing conditions indicates:

- All potentially significant but mitigable adverse impacts that were identified when compared to the No Action Alternative would still be considered significant when compared to Existing Conditions.

- No additional significant environmental consequences have been identified when program effects are compared to existing conditions as opposed to No Action.

- The beneficial effects to water supply availablity and reliability would still be beneficial when compared to Existing Conditions. These effects are beneficial compared to existing conditions and are even more beneficial when considered with respect to future demands on surface water.

In summary, the conclusions regarding the significance of project effects on water supply and management when compared to existing conditions would be similar to those compared to No Action.

6.1.4.6 Mitigation Strategies

Potential mitigation strategies revolve around changes that may be made in the system operating rules. Some of these rules may now place unduly large obstacles in the way of storing water for future beneficial use, or obtaining maximum benefits from water that cannot be stored. Among the changes that could result in improved water allocation are:

- Revised reservoir storage diversion rules;
- Revised in-stream flow requirements; and
- Modified diversion demand targets.

In addition, aquatic and riparian habitat may be provided to make aquatic species less vulnerable to the harsh stream flow conditions caused by the large fluctuations in releases that sometimes accompany optimal operation of system conveyances.

6.1.4.7 Potentially Significant Unavoidable Impacts

None of the water supply impacts is expected to be unavoidable.

6.2 GROUNDWATER RESOURCES

Summary

Three general types of impacts on groundwater resources are identified: reductions in groundwater quality; declines in water levels (or increases that cause drainage problems); and land subsidence induced by water level declines. The significance of these impacts is dependent on their magnitude, and this has been assessed qualitatively, using professional judgement. In many instances, both beneficial and adverse impacts may occur. All potentially significant impacts are also potentially mitigable. Table 6.2-1 provides a summary of environmental impacts related to groundwater resources.

Impacts to Groundwater Resources

- **No Action** would lead to increased groundwater use and potential adverse impacts.
- **Alternatives 1, 2, and 3** are expected to provide additional surface water and groundwater storage which will potentially reduce the significant adverse impacts to groundwater resources throughout all regions.
- Ecosystem restoration, water quality, and levee programs would increase groundwater recharge.
- Potential adverse impacts due to reduction in groundwater recharge from water use efficiency and water transfer program elements.

No Action Alternative. Under the No Action Alternative, increased demand for water combined with constraints on water supply are expected to cause an increase in groundwater use in all regions, leading to potentially significant declines in groundwater levels, possible degradation of water quality, and subsidence in some basins. These effects are expected to be most widely felt in the San Joaquin River Region and in the SWP and CVP Service Areas Outside the Central Valley. Local effects will probably occur in the Sacramento River Region, although subsidence is not expected there. In the Bay Region, significant declines in water levels are likely to occur, but for the most part, these are not expected to lead to significant land subsidence or reductions in water quality. In the Delta Region, where dependence on groundwater is minimal except in the upland margins, no significant change in groundwater levels is expected.

Storage and Conveyance

Alternatives 1 and 2. Additional surface water and groundwater storage has the potential to reverse, to various degrees, the adverse effects on groundwater anticipated under the No Action Alternative. No impacts are expected on groundwater relative to No Action from Configurations 1A and 1B, which do not include surface water or groundwater storage. Additional storage is provided in Configuration 1C.

Short-term construction-related impacts on groundwater resources at potential reservoir sites would vary, could be either adverse or beneficial, and would be addressed by project-specific studies. Many of the potential sites are in isolated groundwater basins and are not likely to cause significant groundwater impacts. The effects of increased storage are generally expected to be beneficial in all regions except in the Delta, where no impacts are expected.

Operation of groundwater storage projects could result in beneficial impacts as well as potentially significant mitigable adverse impacts on groundwater quality such as: cause adverse third party effects in the Sacramento River and San Joaquin River regions; and cause land subsidence in the San Joaquin River Region

Alternative 3. Potential impacts on groundwater resources of Alternative 3 would be similar to

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Reduction in Groundwater Quality	+	+	+	+	+	+	+	+	+	+	+	+
Net Decline in Water Levels	+	+	+	+	◗	+	◗	+	◗	◗	+	◗
Subsidence	+	+	+	+	+	+	+	+	+	+	+	+
Bay Region												
Reduction in Groundwater Quality	+	+	+	+	+	+	+	+	+	+	+	+
Net Decline in Water Levels	+	+	+	+	+	+	+	+	+	+	+	+
Subsidence	+	+	+	+	+	+	+	+	+	+	+	+
Sacramento River Region												
Reduction in Groundwater Quality	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Net Decline in Water Levels	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Subsidence	□	□	□	□	□	□	□	□	□	□	□	□
San Joaquin River Region												
Reduction in Groundwater Quality	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Net Decline in Water Levels	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Subsidence	◗	◗	◗	◗	+	+	+	+	+	+	+	+
SWP and CVP Service Areas Outside the Central Valley												
Reduction in Groundwater Quality	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Net Decline in Water Levels	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗		◗
Subsidence	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:
Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
o	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 6.2-1. Summary of Environmental Impacts Related to Groundwater Resources

those described due to the storage components of the other alternatives. Configurations 3B, 3E, 3H, and 3I include an in-Delta storage facility, which has the potential for increasing groundwater seepage problems on adjacent land tracts within the Delta that may require significantly increased groundwater pumping.

Ecosystem Restoration Program. The Ecosystem Restoration Program would probably impact groundwater resources indirectly through its effects on surface water supplies. Reductions in surface water supplies may lead to substitution of groundwater for surface water. The effects are more likely to be significant in the San Joaquin River Region, but could also occur, to a lesser extent, in the SWP and CVP Service Area Outside the Central Valley. Beneficial impacts are expected due to increased groundwater recharge associated with increased in-stream flows in the Sacramento River and San Joaquin River regions. In the Delta, conversion of agricultural land would probably lead to reductions in pumping for dewatering. Setback levees would probably increase groundwater recharge along Delta margins because widening streams increases the surface area through which recharge occurs.

Water Quality Program. The Water Quality Program is not expected to result in adverse groundwater impacts, but may have beneficial impacts on groundwater quality. These would primarily occur in the Sacramento River and San Joaquin River regions and in the SWP and CVP Service Area Outside the Central Valley.

Coordinated Watershed Management. Coordination of watershed management is expected to have beneficial impacts on groundwater quality and improve groundwater storage (reverse local declines in water levels) in upper watershed areas. Existing groundwater quality in the upper watersheds is generally high. The primary issues of concern to groundwater resources in the upper watershed areas include increased demand for groundwater resources resulting in local depletion of groundwater storage, reduction in groundwater discharge to springs and surface water features, and increased urban and industrial development resulting in increased potential for groundwater contamination.

Water Use Efficiency Program. The Water Use Efficiency Program may have beneficial impacts in all regions, and could have adverse impacts on groundwater resources in the Sacramento River and San Joaquin River regions and in the SWP and CVP Service Areas Outside the Central Valley. Adverse impacts from water conservation could result where reductions in irrigation reduce groundwater recharge. However, one of the Efficient Water Management Practices (EWMP) in the Agricultural Water Management (AB 3616) process is to optimize conjunctive use of surface and groundwater resources. If implemented, this could offset any adverse impacts from improved on-farm water use efficiency.

Water Transfers. Water transfers could improve the distribution of water resources and reduce reliance on groundwater in some areas. However, adverse impacts could occur if the transfers (or water use efficiency measures) induce growth.

Groundwater substitution transfers (where surface water is transferred and replace with pumped groundwater) may contribute to overdraft, may directly affect accretion to or depletion from streams, may result in land subsidence, and may result in increased pumping costs for other groundwater users.

6.2.1 Affected Environment/ Existing Conditions

6.2.1.1 Groundwater Hydrology

About 30% of runoff from rainfall and snowmelt moves quickly over the ground surface and flows into stream channels. Some of the runoff from the upper watershed is transferred out of the watershed in canals or pipelines, but some of the runoff and streamflow is able to percolate below the ground surface and recharge subsurface aquifers. Aquifers may be limited in their lateral extent, thickness and ability to discharge water due to geologic and structural constraints.

Water that percolates deeply enough can reach the groundwater table. At this point, the slope of the groundwater table determines which direction groundwater will flow. Often the slope of the water table mimics the slope of the land surface, but this is not always the case. After travel through the aquifer, some of the groundwater may discharge at the surface further downslope in springs, lakes, or streams.

Groundwater from wells drilled into aquifers are used by private and municipal users for consumption as drinking water, irrigation water, and for industrial uses. Thin soils and steep slopes in upper watershed areas often limit the groundwater storage capacity of aquifers in these areas.

Groundwater is also present in significant quantities in fractured rock aquifers that lie outside of identified groundwater basins. This water is extensively used within upper watershed areas, particularly in the Sierra foothills, for homesite development and some agricultural development. Well yields are typically low, and water quality may be affected by local pollutant sources, such as septic tank effluent.

6.2.1.2 Groundwater Use

Current groundwater conditions in California are the result of human actions superimposed on the physical environment defined by geologic and hydrologic conditions and processes. The human component in this equation is influenced by a complex system of rules and overlapping jurisdictions, some of which are incorporated in the California Water Code, local ordinances, Regional Water Quality Control Board Basin Plans, the California Code of Regulations, and in various federal laws. No summary could adequately encompass the legal and regulatory framework that conditions that portion of human activities that fall into the realm of groundwater "management." Among the pertinent features of the regulatory framework of groundwater management are the following:

- California landowners have a correlative right to extract as much groundwater as they can put to beneficial use. In some basins, that correlative right has been formally defined by a court. But the State does not have statutory authority to manage groundwater, and no systematic statewide groundwater management program currently exists.

- Only a small fraction of the State's groundwater is actively managed under a formal groundwater management program. Those groundwater management programs that exist have usually been developed on an ad hoc basis in response to local initiative. Recent legislation (AB3030) allows certain existing local agencies to manage groundwater. Also, cities and counties may adopt ordinances giving them authority to manage groundwater, although this has not occurred.

- Twelve groundwater management districts have been established through special legislation. Of the six that are within the CALFED program study area, five are within the SWP and CVP Service Areas Outside the Central Valley, and one is in the watershed of the Sacramento River Region.

- In some groundwater basins, disputes over how much groundwater can rightfully be extracted by each landowner have been adjudicated by the courts. In these adjudicated basins, the court defines the basin boundaries and appoints a watermaster to oversee the court judgement. Two adjudicated basins (the Cummings Basin and the Tehachapi Basin) are located in the upper watershed of the southern San Joaquin Valley. One of the adjudicated basins is outside the CALFED Program study area, in the North Coast Region. The remaining 13 adjudicated basins are within the SWP Service Areas Outside the Central Valley.

6.2.1.3 Delta Region

Historical Perspective. Information on use of groundwater in the Delta Region is limited. Historically, groundwater pumping in the central Delta has been used to drain waterlogged soils for agriculture. Groundwater use has been limited to the upland areas on the Delta periphery.

Identification and characterization of groundwater basins is the responsibility of the Department of Water Resources (DWR). The first comprehensive inventory of the groundwater basins in the State was completed in 1975, and published as Bulletin 118. Bulletin 118 was revised in 1980 in response to legislation requiring that DWR "identify the State's groundwater basins on the basis of geological and hydrological conditions and consideration of political boundary lines whenever practical." DWR was also asked to identify basins subject to "critical conditions of overdraft." Bulletin 118-80 identified 450 groundwater basins, 11 of which were found to be subject to critical conditions of overdraft. One of these, the Eastern San Joaquin County Basin, is located in the Delta Region, and extends into the San Joaquin River Region. Figure 6.2.1-1 shows the distribution of geologic materials that have been defined as groundwater basins.

DWR has recently revised the descriptions of some groundwater basins, which will be published in a future edition of Bulletin 118. The description of groundwater basins presented in this report is based, to the extent possible, on the working definitions currently used by DWR staff.

Existing Conditions. The Delta Region is underlain by organic-rich, fine-grained alluvial soils. Peat deposits more than 20 feet thick are found in the central Delta. These deposits have been mined in some areas for use as a soil amendment. Beneath the young surficial deposits are up to 3,000 feet of unconsolidated non-marine sediments. These deposits contain the principal regional aquifer in the Delta.

In the central Delta, the aquifer consists of many poorly connected sand and gravel units that are locally confined by silt and clay layers. Both low yields to wells and poor water quality limit the use of groundwater in the central Delta. Groundwater from depths of less than 100 feet is too saline for most beneficial uses in an area covering over 200 square miles of the central Delta.

Most of the groundwater pumping that occurs on Delta islands is for the purpose of draining crop lands. The land surface on many Delta islands lies below the elevation of water in the surrounding channels, and would be flooded if groundwater levels were not lowered by pumping. The Delta aquifer is recharged primarily by stream flow, and to a lesser degree by underflow from adjacent aquifers.

One type of land subsidence is associated mainly with loss of peat soils. As water levels decline, oxygen from the atmosphere enters the poor space once occupied by water. The oxygen reacts with the peat, which is composed of plant material, and slowly causes it to oxidize, which is a chemical process like burning. The byproducts of oxidation of peat are carbon dioxide and water. As a result, the peat disappears and no longer supports the overlying soil, resulting in subsidence.

Around the margins of the Delta Region both the quality and yield of groundwater is higher than in the central Delta lowlands. Groundwater is relied upon in the peripheral Delta uplands for both domestic and agricultural uses. Average annual groundwater withdrawals are estimated to range from 100,000 to 150,000 acre-feet in upland areas of the Delta.

6.2.1.4 Bay Region

Historical Perspective. Groundwater resources in basin areas of the Bay Region have been subject to overdraft conditions leading to salt water intrusion and subsidence, and pollutant loading from urban-industrial sources. Basin aquifers are generally protected from surface contamination to some extent by thick clay deposits.

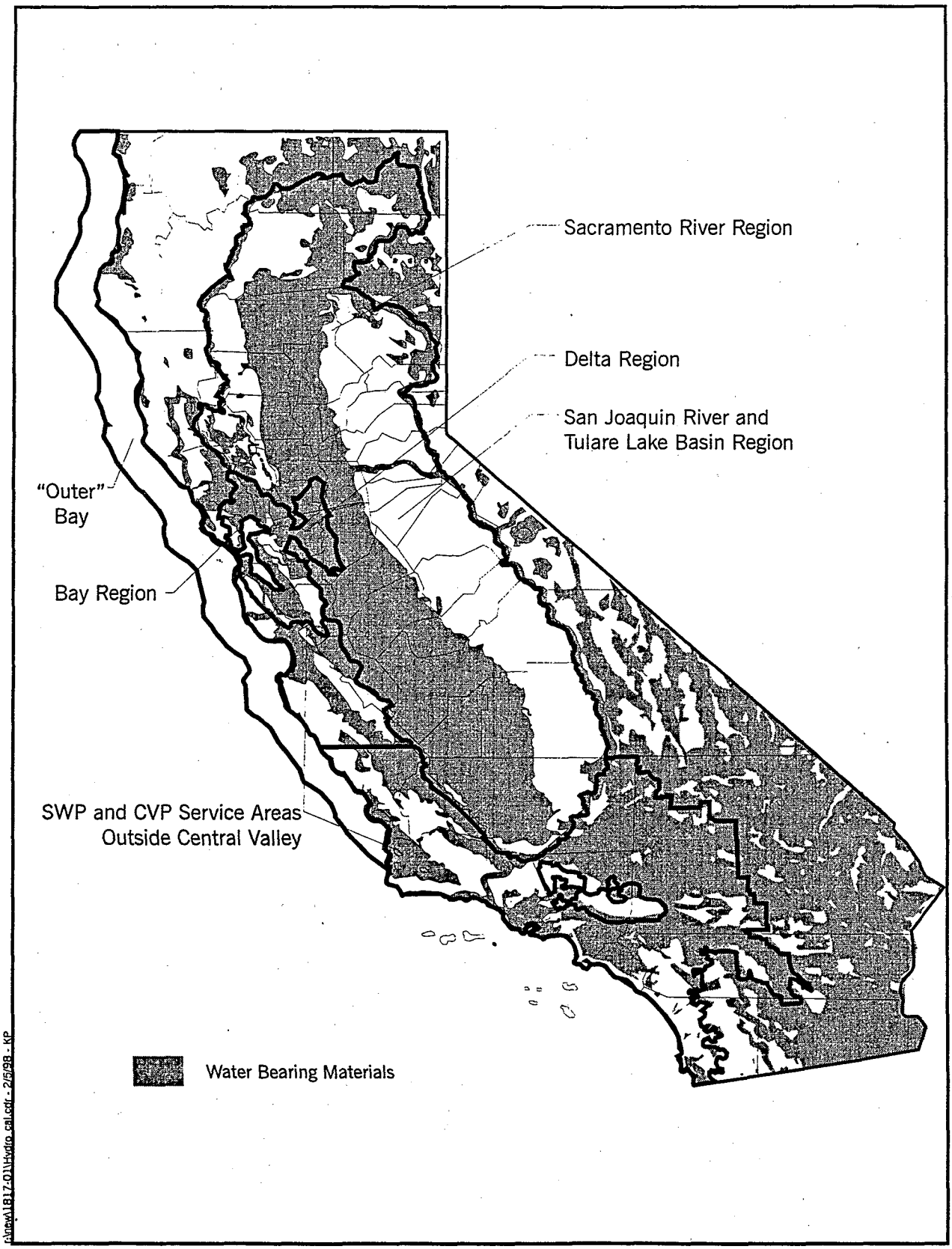

Figure 6.2.1-1. Distribution of Groundwater Basins in California

Groundwater conditions in the Santa Clara County Basin exemplify the range of problems encountered elsewhere in the Bay Region. The basin aquifers were heavily pumped to meet agricultural and municipal demands prior to the 1960s, causing land subsidence, increased flooding potential, and salt water intrusion in portions of the basin. A county-wide groundwater management program was implemented, including construction of artificial recharge basins to replenish groundwater, well registration to control cross-contamination of aquifers by intruding salt water, and a groundwater extraction monitoring and pumping fee program to track withdrawals and fund the replenishment program. Widespread groundwater pollution from industrial sources also occurred as the region underwent intense industrial development and urban expansion. Large-scale, long-term groundwater extraction and treatment projects have been undertaken to remediate some of the groundwater contamination sites.

Groundwater use in the Bay Region has decreased and surface water use has increased as the region has undergone urban expansion. Surface water is imported from the Delta through the CVP and SWP and from other sources. However, groundwater use tends to increase during low rainfall periods. During the 1987 to 1992 drought for example, groundwater use increased substantially to make up for decreased surface water supplies.

Existing Conditions. Within the Bay Region, groundwater is found in both alluvial aquifers and in fractured rock. Alluvial basin deposits near the Bay range in thickness up to 1,000 feet. Well yields typically range from less than 100 to over 3,000 gallons per minute. Recharge to the alluvial basins occurs primarily from infiltration of rainfall along stream channels. Artificial recharge in Santa Clara County and the Niles Cone Basin also account for significant local groundwater recharge.

Total average groundwater use in the region is estimated to be about 190,000 acre-feet per year. The estimated groundwater storage in the North Bay is estimated to be 1.7 million acre-feet. Groundwater storage in the South Bay is estimated to be 6.5 million acre-feet.

Groundwater quality may be affected by a number of processes. Contaminants may reach groundwater from surface or subsurface sources, such as hazardous waste sites, underground storage tanks, or from polluted streams. Groundwater pumping may induce poor quality groundwater from one area to migrate into another area. Salt water intrusion caused by groundwater pumping in coastal areas is an example of this. In general, any long-term degradation in groundwater quality is considered significant. However, under some conditions, a reduction in groundwater quality may be less than significant if it does not result in a reduction in the beneficial uses of the water resource, and if it does not conflict with a promulgated regulatory standard.

Groundwater quality varies throughout the Bay Region depending on local geological and land use conditions. In the North Bay, water quality is generally good, although some areas experience elevated iron, boron, hardness, total dissolved solids (TDS), and chloride. Elevated concentrations of nitrates occur in the Napa and Petaluma basins where fertilizers are intensively used. In the southern Suisun-Fairfield Basin, saltwater intrusion has occurred due to over-extraction of groundwater.

Groundwater quality is poor in many parts of the South Bay. Elevated levels of TDS, chloride, boron, and hardness occur in the Livermore Basin. In the San Mateo, Santa Clara County, Pittsburg Plain, and Niles Cone basins salt water intrusion induced by over-extraction of groundwater has been a problem in the past, and is now being addressed through artificial groundwater recharge and monitoring of groundwater withdrawals.

6.2.1.5 Sacramento River Region

Historical Perspective. Prior to development, aquifer recharge to the Sacramento Valley Basin was mainly from infiltration along streambeds and from subsurface inflow along basin boundaries. With the introduction of agriculture to the region,

seepage from irrigation canals and deep percolation of applied irrigation water contributed to recharge.

Historical data show that surface water and groundwater are closely linked in many parts of the basin. When the water table rises above the level of water in a stream channel, groundwater tends to flow from the aquifer to the stream (gaining stream). When groundwater levels fall, the stream loses water by seepage to the underlying aquifer (losing stream) contributing to groundwater recharge. The gaining component of a stream is dependent on cyclic changes in recharge, and is an indicator of the unfilled storage capacity of the upper aquifer. A study of stream gains and losses for the period 1961 to 1977, an average recharge period, indicated that streams in the central and eastern Sacramento Valley were generally gaining streams, while west side streams and the American River were losing streams.

Over the long term though, if the amount of water stored in a groundwater basin is to remain constant, the outflow from a basin cannot be greater than the recharge to the basin. A long-term decline in groundwater storage, which would be observed as a general decline in regional water levels, is the result of more outflow than inflow. Recharge can include infiltration of surface water, groundwater underflow, or groundwater injection. Outflows include groundwater underflow, discharge to surface water bodies (springs, streams, lakes), groundwater pumping, and evapotranspiration.

In the fall of 1960, regional groundwater levels north of the Sutter Buttes were similar to water levels observed in the early 1900s. However, south of the Sutter Buttes, groundwater levels in several areas of Yolo, Solano, and Sacramento counties had dropped nearly 50 feet since the early 1900s. Groundwater levels in areas north of the Sutter Buttes continued to show little sign of long-term declines through the mid 1970s. By the spring of 1974, groundwater levels south of the Sutter Buttes had recovered somewhat, due to above normal runoff. However, continued groundwater development in Sacramento County and in the Marysville area east of Sutter Buttes resulted in additional declines between 1960 and 1974.

Groundwater levels in the spring of 1986 indicated little change from 1974 levels. Spring 1993 water level data indicated the presence of a pumping depression in Sacramento County. Groundwater levels in much of the western part of both Sacramento and San Joaquin counties were more than 40 feet below sea level. In all other areas of the Sacramento Valley alluvial basin, above normal runoff during the 1992/1993 wet season resulted in nearly full recovery of groundwater levels to pre-drought (1987 to 1992) conditions.

A long-term decline in groundwater storage can have a number of secondary impacts, depending on specific conditions in the basin. Among these are land subsidence, increased cost of pumping, permanent reduction in permeability of aquifers, and reduction in water quality.

Declining water levels may cause land subsidence in at least two ways. In some aquifers, the sand and silt particles that form the matrix of the aquifer are kept slightly separated from each by the buoyancy effects of the water. The water prevents the particles from compressing under the weight of the overlying soil. When the water is removed, however, the particles settle closer together. Subsidence is just the combined effect of all of the settling of particles within the aquifer. The more water is removed, the more subsidence. Some of this compression is irreversible, so that even if groundwater returns to its previous level, the pore space between particles will remain smaller than before the compression occurred. Subsidence can cause damage to structures and increase flooding potential on low-lying land. Reduction in the pore space in the aquifer may also reduce the permeability of the aquifer, reducing the rate of groundwater flow under pumping pressure.

Land subsidence due to groundwater declines exceeded two feet by 1973 in the area east of Zamora and west of Arbuckle. Subsidence exceeded one foot near Davis by 1973. Localized

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land subsidence continued to occur in the Davis-Zamora area during the 1987 to 1992 drought. Figure 6.2.1-2 shows areas of historical land subsidence.

Existing Conditions. For discussion purposes, groundwater sub-basins located within the floor of the Sacramento Valley, between Redding and the Delta Region, are considered together as one unit herein called the Sacramento Valley Alluvial Basin. Depth to the base of freshwater in the Sacramento Valley Alluvial Basin, ranges from 1,000 feet in the Orland area to nearly 3,000 feet in the Sacramento area. Most recharge to the basin occurs along the north and east boundaries of the Sacramento Valley, where runoff is greatest. Seepage from applied irrigation and from irrigation distribution canals is an important component of groundwater recharge in some parts of the Sacramento Valley. Usable storage capacity is currently estimated to be 40 million acre-feet. The perennial yield (the amount of groundwater that can be extracted indefinitely from an aquifer without long-term adverse impacts) has been estimated to be 2.4 million acre-feet per year. Current groundwater withdrawals from the alluvial basins are estimated to total 2.6 million acre-feet. Although total withdrawals are not much greater than the estimated perennial yield, local groundwater depressions have developed in some areas due to the uneven distribution of pumping. In particular, a severe groundwater depression has developed in the regional aquifer beneath Sacramento County. Figure 6.2.1-3 shows recent groundwater levels in the Sacramento Valley.

In some areas, near the Sacramento River, the stream channel is higher in elevation than the surrounding land surface. This condition can result in waterlogging of lands adjacent to the river and consequent crop losses due to seepage from the stream channel. DWR has identified several areas where this problem occurs.

Groundwater is not widely used in the upper watershed area due to the availability of surface water. In general, groundwater quality in the upper watersheds of the Sierra Nevada is good; recharge is generally high and groundwater resources are relatively undeveloped. However, in some areas wells drilled in fractured rock provide the water supply for permanent or recreational homesites. Due to the low porosity of rock fractures, the rapid flow along fractures, and the potential for fractures to intercept surface sources of pollutants, development of groundwater in fractured rock has led to problems of interference between wells and contamination from septic tank effluent. The Sierra Valley Basin has been identified as a special problem basin. Drilling of large agricultural wells and growth of housing subdivisions has also caused water levels in the formerly artesian aquifer to drop below the ground surface, complicating the problem of providing winter water for cattle.

Natural groundwater quality is generally excellent throughout the Sacramento Valley and is suitable for most uses. The concentration of TDS is a general indicator of water quality. TDS is less than 300 mg/L in most areas of the Sacramento Valley. However, TDS has been reported above the short-term drinking water standard of 1,500 mg/L in groundwater samples from wells south of the Sutter Buttes and west of Sacramento. Iron and manganese concentrations from mineral sources have been reported in excess of drinking water standards in some wells in the Butte, Sutter, and Colusa sub-basins and in the southern Sacramento Valley. Levels of boron in the range of 0.75 mg/L, which is high enough to impact boron-sensitive plants, have been observed in a wide region of the southern Sacramento Valley that includes Vacaville, Rio Vista, and West Sacramento, and also east of Red Bluff.

Elevated concentrations of introduced contaminants have been observed in some areas. Nitrate concentrations from dispersed sources has exceeded the primary drinking water standard of 45 mg/L in some wells in the Butte and Colusa sub-basins, in the Chico area, and in the southern Sacramento Valley. Pesticides have been observed sporadically in wells in the Butte sub-basin. The pesticides bentazon and dibromochloropropane (DBCP) have been widely reported in groundwater in Sutter County. Various pesticides are widely reported in wells in the Colusa sub-basin. Bentazon is reported

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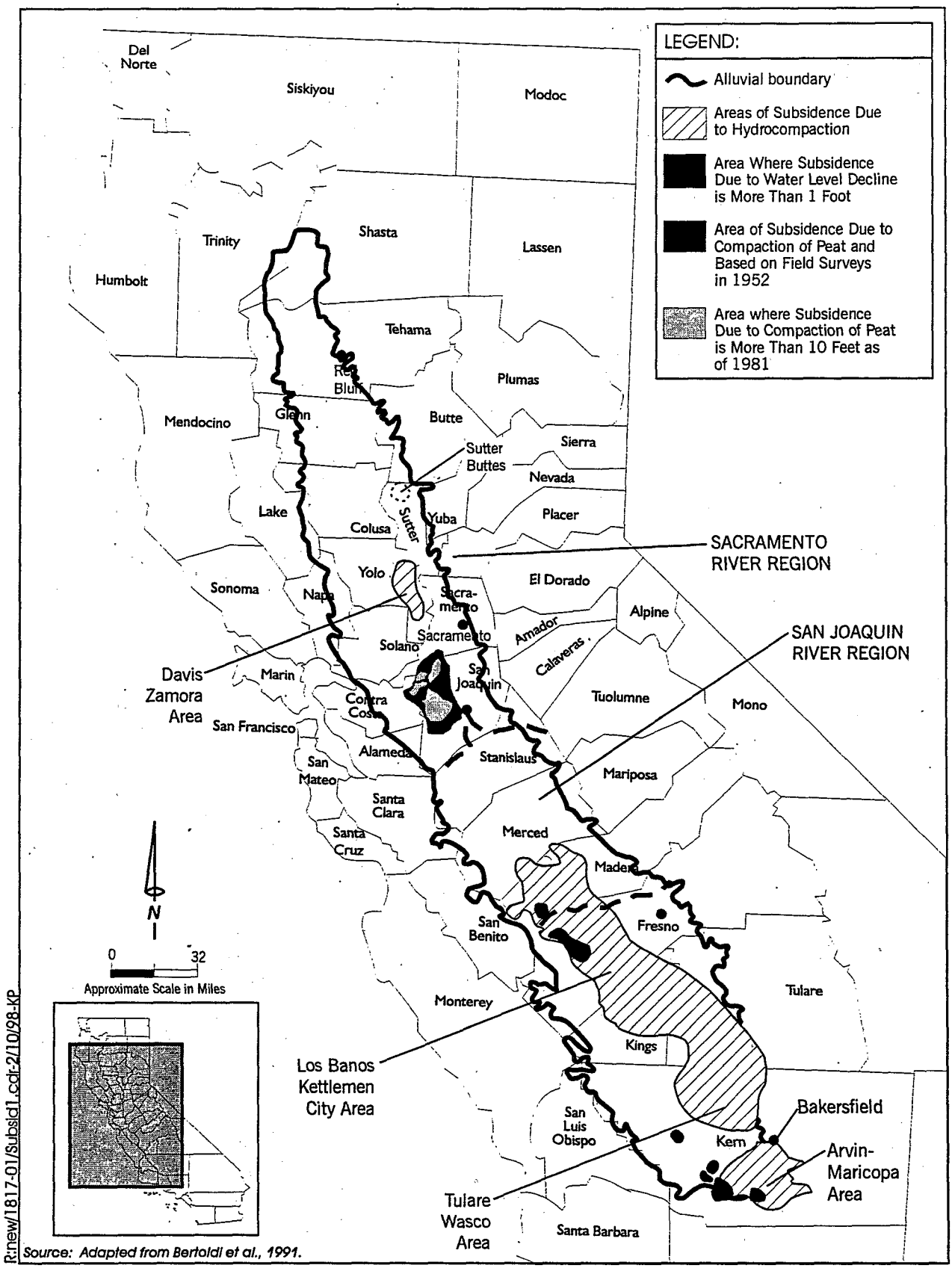
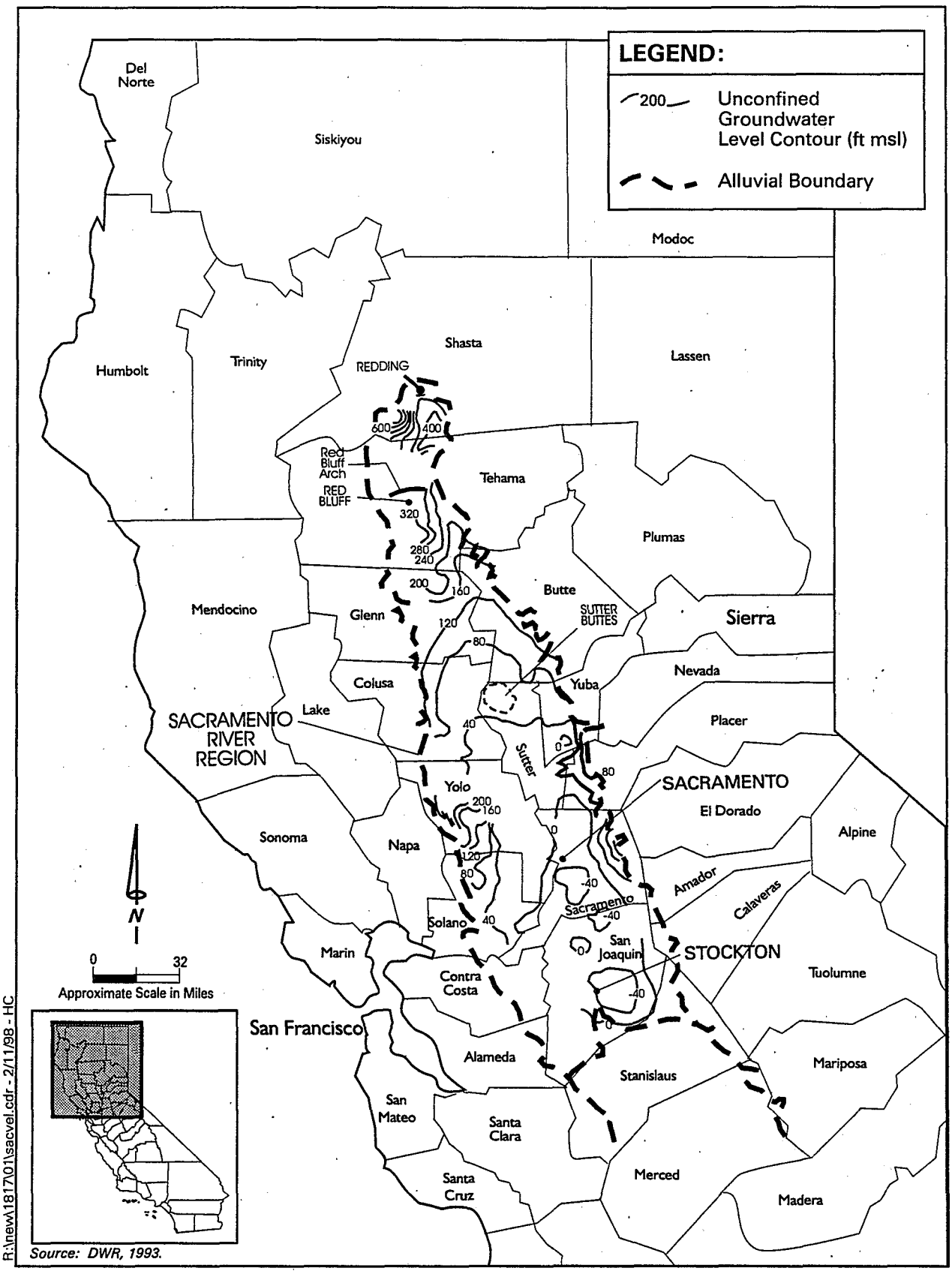


Source: Adapted from Bertoldi et al., 1991.

Figure 6.2.1-2. Areal Extent of Land Subsidence in Central Valley



Source: DWR, 1993.

Figure 6.2.1-3. Groundwater Elevations in the Sacramento Valley

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throughout the Feather River Basin in Butte, Yuba, Placer, and Sutter counties, and in isolate wells in the Yuba and American sub-basins. Elsewhere, groundwater contamination is generally limited to specific contaminant release sites.

6.2.1.6 San Joaquin River Region

Historical Perspective. Prior to development, streams were typically in hydraulic connection with shallow groundwater. Agricultural development has caused groundwater levels to decline in many areas, so that most streams lose water from seepage rather than gaining water from groundwater. Prior to development, groundwater in the San Joaquin River Region flowed from the valley flanks to the axis, then north toward the Delta. Large-scale groundwater development during the 1960s and 1970s, combined with the introduction of imported surface water supplies, has modified the regional groundwater flow pattern, creating small groundwater depressions and mounds. Also, thousands of wells perforated both above and below confining layers have increased the connection between distinct aquifer units.

From the 1920s until the mid-1960s, the use of groundwater for irrigation of crops in the San Joaquin Valley increased rapidly. Declines in groundwater levels due to this increased groundwater use caused land subsidence throughout the west side and southern portions of the valley. From 1920 to 1970, almost 5,200 square miles of irrigated land in the San Joaquin River Region registered at least one foot of land subsidence. Land subsidence has been concentrated in areas underlain by the Corcoran Clay, where pumping from the confined aquifer resulted in dramatic reductions in the confining pressure that supported the overlying deposits. The effect is less pronounced in areas underlain only by an unconfined or semi-confined aquifer. Figure 6.2.1-4 shows the distribution of the Corcoran Clay and of subsidence in the San Joaquin River Region from 1926 to 1970. The largest area is the Los Banos-Kettleman Hills area, which covers 2,600 square miles from Merced County to Kings County. Subsidence of up to 30 feet has been measured in parts of northwest Fresno County.

From 1984 to 1996, land subsidence has been reported along the Delta-Mendota Canal. About 1.3 feet of land subsidence occurred near the Mendota Pool, and about 2.0 feet of subsidence occurred about 25 miles northeast of Mendota Pool. From 1990 to 1995, up to 2.0 feet of subsidence was reported in the Westlands Irrigation District along the California Aqueduct.

Existing Conditions. For purposes of this report, the groundwater basins that occupy the floor of the Central Valley within the San Joaquin River Region are referred to as the San Joaquin Alluvial Basin. This is the most important basin in the region, although a number of small, isolated basins also exist in the upland margins of the valley. Although the aquifers underlying the entire San Joaquin Alluvial Basin are able to drain north to the Delta Region, the southern portion of the basin (roughly south of the Kings River) is sufficiently isolated from the northern portion of the basin, that it can be thought of as a distinct groundwater basin called the Tulare Basin.

Because the Modified E Clay and other clay layers prevent recharge of the confined aquifer in the central portion of the valley, most recharge to the confined aquifer occurs along the margin of the valley. Recharge to the shallow unconfined and semi-confined aquifers is contributed by seepage from stream channels, deep percolation of applied irrigation water, and seepage from irrigation distribution and drainage canals.

Currently, heavy groundwater pumping in some parts of the San Joaquin Valley, combined with reductions in recharge, has created local cones of depression that draw groundwater from surrounding areas into the regions of concentrated pumping. Regional groundwater level contours from wells completed in the unconfined or semi-confined aquifer zone are shown in Figure 6.2.1-5 to illustrate the compartmentalized flow pattern in the shallow aquifer. Similar conditions occur in the confined aquifer.

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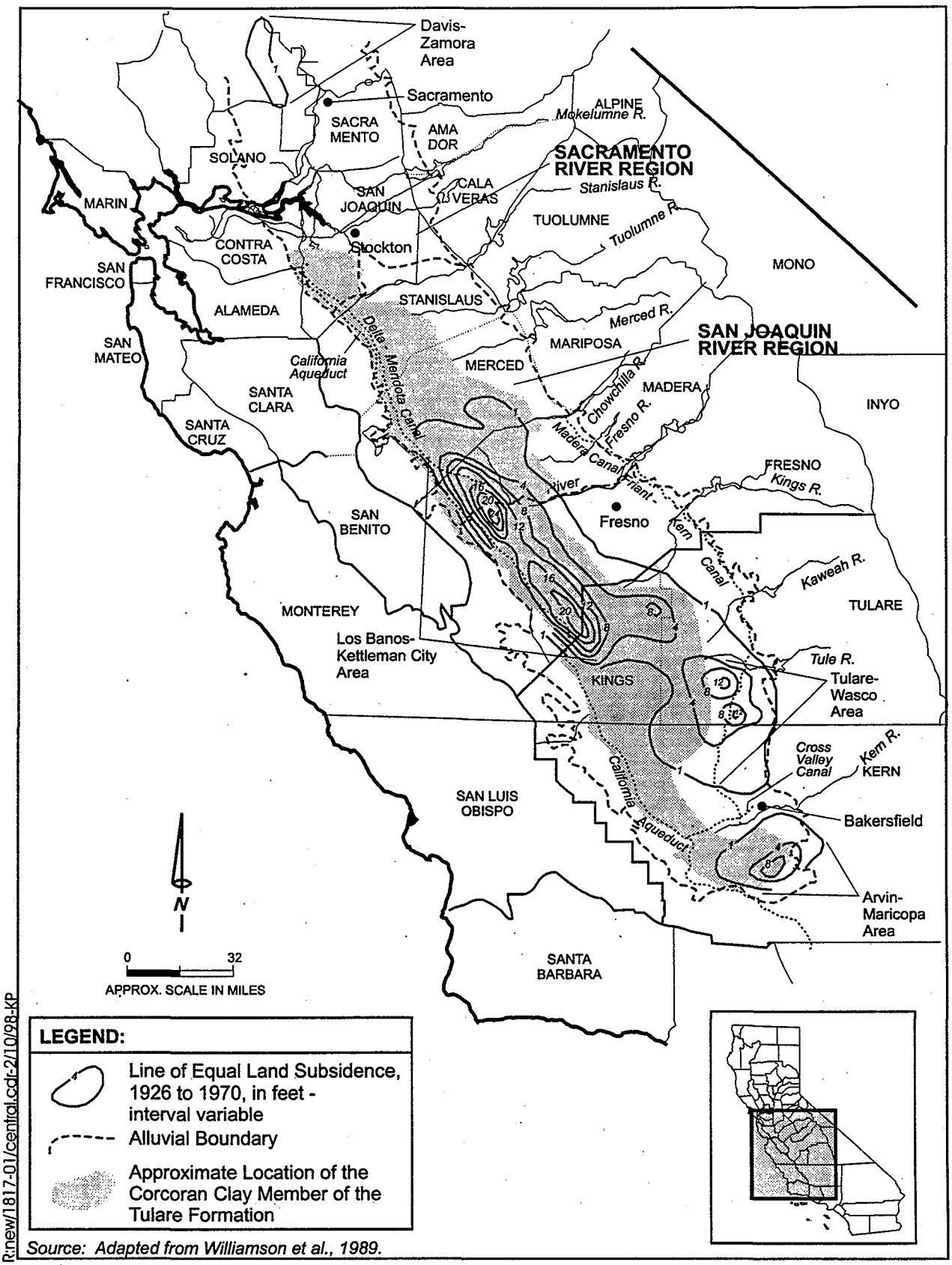

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Source: Adapted from Williamson et al., 1989.

Figure 6.2.1-4. Areal Extent of Land Subsidence in Central Valley Due to Groundwater Level Decline

Cones of depression can be seen in Figure 6.2.1-5 in the vicinity of Fresno and near Merced, while a groundwater high, shown as a closed 200-foot contour, can be seen near the boundary between Fresno and Kings County. This groundwater high, due to inflow from the alluvial fan of the Kings River, acts as a hydraulic barrier preventing groundwater from the Tulare Lake Basin from flowing north into the Kings Basin.

Northwest of the groundwater high and southwest of Fresno is a groundwater depression, shown by the open 50-foot elevation contour. The depression prevents groundwater in the vicinity of the Kings River from flowing north into the Chowchilla area. Further to the north is another groundwater depression shown by a closed 50-foot contour. This depression captures water in the Chowchilla area and prevents it from moving north into the Merced area.

Usable groundwater storage capacity for the northern portion of the San Joaquin Valley is estimated to be approximately 24 million acre-feet. The perennial yield is estimated to be approximately 3.3 million acre-feet per year. Average annual groundwater withdrawals are estimated to be 3.2 million acre-feet, of which about 70% is used for agriculture.

Total groundwater overdrafts in the northern San Joaquin Valley were recently estimated to be about 0.2 million acre-feet per year for 1990 normalized conditions. Conditions are normalized to a 1990 level of development and adjusted to remove unusual conditions affecting water supply and demand to facilitate identification of long-term trends.

Groundwater level declines in the lower confined aquifer of more than 400 feet have been observed along the west side of the region. The declines were partially reversed after the introduction of imported water supplies.

In some areas, high groundwater levels rather than declining water levels, are the principal concern. In the lower reaches of the San Joaquin River, the confluences of major tributaries, and in certain other areas, a high water table reduces use of land for agriculture. In the western portion of the Stanislaus River watershed, groundwater pumping has historically been used for control of high groundwater levels. Along the San Joaquin River from the confluence with the Tuolumne River through the South Delta, flood control operations in conjunction with spring pulse flow requirements have recently contributed to seepage-induced waterlogging damage of low-lying farm land.

TDS concentrations in groundwater along the east side of the San Joaquin Valley are generally lower than along the west side. The difference is mainly due to differences in quality of aquifer recharge. On the west side of the valley, concentration range from 500 to 2,000 mg/L. The concentrations in excess of 2,000 mg/L typically occur above the Modified E Clay layer, in the semi-confined zone. In the center and east side of the valley, concentrations are generally less than 500 mg/L.

Use of groundwater from above the Modified E Clay by agriculture is limited in the western portion of Fresno and Kings counties due to high TDS concentrations. Municipal use of groundwater is limited by TDS concentrations in scattered locations throughout the San Joaquin Valley.

High boron concentrations occur in the northwestern part of the San Joaquin River Region. Agricultural use of groundwater is limited by boron in eastern Stanislaus and Merced counties, and in western Fresno and Kings counties. In the southern portion of the Tulare Lake Basin, high concentrations of boron are generally found in areas southwest of Bakersfield (greater than 3 mg/L) and southeast of Bakersfield (1 to 4 mg/L). Concentrations as high as 4.2 mg/L have been measured near Buttonwillow Ridge and Buena Vista Slough.

Arsenic is a naturally occurring trace element that can be toxic to both plants and animals. Arsenic concentrations should generally be less than 1.0 mg/L for irrigation use, while the primary drinking water standard is 0.050 mg/L. Arsenic concentrations limit the use of groundwater as a

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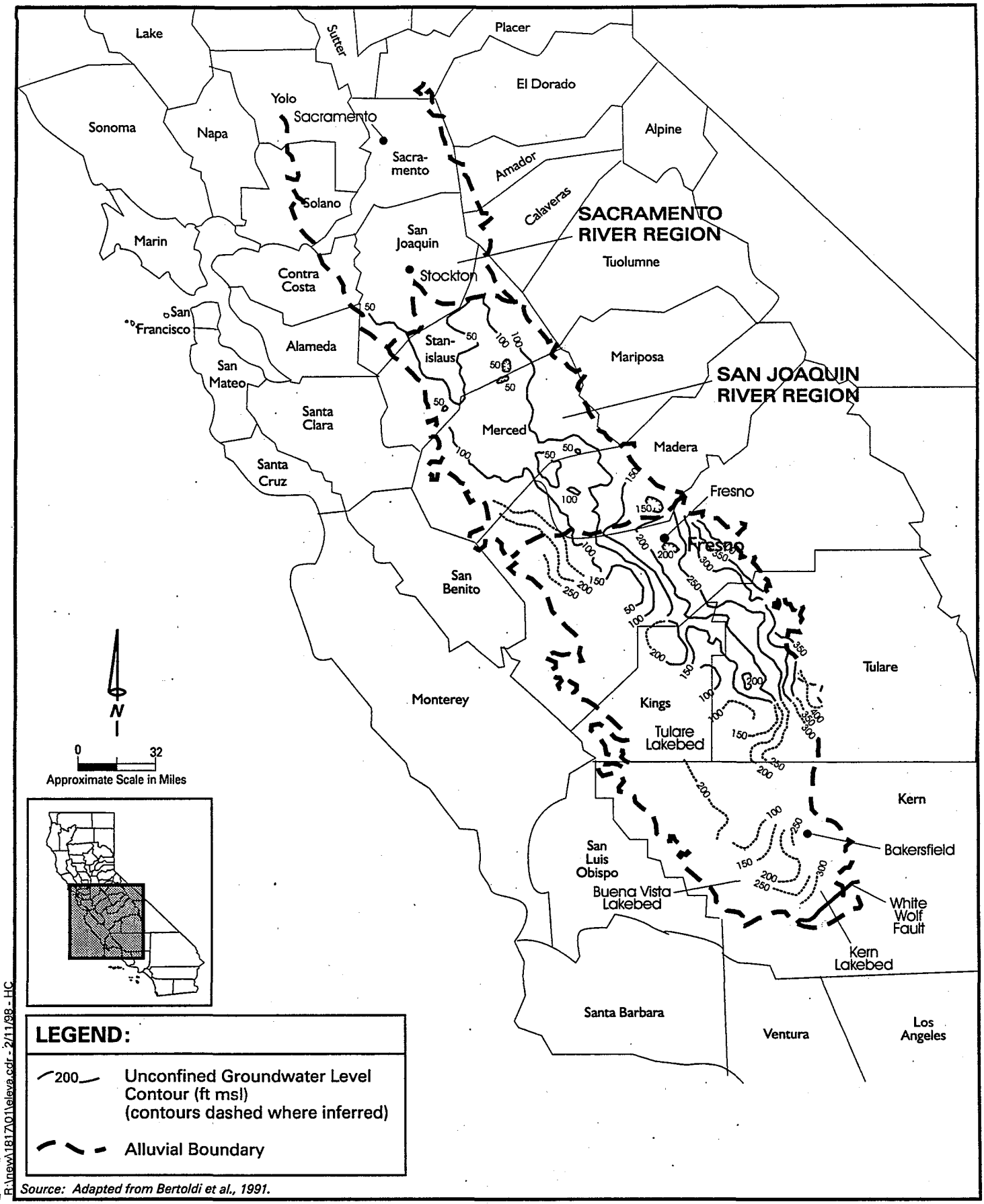

Source: Adapted from Bertoldi et al., 1991.

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Figure 6.2.1-5. Groundwater Elevations in the San Joaquin Valley, Spring 1993

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source of drinking water in eastern Contra Costa, Stanislaus, and Merced counties, and western San Joaquin County, and the southwest corner of the Tulare Lake Basin. Agricultural use of groundwater is impaired due to elevated arsenic concentrations in the Tulare Lake Basin, particularly in areas of the Kern Basin near Bakersfield.

Naturally high concentrations of selenium occur in soils and groundwater on the west side of the San Joaquin River Region. Selenium and other mineral constituents is leached from soils by irrigation, and may be concentrated in shallow groundwater or agricultural drain water. The primary drinking water standard for selenium is 0.050 mg/L, but U.S. EPA has identified chronic and acute threshold concentrations for protection of wildlife and aquatic organisms, of 5 and 20 μg/L, respectively, while the Regional Water Quality Control Board has set monthly mean and daily maximum selenium objectives of 5 and 12 μg/L, respectively. Selenium concentrations in groundwater in the western part of Fresno and Kings counties has limited its use as a drinking water supply.

In the Tulare Basin, and in large areas of eastern Fresno and Tulare Counties, the pesticides DBCP and ethylene dibromide (EDB) have exceeded primary drinking water standards, resulting in limitations on groundwater use.

Groundwater in the Yosemite Valley basin is not widely used.

6.2.1.7 SWP and CVP Service Areas Outside Central Valley

The CVP and the SWP supply water to water agencies both inside and outside the Central Valley. Contractor agency jurisdictions typically are large enough to include several groundwater basins. Some groundwater basins extend beyond the boundaries of one contractor agency into an adjacent contractor area, while portions of other groundwater basins lie outside any SWP contractor area boundary. Since CVP and SWP water potentially contributes to groundwater recharge or may be used in lieu of groundwater (and vice versa), the mismatch of jurisdictional boundaries presents a potential problem for the conjunctive management of surface water and groundwater.

Of the CVP service area, only the San Felipe Division lies outside the Central Valley. The San Felipe Division overlaps several distinct groundwater basins.

In the northern central coast, groundwater is the primary source of water for both urban and agricultural use. The Carmel, Pajaro, and Salinas rivers provide most of the groundwater recharge for the area. Extraction of groundwater in excess of recharge has resulted in groundwater level declines and seawater intrusion in coastal areas. Within the Pajaro Valley, groundwater withdrawals are estimated to be about 64,000 acre-feet per year. About 550,000 acre-feet per year is extracted from the Salinas Valley.

The SWP service area overlaps the CVP's San Felipe service area in Santa Clara County, and includes more than 15 million additional acres outside the Central Valley. Units of the SWP service area outside the Central Valley include parts of the North Bay and South Bay service areas and the entire Central Coastal and Southern California service areas. These are briefly described below.

The North Bay service area, which includes the Napa County and Solano County Flood Control and Water Conservation districts, overlaps groundwater basins in Napa and Solano counties. The South Bay service area includes the Santa Clara Valley Water District, the Alameda County Flood Control and Water Conservation District, Zone 7, and the Alameda County Water District. These districts overlap several distinct groundwater basins in Santa Clara and Alameda counties.

The Central Coastal service area of the SWP includes the San Luis Obispo and Santa Barbara County Flood Control and Water Conservation Districts, and overlaps a number of distinct groundwater basins.

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In the inland desert areas, groundwater is the principal source of water. Relatively low recharge rates in comparison to their large storage capacities has lead to groundwater extraction in excess of recharge in many desert basins.

A large number of distinct groundwater basins lie within the Southern California service area of the SWP. Much of this area (over three million acres), is in the service area of the Metropolitan Water District (MWD) of Southern California, the San Bernardino Valley Municipal Water District (over 200,000 acres), or the San Gorgonio Pass Water Agency (140,000 acres). In this heavily urbanized area there is less reliance on groundwater and more on surface water imports. However, past uncontrolled groundwater use has lead to declining groundwater levels and seawater intrusion in some basins. Most of the major groundwater basins have been adjudicated, or groundwater use is restricted through a basin-wide planning process.

Contamination is another factor limiting the use of groundwater in some parts of the region, including the San Fernando, San Gabriel, Upper Santa Ana Valley, and San Jacinto areas, and scattered portions of San Diego County.

Two of the principal water contracting agencies in the Lahontan region are the Mojave Water Agency, which serves an area of over three million acres, and the Antelope Valley-East Kern Water Agency, which serves an area of over 1.5 million acres. Approximately the northern half of the Colorado Desert Region is in the service area of the Mojave Water Agency, while the southern half represents the service areas of the Coachella Valley County Water Agency (about 600,000 acres) and the Desert Water Agency (about 200,000 acres).

6.2.2 *Environmental Consequences*

6.2.2.1 Assessment Methods

Groundwater impacts were evaluated qualitatively. No groundwater modeling studies were performed. Descriptive information for each alternative was used together with SWP and CVP simulation studies and professional judgment to determine whether potential changes in groundwater conditions could occur under the alternatives. Particular focus was given to stakeholder concerns that have been identified through the CALFED groundwater outreach program.

6.2.2.2 Significance Criteria

Groundwater impacts include changes in groundwater quantity or quality. The following conditions would be considered significant impacts if they occurred as a result of implementing program actions:

- any measurable degradation in groundwater quality relative to regulatory standards or potential beneficial uses of groundwater;
- a substantial long-term decline in groundwater levels, or a net reduction in groundwater storage, resulting in third party effects; and
- detectable land subsidence caused by water level declines.

At the programmatic level, these impacts are generally identified at the scale of a groundwater basin or sub-basin. Impacts may be either adverse or beneficial. Although increases in groundwater levels are typically considered to be beneficial, increases that cause waterlogging of agricultural crop lands would also be considered an adverse impact under some conditions.

The significance of declining (or increasing) water levels depends on the duration and permanence of the impact. In the short-term, groundwater levels fluctuate naturally because of changes in rainfall that affect recharge rates. Short term changes in water levels that are within the normal range of groundwater fluctuations would not be considered significant.

Discussion of third-party effects can be found in the Agricultural Resources Section 8.1 and Environmental Justice Section 8.10 of this document.

6.2.2.3 Comparison of No Action Alternative to Existing Conditions

Delta Region. No net change in groundwater use in the Delta is expected under the No Action Alternative. However, subsidence of Delta Islands will continue due to continued groundwater pumping for drainage of crop lands. Subsidence is a significant, mitigable impact. No other groundwater impacts are expected in the Delta Region.

Bay Region. Under the No Action Alternative, groundwater quality is likely to continue to improve in areas with point source pollution problems, as identified groundwater pollution sites are cleaned up and point and non-point sources continue to be eliminated. Water levels in areas subject to subsidence will continue to be monitored, and groundwater recharge basins will continue to be operated to prevent subsidence due to groundwater withdrawals. Similarly, groundwater basins adjacent to the Bay which have been subject to salt water intrusion will continue to improve with maintenance of hydraulic barriers.

With increasing populations and the resulting increased water demand, water agencies in the Bay Region are evaluating a number of options to increase supplies as well as to ensure reliability of their existing water sources. As part of these efforts, groundwater and surface water will continue to be used conjunctively. To what degree future supply shortages will be met by increased groundwater overdraft is unknown. However, in some areas of California, the historical response to increasing water demands has been to overdraft groundwater basins to meet those shortages. This could lead to significant declines in groundwater levels in areas with good quality groundwater supplies. Increased groundwater use would probably occur mainly in rural areas, including those with expanding urban populations, where local sources of groundwater may be an economical alternative to imported surface water. Significant but mitigable impacts would probably occur in basins such as the Livermore, Napa and Sonoma valleys.

Groundwater quality degradation due to salt water intrusion may occur in shoreline areas around the Bay Region, and land subsidence may occur locally in areas where groundwater basin management plans have not been developed. However, these impacts are not likely to be significant because these problems are widely recognized, and monitoring will be conducted to identify problems before they become severe.

Sacramento River Region. Changes in groundwater conditions are expected to occur in response to increased local demand for groundwater. Based on current trends, groundwater declines could continue in the Yolo County area of the Sacramento Valley Basin, and in the Sacramento County Basin. In the Yolo County area, groundwater declines could result in additional land subsidence. The expected continued groundwater declines in both areas are considered a significant but mitigable impact.

Groundwater quality could be adversely impacted by expected increases in groundwater extraction in the Sutter Buttes area and in southern Yolo County. Groundwater containing relatively high concentrations of TDS (Sutter Buttes area) and boron (southern Yolo County) is expected to continue to be drawn toward groundwater pumping centers in these two areas. This is considered to be a potentially significant but mitigable impact.

A reduction in groundwater recharge may result from reduced infiltration and storage in the upper watersheds as retention capacity in the watersheds continue to decrease. This is not expected to impact groundwater levels in the Sacramento River Region, but could have significant local

impacts in the upper watershed. For example, a reduction in the groundwater underflow component of stream flow could cause a decline in stream flows.

Upper watershed activities may result in increased dependence on groundwater locally within the upper watersheds, but will rely most heavily on increased use of surplus, unappropriated surface water from within the watershed. Increased demand for surface water in the upper watersheds may indirectly result in increased overdraft of groundwater in the Sacramento River Region.

Similarly, increased demands on groundwater resources that will occur with the No Action Alternative will continue to result in deterioration of groundwater quality, with potential for poor quality water to be drawn into basin pumping centers.

Significant local impacts may occur in the upper watershed due to increased use of groundwater from fractured rock aquifers, where groundwater resources are depleted and contaminants are drawn into domestic wells.

Declining groundwater levels associated with increased demands on local aquifers in the upper watershed will reduce the economic feasibility of agriculture in some areas, such as in the Sierra Valley Basin. This may accelerate the shift from agriculture to more intensive land uses (homesite development), resulting in increased demands on water resources. This would be a significant but mitigable impact in areas with limited groundwater resources.

San Joaquin River Region. The population of the San Joaquin River Region is expected to more than double by year 2020. This growth is expected to lead to conversion of some agricultural land to urban uses. The impacts on groundwater resources will depend on where this growth occurs. In general, it is likely that population growth will result in increased dependence on groundwater during dry years, when surface water storage decreases. If managed carefully, municipal wells could be strategically placed to achieve maximum regional yields while minimizing local declines in water levels that are typically caused by concentrating production wells in a small area. Increased dependence on groundwater in areas where groundwater extraction is already at or above sustainable levels would result in a significant long-term decline in water levels.

Increased population would probably result in a reduction in the amount of surface water available to agriculture during dry periods, since municipal use is generally given higher priority than agriculture when water supplies must be rationed. This could force a shift to increased use of groundwater by agriculture. The impacts could be significant locally but would probably not be widespread, since most municipal and industrial water use in the San Joaquin Region is supplied by groundwater sources.

Increased groundwater extraction could result in increased potential for land subsidence in susceptible areas, such as along the west side of the San Joaquin River Region and in the southwestern portion of Tulare County. Land subsidence would be a significant mitigable impact.

In addition to the increased year 2020 demands due to population growth, under the No Action Alternative, the CVPIA would require allocation of up to 800,000 acre-feet of water per year for environmental purposes. This is expected to require reallocation of water during some periods, from agriculture and municipal and industrial uses to environmental uses. Therefore, it is expected that there would be a reduction in exports to water contractors both inside and outside the Central Valley. The reduction in water available for existing beneficial uses will require water contracting agencies to look elsewhere for supplemental water supplies. Although difficult to quantify, the increased demand for water and decreased availability of water is likely to result in significant but mitigable impacts on groundwater resources in some areas, including declines in water levels, increased potential for subsidence in severely depleted areas, and degradation of water quality through migration of poor quality water toward pumping centers.

Shallow, unconfined aquifers are more susceptible to surface contamination than deep, confined aquifers. Increased withdrawals of high-quality water from deep aquifers will increase the potential for shallow groundwater, which may be contaminated by pesticides, fertilizers, or mineral salts, to migrate to deeper aquifers. Confining layers are seldom completely effective in preventing downward migration of groundwater because of natural discontinuities in deposition or because of man-made conduits, such as improperly sealed wells. Although it may take time, declining water levels in confined aquifers could result in gradual declines in water quality from shallow groundwater sources.

Impacts on the upper watershed would be similar to those described for the Sacramento River Region.

SWP and CVP Service Areas Outside the Central Valley. As described for the San Joaquin River Region, reallocation of 800,000 acre-feet of water per year for environmental purposes to meet CVPIA requirements could result in a reduction in exports to water contractors outside the Central Valley through the SWP and CVP. This is likely to result in significant but mitigable impacts on groundwater resources in some areas, including declines in water levels, saltwater intrusion in coastal areas, increased potential for subsidence in severely depleted areas, and degradation of water quality through migration of poor quality water toward pumping centers.

6.2.2.4 Comparison of Program Alternatives to No Action Alternative

The impacts to groundwater resulting from the storage and conveyance program element will vary by alternatives, as discussed below. Impacts to groundwater quality resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternatives to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternatives. In those cases where no environmental impacts have been associated with a program element within a regions, the program element is not discussed.

Delta Region

Storage and Conveyance

Each of the alternatives includes a south of Delta off-aqueduct surface storage component (Configurations 1C, 2B, 2D, 2E, 3B, 3E, 3H, and 3I). One option includes expanding an existing reservoir. Enlargement of the reservoir would increase both the area of the reservoir and the hydraulic head in the reservoir, both of which would increase the rate of recharge to the underlying aquifer. Groundwater in the general region of the site is considered to be of poor quality. Recharge from the reservoir would serve to dilute mineral concentrations in the aquifer and accelerate existing groundwater flow. Increased groundwater elevations could result in increased groundwater discharge to adjacent streams, further improving water quality in the streams. This is considered to be a beneficial impact.

Alternatives 1 and 2. Alternatives 1 and 2 are not expected to result in any impacts on groundwater resources in the Delta.

Alternative 3. Currently, groundwater flows from Delta channels toward the interiors of islands that are drained for agricultural production. The in-Delta storage component of Configurations 3B, 3E, and 3I would increase hydraulic head at the storage site. The difference in hydraulic head across the levees toward the interior of the example storage facility is about 15 feet. After filling, the difference in head across the levees would be about 4 feet, and the direction of the hydraulic potential will be toward the surrounding channels and adjacent land tracts. The increase in the hydraulic head, greater wetted surface area and larger volume of water in the new reservoir relative to the rivers may cause significant groundwater underflow toward the tracts on the opposite banks of the Old River and Middle Rivers. This represents a potentially significant and mitigable impact on groundwater levels in the adjacent tracts.

Leakage would occur through the unlined canals of the isolated facilities. The amount of leakage would depend upon the permeability of the bottom of the canal, the permeability of the soils underlying the canal, and the difference between the elevation of water in the canal and the elevation of the water table beneath the canal. Leakage could cause waterlogging of soils along the alignment of the canal. The rate of leakage would also depend on the width of the canal. The leakage rate would be highest for a 15,000 cfs capacity canal (Configurations 3E and 3I) and lowest for a 5,000 cfs canal (Configurations 3A, 3B, and 3H). Leakage could have a significant adverse impact on water levels in soils adjacent to the canal.

Ecosystem Restoration. The Ecosystem Restoration Program would convert agricultural lands to wetland or aquatic habitat. Groundwater pumping, currently needed to grow crops on low-lying lands, would no longer be needed on these lands. A reduction in groundwater pumping would provide a potentially significant benefit from reduction in pumping-induced subsidence, and an unknown but potentially significant reduction in loading of farm chemicals (such as nitrates, phosphates, and pesticides) discharged with the drain water to the Delta.

In some parts of the Delta, for example in the Delta portion of the Cosumnes River, setback levees are expected to result in more groundwater recharge because the bottom area of the stream will be increased.

Water Quality. Impacts of the Water Quality Program on groundwater quality in the Delta would be negligible. Most of the point and non-point sources of pollutants with the greatest potential for improvement are outside the Delta and would not be affected by the CALFED Program.

Levee System Integrity. Reductions in agricultural acreage would occur in some areas where levee strengthening required setback levees or flooding of portions of interiors of Delta islands. Some of this acreage would overlap areas included in Ecosystem Restoration Program actions. Reductions in groundwater pumping to drain agricultural lands could have similar results as those described for the Ecosystem Restoration Program. The amount of land, and therefore the potential impacts would be less than for the Ecosystem Restoration Program. This program will have no effects in the other regions.

Water Use Efficiency. Policies designed to increase efficiency of water use would mainly cause reductions in demand, increases in reuse of wastewater, and more effective distribution of water through water transfers. Some opportunities may exist for more efficient use of water in Delta upland areas, which could lead to reduced dependence on groundwater extraction. Since groundwater extraction from deep aquifer zones in excess of recharge can lead to salt water intrusion, water use efficiency could reduce the potential for future saltwater intrusion. Water use efficiency policies would have little or no impact on groundwater use in the Delta lowlands, where groundwater pumping is primarily used for draining waterlogged soils.

Water Transfers. Groundwater is not expected to be transferred from the Delta. Therefore, no impacts on Delta groundwater resources would result from water transfers.

Bay Region

Storage and Conveyance

No groundwater impacts are expected.

Ecosystem Restoration. The Ecosystem Restoration Program would convert agricultural lands to wetland or other habitat uses. This could result in a reduction in groundwater pumping in shoreline areas, most of which is currently done to depress the water table, as in Delta lowlands. This could result in a reduction in pumping-induced subsidence, and a small reduction in loading of farm chemicals where groundwater pumped from farmlands is discharged to Bay waters. A reduction in groundwater pumping in submerged lands could locally reduce the potential for

saltwater intrusion. These would be considered beneficial impacts.

Water Quality. Impacts of the Water Quality Program on groundwater quality in the Bay Region are difficult to predict. The impacts are expected to be beneficial, but are likely to be negligible because most of the point and non-point sources of groundwater contamination in the Bay Region are already subject to regulation.

Water Use Efficiency. Opportunities exist for more efficient use of water in the Bay Region, which could lead to reduced dependence on groundwater extraction. Benefits of reduced groundwater use could include reduced potential for saltwater intrusion in shoreline areas, reduced potential for subsidence, reduced potential for pumping-induced migration of existing contaminants, and a more dependable long-term supply of groundwater.

Water Transfers. Transfers of water to the Bay Region could reduce dependence on groundwater in the Bay Region during low runoff years. This would provide a beneficial impact on groundwater resources relative to the No Action Alternative.

Sacramento River Region

Storage and Conveyance

Alternative 1. Configurations 1A and 1B are not expected to impact groundwater resources in the Sacramento River Region.

The storage components of Configuration 1C include both tributary storage and groundwater storage. Both could have an effect on groundwater resources. Examples of the types of impacts on groundwater resources that might occur because of the construction, and operation and maintenance of surface water storage facilities are described below to illustrate some of the common types of impacts that might occur. More detailed impact analysis would be conducted at the project level for specific sites.

The groundwater impacts at both example sites which were evaluated are similar. Local stream flows are insufficient to maintain the reservoir, and water would be conveyed to the reservoir via a canal. One example site is underlain by upper Cretaceous marine rocks that typically yield poor quality water. Groundwater is present in the shallow alluvial aquifer and in alluvium-filled intermittent stream channels. The site contains several farm wells that draw water from the shallow aquifer. The alluvial aquifer beneath the site is hydraulically isolated from other areas and withdrawal of water from this aquifer is expected to have no impact on wells outside the project area. Therefore, construction-related impacts on local groundwater resources are expected to be less than significant.

Surficial deposits beneath the site include Quaternary alluvium underlain by upper Cretaceous marine rocks of low permeability. The reservoir would be contained in the natural basin formed in the Upper Cretaceous rocks. Groundwater flow in the Cretaceous rocks is expected to occur primarily within joints and fractures. Some leakage may be possible along joints and fractures that extend through a ridge that forms one of the sides of the reservoir. Stream channels typically form along pre-existing permeable geological structures, and the intermittent stream channels probably represent preferential groundwater flow pathways. Significant fractures would be investigated and sealed for construction of the dams, but some leakage may still occur, resulting in discharge to springs downslope of the reservoir site; however, subsurface leakage is not expected to result in a substantial adverse groundwater impact.

Inundation of the reservoir will fully saturate the alluvial materials beneath the site to the depth of the underlying bedrock. Therefore, recharge to the shallow aquifer through existing wells in the reservoir inundation area will have no additional impact on groundwater conditions.

A canal would be constructed to convey reservoir releases to various points in the Sacramento River Region. No significant impacts on local groundwater resources are expected from

operation of the Canal if the canal is lined and hydraulically isolated from the surrounding environment.

The 250,000 acre-foot (250 TAF) groundwater storage component of Configuration 1C could consist of various conjunctive use and/or water banking techniques with the basic objective of maximizing overall water supply and preserving existing surface water and groundwater resources. Techniques for storing and accounting for the water differ, but they are all designed to manage groundwater storage as a renewable supplement to surface water supplies.

The amount of proposed groundwater storage represents approximately 10% of the existing annual perennial yield of the Sacramento Valley alluvial basin.

Both beneficial and adverse impacts on groundwater resources could occur. The potential benefits of an artificial recharge program include increased water supply reliability, reduced long-term lift costs to extract groundwater, and possible reduction or reversal of the adverse effects of past overdrafting of groundwater, such as land subsidence and water quality degradation.

Using an aquifer as a storage could result in impacts associated with overdrafting the aquifer, including land subsidence, water quality degradation, increased pumping costs, reduced well yields, and streamflow depletions.

The nature and magnitude of these impacts would depend on site specific conditions and the groundwater management program governing groundwater extraction and recharge.

Land subsidence results from compaction of unconsolidated aquifer materials, and more importantly, from compaction of compressible clay layers in multilayered aquifer systems. Sands and gravels are far less compressible than clays, and also yield water more easily to wells. But many aquifers consist of a sequence of sands or gravels separated by layers of silts and clays. As groundwater levels decline, the sands compact slightly due to reduction in pore water pressure. But compaction of the clays can be much more significant. Although sandy aquifers tend to rebound when water levels rise again, clay compaction is relatively inelastic. That is, once the clay layers are compacted, they do not recover completely. As a result, most of the subsidence caused by groundwater pumping is not reversible.

These impacts could affect the parties directly involved in the groundwater storage project, and could also affect neighboring third parties. During extended drought periods, unforeseen groundwater level declines could occur as a result of overpumping in the storage facility area, and adverse impacts to third-party users could be significant. In extreme cases, third-party users could lose the use of some wells as a result of groundwater quality degradation or lower groundwater levels. Third-party impacts are also discussed in the Agricultural Resources and Environmental Justice sections of this document.

The goal of the CALFED Program would be that operation of a groundwater storage facility would not result in a net long-term decrease in storage relative to the No Action Alternative. Consequently, adverse impacts associated with the groundwater storage program could be minimized. In fact, groundwater levels would be expected to increase over the long-term as a result of increased storage. There could be some long term beneficial impacts to third-party users, including reduced pumping costs and possibly a reversal of the adverse impacts of past groundwater declines.

Most of the remaining potential adverse impacts of operating a groundwater storage project would result from groundwater recharge. The magnitude, extent, and type of impacts would depend on the size, location, and operation of the specific project, and would be identified for a particular project in a project-level EIS/EIR. The following impacts refer to artificial recharge systems, but also apply to in-lieu recharge.

Artificial recharge systems are designed to speed up natural recharge rates, either by enhancing the rate of percolation to the water table or bypassing natural barriers to recharge. Percolation ponds speed up groundwater percolation by providing

constant downward water pressure (in-lieu recharge does this through deep percolation of applied irrigation water). Percolation ponds are usually used to recharge shallow, unconfined water table aquifers. Injection wells are designed to conduct recharge water past fine-grained soil layers that would otherwise impede the downward flow of water. Injection wells can be used to place surface water into a targeted aquifer unit at a selected depth.

Differences in the chemical or biological properties of the recharge water relative to the water in the targeted aquifer, (such as the dissolved oxygen concentration, pH, mineral content, temperature, microbial population, and other parameters) could result in potentially adverse impacts. For example, introduction of nutrients can cause existing dormant microbial populations to bloom. New, undesirable microbial populations may be introduced. Changes in water chemistry can cause precipitation or solution of minerals. In addition, in some locations recovery of water levels could remobilize residual chemical contaminants that have been left behind by falling water levels.

In most locations the adverse impacts would be less than significant, however, potentially significant but mitigable impacts may also occur.

Alternatives 2 and 3. Similar to Configurations 1A and 1B, no impacts on groundwater resources would occur from implementation of Configurations 2A, 2D, and 3A. The impacts of Configurations 2B and 2E and the remaining configurations of Alternative 3 would be similar to those described for Configuration 1C, as a result of the storage components included in these configurations.

Ecosystem Restoration. The Ecosystem Restoration Program would convert agricultural lands to riparian habitat. Conversion of agricultural land could result in a reduction in groundwater pumping either for drainage or for irrigation. It could also result in a reduction in recharge from deep percolation of applied irrigation water. However, most of the groundwater being pumped on lands adjacent to large streams is shallow groundwater in connection with the streams, which is rapidly recharged from the stream channels. Similarly, the proportion of applied irrigation that percolates to the water table would probably not exceed the quantity of groundwater withdrawn from these lands. Therefore, the effects on groundwater resources are expected to be negligible. As described for the Delta, groundwater extracted from agricultural lands to depress a high water table may contain farm chemicals, which are pumped with the drain water into the adjacent stream channel. A decrease in pumping for farm drainage could result in a small decrease in loading of these chemicals in the stream waters. This reduction would result in a beneficial impact on surface water quality.

Water Quality. The focus of the program is expected to be on reducing contaminant loading to surface waters from point and non-point sources. However, many of these sources also have the potential to contaminate shallow groundwater. Although existing regulations prohibit degradation of surface and groundwater, the emphasis of most contaminant reduction regulations has been on elimination of industrial point sources. Non-industrial non-point sources have resulted in widespread low level contamination of shallow aquifers in the past, and reduction in these sources would result in a beneficial impact on groundwater quality.

Increased recharge and groundwater storage in the upper watershed would reduce the potential for significant groundwater impacts within the upper watershed, such as well interference in fractured rock aquifers and reductions in artesian head in the Sierra Valley basin.

Reductions in pollutant loading due to educational initiatives, shifts in land use policy and practices, and engineering controls could result in substantial local benefits but would probably have negligible impacts on groundwater quality in the lower watershed because the net change in pollutant loading would be negligible.

Water Use Efficiency Program. Increased water use efficiency could result in both beneficial and

adverse impacts. Reduced demand for water places less stress on both groundwater and surface water resources. However, inequalities in distribution and use of groundwater and surface water could lead to local adverse groundwater impacts.

Agricultural water conservation, including reduction in deep percolation of applied irrigation or reduction in seepage from irrigation conveyance facilities, can result in local reductions in groundwater recharge. In most areas, applied irrigation is managed to minimize the amount of deep percolation and reduce irrigation costs. But in some areas, this seepage is a significant source of recharge and could result in loss of beneficial use to other local groundwater users, or reductions in flows of gaining streams dependent on a high water table. The loss of recharge would not necessarily be accompanied by a decrease in loading of salts and agricultural chemicals since irrigation systems are normally operated to ensure that these chemicals are leached through the root zone of plants. However, one of the Efficient Water Management Practices (EWMP) in the Agricultural Water Management (AB 3616) process is to optimize conjunctive use of surface and groundwater resources. If implemented, this could offset any adverse impacts from improved on-farm water use efficiency.

As irrigators turn toward some of the more efficient methods, such as drip and micro irrigation systems, some growers may switch to groundwater as a more reliable source of high-quality water. This could result in groundwater declines and possibly land subsidence. The significance of this impact is not known, and would depend on many variables, including the location, groundwater quality, relative cost of pumping groundwater compared to the cost of surface water, and the applicability to crops. Also, the reduction in surface water use could result in indirect groundwater savings elsewhere.

For some communities, treated wastewater is intentionally applied to spreading basins for recharge of local groundwater resources. To the extent that conservation or recycling reduces the amount of artificial recharge, there may be associated adverse impacts to the local aquifer. The significance of the impact is unknown, and depends on whether reductions in water use are larger or smaller than reductions in recharge.

Reductions in the amount of wastewater generated due to increased water efficiency could also result in reduced stream flows and a resulting adverse impact on downstream water users who capture those flows. This impact is generally not expected to be significant.

Water Transfers. Water transfers provide an opportunity to take water from a watershed or basin with surplus water supplies for use in a watershed or basin with inadequate supplies. (The terms "surplus" and "inadequate" are used here in a relative sense. Criteria could include market forces, hydrologic factors, or any criteria that support moving water from one location to another.) The transferred water may include either groundwater or surface water.

Reducing barriers to water transfers would probably cause groundwater use to increase first in basins where groundwater is not yet being withdrawn at rates greater than the perennial yield, where groundwater management programs do not restrict groundwater use, and in basins that have not been adjudicated.

Adverse groundwater impacts could occur if transfers from a basin exceeded inflows. The reasons that this might occur include inadequate planning, low inflow compared to forecast inflow, or intentional overdrafting of a groundwater basin to achieve regional objectives or economic benefits.

The ability to condition transfers on the implementation of water conservation measures in the receiving basin could be an important incentive for increasing water use efficiency. Impacts in the exporting basin could also depend on the extent to which transfers involved groundwater substitution or land fallowing. Transfers of surface water that result in increased use of groundwater could result in groundwater declines in the exporting basin. Water transfers

that involve land fallowing could result in reduced recharge from deep percolation.

In general, the Sacramento River Region is expected to be a net exporter to other regions. Cross-Delta transfers from the Sacramento River Region to other regions would be limited by conveyance capacity under the No Action Alternative. CALFED program alternatives would increase this capacity to varying degrees. Thus, the impacts on water supply in the Sacramento River Region, and indirectly on groundwater supplies, would vary somewhat with the alternatives. Alternatives 1 and 2, which do not include isolated conveyance facilities, would have negligible adverse impacts from increased cross-Delta transfers, although some increased export capacity would occur under all alternative configurations except 1A.

The largest potential adverse impacts on groundwater basins in the Sacramento River Region would result from Alternative 3, which includes isolated cross-Delta conveyance facilities. However, the actual impacts on groundwater basins could range from negligible to significant, depending on how the transfers are accomplished.

Increased transfers within the region could also occur. The CALFED program would provide assistance in coordinating these transfers, but the program does not propose new infrastructure to accommodate intra-regional transfers.

Water transfers could result in adverse impacts on groundwater in basins that over-export their water supplies. Adverse groundwater impacts may also occur in the basin receiving the transferred water. The availability of a new source of imported water could induce growth in the receiving basin. However, the receiving basin may have limited control over the availability of the source of water. If conditions change in the exporting basin and the supply from transfers decreased, then the receiving basin would be forced to reduce water use, or to find alternative sources. The alternative sources could include groundwater, leading to additional overdrafts of groundwater resources.

Groundwater transfers or surface water transfers based on groundwater substitution, unless properly regulated, could result in significant adverse impacts to third-party groundwater users, with significant adverse environmental effects in the source water area. Such impacts might include land subsidence, lower groundwater levels and higher pumping costs, degradation of groundwater quality, impacts to vegetation dependant on groundwater, or in extreme cases, losses of existing wells.

Prior to implementation of any groundwater transfers, safeguards would have to be implemented to protect third-party users. For example, a regional entity (perhaps a joint powers agency of Sacramento Valley counties) or separate watershed management entities could be created to study the groundwater resources of a particular area and to provide technical review and advice to local agencies regarding transfers involving groundwater.

Coordinated Watershed Management. Upper watershed actions could increase net surface water storage, reducing demand for groundwater withdrawals and increasing the amount of surplus water available for recharging groundwater storage facilities. Direct impacts on groundwater recharge in basin areas due to watershed improvements would probably be negligible, since the principal basin recharge areas are located within the lower watershed.

San Joaquin River Region

Storage and Conveyance

Alternative 1. The impacts on groundwater from implementation of Alternative 1 would be similar to those described for the Sacramento River Region. Configurations 1A and 1B would have negligible impacts on groundwater resources. Configuration 1C includes both groundwater storage and off-aqueduct storage that may be located in the San Joaquin River Region.

Operation of the groundwater storage component could result in similar groundwater impacts to those discussed in the Sacramento River Region

under Configuration 1C. The potential for land subsidence is of considerable concern in this region given the large, regional occurrence of land subsidence along the west side and southern San Joaquin Valley.

No significant construction-related impacts on groundwater are expected at surface storage sites. Wastewater discharges from construction activities would be impounded to prevent sediment from discharging to local intermittent stream channels. The impounded water would evaporate, and some would infiltrate to groundwater. However, the wastewater is not expected to contain significant hazardous substances.

Leakage from reservoirs to the underlying formation could result in raising the local water table. Leakage could potentially adversely affect local subsurface drainage conditions.

Significant leakage from a reservoir to the underlying formation may be difficult to seal in some potential reservoir sites. Leakage could increase flows in a stream below the dam, or raise groundwater levels in the aquifer surrounding the reservoir. These impacts could range from beneficial to significantly adverse, depending upon the nature of the underlying geology. Additional geologic and hydrologic studies would be conducted to determine the suitability of the site and to identify potential mitigation measures, if necessary.

The proposed 500 TAF groundwater storage component is equivalent to about 15% of the estimated perennial yield of the northern portion of the San Joaquin Valley. The impacts of groundwater storage on groundwater resources would be similar to those described for the Sacramento River Region.

Alternatives 2 and 3. Negligible groundwater impacts are expected from Configurations 2A and 3A. Configuration 2D includes twice as much surface storage as Configuration 1C, but the impacts would be similar to those described for Configuration 1C. Configurations 2B, 2E, 3B, 3E, 3H, and 3I include both surface storage and groundwater storage. The impacts would be similar to those described for Configuration 1C.

Ecosystem Restoration. The Ecosystem Restoration Program would convert agricultural lands to riparian or aquatic habitat. The impacts would be the same as described for the Sacramento River Region, except that a smaller amount of acreage would be affected. Increased stream flows during low runoff periods and restoration of natural stream meanders, which tend to reduce the rate of flow in a stream channel, could increase groundwater recharge along the San Joaquin River. This would be considered a beneficial impact on groundwater resources.

Additional in-stream flow requirements may result in reduced frequency of meeting agricultural (and to some extent) municipal and industrial demands in the San Joaquin River Region relative to the No Action Alternative. This would put increased pressure on groundwater resources to supply the unmet demand and could result in potentially significant adverse impacts on groundwater resources in some basins during low runoff years.

Water Quality. The impacts on groundwater quality would be the same as described for the Sacramento River Region.

Water Use Efficiency. Opportunities exist for more efficient use of water in the San Joaquin River Region, which if implemented, could lead to reduced dependence on groundwater. This would result in beneficial impacts in areas currently subject to groundwater overdraft. Agricultural and landscape water use efficiency could cause reductions in recharge to the water table aquifer. These reductions would probably not be significant compared to the amount of recharge that occurs along stream channels during high flow periods, but if not replaced, the loss of recharge could result in declines in the shallow water table.

Many water districts use delivery canals as recharge basins. During wet years, these canals are purposely filled with water during the winter months to recharge the underlying aquifer.

Recharge also occurs during normal periods of operation. Canal lining would reduce this source of groundwater recharge.

The most important recharge zone for the deep, confined aquifer is along margin of the valley, on alluvial fans of large streams at the base of the Sierra Nevada foothills. The Water Use Efficiency Program is unlikely to have a significant impact on recharge of the confined aquifer, unless water savings from water use efficiency programs are transferred to a program to artificially recharge the deep aquifer. The CALFED program provides a possible institutional format in which to transfer water savings in one sector to another sector to achieve desired regional objectives.

Water Transfers. The impacts of the water transfer program could be both beneficial and adverse, similar to those described for the Sacramento River Region. As recipients of cross-Delta transfers, basins in the San Joaquin River Region would receive immediate benefits from water transfers that alleviate pressure on the groundwater resources in the region. However, in the long term, increased reliance on interbasin transfers could result in significant adverse impacts if the availability of imported water is reduced.

SWP and CVP Service Area Outside the Central Valley

Ecosystem Restoration. The Ecosystem Restoration Program would not directly impact groundwater resources in the SWP and CVP service areas outside the Central Valley. However, to the extent that it reduced the amount of water available for export to the service areas at certain times, it could have the indirect effect of requiring water supply contractors to increase their dependence on groundwater at these times. The impacts would probably be less than significant.

Water Quality. In some areas groundwater contamination has reduced the beneficial uses of large amounts of groundwater. It is possible that additional efforts to reduce point and non-point sources of contamination could lead to an increase in the amount of high quality groundwater resources available to supplement surface water sources. Without these efforts, additional groundwater resources may be rendered unusable in the future.

Water Use Efficiency. More efficient use of water in the SWP and CVP service areas outside the Central Valley would have the same impacts on groundwater resources as described for the Sacramento River Region. Reducing demand and/or increasing supply through recycling waste water would decrease dependence on groundwater.

Water Transfers. The SWP and CVP service areas could receive additional water from transfers from the Central Valley, or from transfers from other basins outside the Central Valley. This water could partially offset groundwater overdrafts in the service areas, thereby resulting in a beneficial impact on groundwater resources outside the Central Valley. As described in the previous sections, increased reliance on imported water could result in significant adverse impacts if the availability of the imported water changes.

6.2.2.5 Comparison of Program Elements to Existing Conditions

Comparison of Program Alternatives to existing conditions indicates that:

- All significant adverse impacts identified when comparing to the No Action Alternative are still significant when comparing to existing conditions.

- Some actions which are beneficial when compared to the No Action Alternative could result in a significant adverse effect when compared to existing conditions. While CALFED is expecting an overall improvement in groundwater resources relative to the No Action Alternative, there is still the potential that groundwater conditions could be worse than those that currently exist. Implementation of the CALFED Program will

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likely result in groundwater resources being better than they would be in absence of the program, but that groundwater resources could still be degraded relative to existing conditions.

6.2.2.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

Mitigation strategies to prevent groundwater level declines could include creating additional groundwater or surface water storage facilities so that demand can be met without resorting to groundwater overdrafting, importing water from other basins, purchasing water rights from willing sellers, regulating groundwater withdrawals so that they do not exceed the perennial yields of the basin, or implementing conservation measures to reduce demand. Of these, the only sure method of preventing significant groundwater declines is to regulate groundwater withdrawals.

Additional mitigation to prevent groundwater level declines could include integration of Ecosystem Restoration floodplain restoration efforts with setback levees along streams tributary to the Delta. In some areas, data indicate levee removal or setback will provide for the seasonal recharge of aquifers through natural floodplain inundation.

There are several options available to water agencies to meet increased demands for water in the SWP and CVP Service Areas Outside the Central Valley. These include constructing additional storage facilities, purchasing water from willing sellers (including transferring water rights from one sector, such as agriculture, to another, such as municipal use), reducing demand through conservation, and increasing supplies through recycling.

Mitigation strategies to prevent adverse impacts associated with overuse of groundwater in fractured rock aquifers in upper watershed areas could include increased regulation of new and existing domestic wells and septic systems, development of alternative water supplies, monitoring and testing, and limitations on new septic tank systems in vulnerable areas.

Mitigation strategies to prevent additional subsidence or reduce the effects of subsidence on Delta Islands include allowing water levels to increase periodically, and importing new soil (including dredge spoil) to raise the land surface.

Degradation of groundwater quality from saltwater intrusion is mitigable by reversing the hydraulic gradient that causes intrusion. This can be accomplished by discontinuing groundwater pumping from coastal aquifers, and recharging the aquifer through injection wells (confined aquifers) or percolation ponds (unconfined aquifers). Local incursions of salt water can be prevented by distributing groundwater pumping over a wide region rather than in a concentrated area to minimize the drawdown that induces incursion of salt water.

Similarly, mitigation strategies to prevent drawing contaminated or naturally poor quality groundwater into a region of high quality groundwater includes reducing or discontinuing pumping or more widely distributing extraction wells to prevent aquifer drawdown from being concentrated in one area. In some cases, exposure to contaminants can be prevented by well head treatment of the extracted groundwater or dilution by blending with higher quality water.

Potential adverse impacts associated with operation of groundwater recharge and storage systems would be mitigated through an iterative process involving initial characterization of groundwater conditions, monitoring, and instituting corrective action, if needed. Prior to implementing artificial groundwater recharge projects, studies will be conducted to identify baseline conditions and potential problems associated with introducing surface water to the target aquifer. A number of the policy issues may

need to be resolved before a groundwater storage project goes online, including identifying hydrologic boundaries, rules for managing the withdrawals, and establishing legal rights to the stored water. Management plans will be developed for the groundwater recharge project, defining the objectives, project boundaries, management responsibilities, and operations and maintenance specifications and procedures. Water level and chemical/biological monitoring of the recharge water and of groundwater will be conducted during operation of the groundwater storage project. The management plans will define the conditions under which corrective action must be taken, including closure of the facility. These measures are generally expected to reduce potential adverse impacts to non-significant levels. If undesirable conditions develop, then additional measures would be taken to reverse these conditions, including taking the recharge system out of service temporarily.

Prior to surface storage facility construction, wells in the inundation area will be surveyed and abandoned by sealing according to state requirements, as needed.

Mitigation strategies to reduce the adverse impacts of an in-Delta storage facility on rising water levels in adjacent land tracts could include increased groundwater pumping, lining of the reservoir with a low permeability material (such as clay), or retiring the affected agricultural lands by including them in the Ecosystem Restoration Program.

Mitigation strategies to reduce or prevent adverse impacts from water transfers include both policy measures and engineering measures. Policy measures include setting appropriate basin objectives, preparing basin management plans to meet these objectives, providing regulatory support and oversight, providing incentives for controlling demand (such as making water conservation a contingency of the transfer contract), and specifying corrective actions when objectives are not met.

Engineering measures should include data gathering to support basin management, monitoring groundwater levels and subsidence, accurately quantifying the basin water balance and reporting the status of changes, and monitoring groundwater quality.

6.2.2.7 Potentially Significant Unavoidable Impacts

None of the significant groundwater impacts associated with the alternatives are unavoidable.

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6.3 GEOLOGY AND SOILS

Summary

No Action Alternative. Soil salinity could worsen in the south and west Delta due to seepage and poor quality of applied water. Selenium concentrations could increase in the channels and applied irrigation water in the south Delta, and the Delta levees would become increasingly susceptible to seismic failure because of continued subsidence. In the Sacramento River and San Joaquin River regions, surface-soil erosion can be expected to worsen. In the San Joaquin River Region, soil salinity and selenium concentrations can be expected to worsen, and subsidence caused by groundwater withdrawals can be expected to continue and worsen as groundwater pumping continues and increases. Table 6.3-1 provides a summary of environmental impacts related to geology and soils.

To the extent that current timber harvesting, road building, and livestock grazing practices continue, the No Action alternative would likely result in a gradual aggradation of streams in the Sacramento and San Joaquin River regions as a result of continued sediment input. Future development in each of the five geographic regions will likely result in continued production of anthropogenically derived sediment that contributes to the sediment load of streams.

Storage and Conveyance. Reduced applied salt loads due to increased flows from additional storage facilities would occur for the Sacramento River and Delta regions under Configuration 1C; reduced levee soil erosion in the south Delta due to channel enlargements would occur under Configuration 1C.

Potential acreage of Important Farmland soils affected by each alternative and each program element are presented in Chapter 5, Section 5.2.

Impacts to Geology and Soils Resources

- **No Action** conditions are expected to be similar in type but of greater magnitude than existing conditions due to continued soil erosion, sediment contamination, subsidence, and channel degradation.
- **Storage and Conveyance**

  Alternative 1 is expected to reduce channel erosion and sedimentation in the Delta Region through channel widening.

  Alternatives 2 and 3 are expected to reduce the potential for erosion of channel, levee, and interior island soils through levee setbacks and shallow flooding of Delta island interiors.

  Applied salt loads would be reduced in the Delta and San Joaquin River regions due to increased flows from additional storage facilities; however, applied salt loads could increase if leaching becomes inadequate.

  The conversion of agricultural soils is expected to be a significant and unavoidable impact in the Delta Region.
- Ecosystem restoration is expected to have beneficial long-term effects in all geographic regions except the SWP and CVP Service Areas to soil erosion, geomorphology, and sediment transport.
- Coordinated Watershed Management efforts may have adverse short-term impacts on surface soil and channel erosion in the upper watersheds, but are expected to have beneficial long-term impacts on stream geomorphology by reducing sediment inputs from hillslope, bank, and channel erosion.
- The water use efficiency program is expected to reduce erosion on agricultural lands.

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Conversion of Agricultural Soils	□	●	●	●	●	●	●	●	●	●	●	●
Surface Soils Erosion	o	o	o	o	o	o	o	o	o	o	o	o
Levee Erosion	+	+	+	+	+	+	+	+	+	+	+	+
Channel Erosion and Sedimentation	o	o	o	o	o	o	o	+	+	+	+	+
Soil Salinity	+	+	+	+	+	+	+	+	+	+	+	+
Soil Selenium	+	+	+	+	+	+	+	+	+	+	+	+
Subsidence from Peat Oxidation	+	+	+	+	+	+	+	+	+	+	+	+
Levee Susceptibility to Seismicity	+	+	+	+	+	+	+	◗	◗	◗	◗	◗
Bay Region												
Changes in Sediment Transport from Delta to Bay	o	o	o	o	o	o	o	o	o	o	o	o
Decreases in Point and Nonpoint Source Pollutants	+	+	+	+	+	+	+	+	+	+	+	+
Surface Soil Erosion	+	+	+	+	+	+	+	+	+	+	+	+
Sacramento River Region												
Surface Soils Erosion	o	o	o	o	o	o	o	o	o	o	o	o
Channel Erosion and Sedimentation	o	+	+	+	+	+	+	+	+	+	+	+
Subsidence from Peat Oxidation	□	□	□	□	□	□	□	□	□	□	□	□
Levee Susceptibility to Seismicity	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗
San Joaquin River Region												
Surface Soil Erosion	o	o	o	o	o	o	o	o	o	o	o	o
Channel Erosion and Sedimentation	o	+	+	+	+	+	+	+	+	+	+	+
Soil Salinity	□	□	□	+	+	+	+	+	+	+	+	+
Subsidence from Groundwater Withdrawals	□	□	□	+	+	+	+	+	+	+	+	+
Soil Selenium	□	□	□	+	+	+	+	+	+	+	+	+
SWP and CVP Service Areas Outside the Central Valley												
Geology or Soils Impacts	□	□	□	□	□	□	□	□	□	□	□	□

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:
Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
o	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 6.3-1. Summary of Environmental Impacts Related to Geology and Soils

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Potentially adverse impacts in the Sacramento and San Joaquin River and Delta regions would be conversion of agricultural soils for conveyance improvements and storage facilities, and short-term increases in erosion rates resulting from the construction of conveyance improvements.

Adverse impacts in the Sacramento River Region would include short-term increases in erosion rates resulting from the construction of storage and related facilities, and sediment trapping in new reservoirs.

Reduced applied salt loads due to increased flows from additional storage facilities would occur in the Sacramento River and San Joaquin River regions under Configurations 2B and 2E; levee setbacks and shallow flooding of Delta islands would reduce the potential for levee and interior island soil erosion for the Delta Region under Configurations 2A, 2B, 2D, and 2E. Applied salt loads could increase, however, if leaching becomes inadequate.

Reduced applied salt loads due to increased flows from additional storage facilities would occur in the Sacramento River and San Joaquin River regions under Configurations 3B, 3E, 3H, and 3I; use of an isolated facility could reduce channel velocities and resultant erosion of levee soils for the Delta Region under Configurations 3A, 3B, 3E, 3H, and 3I. Applied salt loads could increase, however, if leaching becomes inadequate.

Ecosystem Restoration. Potentially beneficial impacts identified in the Delta Region would be reduced soil depletion and wind erosion on Delta islands due to habitat restoration actions, reduced levee soil erosion rates due to implementation of modified levee and berm management practices, and reduced wave-induced levee soil erosion due to creation of in-channel islands.

A potentially adverse impact in the Delta Region would be conversion of agricultural soils for habitat restoration.

Water Quality. A beneficial impact identified in the Delta Region would be reduction in release of pollutants resulting in a reduction in potential sediment contamination, soil salinity, and soil selenium concentrations.

Water Use Efficiency. Water use efficiency can result in beneficial impacts in all regions. These include reduced erosion from agricultural fields and potentially decreased salinization of agricultural soils in all regions though inadequate leaching of salts could increase soil salinity. To the extent that increased efficiency results in an increased reliance on groundwater resources, potential adverse land subsidence impacts could also occur in some basins. However, one of the Efficient Water Management Practices (EWMP) in the Agricultural Water Management (AB 3616) process is to optimize conjunctive use of surface and groundwater resources. If implemented, this could offset any adverse impacts from improved on-farm water use efficiency.

Levee System Integrity. Potentially beneficial impacts in the Delta Region would be reduced subsidence of central and western Delta islands because soil transport and oxidation would be halted by shallow flooding. Additionally, beneficial impacts include both reduced risk of increased salinity in Delta island soils by reducing potential for flooding by saline water; and the replacement of lost soils due to reuse of dredged material.

Water Transfers. Water transfers could have beneficial or adverse impacts to geological or soil conditions, depending on the source of the transfer, timing, magnitude, and pathway of each transfer.

Coordinated Watershed Management. Coordinated Watershed Management efforts in the upper watershed areas of the Sacramento River and San Joaquin River regions would be generally beneficial, and include improvement to stream geomorphology due to reduction of erosion potentials and decreases in sediment inputs to streams. Lower potentials for landsliding due to slope stabilization efforts, road improvements, and road deconstruction would also be beneficial.

Beneficial impacts in the upper and lower watersheds of these regions would include

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improved geomorphology and associated soils, improved gravel recruitment, and restoration of more natural sediment transport regimes.

6.3.1 Affected Environment/ Existing Conditions

Key resource categories and assessment variables described in this section include geology and physical processes; fluvial geomorphology, especially erosion and sedimentation; oxidation, wind erosion, and land subsidence; soil salinity and drainage problems; and seismicity.

6.3.1.1 Environmental Setting

Overview. Different geologic processes acting on various rock formations over millions of years have created many geologically different areas within California. The areas have been grouped into 11 geologic provinces. From north to south, they are the Coast Ranges, Klamath Mountains, Cascade Range, Modoc Plateau, Central Valley, Sierra Nevada, Basin and Range, Mojave Desert, Transverse Range, Peninsular Range, and the Salton Trough. The study area for this investigation includes all of the provinces mentioned except the Basin and Range, and Salton Trough. Figure 6.3.1-1 shows all the geologic provinces in the state.

The Central Valley geological province is a valley trough that extends over 400 miles from north to south, and consists of the Sacramento Valley and the San Joaquin Valley. The San Joaquin Valley is comprised of the San Joaquin River basin, drained by the San Joaquin River from the south, and the Tulare basin, a hydrologically closed basin that is drained only during extremely wet periods. The Sacramento Valley is drained by the Sacramento River from the north. The confluence of these two major river systems and lesser streams and systems forms the inland Delta, which is drained through Suisun Bay and the narrow Carquinez Strait, into San Pablo and San Francisco bays, and into the Pacific Ocean.

The upper and lower watersheds of the area contain four primary physiographic land types, each with characteristic soil conditions: valley land, valley basin land, terrace land, and upland (Figure 6.3.1-2). Valley land and valley basin land soils occupy most of the Central Valley floor. Valley land soils consist of deep alluvial and aeolian soils that make up some of the best agricultural land in the state. Valley basin lands consist of organic soils of the Sacramento-San Joaquin Delta, poorly drained soils, and saline and alkali soils in the valley trough.

Areas above the Central Valley floor consist of terrace and upland soils, which are primarily used for grazing and timberland.

Existing soils and the geomorphology of streams in the upper watersheds of the Bay Region mainly show the effects of urbanization, whereas these same resources in the upper watersheds of the Sacramento River and San Joaquin River regions are primarily influenced by grazing and logging.

Delta Region

Historical Perspective. The Delta, a triangular-shaped network of channels and islands, is the meeting point for the Sacramento, San Joaquin, and Mokelumne rivers.

The Delta islands have been reclaimed for agricultural use because of their fertile soils. Conversion of the Delta wetlands to farmlands began in 1850 when the federal government transferred ownership of "swamp and overflow" lands to the states. Substantial reclamation was accomplished between 1880 and 1920. By 1930, the Delta was essentially developed to its current configuration.

Development of the islands resulted in subsidence of the island interiors and greater susceptibility of the topsoil to wind erosion. Subsidence, as it relates to Delta islands, refers generally to the falling level of the land surface that results from the processes of peat soil oxidation and wind erosion of the surface soil layers.

By 1920, it was recognized that the drained Delta lands were subsiding. Elevation measurements made from 1922 to 1981 indicate that agricultural

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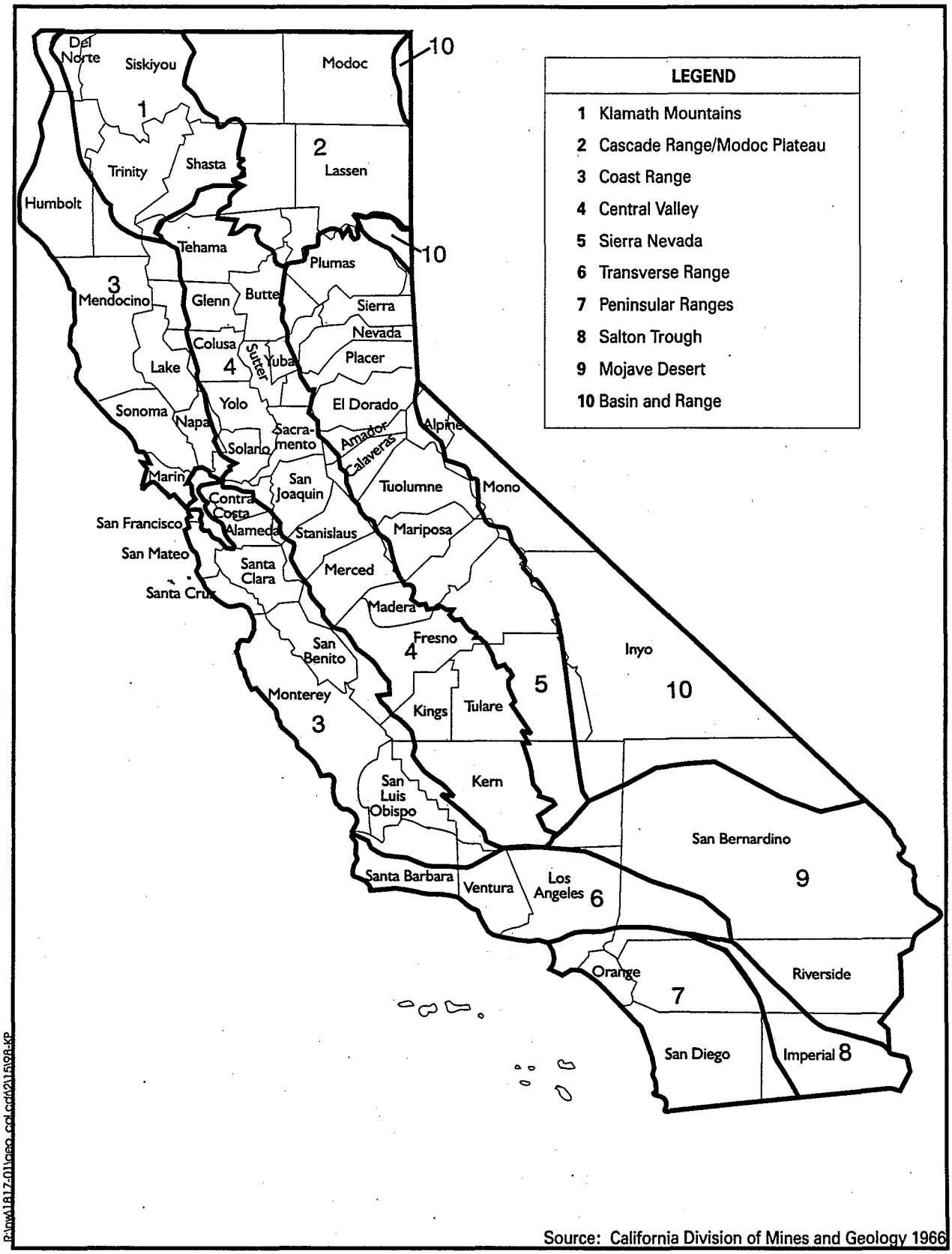

Figure 6.3.1-1. Geologic Provinces of California

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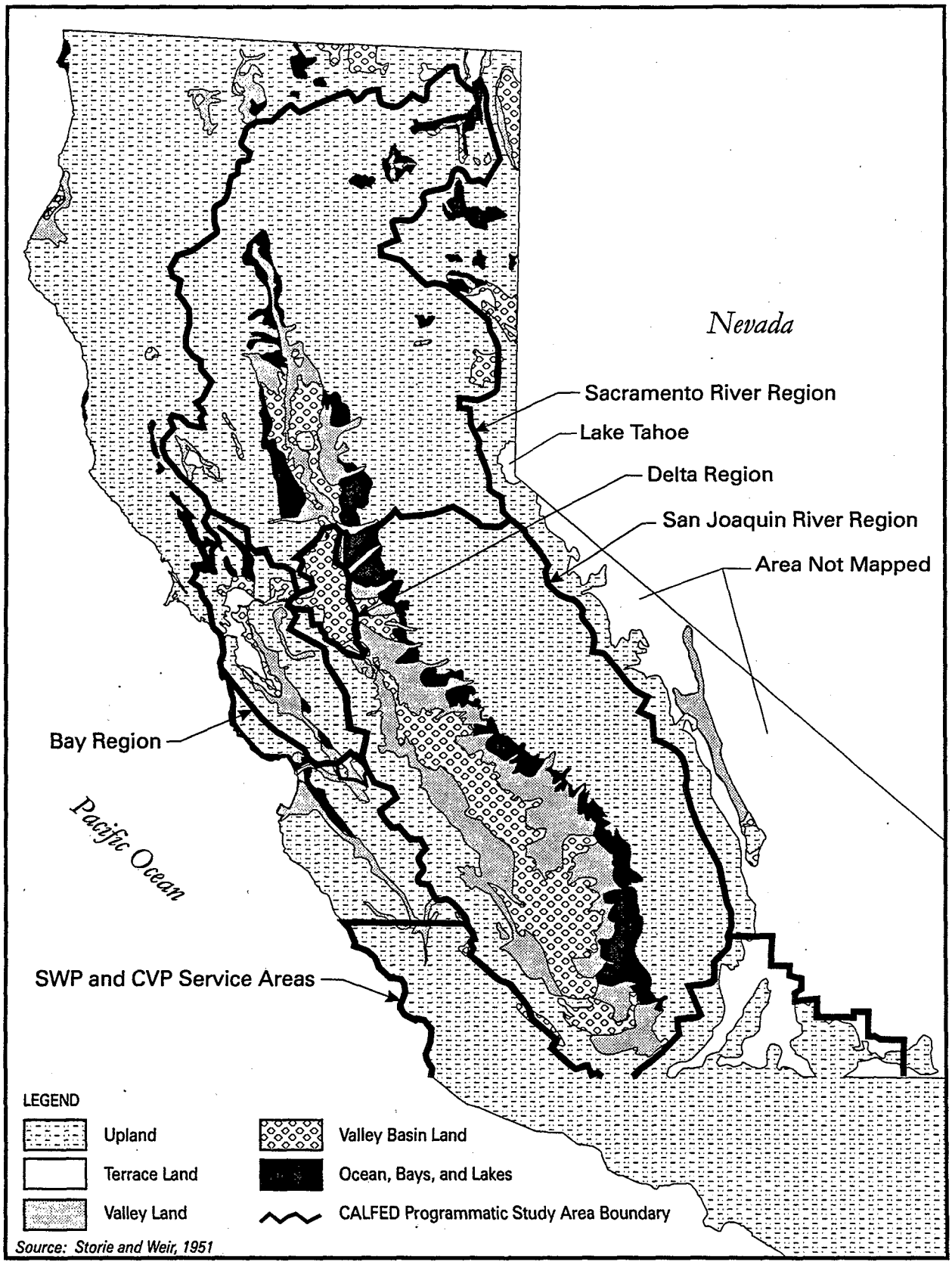

Figure 6.3.1-2. Generalized Soils of California

practices tended to cause 1 to 3 inches of subsidence per year.

Although California is the most seismically active area in the United States, the Delta region has been relatively inactive. Active faults in or near the Delta with movement within the historic record include the Concord, Greenville, Hayward, and San Andreas faults (Figure 6.3.1-3). Historically, the Delta has not suffered catastrophic earthquake damage.

Existing Conditions

Soils. The soils of the Delta Region vary primarily as a result of differences in climate, parent material, biologic activity, topography and time. For the purposes of this discussion, the soils are divided into four general soil types:

- Delta organic soils and highly organic mineral soils
- Sacramento River and San Joaquin River deltaic soils
- Basin and basin rim soils
- Moderately well- to well-drained valley, terrace, and upland soils

The Delta Region contains primarily soils with the required physical and chemical soil characteristics, growing season, drainage and moisture supply necessary to qualify as prime farmlands. This includes 80% to 90% of the area of organic and highly organic mineral soils, Sacramento River and San Joaquin River deltaic soils, and basin and basin rim soils. Most of the remaining soils of the Delta Region qualify as Farmlands of Statewide Importance.

The Delta soils that have been affected the most by agricultural development are the organic soils and highly organic mineral soils. These effects are brought about by the flood protection of levees and the lowering of water tables by pumps and drainage ditches in order to make production possible.

Soil Subsidence. Subsidence of the Delta's organic soils and highly organic mineral soils (Figure 6.3.1-4) continues to be a critical problem and presents a serious threat to the long-term viability and use of the Delta islands.

The average current subsidence rate is estimated to be about 1 inch per year and is largely attributed to biochemical oxidation of organic soil material as a result of long-term drainage and flood protection. The highest rates of subsidence occur in the central Delta islands, where organic matter content in the soils is highest.

Delta Seismicity. The primary seismic threat to the Delta is the threat of massive or widespread levee failures resulting from lateral displacement and deformation, with resultant breaching and/or mass settlement due to ground shaking and liquefaction of underlying soils. Many levees include sandy sections with low relative density and high susceptibility to liquefaction. Therefore, the seismic risk to the Delta levees is high and apparently is increasing with time.

Soil Salinity. Dissolved salts in irrigation water can lead to high soil salinity, an unfavorable condition for agricultural crop production. High soil salinity is an issue in several portions of the Delta, including the south-Delta area served by the South Delta Water Agency, the west-Delta area (primarily Sherman and Twitchell islands), and Suisun Marsh. North- and east-Delta areas receive relatively low-salinity water from the Sacramento River and east-side tributaries, and do not experience salinity problems.

The concentration of salinity in shallow groundwater and the salt mass contained in Delta soils are direct consequences of the quality of the irrigation water drawn from Delta channels.

Wind Erosion. The Delta organic soils and highly organic mineral soils have wind erodibility ratings of 2 to 4 on a scale where 1 is most erodible and 8 is least erodible. The wind erodibility of Delta soils is due to the organic matter contained in them. The rate of wind erosion is estimated at 0.1 inch per year.

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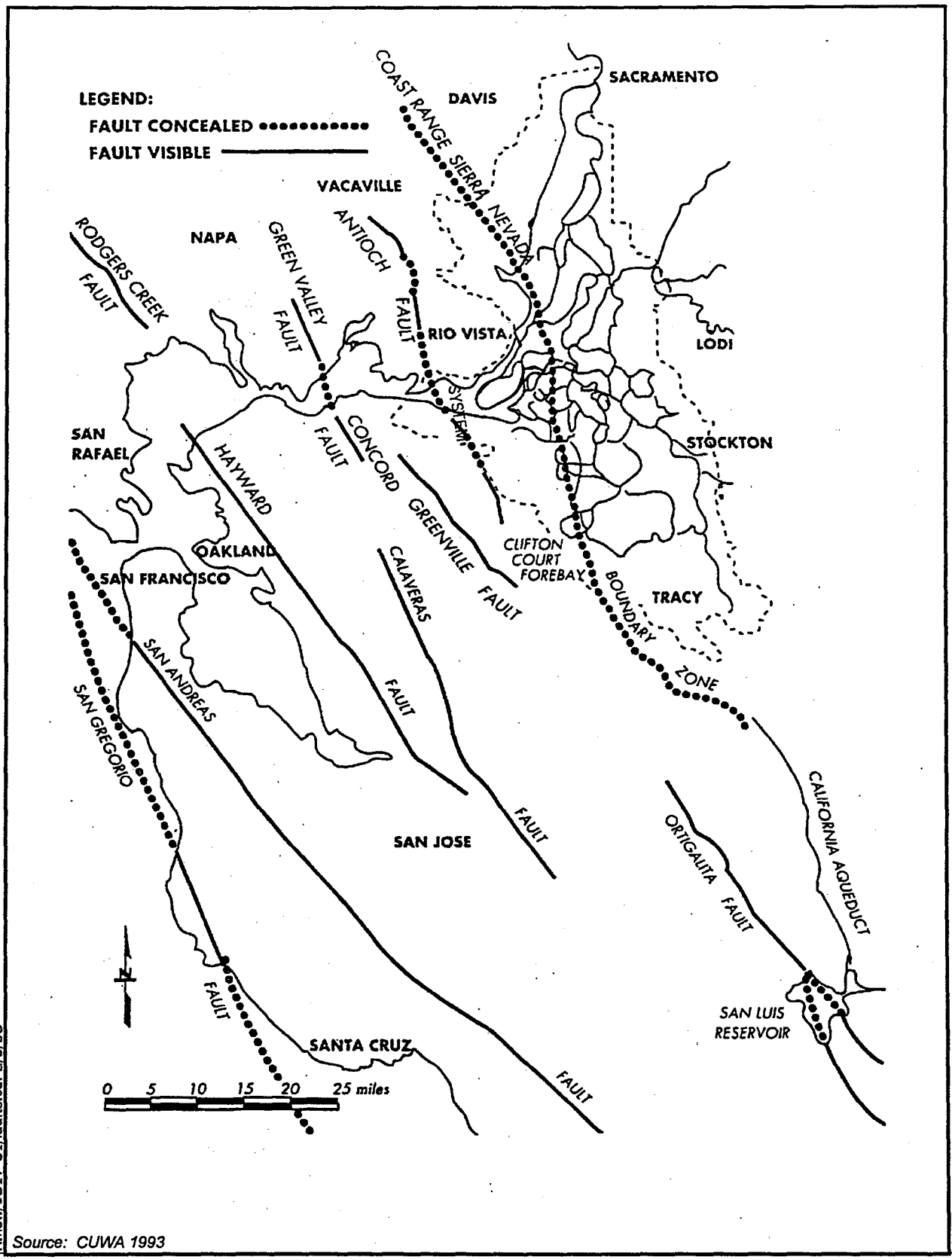

Source: CUWA 1993

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Figure 6.3.1-3. Faults Within and Near the Delta

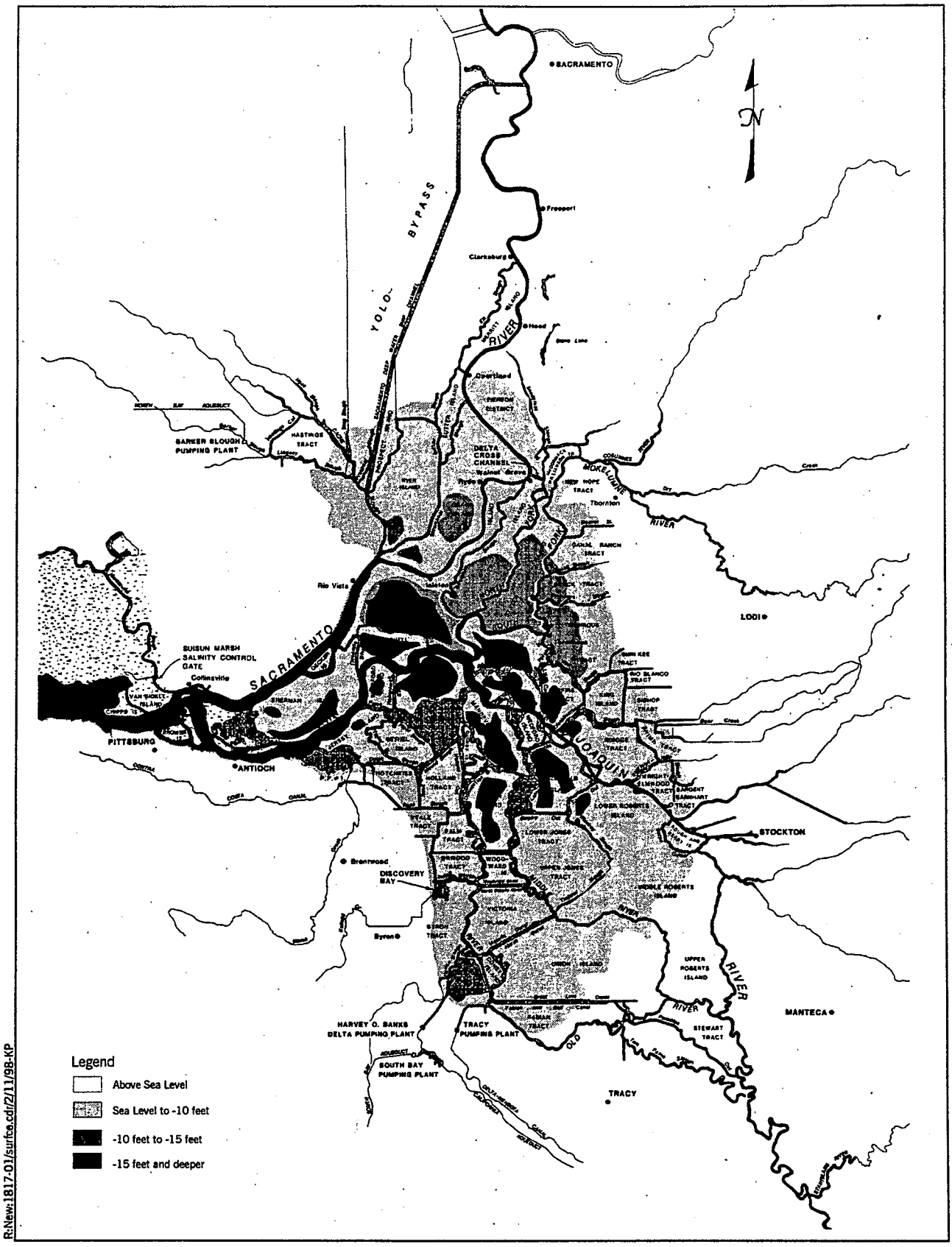

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Figure 6.3.1-4. Land Surface Below Sea Level in the Delta

Sedimentation and Fluvial Erosion in the Delta. The great quantities of sediment transported by the rivers into the Delta move primarily as suspended load. Of the estimated 5 million tons per year of sediment inflow into the Delta, about 80% originates from the Sacramento River and San Joaquin River drainages; the remainder is contributed by local streams. Approximately 15% to 30% of the sediment is deposited in the Delta; the balance moves into the San Francisco Bay system or out through the water project facilities.

Sediment circulation within the Bay-Delta system is complex due to the numerous interconnected channels, tidal flats, and bays, within which the interaction of freshwater flows, tides, and winds produce an ever-changing pattern of sediment suspension and deposition. Pumping at the CVP and SWP Delta facilities alters this circulation of sediments within the system, and may cause erosion of the bed and banks by inducing higher water velocities in the channels.

The mechanics of sediment transport in either saline or tidally affected streams, such as the lower Sacramento River and the Delta, are even more complex than in freshwater streams. This complexity results from changes in flow velocity, flow direction, and water depth caused by the tides.

The Delta is primarily a depositional environment, but variations in water and sediment inflow result in either erosion or deposition.

Erosion may occur when: 1) the velocity of flow in a channel is increased, 2) the sediment inflow to a channel in equilibrium is reduced, or 3) predominance of flow in one direction is altered in a channel that experiences reverse flows. The actual rate of erosion depends on the composition of the material on the bed and banks and on the amount of change in the factors listed previously.

Deposition is induced when conditions are the opposite of those favorable for erosion. The rate of deposition depends on the type and amount of sediment in suspension, the salinity, and the extent to which the transport capacity of the channel has been changed by reduction in flow velocity and channel size. Increasing salinity causes the suspended load of clay and silt particles to form aggregates that settle and deposit more rapidly than individual sediment particles. Deposition near Rio Vista may be caused by the convergence of the Sacramento River with the Deep Water Channel, forming a wider channel with resultant lower water velocities.

Flows induced by use of the Delta Cross Channel have affected the North Fork of the Mokelumne River by eroding a rather deep channel near New Hope, thereby accelerating the need for riprap on the Mokelumne River levees. Delta Cross Channel flows that go down the South Fork pass through Dead Horse Cut and impinge on the Staten Island Levee at a right angle, resulting in erosion of the bank in this area.

The discharges and velocities in the channels south of the San Joaquin River are influenced significantly by exports at the CVP and SWP pumping plants. Sediment deposition and gain from local drainage alter the amount and composition of the sediment transported in the channels. In addition, degradation or aggradation and widening or narrowing of certain channels may be occurring due to the higher velocities caused by pumping.

Bay Region

Historical Perspective. The Bay occupies a structural trough that formed during the late Cenozoic when it was part of a great drainage basin of the ancestral San Joaquin, Sacramento, and Coyote rivers. The Bay was formed between 10,000 and 25,000 years ago when the polar ice caps melted at the end of the fourth glacial period. Sea level rose in response to the melting of the ice caps. As the ocean rose, it flooded river valleys inland of the Golden Gate, forming San Francisco Bay, San Pablo Bay, and Suisun Bay.

Existing Conditions

Soils and Sediment Conditions. The sediments of the shallows comprise silty clay, clayey silt, and sand-silt-clay, while sand and silty sand cover the

deeper areas of the Central Bay and San Pablo Bay. Gravelly sands are found at Golden Gate and grade seaward to a well-sorted sand that covers most of the intercontinental shelf region of the Gulf of Farallones.

The Bay Region can be divided into four major landform types (each with characteristic soils): 1) basin floor/basin rim, 2) floodplain/valley land, 3) terraces, and 4) foothills and mountains. Basin lands consists of organic-rich saline soils adjacent to the Bay and poorly drained soils somewhat farther from the Bay. Valley land soils are generally found on gently sloping alluvial fans that surround the floodplain and basin lands and, along with floodplain alluvial soils, represent the most important agricultural group of soils in California. In the Bay area, most of the floodplain and valley land soils have been urbanized.

Terrace land soils are found along the southeastern edge of the San Francisco Bay area at elevation 5 to 100 feet above the valley land. Most of these soils are moderately dense soils of neutral reaction.

Soils of the foothills and mountains which surround the Bay are formed in place through the decomposition and disintegration of the underlying parent material. The most prevalent foothills soil group is that with a moderate depth to bedrock (20 to 40 inches), with lesser amounts of the deep depth (>40 inches) and shallow depth (<12 inches) to bedrock soil groups being present. Moderate depth soils are generally dark colored, fairly high in organic matter, and constitute some of the best natural grazing lands of the state. Deep soils occur in the high rainfall zones at the higher elevations in the Coast Range. They generally support the forested lands in the Bay Region and are characterized by acid reaction and depths to bedrock of 3 to 6 feet. Shallow soils occur in the medium-to-low rainfall zone. They are loamy in character and are used principally for grazing.

San Francisco Bay Seismicity. Major earthquake activity has centered along the San Andreas Fault zone, including the great San Francisco earthquake of 1906. Since that earthquake, there have been four events of magnitude 5.0 (Richter scale) or greater in the Bay Region. The San Andreas and Hayward faults remain active with evidence of recent slippage along both faults.

Sedimentation and Erosion in San Francisco Bay. The major source of suspended sediment in the Bay is outflow from the Delta. Approximately three-quarters of the suspended sediment enters the Bay with the high winter and early spring flood flows. The highest suspended sediment and turbidity levels occur during these periods. Although much of the suspended sediment begins to aggregate at the salinity gradient and deposit in the shallow areas of Suisun and San Pablo bays, high seasonal flows can transport incoming sediment as far as the Central and South bays.

Sediments deposited in the shallower regions are resuspended by wave and wind action. Approximately 15 times as much material is resuspended each year as actually enters the Bay. Resuspension of sediment is the most important process in maintaining turbidities in the Bay from late spring through the fall.

Sacramento River Region

Historical Perspective. The Sacramento River drains over 21,000 square miles (above the Feather River confluence), producing an annual average flow of 19,000 cfs. The upper watersheds of the Sacramento River Region include the drainages above Shasta Reservoir, the Clear Creek drainage basin west of Redding, the upper Colusa watershed and Cache Creek watersheds west of the valley, and the Feather River and American River watersheds east of the valley. These watersheds are described in detail in Section 6.1.

Hydraulic mining on the western slopes of Sierra Nevada between 1853 and 1884 dramatically increased the sediment budgets of central Sierran streams and rivers. The addition of abundant coarse material overwhelmed the capacity of the rivers, resulting in temporary storage of the sediment in channels and floodplains and widespread flooding of the Central Valley towns and farms. Since the end of hydraulic mining more than 100 years ago, most rivers have

reestablished their original gradients, aided by trapping of the mining sediment behind dams and scouring of the channels promoted by levees built along the rivers.

The Sacramento River's hydrology has been profoundly altered by reservoir construction. At Red Bluff, the average annual flood flow was 121,000 cfs before construction of Shasta Dam (1879 to 1944), and 79,000 cfs after (1945 to 1993). The 10-year flood has been reduced from 218,000 cfs to 134,000 cfs. This has reduced the energy available to transport sediment in the Sacramento River. Moreover, the sediment supply to the river has been reduced by sediment trapping in reservoirs; by mining of sand and gravel from channel beds; and from artificial protection of river banks. The erosion of the river banks had supplied sediment to the channel.

Rates of bank erosion and channel migration have declined since 1946, presumably due to change in flow and blockage of upstream sediment supply as a result of Shasta Dam, and due to the construction of downstream bank protection projects. The channel sinuosity (ratio of channel length to valley length) also has decreased.

Existing Conditions

Soils. The Sacramento River Valley contains four major landform types (each with its own characteristic soils): 1) floodplain, 2) basin rim/basin floor, 3) terraces, and 4) foothills and mountains (Figure 6.3.1-2). Floodplain alluvial soils make up some of the best agricultural land in the state. Basin landforms consist of poorly drained soils, and saline and alkali soils in the valley trough and on the basin rims. These soils are used mainly for pasture, rice, and cotton. Areas above the valley floor have terrace and foothill soils, which are primarily used for grazing and timberland.

The upper watersheds of the Sacramento River Region area mainly drain foothill soils. These soils are found on the hilly to mountainous terrain surrounding the Sacramento Valley and are formed in place through the decomposition and disintegration of the underlying parent material. The most prevalent foothill soil group is that with a deep depth (>40 inches) to bedrock, shallow depth (<20 inches) and very shallow depth (<12 inches) to bedrock.

Deep soils occur in the high rainfall zones at the higher elevations in the mountains surrounding the Sacramento River Valley. These areas are important timberlands and are characterized by acid reaction and depths to bedrock of 3 to 6 feet.

Shallow soils occur in the medium-to-low rainfall zones at lower elevations. They range from calcareous brown stony clay (e.g., Lassen soils) to noncalcareous brown loam (e.g., Vallecitos soils) in character and are used principally for grazing.

Very shallow soils are found on steep slopes, often at high elevations. They consist of stony clay loam or stony loam and are not useful for agriculture or timber because of their very shallow depth, steep slopes, and stony texture. As such, they are also rated very low for grazing purposes.

Geologic Conditions. The geologic provinces composing the Sacramento River Region include the Klamath Mountains, the Coast Ranges, The Cascade Range/Modoc Plateau, the Sierra Nevada, and the Central Valley provinces (Figure 6.3.1-1).

Geomorphologic Conditions. Downstream of Red Bluff, the Sacramento River flows within a meander belt of recent alluvium. The river is characterized by an active channel, with point bars on the inside of meander bends, and is flanked by active floodplain and older terraces. While most of these features consist of easily erodible, unconsolidated alluvium, there are also outcrops of resistant, cemented alluvial units such as the Modesto and Riverbank formations.

Within the channel itself, the bed is composed of gravel and sand (less gravel with distance downstream), and point bars are composed of sand. The bottomlands flanking the channel consist of silts and sands (deposited from suspended load in floodwaters) commonly overlying channel gravels and sands. Higher,

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older surfaces consisting of (often cemented) Pleistocene deposits also are encountered.

The river channel migrates (maintaining roughly constant dimensions) across the floodplain to the limits of the meander belt, constrained only by outcrops of resistant units or artificial bank protection. As meander bends grow, they may become unstable and form cutoffs.

Since construction of Shasta Dam in the early 1940s, flood volumes on the river have been reduced, which reduces the energy available for sediment transport. Straightening and reduced meander migration rate of the river may be associated with flow regulation due to Shasta Dam. The reduction in active channel dynamics is compounded by the physical effects of riprap bank protection structures, which typically eliminate shaded bank habitat and associated deep pools, as well as halting the natural processes of channel migration.

Sediment loads in the streams draining the upper watersheds have been artificially increased due to past and current logging and grazing practices . Both practices remove soil-stabilizing vegetation, create preferential drainage ways, and promote localized soil compaction. Erosive overland flow is enhanced by the loss of vegetation and compacted soils. Larger amounts of sediment are delivered to the streams from increased rates of soil erosion and from enhanced rates of mass movement, such as landslides. During high runoff events, the sharp increases in sediment yields can lead to widespread channel aggradation, which in turn, can lead to lateral migration of the channels and increased rates of landsliding.

Where reservoirs have been created by dams, most of the sediment is trapped behind the dam and during the life of the reservoir will not be transported downstream of the dam. Where such sediment traps are not in place, the sediment load will be transferred downstream.

Soil Subsidence. Land subsidence in the Sacramento Valley is localized and concentrated in areas of groundwater-pumping-induced overdraft. Land subsidence had exceeded 1 foot by 1973 in two main areas in the southwestern part of the valley, near Davis and Zamora; additional subsidence since then, however, has not been reported.

Seismicity. The Great Valley thrust fault system forms the boundary between the Coast Ranges and the Sacramento and San Joaquin valleys. This fault system is capable of earthquakes up to magnitude 6.8 along the west side of Sacramento Valley. The Mendocino Range west of the valley is mainly subject to seismicity from northwest-trending faults associated with the right-lateral strike-slip San Andreas Fault System.

The mapped active faults of this system that are most likely to affect the upper watersheds west of the Sacramento Valley are the Green Valley, Hunting Creek, Bartlett Springs, Round Valley, and Lake Mountain Faults. These faults lie along a 150-mile long northwest-trending zone of seismicity 10 to 45 miles west of the Sacramento Valley that extends from Suisun Bay past Lake Berryessa and Lake Pillsbury to near the latitude of Red Bluff. These faults are capable of earthquakes up to magnitude 7.1.

Active faults likely to affect the upper watersheds northeast of the Sacramento Valley, in the drainages upstream of the Shasta Reservoir, include the Mayfield-MacArthur-Hat Creek Faults, 25 to 85 miles north of Lake Almanor, the Gillem-Big Crack Faults near the California-Oregon border southeast of Lower Klamath Lake, and the Cedar Mountain Fault southwest of Lower Klamath Lake. These faults are part of the Sierra Nevada-Great Basin dextral shear zone and are capable of earthquakes up to magnitude 7.0. Farther northeast, the Likely Fault is judged capable of a magnitude 6.9 earthquake, and in the northeast corner of the state the Surprise Fault is capable of a magnitude 7.0 earthquake.

Active faults likely to affect the upper watersheds east of the Sacramento Valley include the Indian Valley Fault southeast of Lake Almanor and the Honey Lake Fault Zone east of Lake Almanor, which is capable of a magnitude 6.9 earthquake. Surface rupture occurred in 1975 along the Cleaveland Hill Fault south of Lake Oroville. The

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Foothills Faults System, which border the east side of the Sacramento and San Joaquin Valleys, is judged to be capable of a magnitude 6.5 earthquake.

In-Stream Gravel Mining. Aggregate mining occurs within many streams in the western foothills of California and in the lower foothills of the Sierra Nevada. Because of their convenient proximity to the ground surface and their location on flat land, these deposits have been mined for many years. Instream gravel mining causes significant water quality and habitat problems due to the increased release of sediments in the river as well as the removal of soils in the areas of mining activities.

Wind Erosion. Soil erodibility, climatic factors, soil surface roughness, width of field, and quantity of vegetative coverage affect the susceptibility of soils to wind erosion. Wind erosion renders the soil more shallow, and can remove organic matter and needed plant nutrients. Also, blowing soil particles can damage plants, particularly young plants. Blowing soils also can cause offsite problems such as reduced visibility and increased allergic reaction to dust.

San Joaquin River Region

Historical Perspective. The San Joaquin River drains 13,500 square miles along the western flank of the Sierra Nevada and eastern flank of the Coast Ranges, producing an average flow of 4,600 cfs near Vernalis. The San Joaquin has three major tributaries that drain the Sierra Nevada. In downstream order, they are the Merced (drainage area 1270 square miles, average flow 1,350 cfs), Tuolumne (1,884 square miles, 2,254 cfs), and Stanislaus rivers (980 square miles, 1,400 cfs). Precipitation is predominantly snow above 4,000 feet in the Sierra Nevada, and rain in the middle and lower elevations of the Sierra Nevada and Coast Ranges. As a result, the natural hydrology reflects a mixed runoff regime of summer snowmelt and winter-spring rainfall runoff. Another major river, the Mokelumne, enters the eastern Delta along with minor tributaries (including the Cosumnes and Calaveras rivers), joining the San Joaquin River prior to its confluence with the Sacramento. The drainage area of the Mokelumne River is 660 square miles. The hydrology of the San Joaquin River and its tributaries has been profoundly altered by dam construction and surface water diversions. So much water is diverted from Friant Dam that the mainstem San Joaquin River now goes dry at Gravelly Ford, some 30 miles downstream, except during periods of high flow. Storage of flood waters behind Friant Dam has resulted in a decline in flood magnitudes on the mainstream San Joaquin River. Similar reductions have occurred on the major tributaries, such as the Merced River. This has reduced the energy available to transport sediments.

Sediment supply to the river system has been reduced by catchment and trapping in reservoirs; mining of sand and gravel from channel beds; and from artificial protection of river banks, the erosion of which had supplied sediment to the channel.

The floodplains of the San Joaquin River and tributaries have been extensively modified for agricultural development, with elimination of many acres of slough and side channel habitat.

Gravel extraction has been both extensive and intensive from the upper mainstem and the major tributaries. The combined effects of sediment trapping by upstream reservoirs and, to a lesser extent, reduced bank erosion from riprapping, have resulted in a condition of sediment-starvation. In addition, excavation of pits for aggregate production has directly transformed many reaches of the San Joaquin River and its tributaries from flowing rivers to quiescent lakes.

Increasing soil salinity has been recognized as a problem in the San Joaquin Valley since the late 1800s, when a rapid increase in irrigated acreage coincided with increasingly poor drainage (due to elevated shallow groundwater table levels) and elevated soil salinity levels in the western and southern portions of the San Joaquin Valley. It was not until the 1920s that deep well pumping lowered the water table below the root zone of plants on the east side of the valley. Dry-farming practices were replaced with irrigated agriculture on the west side in the 1940s, leading to the

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spreading and worsening of drainage problems on the west side of the valley and near the valley trough in the 1950s.

As a result of heavy pumping, groundwater levels declined by more than 300 feet in certain areas during the 1940s and 50s. The groundwater level declines resulted in significant land subsidence over large areas. Significant historic land subsidence caused by excessive groundwater pumping has been observed in the Los Banos-Kettleman Hills area, the Tulare-Wasco area, and the Arvin-Maricopa area.

Existing Conditions

Soils. The San Joaquin River Valley contains four major landform types (each with its own characteristic soils): 1) floodplain, 2) basin rim/basin floor, 3) terraces, and 4) foothills and mountains. Floodplain lands contain two main soil types: alluvial soils and aeolian soils. The alluvial soils make up some of the best agricultural land in the state, whereas the aeolian soils are prone to wind erosion and are deficient in plant nutrients. Basin lands consist of poorly drained soils, and saline and alkali soils in the valley trough and on the basin rims. These soils are used mainly for pasture, rice, and cotton.

Areas above the valley floor have terrace and foothill soils, which are primarily used for grazing and timberland.

The upper watersheds of the San Joaquin Valley area mainly drain foothills soils (Figure 6.3.1-2) which are found on the hilly to mountainous topography surrounding the San Joaquin Valley. Moderate depth to bedrock (20-40 inches) soils occur on both sides of the northern part of the San Joaquin Valley where the annual rainfall is intermediate to moderately high. Deep (>40 inches) soils are the important timberlands of the area and occur in the high rainfall zones at the higher elevations in the mountains east of the valley. Shallow (<20 inches) soils, used for grazing, occur in the medium-to-low rainfall zone at lower elevations on both sides of the valley. Very shallow (<12 inches) soils are found on steep slopes, mainly at higher elevations, and are not useful for agriculture, grazing, or timber because of their very shallow depth, steep slopes, and stony texture.

Geologic Conditions. The geologic provinces composing the San Joaquin River Region include the Coast Ranges, Central Valley, and Sierra Nevada provinces (Figure 6.3.1-1).

Geomorphologic Conditions. The mainstem San Joaquin River meanders within a meander belt of recent alluvium. The river is characterized by an active channel, with point bars on the inside of meander bends, flanked by an active floodplain and older terraces. While most of these features consist of easily erodible, unconsolidated alluvial deposits, there are also outcrops of resistant, cemented alluvial units such as the Modesto and Riverbank formations.

Within the channel itself, the bed is composed of gravel and sand (less gravel with distance downstream), and point bars are composed of sand. The bottomlands flanking the channel consist of silts and sands (deposited from suspended load in floodwaters) commonly overlying channel gravels and sands. Higher, older surfaces consisting of (often cemented) Pleistocene deposits are also encountered.

The river channel migrates (maintaining roughly constant dimensions) across the floodplain to the limits of the meander belt, constrained only by outcroppings of resistant units or artificial bank protection. As meander bends grow, they may become unstable and form cutoffs, leaving oxbow lakes like those visible along lower reaches of the mainstem.

Sediment loads in streams draining the upper watersheds of the San Joaquin River Region are similar to those described in the Sacramento River Region.

Soil Subsidence. After nearly two decades of little or no land subsidence, significant land subsidence recently has been detected in the San Joaquin Valley along the Delta-Mendota Canal due to increased groundwater pumping during the 1987 to 1992 drought.

Seismicity. In the San Joaquin River Region, the Great Valley thrust fault system forms the boundary between the Coast Ranges and the west boundary of the San Joaquin Valley. This fault system is capable of earthquakes up to magnitude 6.7 along the west side of San Joaquin Valley.

The Diablo Range west of the valley is mainly subject to seismicity from northwest-trending faults associated with the right-lateral strike-slip San Andreas Fault System.

The mapped active faults of this system that are most likely to affect the upper watersheds west of the San Joaquin Valley are the Ortigalita Fault and the Greenville-Marsh Creek Fault. These faults lie along northwest-trending zones of seismicity 5 to 20 miles west of the San Joaquin Valley and each is capable of earthquakes up to magnitude 6.9.

Active faults likely to affect the upper watersheds east of the San Joaquin Valley include the Foothills Fault System and major faults along the east margin of the Sierra Nevada. The Foothills Fault System, which borders the east side of the northern part of the San Joaquin Valley, is judged to be capable of a magnitude 6.5 earthquake. Active faults along the east margin of the Sierra Nevada include the Owens Valley Fault, which ruptured in a magnitude 7.6 earthquake in 1872 and is within the Sierra Nevada Fault Zone. Seismic activity along this fault zone can significantly affect the upper watersheds that drain to the San Joaquin Valley.

Active faults likely to affect the upper watersheds at the end of the San Joaquin Valley, include the White Wolf fault, which ruptured in 1952 with a magnitude 7.2 earthquake, the Garlock Fault, capable of the a magnitude 7.3 earthquake, and several smaller faults 10 to 30 miles north of the White Wolf Fault.

Soil Salinity. Soil salinity problems occur primarily in the western and southern portions of the San Joaquin Valley. Most soils in this region were derived from marine sediments of the Coast Ranges, which contain salts and potentially toxic trace elements such as arsenic, boron, molybdenum, and selenium. Soil salinity problems in the San Joaquin Valley have been, and continue to be, intensified by poor soil drainage, insufficient water supplies for adequate leaching, poor-quality (high-salinity) applied irrigation water, high water tables, and an arid climate. A 1984 study estimated that about 2.4 million of the 7.5 million acres of irrigated cropland in the Central Valley were adversely affected by soil salinity.

Selenium Concentrations. Soil selenium is primarily a concern on the west side of the San Joaquin Valley. When soils on the west side are irrigated, selenium (along with other salts and trace elements) dissolves and leaches into the shallow groundwater. Figure 6.3.1-5 shows selenium levels in the top 12 inches of soil as determined by a survey in the mid 1980s. Over the past 30 to 40 years of irrigation, soluble selenium has been leached from the soils into the underlying shallow groundwater aquifers.

SWP and CVP Service Areas Outside the Central Valley. A description of the soils and geomorphologic conditions of the SWP and CVP Services Areas Outside the Central Valley is not included in this report because no impacts to these resource areas are expected as a result of any of the alternatives.

6.3.2 Environmental Consequences: Geology and Soils

6.3.2.1 Assessment Methods

This assessment encompasses analyses of soil changes that could result directly from construction of new facilities or conversion of lands from one use to another, and analyses of indirect effects of changes in policies, resources, or economics. The assessment of the effects of changes on geology and soils addresses both the direct and indirect consequences of Program actions.

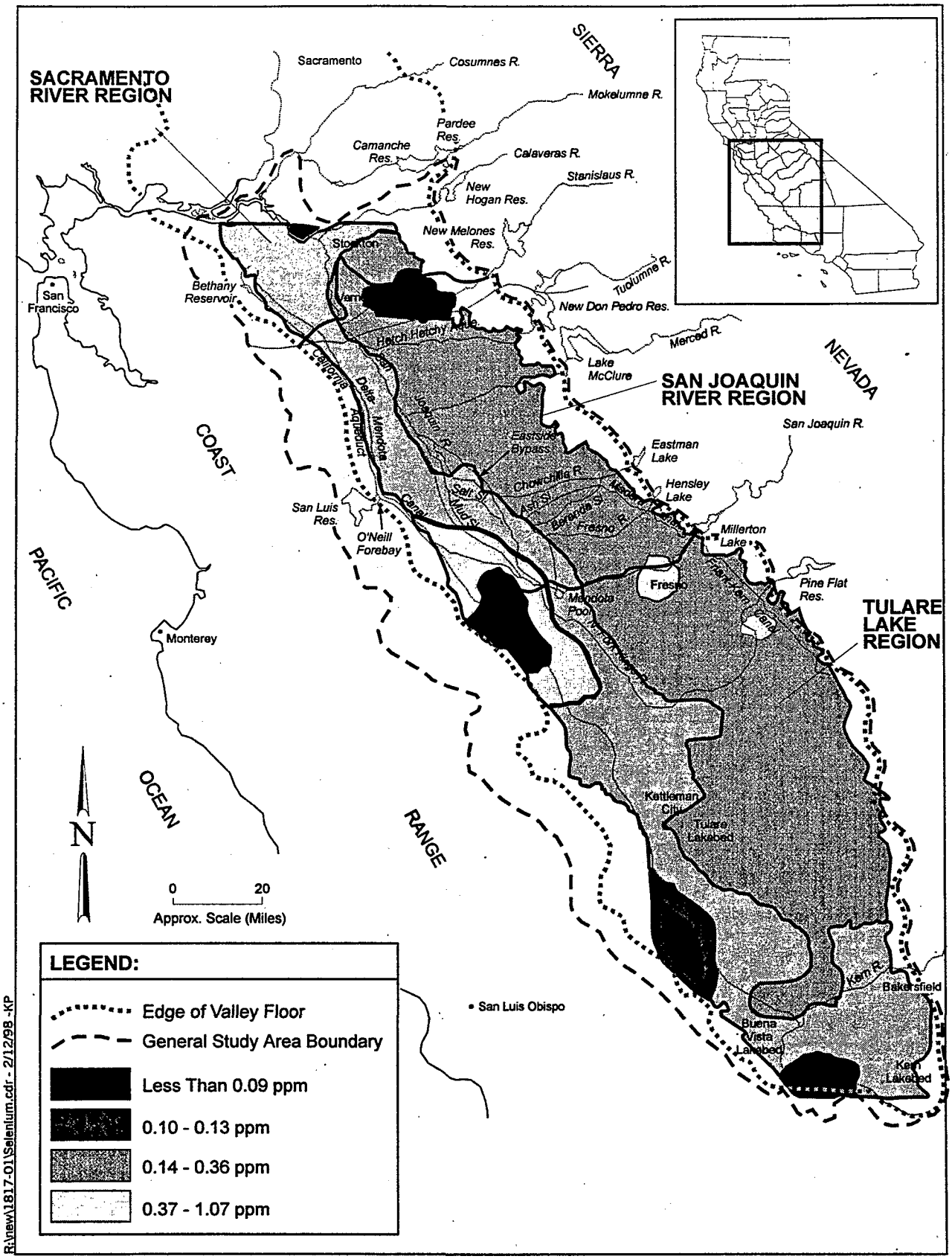

Figure 6.3.1-5. Selenium Concentrations

Two types of analyses have been included: 1) changes in areal extent due to direct loss, or conversion of soil types and geomorphologic conditions; and 2) changes in their quality. Impacts to the areal extent or quality of agricultural soils were caused by two types of activities: conversion to different plant communities as part of a habitat-related restoration action, or direct losses from the construction of project features.

The programmatic geology and soils assessment evaluated potential changes to the following resource categories:

- Surface soil erosion
- Channel, basin, shore, and shallows erosion and sedimentation
- Soil salinity
- Soil drainage characteristics
- Subsidence caused by the mass loading from overburden and oxidation of organic content
- Subsidence caused by groundwater withdrawals
- Geomorphology and soils impacts due to change on land surfaces
- Soil acreage and characteristics due to changes in land use.

Estimated changes in soil erosion are qualitative because of variability in soil type, soil erodibility, slope, and land management practices throughout the regions.

Projection of soil salinity impacts was based on estimates of the affected soils and degree to which area soils would be affected by salts.

Assessing subsidence resulting from groundwater withdrawals was based on changes in the amounts and reliability of delivered water, and resulting changes in the rates of groundwater pumping.

6.3.2.2 Significance Criteria

Impacts are considered significant if they lead to the following suggested threshold criteria:

- Removal, filling, grading, or disturbance of soils
- Substantial degradation of the quantity or quality of native soil types or their environmental and water quality protection characteristics in significant watersheds
- Releases of toxic materials from soils or sediments
- Alterations to, or drainage from, soils or substrates that create conditions that increase the potential for outbreaks of wildlife diseases
- Adverse changes in rates of sedimentation and erosion
- Adverse changes in soil drainage or salinity
- Soil subsidence and increases in subsidence rates that produce adverse effects
- Changes in soil conditions that cause undesirable seepage to adjacent lands
- Increased potential for soil erosion by wind, waves, or currents
- Oxidation of, or drainage from, peat soils where this may cause adverse effects
- Increased potential for erosion and mass failure-induced landslides
- Increased potential for seismic activity or vulnerability of soil-comprised structures to seismic events
- Disruption of natural or favorable soil profiles and horizons
- Increased potential for damage from geological hazards.

6.3.2.3 Comparison of No Action Alternative to Existing Conditions.

The environmental consequences of geology and soils under the No Action Alternative would be very similar to the existing conditions described in the affected environment. Channel geometry in the Delta, Bay, Sacramento River, and San Joaquin River regions would not be altered by other than current ongoing geomorphologic, irrigation, drainage, and/or dredging processes. Negative trends in soil erosion, subsidence, and soil contamination are expected to continue.

In the Delta Region, the No Action Alternative could result in continued problems with soil salinity, soil surface erosion and subsidence, soil selenium, and seismic susceptibility of levees to failure. Elevated levels of soil salinity in the south and west Delta could worsen due to the seepage and the poor quality of applied water caused by increasing amounts of ocean salinity intrusion and high TDS concentrations from increasing amounts of land-derived agricultural drainage. Peat oxidation of the island interior soils would continue, resulting in continued subsidence and susceptibility of the soil to wind-induced erosion. Existing high selenium concentrations could intensify in the channels and applied irrigation water in the south Delta from land-derived San Joaquin Valley agricultural drainage. The susceptibility of Delta levees to seismic failure would be further increased by the continued subsidence.

In the Bay Region, the No Action Alternative is not expected to result in any significant changes to geomorphologic or soils conditions relative to existing conditions.

In the Sacramento River and San Joaquin River regions, surface-soil erosion can be expected to worsen under the No Action Alternative.

In the San Joaquin River Region, soil salinity and selenium concentrations can be expected to worsen as additional salt load is imported to the valley and leached from the soils by irrigation and natural discharge from contaminated soils on the west side. Subsidence caused by groundwater withdrawals can be expected to continue and worsen as groundwater pumping continues and increases.

Geology and soils in the SWP and CVP Service Areas Outside the Central Valley are not expected to be affected by any CALFED alternatives. Therefore, no further discussion of geology or soils is provided for this region.

6.3.2.4 Comparison of Program Alternatives to No Action Alternative

The impacts to geology and soils resulting from the storage and conveyance program element will vary by alternatives, as discussed below. Impacts to geology and soils resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternatives. In those cases where no environmental impacts have been associated with a program element within a regions, the program element is not discussed.

Delta Region

Potential acreage of Important Farmland soils affected by each alternative and each program element is presented in Chapter 5, Section 5.2.

Storage and Conveyance

Alternative 1. Conveyance and storage facility improvements are not included in Configuration 1A, and therefore cause no significant adverse impacts to geology and soils.

Conversion of agricultural soils for Configuration 1B conveyance improvements would have a significant and unavoidable impact.

Construction activities required for conveyance improvements could cause disturbance of soils in the vicinity of the project, resulting in a short-term increased potential for erosion. Increased

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pumping of water out of the Delta could result in increased flows during some months. The magnitude of change in flow velocities would likely be negligible relative to existing flows, however, and so would not adversely impact soil erosion or sediment transport processes. Therefore, the potential for increased erosion of channel and levee soils would be less than significant.

Under Configuration 1C, conversion of agricultural soils would be a significant and unavoidable impact. Enlargement of channels in the south Delta would reduce water velocities in those channels, reducing the potential for levee soil and channel substrate erosion. In the north Delta channel, and levee erosion may occur because channels are not being enlarged under Configuration 1C in that area.

Alternative 2. In Configuration 2A, potential adverse impacts of north- and south-Delta modifications would affect important farmland soils. Adverse impacts are similar to those described in Configuration 1B, and include the conversion of land for conveyance improvements and setback levees, and potential soil erosion associated with construction activities. Construction of setback levees and widening of channels would reduce the potential for levee and channel erosion.

No additional impacts beyond those described under Configuration 1B and 2A are expected to occur under Configurations 2B, 2D or 2E. Landforms and soils potentially adversely impacted by Configuration 2D conveyance improvements would principally affect agricultural with some developed uses associated with Highway 12. Landforms and soils potentially adversely impacted by Configuration 2E are agricultural.

Alternative 3. Configuration 3A includes potentially significant adverse impacts to agricultural landforms and soils in the Delta Region and some developed areas along the Interstate 5 corridor due to the conversion of land for conveyance improvements and associated construction activities. These impacts, described under Configurations 1B and 2A, also apply to Configurations 3E, 3H and 3I.

New groundwater and surface water storage would increase the amount of fresh water available during the summer and fall months. This increase in freshwater would dilute salinity in waters from tributaries with return flows that have potentially high concentrations of salts. The additional flows in the summer and fall would also reduce salinity intrusion from the ocean and transport more dissolved salts to the ocean, thereby reducing applied salt loads. This beneficial impact also applies to Configurations 2B, 2E, 3B, 3E, 3H, and 3I.

Potentially significant and unavoidable impacts under Configurations 3B, 3E, and 3I include the loss and conversion of agricultural soils to new in-Delta water storage facilities and increased potential for catastrophic levee failure due to earthquake-induced liquefaction. Impacts of this alternative associated with conversion of agricultural soils are described under Configuration 1B. In-Delta storage may be developed by flooding one or more Delta island interiors with surplus water during times of high flows. A significant adverse impact of such in-Delta water storage facilities would be the loss of prime Delta farmland due to inundation at the storage site. Structures and levees in the Delta may be susceptible to seismic disturbance by earthquakes, depending on their proximity to nearby faults and degree of relative ground motion during an earthquake. Impacts on soil erosion from the construction of in-Delta water storage sites would be similar to that described under Configurations 1B and 2A.

Ecosystem Restoration. The Ecosystem Restoration Program would potentially affect agricultural landforms and soils in the Delta Region. The following impacts apply to all alternatives for the Delta Region.

Beneficial effects of the Ecosystem Restoration Program in the Delta Region include reducing soil loss (or depletion) on Delta island interiors and levees resulting from wind erosion, wave erosion, and high velocity flows. Habitat restoration

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would allow for improved vegetative growth by returning humus and nutrients to the soils and sheltering soils from the wind. The protection and maintenance of in-channel islands would also decrease wind-fetch distances over open water, and thereby reduce wind-wave erosion on nearby levees.

Agreements with willing levee reclamation districts to implement modified levee and berm management practices could promote the establishment and maturation of shoreline riparian vegetation. Riparian vegetation would reduce flow velocities adjacent to the levees, and thereby reduce potential soil erosion.

Water Quality. Activities proposed for the Water Quality Program would not have an adverse effect on geology and soils in the Delta Region; instead, reductions in point-source and non-point source pollutants would provide beneficial impacts to the Delta Region by decreasing loadings of toxic metals and organic compounds and by removing potential sources of soil and sediment contamination, including salts and selenium.

Water Use Efficiency. The beneficial effects of on-farm water use efficiency improvements, such as tailwater recovery ponds or installation of pressurized irrigation systems (over gravity), is that they could greatly reduce sediment transport from fields to streams and drains.

On-farm efficiency improvements could lead to increased reliance on groundwater due to irrigation needs and secondary use issues. Highly efficient irrigation requires more frequent water deliveries, some of which may not be met from surface water sources, and impoundment of tailwater leaves less surface water available to secondary users. Such users may turn to alternative sources such as groundwater. An increased reliance on groundwater could have adverse impacts if it results in localized subsidence from depletion of groundwater resources.

Levee System Integrity. Within the Delta Region, Levee System Integrity Program improvements would be implemented primarily on lands used for agriculture; hence, changes in soils and geomorphologic conditions would be confined to those lands. Beneficial effects of the levee system integrity improvements include reducing the impact from land subsidence in the Delta, reducing the risk of levee failure, and decreasing soil salinities inboard of levees.

The program would reduce subsidence on about 14,000 acres by converting subsided land to wetlands through shallow flooding. Seismic retrofits to levees could reduce the risk of catastrophic failure, thereby reducing the risk of salinity intrusion from the ocean, which could otherwise increase salinity in the soils.

The conversion of agricultural soils for levee system construction would produce significant adverse changes to soils in the affected areas. Agricultural soils would be covered where new setback levees are constructed. Soil erosion outboard of the levees could be improved by habitat restoration and sediment deposition measures, but would be subject to erosion during floods. The beneficial reuse of dredged material could replace soils that have been lost and/or prevent subsequent losses.

Water Transfers. Water Transfers would affect geology and soils primarily through changes in land subsidence, erosion, and soil salinity. In addition to the source of water for a transfer, the timing, magnitude, and pathway of each transfer have a tremendous effect on the potential for significant impacts.

Potentially significant beneficial impacts are primarily associated with the transferred water's origin, and include: 1) decreasing erosion and sedimentation through reduced land disturbance from fallowing; and 2) decreasing soil salinity, relative to initial conditions, through replacement of irrigation water from surface water sources with higher-quality groundwater.

Potentially significant adverse impacts are primarily associated with the transferred water's destination, and include: 1) increasing erosion and sedimentation through reduced soil cover from fallowing; 2) increasing soil salinity by replacing

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irrigation water with lower quality water from groundwater substitution; and 3) increasing soil salinity by irrigating with a volume of water insufficient to flush the salinity from the soil.

Bay Region

Storage and Conveyance. Potential geology and soils impacts associated with foreseeable changes in water availability are expected to be minimal, and less than significant. The only potential effect would be associated with changes in sediment transport out of the Delta and into the Bay. CALFED alternatives would likely cause only minor decreases in sediment transport from the Delta to the Bay.

Direct, indirect, and construction-related activities associated with the Ecosystem Restoration and Water Quality programs could alter or displace soils in the immediate vicinity of activities, but are not expected to have a significant adverse effect on geology and soils in the Bay Region.

Water Quality. As in the Delta Region, reductions in point-source and non-point source pollutants will provide beneficial impacts to the geology and soils resources of the Bay Region by decreasing toxic metals and organic compounds that accumulate in bottom sediments in the Bay.

Coordinated Watershed Management. Potential beneficial effects of the coordinated watershed management activities include overall lowering of sediment input to watershed streams and localized lowering of the potential for seismically induced landslides.

Sacramento River and San Joaquin River Regions

Storage and Conveyance. Construction of storage facilities would cause significant adverse impacts due to local ground disturbances and inundation, the extent of which would depend upon the type and size of storage facilities enlarged or constructed, construction methods and site(s) selected. Reservoir construction would also require construction of access roads and dams. Increased erosion could occur on areas cleared for storage facilities or access roads. Compaction of soil by heavy equipment during construction would temporarily affect the physical characteristics of the soil, including decreasing permeability and increasing runoff.

Any storage facilities sited on streams would have a significant adverse impact by trapping sediments, thereby reducing sediment transport and potentially increasing stream erosion capabilities and altering geomorphologic characteristics downstream of the storage facility. Reductions of stream bedload would be greatest during high flow events. Off-stream storage sites would not directly impact in-stream sediment transport, but may diminish flows in local stream channels due to their placement across minor drainages. Wind- and wave-generated erosion along the shoreline of the reservoir can cause a significant impact by increasing bank erosion and sedimentation at the site. The potential for landsliding in areas around the reservoir may be increased by saturation of adjacent geologic strata as the reservoir is filled.

Ecosystem Restoration. Certain targets of the Ecosystem Restoration Program could beneficially affect geomorphologic processes in the Sacramento River and San Joaquin River regions.

Establishment of stream meander belts would widen the area available for natural channel migration to accommodate the processes of channel erosion and deposition, and allow the stream system to respond more naturally to morphologic changes without the presently imposed physical constraints.

Gravel recruitment actions would include stockpiling gravel at strategic locations for capture by high streamflows, and would allow sediment-starved reaches to mimic natural stream processes. This program would be monitored to determine the effects on channel erosion, sediment deposition, and meander processes.

The removal and/or reduction of seasonal diversion structures on tributaries to the Sacramento River and San Joaquin River would reduce sediment-trapping and allow for the

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continued transport of sediment downstream. An adverse impact of this would be a need for increased dredging in some areas. However, increased sediment transport may also improve areas that currently experience a net loss of sediment.

Water Quality. Reductions in point-source and non-point source pollutants will provide beneficial impacts to the Sacramento River and San Joaquin River regions by decreasing loadings of toxic metals and organic compounds and by reducing the concentrations of selenium and salts in these and other minor tributaries.

Water Use Efficiency. The Water Use Efficiency Program would generally have the same beneficial and adverse impacts as identified for the Delta Region. Potential reduction of erosion from agricultural fields through use of on-farm efficiency measures is most pronounced in West Stanislaus County and the Sacramento Valley. This would benefit instream water quality by reducing sediment transport to streams and drains.

Soil salinity of agricultural lands in the San Joaquin Valley can potentially be reduced if less (high salinity) water is applied to fields. In turn, this can improve the productive capacity of some fields currently high in soil salinity.

Conjunctive use practices involve using groundwater in combination with surface water for augmenting water supplies. When surplus Sacramento River and/or San Joaquin River water is available, it would be stored in groundwater basins (aquifers) for times when surface water availability is low. Conjunctive use of groundwater could have a beneficial impact in some areas of the San Joaquin Valley by reducing land subsidence that results from overdraft of groundwater reserves.

Water Transfers. Water Transfers would generally have the same beneficial and adverse impacts as identified for the Delta Region. Land subsidence could be impacted either beneficially or adversely following withdrawals for direct groundwater or groundwater substitution transfers depending on groundwater levels and the net change in recharge (input) and withdrawals (output).

Coordinated Watershed Management. Water quality in the Sacramento and San Joaquin rivers would benefit from watershed management activities that reduce hillslope and stream bank erosion which cause sediment loading and increased turbidity in watershed tributaries. Bank and slope stabilization methods will use native vegetation to protect ground surfaces from wind- and water-induced erosion. Road improvements and road deconstruction efforts could provide beneficial impacts by decreasing road-related erosion and reducing the potential for landslides on over-steepened slopes.

Adverse effects associated with upper watershed management activities can include short-term soil erosion and increased sediment deposition during the construction of stream and watershed restoration projects or roadway improvements. Compaction of soil by heavy equipment during construction will temporarily affect the physical characteristics of the soil; however, long-term post-construction effects are expected to be beneficial, and include reducing sediment erosion and excess sedimentation in streams due to poorly managed timber-harvesting, livestock grazing, and other land-use activities. Most watershed restoration efforts would include a re-vegetation component to reduce erosion, stabilize hazardous slopes, and provide terrestrial or aquatic habitat.

6.3.2.5 Comparison of Program Alternatives to Existing Conditions

Comparison of program alternatives to existing conditions indicates that:

- All significant adverse impacts identified when comparing to the No Action Alternative are still significant when comparing to existing conditions.
- CALFED is proposing actions for levee protection, and ecosystem restoration, which could result in additional large-scale land conversions impacting agricultural soils particularly in the Delta. Adverse impacts

resulting from the CALFED alternatives combined with the expected future conversion of agricultural lands could result in greater impacts to agricultural soils when compared to existing conditions.

- CALFED is proposing actions under its each of its programs which could improve soil quality, vulnerability to seismic failure, and sediment load of streams above the existing condition baseline. All benefits which have been identified when compared to the No Action Alternative are still beneficial when compared to existing conditions.

6.3.2.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

The following mitigation measures could be implemented to reduce significant geology and soils impacts:

- Monitor groundwater levels and subsidence in areas of increased reliance on groundwater resources; regulate withdrawal rates at levels below those which cause subsidence;
- Upgrade all levees to PL-99 standards;
- Protect flooded Delta island inboard levee slopes against wind and wave erosion with vegetation, soil matting, or rock;
- Protect exposed soils with mulches, geotextiles, and vegetative ground covers to the extent possible during and after project construction activities to minimize soil loss;
- Implement erosion control measures and bank stabilization projects where needed; this can include grading the site to avoid acceleration and concentration of overland flows, using silt fences or hay bales to trap sediment, and revegetating areas with native riparian plants and wet meadow grasses;
- Increase sediment deposition and provide substrate for new habitat by planting terrestrial and aquatic vegetation;
- Measure channel morphology over time to monitor changes due to re-operation of SWP-CVP flows, and implement erosion control measures where needed;
- Re-use dredged materials to reduce or replace soil loss;
- Leave crop stubble from previous growing season in place while fallowing, and employ cultivation methods that will cause the least amount of disturbance to minimize erosion of surface soils;
- Limit the salinity of replacement water, relative to local conditions, in water transfers;
- Ensure that the volume of irrigation water used is always sufficient to flush accumulated salts from the root zone; and
- Minimize or avoid direct groundwater transfers or groundwater substitution transfers from regions: 1) experiencing long-term overdraft, 2) where subsidence has historically occurred, or 3) where local extensometers indicate that subsidence rates are increasing.

6.3.2.7 Potentially Significant Unavoidable Impacts

Significant unavoidable impacts of the Program alternatives may include: loss of agricultural soils and farmland. This impact occurs under all alternative configuration except configuration 1A.

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6.4 NOISE

Summary

The noise impacts expected in the Bay-Delta regions associated with the No Action Alternative, the three implementation alternatives, and the program elements common to all three implementation alternatives are less than significant. Table 6.4-1 provides a summary of environmental impacts related to noise.

No Action Alternative. Potential noise impacts from the No Action Alternative are considered to be a continuation of existing conditions, and less than significant.

Storage and Conveyance. Under Alternative 1, both potential direct, short-term, construction-related, and indirect, long-term, operations-related noise impacts would accompany the construction and operation of new storage facilities, as well as minor channel improvements in-Delta. The greatest amount of potential construction- and operations-related noise impacts would be associated with the development of the storage facilities within either the San Joaquin or the Sacramento River Region proposed in Configuration 1C. Potentially indirect, long-term, operational noise impacts would also result from increasing pump sizes in water conveyance systems. These impacts are less than significant.

The upstream storage facilities would have the same level of both potential direct, short-term, construction-related, and indirect, long-term, operations-related noise impacts as Alternative 1. However, for Alternative 2, substantial physical changes to the conveyance systems and construction of new diversion structures would result in having a greater level of potential construction- and operations-related noise impacts than Alternative 1. Noise impacts accompanying implementation of Alternative 2 would be less than significant.

Under Alternative 3, new storage facilities could be constructed in the Delta, Sacramento, and San Joaquin River regions. The upstream storage in this alternative is the same as Alternative 2. Also, Alternative 3 would involve construction of a new, separate, conveyance system. Therefore, the level of both direct, short-term, construction-related, and indirect, long-term, operations-related noise impacts accompanying Alternative 3 is potentially greater than for Alternatives 1 and 2.

Noise Impacts
• **No Action** conditions are forecast to be similar to existing conditions • Construction of storage and conveyance systems are expected to result in overall greater potential noise effects than the No Action Alternative, but still be less than significant in any region

Ecosystem Restoration. The installation of new fish screens at certain diversions would potentially be accompanied by direct, short-term, construction-related noise impacts. River channel deepening and subsidence reversal activities, such as those planned for the San Joaquin River Region, would also be accompanied by such impacts. Development of wetlands would involve activities that could cause direct, short-term, construction-related noise impacts.

Water Quality. Land conversion activities intended to reduce drainage-related pollution could result in decreased long-term, operations-related noise impacts for those lands that were previously under active agricultural cultivation. Improvements to existing, and construction of new filtration and treatment facilities could have both temporary direct, short-term, construction-related and indirect, long-term operations-related noise impacts.

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Construction-related Noise	o	o	o	o	o	o	o	o	o	o	o	o
Operations-related Noise	o	o	o	o	o	o	o	o	o	o	o	o
Bay Region												
Construction-related Noise	o	o	o	o	o	o	o	o	o	o	o	o
Operations-related Noise	o	o	o	o	o	o	o	o	o	o	o	o
Sacramento River Region												
Construction-related Noise	o	o	o	o	o	o	o	o	o	o	o	o
Operations-related Noise	o	o	o	o	o	o	o	o	o	o	o	o
San Joaquin River Region												
Construction-related Noise	o	o	o	o	o	o	o	o	o	o	o	o
Operations-related Noise	o	o	o	o	o	o	o	o	o	o	o	o
SWP and CVP Service Areas Outside the Central Valley												
Construction-related Noise	o	o	o	o	o	o	o	o	o	o	o	o
Operations-related Noise	o	o	o	o	o	o	o	o	o	o	o	o

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:
Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
o	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 6.4-1. Summary of Environmental Impacts Related to Noise

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Water Use Efficiency. Modifications to existing filtration plants, development of new pipelines, well fields, and pump stations, and increased (or decreased) pumping would have potential construction- and operation-related noise impacts (both adverse and beneficial) in agricultural and urban environments.

Levee System Integrity. Land conversion adjacent to streams to create buffer areas associated with enhanced levee operation and flood control could also result in decreased operations-related noise impacts for those lands that were previously in active agricultural use. Improvements to existing, and construction of new, levee systems, as well as dredging, would involve activities that would have temporary direct, short-term, construction-related noise impacts.

Coordinated Watershed Management. Timber harvesting and mining operations can generate intermittently high noise levels. Watershed management and restoration activities intended to reduce potential erosion and improve riparian and aquatic habitat could result in short-term construction-related noise impacts.

6.4.1 Affected Environment/ Existing Conditions

This section presents a characterization of the existing noise environment in the Bay-Delta Program study area.

6.4.1.1 Delta Region, Bay Region, Sacramento River Region, San Joaquin River Region, and SWP and CVP Service Areas Outside the Central Valley: Historical Perspective

Prior to the 1850s, the noise character of the five CALFED regions and the upper watershed areas was dominated more by sounds from natural sources than sounds generated by an urbanized, mechanized, and technology-based society. Natural sounds of rushing water, wind, and wildlife were most common. With the advent of large-scale mining and timber harvesting, high noise levels associated with these uses were added to the existing natural sources. Construction of water resource developments also altered noise levels. Further development of new highways and residential communities have added construction, vehicular, and urban noises.

6.4.1.2 Delta Region, Bay Region, Sacramento River Region, San Joaquin River Region, and SWP and CVP Service Areas Outside the Central Valley: Existing Conditions

The noise planning standards and the noise level control ordinances existent in the communities within the five regions of the study area are fairly uniform, typically ranging within 5 dBA for a similar land-use category. Typical land-use categories occurring across the program area range from undeveloped rural land to densely developed urban land. Understandably, the noise levels associated with the range of land uses occurring in the program area, in turn, range from quiet to very noisy.

Based on the results of environmental noise studies conducted in the United States and the study area, it is generally accepted by planners and decision makers that a consistent and direct relationship exists between population density and the associated noise level environment. It follows, therefore, that the more rural and less populated (and less developed) areas within the study area would typically have lower noise levels (measured in dBA L_{dn}) than the more urban and densely populated (and more developed) areas. Table 6.4.1-1 presents this relationship between the population density and associated noise levels within the study area.

It is assumed for this Programmatic EIS/EIR that the affected environment includes the range of population density and land-use categories presented in Table 6.4.1-1, plus potentially noisier land uses such as certain industrial and commercial uses, and areas adjacent to transportation corridors and airports.

Location	Person/sq. km	L_{dn} (dBA)
Rural		
Undeveloped	8	35
Partially Developed	23	40
Suburban		
Quiet	77	45
Normal	230	50
Urban		
Normal	770	55
Noisy	2,300	60
Very Noisy	7,700	65

SOURCE: National Research Council, USA.

Table 6.4.1-1. Relationship Between Population Density and Average Day-Night Noise Levels

6.4.2 Environmental Consequences: Noise

6.4.2.1 Assessment Methods

In assessing potential noise impacts for this Programmatic EIS/EIR, the primary assumption is that the main sources of environmental noise are from construction and operations activities. Typical sources of construction-related noise would include the following:

- Heavy equipment operation,
- Blasting operations at fill material quarry sites,
- Truck traffic along major access and haul routes associated with hauling fill and spoil material, and
- Vehicle traffic associated with the construction labor force.

Facility operation and maintenance activities would become noise sources. Localized increases in noise levels would occur at spillways, pumping-generating plants, and switchyards. Traffic and boating activities associated with recreational use of the reservoirs would be additional noise sources.

The specific locations of potential new facilities and the associated site-specific noise generation characteristics for each alternative are not yet known. Therefore, for this programmatic-level evaluation, the following assumptions about the noise-generating potential of the alternatives have been made:

- Standardized levels of construction and operations would occur for each alternative,
- The proximity of people and sensitive receptors to proposed sources of noise would be equal for all alternatives, and
- The density of population or sensitive receptors in the area of potential effect would be equal for all alternatives.

On this basis, for this Programmatic EIS/EIR, the evaluation of potential noise effects from the alternatives is primarily concerned with the amount of construction activities and the extent and type of facilities likely to be constructed and operated for each alternative and program element.

6.4.2.2 Significance Criteria

Potential noise-related impacts are considered significant if the construction or operations of facilities associated with a particular implementation alternative or program element would cause substantial, adverse changes to the existing (ambient) noise conditions within the affected area.

6.4.2.3 Comparison of No Action Alternative to Existing Conditions

The No Action Alternative is not expected to have any significant adverse impacts on existing noise conditions in the study area.

6.4.2.4 Comparison of Program Alternatives to No Action Alternative

The noise impacts resulting from the storage and conveyance program element will vary by alternative. Noise resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a region, the program element is not discussed.

Delta Region

Storage and Conveyance

Alternative 1. Potential direct, short-term, construction-related noise impacts, in Alternative 1, from vehicles and equipment would accompany the development of minor channel improvements in the south Delta Region. Potential indirect, long-term, noise impacts would result from operating the larger pump sizes that would be installed in water conveyance systems through the Delta Region.

Potential construction- and operations-related noise impacts would be less than significant. Construction-related noise would be present in the area of the construction sites only for short, intermittent periods during construction, and in most cases would likely be located at distances from sensitive receptors so as to not create significant annoyance.

Alternative 2. Substantial physical changes to the conveyance system, as well as construction of a new diversion structure, would result in Alternative 2 having a greater level of potential construction-related noise impacts than Alternative 1. Similarly, the pump sizes in the conveyance systems would be increased to a greater extent compared to Alternative 1. Therefore, potential indirect, long-term operational noise impacts would also be greater than for Alternative 1.

Even though potential noise impacts associated with Alternative 2 would be greater than Alternative 1, potential construction- and operations-related noise impacts accompanying implementation would be less than significant. If construction-related noise levels exceed local noise standards, it would be for short, intermittent periods during construction, and in most cases would likely be located at distances from sensitive receptors sufficient to not create significant annoyance.

Alternative 3. Alternative 3 would involve construction of a new, separate, conveyance system through the region, and the construction and operation of new storage facilities. Therefore, the level of direct, short-term, construction-related, and indirect, long-term, operations-related noise impacts is potentially greater than for Alternatives 1 and 2.

Although possibly greater than both Alternatives 1 and 2, potential construction- and operations-related noise impacts would be less than significant.

Ecosystem Restoration. The installation of new fish screens at certain diversions as part of this element would potentially be accompanied by direct, short-term, construction-related noise impacts. Development of wetlands and other habitat restoration efforts would involve activities that could cause direct, short-term, construction-related noise impacts.

Water Use Efficiency. Modifications to existing filtration plants, development of new pipelines, well fields, and pump stations, and increased (or decreased) pumping are some of the activities associated with this program element that would have potential construction- and operation-related noise impacts (both adverse and beneficial) in agricultural and urban environments.

Levee System Integrity. Land conversion adjacent to streams to create buffer areas associated with enhanced levee operation and flood control could also result in decreased operations-related noise impacts from those lands that were previously in active agricultural use. Improvements to existing,

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and construction of new levee systems, as well as dredging, would involve activities that would have temporary direct, short-term, construction-related noise impacts.

Water Transfers. The Water Transfer Program will have an overall negligible effect on noise under any of the alternatives. No effects are anticipated to contribute to exceedence of temporary, long-term, or permanent noise regulation ordinances, or cause significant beneficial or adverse changes in the ambient noise conditions in the area is affected by the Water Transfer Program.

Bay Region

Coordinated Watershed Management. Potential construction activities associated with coordinated watershed management activities in the Bay Region's upper watershed areas could result in short-term noise impacts during construction. Noise associated with restoration projects could adversely affect local residents, recreation users, and sensitive wildlife species, but would likely occur only in the area of construction for short periods during construction.

Where construction activities are to be performed in sensitive wildlife areas and popular recreation areas, noise-generating operations can be scheduled to avoid breeding periods of sensitive species and peak recreation use. Potential construction- and operations-related noise impacts in the Bay Region would be less than significant.

There would be no other noise impacts expected in the Bay Region other than those associated with the Ecosystem Restoration and Water Quality programs. Impacts would be similar to those discussed in the Delta Region.

Sacramento River and San Joaquin River Regions

Storage and Conveyance. Potential noise impacts would accompany the construction and operation of new storage facilities in the Sacramento River and San Joaquin River regions.

Potential construction- and operations-related noise impacts in the Sacramento River and San Joaquin River regions would be less than significant. The reasons why these potential impacts are not expected to be significant are the same as those discussed previously for the Delta and Bay regions.

Operations-related noise impacts would also be associated with the Ecosystem Restoration and Coordinated Watershed Management programs discussed above with regard to the Delta and Bay regions.

Water Quality. Land conversion activities intended to reduce drainage-related pollution could result in decreased long-term, operations-related noise impacts. This would especially be the case for those lands that were previously under active agricultural cultivation. The cessation of cultivation, and subsequent revegetation of these lands, would reduce potential noise impacts associated with operation of farm equipment.

Improvements to existing, and construction of new, filtration and treatment facilities as part of this program element could have both temporary direct, short-term, construction-related and indirect, long-term, operations-related noise impacts.

SWP and CVP Service Areas Outside the Central Valley

There would be no noise impacts in the SWP and CVP Service Areas Outside the Central Valley.

6.4.2.5 Comparison of Program Alternatives to Existing Conditions

Future noise impacts compared to the No Action Alternative are expected to be similar when compared to existing conditions.

6.4.2.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific

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projects are approved by subsequent environmental review.

Mitigation strategies have been identified that can be employed, as required, to minimize construction- and operations-related noise. To minimize construction-related noise impacts, the following mitigation measures apply:

- Equip all construction vehicles and equipment with appropriate mufflers and air-inlet silencers;
- Use electrically powered equipment instead of internal combustion equipment where feasible;
- Locate staging and stockpile areas, and supply and construction vehicle routes as far away from sensitive receptors as possible;
- Establish and enforce construction site and haul-road speed limits;
- Restrict hours of construction to periods permitted by local ordinances;
- Restrict use of bells, whistles, alarms, and horns to safety warning purposes;
- Erect temporary noise-attenuation barriers where appropriate;
- Design equipment to conform to local noise standards; and
- Locate equipment at distances from sensitive receptors so as not to create a significant annoyance.

To minimize operations-related noise impacts, the following mitigation measures apply:

- Locate noisy equipment within suitable sound-absorbing enclosures;
- Use electrically-powered equipment where feasible, in lieu of pneumatic- or internal combustion-powered equipment; and
- Erect sound wall barriers or noise attenuation berms between noise generation sources and sensitive receptors.

Additional site-specific mitigation measures would likely be developed, as required, once locations for specific facilities are identified, to further minimize potential noise impacts.

6.4.2.7 Potentially Significant Unavoidable Impacts

None of the alternatives has potentially significant unavoidable noise impacts. All potential impacts identified at this programmatic level would be minor, temporary, or mitigable to within acceptable noise limits in the affected areas.

6.5 TRANSPORTATION

Summary

Impacts to transportation could result from activities that involve modifications to roads and bridges. Improvement or rerouting of these roads may occur during construction, which could potentially attract more traffic to or divert traffic from the route.

Under all alternatives, there would be no alterations or modifications to existing commercial shipping routes or commercial ports. Table 6.5-1 provides a summary of transportation-related impacts.

No Action Alternative. Existing trends in traffic patterns in each region are expected to continue. Growth in the Bay Region is continuing, as is the traffic demand for the existing roadway system. There would likely be continued increase in traffic volumes on the existing roadways. Growth near the Central Valley areas is expected to continue, which would further increase impacts to the already congested traffic. Growth in the SWP and CVP Service Areas is continuing, and so is the traffic demand for the existing roadway system. There would be no impacts to the existing railway system.

Storage and Conveyance. In Alternative 1, roads that are alongside or adjacent to the construction associated with water storage and conveyance facilities could be affected. Traffic would have to detour around the construction. If a road was closed and no nearby detour was available, traffic would be rerouted altogether, and there would be a greater impact. An indirect and long-term impact could occur if a road on or near a levee was closed permanently.

During construction, traffic may be diverted to temporary detours while construction of bridges or road segment is completed. If detour locations are convenient to the existing traffic demand, impacts to traffic would likely be minimal. If the detours are significant during the construction period, some impact to traffic volumes could occur as a portion of the existing traffic would use another route. There could be the potential for improvements or rerouting of these roads during construction associated with the proposed project. This could potentially attract more traffic to or divert traffic from the route, and there may be impacts associated with such activities.

In addition to the effects noted for Alternative 1, Alternatives 2 and 3 could involve the relocation of several miles of local roads, relocation of highways, and construction of new bridges.

Transportation Impacts

- **No Action** conditions are forecast to be similar to existing conditions, but traffic demands and traffic volume on existing roadways are expected to increase. No impacts are expected to existing railway systems or existing commercial shipping routes
- **Storage and Conveyance**

  Alternative 1 is expected to cause significant but mitigable impacts to roads where construction of levee and storage and conveyance improvements may cause re-routing, and potentially significant impacts where construction closes traffic routes

  Alternatives 2 and 3 could cause significant but mitigable impacts due to relocation of roads and highways and construction of new bridges for conveyance improvements
- Construction activities associated with other program elements may cause significant but mitigable impacts to roadways and traffic routes if detours or road closures occur

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Construction-related Ground Transportation Impacts	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Operations-related Ground Transportation Impacts	○	○	○	○	○	○	○	○	○	○	○	○
Shipping Routes & Ports	□	□	□	□	□	□	□	□	□	□	□	□
Bay Region												
Construction-related Ground Transportation Impacts	□	□	□	□	□	□	□	□	□	□	□	□
Operations-related Ground Transportation Impacts	○	○	○	○	○	○	○	○	○	○	○	○
Shipping Routes & Ports	□	□	□	□	□	□	□	□	□	□	□	□
Sacramento River Region												
Construction-related Ground Transportation Impacts	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Operations-related Ground Transportation Impacts	○	○	○	○	○	○	○	○	○	○	○	○
Shipping Routes & Ports	□	□	□	□	□	□	□	□	□	□	□	□
San Joaquin River Region												
Construction-related Ground Transportation Impacts	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Operations-related Ground Transportation Impacts	○	○	○	○	○	○	○	○	○	○	○	○
Shipping Routes & Ports	□	□	□	□	□	□	□	□	□	□	□	□
SWP and CVP Service Areas Outside the Central Valley												
Construction-related Ground Transportation Impacts	□	□	□	□	□	□	□	□	□	□	□	□
Operations-related Ground Transportation Impacts	○	○	○	○	○	○	○	○	○	○	○	○
Shipping Routes & Ports	□	□	□	□	□	□	□	□	□	□	□	□

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:
Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
○	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 6.5-1. Summary of Environmental Impacts Related to Transportation

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Levee System Integrity. Roads alongside or adjacent to the levees could be affected during the construction period; however, if a convenient detour were provided, impacts to traffic would be minimal. If a road were closed and no nearby detour were available, traffic would be rerouted altogether, and there would be a greater impact. An indirect and long-term impact could occur if a road on or near a levee was closed permanently. In this case, traffic that regularly used the levee road would affect the traffic on the alternate route by adding more traffic to it.

Coordinated Watershed Management. Potential upper watershed management activities could result in short-term localized impacts to traffic routes during construction activities. These impacts, however, would be temporary and less than significant if detour locations are convenient to the existing traffic demand.

6.5.1 Affected Environment/ Existing Conditions

6.5.1.1 All Regions

Historic Conditions. By 1920, the highway system traversed the Central and Sacramento valleys and was established along Highway 101 to just north of San Francisco. By the mid 1920s, highways were built in the east-west direction, intersecting with the current State Route (SR) 99. By the late 1940s, the highway system had expanded considerably, with many of the complex, interconnecting highways and freeways in Los Angeles and the Bay Area that exist today. The state's highways are arranged in roughly parallel routes, extending the length of the state and crossed by five major transcontinental east-west routes. New roadway networks have facilitated growth and urbanization along these corridors, and within parts of the upper watershed areas of each region.

The railroad system was the first major transportation network in the state, starting in the late 1800s. The routes at that time served the Bay Area, Delta, and Sierra Nevada foothills, roughly following the path of Interstate 80 (I-80). Within approximately a decade, the railroad had expanded north along the Central Valley, to the eastern Los Angeles area and southeast to Arizona. By the end of World War I, the railroad system had expanded to the same areas it covers today.

The leading ports of California are the Los Angeles-Long Beach installation on San Pedro Bay and the complex of harbors in San Francisco Bay. The growth of Los Angeles led to the creation of its artificial harbors, whereas the presence of the natural harbors led to the growth of San Francisco. Crude oil and petroleum products dominated the port traffic of California in the 1970s. Oakland and San Francisco handled extremely varied cargoes, Sacramento exported grain and wood chips, and Stockton handled mainly farm products.

6.5.1.2 Delta Region

Existing Conditions

Freeways and Major Highways. The major access-controlled freeways that run north-south through the Delta Region are I-5 and Highway 99. I-80, another access-controlled freeway, runs east-west through Sacramento, and U.S. 50 also runs eastward from Sacramento. Other minor, full-access highways run from Sacramento and Stockton to other small cities and towns in the Delta Region.

Railways. The major railways in California are Southern Pacific; Union Pacific; Western Pacific; and Atchison, Topeka and Santa Fe. Southern Pacific operates the most comprehensive system, with lines that span the state from north to south, mainly along the Central Valley and coast south of San Francisco.

The Delta Region is serviced by the Southern Pacific; Western Pacific; and Atchison, Topeka and Santa Fe lines. These lines run from Sacramento to Stockton, and the Southern Pacific line runs from these major cities to other smaller cities in the Delta Region.

Commercial Shipping Routes. Commercial shipping routes originate at the Golden Gate and traverse the San Francisco Bay, San Pablo Bay, Suisun Bay, and Delta waterways, where the destinations are commercial and industrial ports. In the Delta Region, commercial and industrial ports are situated along rivers in the Delta. Two ports are located along the Sacramento River between Sacramento and Walnut Grove. Another commercial port is located at Isleton, also along the Sacramento River. An additional commercial port is located near Terminous, on the Little Potato Slough, and two ports are located adjacent to one another, on the Old River and Middle River, northeast of Brentwood. Finally, a commercial port is located in Stockton, the Port of Stockton, on the San Joaquin River.

6.5.1.3 Bay Region

Existing Conditions

Freeways and Major Highways. The Bay Region is served by numerous access-controlled interstate and U.S. freeways. On the west side of the San Francisco Bay, I-280 and U.S. 101 run north-south. U.S. 101 continues north of San Francisco into Marin County. I-880 and 680 run north-south on the east side of the Bay; and I-80 starts in San Francisco, crosses the Bay Bridge, and runs northeast toward Sacramento. State Routes (SR) 92 and 84, both full-access highways in certain parts of the region, become access-controlled freeways that run east-west and cross the Bay. I-580 starts in San Leandro on the east side of the Bay and runs eastward toward Livermore.

Railways. Southern Pacific is the predominant rail line in the Bay Region, with minor spurs of the Western Pacific and Atchison, Topeka and Santa Fe lines.

Commercial Shipping Routes. Commercial shipping routes originate at the Golden Gate and traverse the San Francisco Bay, San Pablo Bay, and Suisun Bay, where the destinations are commercial and industrial ports. Numerous commercial ports are located along the northeastern and eastern bayshore of San Francisco, and are also located at Treasure Island and Yerba Buena Island. In addition, shipping routes go southward into San Francisco Bay, where commercial ports are located along the peninsula in South San Francisco and San Carlos. On the east side of San Francisco Bay, commercial ports are located in Alameda and Oakland. Shipping routes that head north into the San Pablo Bay have ports at San Rafael and along the bayshore of Richmond, San Pablo, Hercules, Rodeo, Vallejo, and Mare Island. The shipping route continues through the Carquinez Strait and into Suisun Bay, with ports at Crockett, Martinez, Port Chicago, Pittsburg, and Antioch.

6.5.1.4 Sacramento River Region

Existing Conditions

Freeways and Major Highways. SR 45, a full-access highway, follows the Sacramento River north from Sacramento. I-5, an access-controlled freeway, parallels SR 45 and the Sacramento River to the west and passes through Redding. Highway 99 and SR 70, both full-access freeways on a portion of the route and limited-access expressways on other portions of the route, also run north-south from Sacramento northward toward Chico.

The upper watershed areas west and east of the Sacramento Valley also contain a network of state freeways. Major routes on the west side of the valley include SR 29 which runs north-south through Napa and Lake counties, and several east-west freeways including SR 20 in Lake County, SR 162 in Glenn County, and SR 36 in Tehama and Trinity counties. SR 299, also an east-west route, traverses Trinity, Shasta, Lassen, and Modoc counties in the northern watershed areas. Major east-west routes on the east side of the valley include SRs 70, 49 and 88, US Highway 50, and I-80.

Railways. Southern Pacific is the main line serving the Sacramento River Region, roughly following the I-5 route. Western Pacific also has lines in this area, traveling farther east through Marysville and Oroville. Western Pacific also provides rail service in the upper watershed areas east of the

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Sacramento Valley through Plumas and Lassen Counties.

Commercial Shipping Routes. A deep-water ship channel runs from Cache Slough in the Delta Region to Sacramento, where the Port of Sacramento is located.

6.5.1.5 San Joaquin River Region

Existing Conditions

Freeways and Major Highways. I-5 and Highway 99 are the two major access-controlled freeways that run north-south from Stockton through the Central Valley to Bakersfield. SR 41 runs in a north-south direction south of Fresno. Other minor full-access highways connect smaller cities and towns in the Central Valley with the two interstate freeways and SR 152, a limited-access expressway that runs east-west and connects Los Banos and Chowchilla.

There are several east-west routes that traverse areas in the upper watershed on the east side of the San Joaquin Valley including SR 180 that terminates in Yosemite National Park, SR 168 (Fresno County), and SRs 190 and 198 (Tulare County).

Railways. The San Joaquin River Region is served mainly by the Southern Pacific and Atchison, Topeka and Santa Fe lines, which roughly follow the route of I-5 through the San Joaquin Valley.

Commercial Shipping Routes. No commercial ports or shipping routes are located in this region.

6.5.1.6 SWP and CVP Service Areas Outside the Central Valley

Existing Conditions.

Freeways and Major Highways. This service area is located mainly in the western portion of southern California, below the Central Valley boundary, and includes San Luis Obispo County. The area is served by numerous full-access highways and limited-access expressways. U.S. 101 travels north and south near the coast from San Luis Obispo south to Los Angeles, and I-5 travels north and south through the Central Valley to Los Angeles and on to San Diego. The Los Angeles area is served by a very extensive and intricate freeway system. I-10 runs east from Los Angeles toward Arizona while I-8 is the east-west route from San Diego to Arizona.

Railways. The Southern Pacific line runs north and south near the coast, from the Bay Area through Los Angeles then southeast toward the Arizona/Mexico border.

Commercial Shipping Routes. Harbors along the coast that serve commercial shipping are located at San Luis Obispo, Santa Barbara, Carpinteria, Port Hueneme, El Segundo, Los Angeles, Long Beach, and San Diego.

6.5.2 Environmental Consequences: Transportation

6.5.2.1 Assessment Methods

Features of each of the program actions were reviewed to evaluate whether or not there would be any modifications or relocations of roads, rail lines, or shipping routes. If any feature involved a change to existing conditions, it was considered to be an impact.

6.5.2.2 Significance Criteria

The significance of impacts was based primarily on the extent to which activities would change the way existing traffic behaves or that would change the volume of traffic on an existing route. Significance of impacts would also relate to actions that could alter existing railroad tracks or alter commercial shipping routes or ports. As such, significance criteria are summarized as follows:

- Changes to traffic flows or patterns,
- Attraction to or diversion from an existing route of substantial traffic volumes,

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- Changes to a railway route by a major relocation of railroad tracks,
- Changes to commercial shipping routes or ports, and
- Navigation impacts are considered significant if implementation of a proposed action would create a substantial hazard to navigation or substantially affect the ease of navigation.

6.5.2.3 Comparison of No Action Alternative to Existing Conditions

Existing trends in traffic patterns in each region are expected to continue. The Delta area has experienced considerable growth over the last several years, as people seeking affordable housing move to the area. Many of these people work in the Bay Area, and therefore traffic on the major freeways and highways has increased. This has direct impacts to traffic in the region.

The Bay Region is one of the most populated regions in the study area, and numerous freeways and highways serve the Bay Region's traffic demands. Growth in the area is continuing, as is the traffic demand for the existing roadway system. There would likely be continued increase in traffic volumes on the existing roadways which would result in an impact to traffic.

Traffic in the Sacramento metropolitan area is heavily congested, and the area is expected to continue to experience growth, resulting in continued impacts to traffic. North of the Sacramento urbanized area, however, the major freeways and highways are not heavily congested, and it is unlikely that there would be impacts to traffic in the future, as this area is not one of heavy growth.

Areas of the Central Valley that are near urban centers experience fairly heavy traffic congestion. Growth near these urban centers is expected to continue, which would further increase impacts to the already congested traffic.

SWP and CVP Service Areas Outside the Central Valley include San Luis Obispo, Santa Barbara, Ventura, eastern Kern, Los Angeles, Orange, San Bernardino, Riverside, and San Diego counties, which are some of the most populated regions in the study area. Numerous freeways and highways serve these counties. Growth in the area is continuing, and so is the traffic demand for the existing roadway system. There would likely be continued increasing traffic volumes on the existing roadways, even though use of public transit is encouraged, and this would result in an impact to traffic.

Any major changes to the existing railway system and existing commercial shipping routes would be unlikely.

6.5.2.4 Comparison of Program Alternatives to No Action Alternative

The impacts to transportation resulting from the storage and conveyance program element will vary by alternative, as discussed below. Impacts to transportation resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a regions, the program element is not discussed.

Delta Region

Storage and Conveyance. Construction of storage and conveyance facilities could involve additional construction of new roadway and railroad bridges, and relocation of some local roads. During construction, traffic may be diverted to temporary detours while construction of bridge(s) or road segments is completed. If detour locations are convenient to the existing traffic demand, impacts to traffic would likely be minimal. If the detours are significant during the construction period, some impact to traffic volumes could occur as a portion of the existing traffic would use another route. Construction-related ground transportation

impacts are expected to be significant and mitigable.

Potential indirect and operational impacts to transportation could occur under all alternatives for activities that would involve modifications to roads and bridges. There could be the potential for improvements to (for example, widening) or rerouting of these roads during construction associated with the proposed project. This could potentially attract more traffic to or divert traffic from the route. Operations-related ground transportation impacts are expected to be less than significant.

If a convenient detour was provided, impacts to traffic would be minimal. However, if a road was closed and no nearby detour was available, traffic would be rerouted altogether, and there would be a greater impact. This could be a significant adverse impact to the traffic that regularly uses such a road.

An indirect and long-term impact could occur if a road on or near a levee was closed permanently. In this event, traffic that regularly used the levee road would find another route to use. This in turn would affect the traffic on the alternate route by adding to the traffic volume. The magnitude of such an impact depends on how much traffic would be diverted onto a new route and how congested that new route would be to begin with. This potentially adverse impact could occur for all alternatives.

Additional activities under Alternatives 2 and 3 may involve construction of a bridge for the Atchison Topeka Railroad. If construction of the bridge takes place on the current rail line, it could be necessary to divert the train traffic to a temporary detour line. This could potentially alter the route or schedule of these trains. Potential impacts to railway traffic during construction of the Atchison Topeka Railroad bridge could be mitigated by allowing trains to use the existing track while the bridge is being built.

Operational impacts caused by the possible road relocations and new bridges could involve the long-term rerouting of traffic that would use the new roads and bridges. Localized impacts could occur if the use of the new roads and bridges would involve travel though congested areas.

Construction of an in-Delta reservoir or conveyance structures in Alternative 3 could involve the relocation of several miles of local roads, relocation of highways, and construction of new bridges. Examples of some roads that may need to be rerouted or constructed include Highway 160, South River Road, and an elevated embankment roadway across Bouldin Island. It might be necessary for several bridges to be constructed over or around some of the conveyance facilities. Examples of some new bridges would include the Highway 12 crossing of the Lower Mokelumne River, Thornton-Walnut Grove Road, Lambert Road, Twin Cities Road, Hood-Franklin Road, Barber Road, Woodbridge Road, and Eightmile Road. Another example could be a new bridge for Highway 4 over Old River. These activities would cause an adverse impact to traffic that would have to detour during construction/relocation. The magnitude of such an impact would depend on the location of detours and the length of time the road would be under construction.

Alternatives would not alter or modify and existing commercial shipping routes or commercial ports.

Levee System Integrity Program. Roads that are alongside or adjacent to the levees could be affected by levee construction work. In such a case, traffic would have to detour around the construction.

Bay Region. No direct or construction-related impacts to transportation facilities would occur with any of the alternatives, as there would be no modifications to any roads, railways or commercial shipping routes.

Operational impacts are expected to be less than significant. Changes to water availability that could occur with the proposed project may lead to indirect impacts to growth in these areas, thus affecting transportation facilities.

Sacramento River and San Joaquin River Regions

Storage and Conveyance. Reservoir projects would generate additional vehicular traffic on roadways serving project sites during the multi-year construction period. Construction-related traffic would include equipment and supply deliveries, concrete trucks, service vehicles, and construction worker transportation. Increased construction traffic would cause some delays but would probably not preclude the use of county roads. Delays and disruptions would be temporary but would be considered a significant and mitigable impact.

During reservoir and facility construction, traffic might be diverted as some roads may require improvement for constructing the proposed project or require relocation as part of the proposed project. Detours also may be necessary when facilities intersect with roadways. Impacts could be minimal if detour locations are convenient to the existing traffic route; however, traffic travel time could increase and cause some delay. If detours significantly affect traffic flows, a portion of the existing traffic could choose another route altogether, thereby further affecting traffic volumes. This is a potentially significant impact.

Operations-related ground transportation impacts are expected to be less than significant.

Coordinated Watershed Management Program. Traffic volumes in the upper watershed areas of the Sacramento and San Joaquin River regions, away from the metropolitan areas, are expected to grow along with regional traffic and population growth. Potential road improvements and possible deconstruction of roads in upper watershed areas could result in short-term construction impacts. Possible improvements may include road widening, regrading, or paving to minimize sediment erosion. Traffic may be diverted to temporary detours while construction is completed. Impacts to traffic would likely be minimal and not significant if detour locations are convenient to the existing traffic demand. If alternative routes are not available, the affected route could be closed to one traffic lane while construction is ongoing. Temporary traffic detours during construction of road improvements would not be significant. No impacts are expected to railways in these areas.

SWP and CVP Service Areas Outside the Central Valley

No direct or construction-related impacts to transportation facilities would occur with any of the alternatives, as there would be no modifications to any roads, railways, or commercial shipping routes.

Operations-related ground transportation impacts are expected to be less than significant.

Changes to water availability that could occur with the proposed project may lead to indirect impacts to growth in these areas, thus affecting transportation facilities,

6.5.2.5 Comparison of Program Elements to Existing Conditions

Comparison of Program Alternatives to existing conditions indicates that:

- All significant adverse impacts identified when comparing to the No Action Alternative are still significant when comparing to existing conditions.
- Adverse transportation impacts resulting from the CALFED Alternatives combined with the expected future increase in traffic volume could result in greater impacts when compared to existing conditions.

6.5.2.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

In the Delta, Sacramento River, and San Joaquin River regions, potentially direct and

construction-related impacts to traffic from relocation and modifications to roads and bridges could be mitigated by providing a convenient and parallel detour to those routes while construction is taking place. This mitigation could cause adverse, secondary impacts from the diversion of traffic onto parallel or alternate routes. It is also conceivable that temporary or permanent diversion routes would be constructed for this purpose, which could also have adverse impacts. Potential impacts to railway traffic during construction of any railroad bridges could be mitigated by allowing trains to use existing track while bridges are being built.

Examples of mitigation measures for indirect and operational transportation impacts include expansion of public transportation facilities or freeways and highways, scheduling railway traffic to handle increases in freight shipment efficiently, and construction of new or enhancement of existing commercial shipping ports.

If changes in growth patterns in the Bay Region or SWP and CVP Service Areas Outside the Central Valley caused adverse impacts to transportation, such as increased congestion, changes to railway operation and scheduling, or changes to commercial shipping, then mitigation could be a consideration. Examples of mitigation measures for indirect transportation impacts include expansion of public transportation facilities or freeways and highways, scheduling railway traffic to handle increases in freight shipment efficiently, and construction of new or enhancement of existing commercial shipping ports.

6.5.2.7 Potentially Significant Unavoidable Impacts

No potentially significant unavoidable impacts were identified.

6.6 AIR QUALITY

Summary

Potential air quality impacts in the study area associated with the No Action Alternative are expected to be less than significant. Potentially significant direct, short-term air quality impacts would be associated with those alternatives that involve development of storage facilities in the Sacramento River, San Joaquin River, and Delta regions (Configurations 1C; 2B and 2E; and 3B, 3E, 3H, and 3I). Potential indirect, long-term operations-related impacts associated with these alternatives are expected to be less than significant. Table 6.6-1 provides a summary of environmental impacts related to air quality.

Air Quality Impacts

- **No Action** conditions are forecast to be similar to existing conditions.
- **Storage and Conveyance**

  Alternatives 1 and 2 are expected to have significant but mitigable short-term adverse air quality effects from construction of storage facilities in both the Sacramento River and San Joaquin River Regions.

  Alternative 3 is expected to have significant adverse air effects in the Delta Region, the Sacramento River Region, and the San Joaquin River Region from construction of storage facilities.

No Action Alternative. Under the No Action Alternative there would be no construction and operation of new facilities or physical improvements to meet the Delta-Bay Program objectives. Water supply, storage and conveyance, levee systems, and the activities associated with the array of beneficial uses of water within the study area would continue as at present. Therefore, potential air quality impacts from the No Action Alternative are considered to be a continuation of existing conditions, and less than significant.

Storage and Conveyance. The construction- and operations-related impacts associated with Configurations 1A and 1B; 2A and 2D; and 3A are expected to be less than significant. Also, potential direct, short-term, construction-related impacts associated with minor channel improvements in portions of the Bay-Delta area, and potential indirect, long-term operational air quality impacts resulting from increasing pump sizes in water conveyance systems would be less than significant. However, potentially significant direct, short-term, construction-related air quality impacts would be associated with Configurations 1C; 2B and 2E; and 3B, 3E, 3H, and 3I, which involve development of storage facilities in the Sacramento and San Joaquin River regions. These storage-related air quality impacts would also take place in the Delta in Configurations 3B, 3E, and 3I. In addition, some adverse impacts to air quality could occur if thermal or fossil fuel is substituted for hydropower production as a result of CALFED alternatives. The indirect, long-term, operations-related impacts associated with this alternative are expected to be less than significant.

Ecosystem Restoration. The installation of new fish screens at certain diversions would potentially be accompanied by direct, short-term, construction-related air quality impacts. River channel deepening and subsidence reversal activities, such as those planned for the San Joaquin River Region, would also be accompanied by such impacts. Development of wetlands would involve activities that could cause direct, short-term, construction-related air quality impacts.

Water Quality. Land conversion activities intended to reduce potential erosion and drainage-related pollution could result in decreased long-term, operations-related air emissions for those lands that were previously under active agricultural cultivation. Improvements to existing, and construction of new, filtration and treatment facilities could have both temporary direct, short-

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Construction Air Quality Impacts	○	○	○	○	○	○	○	○	◗	◗	○	◗
Operations Air Quality Impacts	○	○	○	○	○	○	○	○	○	○	○	○
Bay Region												
Construction Air Quality Impacts	○	○	○	○	○	○	○	○	○	○	○	○
Operations Air Quality Impacts	○	○	○	○	○	○	○	○	○	○	○	○
Sacramento River Region												
Construction Air Quality Impacts	○	○	◗	○	◗	○	◗	○	◗	◗	◗	◗
Operations Air Quality Impacts	○	○	○	○	○	○	○	○	○	○	○	○
San Joaquin River Region												
Construction Air Quality Impacts	○	○	○	○	◗	○	◗	○	◗	◗	◗	◗
Operations Air Quality Impacts	○	○	○	○	○	○	○	○	○	○	○	○
SWP and CVP Service Areas Outside the Central Valley												
Construction Air Quality Impacts	○	○	○	○	○	○	○	○	○	○	○	○
Operations Air Quality Impacts	○	○	○	○	○	○	○	○	○	○	○	○

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:
Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
○	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 6.6-1. Summary of Environmental Impacts Related to Air Quality

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term, construction-related, and indirect, long-term operations-related air quality impacts.

Water Use Efficiency. Modifications to existing filtration plants, development of new pipelines, well fields, and pump stations, and increased (or decreased) pumping are some of the activities associated with this program element that would have potential construction- and operations-related air quality impacts (both adverse and beneficial) in agricultural and urban environments.

Additionally, increased reliance in the agricultural sector on pressurized irrigation systems would require a greater reliance on fossil fuels or other energy sources. This increase could have an adverse impact to air quality either locally (with fossil fuels) or regionally if energy is provided from out-of-region facilities. Changes in cultivation practices to accompany increased water use efficiency can have adverse or beneficial impact depending on what changes are made.

Levee System Integrity. Land conversion adjacent to streams to create buffer areas associated with enhanced levee operation and flood control could also result in decreased operations-related air emissions on those lands that were previously in active agricultural use. Improvements to existing, and construction of new levee systems, as well as dredging, would involve activities that would have temporary direct, short-term, construction-related air quality impacts.

Coordinated Watershed Management. Construction activities related to watershed restoration and habitat improvement activities can cause short-term air quality impacts.

6.6.1 Affected Environment/ Existing Conditions

This section presents a characterization of the existing air quality environment in the study area. The regulation of air quality is an essential ingredient of regional and local planning and the governing of interactions within communities to protect the public health and welfare and to ensure quality of life.

The Clean Air Act (CAA) requires the EPA to establish and maintain standards for maximum concentrations of common air pollutants, and to apply these standards through cooperation with state and local jurisdictions in the management of air quality in the United States (Table 6.6.1-1). To establish standards, the EPA has selected certain common air pollutants as "criteria pollutants," or "pollutants of concern," that are typically associated with the array of human activities in communities. These pollutants of concern include carbon monoxide (CO), ozone (O_3), oxides of nitrogen (NO_x), particulate matter smaller than 10 microns in diameter (PM_{10}), and sulfur dioxide (SO_2). The EPA has established standards for each of these criteria pollutants as a means of managing air quality across the country. The EPA adopted new ozone and particulate matter standards in July 1997, but implementation of the new standards will not occur for several years. Requirements related to the new ozone standard (an 8-hour average of 0.08 ppm) will not become effective until the current ozone standard (a 1-hour average of 0.12 ppm) is met. New $PM_{2.5}$ standards (15 micrograms per cubic meter as an annual average and 65 micrograms per cubic meter as a 24-hour average) will supplement, but not replace, the current PM_{10} standards. Implementation of the new $PM_{2.5}$ standards will not occur prior to 2005. Most states have also adopted standards for these pollutants of concern, and in some cases the state standards are more stringent than EPA standards, to more precisely reflect local air quality conditions and planning objectives.

The EPA has concluded that monitoring the level of criteria pollutants can help determine and manage the relative air quality in a particular area. If the levels of any of the criteria pollutants in a particular geographic area are found to exceed the state or federal standards established for those pollutants, the area is designated as "nonattainment" for those pollutants of concern.

			Standards, as parts per million		Standards, as micrograms per cubic meter		Violation Criteria	
Pollutant	**Symbol**	**Averaging Time**	**California**	**Federal**	**California**	**Federal**	**California**	**Federal**
Ozone	O_3	1 Hour	0.09	0.12	180	235	If exceeded	If exceeded on more than 3 days in 3 Years
		8 hours	---	0.08	---	160	---	If exceeded by 4th Highest value during a 3-year period.
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
		8 Hours (Lake Tahoe only)	6	---	7,000	---	If exceeded	
Inhalable Particulate Matter	PM_{10}	Annual Geometric Mean	---	---	30	---	If exceeded	
		Annual Arithmetic Mean	---	---	---	50		If exceeded
		24 Hours	---	---	50	150	If exceeded	If exceeded on more than 1 day per year
Fine Particulate Matter	$PM_{2.5}$	Annual Arithmetic Mean	---	---	---	15	---	If exceeded
		24 Hours	---	---	---	65	---	If exceeded by 98th percentile over 3 years
Nitrogen Dioxide	NO_2	Annual Average	---	0.053	---	100		If exceeded
		1 Hour	0.25	---	470	---	If exceeded	
Sulfur Dioxide	SO_2	Annual Average	---	0.03	---	80		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	---	655	---	If exceeded	
Lead Particles	Pb	Calendar Quarter	---	---	---	1.5		If exceeded
		30 Days	---	---	1.5	---	If equaled or exceeded	
Sulfate Particles	SO_4	24 Hours	---	---	25	---	If equaled or exceeded	
Hydrogen Sulfide	H_2S	1 Hour	0.03	---	42	---	If equaled or exceeded	
Vinyl Chloride	C_2H_3Cl	24 Hours	0.010	---	26	---	If equaled or exceeded	

NOTES:
All standards are based on measurements corrected to 25 degrees C and 1 atmosphere pressure
Decimal places shown for standards reflect the rounding precision used for evaluating compliance
National standards shown are the primary (health effects) standards
Regulations implementing the national 8-hour ozone standard will not become effective until the 1-hour standard has been achieved.
Regulations implementing the national $PM_{2.5}$ standards will not be developed until 2005.
SOURCE: California Air Resources Board 1997b; 40 CFR Part 50

Table 6.6.1-1. Ambient Air Quality Standards

Likewise, if the standards for pollutants are met in a particular area, it is designated as "attainment" for those pollutants. In areas where standards may not have been established for certain criteria pollutants, these areas are considered "unclassified" for the pollutants.

Air pollution discussions require an understanding of technical terms. At a general level it is important to understand the distinction between air pollutant emissions and ambient air quality. Other important terms include primary pollutants, secondary pollutants, and pollutant precursors.

Emissions and Ambient Air Quality. The term "pollutant emissions" refers to the amount (usually stated as a weight) of one or more specific compounds introduced into the atmosphere by a source or group of sources. In practice, most pollutant emissions data are presented as "emission rates": the amount of pollutants emitted during a specified increment of time or during a specified increment of emission source activity. The term "ambient air quality" refers to the atmospheric concentration of a specific compound (amount of pollutants in a specified volume of air) actually experienced at a particular geographic location that may be some distance from the source of the relevant pollutant emissions.

Primary Pollutants, Secondary Pollutants, and Pollutant Precursors. Air pollutants are often characterized as being "primary" or "secondary" pollutants. Primary pollutants are those emitted directly into the atmosphere, such as carbon monoxide (CO), sulfur dioxide (SO_2), lead particulates, and hydrogen sulfide. Secondary pollutants are those formed through chemical reactions in the atmosphere, such as ozone (O_3), nitrogen dioxide (NO_2), and sulfate particles.

The primary sources of CO emissions in the study area are motor vehicles. Motor vehicles are also the primary sources of O_3, as well as NO_x. The secondary CO sources in the study area include waste burning and disposal, residential fuel combustion, operation of utility equipment, and industrial fuel combustion. The secondary sources of NO_x include industrial fuel combustion, solvent evaporation, petroleum production and marketing, cleaning and surface coatings, and waste burning and disposal.

Ozone Precursor Emissions. Ozone, a major component of photochemical smog, is the secondary pollutant of greatest concern in most portions of California. The pollutant emissions generally categorized as ozone precursors fall into two broad groups of chemicals: nitrogen oxides and organic compounds. Many different terms are used to refer to these groups of ozone precursors.

Particulate Matter Precursors. Inhalable particulate matter (PM_{10}) can be generated as a primary pollutant by abrasion or erosion processes. PM_{10} can also form as a secondary pollutant through chemical reactions or by condensation of gaseous pollutants into fine aerosols. Major gaseous precursors of PM_{10} include reactive organic gases, sulfur oxides, and nitrogen oxides. Additional precursors of PM_{10} can include ammonia, hydrogen sulfide, sulfuric acid, and nitric acid.

The primary source of PM_{10} emissions in the study area is roadway dust. The secondary sources of PM_{10} are fugitive windblown dust, agricultural operations, construction and demolition, mobile sources, and waste burning and disposal.

For many states, including California, management of air quality includes dividing the state into distinct areas, or "air basins," based on meteorological and geographic conditions and, where possible, on jurisdictional boundaries. In California, 15 air basins have been delineated. The regulation of air quality within each air basin in California is carried out by individual air quality management agencies or pollution control districts. Overall management of air quality in California is coordinated by the Air Resources Board (ARB), a department of the California Environmental Protection Agency (Cal-EPA).

The CAA also requires that nonattainment areas for criteria pollutants must prepare and put into action State Implementation Plans (SIP) to achieve the standards. A separate SIP must be prepared for each nonattainment pollutant. In

California, the individual air quality management agencies throughout the state are responsible for preparing and submitting air quality attainment plans to the ARB for criteria pollutants for which their respective air basins, or portions of air basins, are not in attainment.

In the remainder of this section, the historical perspective and existing air quality conditions with respect to criteria pollutants in the Bay-Delta regions are briefly discussed. SO_2 is not discussed in this report because it is emitted primarily by industrial sources and is not considered to be a pollutant of concern in the study area, which is in attainment with state and federal standards for SO_2.

6.6.1.1 Delta Region

Existing Conditions. The Delta region includes portions of the Sacramento Valley, San Joaquin Valley, San Francisco Bay, and Sacramento Valley Urban Air Basins. During summer, the Pacific high-pressure system can isolate the Delta Region from storms, and create inversion layers in the lower elevations that prevent the vertical dispersion of air. Topographic barriers in the Delta Region also can act to prevent lateral dispersion. As a result, air pollutants in this region can become concentrated during summer months, lowering air quality. During winter, when the Pacific high-pressure system moves south, stormy, rainy weather intermittently dominates the Delta Region. Prevailing winter winds from the southeast disperse pollutants, often resulting in clear, sunny weather over most of the region.

The Sacramento Valley Air Basin is discussed under the Sacramento River Region.

The San Joaquin Valley Air Basin is discussed under the San Joaquin River Region.

The San Francisco Bay Area Air Basin is discussed in the next section.

6.6.1.2 Bay Region

Existing Conditions. The Bay Region falls within the San Francisco Bay Area Air Basin. This region has similar weather and pollutant dispersion patterns as the Delta Region, with the exception that the Bay Region gets more rainfall during winter. In summer, the Pacific high-pressure system typically remains near the coast, diverting storms to the north. Subsidence of warm air can create frequent summer atmospheric temperature inversions that may be several hundred to several thousand feet deep, often trapping pollutants near the ground and degrading air quality.

Most of the rainfall in this region falls during the winter months (November to April), after the Pacific high pressure system has moved south. Winds during winter predominantly flow from the south and southeast, generally dispersing air pollutants and increasing air quality.

The San Francisco Bay Area Air Basin is currently a federally designated nonattainment area for CO, but a SIP has been prepared and is under EPA review. The basin is in attainment of federal standards for O_3, NO_X, and PM_{10}, but does not attain state standards for O_3 or PM_{10}.

6.6.1.3 Sacramento River Region

Existing Conditions. The Sacramento River Region includes portions of the Sacramento Valley, Northeast Plateau, Lake County, and Mountain Counties air basins. Upper watersheds and areas of the region lying within the Northeast Plateau, Lake County, and Mountain Counties air basins are characterized by warm days and cool nights in summer, and cool days and cold nights in winter. The Northeast Plateau Air Basin area east of the mountains has relatively little precipitation because of the rainshadow effect of the mountains, whereas the Mountain Counties and Lake County Basin areas to the west receive considerably more precipitation, including appreciable snowfall in the higher elevations of the upper watersheds. Winds moving through both of these air basins from a variety of

directions throughout the year tend to disperse air pollutants, resulting in relatively good air quality.

The Northeast Plateau Air Basin attains (or is unclassified for) state and federal standards for O_3, CO, and NO_x. For PM_{10}, the area attains (or is unclassified for) federal standards but is in nonattainment in Siskiyou and Modoc counties for the state standard, which is more stringent than the federal standard. Upper watershed areas of the Sacramento River Region are located in Siskiyou, Modoc, and Lassen counties within the Northeast Plateau Air Basin. Upper watershed areas in El Dorado, Placer, Nevada, Sierra, Plumas, and Butte counties are within the Mountain Counties Air Basin. The Lake County and Mountain County air basins attain (or are unclassified for) both federal and state standards for all pollutants. Air quality problems in the Mountain counties Air Basin include ozone and particulate matter. State ozone standards are violated in all but the Plumas and Sierra Counties portion of the air basin. Federal ozone standards are violated in the El Dorado and Placer Counties portion of the air basin. State PM_{10} standards are violated in most portions of the air basin. Federal PM_{10} standards are not violated in the Mountian Counties Air Basin.

With respect to the portion of the region lying within the Sacramento Valley Air Basin, during summer, the Pacific high-pressure system can create inversion layers in the lower elevations that prevent the vertical dispersion of air. As a result, air pollutants in this portion of the region can become concentrated during summer months, lowering air quality. During winter, when the Pacific high-pressure system moves south, stormy, rainy weather intermittently dominates the region. Prevailing winter winds from the southeast disperse pollutants, often resulting in clear, sunny weather and better air quality over most of this portion of the region.

The Sacramento Valley Air Basin is currently a federally and state designated attainment area for NO_X. The urbanized area in Sacramento County is a federally designated nonattainment area for PM_{10}, but the remainder of the Sacramento Valley Air Basin attains the federal PM_{10} standard. The entire basin is nonattainment (federal and state standards) for CO and O_3.

6.6.1.4 San Joaquin River Region

Existing Conditions. The San Joaquin River Region contains portions of the San Joaquin Valley, Mountain Counties, and San Francisco Bay air basins. With respect to that portion of the region that lies within the San Joaquin Valley Air Basin, in summer, when the Pacific high-pressure system moves north, no major storms or precipitation occur, creating daily inversion layers characterized by a layer of cool air over warm air. Surrounding mountains and upper watersheds of the region are at an elevation higher than that of summer inversion layers. As a result, the region is highly susceptible to pollutant accumulation over time. In winter, the influence of the Pacific high-pressure system moves south and gives rise to alternate periods of unsettled stormy weather and stable, rainless conditions with winds from the southwest. Most of the San Joaquin Valley is in the rainshadow of the Coast Range and depends on cold, unstable northwesterly flow for its precipitation, which produces showers following frontal passages.

The San Joaquin Valley Air Basin is currently a federally designated nonattainment area for CO, O_3, and PM_{10}, but the state has completed SIPs for each of these criteria pollutants, currently under review by EPA. The basin attains both state and federal NO_X standards.

The portion of the San Joaquin River Region that lies within the Mountain Counties Air Basin (including Mariposa, Tuolumne, Calaveras, and Amador counties) is characterized by warm days and cool nights in summer, and cool days and cold nights in winter. The area receives considerable precipitation, including appreciable snowfall in the higher elevations of the upper watersheds. Winds moving through this air basin from a variety of directions throughout the year tend to disperse air pollutants, resulting in relatively good air quality. The Mountain Counties Air Basin attains (or is unclassified for) both federal and state standards for all pollutants.

With respect to the small portion of the San Joaquin River Region that lies within the San Francisco Bay Air Basin, in summer, the Pacific high-pressure system typically remains near the coast, diverting storms to the north. Subsidence of warm air can create frequent summer atmospheric temperature inversions that may trap pollutants near the ground and degrade air quality. Most of the rainfall in this portion of the region falls during the winter months (November to April), after the Pacific high pressure system has moved south. Winds during winter predominantly flow from the south and southeast, generally dispersing air pollutants and increasing air quality.

6.6.1.5 SWP and CVP Service Areas Outside the Central Valley

Existing Conditions. This region includes portions of the South Central Coast, South Coast and San Diego, and Mohave Desert and Salton Sea air basins.

With respect to the portion of the region lying within the South Central Coast, and the South Coast and San Diego air basins, during summer the Pacific high-pressure system often stays near the coast, and can create inversion layers that prevent the vertical dispersion of air. As a result, air pollutants in this portion of the region can become concentrated during summer months, lowering air quality. During winter, when the Pacific high-pressure system moves south, stormy, rainy weather intermittently dominates the region. Prevailing winter winds from the southeast disperse pollutants, resulting in better air quality conditions over most of this portion of the region.

The South Central Coast Air Basin attains (or is unclassified for) state and federal standards for CO and NO_x but does not attain either the federal or state standard for O_3. For PM_{10}, the South Central Coast Air Basin attains (or is unclassified for) federal standards but is in nonattainment for the state standard. The South Coast and San Diego Air Basin attains state and federal standards for CO and NO_x. Because this latter basin does not attain either the federal or state standard for O_3, it has had to submit an SIP to EPA for approval. For PM_{10}, this latter basin does not attain federal or state standards.

The portion of the region lying within the Mojave Desert and Salton Sea Air Basin is characterized by warm days and cool nights in summer, and cool days and cold nights in winter. Most of the sparse annual rainfall in this portion of the region occurs during November to April.

Predominant winds out of the northwest in winter, spring, and fall, and out of the south in summer tend to disperse air pollutants, resulting in relatively good air quality. The Mojave Desert and Salton Sea Air Basin attains (or is unclassified for) state and federal standards for CO and NO_x but does not attain either federal or state standards for O_3 and PM_{10}.

6.6.2 Environmental Consequences: Air Quality

6.6.2.1 Assessment Methods

The majority of air quality impacts would result from construction associated with Program activities. Air emissions of concern associated with construction include PM_{10} as fugitive dust, as well as CO and NO_X from construction vehicle exhaust.

Operations-related impacts from long-term activities such as pumping operations, changes in agricultural activities, and traffic and boating activities associated with recreational use of newly developed storage reservoirs also could result in changes to air quality. Air emissions of concern associated with these activities include PM_{10}, CO, NO_X (dust and exhaust emissions), as well as herbicides and pesticides used in agriculture.

At the level of this Programmatic EIS/EIR, potential air emissions associated with specific locations of potential facilities cannot be quantified. However, the general nature and relative degree of potential impacts that could accompany each alternative and program element have been addressed. The evaluation of potential

air quality effects is primarily concerned with the amount of construction activities and the extent and type of facilities likely to be constructed and operated.

6.6.2.2 Significance Criteria

The criteria used to evaluate potential air quality impacts are based on standardized air emission levels.

Potential air quality impacts are considered significant if the construction or operations of facilities associated with a particular implementation alternative or program element would cause substantial, adverse changes to the existing (ambient) air quality conditions within the affected area. The range of such changes includes producing emissions that would 1) either on their own, or when combined with existing emissions, violate federal or state ambient air quality standards, 2) cause a lowering of attainment status, or 3) conflict with adopted air quality management plan policies or programs.

6.6.2.3 Comparison of No Action Alternative to Existing Conditions

The No Action Alternative is not expected to have any significant adverse impacts on existing air quality conditions in the study area. Under the No Action Alternative, existing and potential air pollution sources would continue as at present.

6.6.2.4 Comparison of Program Alternatives to No Action Alternative

The impacts to air quality resulting from the storage and conveyance program element will vary by alternative, as discussed below. Impacts to air quality resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a regions, the program element is not discussed.

Delta Region

Storage and Conveyance. In Alternatives 1 and 2, potential direct, short-term increases in levels of PM_{10} (fugitive dust), as well as NO_x and CO_x (exhaust) from vehicles and equipment, would accompany development of minor channel improvements in the south Delta. Potential indirect, long-term increases in NO_x and CO (exhaust) would result from operating the larger pump sizes that would be installed in water conveyance systems.

Alternative 2 would also lead to substantial physical changes to the conveyance system, as well as construction of a new diversion structure in the Delta Region. Similarly, the pump sizes in the conveyance systems in the Delta Region would be increased to a greater extent than under Alternative 1.

In Alternatives 1 and 2, construction-related pollutants of concern (NO_x, CO, PM_{10}) might exceed ambient air quality standards only for short, intermittent periods during construction, and would contribute less-than-significant amounts to regional air pollution.

In addition to having the same physical changes to the conveyance system in the Delta Region as Alternative 2, Alternative 3 would involve construction of a new, separate, conveyance system through the Delta Region, and new storage facilities in the region. Therefore, the level of direct, short-term construction-related, and indirect, long-term operations-related air quality impacts in the Delta Region is potentially greater for Alternative 3 than for Alternatives 1 and 2.

The potential construction- and operations-related air quality impacts accompanying implementation of Configurations 3A and 3H (not involving development of storage facilities) in the Delta Region would be less than significant. Construction-related pollutants of concern (NO_X, CO, PM_{10}) might exceed ambient air quality standards only for short, intermittent periods during construction, and would not result in sufficient quantities to significantly contribute to regional air quality degradation.

Potentially significant and mitigable direct, short-term construction-related air quality impacts would likely be associated with Configurations 3B, 3E, and 3I, which involve development of storage facilities in the Delta Region. These projects would be of sufficient magnitude that construction-related pollutants of concern (NO_X, CO, PM_{10}) would likely occur at levels exceeding ambient air quality standards for extended periods, thereby likely contributing significantly to regional air quality degradation. The actual extent to which the construction of the storage facilities would contribute to regional air pollution can only be determined when specific project locations for the storage facilities associated with these alternatives are identified.

Reservoir and associated facility construction would be a source of vehicle emissions and fugitive dust emissions. These emissions would contribute to existing regional ozone and PM_{10} problems. Construction-related traffic would be unlikely to cause localized carbon monoxide problems.

Facility operation and maintenance activities would not be significant sources of air pollutant emissions. Traffic and boating activities associated with recreational use of the reservoir would be additional emission sources but would not be significant.

EPA regulations implementing CAA general conformity requirements would apply only if reservoir construction was undertaken by a federal agency instead of a state or local agency. If a federal agency was responsible for reservoir construction, a CAA conformity determination would be required. Achieving CAA conformity might require local and state agencies to amend existing SIP documents (that is, federally required air quality management plans) to specifically include the reservoir project.

The indirect, long-term, operations-related impacts associated with Configurations 3B, 3E, and 3I are not expected to be significant.

Ecosystem Restoration. The installation of new fish screens would potentially be accompanied by direct, short-term, construction-related air quality impacts. River channel deepening and subsidence reversal activities, such as those planned for the San Joaquin River Region, would also be accompanied with direct, short-term, air pollutant emissions during construction.

Development of wetlands would involve activities that could cause direct, short-term, construction-related air quality impacts.

Water Use Efficiency. Modifications to existing filtration plants, development of new pipelines, well fields, and pump stations, and increased (or decreased) pumping are some of the activities associated with this program element that would have potential construction- and operation-related air quality impacts (both adverse and beneficial) in agricultural and urban environments.

Additionally, increased reliance in the agricultural sector on pressurized irrigation systems would require a greater reliance on fossil fuels or other energy sources. This increase could have an adverse impact to air quality either locally (with fossil fuels) or regionally if energy is provided from out-of-region facilities. Changes in cultivation practices to accompany increased water use efficiency can also have adverse or beneficial impact depending on what changes are made.

Levee System Integrity. Land conversion adjacent to streams to create buffer areas associated with enhanced levee operation and flood control could also result in decreased operations-related air emissions from those lands that were previously in active agricultural use. Improvements to existing, and construction of new levee systems, as well as dredging, would involve activities that would have temporary direct, short-term, construction-related air quality impacts.

Water Transfers. The Water Transfer Program would affect air quality primarily through changes in crop type or agricultural acreage. The extent of impacts depends on the source of water, the timing, magnitude and pathway of each transfer.

Potential significant beneficial impacts are associated with the transferred water's origin, and include: 1) reducing fugitive dust production due to crop fallowing; 2) reducing air emissions resulting from declining use of equipment due to crop fallowing; 3) reducing air emissions due to crop burning resulting from crop shifting; and 4) reducing air emissions resulting from declining use of agricultural chemicals due to crop fallowing.

Potential significant adverse impacts are primarily associated with the transferred water's destination, and include: 1) increasing fugitive dust production from increased cultivation; 2) increasing air emissions resulting from increasing equipment use and cultivation; 3) increasing air emissions resulting from increasing agricultural chemical use; and 4) increasing air emissions resulting from increased crop shifting and burning. Other potential significant adverse impacts are associated with the transferred water's origin, and include; 5) increasing fugitive dust production resulting from shifts to crops associated with drier topsoil; and 6) increasing air emissions resulting from increased crop shifting.

Bay Region

Storage and Conveyance. No storage or conveyance facilities are being developed in the Bay Region under any program alternatives. Potential construction- and operations-related air quality impacts accompanying implementation of any project elements other than coordinated watershed management would be less than significant.

Coordinated Watershed Management. Prescribed burning programs in upper and lower watershed areas would be potentially significant sources of ozone precursor emissions and PM_{10} emissions. If federal land management agencies undertake prescribed burning programs, those programs may require evaluation for compliance with EPA Clean Air Act conformity regulations. Continuation of existing prescribed burning programs would normally be exempt from Clean Air Act conformity requirements.

Vehicle travel and construction activities associated with erosion control and habitat restoration programs would result in minor quantities of ozone precursor and PM_{10} emissions.

There would be no other air quality impacts expected in the Bay Region other than those previously discussed for the Ecosystem Restoration Program in the Delta Region.

Sacramento River and San Joaquin River Regions

Storage and Conveyance. The potential construction- and operations-related air quality impacts accompanying implementation of alternatives that do not involve development of storage facilities (that is, Configurations 1A, 1B, 1C; 2A and 2D; and 3A in the Sacramento River and San Joaquin River regions) would be less than significant. Construction-related pollutants of concern (NO_X, CO, PM_{10}) might exceed ambient air quality standards only for short, intermittent periods during construction, and would not result in sufficient quantities to significantly contribute to regional air quality degradation.

Potentially significant and mitigable direct, short-term construction-related air quality impacts would likely be associated with Configurations 1C; 2B and 2E; and 3B, 3E, 3H, and 3I which involves development of storage facilities in the Sacramento River Region. These facilities would be of sufficient magnitude that construction-related pollutants of concern (NO_X, CO, PM_{10}) would likely occur at levels exceeding ambient air quality standards for extended periods, thereby likely contributing significantly to regional air quality degradation. The actual extent to which the construction of the storage facilities would contribute to regional air pollution can only be determined when specific project locations for the storage facilities associated with this alternative are identified.

The indirect, long-term, operations-related impacts associated with alternatives in both the Sacramento River and San Joaquin River regions are not expected to be significant. However, some air quality affects could occur if fossil or thermal

fuel power generation is substituted for hydropower as a result of CALFED actions.

Ecosystem Restoration, Water Use Efficiency, Water Transfers, and Coordinated Watershed Management. Activities associated with implementation of these programs would be similar to those discussed previously with respect to the Delta Region.

Water Quality. Land conversion activities intended to reduce potential erosion and drainage-related pollution could result in decreased long-term, operations-related emissions of pollutants of concern. This would especially be the case for those lands that were previously under active agricultural cultivation. The cessation of cultivation, and subsequent revegetation of these lands would reduce potential fugitive dust (PM_{10}) emissions and exhaust emissions (NO_X, and CO) from operation of farm equipment.

Improvements to existing, and construction of new filtration and treatment facilities as part of this program element could have both temporary direct, short-term construction-related and indirect, long-term operations-related air quality impacts.

SWP and CVP Service Areas Outside the Central Valley

Storage and Conveyance

Air quality may be negatively impacted to the extent that delivery of water fosters growth in this area. The magnitude of impacts is unknown. Impacts are expected to be less than significant compared to the No Action Alternative.

6.6.2.5 Comparison of Program Alternatives to Existing Conditions

Future air resources under the No Action Alternative are expected to be similar to those under existing conditions.

6.6.2.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

Mitigation strategies can be employed, as required, to minimize construction- and operations-related emissions of pollutants of concern. These mitigation measures include the following:

- Regular, periodic watering of construction sites to control levels of dust in the air.
- Using soil stabilizers and dust suppressants on unpaved service roadways.
- Daily contained-sweeping of paved surfaces.
- Hydroseeding and mulching exposed areas.
- Setting traffic limits on construction vehicles.
- Maintaining properly tuned equipment.
- Limiting vehicle idling time.
- Using alternatively fueled equipment.
- Limiting the hours of operation or amount of equipment.
- Limiting the use of agricultural chemicals.
- Coordinating planned prescribed burning programs with relevant air quality management agencies to ensure that they are accounted for in state and federal air quality management plans.

Additional site-specific mitigation measures would likely be developed, as required, once locations for specific facilities are identified, to further minimize potential operations-related air quality impacts.

6.6.2.7 Potentially Significant Unavoidable Impacts

No significant unavoidable impacts were identified.

7 BIOLOGICAL ENVIRONMENT

7.1 FISHERIES AND AQUATIC ECOSYSTEMS

Summary

The impact assessment for fisheries and the aquatic ecosystem is based on available information. CALFED actions will be implemented through adaptive management because effects on the ecosystem are uncertain. Adaptive management includes identification of indicators of ecosystem health, phased implementation of substantial project actions, comprehensive monitoring of the indicators, and a commitment to remedial actions necessary to avoid, minimize, or mitigate immediate and future adverse impacts of project actions on ecosystem health. Adaptive management will help achieve the intent of the CALFED Bay-Delta Program and the major ecosystem-quality objectives.

Table 7.1-1 provides a summary of potential environmental impacts related to fish and aquatic ecosystems. Impacts to listed and proposed fish species are shown in Table 7.1-2. Detailed information on a CALFED action or response to the action is sometimes unavailable; therefore, assessment of impacts for individual actions cannot precisely be determined and impacts may range from beneficial to adverse depending on the nature of an action. Whenever the impact of a CALFED action could be adverse or beneficial, depending on currently undefined aspects of the action, the adverse effect is identified.

> Commercial and sportfishing discussion are presented in Chapter 8, Section 8.3.

Impacts to Fisheries and Aquatic Ecosystems

- **No Action** conditions would be similar to existing conditions, although increased input of contaminants and increased Delta exports would adversely affect aquatic organisms.
- **Storage and Conveyance**

  Alternative 1 would include the beneficial impacts of the Ecosystem Restoration and Water Quality programs. Adverse impacts, including increased entrainment loss, reduced productivity, and delayed migration of fish species, would result from diversions to new offstream storage and increased exports, operation of an intertie, and construction of south Delta barriers. In addition, construction and operation of new reservoirs would have potentially adverse impacts to spawning and rearing habitat.

  Alternative 2 would include the beneficial and adverse impacts identified under Alternative 1. Additional beneficial impacts would result from Delta flow conditions in the lower San Joaquin River that improve fish migration toward the Bay and restoration actions that would potentially increase habitat abundance. Additional adverse impacts from operation of a through-Delta facility include increased entrainment mortality, reduced productivity, and habitat loss or degradation.

  Alternative 3 would include the beneficial and adverse impacts under Alternative 1. Additional beneficial impacts result from Delta flow conditions in the east, central, and south Delta that would substantially reduce entrainment loss, increase productivity, and improve fish migration toward the Bay. Adverse impacts from operation of an isolated facility include increased entrainment mortality and habitat degradation affecting North Delta channels.

  Under Alternatives 1, 2, and 3, the Ecosystem Restoration and Water Quality programs would benefit many aquatic species through increased habitat abundance and improved habitat conditions.
- Potential benefits of the **Water Use Efficiency Program, and Water Transfers** include improvements in water use, providing opportunities to modify flow and diversion timing and reduced entrainment impacts through reduced diversions.

Delta Region

Beneficial Impacts. Under Alternatives 1, 2, and 3, the primary beneficial impacts for the Delta Region result from restoration of aquatic and adjacent communities, including riparian, shaded

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IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Change in CVP and SWP exports from the south Delta would impact: *– entrainment loss of organisms and nutrients;* *– entrainment of fish species; and* *– net reverse flow in the south and central Delta; potentially affecting productivity and migration of fish species.*	○	○	◗	◗	◗	◗	◗	+	+	+	+	+[1]
The screened through-Delta facilities and the isolated facility intake would cause entrainment-related mortality for Sacramento River fish.	□	□	□	◗	◗	◗	□	◗	◗	◗	◗	◗
Through-Delta facilities would increase cross-Delta flow, potentially: *– reducing productivity in the Mokelumne River channels; and* *– increasing movement of fish from the Sacramento River and into the Mokelumne River channels.*	□	□	□	◗	◗	◗	◗	□	□	□	◗	□
Through-Delta facilities and the isolated facility would reduce habitat quality and fish survival through: *– increased proportion of flow and fish drawn off the Sacramento River and into Georgiana Slough;* *– reduced Sacramento River flow; and* *– an upstream shift in X2.*	□	□	□	◗	◗	◗	◗	◗	◗	◗	◗	◗

Table 7.1-1. Summary of Environmental Impacts Related to Fish and Aquatic Ecosystems (page 1 of 5)

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IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Adult fish bound for the Sacramento River would be attracted by cross-Delta flow into the Mokelumne River channels and their return to the Sacramento River would be blocked by fish screens.	□	□	□	◗	◗	◗	□	□	□	□	□	□
The through-Delta and isolated facilities would increase net flow in the lower San Joaquin River, potentially improving conditions affecting migration of fish toward the Bay.	□	□	□	+	+	+	+	+	+	+	+	+
Construction of an intertie between the existing CVP intake and Clifton Court Forebay may increase entrainment of organisms and nutrients from the south Delta.[2]	□	◗	◗	◗	◗	◗	◗	□	□	□	□	□
South-Delta barriers potentially reduce connectivity to other Delta channels, reduce water quality conditions, and increase loss of nutrients and organisms from south-Delta channels (increased Old and Middle Rivers flow toward the CVP and SWP export facilities under Configurations 1B, 1C, and Alternative 2).	□	◗	◗	◗	◗	◗	◗	o[1]	o[1]	o[1]	o[1]	o[1]
The head-of-Old-River barrier may improve survival of juvenile chinook salmon from the San Joaquin River.	□	+	+	+	+	+	+	+	+	+	+	+
Ecosystem Restoration Program actions provide short-term flow events that reestablish ecosystem processes and structure, improving habitat conditions for fish and aquatic species.	+	+	+	+	+	+	+	+	+	+	+	+

Table 7.1-1. Summary of Environmental Impacts Related to Fish and Aquatic Ecosystems (page 2 of 5)

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IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Conversion of managed wetlands and agricultural land to inundated wetlands and open water would reestablish the natural structure of the Delta and increase abundance of species habitat.	+	+	+	+	+	+	+	+	+	+	+	+
Creation of riparian communities and floodplain/meander belts will reestablish natural channel processes and structure and increase and improve species habitat. (all regions)	+	+	+	+	+	+	+	+	+	+	+	+
CALFED actions (Water Quality and Ecosystem Restoration Programs) would reduce contaminant input relative to the No Action Alternative, potentially increasing productivity and species survival. (all regions)	+	+	+	+	+	+	+	+	+	+	+	+
New fish screens on agricultural, municipal, industrial, and managed wetland diversions would reduce fish entrainment loss. (all regions)	+	+	+	+	+	+	+	+	+	+	+	+
Management actions in the Ecosystem Restoration Program would be implemented to integrate artificial production goals consistent with rehabilitation of naturally producing fish populations. (all regions)	+	+	+	+	+	+	+	+	+	+	+	+
Ecosystem Restoration Program actions, including restrictions on discharge of ship ballast water and transport of non-native species at border crossings, direct control of non-native species populations, and reduced predator habitat, may reduce and prevent unnatural levels of predation and competition. (all regions)	+	+	+	+	+	+	+	+	+	+	+	+

Table 7.1-1. Summary of Environmental Impacts Related to Fish and Aquatic Ecosystems (page 3 of 5)

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IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Ecosystem Restoration Program actions would include management recommendations to reduce harvest-related impacts on self-sustaining natural fish populations. (all regions)	+	+	+	+	+	+	+	+	+	+	+	+
Bay Region												
Conversion of managed wetlands and agricultural land to inundated wetlands and open water would reestablish the natural structure of the Bay including Suisun Marsh and increase abundance of species habitat.	+	+	+	+	+	+	+	+	+	+	+	+
Sacramento River and San Joaquin River Regions												
Ecosystem Restoration Program actions provide short-term flow events that reestablish ecosystem processes and structure, improving habitat conditions for fish and aquatic species.	+	+	+	+	+	+	+	+	+	+	+	+
Construction and operation of new reservoirs, depending on location, could eliminate existing spawning and rearing habitat and increase entrainment loss of juvenile fish. (Primarily for the Sacramento Region)	□	□	●	□	●	□	●	□	●	●	●	●

Table 7.1-1. Summary of Environmental Impacts Related to Fish and Aquatic Ecosystems (page 4 of 5)

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IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
SWP and CVP Service Areas												
Additional water supply may increase urban and industrial development and cause additional degradation of the aquatic environment through increased contaminant input, increased incidence of human-caused disturbance, and other factors.	○	○	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:

Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
○	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

[1]Depending on operations, the alternative could cause significant adverse impacts.
Note: All CALFED alternatives are compared to the No Action Alternative.

Table 7.1-1. Summary of Environmental Impacts Related to Fish and Aquatic Ecosystems (page 5 of 5)

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IMPACT ISSUES	LISTED OR PROPOSED SPECIES[1]	ALTERNATIVE 1[2]			ALTERNATIVE 2[2]				ALTERNATIVE 3[2]				
		1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region													
Change in CVP and SWP exports from the south Delta would impact: - food availability - entrainment loss, - movement and migration	delta smelt	○	○	◗	◗	◗	◗	◗	+	+	+	+	+[3]
	winter-run	○	○	○	○	○	○	○	+	+	+	+	+[3]
	spring-run	○	○	○	○	○	○	○	+	+	+	+	+[3]
	steelhead	○	○	○	○	○	○	○	+	+	+	+	+[3]
	splittail	◗	○	◗	◗	◗	◗	◗	+	+	+	+	+[3]
Construction of a through-Delta facility in Configurations 2A, 2B, and 2D and the south-Delta barriers in Configurations 1B, 1C, 2A, 2B, 3A, and 3B would modify and destroy spawning and rearing habitat.	delta smelt	□	◗	◗	◗	◗	◗	□	◗	◗	□	□	□
	splittail	□	◗	◗	◗	◗	◗	□	◗	◗	□	□	□
X2 may shift farther upstream in the Delta during summer and fall in response to reduced net Sacramento River flow past Rio Vista, potentially reducing habitat quantity and quality for organisms associated with X2.	delta smelt	□	□	□	◗	◗	◗	◗	◗	◗	◗	◗	◗
The through-Delta and isolated facilities would increase the proportion of juvenile fish drawn into Georgiana Slough and the Mokelumne River channels.	winter-run	□	□	□	◗	◗	◗	◗	◗	◗	◗	◗	◗
	spring-run	□	□	□	◗	◗	◗	◗	◗	◗	◗	◗	◗
	steelhead	□	□	□	◗	◗	◗	◗	◗	◗	◗	◗	◗
	splittail	□	□	□	U	U	U	U	U	U	U	U	U
The through-Delta and isolated facilities would increase in the lower San Joaquin River, flow toward improving conditions affecting movement of fish toward Suisan Bay.	delta smelt	□	□	□	+	+	+	+	+	+	+	+	+
	winter-run	□	□	□	+	+	+	+	+	+	+	+	+
	spring-run	□	□	□	+	+	+	+	+	+	+	+	+
	steelhead	□	□	□	+	+	+	+	+	+	+	+	+
	splittail	□	□	□	U	U	U	U	U	U	U	U	U

Table 7.1-2. Summary of Environmental Impacts Related to Listed and Proposed Species (page 1 of 5)

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IMPACT ISSUES	LISTED OR PROPOSED SPECIES[1]	ALTERNATIVE 1[2]			ALTERNATIVE 2[2]				ALTERNATIVE 3[2]				
		1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
The screened through-Delta facility would attract adult fish and increase mortality through disorientation and migration delay.	delta smelt	□	□	□	○	○	○	□	□	□	□	□	□
	winter-run	□	□	□	◗	◗	◗	□	□	□	□	□	□
	spring-run	□	□	□	◗	◗	◗	□	□	□	□	□	□
	steelhead	□	□	□	◗	◗	◗	□	□	□	□	□	□
	splittail	□	□	□	◗	◗	◗	□	□	□	□	□	□
Ecosystem Restoration Program actions would reestablish natural short-term flow events and improve environmental conditions affecting spawning, rearing, and migration.	All species	+	+	+	+	+	+	+	+	+	+	+	+
Conversion of managed wetlands and agricultural land to inundated wetlands and open water could markedly increase abundance of spawning and rearing habitat.	All species	+	+	+	+	+	+	+	+	+	+	+	+
Reestablishment of riparian communities, floodplain/meander belts, and natural channel processes, will increase spawning and rearing habitat quantity and quality. (all regions)	All species	+	+	+	+	+	+	+	+	+	+	+	+
CALFED actions (Water Quality and Ecosystem Restoration Programs) would reduce contaminant input relative to the No Action Alternative, potentially increasing organism growth and fecundity and reducing susceptibility to disease. (all regions)	All species	+	+	+	+	+	+	+	+	+	+	+	+

Table 7.1-2. Summary of Environmental Impacts Related to Listed and Proposed Species (page 2 of 5)

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IMPACT ISSUES	LISTED OR PROPOSED SPECIES[1]	ALTERNATIVE 1[2]			ALTERNATIVE 2[2]				ALTERNATIVE 3[2]				
		1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Ecosystem Restoration Program actions, including restrictions on discharge of ship ballast water and transport of non-native species at border crossings, direct control of non-native species populations, and reduced predator habitat, may reduce and prevent unnatural levels of predation and competition. (all regions)	All species	+	+	+	+	+	+	+	+	+	+	+	+
Ecosystem Restoration Program actions would include management recommendations to reduce harvest-related impacts on self-sustaining natural fish populations. (all regions)	winter-run	+	+	+	+	+	+	+	+	+	+	+	+
	spring-run	+	+	+	+	+	+	+	+	+	+	+	+
	steelhead	+	+	+	+	+	+	+	+	+	+	+	+
Management actions in the Ecosystem Restoration Program would be implemented to integrate artificial production goals consistent with rehabilitation of naturally producing fish populations. (all regions)	All species	+	+	+	+	+	+	+	+	+	+	+	+
New fish screens on agricultural, municipal, industrial, and managed wetland diversions would reduce fish entrainment loss. (all egions)	All species	+	+	+	+	+	+	+	+	+	+	+	+
Bay Region													
Conversion of managed wetlands and agricultural land to inundated wetlands and open water could markedly increase abundance of spawning and rearing habitat.	All species	+	+	+	+	+	+	+	+	+	+	+	+

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IMPACT ISSUES	LISTED OR PROPOSED SPECIES[1]	ALTERNATIVE 1[2]			ALTERNATIVE 2[2]				ALTERNATIVE 3[2]				
		1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Sacramento River Region													
Reoperation of Reservoirs potentially degrades water temperature conditions and increases spawning and rearing mortality	winter-run	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
	spring-run	o	o	o	o	o	o	o	o	o	o	o	o
	steelhead	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Construction and operation of new reservoirs, depending on location, could eliminate existing spawning and rearing habitat and increase entrainment loss of juvenile fish.	winter-run			◗		◗		◗		◗	◗	◗	◗
	spring-run			◗		◗		◗		◗	◗	◗	◗
	steelhead			●		●		●		●	●	●	●
Ecosystem Restoration Program actions would reestablish natural short-term flow events and improve environmental conditions affecting spawning, rearing, and migration.	winter-run	+	+	+	+	+	+	+	+	+	+	+	+
	spring-run	+	+	+	+	+	+	+	+	+	+	+	+
	steelhead	+	+	+	+	+	+	+	+	+	+	+	+
	splittail	+	+	+	+	+	+	+	+	+	+	+	+
Channel modifications and reestablishment of riparian communities have the potential to improve water temperature conditions in the Sacramento River and its tributaries.	winter-run	+	+	+	+	+	+	+	+	+	+	+	+
	spring-run	+	+	+	+	+	+	+	+	+	+	+	+
	steelhead	+	+	+	+	+	+	+	+	+	+	+	+
Improvement of fish passage at barriers would improve access to existing habitat and increase survival during up- and downstream migration.	winter-run	+	+	+	+	+	+	+	+	+	+	+	+
	spring-run	+	+	+	+	+	+	+	+	+	+	+	+
	steelhead	+	+	+	+	+	+	+	+	+	+	+	+

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IMPACT ISSUES	LISTED OR PROPOSED SPECIES[1]	ALTERNATIVE 1[2]			ALTERNATIVE 2[2]				ALTERNATIVE 3[2]				
		1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
San Joaquin River Region													
Ecosystem Restoration Program actions would reestablish natural short-term flow events and improve environmental conditions affecting spawning, rearing, and migration.	steelhead	+	+	+	+	+	+	+	+	+	+	+	+
	splittail	+	+	+	+	+	+	+	+	+	+	+	+

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:
Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
o	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

1 - Proposed and listed species include delta smelt, winter-run chinook salmon, spring-run chinook salmon, steelhead, and splittail. These species do not occur in the SWP and CVP Service Areas outside the Central Valley.

2 - All CALFED alternatives are compared to the No Action Alternative.

3 - Depending on operations' the alternatives could cause significant adverse impacts.

Table 7.1-2. Summary of Environmental Impacts Related to Listed and Proposed Species (page 5 of 5)

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riverine aquatic, shallow water, channel islands, and tidal marsh. Beneficial impacts, however, will depend on adaptive management that ensures restoration actions provide for the needs of target species. Additional beneficial impacts result from actions that reduce stress on the processes and structure of those communities, including implementation of plans proposed in the Ecosystem Restoration and Water Quality programs to reduce erosion attributable to boat wakes, reduce adverse effects of dredging and channel maintenance activities, and reduce input of contaminants upstream of and within the Delta. Primary beneficial impacts include restoration of sediment supply and transport processes; restoration of natural structural characteristics of the Delta system; and restored biological productivity. For species, beneficial impacts include increased abundance of spawning and rearing habitat and increased survival attributable to reduced stress from contaminants and potentially increased food availability. Additional restoration of aquatic and adjacent communities under Alternatives 2 (Configurations 2D and 2E) and 3 (Configuration 3H) would increase the beneficial impacts described above.

In addition, reoperation of reservoir and diversion facilities under Alternatives 1, 2, and 3 may provide short-term flows that may protect and enhance the ecological functions and processes that operate within the Delta. Flow changes could benefit all Delta species.

Installation of new fish screens at the SWP and CVP facilities and on agricultural diversions would also provide beneficial impacts under Alternatives 1, 2, and 3. Species' benefits include reduced entrainment loss. Alternatives 1, 2, and 3 also include actions as described in the Ecosystem Restoration Program that may reduce or eliminate the influx of non-native aquatic species from ship ballast water and reduce the potential for influx of non-native aquatic plant and animal species at border crossings. This would decrease the adverse impacts associated with establishment of non-native species populations in the Delta, including impacts of increased competition for limited resources, predation, and disease.

Under Alternatives 1, 2, and 3, implementation of water use efficiency measures are anticipated to create ecosystem benefits through reduced diversion entrainment impacts, modifications in flow timing, improved in-stream water quality, and new water for ecosystem purposes (through water transfers).

Under Alternatives 2 and 3, through-Delta facilities and the isolated facility would reduce the incidence of reversed flows, particularly in the southern Delta. The change would have beneficial impacts through improved conditions potentially affecting movement of Delta species (including delta smelt, juvenile chinook salmon, and striped bass) toward downstream habitats and away from Delta diversions. The benefit would be less under Alternative 2 because the export location is similar to the location under the No Action Alternative and the benefits are restricted to the lower San Joaquin River.

The isolated facility would provide substantial beneficial impacts to the Delta ecosystem under Alternative 3. The larger isolated facility (Configurations 3E and 3I) increases the opportunity for beneficial impacts. Benefits are dependent on reduced export from the south Delta facilities with subsequent increase in diversion to the isolated facility. Beneficial impacts include closer approximation of natural flow patterns (that is, net flow toward Suisun Bay), and increased productivity through reduced entrainment loss of biological production and increased residence time. Species benefits include reduced entrainment of species in the central and south Delta and a net flow toward Suisun Bay, providing migration cues and a net flow movement toward downstream habitat. Striped bass, delta smelt, longfin smelt, Sacramento splittail, and chinook salmon are among the species that would benefit.

Adverse Impacts. Under Alternative 2, construction of a new channel to provide a net flow of up to 10,000 cfs from the Sacramento River into the Mokelumne River channels would have a significant adverse impact. Net flow in the eastern and central Delta would be increased. Net flow in the Sacramento River downstream of the new

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channel would be reduced. In addition, construction of the new channel would modify or destroy existing aquatic ecosystem components in the Snodgrass Slough area of the Delta (except Configuration 2E) and in the Mokelumne River channels. Adverse impacts include increased deviation from natural flow patterns in the eastern and central Delta and in the Sacramento River channel. Impacts on species with Configuration 2E would include loss of existing spawning and rearing habitat and potential increase in exposure of egg, larval, and juvenile fish to central Delta diversions.

Flow through the new channel at Hood would also attract upstream migrating adult fish, including chinook salmon, steelhead, striped bass, American shad, splittail, and sturgeon. The fish screen in Configurations 2A, 2B, and 2D would prevent movement into the Sacramento River. Adverse impacts would include losses from disorientation and migration delay and potential effects on genetic integrity through increased straying of chinook salmon from the Sacramento River into the Mokelumne River.

Under Configuration 3I, the three unscreened intakes would potentially increase entrainment losses through increased predation-related mortality, similar to existing conditions for Clifton Court Forebay. The three intakes may also adversely affect movement of Delta species, including delta smelt and striped bass, retaining larvae within the influence of central and south Delta diversions and exports.

Under Configuration 1C, all configurations of Alternative 2, and possibly Configuration 3I, additional SWP and CVP exports from the south Delta would increase entrainment losses. Under Configurations 2A, 2B, 2D, and Alternative 3, entrainment and associated mortality of Sacramento River fish would increase.

Bay Region

Beneficial Impacts. Under Alternatives 1, 2, and 3, beneficial impacts for the Bay Region, including Suisun Marsh, result from restoration of aquatic and adjacent communities, including riparian, shallow water, and tidal marsh. Additional beneficial impacts result from actions that reduce stress on the processes and structure of those communities, including implementation plans to reduce erosion attributable to boat wakes, reduce adverse effects of dredging and channel maintenance activities, and reduce input of contaminants upstream and in the Bay. Primary beneficial impacts include restoration of sediment supply and movement processes, restoration of natural structural characteristics of the Bay system, and restored biological productivity. For species, beneficial impacts include increased abundance of spawning and rearing habitat and increased survival attributable to reduced stress from contaminants and potentially increased food availability. As in the Delta, implementation of adaptive management will be required to achieve habitat benefits.

Primarily in Suisun Marsh, installation of new fish screens on managed wetlands and agricultural diversions would also provide beneficial impacts under Alternatives 1, 2, and 3. Species benefits include reduced entrainment loss.

Alternatives 1, 2, and 3 include actions that may reduce or eliminate the influx of non-native aquatic species from ship ballast water and reduce the potential for influx of non-native aquatic plant and animal species at border crossings. The actions may decrease the adverse impacts associated with establishment of non-native species populations in the Bay, including impacts due to increased competition for limited resources, predation, and disease.

Adverse Impacts. No significant adverse impacts were identified for the Bay Region.

Sacramento River and San Joaquin River Regions

Beneficial Impacts. Under Alternatives 1, 2, and 3, the primary beneficial impacts in the Sacramento River and San Joaquin River regions result from restoration of aquatic and adjacent communities, including riparian, shaded riverine aquatic, and floodplain. Additional beneficial impacts result

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from actions that reduce stress on the processes and structure of those communities, including reduced input of contaminants, re-establishment of the floodplain and meander belts, removal and modification of existing barriers, and improvement of land management practices. Primary beneficial impacts include restoration of sediment supply and movement processes, restoration of natural structural characteristics of the river systems, and restored biological productivity. For species, beneficial impacts include increased abundance of spawning and rearing habitat, increased survival attributable to reduced stress from contaminants, and potentially increased food availability.

In addition, reoperation of reservoir and diversion facilities under Alternatives 1, 2, and 3 may provide short-term flows that protect and enhance the ecological functions and processes that operate within the riverine systems. Flow changes could benefit all river species. Flow and operations changes could also improve water temperature conditions for chinook salmon and steelhead trout. The description of the level and nature of impact will be improved with flow and operations data analysis during project-specific, site-specific impact assessment.

Installation of new fish screens on agricultural and municipal diversions would also provide beneficial impacts under Alternatives 1, 2, and 3. Species benefits include reduced entrainment loss, primarily for chinook salmon and steelhead trout.

Under Alternatives 1, 2, and 3, implementation of water use efficiency measures is anticipated to create ecosystem benefits through reduced diversion entrainment impacts, modifications in flow timing, improved instream water quality, and new water for ecosystem purposes (through water transfers).

Other beneficial impacts under Alternatives 1, 2, and 3 may result from Ecosystem Restoration Program actions directed toward improved management of hatchery production and harvest. Actions that may reduce or eliminate the influx of non-native aquatic species may decrease the adverse impacts associated with establishment of non-native species populations in the rivers, including impacts of increased competition for limited resources, predation, and disease.

Construction of off-stream storage facilities would result in the creation of open water/reservoir fisheries. Coordinated Watershed Management Program efforts could increase the quality of upstream habitat by increasing stream-side vegetation, improving and/or stabilizing aquatic habitat, and reducing sedimentation.

Adverse Impacts. Construction of off-stream storage facilities would result in the loss of stream fisheries and control structures at on-stream reservoir sites may block upstream migration of anadromous species. Diversions to fill off-stream storage could increase entrainment loss of Sacramento River species. Change in Shasta Reservoir operations may increase temperature-related mortality for winter-run chinook salmon.

7.1.1 Affected Environment/ Existing Conditions

7.1.1.1 Fisheries

This report describes impacts at an ecosystem level, and subsequently provides information specific to selected species. Representative fish and invertebrate species selected for inclusion in this assessment are listed in Table 7.1.1-1

A representative species was selected based on the following criteria:

- Species supports a commercial fishery;
- Species supports a sport fishery;
- Species is listed under the federal ESA or the California ESA, is proposed for such listing, or is a species of special concern; or

Species		Region					
				Sacramento River		San Joaquin River	
Common Name	Scientific Name	Delta	Bay	Reser-voir	River	Reser-voir	River
Fish							
Rainbow trout*	*Oncorhynchus mykiss*			X		X	
Largemouth bass	*Micropterus salmoides*	X		X	X	X	X
White sturgeon	*Acipenser transmontanus*	X	X		X		X
Chinook salmon	*Oncorhynchus tshawytscha*	X	X		X		X
Steelhead*	*Oncorhynchus mykiss*	X			X		X
Sacramento squawfish	*Ptychocheilus grandis*				X		X
American shad	*Alosa sapidissima*	X			X		X
Sacramento blackfish	*Orthodon microlepidotus*	X			X		X
Splittail	*Pogonichthys macrolepidotus*	X	X		X		X
Striped bass	*Morone saxatilis*	X	X		X	X	X
Smallmouth bass	*Micropterus dolomieui*				X		X
Tule perch	*Hysterocarpus traskii*	X			X		X
Delta smelt	*Hypomesus transpacificus*	X	X				
Longfin smelt	*Spirinchus thaleichthys*	X	X				
White catfish	*Ictalurus catus*	X					
Inland silverside	*Menidia audens*	X					
Pacific herring	*Clupea harengeus pallasii*		X				
Starry flounder	*Platichthys stellatus*		X				
Invertebrates							
Terrestrial invertebrates		X			X		X
Other aquatic invertebrates					X		X
Rotifers	*Rotifera*	X					
Native mysid shrimp	*Neomysis mercedis*	X	X				
Crayfish	*Pacifastacus leniusculus*	X			X		X
Asian clam	*Potamocorbula amurensis*	X	X				
Bay shrimp	*Crangon franciscorum*		X				

NOTE:
* Oncorhynchus mykiss that are anadromous (move from the sea into fresh water to spawn) are referred to as steelhead, while those that do not exhibit anadromy are referred to as rainbow trout.

Table 7.1.1-1. Fish and Invertebrates Selected as Representative Species for the Impact Assessment

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- Species has a potentially significant and distinctive response to environmental variables affected by CALFED actions. Some species spend only part of their life in the CALFED study area, migrating into the area to spawn and leaving after rearing as juveniles (such as salmon, steelhead, sturgeon, and American shad). Many of the species are year-round residents including delta smelt, longfin smelt, Sacramento splittail, Sacramento squawfish, Sacramento blackfish, smallmouth bass, tule perch, white catfish, and inland silverside. Others spawn in the ocean and are found in the San Francisco Bay as adults and juveniles, such as the starry flounder.

Detailed information on the life history, historic population abundance, and factors affecting production for specific species can be found in the Fisheries and Aquatic Resources supporting document. In general, distribution and abundance of these species throughout the upper and lower watersheds are affected by water temperature, flows, barriers, entrainment in diversions, fishing, and habitat. The actual effects are influenced by a number of interacting factors. For example, the effects of temperature depend on duration of exposure, acclimation, food availability, water quality, and cool water refuges.

Direct losses occur from diversion of water for agricultural and other uses. Diversion directly removes fish, invertebrates, and nutrients from the system. Migration of adults and juveniles is also affected by stream flow, temperature, barriers, and other factors. In addition, reverse flows in Delta channels caused by pumping operations may have adverse effects on migrating adults and juveniles by confusing migrants and delaying migration and/or lengthening migration routes.

Most of the species discussed have suffered from declining populations. Losses have occurred from environmental degradation, barriers to migration, historical commercial fisheries, sport fisheries, competition by non-natives, and direct loss of spawning and rearing habitat.

Invertebrate species discussed are important to the aquatic ecosystem in that they provide either an important food source to the fish species or are non-native competitors.

7.1.1.2 Delta Region

Historical Perspective. The ratio of water to land acreage was higher prior to levee construction and channelization, when wetlands dominated land cover throughout the Delta. Historically, a much higher percentage of open water in the Delta consisted of backwater areas, tidal sloughs and channel networks that supplied and drained highly productive tidal-marsh and wetland complexes. The marsh vegetation, in turn, supplied the Delta aquatic system with an abundant source of coarse organic matter. Marsh vegetation also slowed the movement of water through the Delta during floods, increasing hydraulic residence times and the opportunity for nutrients to be consumed.

Existing Conditions. The Delta Region includes the tidally influenced aquatic areas from the Sacramento River at the confluence with the American River, and the San Joaquin River at Vernalis downstream to Chipps Island. Under existing conditions, most of the open water is deep-channel habitat that has been modified to provide passage for oceangoing vessels as well as efficient conveyance of freshwater from the Sacramento River through the Delta. The levees are kept bare of vegetation to reduce the probability of levee failure. The amount of shallow water and shaded riverine habitat throughout the Delta is much lower now than it was historically.

The total surface area of the legal Delta area is approximately 678,200 acres, most of which is irrigated cropland. A lesser portion consists of riparian vegetation, wetlands, and other forms of "idle land." The remaining portion is occupied by channels, sloughs, and other open water.

The bulk of the total freshwater inflow to the Delta is from the Sacramento River. Under existing conditions, most of the total inflow occurs during the wet season. The average residence

time of Delta water, nutrients, algae, and other forms of fine particulate organic matter has been greatly reduced compared to historical conditions. This reduction has been greatest for the dry season, when most primary and secondary production normally takes place throughout the system.

Varying portions of the inflow are diverted under different conditions. Thus, the amount of water, sediment, and nutrients flowing out of the Delta to Suisun Bay is greatly reduced at certain times.

These diversions can reverse the direction of net flows in some central- and south-Delta channels. Reverse flows and loss of algae and other food resources have contributed to the reduction of Bay-Delta productivity and some Bay-Delta invertebrate and fish populations.

The rivers flowing into the Delta, together with agricultural return flows and urban wastewater flows within the Delta, transport contaminants in addition to water, sediment, and nutrients. Some contaminants arrive in dissolved forms but most, such as trace metals, a number of herbicides, and other synthetic organic toxicants, are transported in association with fine particulate sediment and organic matter. It is known that some contaminants accumulate within the foodweb. The concentration in fish or other high-trophic-level organisms can be orders of magnitude greater than concentrations in the water or in algae, invertebrates, and other lower trophic-level organisms.

7.1.1.3 Bay Region

Historical Perspective. Wetlands and related habitat are some of the most valuable natural resources in the Bay and Suisun Marsh. Most of the mudflats, tidal and seasonal marshes, and riparian woodland have been drastically reduced over the past 140 years, primarily as a result of urban and agricultural development. Large areas that were once tidal marsh habitat have been transformed into saltponds and agricultural land, reducing the shallow water habitat available to fisheries resources. In addition, the Bay's open-water area has diminished by one-third, with wetland and riparian wildlife habitats eliminated or degraded. Seasonal stormflows have increased and sediment and nutrient transport processes changed in the estuarine ecosystem. Past projects have decreased the surface area of the San Francisco Bay by 37% and removed valuable habitat for aquatic and terrestrial organisms.

Most of the tributary streams in the Bay Region have lost habitat through channelization, riparian vegetation removal, reduced water quality, and the construction of fish barriers. The fish of the tributary streams of the Bay are sensitive to changes in habitat, and fish abundance in these streams generally reflects the intensity of urbanization of the surrounding lands.

Previously, considerable organic material entered the rivers and Bay-Delta from sewage- and food-processing plants. These point-source loadings have since been reduced as part of an overall effort to improve water quality.

Existing Conditions. The Bay Region extends downstream from Chipps Island to the Golden Gate Bridge and includes aquatic habitat in Suisun Marsh, Suisun Bay, San Pablo Bay, Central Bay, and South Bay. Shoals and mudflats cover most of the surface area of the Bay, whereas most of the Bay's volume is contained within deep, fairly narrow channels that are dredged periodically to maintain shipping lanes for oceangoing cargo vessels. From an ecosystem standpoint, the Bay functions as a temporary storage, mixing and processing basin for freshwater, sediment, nutrients, and food resources flowing out of the Delta. The first embayment to receive these resources is Suisun Bay including Suisun Marsh, a critical food production and food consumption area of the Bay Region aquatic ecosystem, which serves as a critical rearing area for resident and anadromous fish.

The Bay-Delta foodweb has changed in recent years, especially as algae abundance has declined in Suisun Bay. Low chlorophyll levels in Suisun Bay coincide with very low Delta outflow during the drier years such as in 1977, 1987, and 1992

and with very wet years, such as 1983 and 1995. In some wet years, some of the algae biomass in Suisun Bay is washed downstream into the wider expanses of San Pablo Bay. Many native aquatic invertebrate species have become less abundant or more narrowly distributed, while dozens of new, non-native species have become well established and widely dispersed. In general, the abundance of plankton has declined, while populations of many bottom-dwelling invertebrates, most notably Asian clams, have increased. This transition has been most evident in Suisun Bay.

The entrapment zone, where freshwater and sea water mix in Suisun Bay, permits the development of high zooplankton populations on which many estuarine resident and anadromous fish depend. The deterioration of the zooplankton community and its algal food supply in critical habitat areas of the Bay Region is considered a serious problem, because striped bass, delta smelt, chinook salmon, and other species that use Suisun Bay and the Delta as a nursery area feed almost exclusively on zooplankton during early stages of their life cycles.

Much of the plant biomass and other forms of organic matter consumed by zooplankton in the Bay Region is not produced in the Bay, but is transported in from the Sacramento and San Joaquin rivers and accumulates in Suisun Bay and the western Delta. The proportion of the organic material imported to or produced within and upstream of the Delta that reaches Suisun Bay varies considerably from year to year and depends, in part, on prevailing flow conditions. At higher flows, much of the organic material brought in by the rivers would travel to Suisun Bay or to San Pablo and central San Francisco bays. At low flows, more biological production remains in the Delta.

The decline of fish and zooplankton populations in the Bay Region may be a result, at least in part, of the effects of heavy metals, herbicides, pesticides, and other toxic substances. Very low concentrations of these substances in the water column may act individually or in combination to reduce productivity.

Delta outflow transports organisms and organic material into Suisun Bay and is affected by upstream river inflow and Delta diversions. High Delta outflow can transport organisms out of the Delta into Suisun Bay, where conditions for survival are improved over conditions within the Delta. The operation of dams on the tributary streams and diversions in and upstream of the Delta has reduced Delta outflow. The greatest effects occur during spring and summer, especially during drier periods.

7.1.1.4 Sacramento River Region

Historical Perspective. Historically, wetlands covered an estimated 1,400,000 acres of the Sacramento Valley. These wetlands were comprised of mostly riparian forests and semi-permanently flooded tule marshes. Currently, approximately 170,000 acres of wetlands remain and are dominated by tule marsh. In addition, a large portion of agricultural lands are subject to flooding during wet years. Some 500,000 acres of riparian forest historically fringed the entire length of the mainstem Sacramento River channel. Today, less than 5% of the mainstem riparian forest remains. As in the Delta, wetland plants and riparian forests provided food and shelter for aquatic biota and greatly increased hydraulic residence time of the system.

Existing Conditions. The Sacramento River Region encompasses aquatic habitat in the major stream reaches in the Sacramento River Basin. The major reservoirs (reservoirs that provide flood control and water storage) on the Sacramento River and its tributaries are also included in this region. In addition, reservoirs that provide new water storage in the Sacramento River Region under the CALFED alternatives are included in the impact assessment. The Fisheries and Aquatic Resources supporting document includes a description of each of the streams and reservoirs in the Sacramento River Region.

Under existing conditions, most of the acreage adjacent to the river is protected by levees, and long sections of the river have been straightened to maximize agricultural land and improve channel conveyance capacity. On the Sacramento River, the section from Chico Landing to the Delta is contained within levees. As in the Delta, levees are reinforced and kept relatively free of vegetation, measures that have greatly reduced the occurrence of sloughs and side channels, the supply of organic material, and the quality of invertebrate and fish habitat in the river ecosystem.

Most of the volume of the Sacramento River system is stored in reservoirs; therefore, Sacramento River and tributary flows are highly regulated and under the direct control of the Bureau of Reclamation, DWR, and others. The main purposes of the reservoirs are flood control and storage for subsequent release to downstream diverters and generation of electricity. Relative to the natural flow regime, the present river flows are lower in spring and winter but higher in summer and fall.

The reservoirs also function as settling basins for all of the coarse sediment and organic material and a large fraction of the fine sediment brought in by inlet streams. The major reservoirs have low nutrient levels and support modest phytoplankton production. Reservoirs shorelines are mostly barren because water levels fluctuate and vegetation is not supported.

Algal biomass and fine particulate organic matter derived from terrestrial vegetation form the basis of the foodweb in these stream ecosystems. Planktonic algae abundance is generally low because residence time is short and relatively high amounts of suspended sediment prevent light penetration.

Inactive and abandoned mines discharge acid mine drainage into the upper Sacramento River and tributaries. This drainage contains trace metals, especially copper and zinc, that are toxic to aquatic organisms. Abandoned mines and natural erosion in other parts of the catchment contribute mercury. Urban runoff and municipal and industrial discharges are sources of metals and organochlorine compounds that can accumulate in fish and other high-trophic-level aquatic organisms. Agricultural return flows also discharge potentially harmful herbicides and pesticides into the system, as well as increasing turbidity through input of fine sediments.

7.1.1.5 San Joaquin River Region

Historical Perspective. Precipitation in the San Joaquin River Basin is less than that in the Sacramento River Region. Snowmelt runoff is the major source of water for the San Joaquin River and the larger tributaries. Historically, peak flows occurred in May and June and natural overbank flooding occurred in most years along all the major rivers. When floodflows reached the valley floor, they spread out over the lowland, creating several hundred thousand acres of permanent tule marshes and over 1.5 million acres of seasonally flooded wetlands and native grasslands. The rich alluvial soils of natural levees once supported large, diverse riparian forests. Above the lower floodplain, the riparian zone graded into higher floodplains, supporting valley oak savanna and native grasslands interspersed with vernal pools. Currently, about 126,000 acres of wetlands remain in the San Joaquin Valley. Riparian forest acreage is less than 5% of its former extent and exists in small isolated patches. Human-made levees isolate the river from most of its former floodplain.

Existing Conditions. The San Joaquin River Region encompasses aquatic habitat in the major stream reaches in the San Joaquin River Basin. The major reservoirs in the San Joaquin River Basin (i.e., San Luis Reservoir) and on the San Joaquin River and its tributaries are also included in this region. The aquatic system, as in the Sacramento River, consists of a mainstem channel and its major tributaries, the Stanislaus, Tuolumne, and Merced rivers; and several hundred small tributary streams. The Fisheries and Aquatic Resources supporting document includes a description of each of the streams and reservoirs in the San Joaquin River Region. The region

encompasses approximately 10.2 million acres, of which approximately one-third is the San Joaquin Valley. Approximately one-fifth of the region supports irrigated agriculture, whereas only a small portion of the acres belong to urban areas.

Most of the total volume of water in the San Joaquin River Region is stored in reservoirs; therefore, outflow from this region is highly regulated. Relative to natural flow conditions, the present flow of the San Joaquin River and tributaries is lower in spring and winter, and higher in summer and fall. The reservoirs function as settling basins for all of the coarse sediment and organic material, and a large fraction of the fine sediments brought in each year by inlet streams.

Most of the flow in the mainstem of the San Joaquin River during the summer growing season consists of agricultural return flow, rich in nutrients and suspended solids. In winter, soils are flushed to reduce salt buildup, and the resulting wastewater is conveyed to the streams and San Joaquin River by an extensive system of tile lines and drainage ditches. High nutrient concentrations and long residence times combine to make the San Joaquin River mainstem an extremely productive system. Therefore, the San Joaquin River contributes a disproportionately high percentage of inflowing nutrients and food resources to the Delta. These nutrients and food resources benefit the ecosystem by contributing to Bay-Delta productivity but can, in combination with sewage and urban discharge, lead to reduced summer and fall dissolved oxygen levels in localized reaches of deep, poorly flushed channels.

On the west side of the region, over 100,000 acres of land are underlain by shallow, semi-impermeable clay layers that prevent water from percolating downward. Soils in this region are naturally high in selenium. Inadequate natural drainage, salt accumulation, and high selenium concentrations in agricultural return flow have been long-standing problems in this area and have intensified with the importation of irrigation water from the Delta. In addition to sediment, nutrients, and food resources, the San Joaquin River is an important source of herbicide and pesticide loading to the Delta.

7.1.1.6 SWP and CVP Service Areas Outside the Central Valley

Historical Perspective. As rainfall and moisture diminish southward along the California Coast and south of the Tehachapis, runoff decreases and rivers are accordingly smaller in size. Historically, in the SWP and CVP Service Areas Outside the Central Valley, rivers and streams only maintained year-round flows near their headwaters. At river mouths, groundwater accretion and agricultural runoff may have provided the only source of water flow during the summer months.

The Los Angeles Basin, formed by the Los Angeles, San Gabriel, and Santa Ana rivers, has been the site of extensive urbanization. Streams in the region have been contained within levees or concrete channels because they were subject to periodic flooding.

Existing Conditions. The SWP and CVP Service Areas Outside the Central Valley include reservoirs, streams, and estuaries in areas that receive water exported from the Delta.

7.1.2 Environmental Consequences: Fisheries and Aquatic Ecosystems

The presentation of impacts is organized by alternative and subdivided into ecosystem-level and species-specific impacts. The ecosystem-level analysis focuses on change in functional and structural characteristics. Discussion of species-specific impacts focuses on changes in conditions that may affect species abundance and distribution.

The actions included in the CALFED alternatives affect physical, chemical, and biological features of the aquatic ecosystem. The changes will be described using qualitative data, which include general descriptions of the effect of the CALFED

actions; measured data, such as floodplain acreage or river length; and modeled data, such as simulated flow, reservoir storage, and diversion. Functional and structural characteristics are evaluated to determine beneficial or adverse impacts of an action. The characteristics were selected based on:

- sensitivity to change in environmental variables that enables at least a qualitative comparison of the alternatives at the programmatic level of analyses;
- availability of supporting data, including current and historical data or professional judgement; and
- fair and consistent applicability to all alternatives.

Existing social and economic values preclude the restoration of the current ecological landscape of the CALFED study area to prehuman disturbance levels. Consequently, CALFED actions are considered beneficial if the changes in structural and functional characteristics result in an ecosystem that emulates a natural, functioning, self-regulating system that is integrated with the ecological landscape in which it occurs.

In an effort to capture the "big picture" of beneficial and adverse impacts of the CALFED Program, alternatives were assessed at the ecosystem level by evaluating changes in functional and structural characteristics of the system. The needs of individual species cannot be ignored, thus effects of changes in the environmental variables on species-specific needs are also assessed.

Flows, diversions, and reservoir operations were simulated on a monthly timestep for the Sacramento-San Joaquin River system. The DWRSIM studies used in the assessment of alternatives include: 469 (existing conditions), 516 (No Action Alternative), 518 (Alternatives 1A and 1B), 528 (Alternative 2A), 529 (Alternative 3A), 530 (Alternative 2D), 531 (Alternative 1C), 532 (Alternatives 2B and 2E), 533 (Alternatives 3B and 3H), and 534 (Alternatives 3E and 3I). DWR studies provided simulated flow in specific Delta channels and mass tracking information. DWRDSM studies used 16 years of hydrology from DWRSIM study 472B and focused on change in Delta structure and diversion location under Alternatives 1A and 1C; and 2B, 2D, 2E, and 3E.

The assessment relationships that follow generally indicate beneficial impacts. For most relationships, the opposite action or condition would have adverse impacts.

7.1.2.1 Ecosystem Level Analysis

Functional Characteristics. Functional characteristics are the processes that contribute to the development and maintenance of the Bay-Delta river system. Ecosystem processes act directly, indirectly, or in combination to shape and form the ecosystem. Functional characteristics included in the programmatic impact assessment are flow; water temperature (heat transfer and storage); sediment, nutrient, and contaminant input and movement; and productivity.

Flow. Flow affects a multitude of physical, chemical, and biological processes that operate within stream and estuarine channels and is a primary driving force within the riverine ecosystem. Restoration of the basic hydrologic features reactivates and maintains ecological processes and structures that sustain healthy fish, wildlife, and plant populations.

Beneficial impacts on flow-related processes include:

- flow variability that approximates the natural seasonal flow variability, including effects of Delta outflow on natural seasonal variability in salinity distribution; and
- flow conditions in Delta channels, including net and tidal flow effects, which emulate natural channel flow conditions.

Changes in flow that approximate the natural seasonal pattern are assumed to restore flow-related processes in the aquatic ecosystem, including residence time and transport rates. In Delta channels, flow pattern includes net flow direction and tidal flow. The natural net flow direction for Delta channels is toward Suisun Bay. Tidal flow in the Bay-Delta is also affected by change in structural characteristics. Tidal flow affects essential processes associated with mixing, cycling, and movement. Re-establishing historical tidal connections and restoring the natural structure of the Delta are assumed to restore essential processes associated with tidal flow.

The Bay-Delta ecosystems are characterized by short-term, seasonal, annual, and long-term variability in salinity. Natural variability in salinity distribution is important to maintaining a healthy estuarine ecosystem. Salinity affects a multitude of ecological processes, including those affecting the distribution and abundance of wetland vegetation and other aquatic organisms. Flow is the primary determinant of salinity distribution. Changes in Delta outflow and the resulting salinity distribution that approximate the natural seasonal pattern are assumed to restore salinity-related processes in the Delta and Bay ecosystems.

Water Temperature. Water temperature is primarily affected by heat transfer and storage. Water temperature affects a multitude of physical, chemical, and biological processes. Human-caused changes in the Bay-Delta river system have resulted in major changes in short-term and seasonal water temperature variability.

In the absence of water temperature data, implementation of actions that increase the flexibility to meet target water temperature conditions or restore natural heat transfer and storage processes are considered beneficial. Actions that increase flexibility to meet target water temperature conditions include:

- construction of multi-level reservoir release structures,
- increased carry-over reservoir storage, and
- increased volume of water dedicated for ecological flow and water temperature purposes.

Multi-level release structures improve management of the coldwater pool, allowing release of warmer water during periods of low species sensitivity or low ambient air temperature. The coldwater pool within the reservoir is conserved for use during periods of greater species sensitivity and months when river water temperatures may exceed species needs. Similarly, increased carry-over storage and increased volume of water dedicated to flow and water temperature needs may increase the coldwater pool or increase the ability to affect downstream reaches, providing water temperature within target ranges. The actions identified above are applicable to river reaches below reservoirs and would minimally affect Delta water temperature. Because of the distance from the upstream reservoirs, water temperature in the Delta is primarily driven by weather.

Actions that restore natural heat transfer and storage processes include:

- reduction or relocation of agricultural return flows,
- reduction or relocation of municipal and industrial discharge of thermal waste,
- re-establishment of natural channel structure, and
- increased length of restored riparian or SRA communities.

Reduced return flows and reduced discharge of heated municipal and industrial effluent may reduce thermal inputs to natural channels. Restoration of riparian communities, SRA communities, and channel structure will provide shading and re-establish natural heating and cooling processes.

Sediment and Nutrient Input and Movement. Input and movement of sediment and associated nutrients are important processes affecting the development and maintenance of the Bay-Delta river system. Re-establishing conditions that approximate natural sediment delivery to and movement within the system have beneficial impacts. Actions that re-establish natural sediment supply and movement include:

- remove dams and other barriers to sediment and nutrient movement;
- cease or limit sediment extraction, such as gravel mining and dredging;
- re-establish natural channel structure;
- improve watershed management;
- restore riparian, shaded riverine, marsh, and floodplain communities;
- implement Best Management Practices during construction activities; and
- establish flow patterns consistent with sediment movement dynamics required to maintain desired biological communities.

Several of the actions re-establish pathways for sediment movement. Dams retain sediment, preventing movement from the upper watershed to downstream reaches. Removal of dams would reconnect the supply of sediment to downstream reaches of rivers and the estuary. Limits on sediment extraction would also increase the supply of sediment to downstream reaches. Re-establishment of natural channel structure, including floodplain connections and river meanders, restores processes affecting movement of sediment within the main channel and from adjacent lands. Re-establishment of natural channel structure may include removal of levees, weirs, and bank protection.

Watershed management actions in both the upper and lower watersheds may address grazing, wildfires, agriculture, and urban development. Improved watershed management and restoration of riparian, shaded riverine, marsh, and floodplain communities would affect erosion and deposition processes, increasing sediment stability and restoring channel dynamics. Implementation of Best Management Practices during construction activities would prevent short-term increases in sediment input that may have detrimental impacts on aquatic communities through increased sedimentation or turbidity.

Human-caused changes in the Bay-Delta river system have resulted in major changes to channel structure. Although re-establishment of natural flow patterns potentially restores natural sediment input and movement processes, natural flows through the existing system could damage existing or desired biodiversity and the integrity of the aquatic ecosystem. Establishment of flow patterns requires consideration of management priorities and concurrent actions to re-establish natural channel structure and restore riparian, floodplain, wetland, and aquatic communities.

Adding gravel substrate to river reaches below reservoirs is also assumed to have beneficial impacts. Adding sediment replaces, to some degree, the natural process of gravel recruitment now interrupted by dams.

Contaminant Input and Movement. Contaminants are substances that are toxic to aquatic organisms or create conditions that adversely affect aquatic organisms in the Bay-Delta river system. Contaminants include metals (for example, mercury, copper, cadmium, and zinc); selenium; ammonia; salinity from runoff; pesticides; fertilizers; sewage; and uncharacteristically high fine sediment loading. Toxic effects may include death, reduced growth rate, and reduced fertility of individual organisms. Changes in conditions that adversely affect aquatic organisms include reduced dissolved oxygen levels in response to input of excessive nutrients from agricultural and urban runoff or sewage discharge.

Beneficial impacts on functional characteristics of the ecosystem would be achieved primarily by

reducing input of contaminants. Reduced contaminant input may be achieved through:

- development of more benign application techniques and use of less toxic agricultural and industrial chemicals;
- improved point and non-point wastewater treatment prior to discharge;
- improved watershed management; and
- implementation of Best Management Practices during construction activities.

Improved point and non-point wastewater treatment may include upgraded sewage treatment, construction of stormwater run-off storage, and discharge to constructed wetlands prior to discharge to the Bay-Delta river system. Watershed management could reduce excessive input of fine sediment, pesticides, and other material. Watershed management actions in both the upper and lower watersheds may address grazing, wildfires, agriculture, and urban development. Implementation of Best Management Practices during construction activities would prevent short-term discharge of contaminants and reduce the probability of contaminant spills.

In addition to reduced inputs, natural biological processing of contaminants may be increased by restoring marshes and wetlands. Reliance on natural processing of contaminants, however, must include implementation of monitoring and mitigation components. Monitoring should focus on detecting increased contaminant concentrations and the potential for aquatic organisms to accumulate, magnify, transform, and mobilize contaminants to the detriment of aquatic communities or individual organisms. The mitigation should include potential actions to reduce or eliminate input of contaminants and remove contaminants accumulated in sediment or vegetation.

Although reduced input is the primary avenue for beneficial impacts related to contaminants, actions that minimize adverse impacts may also be implemented. Adverse affects of contaminants may be minimized through:

- avoiding discharge of contaminants during sensitive periods;
- relocating discharges to less-sensitive areas, and
- discharge of dilution flows.

Some species or life stages are sensitive to specific contaminants. Discharging contaminants when sensitive species are not present or relocating the discharge to areas not supporting sensitive species would minimize adverse affects. Dilution flows reduce the concentration of contaminants (such as salts from agricultural return flow to the San Joaquin River). Dilution flow may be achieved by increasing reservoir releases, reducing diversion, or operating barriers to direct flow along pathways receiving contaminants. Dilution may not coincide with other flow needs associated with reactivation and maintenance of ecological processes and structure, and may have limited ecosystem benefits because contaminants continue to enter the ecosystem.

Productivity. Productivity is the capacity of the aquatic ecosystem to produce a product of interest (for example, a species population or group of species). The capacity of an ecosystem to produce a product of interest depends on basic energy and material resources, both those developed within an ecosystem and those introduced from external sources. Changes in energy and material resources inevitably lead to changes in the abundance of species and changes in ecological communities. Healthy fish, wildlife, and plant populations in the Bay-Delta river system are dependent on the maintenance and improvement of processes that affect productivity.

The complexity and magnitude of energy and material transfer through the ecosystem has limited the description of cause and effect productivity relationships to relatively simple controlled studies. Pathways of energy and

material transfer through the Bay-Delta river ecosystem may eventually be described in qualitative terms. Quantifying rates of food consumption, assimilation, respiration, growth, and production through all trophic pathways in the ecosystem is not possible. Although results will be speculative, impacts of project actions on productivity of the Bay-Delta river system warrants consideration because human activities substantially affect productivity, including changes in species abundance.

Through density-dependent relations, an increase or decrease in the basic energy and material resources changes the abundance of food, affects the abundance of species and changes production-biomass relationships. Even small changes in basic energy and material resources (such as, input of organic material) may cause substantial changes in the capacity of the Bay-Delta river ecosystem to produce organisms, altering aquatic communities and affecting species abundance. The qualitative assessment of project actions on productivity is based on the assumption that project actions are beneficial if structural and functional characteristics of the aquatic ecosystem are restored, including reduction of human-induced stresses. Actions assumed to have beneficial impacts on productivity include:

- reduce the loss of nutrients and organisms to diversions,
- reduce input of contaminants;
- re-establish basic hydrologic features, including flow variability and residence time;
- re-establish conditions that approximate the natural sediment and nutrient delivery to the system; and
- restore structural characteristics to approximate the natural structural characteristics of the aquatic ecosystem.

Diversions remove material from the ecosystem, affecting the capacity of the ecosystem to produce products of interest through direct reduction of both food and species abundance. Adverse impacts of diversions on productivity may be lessened through reduced diversion volume, relocation of diversions to locations outside of the range for species of interest, reoperation of diversions to avoid sensitive periods (such as, during periods of high biomass or susceptible life stages), and installation of fish protection facilities (such as, fish screens).

Input of contaminants may increase mortality or decrease reproduction and growth, reducing food and species abundance. Actions that reduce contaminant input are discussed under "Contaminant Input and Movement."

Re-establishing basic hydrologic features, in combination with re-establishing natural sediment and nutrient delivery and restoration of structural characteristics, moves the system toward natural ecosystem conditions. Variability in the levels of energy and material resources derived from within and introduced from external sources will be more consistent with variability in a natural system, potentially improving conditions for species native to the system. Increased productivity for products of interest, however, is speculative because of the complexity and magnitude of energy and material transfer through the ecosystem and potential effects of historical conditions, introduced species, and ongoing human perturbations.

Structural Characteristics. Structural characteristics refer to the physical components of the Bay-Delta river system and their spatial relationships to one another. The analysis of structural characteristics is restricted to distinct surface and subsurface features (for example, floodplain, flooded islands, dead-end sloughs, river channels, riparian communities, tidal marsh). Re-establishment of natural structural characteristics is considered to have a beneficial impact. Actions assumed to restore or re-establish natural structural characteristics include:

- restore area, volume, and length of surface and subsurface features of the aquatic ecosystem;

- re-establish channel density and complexity;
- increase the ratio of natural to protected levees and banks;
- increase the ratio of unconstrained river or channel reaches to reaches constrained by levees;
- increase the length of river or Delta channels not blocked by dams and other barriers; and
- increase the ratio of floodplain acreage subject to unconstrained flooding to floodplain acreage separated from the river by levees and weirs.

Beneficial impacts of changes in the structural characteristics described above are primarily reflected in the preceding discussions under "Functional Characteristics" and in the "Species-Specific Analysis" that follows. Structural characteristics substantially affect functional characteristics of the aquatic ecosystem, including flow, water temperature, sediment and nutrient input and movement, contaminant input and movement, and productivity.

7.1.2.2 Species-Specific Analysis

All aquatic species in the Bay-Delta system have an intrinsic value as components of biological diversity. Several species in the system also have significant social and political value, including value to commercial and sport fisheries. The method for assessing the effects of CALFED actions on representative species is described in this section and includes integration of species-specific relationships with the ecosystem-level analysis described above.

Assessment relationships are grouped into eight categories: habitat, water quality, entrainment, water surface level, movement, species interactions, artificial production, and harvest. Species and life-stage needs, along with geographical and seasonal occurrence, determine application of the species-specific relationships identified below.

Physical Habitat Relationships. Physical habitat includes the resources and conditions present in an area that allows an organism to survive, grow, and reproduce, including spawning areas, rearing areas, and migration pathways. In the project area, habitat loss and degraded value have been major factors in the decline of many species. Providing habitat is critical to maintaining and increasing abundance and distribution of all representative species.

Physical habitat relationships focus primarily on habitat abundance. Habitat abundance refers to abundance of specific resources that are used by an organism. For example, increased area of spawning gravel increases the spawning habitat abundance for chinook salmon. Increased habitat abundance is assumed to have beneficial impacts on a species (that is, increased habitat improves survival, growth, and reproductive success). Re-establishment of natural river dynamics and restoration of natural ecosystem structure is assumed to increase habitat abundance. Depending on the species, specific actions to increase habitat abundance include:

- breach, setback, or remove of levees and hard bank protection (such as, rip-rap) in the Delta and along rivers;
- increase length of river or Delta channels not blocked by dams and other barriers;
- improve habitat conditions attributable to flow, water temperature, and salinity variability that more closely approximates natural conditions or specific needs of a species;
- establish riparian, wetland, and aquatic plant communities;
- add gravel to selected stream reaches; and
- increase reservoir storage, including new and enlarged reservoirs, to provide additional habitat for reservoir species.

An increase in the area, volume, and length of habitat that results from breach, setback, or removal of levees in the Delta and along rivers and an increase in the length of river or Delta channels not blocked by dams and other barriers is assumed to provide additional habitat for the representative species. The extent of benefits to individual species will depend on the location and type of restoration relative to the spawning and rearing habitat needs of each species.

Improved habitat conditions attributable to flow, water temperature, and salinity variability that approximates natural conditions is also assumed to benefit most of the representative species. For some species, however, natural flow, water temperature, and salinity conditions may be detrimental to existing populations. Reservoirs have blocked access to most of the historical habitat used by chinook salmon and steelhead and existing populations are restricted to habitat downstream of the major reservoirs. Under natural conditions, the existing habitat may be marginal to sustain viable chinook salmon and steelhead populations; therefore, the target range for flows should reflect the needs of individual species.

Gravel is added to stream channels to create and enhance spawning habitat for chinook salmon and steelhead. Increased spawning habitat is assumed to benefit chinook salmon and steelhead in the affected river. The magnitude of the benefit and the relative need for additional or enhanced habitat cannot be determined with the available information, but the level of impact may be based on the proportional change in habitat relative to existing habitat abundance.

The actions above are assumed to increase habitat abundance and benefit species of interest. Incomplete knowledge of species needs and unpredictable responses to actions, however, may adversely impact some species. Habitat in close proximity to diversions may be of minimal value because individuals or food organisms may be lost to entrainment. Habitat isolated from existing populations may not be colonized by the species of interest. Environmental conditions in affected habitats may not be consistent with a species needs (for example, depth, velocity, salinity, substrate, cover). In addition, although habitat may be created for a species of interest, the abundance of competing or predatory species may also increase, with subsequent detrimental effects on a species population (for example, interactions between silversides and delta smelt or effects of Asian clams on primary productivity).

Increased habitat abundance depends on developing knowledge of species needs and understanding of the project actions. Beneficial impacts of increased habitat abundance can be assured only through implementation programs that include adaptive management.

Water Quality Relationships. Death, reduced growth, or reduced reproductive success occur when water quality stresses the metabolic tolerances of an organism. Water quality relationships address the effects of water temperature, contaminants, and dissolved oxygen at a programmatic level. The indicators of beneficial impacts identified for water temperature, sediment supply and movement, and contaminant input and movement in the ecosystem-level analysis are applied to the species-specific analysis for water quality. Beneficial impacts at the ecosystem level on water temperature, sediment and nutrient input and movement, and contaminant input and movement are assumed to provide beneficial impacts on the representative species.

Entrainment Relationships. Water diversions cause fish mortality through entrainment, impingement on fish screens or other diversion structures, abrasion, stress as a result of handling, and increased predation. Entrainment and associated mortality is a concern for all fish species included in the impact assessment. Life stages most vulnerable to entrainment vary by species. For example, chinook salmon are most affected during fry and juvenile rearing and downstream migration. Some species are most vulnerable during the egg and larval stage. Other species, such as delta smelt, are vulnerable as larvae, juveniles, and adults because of their small size at maturity and residence near diversions.

The environmental variables considered in assessing entrainment mortality are diversion location and timing, fish screen efficiency, and predation. Actions that reduce entrainment-related losses include:

- build new or improve existing fish screens to reduce entrainment and impingement losses,
- relocate diversions to areas outside of the distribution of a species,
- relocate species distribution to Suisun Bay and subsequently reduce exposure to Delta diversions,
- re-operate diversions to avoid periods when species are present, and
- redesign diversions and associated facilities to reduce predator habitat or remove predators from habitat associated with diversion facilities.

Most life stages of the representative species are vulnerable to entrainment mortality; however, adults of the large-bodied species, such as striped bass, chinook salmon, green and white sturgeon, and American shad are minimally affected by diversion operations and facilities.

Project actions to construct and improve fish screens would reduce the loss of life stages large enough to be efficiently screened; however, fish screens would provide minimal protection for planktonic eggs and larvae. American shad and striped bass spawn planktonic eggs that are small and pass through the fish screens. American shad, striped bass, delta smelt, and longfin smelt have planktonic larvae that would either pass through the screens or, because larvae are weak swimmers, would be impinged on the screen surface.

Diversion facilities provide habitat and increased feeding opportunity for predatory fish. Project actions that implement programs to remove predators and change facility design to reduce prey vulnerability reduce predation on the representative species.

Shift in estuarine salinity may alter the geographic distribution of aquatic organisms. The occurrence of 2 ppt salinity upstream of Chipps Island shifts the primary distribution of larval and juvenile delta smelt and striped bass into the Delta. Redistributing species to Suisun Bay, through provision of conditions meeting species needs (such as salinity), reduces exposure to Delta diversions and potentially reduces diversion-related mortality.

Water Surface-Level Relationships. Short-term changes in water surface levels may result in mortality by exposing nests, stranding individuals, reducing or eliminating cover, and other means. The effects of changes in water surface levels are assessed for rivers and reservoirs.

Water surface-level fluctuation in rivers is assessed for chinook salmon, steelhead, and splittail. Water surface-level fluctuation in reservoirs is assessed for largemouth bass. Chinook salmon and steelhead lay eggs in gravel nests, splittail lay eggs on flooded vegetation, and largemouth bass lay eggs in nests in relatively shallow water near the reservoir shore. Increased frequency and magnitude of short-term water surface-level fluctuation increases mortality caused by exposure of nests, desiccation of eggs, and mortality associated with movement of larvae and juveniles into less-optimal habitat where food may be less available and vulnerability to predation may increase.

Project actions that minimize flow reduction in rivers over short time intervals are assumed to improve habitat conditions affected by water surface-level fluctuation and have beneficial impacts on affected species. Additionally, actions to reduce stranding by restructuring habitat are also considered to have beneficial impacts. Actions to reduce stranding may include filling gravel mining pits; establishing permanent connections between oxbows and sloughs and the main river channel; and contouring the flood bypasses to efficiently drain isolated ponds, rice fields, and sloughs to the main channels.

For reservoirs, monthly drawdown is calculated by comparing the surface elevation at the end of an applicable period (for example, day, month) with the elevation in the preceding period for each reservoir. Reduced rates of drawdown are assumed to reduce mortality attributable to short-term water surface-level fluctuation and have beneficial impacts on reservoir species.

Movement Relationships. Movement of organisms includes passive transport, migration, and attraction. Maintaining active or passive movement patterns is a concern for all representative species. Effects of project actions on a species is dependent on life stage characteristics. For example, the movement patterns of American shad and striped bass will be affected primarily during the planktonic egg and larval life stages. Chinook salmon, steelhead, and sturgeon are affected during up- and downstream migration of adults and juveniles.

Environmental conditions that support passive and active movement of eggs, larvae, juveniles, and adults to habitat that facilitates growth, reproduction, and survival are assumed to have beneficial impacts for the selected species. The environmental variables considered in assessing movement conditions are flow, diversion, barriers, physical habitat, water quality, and species interactions. Project actions that enhance environmental conditions supporting transport, migration, and attraction include:

- re-establish flow variability that approximates the natural seasonal flow variability or meets species needs within the constraints of the existing ecological landscape;

- re-establish flow conditions in Delta channels, including net and tidal flow effects, that emulate natural channel flow conditions or meet species needs within the constraints of the existing ecological landscape; and

- remove and modify barriers, install and improve fish passage facilities, or restore and modify channel structure to facilitate access to resources and conditions that allow a species to survive and reproduce.

Information on the need and timing for flow events is generally unavailable. Flow that emulates natural conditions is assumed to improve survival during downstream movement of juvenile chinook salmon and steelhead; striped bass eggs and larvae; sturgeon larvae and juveniles; and American shad eggs, larvae, and juveniles. Project actions that provide flow events consistent with natural flow patterns and consistent with species needs are assumed to move juvenile fish into suitable rearing areas, provide cues that reduce outmigration delay, and increase survival.

In the Delta, natural net channel conditions (such as flow toward Suisun Bay) are assumed to facilitate movement of organisms to downstream habitat more conducive to increased growth and survival. For chinook salmon of both Sacramento River and San Joaquin River origin, mortality during migration through the Delta may vary depending on pathway and existing environmental conditions. Under existing conditions, the mortality of juvenile chinook salmon that move into the Delta Cross Channel and Georgiana Slough from the Sacramento River is greater than the mortality of juvenile chinook salmon that continue down the Sacramento River toward Rio Vista. Steelhead are assumed to be affected similarly.

For San Joaquin River chinook salmon, juveniles that move with flow into Old River at Mossdale may suffer greater mortality than juvenile chinook salmon that continue down the San Joaquin River toward Stockton. Additionally, closure of Old River may increase entrainment of delta smelt, striped bass, and other species in the central and south Delta. Construction of an operable barrier on Old River at Mossdale could provide the opportunity to reduce potential mortality associated with the flow division into Old River at Mossdale.

The actions discussed above are assumed to enhance environmental conditions supporting transport, migration, and attraction, thereby

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benefitting species of interest. Incomplete knowledge of species needs and unpredictable responses to actions, however, may adversely impact some species. Implementation of actions that support movement will depend on developing knowledge of species needs and understanding effects of the actions. Beneficial impacts of actions to improve transport, migration and attractions can be assured only through implementation programs that include adaptive management.

Species Interactions. Predation occurs naturally in the system; however, fish and other aquatic organisms that are stressed by toxicants, elevated water temperatures, turbulence created by barriers or screening facilities, and other factors may be more susceptible to predation and experience artificially high mortality rates. In-channel gravel mining in the past in certain areas has also altered channel morphological characteristics and created predator habitat.

CALFED actions that reduce predator populations or reduce habitat for predators are assumed to increase survival of juvenile fish and other organisms susceptible to high predation rates. CALFED actions that reduce or eliminate the influx of non-native aquatic species in ship ballast water, and reduce the potential for influx of non-native aquatic plant and animal species at border crossings, are assumed to avoid competition, predation, and introduction of disease potentially associated with establishment of non-native species populations.

Artificial Production. Artificial production of salmon and steelhead can increase predation and competition with naturally produced populations, lower the genetic integrity of natural populations, and increase harvest rates on natural populations.

CALFED actions that address stocking practices are assumed to have beneficial impacts. Actions may include marking hatchery-produced fish, consideration of stocking location and timing relative to natural fish population sensitivity, and development of hatchery practices consistent with management needs of natural fish populations.

Harvest. Illegal and legal harvest of anadromous fish, such as chinook salmon, steelhead, and striped bass, has been identified as a factor affecting natural production. CALFED actions that address illegal and legal harvest are assumed to have beneficial impacts. Actions may include additional law enforcement, cooperative programs to increase public awareness, providing a means for reporting illegal harvest violations, and recommendations to the regulatory agencies for improved harvest practices relative to maintenance of natural fish populations.

7.1.2.3 Significance Criteria

Impacts are significant when project actions cause or contribute to substantial short- or long-term reductions in aquatic ecosystem characteristics and degrade conditions that potentially reduce abundance and distribution of species populations.

The general nature of the planning and the broad range of settings and impacts contained in the Phase II CALFED Bay-Delta Program dictate the use of qualitative thresholds of significance for the Programmatic EIS/EIR. Thresholds are phrased in qualitative terms indicating potential changes from either existing conditions or conditions under the No Action Alternative. An effect is found to be significant if it substantially degrades aquatic ecosystem processes; substantially reduces structural characteristics of the aquatic ecosystem; substantially degrades conditions affecting or potentially affecting the abundance or range of a rare, threatened, and endangered species or a species having economic or social value; or has considerable effects when viewed with past, current, and reasonably foreseeable future projects.

7.1.2.4 Comparison of No Action Alternative to Existing Conditions

The differences between the No Action Alternative and Existing Conditions result primarily from changes in water project operations in response to new or modified facilities and increased demands.

Delta Region. Although operations and surface water and groundwater storage would change under the No Action Alternative, Delta inflow and outflow would be similar to flows under existing conditions. Operations rules and demands, similar under both the No Action Alternative and existing flow conditions, would limit the ability to change flow patterns and the associated salinity distribution in the Delta.

Water temperature conditions in the Delta under the No Action Alternative would be similar to temperature conditions under existing conditions. Sediment supply and movement may be affected by actions upstream of the Delta, such as the Sacramento River Flood Control Project (SRFCP). The projects would not substantially change the structure of the existing ecosystem, and change in sediment supply and movement would most likely be minimal.

Contaminant input and movement could possibly be reduced by restoration associated with the Stone Lakes National Wildlife Refuge. Contaminant input under the year 2020 level of development, however, may increase and could negate any reduction attributable to restoration.

Increased input of urban and industrial contaminants would increase stress on biological processes (for example, reduced organism growth and fecundity, increased organism susceptibility to disease) and would have an adverse effect on species population distribution and abundance.

Relative to existing conditions, projects under the No Action Alternative that could increase biological productivity and nutrient input and movement in the aquatic ecosystem include changes in wildlife refuge operations, restoration associated with the Stone Lakes National Wildlife Refuge and SRFCP. Restoration of riparian, shaded riverine aquatic, and tidal marsh areas could slightly increase productivity through increased input of organic carbon and provide a small benefit to Delta species.

Structural characteristics of the Delta would also be similar for both the No Action Alternative and existing conditions. A project that may affect structural characteristics of the Delta ecosystem and species habitat is the Stone Lakes National Wildlife Refuge. Change in structural characteristics is considered to have a beneficial effect when the change moves toward a natural condition. Restoration of tidal marsh and connecting sloughs in the Stone Lakes National Wildlife Refuge would have small beneficial effects relative to the existing Delta aquatic system. The structural changes could result in a slight increase in spawning and rearing habitat for Delta species, including chinook salmon, Sacramento blackfish, Sacramento splittail, largemouth bass, and striped bass.

Bay Region. Under the No Action Alternative, effects on fisheries and aquatic ecosystems in the Bay Region are primarily dependent on movement of contaminants, sediment, nutrients, and production from the Delta Region. Change in simulated Delta outflow would be small and have little effect on the Bay Region ecosystem, including Suisun Marsh.

Sacramento River Region. Differences between the No Action Alternative and existing conditions would primarily be reflected by flow changes. Although operations and surface and groundwater storage would change under the No Action Alternative, Sacramento River and tributary flows would be similar to flows under existing conditions. Operations rules and demands, similar under both the No Action Alternative and existing conditions, would limit the ability to change flow patterns. Yuba River flows may be altered in response to revised regulations to improve spawning and rearing conditions, providing a beneficial impact primarily on chinook salmon and steelhead.

Water temperature conditions in most rivers in the Sacramento River Region under the No Action Alternative would be similar to temperature conditions under existing conditions. The additional flexibility for water temperature control from operation of the Shasta Reservoir Temperature Control Structure would benefit all runs of chinook salmon and steelhead trout.

Steelhead and chinook salmon are currently restricted to habitat below Nimbus Dam and migration, and rearing conditions may be adversely effected by increased water temperature associated with reduced summer flow relative to existing conditions.

The SRFCP may affect structural characteristics of the Sacramento and American rivers. Change in levee maintenance practices to allow development of natural riparian and shaded riverine aquatic communities would have small beneficial effects relative to the existing levee system. The structural changes could result in a slight increase in rearing habitat for river species, including chinook salmon, steelhead trout, and Sacramento splittail.

San Joaquin River Region. As for the Sacramento River, differences between the No Action Alternative and existing conditions reflected by simulated flow changes are minimal. San Joaquin River and tributary flows would be similar to flows under existing conditions. In the Mokelumne and Tuolumne rivers, short-term flows may be altered to improve spawning and rearing conditions, providing a beneficial impact primarily for chinook salmon.

Water quality conditions in most rivers in the San Joaquin River Region under the No Action Alternative would be similar to water quality conditions under existing conditions. The retirement of 35,000 to 45,000 acres of agricultural land could affect input of contaminants to the San Joaquin River Region. Reduced input of contaminants to the San Joaquin River would have a beneficial impact on survival and spawning success of aquatic species, including chinook salmon and splittail. Change in contaminant effects, however, would likely be minimal.

SWP and CVP Service Areas Outside the Central Valley. The 2020 level of development under the No Action Alternative, including increased exports from the SWP and CVP Delta facilities, may assist growth in SWP and CVP Service Areas Outside the Central Valley. Additional agricultural or urban development may have impacts on aquatic ecosystems in the service areas. Implementation of the CVPIA may also affect water deliveries to service areas outside the Central Valley. Specific impacts cannot be determined.

The Metropolitan Water District (MWD) Eastside Reservoir Project would create additional habitat for reservoir species. The Coastal Aqueduct and the MWD Inland Feeder Project transport Delta water to streams, reservoirs, and estuaries outside of the Central Valley. Introduction and establishment of non-native species to areas currently isolated from the Central Valley may result in adverse impacts on native species, including increased competition for resources, predation, and disease.

7.1.2.5 Comparison of Program Alternatives to No Action Alternative

The impacts to fisheries and aquatic systems resulting from the storage and conveyance program element will vary by alternatives, as discussed below. Impacts to fisheries and aquatic systems resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternatives to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternatives. In those cases where no environmental impacts have been associated with a program element within a region, the program element is not discussed.

Delta Region

Storage and Conveyance

Alternative 1. Diversions and reservoir operations, including storage and discharge, change relative to the No Action Alternative and Existing Conditions. Diversion and reservoir operations are also different under all three Alternative 1 configurations because of changes in the export facilities (Configurations 1B and 1C) and

increased storage north and south of the Delta (Configuration 1C).

Change in Delta inflow and outflow relative to the No Action Alternative would most likely be minimal. South Delta channel modifications would allow use of the full physical SWP pump capacity. The volume of acquired water would be small relative to total Delta inflow and outflow.

Under Configuration 1C, beneficial impacts could be realized by providing flow for environmental needs. Capture of additional flow for agricultural and municipal needs however, may result in adverse impacts through changes in flow that are inconsistent with natural flow patterns. In addition to operations changes, barriers would be constructed in the south Delta under the conveyance component of Configurations 1B and 1C and would have an adverse impact on structural characteristics in the south Delta.

Configurations 1B and 1C would maintain a positive flow down the San Joaquin River between Mossdale and Stockton during April and May. The survival of outmigrating chinook salmon juveniles may be increased when there is positive flow down the San Joaquin River past the head of Old River. An operational barrier on Old River may have beneficial impacts on conditions affecting juvenile and adult chinook salmon in the San Joaquin River, but adverse effects on other Delta species in the central and south Delta.

Configurations 1B and 1C may increase water surface levels and reduce variability in the affected south Delta channels. The effects of this change in stage variability on fish and aquatic ecosystems are expected to be minor. Effects on other vegetation and wetland resources, however, may be greater.

The addition of fish screens under Configurations 1B and 1C would decrease entrainment losses of all Delta species. An unknown level of predation would continue to occur in the Delta channels.

Alternative 2. Flow from the new channel constructed under Configurations 2A, 2B, and 2D could cause additional deviation from the natural flow pattern and would have an adverse impact on flow patterns in the eastern and central Delta.

Configuration 2E could have effects on flow patterns and water residence time. The impacts are contingent on operation of new facilities and the Delta Cross Canal.

All of the new connections could reduce net flow and increase water residence time in the Sacramento River channel. Adverse impacts may occur during low-flow periods because the new through-Delta connections may cause Sacramento River flow conditions in the Delta to substantially deviate from natural conditions.

The structural characteristics Configurations 2D and 2E would substantially add to restoration under the elements common to all alternatives. Under Configurations 2A and 2B, barriers in the south Delta are included in the conveyance component and would have adverse impacts on structural characteristics in the south Delta.

Restoration actions would increase aquatic habitat in the Delta under Alternative 2. Potential effects on habitat abundance for Delta species are similar to those described for Alternative 1. Under Configurations 2A, 2B, and 2D, existing good-quality shallow-water, riparian, and shaded riverine aquatic habitat in Snodgrass Slough and adjacent areas would be eliminated or modified by the through-Delta conveyance. Setback levees and erosion of the channel islands may also reduce existing habitat along the Mokelumne River channels. The replacement value of newly created habitat under Configuration 2D may replace habitat lost from the Snodgrass Slough area. The loss or change in habitat under Configurations 2A, 2B, and 2D could have adverse impacts on spawning and rearing habitat for many Delta species. Configuration 2E would not include the modifications to the Snodgrass Slough area. Configuration 2E would have beneficial impacts on habitat abundance for Delta species.

Under all configurations, mainstem Sacramento River flow would be reduced in areas downstream

of Hood and the Delta Cross Channel. Reduced flow would affect habitat quality, but the effect of habitat changes cannot be determined with the available information.

Delta flow patterns and entrainment would be altered under Alternative 2. Under the No Action Alternative, fish from the Sacramento River are drawn into the central and south Delta, where survival is lower because of entrainment and other factors. Configuration 2E could increase entrainment of Sacramento River migrants to the central and south Delta diversions relative to the No Action Alternative. Entrainment may be reduced by closing the diversion during periods of peak fish abundance.

Entrainment of egg and larval life stages cannot be effectively screened, therefore losses relative to the No Action Alternative may be increased under Configurations 2A, 2B, and 2D. Egg and larval striped bass, American shad, and splittail transported down the Sacramento River would be affected to the greatest degree. Entrainment may be reduced by closing the Hood diversion during periods of egg and larval occurrence. The Sacramento River diversion could have a significant adverse impact on striped bass. The other species would be less effected.

During drier years, splittail spawning occurs primarily in the Sacramento River and the adverse impact on the year-class could be substantial. Entrainment loss of larval and juvenile splittail would most likely have minimal effects on the population during wet years.

The screened through-Delta facility in Configurations 2A, 2B, and 2D would attract additional upstream migrating adult anadromous fish, including chinook salmon, steelhead trout, striped bass, American shad, and sturgeon. Adult chinook salmon returning to the Sacramento River basin may stray into the Mokelumne River, potentially affecting genetic integrity of Mokelumne River populations. Adult fish mortality may increase because of delay and blockage of migration.

Alternative 3. Flows in the mainstem Sacramento River downstream of the intake at Hood would be reduced in this Alternative. Reduced flow could have an adverse impact on transport of striped bass eggs and larvae and could increase mortality relative to the No Action Alternative.

An isolated facility and south Delta channel modifications would allow the use of full physical SWP pump capacity. In addition, an isolated facility may allow relaxation of the export:inflow criteria. Relative to the No Action Alternative, new storage, especially offstream storage south of the Delta, full use of the SWP pump capacity, and relaxation of export:inflow criteria would increase the potential for water transfers. Depending on the source of water transfers, Delta exports may increase, Delta outflow may be reduced, and timing of Delta inflow may be altered. Transfer of stored water in reservoirs has the potential for significant adverse impacts, potentially contributing to adverse impacts that result from existing reservoir operations.

Diversion in an isolated facility would provide the opportunity to increase natural flow patterns in the Delta. Configurations 3E and 3I have larger isolated facilities and provide greater opportunity for flow change than do other configurations. Alternative 3 would have a beneficial impact through increased natural flow patterns and water residence time.

Construction of a new connection to the Sacramento River under Configuration 3H could have affects on flow patterns and water residence time similar to that under Configuration 2E. The impacts are contingent on operation of new facilities and the Delta Cross Channel in conjunction with the isolated facility. All of the new connections could reduce net flow and increase water residence time in the Sacramento River channel. Adverse impacts may occur during low-flow periods because the new through-Delta connections may cause Sacramento River flow conditions in the Delta to substantially deviate from natural conditions.

Configuration 3I could result in flow patterns approximating natural conditions in Old and Middle rivers and the connecting sloughs. Any change in ecosystem processes associated with flow conditions under Configuration 3I would most likely be dependent on coordinated operation with a 15,000-cfs isolated facility.

Configurations 3E and 3I provide greater opportunity to avoid entrainment of production because of the larger isolated facility size. Reoperation of diversions to avoid seasonal peaks in production may also have beneficial impacts on productivity and movement.

Increased water residence attributable to reduced flow volume in the Sacramento River channel could increase productivity. In the central and south Delta, greater residence time in combination with more San Joaquin River flow remaining in the Delta could substantially increase productivity. The San Joaquin River historically carried higher nutrient concentrations than the Sacramento River. Reduced diversion of the nutrient input would increase the availability to Delta organisms. Setback levees and flooding of Delta islands would also increase residence time and area and may increase productivity.

Actions affecting structural characteristics under Alternative 3 are primarily part of the Ecosystem Restoration Program. Restoration of several thousand acres of aquatic areas in the Delta would occur under Configuration 3H and would substantially add to restoration under the elements common to all alternatives. Under Configurations 3A and 3B, barriers in the south Delta are included in the conveyance component and would have an adverse impact.

Potential effects on habitat abundance for Delta species are similar to those described under Alternative 1. Levee breaches would increase the abundance of deep- and shallow-water habitat. Spawning and rearing habitat would be increased for anadromous and resident species throughout the Delta, including delta smelt, striped bass, chinook salmon, Sacramento splittail, white catfish, and largemouth bass. The opportunity for aquatic habitat restoration is increased in this alternative.

Fish species that spawn and rear in the central and south Delta, including delta smelt, striped bass, and Sacramento splittail, would benefit under all configurations of Alternative 3. The 15,000-cfs isolated facility (Configurations 3E and 3I) would provide greater opportunities to reduce entrainment impacts compared to the 5,000-cfs facility.

Configuration 3H could increase entrainment of Sacramento River migrants to the central and south Delta diversions relative to the No Action Alternative. Entrainment may be reduced by closing the diversion during periods of peak fish abundance and diversion through the screened diversion on the isolated facility component. Entrainment of egg and larval life stages cannot be effectively screened and losses relative to the No Action Alternative may be increased under Alternative 3. Egg and larval striped bass, American shad, and splittail transported down the Sacramento River would be affected to the greatest degree. Entrainment may be reduced by stopping diversion into the isolated facilities during periods of egg and larval occurrence.

The Sacramento River diversion could have a significant adverse impact on striped bass. The other species would be less affected because the proportion of the population affected is lower. Although some shad enter the Delta as eggs or larvae, American shad rear in areas upstream of the Delta and enter the Delta at a size large enough to be effectively screened. During drier years, the adverse impact on splittail in the year-class could be substantial. Entrainment loss of larval and juvenile splittail to diversion into the isolated facility would most likely have minimal effects on the population during wet years.

In Configuration 3I, the three unscreened intakes in the south Delta could increase entrainment loss of fish from the lower San Joaquin River and the central Delta compared with the No Action Alternative. The diversion points would not be screened and the isolated channels would most

likely increase predation-related mortality. The 15,000-cfs isolated facility included in Configuration 3I provides additional opportunity to avoid entrainment-related impacts on species in the central and south Delta.

The installation of an operable barrier at the head of Old River under Alternative 3 would maintain a positive flow down the San Joaquin River. Entrainment of outmigrating fall-run chinook salmon juveniles from the San Joaquin basin may be reduced at the export facilities with the barrier in place.

In addition, the installation of the Old River barrier would increase net southerly flow toward the export facilities. This may increase entrainment of species rearing in the central and south Delta, such as delta smelt, striped bass, and splittail. An operational barrier on Old River provides the opportunity to have beneficial impacts on conditions affecting juvenile and adult chinook salmon in the San Joaquin River and other Delta species in the central and south Delta.

Alternative 3 would provide beneficial impacts on movement of Delta species. Fish species that spawn and rear in the central and south Delta, including delta smelt, striped bass, and Sacramento splittail, would benefit. The 15,000-cfs isolated facility associated with Configurations 3E and 3I would provide greater opportunities to improve conditions affecting movement compared to the 5,000-cfs facility.

Under Configuration 3I, the three unscreened intakes in the south Delta would reduce southerly flow in Old and Middle rivers; however, the unscreened intakes would be located closer to the center of distribution of many Delta species, including larval and early juvenile striped bass and delta smelt. The 15,000-cfs isolated facility included in Configuration 3I provides additional opportunity to avoid impacts on movement of species in the central and south Delta.

Flows in the mainstem Sacramento River downstream of the intake at Hood would be reduced in this alternative. Reduced flow could have an adverse impact on transport of striped bass eggs and larvae and could increase mortality relative to the No Action Alternative.

Ecosystem Restoration. Actions in the Ecosystem Restoration Program would increase survival of adult fish and reduce impacts on self-sustaining natural populations. Species likely to benefit from such actions include striped bass, sturgeon, chinook salmon, and steelhead.

The actions of the Ecosystem Restoration Program may decrease the adverse impacts associated with the establishment of non-native species populations in the Delta.

Restoration of aquatic and adjacent communities, including riparian, shaded riverine aquatic, shallow water, channel islands, and tidal marsh, would increase productivity through increased input of organic carbon. Beneficial impacts on productivity and nutrient movement upstream of the Delta would also provide beneficial impacts in the Delta ecosystem.

The conversion of some Delta islands from agricultural use to inundated wetlands and open-water habitat under the elements common to all alternatives would markedly increase the abundance of aquatic habitat for Delta species. If restored areas are located in close proximity to export facilities, are isolated from existing aquatic habitat, or provide depth or salinity unsuitable for important Delta species, the habitat value may be minimal. Under the existing Delta configuration, habitat restored in the south Delta would have the least value to Delta species. Restored habitat in the central Delta would also be of minimal value, primarily because of the effects of diversion and export, but also because setback of levees and flooding of Delta islands would create primarily deepwater habitat. More extensive restoration actions that reduce water depth and increase channel complexity could increase the habitat value.

Restored habitats in the north Delta are farthest from the export facilities, potentially include more shallow habitat with greater channel complexity,

and are in close proximity to existing more natural habitat. In addition, production from north Delta habitat is more likely to contribute to production in habitats downstream in Suisun Marsh and Bay. Because the location of restoration and the characteristics of the flooded habitat are not known, it is difficult to assess the benefits to individual Delta species. New spawning and rearing habitat may be provided for resident species in the Delta, such as delta smelt, Sacramento splittail, Sacramento blackfish, Sacramento squawfish, tule perch, largemouth bass, and white catfish. Anadromous species such as striped bass, chinook salmon, steelhead, American shad, and white sturgeon, may also benefit from the availability of additional juvenile rearing and adult habitat. However, newly created habitat may also increase the abundance and distribution of carp, inland silversides, or other non-native species that compete with or prey on native species and species with higher economic and social value (such as chinook salmon, delta smelt, striped bass).

Restoration of aquatic areas, possibly several thousand acres, may result from the breaching of levees and flooding of existing agricultural lands and from setback of levees along existing Delta channels.

Water Quality and Watershed Management. In general, water temperature conditions under all of the alternatives would most likely be similar to conditions under the No Action Alternative. The actions affecting water temperature would not likely affect the entire Delta, but may affect specific sections of some channels. Water temperature in the Delta is primarily determined by weather conditions.

Actions that address contaminant input and movement upstream of the Delta would also have beneficial impacts on the Delta ecosystem. In addition to actions identified for the Delta, improved source control and treatment of mine drainage; reduced scour of metal-laden sediments; and watershed management coordination, including improved land use practices, would reduce movement of contaminants into the Delta system.

For this programmatic document, information is insufficient to develop impact conclusions for individual species. Reduced input of contaminants would most likely benefit all Delta species.

Water Use Efficiency. The Water Use Efficiency Program is expected to result in significant benefits to fisheries and aquatic resources. These may include reduced entrainment and impingement impacts associated with reduced diversions, modifications in flow timing and reservoir releases, improved instream water quality, and water transfers directly for ecosystem purposes. Potential adverse impacts may occur if efficiency improvements result in less water available to indirect downstream uses, such as Delta outflow and wetlands and riparian habitats in drains.

Water use efficiency improvements that can result in reduced diversions can allow water to remain in source streams for ecosystem benefits. This can provide improved flow conditions for a reach of stream previously bypassed because of diversions.

Levee System Integrity. There would be impacts to fisheries and aquatic ecosystems related to the Levee System Integrity Program in the Delta Region that apply across all alternatives.

Changes in levee maintenance practices to allow development of natural riparian and marsh communities would have beneficial impacts on structural characteristics of the Delta.

Water Transfers. Water Transfers would affect fisheries and aquatic resources primarily through changes to riverine flow and water temperatures. Several factors including the source of water for a transfer, the timing, magnitude, and pathway of each transfer have a tremendous effect on the potential for significant impacts. To the extent that transfers are made directly for ecosystem purposes, fisheries and aquatic ecosystems will be beneficially impacted. Significant adverse impacts

may result from transfers between agricultural and urban uses if proper planning and management of specific transfers is not undertaken.

Coordinated Watershed Management Program. Most of the impacts to the Delta Region from upper watershed activities would be the result of activities in the Sacramento River and San Joaquin River regions, described below. Species and habitats in the Delta could be potentially impacted by water quality and quantity changes as a result of upper watershed management activities. Many potential watershed management activities are expected to improve water quality and flows in the upper watershed areas and would also improve water quality and flows in the Delta. These improvements would benefit resident and migratory fish species of the Delta. Improved flows may also benefit native vegetation in the Delta such as riparian and freshwater marsh habitat that would further benefit the aquatic resources by providing additional cover and food production.

Bay Region

Storage and Conveyance. Most of the actions affect the Bay Region through changes in the quantity and quality of Delta outflow. The effects of storage and conveyance actions are similar to those discussed for the Delta.

Ecosystem Restoration. Restoration of aquatic and adjacent communities, including riparian, shallow water, and tidal marsh, would increase productivity through increased input of organic carbon. Increased production results from increased area available to support plants, including algae and vascular plants, and increased density of plants in restored habitats. Increased input may result from re-establishing connections between terrestrial and aquatic habitats. Beneficial impacts on productivity and nutrient movement upstream of the Bay Region would also provide beneficial impacts on the Bay ecosystem.

The conversion of some managed wetlands to inundated tidal wetlands and open-water habitat would markedly increase the abundance of aquatic habitat for Bay species. The habitat value of newly inundated areas for Bay species would vary greatly depending on the location and morphological characteristics of the restored areas. New spawning and rearing habitat may be provided for resident species in the Bay and Suisun Marsh, such as longfin smelt and striped bass. Anadromous species, such as chinook salmon, steelhead, and white sturgeon, may also benefit from increased abundance of juvenile rearing and adult habitat.

Ecosystem restoration actions may decrease the adverse impacts associated with establishment of non-native species populations in the Bay, including impacts of increased competition for limited resources, predation, and disease.

Artificial production targets in the Ecosystem Restoration Program include managing artificial fish propagation programs consistent with rehabilitation of naturally producing populations, conserving ecological and genetic values, achieving recovery of special-status species, and maintaining healthy populations of other species. In general, these actions would result in beneficial impacts to longfin smelt and striped bass in the Bay Region.

Actions in the Ecosystem Restoration Program designed to reduce illegal harvest and improve sport and commercial harvest management for anadromous fish would result in increased survival of adult fish and reduced impacts on self-sustaining natural populations. Such actions include improving harvest regulations, providing additional law enforcement, developing cooperative programs to increase public awareness, and providing a means for reporting illegal-harvest violations. Species likely to benefit from such actions in the Bay Region include striped bass, chinook salmon, and sturgeon.

Water Quality. In general, water temperature conditions in the Bay Region under all of the alternatives would most likely be similar to conditions under the No Action Alternative.

Within the Bay Region, actions having beneficial impacts on contaminants are directed primarily at reducing inputs. In addition, restoration of marsh and riparian communities provides increased opportunity for biological processing of nutrients and capture of sediments entering the Bay from urban and agricultural discharges and runoff. Contaminants in the Sacramento and San Joaquin rivers and the Delta eventually enter the Bay. Actions that address contaminant input and movement upstream of the Bay Region would also have beneficial impacts on the Bay ecosystem by reducing contaminant inputs to the Bay.

For this Programmatic EIS/EIR, the contaminant information is insufficient to develop impact conclusions for individual Bay species. Reduced input of contaminants would most likely benefit all Bay species, although the pathway and magnitude of the beneficial impact cannot be determined at this time.

Water Use Efficiency. Impacts resulting from the Water Use Efficiency Program, including water transfers in the Bay Region are similar to those discussed for the Delta Region. However, because most efficiency measures will occur in the urban sector, modifications to flow timing and return flow water quality will be minimal.

Levee System Integrity. Changes in levee maintenance practices to allow development of natural riparian and marsh communities would have beneficial impacts on structural characteristics of the Bay.

Water Transfers. Water transfers to urban uses that divert from the Delta (Contra Costa, South Bay Aqueduct, North Bay Aqueduct) are expected to be coordinated to maximize the fishery and aquatic ecosystem benefits.

Coordinated Watershed Management. The impacts of coordinated watershed management activities in the Bay Region would be similar to the Sacramento and San Joaquin River regions described below.

Sacramento River and San Joaquin River Regions

Storage and Conveyance. In Alternative 1, setback of levees would restore more natural surface features associated with floodplains and meander belts.

Effective screening would reduce entrainment of all representative species in the mainstem river and tributaries. Target species for entrainment reduction include chinook salmon (all races) and steelhead.

The potential for increased reservoir storage under Configuration 1C may provide additional opportunity to reduce water surface-level fluctuations in streams and existing reservoirs. Details of reservoir operations would be needed to fully evaluate effects on water surface levels.

Development of new offstream storage would create additional aquatic reservoir habitat or groundwater recharge. Extreme water surface-level fluctuations in offstream reservoirs would probably occur, limiting the habitat value of the reservoirs for aquatic species. If diversions to fill offstream reservoirs are timed appropriately, impacts on existing stream ecosystems would be limited. Development of new onstream storage would have the greatest adverse impact on stream ecosystems, converting stream habitat to reservoir habitat and altering natural streamflow patterns. New onstream storage may also block passage of anadromous fish to upstream spawning and rearing areas.

Reduced entrainment of striped bass under Alternative 3 could reduce striped bass abundance in San Luis Reservoir and connecting canals.

Fisheries and aquatic ecosystems and impacts of Alternatives 2 and 3 would be similar to those described under Alternative 1. Most of the CALFED actions affecting the Sacramento River and San Joaquin River regions are included in the Ecosystem Restoration and Water Quality programs.

Ecosystem Restoration. Restoration actions have the potential to lessen adverse streamwater temperature conditions in the Sacramento River

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and San Joaquin River regions. Increased riparian shading and natural channel configurations, especially on small tributary streams, would provide stream temperatures that approximate more natural conditions.

Restoration actions in the Sacramento River and San Joaquin River regions would increase nutrient input into the system and increase biological productivity. Restoration of the floodplain and floodplain processes would increase the nutrient flow from terrestrial zones to the aquatic ecosystem. Meander zones would increase the interface between terrestrial and aquatic zones. Riparian restoration would increase the input of terrestrial invertebrates and nutrients into the stream system. Restoration of natural surface features would allow development of channel complexity.

Actions under the Ecosystem Restoration Program that address short-term flow fluctuations would reduce habitat loss, interruption of spawning, desiccation of eggs, predation, and stranding of juvenile fish.

Actions under the Ecosystem Restoration Program would improve conditions for upstream and downstream migration of anadromous fish. Species affected in the Sacramento River basin include chinook salmon (all races), steelhead, sturgeon, and American shad. Actions under the straying of upstream migrating adult chinook salmon and steelhead would be reduced.

Restoration actions that reduce the areal extent of invasive non-native aquatic and riparian plants and reduce the potential for influx of non-native aquatic plant and animal species at border crossings may be implemented. The actions may decrease the adverse impacts associated with establishment of non-native species populations in the Sacramento River Region, including impacts of increased competition for limited resources, predation, and disease.

Actions under the Ecosystem Restoration Program would generally result in beneficial impacts on all representative species in the Sacramento River and San Joaquin River basins. Modification or removal of gravel mining ponds to improve survival of chinook salmon would, however, reduce habitat abundance for largemouth bass and other warm-water species.

Water Quality. The Water Quality Program would also increase biological productivity in the Sacramento River Region. Reducing the input of contaminants in the region would decrease toxic effects on aquatic organisms.

Water Use Efficiency and Water Transfers. Impacts resulting from the Water Use Efficiency Program, and water transfers in the Coordinated Watershed Management Sacramento River and San Joaquin River regions are similar to those discussed for the Delta Region.

Coordinated Watershed Management. Watershed management activities can be grouped into several types. A conceptual description of the types of activities that might take place and their potential impacts are described below. Impacts can be characterized as local (those occurring in the general vicinity of project construction), and regional (those extending beyond the immediate project area).

Fisheries restoration projects could include removing migration barriers, establishing shaded riverine habitat, improving fish passage facilities or improving instream conditions. Potential negative impacts would be short term while instream work is completed. This may result in the temporary displacement of species or temporary water quality impacts such as increased siltation during construction. Long-term benefits may include improved local resident fisheries by increasing spawning habitat or increasing benthic food sources. Stream restoration projects could also benefit benthic organisms providing improved food source. Streambed restoration work may also provide additional benefits to downstream fisheries by improving water quality such as decreased turbidity, increased dissolved oxygen and decreased temperatures. Benefits may extend well downstream into other regions if

restoration projects target anadromous or migratory species.

Improving wastewater and stormwater treatment, controlling mine waste, implementing erosion control and improving forest and land use management practices would result in improved water quality conditions in streams and reservoirs. These types of water quality improvement projects could result in decreased sediment loading, increased dissolved oxygen and reduced heavy metals and would benefit both fisheries and benthic organisms in the targeted streams. Some activities such as land use management may provide stream flows that more closely approximate natural conditions, further benefitting fisheries. These water quality and quantity changes may also benefit fish and aquatic ecosystems in downstream areas as well. Adverse impacts may include temporary disturbance to aquatic resources due to construction activities, temporary erosion and siltation due to construction, and loss of vegetation at the project sites. It is assumed that the proposed activities would be designed to avoid impacts to special status species and/or sensitive habitats.

Activities might include improved maintenance of roadways, removal of old roadways, installation of erosion control structures, and improved channel improvements such as realignment, bank stabilization and revegetation. Since improvements will be made to areas already heavily disturbed it is anticipated that little or no long-term adverse impacts to aquatic resources would occur. Short-term adverse impacts to fish and aquatic ecosystems might include increased erosion and siltation during construction. These impacts are expected to be restricted to construction periods and local in nature. Long-term impacts would include improvements in downstream water quality including decreased turbidity and increased dissolved oxygen benefitting local and downstream fisheries and benthic organisms. Removal of roadways would also increase natural vegetation and reduce access, and would thereby minimize human disturbance to fish and aquatic resources.

SWP and CVP Service Areas Outside the Central Valley. Implementation of the CALFED alternatives would most likely have minimal impact on fisheries and aquatic resources in streams, reservoirs, and estuaries in SWP and CVP Service Areas Outside the Central Valley. Although the volume and quality of water exported may increase, organisms transported with the water and the destination of the water would be the same as under the No Action Alternative. Actions that address introduction of non-native species to the Bay-Delta system would limit introduction to areas receiving SWP and CVP water.

Operations rules and demands are the same under the No Action Alternative and Alternatives 1, 2, and 3 and would limit the ability to change patterns of delivery to SWP and CVP service areas. Additional water delivered to the SWP and CVP service areas may induce municipal, industrial, or agricultural development and impact aquatic resources. Impacts require detailed site-specific information on delivery areas, potential for increased development, and vulnerable aquatic resources.

7.1.2.6 Comparison of Program Alternatives to Existing Conditions

Comparison of Program Alternatives to existing conditions indicates:

- All potentially significant adverse impacts that were identified when compared to the No Action Alternative would still be considered significant when compared to existing conditions. In general, these impacts would result from the disturbance of aquatic habitat associated with the construction and operation of new facilities or by land use changes. Such project-related consequences are not dependent on whether the basis of comparison is existing conditions or the future conditions associated with the No Action alternative.

- No additional significant environmental consequences have been identified when

program effects are compared to existing conditions as opposed to No Action.

- The beneficial effects of the program would still be beneficial when compared to existing conditions. Many of the beneficial effects would be related to habitat enhancements associated with the ecosystem restoration program element. These effects are beneficial compared to existing conditions, and even more beneficial when considered with respect to future demands on the ecosystem.

In summary, the conclusions regarding the significance of project effects on fisheries and aquatic habitats when compared to existing conditions would be similar to those compared to No Action.

The biologic environment is complex with many unique interrelationships about which little is known. There is uncertainty involved in anticipating the effect of Program actions on the ecosystem. Because of the lack of knowledge on how the ecosystem may respond to Program actions, it is possible that restoration actions may fail to achieve the Program objectives. It is possible that individual projects may cause some negative impacts in achieving its ultimate objective. The adaptive management program is intended to address these uncertainties. Adaptive management is a key component of the CALFED Program as it provides a decision support system for stakeholders and resource managers. Adaptive management addresses risks and uncertainties by increasing opportunities to redirect management with new information. More information on adaptive management can be found in the Phase II Report Technical Appendix.

7.1.2.7 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

The impact assessment for fisheries and the aquatic ecosystem is based on available information. Detailed information on CALFED actions or responses to the actions are sometimes unavailable. Because of the uncertain results of actions affecting the ecosystem, CALFED actions will be implemented through adaptive management. Adaptive management includes identification of indicators of ecosystem health, phased implementation of substantial project actions, comprehensive monitoring of the indicators, and a commitment to remedial actions necessary to avoid, minimize, or mitigate immediate and future adverse impacts of project actions on ecosystem health. The following section summarizes potential mitigation measures by impact. Mitigation measures would be part of an adaptive management program implemented to achieve the intent of the CALFED Bay-Delta Program and the major ecosystem-quality objectives.

Additional CVP and SWP exports from the south Delta would increase entrainment loss and increase net reverse flow in Old and Middle rivers, potentially reducing productivity and disrupting migration of fish species. Impacts of increased export could be minimized by shifting the timing of diversions to periods when species are less vulnerable, such as when the proportion of the population in the vicinity of the diversion is small or when individuals are relatively large and fish facilities are more efficient. Timing could be dependent on time of year (such as August to October) or restricted to periods of relatively high inflow. Impacts of increased export from the south Delta could be avoided through change in location of the diversion point, similar to conveyance components included in Alternative 3.

The screened through-Delta facility and isolated facility intakes would cause entrainment-related mortality for Sacramento River fish. The significance of the impact is uncertain. A monitoring program would be implemented to determine the mortality attributable to the fish screening facility. Mortality thresholds would be established through consultation with USFWS, NMFS, and DFG. Actions would be implemented

to avoid mortality in excess of the mortality thresholds and could include:

- improved facility design,
- implementation of predator removal programs,
- change in location of the diversion point (for example revert to the conditions under the No Action Alternative), and
- shift in timing of diversion to periods when species are less vulnerable, such as when the proportion of the population in the vicinity of the diversion is small or when individuals are relatively large and fish facilities are more efficient.

Through-Delta facilities would increase cross-Delta flow, potentially reducing productivity and increasing mortality of fish. The significance of the impact is uncertain. A monitoring program would be implemented to determine the mortality attributable to movement into the Mokelumne River channels. Mortality thresholds would be established through consultation with USFWS, NMFS, and DFG. Actions would be implemented to avoid mortality in excess of the mortality thresholds and could include:

- change in location of the diversion point (for example revert to the conditions under the No-Action Alternative), and
- shift in timing of diversions to periods when the proportion of the population drawn into the Mokelumne River channels is small.

Through-Delta facilities and isolated facility would increase the proportion of flow and fish drawn off the Sacramento River and into Georgiana Slough, reducing survival of chinook salmon and steelhead. Mitigation is similar to that described for the preceding impact.

Through-Delta and the isolated facilities would reduce Sacramento River flow and shift X2 upstream, potentially reducing survival and habitat quantity and quality for striped bass, delta smelt, and other species. The significance of the impact is uncertain. A monitoring program would be implemented to determine the shift in X2 attributable to reduced net Sacramento River flow past Rio Vista and effects on distribution of Delta species (such as delta smelt and striped bass). Monitoring would also determine the change in species mortality attributable to reduced Sacramento River flow, focusing primarily on chinook salmon and striped bass. Actions would be implemented to avoid mortality in excess of specific mortality thresholds and to avoid shift in distribution that may be detrimental to species survival. Mitigation actions could include:

- change in location of the diversion point (for example, revert to the conditions under the No-Action Alternative), and
- shift in timing of diversions to periods when the proportion of the population affected is small.

Adult fish bound for the Sacramento River would be attracted by cross-Delta flow into the Mokelumne River channels and their return to the Sacramento River would be blocked by fish screens. Impacts of through-Delta facility screens on adult migration could be minimized by shifting the timing of diversions to periods when potentially affected species are least abundant. Based on monitoring to determine the response of adult fish to migration cues, through-Delta diversions could be contingent on the magnitude of Sacramento River flow and the relationship to attraction of adult fish along specific migration routes through the Delta. Impacts of attraction could also be minimized through design that facilitates movement of adult fish past the screened facility, including construction of fish bypasses or trapping and transport of adult fish.

New isolated facility intakes along the San Joaquin River would increase entrainment loss, potentially reducing productivity and disrupting migration of fish species. Diversion from new isolated facility intakes along the San Joaquin River would be contingent upon development of

an intensive monitoring program that conclusively indicates beneficial change in potential entrainment, fish distribution, and flow conditions. If specific criteria are not met or cannot be substantiated, exports would occur from facilities consistent with the No Action Alternative or from an isolated facility diversion point off the Sacramento River. Diversion from the isolated facility diversion point off the Sacramento River would require implementation of mitigation identified for isolated facility impacts above.

Operation of an intertie between the existing CVP intake and Clifton Court Forebay may increase entrainment of organisms from the south Delta. Exports with operation of the intertie would be contingent on the development of an intensive monitoring program that conclusively indicates beneficial changes in potential entrainment, fish distribution, and flow conditions. If specific criteria are not met or cannot be substantiated, exports would occur from facilities consistent with the No Action Alternative.

South-Delta barriers potentially reduce connectivity to other Delta channels, reduce water quality conditions, and increase loss of nutrients and organisms from south-Delta channels. Mitigation could include restoration of equivalent areas through setback levees and island flooding in the south and central Delta. Operation of barriers would be contingent on development of an intensive monitoring program that conclusively indicates beneficial change in potential entrainment, fish distribution, water quality, and flow conditions. If specific criteria are not met or cannot be substantiated, the barriers would be operated to provide conditions consistent with the No Action Alternative.

Construction of a through-Delta facility would modify and destroy spawning and rearing habitat for splittail, delta smelt, and other Delta species. Mitigation could include restoration of equivalent areas through setback levees and island flooding in the eastern and north Delta. Reconstruction of aquatic areas associated with Storage and Conveyance under variation 2D may mitigate this impact. Aquatic communities would need to meet specific restoration objectives. A monitoring program would be implemented to determine sufficiency of mitigation actions and need for additional remedial actions.

Diversion to fill new offstream reservoirs could increase entrainment loss of juvenile fish. Impacts could be minimized by restricting the timing of diversions to periods when species are less vulnerable, such as when the proportion of the population in the vicinity of the diversion is small or when individuals are relatively large and fish facilities are more efficient. Timing could be dependent on time of year (such as August to October) or restricted to periods of relatively high river flow. Impacts could be avoided through change in location of the diversion point. Diversions could be directly from the most upstream reservoirs, avoiding entrainment effects on anadromous species.

Reoperation of upstream reservoirs to meet downstream flow needs potentially increases water temperature, increasing spawning and rearing mortality for chinook salmon and steelhead. Impacts could be avoided or minimized through implementation of reservoir operations criteria that maintain sufficient carry-over storage and stream flow to meet water temperature needs of chinook salmon and steelhead. Related actions could include water transfers, increased water use efficiency, and construction of water temperature control structures.

7.1.2.8 Potentially Significant Unavoidable Impacts

Most of the impacts identified in this assessment can be avoided, minimized, or mitigated. Some impacts, however, irreversibly affect ecosystem structure and species habitat. Construction and operation of new reservoirs, depending on location, could eliminate existing spawning and rearing habitat. Loss of aquatic species habitat, particularly anadromous salmonid habitat, is a significant adverse impact that cannot be mitigated. Reservoir sites should be constructed in areas not currently supporting spawning and rearing habitat for anadromous species.

Actions that destroy or modify existing ecosystem structure and species habitat include: breach, setback, or removal of levees and hard bank protection; establishment of riparian, wetland, and aquatic plant communities; addition of gravel to selected stream reaches; and construction of through-Delta facilities, south Delta barriers, diversion facilities, and other channel "improvements." Although re-establishment of ecosystem structure and species habitat is assumed, the value of enhanced or re-established habitat to a species will vary greatly depending on location and morphological characteristics. If reestablished habitats are located in close proximity to export facilities, are isolated from existing habitat, lack components critical to species needs, or provide habitat for competing or predatory species, the habitat value may be minimal.

Incomplete knowledge of species needs and unpredictable responses to restoration actions may adversely impact some species and cause unavoidable impacts. Avoiding habitat loss depends on developing knowledge of species needs and understanding of the project actions. Avoiding adverse impacts of habitat loss can be assured only through implementation programs that include adaptive management.

In addition to actions directly affecting ecosystem structure and species habitat, additional water supply may increase urban and industrial development and cause additional loss and degradation of the aquatic environment through increased contaminant input, increased incidence of human-caused disturbance, and other factors. The adverse impacts may be unavoidable because they are indirect and often not site specific. Development of mitigation for growth-inducing factors requires information currently not available.

7.2 VEGETATION AND WILDLIFE

Summary

The vegetation and wildlife resources occurring within the CALFED project area can be broken down into several categories: natural and agricultural communities; special-status species, rare natural communities and significant natural areas, and waterfowl and shorebirds. Natural and agricultural communities include open water habitats, wetlands, vernal pools, riparian areas, upland communities, and agricultural lands. Special-status species are plants and animals that are recognized as rare by state and federal agencies and conservation groups. They include federally-listed and state-listed threatened or endangered species as well as species of concern. Waterfowl and shorebirds forage primarily in natural and artificial wetlands and agricultural lands within the CALFED project area. The Central Valley portion of California is the most important waterfowl wintering area on the Pacific Flyway, annually supporting approximately 60% of the flyway populations.

Vegetation and wildlife changes resulting from CALFED alternatives were assessed using electronic databases to identify which species and habitats could potentially fall within project footprints and be impacted. Potential impacts are considered to be adverse and significant if there is the possibility that important wildlife habitat or use areas (such as waterfowl), special-status species or habitats and communities of concern could be disturbed or diminished. Effects are considered beneficial if CALFED actions provide for the quantitative expansion or qualitative improvements in species, habitats, or communities.

For each alternative, species, habitats, and communities would be enhanced by some Program actions and adversely affected by others. Table 7.2-1 provides a summary of environmental impacts for all CALFED actions. Impacts from the Ecosystem Restoration Program are identified separately from other actions. Table 7.2-2 provides a summary of impacts (both beneficial and adverse) to special status species on vegetation and wildlife.

Impacts to Vegetation and Wildlife

- **No Action** conditions are forecast to be similar to existing conditions except for enhancement projects planned for future implementation.

- **Storage and Conveyance**

  Alternative 1 is expected to have minimal adverse impacts on vegetation and wildlife communities.

  Alternative 2 is expected to have greater adverse impacts on vegetation and wildlife, but will provide benefits to some species as a result of the enhancement and creation of habitat.

  Alternative 3 configurations are expected to generally have the most adverse impacts on vegetation and wildlife resulting from extensive facility construction; however, the habitat that is enhanced or created will benefit numerous species dependent on such areas.

- **Ecosystem Restoration and Water Quality Programs** will lead to improved habitats under all alternatives.

- The **Water Use Efficiency Program** may result in adverse impacts to some habitats benefitting from current inefficiencies as a result of reduced surface water runoff. Changes in crop mix as a result of increase efficiencies and water transfers may reduce the amount of wildlife friendly crops available.

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Loss or Degradation of Wetland and Riparian Communities	○	○	○	◗	◗	◗	◗	◗	◗	◗	◗	◗
Loss or Degradation of Important Wildlife Habitats and Use Areas	○	○	○	◗	◗	◗	◗	◗	◗	◗	◗	◗
Increase or Improvement of Wetland, Open Water, and Riparian Habitats	□	□	□	+	+	+	+	□	□	□	+	+
Ecosystem Restoration actions Would Increase Riparian, Wetland, and Upland Communities	+	+	+	+	+	+	+	+	+	+	+	+
Bay Region												
Loss or Degradation of Wetland and Riparian Communities	○	○	○	○	○	○	○	○	○	○	○	○
Loss or Degradation of Important Wildlife Habitats and Use Areas	○	○	○	○	○	○	○	○	○	○	○	○
Increase or Improvement of Wetland, Open Water, and Riparian Habitats	□	□	□	□	□	□	□	□	□	□	□	□
Ecosystem Restoration actions Would Increase Riparian, Wetland, and Upland Communities	+	+	+	+	+	+	+	+	+	+	+	+
Sacramento River Region												
Loss or Degradation of Wetland and Riparian Communities	□	□	◗	○	◗	□	◗	□	◗	◗	◗	◗
Loss or Degradation of Important Wildlife Habitats and Use Areas	□	□	◗	○	◗	□	◗	□	◗	◗	◗	◗
Increase or Improvement of Wetland, Open Water, and Riparian Habitats	□	□	+	○	+	□	+	□	+	+	+	+
Ecosystem Restoration actions Would Increase Riparian, Wetland, and Upland Communities	+	+	+	+	+	+	+	+	+	+	+	+
Permanent Fragmentation of Riparian Corridors from Storage Reservoirs	□	□	●	□	●	□	●	□	●	●	●	●

Table 7.2-1. Summary of Environmental Impacts Related to Vegetation and Wildlife (page 1 of 2)

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
San Joaquin River Region												
Loss or Degradation of Wetland and Riparian Communities	□	□	◗	□	◗	◗	◗	□	◗	◗	◗	◗
Loss or Degradation of Important Wildlife Habitats and Use Areas	□	□	◗	□	◗	◗	◗	□	◗	◗	◗	◗
Increase or Improvement of Wetland and Riparian Habitats	□	□	+	□	+	+	+	□	+	+	+	+
Ecosystem Restoration actions Would Increase Riparian, Wetland, and Upland Communities	+	+	+	+	+	+	+	+	+	+	+	+
Permanent Fragmentation of Riparian Corridors from Storage Reservoirs	□	□	●	□	●	●	●	□	●	●	●	●
SWP and CVP Service Areas Outside the Central Valley												
Loss or Degradation of Wetland and Riparian Communities	○	○	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Loss or Degradation of Important Wildlife Habitats and Use Areas	○	○	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:
Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
○	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

[1] The magnitude of these impact issues takes into account all adverse and beneficial impacts of storage, conveyance, and all other actions with the exception of the Ecosystem Restoration program. See separate impact ratings for Ecosystem Restoration.

Table 7.2-1. Summary of Environmental Impacts Related to Vegetation and Wildlife (page 2 of 2)

IMPACT ISSUES	Habitat Type	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
		1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Bay Region													
CALFED Programs (Ecosystem Restoration, Water Quality, and Levee Stability) would increase habitat, or improve habitat quality for various special status species	*Uplands*	+	+	+	+	+	+	+	+	+	+	+	+
	Freshwater/ Saline/ Emergent Wetlands	+	+	+	+	+	+	+	+	+	+	+	+
	Agriculture	o	o	o	o	o	o	o	o	o	o	o	o
Delta Region													
CALFED Programs (Ecosystem Restoration, Water Quality, and Levee Stability) would increase habitat, or improve habitat quality for various special status species	*Riparian/ Woodland and Scrub Communities*	+	+	+	+	+	+	+	+	+	+	+	+
	Freshwater/ Saline/ Emergent Wetlands	+	+	+	+	+	+	+	+	+	+	+	+
	Grasslands/ Vernal Pools	+	+	+	+	+	+	+	+	+	+	+	+
	Agricultural Lands	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Construction, expansion, and operation of storage reservoirs could cause temporary and permanent losses of special-status species	*Riparian/ Woodland and Scrub Communities*	□	□	□	□	□	□	□	□	◗	◗	◗	◗
	Freshwater/ Saline/ Emergent Wetlands	□	□	□	□	□	□	□	□	◗	◗	◗	◗
	Grasslands/ Vernal Pools	□	□	□	□	□	□	□	□	□	□	□	□
	Agricultural Lands	□	□	□	□	□	□	□	□	◗	◗	◗	◗

Table 7.2-2. Summary of Environmental Impacts to Listed and Proposed Species (page 1 of 4)

IMPACT ISSUES	Habitat Type	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
		1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Channel modification and other changes to conveyance could cause temporary and permanent losses of special-status species	*Riparian/ Woodland and Scrub Communities*	□	□	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
	Freshwater/ Saline/ Emergent Wetlands	□	□	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
	Grasslands/ Vernal Pools	□	□	□	o	o	o	o	o	o	o	o	o
	Agricultural Lands	□	□	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Sacramento River Region.													
Ecosystem Restoration would increase habitat, or improve habitat quality for various special status species	*Riparian*	+	+	+	+	+	+	+	+	+	+	+	+
	Freshwater Marsh	+	+	+	+	+	+	+	+	+	+	+	+
	Grasslands/ Vernal Pools	+	+	+	+	+	+	+	+	+	+	+	+
	Uplands/ Woodlands	+	+	+	+	+	+	+	+	+	+	+	+
	Agricultural Lands	o	o	o	o	o	o	o	o	o	o	o	o
Construction, expansion, and operation of storage reservoirs could cause temporary and permanent losses of special-status species	*Riparian*	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗
	Freshwater Marsh	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗
	Grasslands/ Vernal Pools	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗
	Uplands/ Woodlands	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗
	Agricultural Lands	□	□	o	□	o	□	o	□	o	o	o	o
Construction of off-aqueduct storage could fragment important special-status species habitat	*Riparian*	□	□	●	□	●	□	●	□	●	●	●	●

Table 7.2-2. Summary of Environmental Impacts to Listed and Proposed Species (page 2 of 4)

IMPACT ISSUES	Habitat Type	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
		1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
	Freshwater Marsh	□	□	●	□	●	□	●	□	●	●	●	●
	Grasslands/ Vernal Pools	□	□	□	□	□	□	□	□	□	□	□	□
	Uplands/ Woodlands	□	□	□	□	□	□	□	□	□	□	□	□
	Agricultural Lands	□	□	□	□	□	□	□	□	□	□	□	□
San Joaquin Region													
CALFED Programs (Ecosystem Restoration, Water Quality, and Levee Stability) would increase habitat, or improve habitat quality for various special status species	*Riparian*	+	+	+	+	+	+	+	+	+	+	+	+
	Grasslands/ Vernal Pools	+	+	+	+	+	+	+	+	+	+	+	+
	Upland/ Scrub	+	+	+	+	+	+	+	+	+	+	+	+
	Freshwater Emergent Wetlands	+	+	+	+	+	+	+	+	+	+	+	+
	Agricultural Lands	○	○	○	○	○	○	○	○	○	○	○	○
Construction, expansion, and operation of storage reservoirs could cause temporary and permanent losses of special-status species	*Riparian*	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗
	Freshwater Marsh	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗
	Grasslands/ Vernal Pools	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗
	Uplands/ Woodlands	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗
	Agricultural Lands	□	□	○	□	○	□	○	□	○	○	○	○
Construction of off-aqueduct storage could fragment important special-status species habitat	*Riparian*	□	□	●	□	●	□	●	□	●	●	●	●
	Grasslands/ Vernal Pools	□	□	●	□	●	□	●	□	●	●	●	●

Table 7.2-2. Summary of Environmental Impacts to Listed and Proposed Species (page 3 of 4)

IMPACT ISSUES	Habitat Type	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
		1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
	Upland/ Scrub	□	□	□	□	□	□	□	□	◗	◗	◗	◗
	Freshwater Emergent Wetlands	□	□	□	□	□	□	□	□	□	□	□	□
	Agricultural Lands	□	□	□	□	□	□	□	□	□	□	□	□

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:
Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
o	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 7.2-2. Summary of Environmental Impacts to Listed and Proposed Species (page 4 of 4)

No Action Alternative. The forecasted changes under the No Action Alternative differ from existing conditions as a result of current species and habitat restoration and enhancement programs already in progress, as well as species and habitat restoration and enhancement programs slated for future implementation.

Storage and Conveyance. Alternative 1 conveyance facility impacts would vary by region, and would vary depending on specific location of these features. For example, conveyance facility impacts within the Delta Region could be limited to between approximately 100 and 400 acres of natural and agricultural habitats and could impact 12 to 14 special-status species, 5 rare natural communities, and 7 significant natural areas.

Potential land use changes due to the various alternatives are depicted in Chapter 5: Sections 5.2.1, 5.2.2, 5.2.3, 5.2.4 and 5.2.5.

Specific construction and operational impacts will depend on siting of storage and conveyance features. Impacts to vegetation and wildlife are anticipated, but the severity of the impacts and the specific species and habitats to be affected are yet to be determined. These impacts would be similar for all 3 alternatives.

Alternative 2 configurations have a greater impact on vegetation and wildlife resources than do Alternative 1 configurations because improvements in conveyance facilities would be more extensive. Benefits associated with construction of conveyance facilities include the creation of wetland and riparian habitats.

Configuration 3A could have the least impact and Configuration 3H the greatest impact on terrestrial vegetation and wildlife resources among the five Alternative 3 configurations. This difference is due to the fact that no storage facilities and the fewest improvements to conveyance facilities would be constructed under Configuration 3A, while storage and conveyance facilities and improvements under Configuration 3H are more substantial and could impact the greatest area of any alternative. Impacts associated with Configuration 3H, however, could substantially be offset because conveyance facilities could create aquatic wetland and riparian habitats. Configurations 3B, 3E, and 3I provide for in-Delta storage, but Configuration 3I could inundate a smaller area than Configurations 3B and 3E. Benefits associated with the construction of conveyance and storage facilities include the creation of open-water, wetland, and riparian habitats.

Ecosystem Restoration. Implementation of the Ecosystem Restoration Program would have beneficial effects on vegetation and wildlife communities. Habitats crucial for species survival could be restored or improved.

Water Quality. The Water Quality Program could benefit most special-status species by providing a cleaner water source, and providing for healthier habitats resulting from less pollution entering important and sensitive natural communities.

Coordinated Watershed Management. Upper watershed activity would mostly be local in nature. Local impacts would be short term, and might include temporary displacement or disturbance of resident species as a result of any construction activities, temporary local erosion and siltation of nearby streams and waterways, and loss of vegetation at the project site. Regional impacts may include siltation of streams and waterways. Upper watershed restoration projects may benefit local natural communities and could benefit wildlife outside the region, such as neotropical migratory birds, through habitat enhancement and expansion.

Levee System Integrity. The Levee System Integrity Program could benefit many species by protecting certain habitats from floods, but could have adverse effects on others resulting from levee construction, maintenance, and dredge deposition.

Water Use Efficiency. The Water Use Efficiency Program could result in less surface runoff available to incidental habitats that are dependent on such existing inefficiencies. Beneficial impacts to riparian and wetland habitats in some stream reaches could result from additional flows present in streams as a result of reduced diversions. Changes in crop mixes as a result of increase efficiencies and water transfers may reduce the amount of wildlife friendly crops (rice, pasture) and may increase the acreage of less wildlife conducive crops (vineyard, orchard).

Water Transfers. Water transfer measures have the potential to both beneficially and adversely impact vegetation and wildlife, depending on the magnitude and source of the transfer along with its timing and pathway. Water transfers specifically allocated for ecosystem purposes could provide beneficial impacts. Water transfers that result in land fallowing could have adverse impacts on the availability of these lands for their incidental wildlife values.

7.2.1 Affected Environment

7.2.1.1 Delta Region

Agricultural lands and associated wildlife species dominate habitats within the Delta Region. Agricultural lands occupy approximately 72% of the total land area within this region. The remaining portions of the Delta Region contain mostly open-water, wetland, and riparian habitats.

Historical Perspective. Years of agriculture and development in the Delta Region have resulted in the reduction or elimination of many natural habitats and species, especially those associated with native grasslands and tidal wetlands. Many historically dominant communities are now found only in isolated, undisturbed areas.

Natural and Agricultural Communities. Until the early 1800s, the Delta Region was dominated by approximately 400,000 acres of tidal marshland. Other wetlands and shallow backwater swamps existed behind natural river levees as winter and spring runoff entered the Delta. The Delta's more than 60 islands were mostly marshy, with some riparian areas and upland shrubs. Open-water areas were most abundant during high-runoff periods, and many reverted to shallow water and marshy habitats as runoff declined during the drier summer and fall months.

Prior to the mid-1800s, agriculture in the Delta Region consisted primarily of dryland farming and irrigated agriculture from artesian wells, groundwater pumping, and some creek canals. By the mid-1800s, Delta Region wetland and terrestrial habitats underwent extensive changes as a result of marsh reclamation for agriculture, water diversions, channelization, and levee construction. Reclamation of Delta wetlands for agricultural use was accelerated during and after the gold rush. Levees around these lands were first constructed in 1852. Since these early levees were no more than low earthen mounds, soil subsidence and other natural forces overcame these barriers, and reclaimed lands frequently flooded. By 1880, about one-fourth of the Delta Region's marsh and wetland areas had been reclaimed. Larger, more substantial levees were constructed beginning in the 1890s, and by 1900 about one-half of the Delta's historic wetland areas had been reclaimed. Extensive reclamation continued through the 1930s and 1940s. As of 1985, it was estimated that of the original 400,000 acres of tidal marshland about 18,000 acres remained.

Historically, native grasslands and vernal pools occurred in the Delta Region, but were not common. As leveed lands and agriculture increased, non-native grasslands emerged in unfarmed areas and abandoned agricultural fields.

Special-Status Species. Prior to agricultural development and reclamation of wetland habitats, the Delta Region contained diverse communities of wetland, riparian, and upland plant species. The relatively small portions of native grassland and upland areas were among the first areas of the Delta Region to be converted to agricultural lands. Two plant species once present in these habitats and now presumed to be extinct are: Mount

Diablo buckwheat (*Eriogonum truncatum*) and caper-fruited tropidocarpum (*Tropidocarpum capparideum*). Two other special-status plant species, Delta button celery (*Eryngium racemosum*) and Mount Diablo manzanita (*Arctostaphylos auriculata*), once occurred within the Delta Region but currently occur only outside the Delta Region.

The Delta Region once supported more than 250 species of wildlife. Several species that historically were present in the Delta Region are now extinct from the region, including the California condor (*Gymnogyps californianus*), grizzly bear (*Ursus horribilis*), gray wolf (*Canis lupus*), Antioch dunes katydid, Antioch weevil, Antioch Cophuran robber fly (*Cophura hurdi*), yellow-banded andrenid bee (*Perdita hirticeps luteocincta*), and Antioch sphecid wasp (*Philanthus nasalia*). The Ecosystem Restoration Program will evaluate the appropriateness of restoring experimental populations of extirpated species. Other species such as elk (*Cervus canadensis*), deer (*Odocoileus* sp.), river otter (*Lutra canadensis*), and bobcat (*Lynx rufus*) were once present in large numbers but have been reduced to small populations. Other special-status wildlife species that once occurred in the Delta Region but that are now found only outside the region include the San Joaquin dune beetle (*Coelus gracilis*), western least bittern (*Ixobrychus exilis hesperis*), western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), and greater western mastiff bat (*Eumops perotis*).

Wildlife populations were not substantially affected by humans until the mid- to late 1800s. Trapping had greatly reduced furbearer populations by 1856, and elk and deer herds were almost eliminated by 1880 as a result of market hunting and habitat destruction. Loss of wetland and associated riparian habitats diminished many other wildlife populations.

Waterfowl and Shorebirds. Resident and migratory waterfowl and shorebirds suffered perhaps the largest declines resulting from development and agriculture in the Delta Region. For example, populations of ducks are estimated to have been 40 times greater in the mid-nineteenth century than in the 1920s. The declines in resident and migratory waterfowl populations before the early 20th century have been attributed to hunting and the large-scale reclamation of tidal marshes that occurred between 1860 and 1910. Loss of wetlands in other portions of the state also contributed to these declines. Shorebirds were similarly affected by habitat changes.

Changes in agricultural cropping patterns since the 1970s have increased the quality of waterfowl and shorebird habitat in the Delta Region. Winter flooding of cornfields and other croplands to leach salts from the soil and control weeds has created favorable foraging conditions. As a result, populations of waterfowl and shorebirds in the Delta have been increasing.

Existing Conditions. Today, the Delta Region contains approximately 546,000 acres of agricultural land which dominates its lowland areas. Hundreds of miles of waterways divide the Delta Region into islands, some of which are 25 feet below sea level. The Delta Region relies on more than 1,000 miles of levees to protect these islands. Other dominant habitats in the region are valley foothill riparian and fresh and saline emergent wetlands. Species occurring in the Delta Region have survived changes and reductions to their habitats, although many species ranges and breeding populations have been reduced in size. Many species' have adapted to agricultural land uses, although agricultural lands often do not supply all life cycle requirements.

Natural and Agricultural Communities. Major Delta Region crops and cover types in agricultural production include small grains (such as wheat and barley), field crops (such as corn, sorghum, and safflower), truck crops (such as tomatoes and sugar beets), forage crops (such as hay and alfalfa), pastures, orchards, and vineyards. Vegetable crops are the most abundant crops in the region. The distribution of seasonal crops in the Delta Region varies annually depending on crop-rotation patterns and market forces. Recent

agricultural trends in the Delta include an increase in the acreage of orchards and vineyards.

Grassland and ruderal habitat are present throughout the Delta Region and are typically small in size, but can provide relatively high wildlife value because intensive and extensive agriculture has greatly reduced the available natural upland habitats. The extent of use by wildlife is dependent on the type of vegetation present and adjacent land uses. Vernal pools occur in grasslands along the fringes of the Delta Region and support a wide diversity of native plants and invertebrates. In particular, the Jepson Prairie Preserve contains vernal pools that support several special-status species.

Riparian scrub and woodland areas typically occur on channel islands, levees, and along unmaintained, narrow channel banks of Delta Region creeks, waterways, and major tributaries. The major rivers of the Delta Region include the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras. Approximately 7,000 acres of riparian vegetation occurs primarily on the levees of Delta Region islands and along the Cosumnes and Mokelumne rivers. The riparian zone along leveed islands is usually very narrow, but more extensive riparian areas occur along the San Joaquin River just below its confluence with the Stanislaus River, and along the Cosumnes River.

Seasonal freshwater wetlands include inland freshwater marshes that maintain surface water during only a portion of the year and vernal pools associated with grasslands. Seasonal wetland conditions are also created when harvested cornfields are flooded in the Delta Region during fall and winter to reduce soil salinity and control weeds. Large seasonal wetlands managed for waterfowl occur in the northwestern part of the Delta Region, west of the Sacramento Deep Water Ship Channel. These seasonal freshwater wetlands are of great importance to migratory waterfowl and shorebird populations for the forage that they provide during the fall, winter, and spring when bird populations in the Delta increase dramatically.

Non-tidal freshwater marsh occurs on the landward side of Delta Region levees and in the interiors of Delta Region islands mostly in constructed waterways and ponds in agricultural areas. Dominant non-tidal freshwater marsh species include tule (*Scirpus* sp.), bulrush (*Scirpus* sp.), cattail (*Typha* sp.), watergrass (*Echinochloa cruuggalli*), and nutgrass (*Cyperus* sp.). Common floating aquatic species include pretty water smartweed (*Polygonum amphibium*) and water weed (*Elodea* sp.).

Tidal freshwater and brackish water emergent marsh habitat is dominated by tules (*Scirpus* spp.) and cattails (*Typha* spp.) with common reed (*Phragmites australis*), buttonbush (*Cephalanthus occidentalis*), sedges (*Carex* spp.), and rushes (*Juncus* spp.). It occurs on instream islands and along mostly unleveed tidally influenced waterways. Tidal emergent marsh provides habitat for many species including the following special status species; Mason's lilaeopsis (*Lilaeoosis masonii*), Delta mudwort (*Limosella subulata*), California hibiscus (*Hibiscus lasiocarpus*), Delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), California black rail (*Laterrullus jamaicensi coturniculus*), and tricolored blackbird (*Agelaius tricolor*).

Open water in the Delta Region includes sloughs and channels in the Delta, flooded islands, ponds, and bays. Deep open-water areas are largely unvegetated; beds of aquatic plants occasionally occur in shallower open-water areas. Typical aquatic plant species include water hyacinth (*Eichhornia crassipes*) (a non-native noxious weed) and water milfoil (*Myriophyllum* sp.). Open water provides resting and foraging habitat for water birds, including loons (*Gavia* sp.), pelicans (*Pelecanns* sp.), gulls (*Larus* sp.), cormorants (*Phalacrocorax* sp.), and diving ducks. These species forage primarily on invertebrates and fish.

Special-Status Species. Generally, the distribution of plant and animal species in the Delta Region is closely linked with the distribution of one or more habitat types on which a species is dependent. A total of 19 special-status plant species occur in the

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Delta Region, 11 of which occur in grassland and vernal pools. The remaining special-status plants occur in the region's other habitat types.

Approximately 36 special-status wildlife species have the potential to occur in the Delta Region. Most of these species are associated with freshwater emergent wetlands, marshes, open water, and agricultural lands.

Several special-status invertebrates occur within the Delta Region. Vernal pools and other freshwater seasonal wetlands support several special-status crustaceans including tadpole shrimp (*Lepidurus packardi*) and fairy shrimp (*Branchinecta lynchi*). Although severely declining due to a dramatic shrinkage of suitable habitat, the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (federally listed as threatened) has been found in the Delta Region on McCormac-Williamson and New Hope Tracts. Several special-status invertebrates occur in the Antioch Dunes area.

Waterfowl and Shorebirds. Waterfowl and shorebirds forage primarily in natural and artificial wetlands and agricultural lands. The Delta supports approximately 10% of the Central Valley's wintering waterfowl and shorebird populations. Several waterfowl species are particularly dependent on the Delta, including tundra swans (*Cygnus columbianus*), white-fronted geese (*Anser albifrons*), snow geese (*Chen caerulescens*), cranes (*Grus* sp.), northern pintails (*Anas acuta*), and mallards (*Anas platyrhyncos*).

More than 30 species of shorebirds regularly use the Delta Region. Six species nest in the Delta Region, and the rest overwinter there or pass through during spring and fall migration. During the 1992-1993 winter, 28,500 shorebirds were counted in the Delta Region, primarily dunlins (*Calidris alpina*) and long-billed dowitchers (*Limnodromus scolopaceus*). Shorebirds prey extensively on invertebrates. Important foraging habitats include permanent saline, brackish and freshwater marshes, seasonal wetlands, and agricultural croplands.

7.2.1.2 Bay Region

The Bay Region is dominated by open water, tidal flats, diked managed wetlands (such as, Suisun Marsh), and some non-leveed lowlands which support wetlands that change in character from salt marsh (in the western portions) to brackish marsh (in the eastern portions). The sections below describe the vegetation and wildlife resources for the entire watershed of the Bay Region.

Historical Perspective. Wetland and terrestrial habitats in the Bay Region have undergone changes over time as a result of marsh reclamation, water diversions, industrialization, and the effects of sedimentation caused by hydraulic mining. Marsh reclamation and water diversions have not been as severe as that in the Delta Region, but extensive hydraulic mining upstream during the late 1800s resulted in the deposition of millions of cubic yards of sediment and debris into low-lying areas and channels of the Bay Region.

Natural and Agricultural Communities. Until the early part of the nineteenth century, the Bay Region was dominated by very large, productive wetlands and tidal flats, with deeper channels and open water areas that drained over 40% of the state. Although these communities are still present in the region, they have been reduced in size by development.

Some agricultural development and associated construction of levees occurred in the eastern portions of the Bay Region during the mid-1800s. The greatest adverse effect on natural communities within this region was the removal of tidal influence. The placement of levees between many wetland areas and the channels prevented water from reaching communities at the higher elevations of the wetlands as it had before when the waters advanced and subsided. Many of these communities could no longer survive and perished.

By the late nineteenth century, small shipping and manufacturing industries were established along

waterways of the Bay Region. This development further decreased wetland acreage, destroyed riparian corridors, and introduced contaminants into many remaining wetland areas. Some of the most severe wetland damage occurred as a result of filling large areas of the Bay Region in order to create additional land area for industry as well as for residential areas that became more abundant as the twentieth century progressed.

The hydraulic mining practices in watersheds upstream of the Bay Region resulted in the deposition of millions of cubic yards of sediment and debris. In addition to adversely affecting the numerous wetlands of the region, this sedimentation reduced channel depth, making dredging necessary in order to keep the waterways navigable. Dredge spoils were merely placed on top of existing levees or within wetlands and riparian areas, eliminating these areas as productive natural communities.

Special-Status Species. Prior to agricultural development and settlement of the Bay Region, diversity of plant species was higher than it has been since, but was not as diverse as in the Delta Region (although the two regions shared many of the same species). Six plant species once present in the Bay Region have been extirpated. Many of these were dependent on the tidally influenced lowlands.

Many if not all of the large mammals once present in the Delta Region were also historically present in the Bay Region. These species also met similar fates. Habitat fragmentation and destruction, as well as subsistence and market hunting, all combined to eliminate many species from the Bay Region. Some species that used the higher upland and cliff parts of the region lingered for some time into the twentieth century, but were driven off by activities associated with continued industrial and residential development.

Waterfowl and Shorebirds. The Bay Region has always been a major waterfowl and shorebird area due to its wetlands combined with the extensive open-water habitats. As with the Delta Region, the Bay Region suffered losses of wetlands and subsequently waterfowl and shorebirds, beginning in earnest during the 1800s. Development, agriculture, and water diversions were not as extensive as that in the Delta Region. Therefore, the losses of these species in the Bay Region, although severe at times, never reached the extent of the Delta Region. Much of the declines in waterfowl numbers in the Bay Region during the nineteenth and twentieth centuries can be attributed to losses incurred in other portions of the state.

Existing Conditions. The Bay Region includes the entire watershed for the San Francisco Bay. However, issues associated with the CALFED Program occur primarily in the area of Suisun Marsh and Bay and northern San Pablo Bay. Therefore, the description of existing conditions focuses on this area. Suisun Bay supports large areas of tidal flats that provide important foraging habitat for shorebirds. Suisun Marsh supports mostly saline emergent wetland, which provides habitat for salt marsh species that prefer infrequently flooded salt marsh habitat.

Natural and Agricultural Communities. The Bay Region contains extensive areas of tidal flats remaining from pre-settlement eras. Tidal flats include shoals, sandy mud bars, and portions of streambeds that are exposed at low tide. Tidal flats are largely unvegetated, although some emergent vegetation may be present. Bay Region tidal flats provide resting and foraging habitat for several bird groups. California (*Larus californicus*) and ring-billed gulls (*Larus delawarensis*) use tidal flats as resting areas. During spring and fall migration, large numbers of shorebirds congregate to forage on invertebrates in and on tidal flat substrates. Mammals such as raccoons (*Procyon lotor*) and skunks (*Spilogale* and *Memphitis* sp.) also forage on Bay Region tidal flats.

Saline emergent wetland is confined to the Suisun Bay/Marsh boundaries and along the northern shore of San Pablo Bay. Common plant species associated with saline emergent wetland include

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cordgrass (*Spartina* sp.), pickleweed (*Salicornia* sp.), and saltgrass (*Distichlis spicata*). Each plant species typically occupies a specific elevational band in relation to the mean tidal water level.

Upland communities exist on hills and plateaus which surround the Bay Region lowlands. The dominant community in these areas is non-native grassland with a varied shrub and oak overstory.

Special-Status Species. Thirty-five special-status plants have known occurrence in the Bay Region. The saline and brackish emergent marsh habitat of Suisun Marsh supports populations of two plant species that are now federally listed as endangered: Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*) and soft bird's-beak (*Cordylanthus mollis* ssp. *mollis*). Mason's lilaeopsis (*Lilaeopsis masonii*) (state listed as rare, no federally listed status) occurs in brackish or freshwater tidal marshes of Suisun Bay/Marsh.

Forty-one special-status wildlife species have known occurrence or could potentially occur in the Bay Region. The majority of these species are associated with upland grasslands and freshwater emergent wetlands and are restricted in their range because of the fragmentation and low diversity of habitats. Species such as bald eagle (*Haliaeetus lencocephalus*) and peregrine falcon (*Falco mexicanus*) are seasonal visitors to the Bay Region. Two federally listed and state-listed endangered species occur in saline emergent wetlands of the Bay Region: the salt marsh harvest mouse (*Reithrodontomys raviventris*) and the California clapper rail (*Rallus longirostris obsoletus*). The salt marsh harvest mouse is known from occurrences in Suisun Marsh, islands in Suisun Bay, and saline emergent marshes south of Suisun Bay. The California clapper rail is known from occurrences in Suisun Marsh and islands in Suisun Bay. California black rails (*Laterallus jamaicensis coturniculus*) occur in saline emergent wetlands of Suisun Marsh, islands of Suisun Bay, and saline emergent marshes of the Contra Costa shoreline. California black rails are state listed as threatened. The salt marsh common yellowthroat (*Geothlypis trichas sinuosa*) uses the tall emergent vegetation that grows in the more brackish areas.

Waterfowl and Shorebirds. The Bay Region is an important waterfowl area for the Pacific Flyway and may contain more than one million birds as they migrate through the area. Mid-winter waterfowl surveys in 1991 estimated nearly 268,700 waterfowl in the entire Bay Region, including approximately 265,000 ducks, primarily scaups (*Aythya* sp.), scoters (*Melanitta* sp.), canvasbacks (*Aythaya valisineria*), ruddy ducks (*Oxyura jamaicensis*), and northern pintail (*Anus acuta*).

The Bay Region is a particularly important area for shorebirds, supporting more shorebirds than all other California coastal wetlands combined. An estimated 300,000 to 400,000 shorebirds in the fall and 600,000 to one million shorebirds in the spring can be found in this region.

7.2.1.3 Sacramento River Region

The region contains the entire drainage of the Sacramento River and its tributaries, and extends from Collinsville in the south to the Oregon border in the north. The Sacramento River Region contains a large diversity of both lowland and upland habitats and species. Remnants of riparian communities along the Sacramento River and tributaries are all that remain of once very productive and extensive riparian areas. Wetlands occupy many areas along Sacramento River Region waterways, but are not as extensive as wetlands found in the Delta Region. On the other hand, grasslands and wooded upland communities are more abundant in this region than in the previously described Delta and Bay regions. Agricultural lands also occupy a significant portion of the Sacramento River Region. Open-water areas occur mainly on the larger waterways, and where waterways converge. The sections below describe the vegetation and wildlife resources for the upper and lower watershed areas of the region.

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Historical Perspective. Perhaps the most drastic difference between the historic Sacramento River Region and that which is present today is the lack of lush, unbroken riparian areas. Development, agriculture, fuel, and construction needs destroyed and fragmented most riparian areas, especially between the early nineteenth and mid-twentieth centuries. Native perennial grasslands covered vast areas of the region, but have since been farmed or invaded by non-native annuals.

Low-lying areas of the region were once routinely flooded, replenishing nutrients and providing water to many portions of the region not situated along waterways. However, diking and construction of levees to protect agricultural lands and the many residential areas has changed this, and many former communities dependent on the regular floods perished. Marshes and emergent wetlands were never as abundant as in the Delta and Bay regions due to inherent differences in the geomorphology of the regions, but vernal pools were important wetland resources that were historically abundant and have decreased dramatically with the agriculture and development of the last two centuries.

Natural and Agricultural Communities. Measurable, documentable changes in the natural landscape of the Sacramento River Region began soon after the Spaniards first settled in California during the 1770s. Spanish settlers introduced a wide variety of annual grasses and forbs from the Mediterranean region. Hundreds of additional non-native plants arrived from around the world during the 1800s. Many of these introduced species were aggressive and successfully out-competed the native species and settled permanently into the California landscape. Grasslands were particularly hard hit by the introduction of non-natives, especially during times of heavy grazing or drought. By 1945, most of California's grasslands were no longer dominated by native plants. The conversion of many grasslands to irrigated croplands and urban areas also contributed to the decline in native grassland. Grassland communities dominated by native bunchgrasses suffered the greatest reductions.

As with the grasslands, many Sacramento River Region vernal pools were destroyed with the development and expansion of agricultural and urban areas. Vernal pools are important and scarce communities. They develop in shallow basins that form in flat-to-hummocky terrain. Soil durapans underlying the basins prevent water infiltration and the nearly level terrain inhibits surface runoff. Saturated soil conditions cause the water table to become exposed because it is "perched" on the durapan. Hence, surface water accumulates in the basins, forming a seasonal wetland. Vernal pools are dominated by terrestrial/endemic annual species, with perennial and aquatic species often contributing significant cover. Although vernal pools are an ephemeral aquatic habitat, some invertebrates and amphibians have life histories that allow them to utilize vernal pools.

The Sacramento River Region floodplains originally supported vast riparian woodlands along the major rivers. Historical maps and accounts indicate the existence of continuous forests up to 5 miles wide along the Sacramento River, plus extensive forests on high terraces even farther from the river. Pre-settlement estimates of riparian vegetation along the Sacramento River range from 800,000 to 1,000,000 acres, not including the extensive forests along some tributaries.

Within the Sacramento River Region, riparian forests were extensively cleared within a few decades of the discovery of gold. Trees were cut to fuel boats, build and heat towns, and make way for levees, farms, and harbors. By 1939, it is estimated that nearly 90% of the historic riparian zones had been eliminated. In the mid-1980s, the area of mature riparian forest along the Sacramento River was estimated to be 2% of the estimated historical riparian forest.

The higher elevations within the Sacramento River Region are dominated by conifers and hardwoods. These areas have sustained some

development and logging, but have suffered less of a decline than the other communities of the region.

Marshes and emergent wetlands were historically more abundant within the Sacramento River Region than they are today, but never to the extent found in the Delta Region. Losses of these communities resulted from levee construction, reclamation for agriculture, construction of canals and harbors, and urban development.

Special-Status Species. Prior to the habitat and community changes resulting from settlement and development in the Sacramento River Region, there were several plants and animals present that have since been extirpated from the region. The rose-mallow (*Hibiscus lasiocarpus*) had a historical range which included the banks and backwaters of the Sacramento River as far north as Red Bluff. Since the 1840s, this species has severely declined due to habitat loss resulting from flood control, levee protection, bank protection, and erosion control projects, as well as agricultural, urban, and recreational development. Its only current Sacramento River Region existence is believed to consist of a few disjunct populations in Butte and Glenn counties.

The yellow-billed cuckoo once maintained high breeding densities in the Sacramento Valley. However, the loss of riparian habitat and widespread use of DDT and other chlorinated hydrocarbons that killed insects serving as a food source for the cuckoo led to substantial declines in cuckoo numbers. A 1977 survey concluded that no more than 200 nesting pairs remained in the state of California. Another statewide survey conducted 10 years later concluded that between 31 and 42 nesting pairs remained.

The giant garter snake (*Thamnophis gigas*) hunts and seeks cover in cattails or bulrushes along the edges of open, calm water. Exposed banks covered with grass are used for basking in the sun, and uplands dotted with rodent burrows are used for cover and refuge from flood waters. Historically, giant garter snakes inhabited flood basins, freshwater marshes, and small tributary streams along the length of the Central Valley. The drainage of wetlands and reclamation for agriculture produced substantial losses of habitat, and subsequent losses in giant garter snake abundance. Additionally, the introduction of predators, such as largemouth bass, have limited the foraging habitat of this piscivorus snake. By the 1970s, the giant garter snake was reduced to a few lowland areas in the Sacramento River Region.

Waterfowl and Shorebirds. Waterfowl in the Sacramento River Region outnumber shorebirds, and both groups have gone through population fluctuations over the last two centuries. Market hunting until the 1920s affected many waterfowl populations in the Sacramento River Region. Conversion of natural habitats to agricultural and urban uses, and drought conditions contributed to declines in numbers of waterfowl and shorebirds using the Sacramento River Region. After the mid-1930s, waterfowl populations increased in the Sacramento River Region. Favorable weather patterns on the Canadian breeding grounds and a reduction in hunters during World War II may have contributed to these increases. Also, labor shortages extended the time required for harvesting rice and other grains, which provided additional forage for waterfowl. Declines in Sacramento River Region waterfowl and shorebird populations due to unfavorable conditions on their breeding grounds occurred during the late 1950s and during the mid-1980s. Populations recovered after these periods of decline.

Existing Conditions. The Sacramento River Region contains numerous habitat types, many of which are remnants of historically larger expanses, including agricultural lands, fresh and saline emergent wetlands, riparian zones, scrubland, coniferous and hardwood forests, and native and non-native grasslands. The majority of special-status plants and wildlife in the region are associated with grasslands.

Natural and Agricultural Communities. Mixed coniferous forest is the most abundant natural

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community in the Sacramento River Region (3,690,000 acres). The lowland areas of the Sacramento River Region are dominated by agricultural land, occupying approximately 1,984,000 acres. Agricultural crops in the Sacramento River Region include grains, pasture, rice, orchards and vineyards, and vegetables. Grains and pasture are the most abundant crops in the region, at 601,000 and 442,000 acres, respectively. Approximately 242,000 acres is naturally unvegetated (barren) land in the northeast portion of Shasta County that consists of lava beds and similar substrates unsuitable for vegetation.

Estimates of riparian vegetation acreage in the Sacramento River Region vary widely. The Sacramento River Environmental Atlas documented 13,107 acres of "young trees, sub-climax, and climax native vegetation" on high and low terraces along the Sacramento River from Colusa to Keswick Dam (excluding vegetation along tributary rivers and streams). The lower 60 miles of the Sacramento River are leveed and support relatively little riparian vegetation. Approximately 157,000 acres of wetlands occur in the Sacramento River Region, comprising 1.3% of the region. Open water accounts for 122,000 acres, or 1% of the region.

Special-Status Species. Sixty-five special-status plants occur in the Sacramento River Region. The largest number of special-status plant species in this region occurs in grassland, which includes vernal pools. The next-largest number of special-status species occurs in chaparral and montane hardwood.

Thirty-nine special-status wildlife species could occur in the Sacramento River Region. The majority of these species are associated with grasslands, freshwater emergent wetlands, lakes, and rivers on the valley floor. Many of these species have been listed by federal and state wildlife agencies because of habitat loss associated with agricultural development and water projects. Grain crops also provide important habitat for species such as the Aleutian Canada goose (*Branta canadensis leucopareia*), Swainson's hawk (*Buteo swainsoni*), ferruginous hawk (*Buteo regalis*), greater sandhill crane (*Grus canadensis*), and loggerhead shrike (*Lanius ludovicianus*).

Waterfowl and Shorebirds. Private duck clubs and state and federal refuges in the Sacramento Valley provide essential habitat for wintering waterfowl and shorebirds of the Sacramento River Region. Approximately 60% of the Pacific Flyway waterfowl population winters in the Sacramento Valley. Midwinter waterfowl surveys in 1991 estimated 2,127,800 waterfowl in the Sacramento Valley, including approximately 1,432,000 ducks and 572,800 geese.

Sacramento Valley wetlands also provide important habitat for shorebirds, with more than 140,000 shorebirds counted in the valley during winter 1992 to 1993. The Sacramento Valley is particularly important to shorebirds in the spring, when 30,000 to 300,000 shorebirds use wetlands in the valley as staging areas during migration to northern breeding grounds.

7.2.1.4 San Joaquin River Region

The San Joaquin River Region has many similarities to the Sacramento River Region including terrain, climate, habitats, and species. Historic and present differences between the two regions do exist, however. For example, the San Joaquin River Region's riparian regions are not and have not been as extensive as that found in the Sacramento River Region, whereas the San Joaquin River Region has more land devoted to agriculture. Many riparian communities within the San Joaquin River Region were lost when historic waterways ran dry as water was diverted through irrigation channels and artificial drainages. Isolated riparian communities exist in the lower portions of the San Joaquin River Region, and more intact communities can be found along the eastern reaches of the region. Wetlands can be found in the northern and western reaches of the region, and are less abundant in other parts of the region. The section below describes the vegetation and wildlife

resourcesfor the upper and lower watershed areas of the region.

Historical Perspective. As with the Sacramento River Region, the San Joaquin River Region has lost most of its historic riparian areas, mostly due to agriculture. Agriculture developed early and quickly in the region and has remained the dominant land use. Historically, the lowlands were a large floodplain of the San Joaquin River that supported vast expanses of permanent and seasonal marshes, lakes, and riparian areas. Almost 70% of the lowlands has been converted to irrigated agriculture, with wetland acreage reduced to 120,300 acres.

Upland shrubs and oak woodlands that surround the San Joaquin River Region to the east, west, and south are less intact than they were prior to the twentieth century. Development and water diversions adversely affected some of these areas. Wetland areas were once very common in the northern, southern, and parts of the western reaches of the San Joaquin River Region, but since the mid-nineteenth century they have been reduced to a fraction of their historic acreage.

Natural and Agricultural Communities. Significant changes to the natural landscape in the San Joaquin River Region began during the late eighteenth century. Agriculture developed quickly, and numerous waterways were altered and channels constructed in order to irrigate these agricultural lands. Many plant communities and wetland areas were lost due to a reduction in available water. As the use of pesticides increased in the twentieth century, many wetlands were poisoned by the runoff from the agricultural communities. By the mid-twentieth century another problem, high salinity, became apparent. Repetitive irrigation and high evaporation in the low-lying areas of the San Joaquin Valley left many minerals and salts behind. Some areas became unusable for agriculture, and nearby wetlands were adversely affected by the saline runoff from these lands.

Historically, wetlands were abundant in the San Joaquin River Region's northern and southern reaches. Wetlands hardest hit by the minerals, salts, and pesticides were those in the south-central and southern portions of the region where many waterways terminated. Losses of other wetlands in the region resulted from diversion and reclamation activities associated with urban and agricultural uses.

Riparian areas along the wetlands and waterways of the San Joaquin River Region were historically not as abundant as those of the Sacramento River Region, but many dense, continuous stands were present into the mid-nineteenth century. Eventually most were cut down for human use or cleared to make way for agriculture. By 1939, nearly 90% of the region's historic riparian zones had been eliminated. An example of remnant riparian habitat is Caswell State Park. Non-native trees such as eucalyptus were introduced into the region to serve as wind breaks adjacent to many agricultural areas.

Most upland areas surrounding the San Joaquin River Region have remained more or less intact. Some of the more herbaceous shrubs and most if not all the native grasses have been overrun and out-competed by the non-native annuals. Some development and water storage and diversions have helped diminish some upland communities.

The higher elevations within the San Joaquin River Region are dominated by conifers and hardwoods. These areas have sustained some development and logging, but have suffered less of a decline than the other communities of the region.

Special-Status Species. Similar to all of the other regions, changes in the natural landscape in the San Joaquin River Region took its toll on plant and wildlife species. As with the Sacramento River Region, the rose-mallow has been adversely affected by water and levee projects, as well as agricultural and urban development in the San Joaquin River Region. Historically, the rose-mallow occurred along the San Joaquin River as far south as Lathrop, but now is limited to

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occurrences in San Joaquin County. The California jewelflower (*Caulanthus californicus*) is another plant species greatly reduced in number within the San Joaquin River Region. The historical range of the California jewelflower covered much of the Tulare basin and several adjoining valleys. Competition with non-native grasses, grazing, and agriculture led to the California jewelflower's decline. At the time it was listed as endangered in 1990, the species was known from only 10 populations. Since then, several more populations have been discovered during the recent wetter winters.

As with the Sacramento River Region, the yellow-billed cuckoo has drastically declined in the San Joaquin River Region due to the loss of riparian communities and the use of pesticides such as DDT. Similarly, the giant garter snake has suffered losses in the San Joaquin River Region due to agricultural development and loss of wetlands. The giant garter snake has been extirpated from most of the San Joaquin River Region. The San Joaquin antelope squirrel (*Ammosper mophilus nelsoni*) is endemic to the semi-arid grasslands of the western and southern San Joaquin Valley. Historically, the squirrels were distributed from southwestern Merced County, along the floor of the San Joaquin Valley to its southern end, east along the base of the Tehachapi Mountains, and north to Tipton in Tulare County. Additional populations occurred in the Cuyama Valley and Carrizo plains. Agriculture and grazing reduced favorable habitat and San Joaquin antelope squirrel populations. Approximately 74% of their habitat remained in 1945, and by 1979 less than 20% remained. More recent surveys have determined that no prime habitat for this species remains in the San Joaquin River Region.

Waterfowl and Shorebirds. Waterfowl and shorebird numbers in the San Joaquin River Region were historically greater than those in the Sacramento River Region. In addition to the factors that reduced waterfowl and shorebird populations in the Sacramento River Region, the aforementioned loss of additional wetlands in the San Joaquin River Region due to the accumulation of minerals and pesticides had a confounding detrimental effect on numbers. Initially, waterfowl and shorebird recovery in the San Joaquin River Region was not as successful as in the Sacramento River Region. Recent efforts to restore damaged wetlands, prevent harmful runoff from entering the wetlands, and manage agricultural lands to favor waterfowl and shorebirds during the winter months have aided recovery of these species.

Existing Conditions. The San Joaquin River Region is dominated by agricultural lands. The region's lowlands are similar to those in the Sacramento River Region, but tend to be more arid in places. Natural communities in the region include native and non-native grasslands, wetlands, sparse riparian zones, chaparral, mixed coniferous woodlands, and foothill hardwood woodlands. Urban areas are expanding in many former farming and agricultural towns.

Natural and Agricultural Communities. The natural terrestrial community types in the San Joaquin River Region occupy approximately 4.6 million acres out of a total land area of 8.3 million acres. Grassland, dominated by non-natives, is the most abundant natural community in this region, with 1.1 million acres, mostly on the edges of the valley floor. Valley foothill woodland is the next-most-common natural community, occupying 1.4 million acres of the foothill areas of the region. The lowland areas of the San Joaquin River Region are dominated by approximately 3.1 million acres of agricultural land. Crops include pastures, orchards and vineyards, vegetables, cotton, grains, and rice. Pastures, orchards, and vineyards are the most abundant croplands in the region. An estimated 30,800 acres of riparian vegetation existed in the San Joaquin River Region in 1977.

Approximately 138,000 acres of freshwater emergent wetlands occur in the San Joaquin River Region, mostly in western Merced County. Upland chaparral and woodland communities are drier than those in the Sacramento River Region, and have remained relatively intact compared to

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their historic extent except for some clearing for logging and grazing.

Special-Status Species. Sixty-nine special-status plant species occur in the San Joaquin River Region. The largest number of special-status plant species (18) occurs in grassland. The second-largest number of special status plant species (16) occurs in valley foothill woodland.

Forty-six special-status wildlife species occur in the San Joaquin River Region. Most of these species are associated with grasslands, freshwater emergent wetlands, lakes, and rivers that occur on the valley floor. Many of the species have been listed by federal and state wildlife agencies because of habitat loss associated with agricultural development and water projects. The kit fox and several species of kangaroo rats are examples of these species. Grain crops do, however, provide important habitat for species such as Aleutian Canada goose, Swainson's hawk, ferruginous hawk, and greater sandhill crane.

Waterfowl and Shorebirds. The San Joaquin River Region supports approximately 25% of the Central Valley waterfowl and shorebird populations and up to 30% of the wintering duck population. Winter shorebird numbers in 1992 to 1993 were estimated at 66,700 birds. Between 100,000 and one million shorebirds were estimated during annual spring staging between 1988 and 1992.

7.2.1.5 SWP and CVP Service Areas Outside the Central Valley

The SWP and CVP service areas outside of the Central Valley contain a large diversity of both lowland and upland habitats and species. Urban growth has reduced the area and connectivity of important habitats that are critical to sustaining a wide variety of unique plants and animals. The conflict between urban growth and conservation of native habitat has resulted in the listing of a number of plants and animals that were threatened with extinction. In response, local land use agencies working with state and federal fish and wildlife agencies, and development and environmental stakeholders have initiated and begun to implement large scale conservation planning efforts to reduce the conflict between development and listed species recovery.

Historical Perspective and Existing Conditions

The most dramatic difference between the historic service area and that which is present today is the fragmentation of what were once large contiguous blocks of habitat such as chamise-redshank chaparral, coastal sage scrub, grassland, oak woodland, oak savanna, southern oak woodland-forest, riparian woodland-forest, succulent scrub, sand dune habitat, alkali desert scrub, desert riparian habitat, desert wash, freshwater/saltwater marsh, and coastal strand. These habitats were located in three sub-areas; the Central Coast Service Area, South Coast Service Area, and Southern Deserts Service Area.

Natural and Agricultural Communities. Significant changes to the natural landscape in the service areas occurred in the late 1800s and early 1900s with land conversions to agriculture, a pattern similar to the San Joaquin River Region. That pattern shifted dramatically compared to the San Joaquin River Region as urban growth in the service areas starting in the 1900s began to displace agricultural lands and convert large areas of remaining native habitats.

Special Status Species. Similar to the San Joaquin River Region and the Tulare Basin, changes in the natural landscape in the service areas took a toll on plant and wildlife species. California condor, light-footed clapper rail, California least tern, Least Bell's vireo, Belding's savannah sparrow, Southwestern willow flycatcher, California gnatcatcher, Mohave ground squirrel, Morro Bay kangaroo rat, Santa Ana River woollystar, and Santa Ynez false-lupine are all examples of species that have been listed.

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7.2.2 Environmental Consequences: Vegetation and Wildlife

7.2.2.1 Assessment Methods

The plant community classification system that is used is a modified Holland system (Holland 1986). This community approach assumes that those species dependent on a plant community would generally be affected in the same direction by a particular CALFED action; that is, if a plant community is adversely affected, the associated plants and animals will most likely be similarly affected.

Some CALFED actions could have a direct effect on specific environmental variables such as flow, water quality, and substrate. Changes in these environmental variables could affect plant communities by changing rates of erosion, sedimentation, or water availability by directly creating new plant communities, or by removing or converting existing communities. These impact mechanisms may cause changes in the quality and/or quantity of plant communities and associated wildlife. Changes may also affect the number of special-status species and/or the area or quality of rare natural communities by altering existing foraging, living, and breeding areas. These changes in quality and quantity are the measures used to determine impacts of the alternatives being considered. Indirect impacts such as noise or human disturbance could also affect habitat quality but cannot be used to differentiate between alternatives at the programmatic level.

Several general categories of impact measures were used to assess the level of impact of the CALFED alternatives on vegetation, wildlife, and special-status species, including:

- Area of natural plant communities including associated wildlife and plant species;
- Quality of natural plant communities including the associated wildlife and plant species, and changes in non-indigenous/ introduced species;
- Area of agricultural land providing habitat value;
- Habitat patterns for plant communities (for example, spatial orientation of habitats, and connectivity, landscape-level diversity);
- Number of known special-status species and/or areas with a critical habitat designation;
- Area and quality of plant communities occupied by special-status species; and
- Area and quality of rare natural communities or significant natural areas.

Two types of analysis have been included to address plant community, and associated wildlife species: (1) changes in areal extent due to direct loss, conversion, or creation of plant communities; and (2) changes in quality. Changes to the areal extent of vegetation have been defined and analyzed using various tools in Geographic Information System (GIS) and hard-copy mapping that focus primarily on spatial analysis of a plant community area. The change in acreage of each plant community is used as the quantitative measure of impacts on wetland and terrestrial habitats, associated vegetation and wildlife, or species groups. The assessment of qualitative impacts on plant communities considers geographic extent, distribution, quality, and spatial configuration. A project that affects the continuity of a linear riparian plant community or drainage patterns in wetlands, for example, may have greater impact than those resulting from changes in areal extent. The severity of impacts is determined by the magnitude of changes in quality or condition of the plant communities.

Geographic comparisons have been made using electronic databases and hard-copy maps of plant community distributions. Results of this analysis provided information on the likelihood of affecting a given plant community or

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special-status species with the implementation of a particular alternative.

The best available information has been used for special-status species. The California Department of Fish and Game (DFG) National Diversity Data Base (NDDB) location information on special-status plants and animal species has been used in the analysis.

Approximate impact footprints corresponding to proposed alternative features were generated using GIS and the NDDB. A list of special-status plant and animal species potentially occurring within these footprints was produced.

The habitat requirements of each species, as defined in the literature (RAREFIND and CNPS), were used to evaluate the effect of changes resulting from alternative features on these special-status species. Each species has been identified as potentially being either positively impacts, negatively impacts, or not significantly impacted (see Table 7.2-2). Mitigation measures are presented that would minimize or eliminate these negative impacts.

It is assumed that the distribution and abundance of special-status species is proportional to the amount and quality of habitat available. Assessment of impacts is based on the potential to impact a special-status species, its critical habitat, and/or its range.

Rare natural communities and significant natural areas were treated qualitatively in part because specific data on the location of the project features in relation to specific areas or communities were not generally available. DFG mapping of vernal pools, and the NDDB and files were utilized to obtain some quantitative information regarding effects to rare natural communities.

Potential land use changes due to the various alternatives are depicted in Chapter 5: Sections 5.2.1, 5.2.2, 5.2.3, 5.2.4 and 5.2.5.

7.2.2.2 Significance Criteria

The significance of any of the CALFED actions would vary depending on the environmental setting in which the activity occurs. Thresholds of significance for a given impact may include flexible standards that recognize differences in the environmental setting. Thresholds may also be qualitative or quantitative. The general nature of the planning and the broad range of settings and impacts dictate the use of qualitative thresholds of significance at this programmatic stage. The thresholds can and will be made more definitive and more quantitative at the project-specific level.

The significance criteria identified for evaluation of impacts to vegetation and wildlife resources are:

- Temporary or permanent removal, filling, grading, or disturbance of wetlands and riparian communities (for criteria related agricultural crop loss refer to Chapter 8: Section 8.1.3.2);
- Substantial decrease in the area of important wildlife habitats or use areas in watersheds of major tributaries to the Sacramento and San Joaquin rivers;
- Substantial fragmentation or isolation of wildlife habitats or movement corridors, especially riparian and wetland habitats;
- Decrease in the amount of available forage including forage from agricultural lands for wintering waterfowl;
- Increase in the potential for outbreaks of wildlife diseases;
- The permanent loss of occupied special-status species habitat or direct mortality of special-status species;
- Reduction in the area or extent of special-status communities; and

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- Reduction in area or habitat value of critical habitat areas designated under the federal Endangered Species Act.

7.2.2.3 Comparison of No Action Alternative to Existing Conditions

Effects of the No Action Alternative are evaluated relative to the existing conditions. The time frame identified for the No Action Alternative is the year 2020. The differences between the No Action Alternative and existing conditions result from changes in water project operations in response to new or modified facilities, increased or reduced demands, changes in cropping patterns to more permanent crop types, and new water resource projects that could affect the area and quality of existing habitat. New or modified facilities include new surface water and groundwater storage, new conveyance, and modified reservoir discharge structures. Changes in demand for water could result from increased SWP and CVP needs, land retirement, full use of existing water rights, revised environmental flow needs, and increased wildlife refuge needs. Watershed management activities would be the same as existing conditions under the No Action Alternative.

Although operations and surface-water and groundwater storage would change under the No Action Alternative, inflow and outflow would most likely be similar to flows under existing conditions. Operations rules and demands, similar under both the No Action Alternative and existing conditions, could limit the ability to change flow patterns and the associated salinity distribution in the Delta. As a result, the quantity and quality of wetland and riparian vegetation in the Delta would not change appreciably. Similarly, positive and negative effects on vegetation and wildlife are expected to be comparable between the No Action Alternative and existing conditions.

7.2.2.4 Comparison of Program Alternatives to No Action Alternative

The impacts to vegetation and wildlife resulting from the storage and conveyance program element will vary by alternatives, as discussed below. Impacts to vegetation and wildlife resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternatives to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternatives. In those cases where no environmental impacts have been associated with a program element within a regions, the program element is not discussed

Delta Region

Storage and Conveyance

Alternative 1. South Delta modifications for conveyance facilities could include direct impacts related to the construction of a barrier at the head of Old River and flow and stage control facilities. Impacts resulting from construction of new access roads, control buildings, and other facilities could potentially remove and disturb natural communities that may include emergent wetland, riparian shrub and woodland, and grassland and ruderal vegetation. Specific acreages of habitats would depend on the specific design and location of facilities to be constructed.

South Delta modifications could potentially result in the removal of up to 5 acres of emergent wetland and up to 15 acres of riparian scrub and woodland, and could potentially affect up to 50 acres of ruderal vegetation. The barrier at the head of Old River, depending on how it is operated, could disrupt tidal flow sufficiently to result in the loss of tidal wetlands or change the plant species composition of wetlands upstream of the barrier.

Construction of an intertie between the Tracy Pumping Plant and Clifton Court Forebay could potentially affect emergent marsh, riparian scrub

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and woodland, and grassland and ruderal vegetation. The impacted acreages would depend on the location and design of the intertie.

Potentially affected common plant species could include Fremont cottonwood (*Populus fremontii*), various willow species (*Salix* sp.), western sycamore (*Platanus racemosa*), blackberry (*Rubus* sp.), common tule, and cattails. Associated common wildlife species that could potentially be affected include emergent wetland wildlife, riparian wildlife, and grassland wildlife.

South Delta modifications could include direct impacts on agricultural lands related to the construction of a barrier at the head of Old River and flow and stage control facilities. Impacts resulting from construction of new access roads, control buildings, and other facilities could remove agricultural communities that could include grain and hay crops, corn and sorghum, other row crops, truck crops, pasture, orchards and vineyards, and idled lands. Specific impacted acreages would depend on the selected location of the facilities. The direct potential impacts of south Delta modifications were assumed to be removal of less than 50 acres of agricultural habitats.

Potential land use changes due to the various alternatives are depicted in Chapter 5: Sections 5.2.1, 5.2.2, 5.2.3, 5.2.4 and 5.2.5.

Construction of an intertie between the Tracy Pumping Plant and Clifton Court Forebay could potentially affect agricultural habitat. The impacted acreage would depend on the location and design of the intertie.

The Clifton Court Forebay intake structure could potentially impact 15 to 20 acres of natural plant communities including emergent wetland, riparian, grassland, and ruderal habitat. Dredging along a 4.9-mile reach of Old River could affect riparian and emergent wetland vegetation along the river. Dredge material would be disposed of on agricultural lands and, therefore, would not affect natural communities. Dredged material is assumed to be held on agricultural lands for 2 years for draining and settling. Consequently, affected agricultural habitats could be temporarily lost until the affected lands are returned to production after removal of the dredged material.

Alternative 2. Alternative 2 implications would be similar to those under Alternative 1. In addition, for conveyance facilities, construction of a 10,000-cfs intake facility at the town of Hood would include construction of the intake, pumping plant, and fish bypass structures, as well as relocation of Highway 160 and associated bridge. These activities could potentially disturb and remove natural communities that could include emergent wetland, riparian scrub and woodland, and grassland and ruderal vegetation. Construction of an open channel from the town of Hood to Lambert Road could potentially remove and disturb natural communities, which could include emergent wetland, riparian scrub and woodland, and grassland and ruderal vegetation.

Construction of a setback channel on the southwestern portion of Glanville Tract could remove and disturb natural communities, which could include emergent wetland, riparian scrub and woodland, and grassland and ruderal vegetation. Approximately 350 to 450 acres of habitat could be created, including open water, emergent wetland, and riparian scrub and woodland communities. The created acreage of wetland and riparian plant communities is expected to exceed the affected existing acreage. Grassland and ruderal communities could establish on the new levee slopes. In addition, they could affect agricultural communities.

Construction of a setback channel at McCormack Williamson Tract could potentially remove and disturb natural communities, which could include emergent wetland, riparian scrub and woodland, and grassland and ruderal vegetation. However, the flooding of McCormack Williamson Tract would create approximately 1,600 to 1,700 acres of shallow water habitat, including open-water and emergent wetland. Riparian scrub and woodland could establish along the levees that would line the flooded island. The created acreage of wetland

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and riparian communities is expected to exceed the affected existing acreage.

North Delta channel modifications would include setback levees, set approximately 500 feet from the existing levees, along the North Mokelumne River from Interstate Highway 5 to the San Joaquin River. Some acreage of existing natural communities could potentially be removed and disturbed in locations where levees are breached. These communities could include emergent wetland, riparian scrub and woodland, and grassland and ruderal vegetation. Setting back the levees could create approximately 1,200 to 1,400 acres of habitat that could include open-water and emergent wetland, and could create riparian scrub and woodland along the levees as well as grassland and ruderal vegetation on levee slopes. The created acreage of wetland and riparian plant communities is expected to exceed the affected existing natural community acreage.

Creation of a Mokelumne River Floodway and east Delta Wetlands Habitat could disturb and remove existing natural communities, which could include emergent wetland, riparian scrub and woodland, and grassland and ruderal vegetation. However, approximately 12,500 to 16,000 acres of habitat could be created and could include shallow open water, emergent marsh, and riparian scrub and woodland. Creation of the Mokelumne River Floodway and east Delta Wetlands Habitat could also remove up to approximately 15,000 acres of agricultural communities. Construction of setback levees along Old River could remove approximately 2,600 to 2,900 acres of agricultural communities.

Flooding of Tyler Island could create approximately 8,000 to 9,000 acres of habitat, which could include shallow open water, emergent wetland, and riparian scrub and woodland. Removal of existing levee sections could remove or disturb existing natural communities, which could include emergent wetland, riparian scrub and woodland, and grassland and ruderal vegetation. The created acreage of wetland and riparian communities is expected to exceed the affected existing acreage. Grassland and ruderal communities could establish on the new levee slopes.

Alternative 3. Alternative 3 implications would be similar to those under Alternative 1. In addition, Alternative 3 conveyance creates the greatest impacts on Delta Region vegetation and wildlife. Under Configurations 3A and 3B, a 45-mile, isolated, open-channel facility would be constructed along the eastern side of the Delta. The channel would include an intake facility near the town of Hood, a Highway 160 bridge relocation site, a fish bypass structure, a pumping plant, access roads, staging areas, and outlet facilities. Construction of the isolated conveyance facility could potentially disturb and remove natural communities, which could include emergent wetland, riparian scrub and woodland, and grassland and ruderal vegetation. The acreage of nonagricultural communities removed is estimated at approximately 100 to 200 acres. The precise area of affected plant communities would depend on the design and location of the facilities. Impacts would be similar if a pipeline were constructed for conveyance rather than an open channel.

Permanent direct impacts to large riparian areas and associated wetlands at major stream crossings could be avoided by properly designed siphons, but construction of the siphons could disturb riparian scrub and woodland and emergent wetland and associated wildlife.

Construction of the isolated open-channel facility could potentially result in removal and temporary disturbance of agricultural lands at the intake facility, at the Highway 160 bridge relocation site, at the fish bypass structure, at the pumping plant, along the 45-mile channel, along access roads, at staging areas, and at a buried outlet. The potentially impacted acreage of agricultural communities was estimated as approximately 700 to 900 acres. The precise affected area would depend on the design of the facilities.

Configuration 3B storage features would involve construction of a 200,000-acre-foot in-Delta storage facility. Construction of this feature could

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remove and disturb natural communities, which could include emergent wetland, riparian scrub and woodland, and grassland and ruderal vegetation. Specific affected acreages would depend on the size and location of the storage facility. Up to 15,000 acres of open-water habitat of varying depth could be created. Periodically, seasonal wetland and mudflats could potentially be supported in the Delta Region storage facility, which could temporarily support shorebirds and waterfowl. The 200,000 acre-foot storage facility in the Delta Region could potentially remove approximately 6,000 to 7,000 acres of agricultural lands.

Configuration 3E conveyance would be similar to that under Configuration 3A, and Configuration 3E storage would be similar to that in Configuration 3B.

Configuration 3H would include isolated conveyance facilities in the south and north Delta areas. Other conveyance features would include the construction of a Mokelumne River floodway, east Delta Wetlands, and south Delta habitat modifications. These features could impact 16 special-status species.

Under Configuration 3I, some shallow water habitat areas to be restored under the Ecosystem Restoration Program would be located in the east Delta, and restored and enhanced habitat areas identified in the Ecosystem Restoration Program for the south Delta located near the proposed new diversions would be relocated to the northern and western Delta.

Storage facilities would be tied in with the 15,000-cfs western conveyance facilities. For example, if Holland Tract were selected for this purpose it would potentially affect 600 to 700 acres of natural communities including emergent wetland and grassland and ruderal vegetation. The precise acreages that would actually be removed or disturbed would depend on the design of the storage facility. The design of this storage facility and all other facilities discussed for all other regions would need to be designed to avoid special status species habitats and protected habitats. Approximately 4,000 to 4,500 acres of open water habitat, varying in depth, could be created. Periodically, seasonal wetlands and mudflats could potentially be supported by the Delta Region storage facility, which could temporarily support shorebirds and waterfowl. In addition, a 500-foot-wide zone on the eastern side of Holland Tract would be dedicated to conveyance. If storage facilities were to be sited on Holland Tract, approximately 3,500 to 3,700 acres of agricultural lands could be affected.

Construction of western, northern, and eastern south Delta intakes and isolated conveyance facility channels could potentially disturb and remove natural communities, which could include emergent wetland, riparian scrub and woodland, and grassland and ruderal vegetation. Construction of setback levees set approximately 500 feet along the western side of Old River could potentially disturb and remove similar types of natural communities. New emergent wetland and riparian scrub and woodland could be created. Approximately 500 to 600 acres of habitat could be created including shallow open-water, emergent wetland, and riparian scrub and woodland. The created acreage of wetland and riparian plant communities is expected to exceed the affected existing acreage. New herbaceous upland communities, including grassland and ruderal vegetation, could be created on the levee slopes. Construction of the south Delta intakes and isolated conveyance channels and the Old River setback levee could remove 900 to 1,000 acres of agricultural lands.

The northern isolated Sacramento River intake and conveyance channel would include a screened intake at Hood and an open 15,000-cfs conveyance channel from Hood to the diversion on the San Joaquin River. The potential impacts of this facility in combination with the eastern south Delta intake and conveyance facility would be the same as the potential impacts of the 15,000-cfs isolated facility described under Configuration 3E, with additional potential impacts of the intake facility on the San Joaquin River. This intake facility could include a low-lift pumping facility and other structures. These facilities could

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potentially disturb and remove natural communities, which could include emergent wetland, riparian scrub and woodland, and grassland and ruderal vegetation. The affected acreages would depend on the design and location of the facilities.

Configuration 3I conveyance and storage features would contain similar elements to both Configuration 3E and Configuration 3H.

Ecosystem Restoration

The Ecosystem Restoration Program would provide a range of benefits for species occurring in both aquatic and terrestrial habitats. The Ecosystem Restoration Program could create or restore the following natural plant community types: tidal freshwater emergent wetland, non-tidal freshwater emergent wetland, tidally influenced channels and distributary sloughs, shallow water habitat, shoals, open-water areas within restored freshwater emergent wetland areas, shallow open-water areas within restored freshwater emergent wetland areas, seasonal wetlands, riparian habitat, and channel islands; and could protect vernal pools and adjacent buffer lands.

The Ecosystem Restoration Program could also protect existing riparian woodland, protect and enhance channel islands, enhance seasonal wetland, and cooperatively manage agricultural lands to improve habitat values for waterfowl and other wildlife. Most habitats could be restored on existing agricultural lands and relatively small acreage of some natural plant communities would be lost or converted to open water or other natural plant communities. The potential impact of the ecosystem restoration on agriculture, for example, loss of agricultural acreage, is discussed in Chapter 8: Section 8.2.2 and Chapter 5, Section 5.2.1.

Water Quality

Implementation of the Water Quality Program could reduce loadings of organic and inorganic constituents (such as metals and insecticides) to the Delta and its tributaries from mine drainage, urban and industrial runoff, wastewater and industrial discharge, and agricultural drainage. Loadings of these constituents could be reduced through source control and treatment.

Water Use Efficiency

The Water Use Efficiency program will result in less water available to incidental habitats that are dependent on existing inefficiencies. These can be wetlands at the end of a field or riparian vegetation in a drainage ditch or channel. There are numerous examples of seasonal wetlands, riparian corridors, and other habitats that have developed as a result of water losses leaving a field and traveling to another field or to a surface stream or drain. Collectively, these habitat areas have significant vegetative and wildlife value. Reduction or elimination of losses that are reused by these habitat areas could adversely impact their survival.

In some instances, tailwater return systems will be built as an efficiency measure. Tailwater ponds included in the return systems can be designed to incorporate beneficial habitat areas. Generally, efficiency measures will result in both temporary (from land grading and construction activities) and permanent (from reduced losses flow to habitats both on-farm and in district level delivery canals) loss of wetland and riparian communities.

Cropping pattern changes will also continue to occur in the future resulting in temporary (through land fallowing, possibly for transfers) and permanent (conversion of rice land and pasture to vineyards and orchards) loss of wintering waterfowl foraging habitat. These impacts have the potential of being significant, especially when considered along with other agricultural impacts, such as urbanization, that is removing valuable, though perhaps not ideal, habitat.

Levee System Integrity

The Levee System Integrity program could upgrade levees, including setback levees. Implementation of the program could affect

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existing levee habitats. Approximately 75% of the existing levee area supports grassland and ruderal vegetation or largely unvegetated riprap and 25% supports riparian vegetation. Increasing the landbase of levees could affect primarily agricultural land and some grassland adjacent to existing levees. Upgraded levees could be engineered to accommodate higher quality habitat than currently exists.

Coordinated Watershed Management

The watershed areas of the Delta basically encompass the entire drainage basin of the Sacramento and San Joaquin watersheds. Therefore, the upper watershed areas for the Delta Region are discussed under the Sacramento River and San Joaquin River regions. Many of the proposed activities are expected to improve water quality and flows in the watershed areas and would also improve water quality and flows in the Delta. These improvements would benefit native vegetation in the Delta such as riparian and freshwater marsh habitat and associated wildlife species and special status species.

Bay Region

Ecosystem Restoration

The Ecosystem Restoration Program could result in a net increase in the following natural plant community types: shallow tidal perennial aquatic habitat, tidally influenced saline emergent wetland, tidally influenced sloughs and deep open-water areas within restored saline emergent wetlands, seasonal wetlands, riparian scrub, and perennial grassland. The Ecosystem Restoration Program could also improve management of existing, degraded, seasonal wetlands. Implementation of the program could affect existing diked saline emergent wetland as a result of restoring tidal flow. Other actions proposed in the program could primarily result in the loss of agricultural lands. Some existing wetland, riparian, and grassland habitats could be lost or converted to open-water or other natural plant communities.

Existing natural terrestrial communities such as grassland and ruderal habitats could be affected by restoration of seasonal wetland, riparian, and perennial grassland habitats. Potentially affected communities are generally dominated by exotic grasses and forbs and are typically associated with rangelands and abandoned agricultural lands. Potential direct impacts on these habitats could result primarily from occasional flooding to restore seasonal wetlands. Conversion of existing annual grassland to perennial grassland could cause temporary ground disturbance, but would improve habitat quality for native plants and wildlife. Relatively small grassland and ruderal habitat areas could potentially be affected by re-establishment of corridors or riparian habitat adjacent to water courses. Losses of grassland and ruderal habitats could be partially or completely offset by restoration of perennial grassland and the natural re-establishment of herbaceous vegetation along higher elevation margins of restored wetland and riparian habitats that are not farmed.

Riparian communities such as scrub, woodland, and forest would be directly restored. Since the type of riparian community that would be restored is dependent on site-specific conditions, such as local hydrology and soils, the area of each type of riparian community that would be restored is not predictable. Little or no existing riparian vegetation is expected to be directly impacted by implementation of the Ecosystem Restoration Program because most restoration activities would occur in Suisun Marsh and in existing historic tidal wetland areas adjacent to San Pablo Bay where little or no riparian vegetation is present.

Restoration of riparian corridors along sloughs and channels would increase the connectivity among existing fragmented riparian areas in the Bay Region. The quality of existing riparian habitats that are treated to control exotic plant species could also increase because treated habitats could become increasingly dominated by native plants as a result of lessening competition with exotic species.

An unknown quantity of riparian vegetation could also naturally re-establish as a result of restoration of other habitat types. Riparian vegetation is expected to establish along the margins of restored tidal slough, shallow-water, and wetland habitat areas where the salinity and soil moisture conditions are suitable to sustain riparian vegetation. To encourage the establishment of native species, periodic removal of exotic plants may be necessary.

Open-water and wetland habitats may be restored or enhanced under the Ecosystem Restoration Program. Existing open-water and wetland habitats could be affected by restoration of tidal perennial aquatic, tidal slough, wetland, and riparian habitats.

Saline emergent wetlands could benefit from reestablishment of tidal flow to historic saline emergent wetlands. An unpredictable quantity of tidal flats could also be associated with restoration of saline emergent wetlands.

Major agricultural cover types in the Bay Region include grain and hay crops, row crops, truck crops, pasture, and orchards and vineyards. Agricultural lands could be lost as a result of implementation of the Ecosystem Restoration Program. The impact of the loss of agricultural land on wildlife is dependent on the affected cover type and attendant land-use practices. Approximately 109 species of wildlife are known to make use of agricultural lands in the Bay Region.

Water Transfers

To the extent that water transfers are completed for specific ecosystem benefits, including Delta outflow, benefits to vegetation and wildlife could also occur within the Bay Region.

Coordinated Watershed Management. Impacts as a result of coordinated watershed management activities would be similar to those described for the Sacramento and San Joaquin regions, but to a lesser degree. Refer to those sections below

San Joaquin River and Sacramento River Regions

Storage and Conveyance

Alternative 1. Configurations 1A and 1B do not have storage associated with them in the San Joaquin River and Sacramento River regions. Sacramento and San Joaquin River Region Configuration 1C storage facilities could inundate between 18,000 and 32,000 acres in the Sacramento Valley and up to 8,500 acres in the San Joaquin Valley. Changes in the area or quality of plant communities inundated by storage facilities could potentially also affect wildlife populations associated with those plant communities over a much larger surrounding area.

Potential land use changes due to the various alternatives are depicted in Chapter 5: Sections 5.2.1, 5.2.2, 5.2.3, 5.2.4 and 5.2.5.

Construction of off-aqueduct storage could result in the temporary or permanent loss or disturbance of wetland, riparian, annual grassland, valley foothill hardwood, and agricultural communities as a result of inundation and construction of roads and other infrastructure. The actual area and habitat types that would be affected by construction of off-aqueduct storage facilities, however, would depend on the siting, design, and operations of facilities. Construction of storage reservoirs could fragment important habitats and disrupt wildlife movement patterns. If off-aqueduct reservoirs are located in watersheds that support riparian vegetation, reservoirs could also lead to the loss or degradation of riparian habitat downstream of reservoirs as a result of sediment supply interruption to the stream channel and alteration of stream hydrology. Some habitat types that could be lost or degraded as a result of storage facilities, such as valley oak woodland, or sycamore woodland, could have declined sufficiently from historic conditions, and additional losses could substantially affect associated wildlife populations. The wildlife value of habitats surrounding reservoirs for some species could also be degraded if public access

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and levels of recreation substantially increase. Local deer populations could be adversely affected if storage reservoirs, attendant facilities, and associated recreational uses result in loss or degradation of DFG-designated critical deer winter range and fawning habitats, and other important deer use areas. Construction of off-aqueduct storage could result in creation of open-water habitats during periods that water is stored.

If groundwater storage is achieved by percolating water through water-spreading grounds, construction of water-spreading grounds and associated facilities could result in the temporary or permanent loss of annual grassland and agricultural habitat types, assuming they are constructed in low land areas of the San Joaquin River Region. The actual habitat area and habitat types that would be affected by construction and operation of groundwater recharge facilities, however, would depend on the siting, design, and operations of the facilities. Shallow open-water habitat could be created during periods that surface water is retained on spreading grounds. Mudflats and bare ground could be created as surface water is drawn down. To maintain percolation efficiency, however, spreading grounds would likely be maintained devoid of vegetation. Consequently, these created habitats would likely provide low forage and cover values for associated wildlife.

Alternative 2. Storage impacts would be the same for the Sacramento Valley as discussed for Configuration 1C. San Joaquin River Region Configuration 2B storage facilities could affect between 22,000-24,000 acres. Impacts from construction of 2 million acre-feet of off-aqueduct storage and associated facilities would be similar to those described previously for construction of 1 million acre-feet of off-aqueduct storage, except that the habitat area impacted and the area of open water created with storage of an additional 1 million acre-feet under Configuration 2B could be greater.

Under Configuration 2B, 500,000 acre-feet of new surface storage would be developed by either enlarging existing storage reservoirs or developing new off-stream storage.

Alternative 3. Storage implications for the San Joaquin and Sacramento River Regions would be similar to those described under Alternative 2 and Configuration 1C.

Ecosystem Restoration

Ecosystem restoration would be similar for all configurations under all alternatives for the San Joaquin River and Sacramento River regions.

Proposed program activities that affect terrestrial biological resources include restoration and protection of stream meander belts; restoration of floodplain processes, such as overbank flooding of floodplains and stream channel migration; and restoration, enhancement, or protection of riparian vegetation to provide shaded riverine aquatic cover. Partial restoration of the ecological processes that sustain healthy riverine ecosystems on affected streams could result in a more natural pattern of stream channel migration, bank erosion, and overbank flooding that are important factors in maintaining healthy riparian and other associated floodplain habitats.

The Ecosystem Restoration Program could result in the direct and indirect restoration, enhancement, or protection of riparian and associated floodplain habitats along the San Joaquin River and its major tributaries, and riparian and associated floodplain habitats along the Sacramento River and its major tributaries. Improvements in riparian habitat could primarily result in the loss of agricultural lands adjacent to streams and rivers. A relatively small area of native plant communities could be temporarily or permanently affected by riparian habitat improvements, depending on the type of improvement actions that are implemented.

Water Use Efficiency

Impacts associated with water use efficiency and water transfers would be similar to those discussed for the Delta Region.

Agricultural land conversion in the San Joaquin River Region is included in the CALFED alternatives as a potential measure to improve water quality by reducing discharges from drainage lands with selenium problems. The CALFED Program policy is not to convert land to reduce water demands. However, depending on water supply and water transfer opportunities available in the various alternatives, farmers may choose to change cropping patterns, temporarily fallow land, or permanently take land out of agricultural production. Program implementation will require some land conversion to accommodate new facilities or restoration activities.

Coordinated Watershed Management

Coordinated watershed management activities can be grouped into several types. A conceptual description of the types of activities that might take place and their potential impacts are described below. Impacts can be characterized as local (those occurring the general vicinity of project construction), and regional (those extending beyond the immediate project area).

Terrestrial habitat restoration activities undertaken as part of the coordinated watershed management program could restore or improve habitat types such as oak woodland, wetland or riparian habitat or to improve specific habitat values targeted to specific plant or wildlife species such as nesting habitat for the great gray owl. Short-term impacts might include displacement of resident species, local erosion and siltation of nearby streams and waterways, and disturbance of resident species as a result of construction activities. Construction impacts to wildlife will likely be short-term and will depend on the type and quality of the habitat being converted or restored. Potential impacts could include the temporary displacement of species dependent on the habitat being restored, or in the case of conversion a shift in wildlife species.

The types of beneficial impacts expected may include, but not be limited to, improved vigor of target species populations, increased habitat diversity within the region and/or an increase in the quality or quantity of limiting factors such as nesting or feeding habitat for target species. The effects of these impacts may occur locally, such as improved feeding areas for deer, or may extend outside the region if the restoration would affect migratory species such as neotropical migratory birds. Presumably restoration projects would only be implemented if the habitat created were of a higher value than the one being replaced. It is further assumed that the proposed activities would be designed to avoid impacts to special status species and/or significant natural areas.

Improving wastewater and stormwater treatment, controlling mine waste, implementing erosion control and improving forest and land use management practices would result in improved water quality conditions in streams and reservoirs. Some activities such as land use management may increase stream flows that would be a direct benefit to riparian vegetation. These water quality and quantity changes may also benefit vegetation and wildlife in downstream areas as well.

Adverse impacts may include temporary disturbance to wildlife due to construction activities, temporary erosion and siltation due to construction, and loss of vegetation and associated wildlife at project site. It is assumed that the proposed activities would be designed to avoid impacts to special status species and/or significant natural areas and that adverse impacts are not expected.

Structural improvements of deconstruction activities might include improved maintenance of roadways, removal of old roadways, installation of erosion control structures, or improved channel improvements such as realignment, bank stabilization and revegetation. Since improvements will be made to areas already heavily disturbed it is anticipated that little or no long-term adverse impacts to natural resources would occur. Short-term adverse impacts to wildlife and vegetation might include increased erosion and siltation during construction. These impacts are expected to be restricted to construction periods and local in nature. Removal

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of roadways would increase natural vegetation and associated wildlife and minimize access thereby reducing human disturbance to wildlife resources.

SWP and CVP Service Areas Outside the Central Valley

Together with improved transportation, expanded sewer, water, and utilities, and other factors, the alternatives will contribute to the inducement of growth by providing additional water supplies and improving the reliability of those supplies.

Alternative 1. Alternative configurations 1A and 1B will not result in a level of additional water supplies or improved supply reliability that would contribute to increased urban and industrial development and cause loss of critical habitats for special status species in the service areas. Alternative 1C however, could contribute to increased urban and industrial development and cause loss of these habitats.

Alternatives 2 and 3. Additional water supplies and improved reliability of those supplies may contribute to increased urban and industrial development and cause additional loss of important upland habitats such as coastal sage scrub, and riparian and wetlands through increased contaminant input, increased incidence of human caused disturbance and other factors. Urban and industrial growth will result in the loss or degradation of wetland and riparian communities, and loss or degradation of important wildlife habitats and use areas.

7.2.2.5 Comparison of Program Alternatives to Existing Conditions

Comparison of Program Alternatives to existing conditions indicates:

- All potentially significant adverse impacts that were identified when compared to the No Action Alternative would still be considered significant when compared to existing conditions. In general, these impacts would result from the disturbance of plant and animal communities associated with the construction and operation of new facilities or by land use changes. Such project-related consequences are not dependent on whether the basis of comparison is existing conditions or the future conditions associated with the No Action Alternative.

- No additional significant environmental consequences have been identified when program effects are compared to existing conditions as opposed to No Action.

- The beneficial effects of the program would still be beneficial when compared to existing conditions. Many of the beneficial effects would be related to habitat enhancements associated with the ecosystem restoration program element. These effects are beneficial compared to existing conditions, and even more beneficial when considered with respect to future demands on the ecosystem.

In summary, the conclusions regarding the significance of project effects on vegetation and wildlife when compared to existing conditions would be similar to those compared to No Action.

The biologic environment is complex and has many unique interrelationships about which little is known. There is uncertainty involved in anticipating the effect of Program actions on the ecosystem. Because of the lack of knowledge on how the ecosystem may respond to Program actions, it is possible that restoration actions may fail to achieve the Program objectives. It also is possible that individual projects may cause some negative impacts in achieving their ultimate objective. The adaptive management program is intended to address these uncertainties. Adaptive management is a key component of the CALFED Program as it provides a decision support system for stakeholders and resource managers. Adaptive management addresses risks and uncertainties by increasing opportunities to redirect management with new information. More information on adaptive management can be found in the Phase II Report Technical Appendix.

7.2.2.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

Where the Ecosystem Restoration Program would cause adverse impacts, phasing of the program would help mitigate potential adverse impacts resulting from ecological restoration actions. All adverse impacts caused by other programs would have to be mitigated separately.

The following section summarizes potential mitigation measures by impact.

Temporary or Permanent Loss or Disturbance of Wetland and Riparian Communities. Potential mitigation measures may include:

- Avoiding wetland and riparian communities,
- Restoring or enhancing sufficient inkind wetland and riparian habitat areas at offsite locations before or at the time that project impacts are incurred to offset habitat losses,
- Initially implementing the Ecological Restoration Program, to the extent feasible, to restore sufficient wetland and riparian habitats in nonwetland/riparian habitat areas before or at the time that project impacts associated with the program are incurred to offset temporary habitat losses, and
- Restoring wetland and riparian communities temporarily or permanently disturbed by onsite construction activities immediately following construction.

Temporary or Permanent Loss or Disturbance of Wintering Waterfowl Habitat. Potential mitigation measures may include:

- Initially implementing the program, to the extent feasible, to restore native waterfowl foraging habitats on agricultural lands that provide little or no existing waterfowl forage values, to defer potential adverse impacts on waterfowl until sufficient natural habitat with high waterfowl forage value develops;
- Initially implementing the program, to the extent feasible, to focus habitat restoration efforts on restoring sufficient high forage value wetland habitat area to offset anticipated loss of agricultural foraging habitats; and
- Restoring or enhancing sufficient waterfowl foraging habitat to offset impacts to the abundance, quality, and availability of waterfowl forage, with specific types of actions.

Coordinated watershed management activities can be grouped into several types. A conceptual description of the types of activities that might take place and their potential impacts are described below. Impacts can be characterized as local (those occurring the general vicinity of project construction), and regional (those extending beyond the immediate project area).

Terrestrial habitat restoration activities undertaken as part of the coordinated watershed management program could restore or improve habitat types such as oak woodland, wetland or riparian habitat or to improve specific habitat values targeted to specific plant or wildlife species such as nesting habitat for the great gray owl. Short-term impacts might include displacement of resident species, local erosion and siltation of nearby streams and waterways, and disturbance of resident species as a result of construction activities. Construction impacts to wildlife will likely be short-term and will depend on the type and quality of the habitat being converted or restored. Potential impacts could include the temporary displacement of species dependent on the habitat being restored, or in the case of conversion a shift in wildlife species.

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The types of beneficial impacts expected may include, but not be limited to, improved vigor of target species populations, increased habitat diversity within the region and/or an increase in the quality or quantity of limiting factors such as nesting or feeding habitat for target species. The effects of these impacts may occur locally, such as improved feeding areas for deer, or may extend outside the region if the restoration would affect migratory species such as neotropical migratory birds. Presumably restoration projects would only be implemented if the habitat created were of a higher value than the one being replaced. It is further assumed that the proposed activities would be designed to avoid impacts to special status species and/or significant natural areas.

Improving wastewater and stormwater treatment, controlling mine waste, implementing erosion control and improving forest and land use management practices would result in improved water quality conditions in streams and reservoirs. Some activities such as land use management may increase stream flows that would be a direct benefit to riparian vegetation. These water quality and quantity changes may also benefit vegetation and wildlife in downstream areas as well.

Adverse impacts may include temporary disturbance to wildlife due to construction activities, temporary erosion and siltation due to construction, and loss of vegetation and associated wildlife at project site. It is assumed that the proposed activities would be designed to avoid impacts to special status species and/or significant natural areas and that adverse impacts are not expected.

Structural improvements of deconstruction activities might include improved maintenance of roadways, removal of old roadways, installation of erosion control structures, or improved channel improvements such as realignment, bank stabilization and revegetation. Since improvements will be made to areas already heavily disturbed it is anticipated that little or no long-term adverse impacts to natural resources would occur. Short-term adverse impacts to wildlife and vegetation might include increased erosion and siltation during construction. These impacts are expected to be restricted to construction periods and local in nature. Removal of roadways would increase natural vegetation and associated wildlife and minimize access thereby reducing human disturbance to wildlife resources. potentially include planting crops that produce high forage value on agricultural lands currently planted with low forage value crops, or planting winter forage crops on fallowed agricultural lands.

Potential for Increased Waterfowl Disease. Potential mitigation measures may include:

- Monitoring waterfowl use of restored and enhanced wetlands to locate incidences of waterfowl disease mortalities;
- Removing carcasses from affected restored and enhanced wetlands to reduce the rate of disease transmission;
- Hazing waterfowl from restored and enhanced wetlands affected by disease outbreaks to reduce the likelihood of disease transmission; and
- Where feasible and consistent with habitat restoration objectives, designing wetlands to allow for rapid dewatering during disease outbreaks to discourage use of the affected habitat area by waterfowl.

Decrease in Important Deer and Elk Use Areas or Other Wildlife Habitat. Potential mitigation measures may include:

- Avoiding critical deer winter range and fawning habitat, and tule elk calving habitat;
- Restoring habitat areas temporarily disturbed by onsite construction activities immediately following construction;
- Restoring historic, but currently unsuitable, habitat areas within affected watersheds or other watersheds used by the affected deer or elk population if sufficient historic habitat for

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restoration is unavailable within the affected watershed; and

- Enhancing habitat areas within watersheds used by the affected deer or elk population or in other watersheds where sufficient habitat for enhancement is unavailable within the affected watershed.

Temporary or Permanent Fragmentation of Riparian Habitats. Potential mitigation measures may include:

- Avoiding riparian vegetation,
- Restoring or enhancing sufficient riparian habitat areas at offsite locations in a manner that reduces the degree of existing habitat fragmentation before or at the time that project impacts are incurred, to offset habitat losses;
- Initially implementing the program, to the extent feasible, to restore sufficient riparian habitat before or at the time that project impacts are incurred to offset habitat losses;
- Restoring riparian vegetation disturbed by onsite construction activities immediately following construction; and
- Phasing the implementation of modification to levees that would be necessary to meet PL-99 standards over a sufficient period, to minimize the effects of fragmentation of riparian habitats and associated wildlife.

Loss of Habitat or Direct Impacts to Special-Status Species. Potential mitigation measures may include:

- Avoiding inundation or other direct disturbance to lands that are of high value for special-status species when creating aquatic habitats—this is a priority measure because species with restricted range and limited populations are characterized by low potential for restoration and/or creation of favorable habitat;
- Restoring additional habitat to serve as alternative habitat over and above that restored as part of the program;
- Managing agricultural lands for multiple foraging special status species (flooding fields in the fall to provide wintering waterfowl habitat, while leaving the fields drier in the spring and summer for other species to utilize); and
- Maximizing the habitat quality of remaining agricultural lands by utilizing various wildlife friendly techniques, such as planting crops of highest forage value.

Loss of Portions of Rare Natural Communities and Significant Natural Areas. Potential mitigation measures may include:

- Avoiding rare natural communities and significant natural areas altogether,
- Restoring or enhancing disturbed rare natural communities or significant natural areas at other locations before or at the time that Levee System Integrity Program impacts are incurred, and
- Restoring rare natural communities or significant natural areas back into impacted locations once Levee System Integrity Program activities are completed.

Temporary loss or disturbance to habitat due to construction. Potential mitigation measures may include:

- Alter timing of construction to avoid sensitive periods such as nesting or migration seasons;
- Implement Best Management Practices to reduce the potential for erosion and siltation;
- Enhance nearby habitat to provide for displaced species.

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7.2.2.7 Potentially Significant Unavoidable Impacts

After mitigation strategies are developed into site-specific mitigation measures and applied, some unavoidable significant impacts may remain. These are identified below. It is assumed that any storage facilities would be located to avoid significant impacts to listed/proposed species and habitat or to rare natural communities. These impacts are therefore considered avoidable.

Delta Region. No significant unavoidable impacts were identified.

Bay Region. No significant unavoidable impacts were identified.

Sacramento River and San Joaquin River Regions. Under Alternatives 1, 2, and 3, existing riparian habitat corridors could be permanently fragmented as a result of inundation of offstream storage reservoirs, potentially blocking the movement and interchange of populations of some wildlife species from upper to lower watershed locations. This impact could not be mitigated. Therefore, this impact was considered a significant unavoidable impact.

SWP and CVP Service Areas Outside the Central Valley. No significant unavoidable impacts were identified.

8 LAND USE, SOCIAL, AND ECONOMICS ISSUES

8.1 AGRICULTURAL RESOURCES

This section discusses relevant agricultural land and water uses, economics, and social issues. The land and water use, economic, and social impacts to agricultural resources are summarized in Tables 8.1-1, 8.1-2, and 8.1-3, respectively.

Potential land use changes are displayed in Sections 5.2.1, 5.2.2, 5.2.3, and 5.2.4 of Chapter 5. Additionally, Section 5.2.5 identifies potential effects to important farmland soils.

No Action Alternative. As the population of California grows, agricultural lands would be converted and developed as cities and counties expand. The projected increase in demand for fruits and vegetables would shift agricultural production away from field crops and grains. The amount of water allocated to agricultural production would continue to decline and the cost of water would continue to increase.

The No Action Alternative could result in potentially significant land use impacts associated with currently proposed storage and conveyance components. These impacts would occur where existing agricultural uses are converted to habitat, infrastructure, and urban uses and where No Action Alternative projects may be inconsistent with agricultural objectives of local and regional plans. Under the No Action Alternative, Department of Water Resources' Bulletin 160-93 projects that 45,000 acres of drainage problem lands in the San Joaquin region could be retired by year 2020.

No Action Alternative economic conditions are expected to be similar to existing conditions except there would be an increasing demand for fruits and vegetables, an increased use of water transfers to meet water demands, and an increase

Impacts to Agricultural Land and Water Use

- Under the **No Action Alternative**, conversion of agricultural lands to urban uses would continue, some agricultural land with drainage problems would be taken out of production in the San Joaquin valley, and a decrease would be expected in the amount of water allocated to agricultural production.
- **Storage and Conveyance** facilities could increase the amount of water available for agricultural production. Storage and Conveyance would convert prime farmland and other agricultural lands, and create potential conflicts between proposed actions and regional agricultural land use plans and policies.
- The **Ecosystem Restoration Program Plan** could improve reliability of water to agricultural lands. The Ecosystem Restoration Program Plan would convert agricultural land to habitat.
- The **Water Quality Program** could significantly benefit agricultural land. Long-term benefits include reduced production costs, higher crop yields, and greater crop selection flexibility. Adverse impacts would result from conversion of lands in drainage problem areas.
- **Water Use Efficiency Program** is not expected to have direct effects on land and water. However, water use efficiency measures may alter crop patterns.
- **Levee System Integrity Program** would provide greater protection to Delta farmland from inundation and salinity intrusion. However, construction of levees would convert agricultural lands.
- **Water Transfers** could adversely affect agricultural land and water use at the source of the transferred water, and benefit agricultural land and water use in water-receiving regions.
- **Coordinated Watershed Management** could alter some land use practices in the upper watershed.

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Conversion or Loss of Agricultural Land	●	●	●	●	●	●	●	●	●	●	●	●
Change in Agricultural Water Supply	○	○	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Inconsistency with Local and Regional Plans	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Bay Region												
Conversion or Loss of Agricultural Land	○	○	○	○	○	○	○	○	○	○	○	○
Change in Agricultural Water Supply	○	○	○	○	○	○	○	○	○	○	○	○
Inconsistency with Local and Regional Plans	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Sacramento River Region												
Conversion or Loss of Agricultural Land	●	●	●	●	●	●	●	●	●	●	●	●
Change in Agricultural Water Supply	○	○	+	+	+	+	+	+	+	+	+	+
Inconsistency with Local and Regional Plans	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
San Joaquin River Region												
Conversion or Loss of Agricultural Land	●	●	●	●	●	●	●	●	●	●	●	●
Change in Agricultural Water Supply	○	○	+	+	+	+	+	+	+	+	+	+
Inconsistency with Local and Regional Plans	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
SWP and CVP Service Areas Outside the Central Valley												
Change in Agricultural Water Supply	+	+	+	+	+	+	+	+	+	+	+	+
Conversion or Loss of Agricultural Land	○	○	○	○	○	○	○	○	○	○	○	○

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:

Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
○	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 8.1-1. Summary of Environmental Impacts Related to Agricultural Land and Water Use

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Loss of Irrigated Acreage	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Change in Water Quality	o	o	o	o	o	o	o	o	o	o	o	o
Change in Agricultural Costs and Revenues	o	o	o	o	o	o	o	o	o	o	o	o
Bay Region												
Loss of Irrigated Acreage	o	o	o	o	o	o	o	o	o	o	o	o
Change in Water Quality	o	o	o	o	o	o	o	o	o	o	o	o
Change in Agricultural Costs and Revenues	o	o	o	o	o	o	o	o	o	o	o	o
Sacramento River Region												
Loss of Irrigated Acreage	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Change in Water Quality	o	o	o	o	o	o	o	+	+	+	+	+
Change in Agricultural Costs and Revenues	o	o	o	o	o	o	o	o	o	o	o	o
San Joaquin River Region												
Loss of Irrigated Acreage	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Change in Water Quality	o	o	o	o	o	o	o	+	+	+	+	+
Change in Agricultural Costs and Revenues	o	o	o	o	o	o	o	o	o	o	o	o
SWP and CVP Service Areas Outside the Central Valley												
Loss of Irrigated Acreage	o	o	o	o	o	o	o	o	o	o	o	o
Change in Water Quality	o	o	o	o	o	o	o	+	+	+	+	+
Change in Agricultural Costs and Revenues	o	o	o	o	o	o	o	o	o	o	o	o

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:

Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
o	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 8.1-2. Summary of Environmental Impacts Related to Agricultural Economics

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Loss of Jobs Due to Conversion of Agricultural Lands	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Bay Region												
Loss of Jobs Due to Conversion of Agricultural Lands	o	o	o	o	o	o	o	o	o	o	o	o
Sacramento River Region												
Loss of Jobs Due to Conversion of Agricultural Lands	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
San Joaquin River Region												
Loss of Jobs Due to Conversion of Agricultural Lands	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
SWP and CVP Service Areas Outside the Central Valley												
Loss of Jobs Due to Conversion of Agricultural Lands	o	o	o	o	o	o	o	o	o	o	o	o

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:
Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
o	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 8.1-3. Summary of Environmental Impacts Related to Agricultural Resources - Social Issues

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in irrigation water cost due to the CVPIA actions and general supply restrictions. Additionally, there would continue to be reallocations of irrigation water to other uses, such as water transferred by the CVPIA from agriculture to environmental flows and restoration. The number of unskilled and seasonal agricultural job opportunities would probably decrease with the expected shift to higher value crops and improvements in irrigation technology and mechanization.

Each of the three alternatives would result in potential significant adverse land use impacts in the Delta Region from converting existing agricultural land for new uses as part of the Ecosystem Restoration Program (habitat restoration) and Levee System Integrity (levee construction). New storage and conveyance improvements built in the Delta, Sacramento River and San Joaquin River regions would also result in significant adverse impacts from conversion of agricultural land. Similarly, implementing the Ecosystem Restoration Program in the Sacramento and San Joaquin River regions would result in the conversion of some important farmlands, including prime and unique farmland.

Storage and Conveyance. During construction of reservoirs, dams, conveyance canals, pumping-generating plants, and other related facilities, access to and around the project area would be temporarily disrupted. The disruption to local land uses would include increased truck traffic on local roads. The greatest disturbance would occur during the excavation phase of reservoir construction. Displacement of residents or businesses not wanting to relocate is considered an unavoidable impact that cannot be mitigated to a less-than-significant level, while converting prime agricultural land to nonagricultural uses is considered a significant unavoidable impact.

The conversion of productive agricultural lands would result in direct and indirect adverse economic impacts, including lost revenue, less labor demand, and reduced farm spending in local economies.

Impacts to Agricultural Economics

- Under the **No Action Alternative** the cost of water is expected to increase and, given an anticipated increased demand for fruits and vegetables, there will be a shift away from field crops and grains to production of more fruits and vegetables.
- **Storage and Conveyance** facilities would potentially increase the amount of water available for agricultural production in some regions. Reductions in agricultural production from land conversion may have adverse economic impacts to local agricultural communities.
- The **Ecosystem Restoration Program** would reduce crop revenues and reduce agricultural employment.
- The **Water Quality Program** would result in short-term reduced agricultural productivity and increased production costs. Benefits include improved irrigation water quality, long-term reduced production costs, higher crop yields, and greater crop selection flexibility.
- **Water Use Efficiency Program** measures may result in increased crop yield for farmers, but could result in farm worker job loss.
- The **Levee System Integrity Program** would convert farmland, but provide greater protection to farmland from inundation and salinity intrusion in the Delta.
- **Water Transfers** could adversely affect agricultural production at the source of the transferred water and benefit production in the water-receiving regions.
- **Coordinated Watershed Management** may result in foregone economic opportunities where grazing and timber harvest practices are modified.

Conversion of agricultural land to other uses could result in the loss of jobs, having a potentially significant impact on social well being. Impacts would be the greatest in the Delta Region. The Water Use Efficiency Program could result in beneficial impacts to farmers from increased crop yields but may result in job losses for farm workers because fewer workers may be required.

It is anticipated that agricultural water users in the Bay Region, the Sacramento River and San

Joaquin River regions, and the SWP and CVP Service Areas Outside the Central Valley would receive some of the additional water supply developed by most of the configurations, ranging from about 60,000 to 700,000 acre-feet (annual average). However, under Configurations 1A and 1B, 2A and 2D, and 3A, the Sacramento River Region would probably not receive additional water supply benefits. Finally, no agricultural water supply benefits would accrue to the Delta Region for Configurations 1A and 1B. And the benefits (or losses) to the Delta Region from the other configurations are unknown. For more discussion about the potential water supply benefits of the configurations, please see Sections 6.1.

Ecosystem Restoration. The long-term benefits of this program include improved water reliability. Potentially significant impacts resulting from the implementation of this program include the conversion of agricultural land and the associated reductions in crop revenues and employment levels. Loss of agricultural land including prime and unique farmland would constitute a significant land use impact, while extensive job loss would have a significant impact on local agricultural economics, and social well being. This program's activities are not anticipated to have a significant effect on agricultural land uses in the Bay Region or in the SWP and CVP Service Areas Outside the Central Valley.

Water Quality. The potential long-term benefits of this program include reduced production costs, higher crop yields, and greater crop selection flexibility. There would be a short-term implementation cost associated with best management practices for improved water quality, which could be offset by long-term savings via higher crop yields and additional cropping pattern opportunities. Potentially significant adverse impacts resulting from implementation of this program include reduced agricultural productivity due to changes in agricultural practices and increased production costs associated with program implementation, and changes in the quantity or pattern of stream flow, which could affect downstream agricultural water users. Implementation of a program to idle drainage/water quality problem lands would have a significant unavoidable impact on up to 45,000 acres of agricultural land, agricultural economics, and social well being in the San Joaquin River Region. The impact to farm workers and agribusiness workers would depend on the impact to farmers, because changes in the cost of water, crop selection, and amount of land in production could affect the number of farm workers that would be hired.

Impacts to Agricultural Social Issues

- Under the **No Action Alternative,** conversion of agricultural lands to urban uses and habitat and a reduction in the amount of water allocated to agricultural production could adversely affect the number of farm worker jobs in the Central Valley.
- **Storage and Conveyance** would potentially increase the amount of water available for agricultural production and, consequently, agricultural jobs for farm workers.
- **Ecosystem Restoration Program** would convert important agricultural land to habitat and reduce employment opportunities for farm workers; particularly in the Delta Region.
- Idling agricultural land with salinity or drainage problems, under the **Water Quality Program,** could result in the loss of farm worker jobs in the San Joaquin River region. One of the benefits of improved irrigation water quality and higher crop yields may be additional farm worker jobs.
- **Water Use Efficiency Program** measures could result in both farm worker job losses and gains. The net effect on farm worker jobs is not certain given the uncertainty regarding the extent or location of implementation of these measures.
- Levee improvements and subsidence control measures under the **Levee System Integrity Program** would convert farmland in the Delta and may lead to the loss of farm worker jobs. However, greater protection of farmland may reduce the number of farm worker jobs lost to catastrophic flooding and salinity intrusion.
- **Water Transfers** could adversely affect farm worker jobs in the region that is the source of the transferred water and benefit agricultural production

Water Use Efficiency. The Water Use Efficiency Program is not anticipated to have direct land use impacts; however, there may be indirect impacts to agricultural land use. Agricultural land may be removed from production because of increased costs and decreased profitability which could result from required efficiency improvements or increased district water charges (for example, as part of tiered water pricing). Conversely, improved efficiency may allow the continued viability of agriculture in some areas. Efficiency improvements that result in greater water supply reliability but also higher annual cost may cause a shift in the types of crops grown. Conversion or loss of agricultural land would be a potentially significant adverse land use impact of this program. Improvement in the long-term viability of some agricultural lands would be a potentially beneficial impact.

Potential economic impacts are difficult to assess for the agricultural sector because impacts will be localized based on specific program objectives. Achieving higher agricultural water use efficiency requires costs at both the farm and district level. Greater capital investment and energy is generally required to deliver and apply water more precisely and on demand. These short-term implementation costs, however, are expected to yield long-term cost savings.

Water use efficiency improvements could have adverse impacts on social well being. One benefit of improved irrigation efficiency may be a reduced need for labor, due either to less cultivation or changes in how crops are irrigated. The addition of pressurized irrigation systems would have the most substantial impact.

Job opportunities also could be created by water use efficiency improvements. As irrigation management improves, so must the knowledge of those irrigating or scheduling irrigations. This would result in the need for more skilled labor, but at a rate of only two skilled laborers for every three unskilled jobs lost. In addition, the design and installation of new or improved on-farm or district water delivery systems would create more jobs for skilled laborers. It is conceivable that efficiency improvements, especially those that involve physical construction, would add to local employment.

Water use efficiency improvements could result in improved crop yields and better quality farm products. Such advances can increase on-farm direct income, benefitting the farmer's net income. This often translates to additional economic activity. Increased income also can help the overall economy in total sales and purchases and increase tax revenues that strengthen vital functions such as schools, roads, and social and health services.

Levee System Integrity. The benefits of the Levee System Integrity Program include greater protection of Delta farmland from inundation and salinity intrusion. The conversion of prime farmland and the associated reduction in crop revenues are potentially significant adverse land use and socioeconomic impacts resulting from implementation of this program. The majority of impacts from this program would primarily affect agricultural land uses in the Delta Region (up to 35,000 acres) and would not affect land uses in the other four regions.

Water Transfers. Water Transfers would affect local economies and social well being primarily through changes to employment and income. In addition to the source of water for a transfer, the timing, magnitude, and pathway of each transfer have a tremendous effect on the potential for impacts. For agricultural operations previously served by water transferred to other users, employment levels, crop revenues, and farm worker income levels may significantly decrease due to costs associated with obtaining water from other sources, such as ground water. Potential benefits, such as increased employment, crop revenues, and farm worker income levels, would occur in regions receiving the transferred water.

Water transfers are not expected to have direct land use impacts; however, they could indirectly affect agricultural opportunities by changing availability in selling and receiving areas.

Coordinated Watershed Management. Watershed management actions would have negligible

impacts on agricultural production. The amount of acreage affected would be minimal, with minor economic impacts. Potential for higher crop yields may result from improved water quality.

Potential watershed activities will be compatible with applicable environmental and land use plans and policies in their affected jurisdiction. Reduced grazing activities could also have potentially significant land use impacts in these two regions if they result in a loss of agricultural productivity.

8.1.1 Affected Environment/ Existing Conditions: Agricultural Land and Water Use

8.1.1.1 All Regions

The CALFED study area represents an important agricultural region for both California and the United States. California is the most diversified agricultural economy in the world, producing more than 250 crop and livestock commodities. The study area encompasses approximately 85 % of total California irrigated land, covering all or portions of 39 of the 58 counties in California. In 1995, the 39 counties together contributed about 95 % of California's agricultural production value and represented nine of the top ten agricultural counties in California and seven of the top ten counties in the nation. Agriculture in the study area is also an important employer and affects the regional economy through the expenditures of farmers and the processing and transportation of crops harvested.

Between 1920 and 1950, irrigated agriculture development increased rapidly from 2.7 million acres to over 4.7 million acres for the entire Central Valley.

Existing Conditions

Agricultural Land Use. The Natural Resources Conservation Service (NRCS) distinguishes among four basic designations of farmland: Prime Farmland, Additional Farmland of Statewide Importance, Unique Farmland, and Additional Farmland of Local Importance. Prime and Additional Farmland of Statewide Importance may currently be used as cropland, pastureland, rangeland, forest land, or other land but not as urban land or water.

Prime Farmland is land best suited for producing food, feed, forage, fiber, and oilseed crops, and also is available for these uses. Prime Farmland has the soil quality, growing season, and moisture supply needed to produce sustained high yields or crops economically when treated and managed (including water management) according to modern farming methods.

Additional Farmland of Statewide Importance is land other than Prime Farmland with a good combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and also is available for these uses.

Unique Farmland is land other than Prime and Additional Farmland that currently is used for the production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to produce sustained high quality and/or high yields of a specific crop when treated and managed according to modern farming methods. Examples of such crops are citrus, olives, avocados, fruit, and vegetables.

Additional Farmland of Local Importance is land used for the production of food, feed, forage, fiber, and oilseed crops, even though these lands are not identified as having national or statewide importance. These lands are identified by a local committee made up of concerned agencies that review the lands under this category on at least a 5-year basis.

Table 8.1.1-1 shows estimated totals of 1994 important farmland acreage based on information from the California Department of Conservation (DOC), Farmland Mapping and Monitoring Program for counties within the Central Valley. The numbers are estimates of important farmland acreage (including prime and unique farmland and

farmland of local and statewide importance) in the Delta, Sacramento River, and San Joaquin River regions, the regions where important farmland is most likely to be affected. (It is important to note that several of the counties in the study area have not been completely surveyed by the California DOC for important farmland and that these summaries have been approximated. For a detailed discussion of the Farmland Mapping and Monitoring Program and acreages by county, visit the California DOC's internet website at http://www.consrv.ca.gov/olc/farmland.html.)

Region	Acres
Delta	520,000
San Joaquin	4,750,000
Sacramento	2,160,000

Table 8.1.1-1. Important Farmland in the Central Valley

Table 8.1.1-2 identifies approximate acres in irrigated agriculture for each of the five CALFED regions.

Agricultural Water Use. Agriculture in the five CALFED study regions receives irrigation water from the CVP, the SWP, local water rights and water projects, and groundwater. Most of this water is delivered to farmers through irrigation districts and other water agencies. The availability and reliability of supply of high quality water limits the productivity of important farmlands.

Table 8.1.1-3 provides agricultural water use and water pricing in all CALFED regions from 1985 to 1990.

Central Valley Project. The CVP supplies about 30% of total agricultural water use in the study area. Most CVP water is delivered to the Central Valley counties in the Sacramento River Region and the San Joaquin River Region. CVP water is delivered to approximately 250 water districts, individuals, and companies through water service contracts, Sacramento River water rights, and San Joaquin River exchange contracts. The terms "water service contract" and "project water" refer here to water developed by the project and delivered pursuant to repayment and water service contracts. CVP exchange contracts and Sacramento River water rights represent water rights that predate the CVP.

State Water Project. The SWP supplies about 10% of total agricultural water use in the CALFED study area. Through contracts with 29 water agencies, the SWP provides water within the Central Valley to Butte, Solano, Kings, and Kern counties; outside the Central Valley to several southern California counties; to Alameda and Santa Clara counties in the south Bay Area; and to Napa and Solano counties in the north Bay Area. In addition, the SWP provides water rights deliveries to water rights holders along the Feather River (Butte and Plumas counties).

Local Surface Water. Local surface water supplies (those not delivered by either project) provide about 40% of all agricultural water supplies in the study area. More local surface water supplies are available on the east side of the valley because of the larger amount of precipitation in the Sierra Nevada. Locally owned water projects are especially important on the Yuba, Stanislaus, Tuolumne, Kings, and Merced rivers; but local sources on the west side like the federal Solano Project also are important.

Groundwater. Groundwater provides a significant supply of water for agriculture in normal years, and it is often used to reduce or eliminate shortages of surface water supplies during drought. On average, groundwater provides about 20% of total agricultural water use in the study area.

Declining groundwater tables, subsidence, and loss of aquifer storage continue to be costly problems, particularly in the western and southern parts of the San Joaquin River Region and the Bay Region, where less surface water is available. Declining groundwater tables increase pumping costs. The costs of subsidence include damage to structures, failure of well casings, and frequent

	Delta Region		Bay Region		Sacramento River Region		San Joaquin River Region		SWP and CVP Service Areas Outside the Central Valley	
Crop Category	Irrigated Acres (1,000 acres)	Production Value (million dollars)	Irrigated Acres (1,000 acres)	Production Value (million dollars)	Irrigated Acres (1,000 acres)	Production Value (million dollars)	Irrigated Acres (1,000 acres)	Production Value (million dollars)	Irrigated Acres (1,000 acres)	Production Value (million dollars)
Pasture	37	4	15	2	189	19	290	34	185	15
Rice	11	9	50	9	161	68	527	374	420	258
Truck crops	28	77	0	0	28	25	51	54	,32	40
Tomatoes	45	91	16	10	335	176	786	532	154	67
Alfalfa	65	37	0	0	469	394	18	12	0	0
Sugar beets	15	13	47	280	16	31	301	982	289	1,514
Field crops	151	76	4	10	135	234	180	433	8	47
Orchards	61	177	26	148	265	578	668	2,074	22	343
Grains	60	16	14	3	175	43	344	103	146	47
Grapes	36	127	70	316	10	42	507	1,681	37	215
Cotton	0	0	0	0	4	2	1,269	1,153	20	19
Subtropical orchards	0	0	0	0	15	30	221	973	167	842
Total	**509**	**628**	**244**	**779**	**1,803**	**1,642**	**5,162**	**8,403**	**1,481**	**3,408**

SOURCE:
CAC reports various years.

Table 8.1.1-2. Irrigated Acres and Production Value in All Regions, 1986 to 1995

C-005473

C-005473

Irrigation Applied Water Use by Region (1,000 acre-feet)					
Water Source	Delta	Bay	Sacramento River	San Joaquin River	SWP and CVP Service Areas Outside the Central Valley
Local water	1,100	123	1,801	4,854	107
CVP water	85	54	1,467	4,268	0
SWP water	0	13	1	1,168	232
Groundwater	110	544	1,448	1,803	229
			Weighted Average Price ($/af)		
Surface water	0-15	15-45	0-15	20-85	15-255
Groundwater	20-35	60-130	30-60	30-80	80-120

SOURCE:
DWR 1994.

Table 8.1.1-3. Agricultural Water Use and Water Pricing in All Regions, 1985 to 1990

surveying. Water from the CVP and SWP had replaced some of the groundwater pumping, and withdrawals were about equal to estimated recharge. However, the recent drought and supply restrictions imposed by the CVPIA of 1992, the Bay-Delta Accord, and Biological Opinions have reduced surface water supplies and renewed the past trend of groundwater depletion throughout the valley.

Agricultural Habitats. Croplands, orchards, and vineyards have been developed on some of the state's most fertile soils. Soils supported a much greater diversity of native species and productive natural habitats historically than they do today. Many wildlife species have adapted to areas now converted to cropland. Wintering waterfowl and shorebirds consume waste grains left in fields after harvest, and use fields flooded for weed control, leaching, and creation of seasonal wetlands. For a more detailed discussion of the types and value of agricultural habitats and seasonal wetlands see the Vegetation and Wildlife section of Chapter 7, and the Ecosystem Restoration Program appendix.

8.1.1.2 Delta Region

Historical Perspective. Agriculture in the Delta Region began in the mid-1800s, consisting primarily of dryland farming or irrigated agriculture from artesian wells, groundwater pumping, and creek side diversions. Extensive Delta development began in late 1850, when the Federal Swamp Land Act promoted converting swamp and overflow lands to agricultural production. During the early 1900s, a series of levees and human-made waterways were developed to enhance future agricultural and urban development.

Between 1976 and 1993, the total amount of agricultural land in the legal Delta was reduced by about 14,500 acres, almost all of which occurred in the Delta Secondary Zone. This was largely due to conversion of agricultural land to urban uses in the Brentwood and Oakley areas of Contra Costa County, the Pocket area in Sacramento County, the West Sacramento area in Yolo County, and the Stockton and Tracy areas in San Joaquin County.

Existing Conditions

Agricultural Land Use. Today, of the nearly 750,000 acres in the legal Delta, about 500,000 acres are rich farmland. Most of this area is classified as prime farmland, unique farmland, and locally important farmland, or as having high statewide significance for agricultural production. The Delta's rich peat and mineral soils support several types of agriculture (DWR 1993b).

> **Peat Soil Loss.** One of the unique problems with organic/peat soil is that, when exposed to aerobic conditions by farm cultivation, it oxidizes and erodes away. This has led to a drop in land surface elevations several feet below sea level throughout much of the Delta from historical levels at or above sea level. For a more thorough discussion of this unique problem, see the Geology and Soils section of Chapter 6.

Agricultural Water Use. Most agricultural water users in the Delta are private water right holders. Local water rights water accounts for over 85% of the total irrigation water use. Other irrigation water sources in the Delta Region are CVP water and groundwater, each accounting for about 5 to 10% of the total agricultural water uses. Between 1985 and 1990, compared with other parts of California, the cost of water was much cheaper in the Delta Region because of large amounts of local riparian and pre-1914 appropriate water rights.

8.1.1.3 Bay Region

Historical Perspective. As is characteristic of all the CALFED study regions, agriculture in the Bay Region expanded greatly during the Gold Rush of 1849. As more people arrived in California and urban development flourished along the Bay and upon lower watershed areas, more land in the upper watersheds was brought into production. Although the number of farms between the end of World War II and the mid-1960s declined, the number of irrigated acres increased by 25 %, with the average farm containing 51 acres (CALFED 1997). Orchards were by far the most important crop in the Bay region, followed by vegetables and other truck crops (such as melons, potatoes, and garlic). Other crops included alfalfa, sugar beets, and field crops. Prior to the 1940s, land uses in the Bay Region were principally urban in the city of San Francisco and rural in other portions of the region. Over the last 50 years, however, land uses throughout the region have become progressively more urbanized.

Existing Conditions

Agricultural Land Use. Approximately 240,000 acres of irrigated agricultural land remain in production, most of which are in Contra Costa, Solano, and Sonoma counties.

Agricultural Water Use. Over 75% of irrigation water sources in the Bay Region are from groundwater pumping. Local water and project water make up the other 25%. Groundwater extractions commonly exceed groundwater replenishment, therefore, many of the region's aquifers are experiencing overdraft conditions (DWR 1994).

Between 1985 and 1990, the average cost of surface water in this region is estimated at $15 to $45 per acre-foot, which is about the average in California. The cost of groundwater in the Bay Region is much higher ($60 to $130 per acre-foot) compared with the Delta and Sacramento River regions.

8.1.1.4 Sacramento River Region

Historical Perspective. Rice was the most important crop in the Sacramento River Region, accounting for 30% of the total irrigated acres. Almost 90% of California rice crops were grown in this region during the 1946 to 1950 period. The next important crops in the Sacramento River Region were irrigated pasture and orchards, each accounting for 20% of the total irrigated acres.

Existing Conditions

Agricultural Land Use. Land uses in the Sacramento River Region are principally agricultural and open space, with urban development focused in the city

of Sacramento. More than half the region's population lives in the greater metropolitan Sacramento area. Other fast-growing communities include Vacaville, Dixon, Redding, Chico, and various Sierra Nevada foothill towns. Urban development has occurred along major highway corridors in Placer, El Dorado, Yolo, Solano, and Sutter counties, and has taken some irrigated agricultural land out of production. Suburban ranchette homes on relatively large parcels surround many of the urban areas, and often include irrigated pastures or small orchards.

Excluding the legal Delta portion of the Sacramento River region, in 1994 there were approximately 2.2 million acres of important farmland mapped in the Sacramento River Region.

Agricultural Water Use. About 40% of irrigation water sources in the Sacramento River Region are from local water rights or local water projects. CVP project water and groundwater each makes up the rest of the total agricultural water uses. The 30% of the region's lands that are irrigated with groundwater generally have a very reliable supply.

The majority of diverters along the Sacramento and Feather rivers existed before major CVP and SWP reservoirs were built. Between 1985 and 1990, the average cost of surface water in this region is estimated at $0 to $15 per acre-foot, among the lowest costs in California. The cost of groundwater is estimated at $30 to $60 per acre-foot, also among the lowest in the state.

8.1.1.5 San Joaquin River Region

Historical Perspective. Between 1946 and 1950, in terms of irrigated acres, cotton and grains were the most important crops in the San Joaquin River Region, accounting for 22% and 20% of the total irrigated acres, respectively. The next important crops in the San Joaquin River Region were irrigated pasture, alfalfa and grapes, each accounting for about 15% of the total irrigated acres. Almost 100% of California cotton and 90% of California grapes were grown in this region during the 1946 to 1950 period.

Prior to the 1960s, land uses in the San Joaquin River Region were principally agriculture and open space, with urban uses limited to small farm communities. Although agriculture and food processing are still the region's major industries, expansion from the San Francisco Bay Area and Sacramento over the past 30 years has resulted in the creation of major urban centers throughout the region.

Existing Conditions

Agricultural Land Use. Land uses in the San Joaquin River Region are predominantly open space in the mountain and foothill areas, and agricultural in the San Joaquin Valley area. Urban land use in 1990 totaled approximately 295,000 acres. Urban areas include the cities of Stockton, Modesto, Merced, and Tracy, as well as smaller communities such as Lodi, Galt, Madera, and Manteca. The western side of the region, south of Tracy, is sparsely populated. Small farming communities provide services for farms and ranches in the area, all relatively close to Interstate 5.

In 1994, excluding the legal Delta portion of San Joaquin County, about 4,750,000 acres of important farmland were mapped in the San Joaquin River Region.

Agricultural Water Use. About 40% of irrigation water sources in the San Joaquin River Region are from local water rights or local water projects. CVP project water provides 35% of total irrigation water uses, mostly to the Westlands Water District. The rest of the region's water is from the SWP and groundwater pumping.

Between 1985 and 1990, the average cost of surface water in this region is estimated at $20 to $85 per acre-foot, among the high end in California. The cost of groundwater is estimated at $30 to $80 per acre-foot, also among the high end in the state.

8.1.1.6 SWP and CVP Service Areas Outside the Central Valley

Historical Perspective. Between 1946 and 1950, in terms of irrigated acres, alfalfa and subtropical orchards were the most important crops in the region, accounting for 24% and 22% of the total irrigated acres, respectively. The next important crops in the region were truck crops, field crops, and grains, each accounting for about 15 to 20% of the total irrigated acres. Other crops grown in the region included pasture and orchards. Over 90% of California subtropical orchards were grown in this region during the 1950 to 1964 period. Development in the region has steadily increased since the 1880s.

Existing Conditions

Agricultural Land Use. About 15% (377,500 acres) of the region's land is estimated to comprise agricultural land uses. Intensive agriculture is in the Santa Maria and lower Santa Ynez valleys; moderate levels of agricultural activity also occur near the South Coast area. Agricultural crops include grapes, vegetables, and truck crops, as well as a thriving flower seed industry. Total irrigated land in the area was about 145,000 acres in 1990.

The South Coast is the most urbanized region in all of California. Irrigated cropland accounts for about 288,000 acres of the region. The largest amount of irrigated agriculture is in Ventura County, where about 116,600 acres of cropland are cultivated, including vegetables, strawberries, citrus fruit, and avocados.

Agricultural Water Use. Outside the Central Valley, SWP water and groundwater each provide 40% of total irrigation water in the region. Local water provides the rest of total irrigation water uses.

Between 1985 and 1990, the average cost of surface water in this region is estimated at $15 to $255 per acre-foot, among the highest in California. The cost of groundwater is estimated at $80 to $120 per acre-foot, also among the highest in the state.

8.1.2 Affected Environment/ Existing Conditions: Agricultural, Economic, and Social Issues

8.1.2.1 All Regions

California agriculture produces an abundance of products including over 50% of the U.S. production of fruits, nuts, and vegetables on 3% of the nation's farmland. The economic value of agriculture to the communities of the Sacramento Valley, the Delta, and the San Joaquin Valley is greater than the gross value of the farm products (farm gate value) or the number of direct farm-related jobs. There are two ways in which the agricultural industry impacts local and regional economies. First, to produce and harvest a crop requires a variety of inputs such as seed, fertilizer and chemicals, water, equipment and fuel, and labor. Then, after harvest, farm produce is transported, stored, processed, packaged, and marketed. These tasks result in direct economic activity. The second way is the distribution of the income resulting from the initial direct economic activity. This income supports local and regional economies as this farm and farm-related income is spent for food, housing, and other consumer items. Depending on the farm commodity produced, and the extent of value-added processing it receives, the economic multiplier effect can range from 1.8 to 4, with a general average of 2.7 often cited. According to California agricultural statistics for 1995, farm income totaled $22.1 billion and generated over $70 billion in related economic activity, resulting in an overall economic multiplier of 3.2.

The importance of agriculture to the economy of the Central Valley is even greater. Farming and farm-related industries in the Central Valley are estimated to directly and indirectly create about three out of ten jobs and about 30% of personal income. Statewide agriculture and related activities account for about one in every ten jobs.

Existing Conditions

Farm Profiles. Numbers and sizes of farms, together with ownership patterns, describe the general structure of agriculture within a region. A large number of farms can mean larger economic influences within the region in terms of employment, spending, and taxes. Ownership patterns can give an indication of the numbers of farm owners and managers who live within a region. Labor expenses are important to workers and the communities in which they live.

Table 8.1.2-1 shows a summary of farm profiles by region.

Cropping Patterns and Production Value. A cropping pattern is the share of acres within a region planted to individual crops or categories of crops, including fallowed land. Agricultural land use can be partially described by its cropping pattern, and cropping patterns are important to agricultural and regional economics.

Agricultural Production Costs and Revenues. Agricultural net returns are revenues less costs. Higher costs reduce farm profits, but some part of costs also represent farm expenditures in the regional economy. Revenues are unit price multiplied by the level of production. Table 8.1.2-2 includes regional summaries of production costs and revenues for example years 1987 and 1992.

Social Well Being Related to Agriculture. To describe the affected environment for social well being, this document relies on the grouping of counties for each region shown as follows in Table 8.1.2-3. This grouping is necessary in order to aggregate racial, income, and population data from the U. S. Census.

The affected environment for social well being involves both community stability issues and environmental justice issues. Although community stability and environmental justice issues overlap in many respects (for example, income and poverty levels) they are discussed separately for organizational purposes. Additionally, community stability is described for the entire study area rather than on a regional basis.

Community Stability. The affected environment for community stability includes the following:

- Social groups in the CALFED study area,
- Economic indicators of social well being,
- Employment opportunities, and
- Community social structure.

Please see Section 8.10 for further discussion of Environmental Justice.

Several important social groups are related to agriculture in the study area: farmers, farm workers, and agribusiness.

Economic indicators of social well being include population demographics, median family income, per capita income, poverty rates, and unemployment rates. These indicators are summarized by region in Table 8.1.2-4.

This section summarizes regional economic indicators of social well being in the study area as they apply to all social groups and communities. Some general conclusions derived from review of the economic data presented in Table 8.1.2-4 are as follows:

- In the study area, people living in predominantly rural areas have lower incomes, higher poverty rates, and higher unemployment rates than those living in the urban regions. However, San Francisco and Los Angeles counties experience high income levels and some of the highest poverty rates in the state.

- In all regions (except the Sacramento River Region) pockets of prosperity have an "averaging effect" of raising average personal income levels and lowering average poverty and unemployment rates.

		Number and Size			Ownership Status		
Region	Year	Number of Farms	Land in Farms (1,000 acres)	Average Farm Size (acres)	Full Owners	Part Owners	Tenants
Delta	1987	4,033	962	238	2,817	691	529
	1992	3,639	900	247	2,525	628	487
Bay	1987	8,377	2,315	276	5,950	1,194	1,233
	1992	7,453	2,261	303	5,306	1,035	1,112
Sacramento River	1987	11,916	4,527	380	8,183	2,160	1,568
	1992	11,507	4,334	377	7,786	2,093	1,629
San Joaquin River	1987	28,742	10,095	351	20,942	4,610	3,730
	1992	26,731	9,656	361	9,144	4,420	3,168
SWP and CVP Service Areas Outside the Central Valley	1987	21,281	6,279	295	16,744	1,837	2,700
	1992	19,899	5,488	276	16,063	1,639	2,197

SOURCE:
U.S. Census, 1989 and 1994.

Table 8.1.2-1. Number of Farms, Farm Sizes, and Farm Ownership in All Regions, 1987 and 1992

		Total Farm Income (million dollars)				Total Production Expenses (million dollars)				
Region	Year	Agric. Product Value	Other Revenue	Total	Livestock Related	Fertilizers and Chemicals	Hired and Contract Labor	Other	Total	Net Cash Return (million dollars)
Delta	1987	496	12	508	81	38	97	169	385	123
	1992	590	10	600	89	48	128	209	474	126
Bay	1987	845	2	847	102	36	255	281	674	173
	1992	1,065	6	1,071	105	53	338	335	831	240
Sacramento River	1987	1,515	145	1,660	126	140	252	525	1,043	617
	1992	1,394	183	1,577	147	180	316	630	1,273	304
San Joaquin River	1987	6,565	222	6,787	1,276	531	1,337	2,197	5,341	1,446
	1992	8,089	308	8397	1,780	670	1,691	2,736	6,877	1,520
SWP and CVP Service Areas Outside the Central Valley	1987	3,743	30	3,773	872	185	842	1,044	2,943	830
	1992	4,295	29	4,324	904	222	1,072	1,312	3,510	814

SOURCE:
U.S. Census, 1989 and 1994.

Table 8.1.2-2. Farm Income and Production Expense in All Regions, 1987 and 1992

CALFED Regions	Counties
Delta Region	98% of Contra Costa, 45% of Sacramento, 46% of San Joaquin, 30% of Solano, and 20% of Yolo.
Bay Region	Alameda, 2% of Contra Costa, Marin, Napa, San Benito, San Francisco, San Mateo, Santa Clara, Santa Cruz, and Sonoma.
Sacramento River Region	Butte, Colusa, Glenn, Placer, 55% of Sacramento, Shasta, 70% of Solano, Sutter, Tehama, 80% of Yolo, and Yuba.
San Joaquin River Region	Fresno, Kern, King, Madera, Merced, 54% of San Joaquin, Stanislaus, and Tulare.
SWP and CVP Service Areas Outside the Central Valley	Imperial, Los Angeles, Plumas, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, and Ventura.

Table 8.1.2-3. CALFED Regions and Groupings of Counties

Personal income is measured as family and/or per capita income, as shown in Table 8.1.2-4. Median family income is a measure of the annual income received by families living together in the same household. The median is a statistical term for the midpoint of a data set. There is a wide range of median family income in the study area. Per capita income in the study area ranges from $10,000 in the Tulare Lake area and Yuba County (Sacramento River Region) to $28,000 in Marin County in the Bay Region.

As shown in Table 8.1.2-4, existing unemployment rates are lowest in the Bay and Delta regions where more employment opportunities are available. Unemployment rates are presented as a range in areas with diverse economies such as the urban and agricultural areas in the Sacramento Valley and San Joaquin Valley.

There is a wide range of poverty rates within the study area. The highest poverty rates in the study area occur in predominantly rural areas, and poverty rates are higher among minority ethnic groups. A 1986 study by the California Employment Development Department (EDD) estimated the poverty rates among races in California during 1980, as summarized in Table 8.1.2-5. Unemployment rates in the study area are higher among minority ethnic groups. The EDD estimated statewide unemployment rates among races in California during 1980, as summarized in Table 8.1.2-6.

Average annual agricultural employment was about 400,000 to 435,000 jobs from 1987 to 1992. Approximately 420,000 people were employed in the agriculture industry in 1992. The relationship between the agricultural sector and the larger economy of the Central Valley is important in the assessment of social factors. Agricultural employment is becoming a less significant factor in measuring the viability of the local economy in all areas of the Central Valley than it once was. The economy of the Central Valley has grown and diversified, and nonagricultural employment opportunities are increasing. This general trend does not hold true for some communities. Agriculture remains the dominant industry and economic force in many smaller communities.

Factors affecting social well being include not only employment opportunities but also job guarantees. Job guarantees are affected by seasonal employment trends and economic trends and, in some cases, natural occurrences. Seasonal employment affects agricultural workers. Economic trends also may affect agriculture. Natural occurrences such as weather conditions can shorten or lengthen seasonal employment opportunities. For example, water shortages can reduce the number of acres farmed. Natural occurrences such as drought and flood conditions and economic conditions are not under the control of CALFED and, although they are not addressed further in this chapter, are important to consider in the assessment of existing conditions.

	Delta	Bay	San Joaquin	Sacramento	CVP and SWP Service Areas Outside the Central Valley
1996 Population[a]	2,362,514	5,498,964	3,004,222	1,666,650	19,159,450
Economic Indicators					
Median Family Income (1989)[b]	40,690	46,373	30,862	31,794	38,825
Per Capita Income[c] (1994)	21,991	28,079	16,475	18,313	20, 358
Poverty Rate[d]	11%	9%	18%	13%	13%
1995 Unemployment Rate[e] Average Range	 7.8% 5.8 to 12.3%	 6.6% 4.3 to 13.5%	 13.3% 8.2 to 16.9%	 11.2% 6.1 to 19.7%	 10% 5.1 to 28.8%

NOTES:
[a] Source: California Department of Finance, County Population Data, aggregated into CALFED Regions according to Table 1.
[b] Source: California Department of Finance, Median Family Income for each county was averaged to show average median family income for each CALFED region.
[c] Source: California Department of Finance, Per Capital Income for each county was averaged to show average per capita income for each CALFED region.
[d] Poverty Rate
[e] Source: California Department of Finance; average of counties within each CALFED Region.

Table 8.1.2-4 Existing Conditions: Regional Demographics and Economic Indicators of Social Well- Being

C-005481

C-005481

Ethnicity	Poverty Rate (Percentage)
White	6
Black	21
Hispanic	18
Asian and other	11

Table 8.1.2-5. Poverty Rate by Ethnicity

Ethnicity	Unemployment Rate (percentage)
White	4
Black	7
Hispanic	7
Asian and other	4

Table 8.1.2-6. Unemployment Rate by Ethnicity

For the CALFED study area, the largest sectors of workers who may be affected are seasonal farm workers and agricultural workers. Seasonal unemployment among farm workers and agricultural workers usually occurs during winter months following harvest and summer vacation periods. Changes in seasonal employment can affect the demand for social services. The demand for social services increases during periods of unemployment, such as requests for unemployment payments, health services, and other family support programs. The need to utilize family, health, and income support services can decrease social well being among persons who are employed during much of the year but are seasonally unemployed.

Local communities provide a social base for people to access assistance and support during times of need. The social structure of a community may provide job training, educational opportunities, family support services, religious and cultural outlets for support and counseling, recreational opportunities, and monetary assistance. These services may be available through community or county agencies or from cultural and religious institutions within the community.

The local community also provides an identifying factor for all residents and a sense of belonging. When economic changes occur within an area, such as the loss or gain of a major employer or drought or flood conditions, the local community can be affected significantly. This is especially true if the local economy is centered around one industry type, such as agriculture. The community is a crucial level of social organization. It is at this level that most social services are delivered, social networks formed, and values and beliefs confirmed.

Environmental Justice. The analysis of potential environmental justice issues focuses on the farm worker population. Within the population potentially affected by the CALFED program, this population is the most racially diverse. Table 8.1.2-7 indicates ethnicity by region, and Table 8.1.2-8 presents the racial distribution of farm workers by region.

The vast majority of U.S. farm workers have been Mexican immigrants and their children since the Bracero Program, which operated from 1942 to 1964, brought in more than 4 million laborers from Mexico. Earlier decades saw substantial numbers of Chinese, Japanese, Filipinos, Native Americans, and African Americans. By 1983, an estimated 90% of the seasonal farm laborers in California were Mexicans or Chicanos, while nationwide the figure was 60%. Most migrant farm workers are either American citizens or are working in the country legally. The Department of Labor estimates that about 25% of migrant farm workers are illegal immigrants.

Additionally, the Department of Labor estimates that at any given time, 12% (or at least 190,000) domestic farm workers are out of work nationwide. The majority of farm workers earn annual wages of less than $7,500. Although wage rates for farm workers have increased over the last decade, when they are adjusted for inflation, farm workers' real wages have decreased 15 to 25% in that time.

Region	Ethnicity (percentage)			
	White	Black	Asian	Hispanic
Delta Region	68	8	9	14
Bay Region	61	8	15	16
Sacramento River Region	82	4	5	10
San Joaquin River Region	62	4	6	30
SWP and CVP Service Areas Outside the Central Valley	52	9	9	30

SOURCE:
California Department of Finance, 1993.

Table 8.1.2-7. Ethnicity by Region

Region	Hispanic	White	Black	American Indian/Eskimo Aleutian	Asian Pacific/ Islander	Total Number of Farm Workers
Delta	77%	15.1%	0.8%	0.3%	6.5%	5,470
Bay	82.2%	14.4%	1%	0%	2.2%	12,230
Sacramento River	58.9%	30.9%	0.4%	1%	8.2%	11,560
San Joaquin River	84%	11.9%	0.3%	0.2%	3.4%	74,220
SWP and CVP Service Areas Outside the Central Valley	86.9%	10.1%	.9%	.2%	1.7%	44,960
Totals	**122,490**	**19,500**	**840**	**400**	**4,860**	**148,440**

SOURCE:
Census of Population and Housing, 1990.

Table 8.1.2-8. Racial Distribution of Farm Workers by Region

8.1.2.2 Delta Region

Historical Perspective. Between 1944 and 1964, the number of farms in the region increased from 3,457 in 1944 to 4,502 in 1949, and then declined to 3,374 in 1964. The decline was due mainly to the accumulation of irrigated land into fewer and larger farms. As a result, the average farm size in the Delta Region increased from 58 acres in 1944 to 132 acres in 1964.

Existing Conditions

Farm Profiles. The number of farms decreased from 4,033 in 1987 to 3,639 in 1992 in the Delta Region, partly due to loss of farmland (62,000 acres) to industrial and urban uses, and partly to the accumulation of farmland into fewer and larger farms. The average farm size increased from 238 acres to 247 acres during this period. About 70% of farms in the Delta are operated by full owners.

Cropping Patterns and Production Value. Truck crops dominate Delta crop production, accounting for 30% of the region's total harvested acres. The next important group of crops in the region include alfalfa, grains, and orchards, each accounting for 10 to 15% of the total crop acreage. Orchards and grapes together accounted for less than 20% of the total harvest acreage in the Delta between 1986 and 1995, but produced about 50% of the total production value, reflecting high crop values per acre. Alfalfa and field crops produced about 15% of total production value, with more than 40% of total harvested acres, indicating lower crop values per acre.

Agricultural Production Costs and Revenues. Agricultural net returns are revenues less costs. Higher costs reduce farm profits, but some part of costs also represent farm expenditures in the regional economy. Revenues are unit price multiplied by the level of production.

Farms in the Delta Region achieved $496 million in agricultural sales in 1987 and $590 million in 1992, as shown in Table 8.1.2-2. Production expenses were about $474 million in 1992, leaving a net cash return of $126 million. Hired and contract labor was the largest expense reported, accounting for 25% of total expenses.

Social Well Being Related to Agriculture. As shown in Table 8.1.2-4, the 1996 total population for the Delta Region was 2,362,514. The median family income was $40,690 (1989), per capita income was $21,991 (1994), poverty rate was 11% (1990), and the unemployment rate ranged from 5.8 to 12.3% (1995).

8.1.2.3 Bay Region

Historical Perspective. Between 1944 and 1964, the number of farms increased from 5,581 in 1944 to 6,146 in 1954 in the Bay Region, then declined to 4,103 in 1964. This was partly due to the accumulation of irrigated land into fewer and larger farms and urban encroachment.

Existing Conditions

Farm Profiles. The number of farms decreased from 8,377 in 1987 to 7,453 in 1992 in the Bay Region, partly due to loss of farmland (54,000 acres) to industrial and urban uses, and partly to the accumulation of farmland into fewer and larger farms. The average farm size increased from 276 acres to 303 acres during this period. About 70% of farms in the Bay Region are operated by full owners.

Cropping Patterns and Production Value. Grapes are the dominant crop in the Bay Region, accounting for 30% of the region's total harvested acres. The next important group of crops in the region is sugar beets and truck crops, each accounting for about 20% of the total crop acreage. Between 1986 and 1995, grapes and orchards together accounted for less than 50% of the total harvest acreage, but produced about 80% of the total production value, reflecting high crop values per acre. Alfalfa, grains, and field crops produced about 2% of total production value, with more than 35% of total harvested acres.

Agricultural Production Costs and Revenues. Farms in the Bay Region achieved $845 million in agricultural sales in 1987 and $1,065 million in 1992, as shown in Table 8.1.2-2. Production

expenses were about $831 million in 1992, leaving a net cash return of $240 million. Hired and contract labor was the largest expense reported, accounting for about 40% of total expenses, and it has been increasing over time.

Social well being Related to Agriculture. As shown in Table 8.1.2-4, the 1996 total population for the Bay Region was 5,498,964. The median family income was $46,373 (1989), per capita income was $28,079 (1994), poverty rate was 9% (1990), and the unemployment rate ranged from 4.3 to 13.5% (1995).

8.1.2.4 Sacramento River Region

Historical Perspective. Between 1944 and 1964, the number of farms increased from 9,948 in 1944 to 11,538 in 1954 in the Sacramento River Region, then declined to 9,255 in 1964. This was mainly due to the accumulation of irrigated land into fewer and larger farms. As a result, the average farm size in the region increased from 64 acres in 1944 to 138 acres in 1964.

Existing Conditions

Farm Profiles. The number of farms decreased from 11,916 in 1987 to 11,507 in 1992 in the Sacramento River Region, primarily due to loss of farmland (193,000 acres) to industrial and urban uses. The average farm size remained about the same during this period. About 70% of farms are operated by full owners.

Cropping Patterns and Production Value. Rice is the number one crop in the Sacramento River Region, accounting for 26% of the region's total harvested acres. The next important group of crops in the region includes field crops (19%), orchards (15%), pasture (11%), and grains (10%). Between 1986 and 1995, orchards and tomatoes together accounted for less than 25% of the total harvest acreage in this region, but produced about 50% of the total production value, reflecting high crop values per acre. Pasture, alfalfa, grains, and field crops produced less than 20% of total production value, with more than 50% of total harvested acres, indicating lower crop values per acre.

Due to extensive re-use of water in the Central Valley, significant savings only occur from fallowing or through crop shifts. Decreased reliability constrains the conversion to high-value crops because of increased risk, particularly when groundwater is unavailable or of low quality. More lower-value but drought-tolerant crops are planted instead.

Agricultural Production Costs and Revenues. Farms in the Sacramento River Region achieved $1,515 million in agricultural sales in 1987 and $1,349 million in 1992, as shown in Table 8.1.2-2. Production expenses were about $630 million in 1992, leaving a net cash return of $304 million. Hired and contract labor was the largest expense reported, accounting for about 25% of total expenses.

The region supports about 2,145,000 acres of irrigated agriculture. About 1,847,000 acres are irrigated on the valley floor; the surrounding mountain valleys within the region add about 298,000 irrigated acres (primarily pasture and alfalfa) to the region's total.

Social Well Being Related to Agriculture. As shown in Table 8.1.2-4, the 1996 total population for the Sacramento River Region was 1,666,650. The median family income was $31,794 (1989), per capita income was $18,313 (1994), poverty rate was 13%, and the unemployment rate ranged from 6.1 to 19.7% (1995).

8.1.2.5 San Joaquin River Region

Historical Perspective. Between 1944 and 1964, the number of farms increased from 30,212 in 1944 to 33,832 in 1949 in the San Joaquin River Region, then declined to 25,153 in 1964. This was mainly due to the accumulation of irrigated land into fewer and larger farms. As a result, the average farm size in the region increased from 78 acres in 1944 to 155 acres in 1964.

Existing Conditions

Farm Profiles. The number of farms in the San Joaquin River Region decreased from 28,742 in 1987 to 26,731 in 1992, partly due to loss of

farmland (439,000 acres) to industrial and urban uses, and partly due to the accumulation of farmland into fewer and larger farms. The average farm size increased from 351 acres to 361 acres during this period. About 73% of farms are operated by full owners.

Cropping Patterns and Production Value. In terms of harvested acres, cotton is the number one crop in the San Joaquin River Region, accounting for 25% of the region's total harvested acres. The next important crops in the region are field crops (15%), orchards (13%), grapes (10%), and alfalfa (10%). Between 1986 and 1995, grapes and orchards together accounted for less than 25% of the total harvest acreage in this region but produced about 50% of the total production value. Pasture, alfalfa, grains, and field crops produced less than 20% of total production value with more than 50% of total harvested acres.

Agricultural Production Costs and Revenues. Farms in the San Joaquin River Region achieved $6,565 million in agricultural sales in 1987 and $8,089 million in 1992, as shown in Table 8.1.2-2. Production expenses were about $2,736 million in 1992, leaving a net cash return of $1,520 million. Hired and contract labor was the largest expense reported, accounting for about 25% of total expenses.

Social Well Being Related to Agriculture. As shown in Table 8.1.2-4, the 1996 total population for the San Joaquin Region was 3,004,222. The median family income was $30,862 (1989), per capita income was $16,475 (1994), poverty rate was 18% (1990), and the unemployment rate ranged from 8.1 to 16.9% (1995).

8.1.2.6 SWP and CVP Service Areas Outside the Central Valley

Historical Perspective. Between 1944 and 1964 in the SWP and CVP Service Areas Outside the Central Valley, the number of farms decreased from 33,715 in 1944 to 13,603 in 1964, mainly due to the accumulation of irrigated land into fewer and larger farms. As a result, the average farm size in the region increased from 30 acres in 1944 to 82 acres in 1964.

Existing Conditions

Farm Profiles. The number of farms in the region decreased from 21,281 in 1987 to 19,899 in 1992, primarily due to loss of farmland (791,000 acres) to industrial and urban uses. The average farm size decreased from 295 acres to 276 acres during this period.

Cropping Patterns and Production Value. In terms of harvested acres, alfalfa is the number one crop in the region, accounting for 28% of the region's total harvested acres. The next important crops in the region are pasture (12%), subtropical orchards (11%), field crops (10%), and grains (10%). Between 1986 and 1995, truck crops and orchards together accounted for less than 30% of the total harvest acreage in this region but produced about 70% of the total production value. Pasture, alfalfa, grains, and field crops produced less than 15% of total production value with more than 50% of total harvested acres.

Agricultural Production Costs and Revenues. Farms in the SWP and CVP Service Areas Outside the Central Valley achieved $3,743 million in agricultural sales in 1987 and $4,295 million in 1992, as shown in Table 8.1.2-2. Production expenses were about $3,510 million in 1992, leaving a net cash return of $814 million. Hired and contract labor was the largest expense reported, accounting for about 30% of total expenses.

Moderate levels of irrigated agriculture subsist in the Mojave River, Antelope, and Indian Wells valleys. Most of the acreage produces alfalfa, pasture, or deciduous fruit. About one-half (30,000 acres) of the entire region's irrigated crop land is estimated to lie in the SWP and CVP Service Areas Outside the Central Valley.

Prominent agricultural crops in the southern portion of San Bernardino County, the middle portion of Riverside County, and the Salton Sea in Imperial County include alfalfa, winter

vegetables, melons, grapes, dates, and wheat, located primarily in the Coachella Valley area.

Social Well Being Related to Agriculture. As shown in Table 8.1.2-4, the 1996 total population for the CVP and SWP Service Areas was 19,159,450. The median family income was $38,825 (1989), per capita income was $20,358 (1994), poverty rate was 13%, and the unemployment rate ranged from 5.1 to 28.8% (1995).

8.1.3 Environmental Consequences: Agricultural Land and Water Use

8.1.3.1 Assessment Methods

Agricultural land and water use impacts could occur in two main categories: direct and construction-related impacts; and indirect and operational impacts.

Direct impacts are those changes in physical land and water uses, or in land use designations, which result from construction of new facilities or conversion of lands from one use to another. For purposes of this analysis, direct impacts are those that would occur if any of alternatives, or combinations of alternatives, were implemented.

Indirect effects occur later in time and could be farther removed in distance. Indirect land use effects would be changes in broad land use policies, resources, or economies which could result from changes in land uses, or in the long-term availability of water resources. Potential indirect and operational impacts of the program include long-term changes in the number of acres in agricultural use.

As a Programmatic EIS/EIR, this assessment does not provide site-specific details or specific estimates of acreages potentially affected for a given alternative. Rather, potential increases or decreases in agricultural land uses by region are qualitatively estimated, or described with a range of gross acres.

8.1.3.2 Significance Criteria

The following impacts would have potentially significant agricultural land or water use effects:

- Permanent or long-term reduction in agricultural acreage within a region or the conversion of any lands categorized as prime or unique farmlands;
- Affects an agricultural resource or operation (for example, impacts to soils or farmlands, or impacts from incompatible land uses);
- Any increase in groundwater pumping that would cause or exacerbate overdraft of a basin;
- Changes in surface water use which lead to changes in land use or higher regional unemployment;
- Inconsistency with agricultural objectives of local, regional, and state plans;
- Conflicts with applicable environmental plans or policies adopted by agencies with jurisdiction over the project; or
- Conflicts with general plan designations or zoning.

8.1.3.3 Comparison of No Action Alternative to Existing Conditions

The key changes between current conditions and No Action Alternative conditions involve the conversion of agricultural land uses to accommodate facilities associated with reasonably foreseeable future actions in the Central Valley. Additional agricultural impacts are anticipated from urbanization of agricultural lands as Central Valley towns and cities grow in population. Specific agricultural land use impacts (versus impacts to open space or municipal and industrial lands) would depend upon the actual location of the modifications and improvements to be implemented under the No Action Alternative.

In addition, under the No Action Alternative, it is estimated that about 45,000 acres of drainage problem lands in the San Joaquin River Region will be retired by year 2020.

Table 8.1.3-1 summarizes the agricultural water use in the Central Valley before and after water was reallocated according to the CVPIA. This table illustrates how changes in surface water delivery correspond to changes in groundwater pumping. The estimates indicate that part of any change in surface water delivery is likely to be offset by a change in groundwater use. The degree of replacement depends on the relative cost of groundwater and surface water, and on the relative cost and benefit of other potential adjustments (for example, changing the amount of acreage irrigated or changing irrigation methods).

8.1.3.4 Comparison of Program Alternatives to No Action Alternatives

The impacts to agricultural land and water use resulting from the storage and conveyance program element will vary by alternative, as discussed below. Impacts to agricultural land and water use resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a regions, the program element is not discussed.

> Potential land use changes attributable to each alternative are noted in Chapter 5, in Sections 5.2.1, 5.2.2, 5.2.3 and 5.2.4. Further, potential effects on important farmlands are noted in Section 5.2.5.

Delta Region

Storage and Conveyance. Significant and unavoidable adverse land use impacts could occur by converting existing land uses from new or expanded surface storage. Specific land use impacts would depend on the exact location of the new storage facility. For purposes of this programmatic analysis, it is assumed that most new reservoir sites would be located in the foothills rather than in flat, valley-bottom areas where agricultural land uses would occur. Therefore, storage elements would likely affect less productive agricultural lands, such as grazing lands, and not the better farmland generally found on the valley floor.

Channel widening and island flooding proposed in Alternative 2 will require the purchase and conversion of between 4,000 and 28,000 acres of agricultural land, depending on the variation chosen. Adverse land use impacts of the modifications would be significant.

Creating an open-channel isolated conveyance in Alternative 3 would be a significant adverse land use impact due to permanent conversion of between 4,500 and 33,500 acres of important farmland.

Conversion of prime or unique farmland to other uses could also conflict with local or regional agricultural land use plans or policies, which could be a significant impact.

The specific locations of improvements contemplated for the alternatives have not been identified for this programmatic-level analysis. Thus, the consistency of project alternatives with general plan land use designations or zoning are not evaluated herein. However, inconsistency with these plans could result in a significant adverse land use impact.

The cost and availability of water from new storage and conveyance facilities will depend on the
alternative selected, the location of facilities proposed, and amount of new water from each of these facilities. Neither a cost analysis nor a willingness-to-pay study have been completed. Consequently, the allocation of new water by region is uncertain. However, based on proposed alternative configurations some general statements can be made about potential water supply benefits

Source	Agricultural Water Use — 2020 Condition Without CVPIA (TAF/year)	Change due to CVPIA Dedicated Water for Restoration (TAF/year)
Sacramento Region		
Surface Water	4,524	-39
Groundwater	2,603	25
Total applied	7,127	-14
San Joaquin River Region		
Surface Water	4,453	-302
Groundwater	3,427	134
Total applied	7,880	-168

NOTES:
TAF = Thousand acre-feet
These estimates were based on regions defined in the CVPIA Programmatic Environmental Impact Statement (EIS) and are shown as an example, based on estimates for the Programmatic EIS Alternative 1

Table 8.1.3-1. Substitutions for Groundwater for Surface Water in the Central Valley—Before and After CVPIA Reallocation of Water

in each of the regions. No agricultural water supply benefits would accrue to the Delta Region for Configurations 1A and 1B. And the benefits (or losses) to the Delta Region from the other configurations are unknown. For more discussion about the potential water supply benefits of the configurations, please see Sections 6.1.

Ecosystem Restoration. The Ecosystem Restoration Program recommends conversion of land in the Delta Region to habitat and ecosystem restoration, levee setbacks, and floodways. In general, agriculture is the dominant land use on the nonconveyance side of levee structures in the Delta. The ecosystem restoration program could convert up to 115,000 acres of important farmland. Some of these agricultural uses may be shifted to the Central Valley or elsewhere.

The mix of crops taken out of production and converted to habitat is difficult to assess because the specific locations where willing seller land acquisitions and restoration will occur are still unknown. Consequently, estimating the reduction in applied water is somewhat speculative. However, using a hypothetical example, and assuming a rough average of 4 acre-feet of applied water per acre of land in production and that the maximum potential footprint of 115,000 acres was converted to habitat in the Delta, about 460,000 acre-feet of applied water would be left in the stream or consumed by the new habitat. (See sidebar on page 8.1-28 titled Applied Water Reduction Versus Real Water Savings.)

It is important to note that this reduction in agricultural applied water does not equal water potentially available for other beneficial users other than the new habitat. Much of the water applied to Delta lands not consumed by crops returns as flow to the rivers in the Delta. In addition, flora that is restored in the Delta will consume much of the water that would have been used by crops.

Water Quality. The long-term benefits of this program include improved water quality conditions relative to the No Action Alternative.

Water Use Efficiency. This program is not anticipated to have direct land use impacts; however, there may be indirect impacts to

agricultural land use. Agricultural land may be removed from production because of increased costs and decreased profitability which could result from required efficiency improvements or increased district water charges (for example, as part of tiered water pricing). Conversely, improved efficiency may allow the continued viability of agriculture in some areas. Efficiency improvements that result in greater water supply reliability but also higher annual cost may cause a shift in the types of crops grown. A shift to high-value crops may lead to a hardening of water demand. Conversion or loss of agricultural land would be a potentially significant adverse land use impact of this program. Improvement in the long-term viability of some agricultural lands would be a potentially beneficial impact.

Levee System Integrity. Levee system integrity measures could affect up to 35,000 acres of land in the Delta, most of which would likely be important agricultural land. However, the specific locations of lands that would be affected by the Program are not known at this time. The impacts from this program would primarily affect agricultural land uses in the Delta Region and would not directly affect land uses in the other four regions.

Water Transfers. This program would affect land use economics primarily through changes to agricultural, open space, habitat, and developed land use. In addition to the source of water for a transfer, the timing, magnitude, and pathway of each transfer have a tremendous effect on the potential for significant impacts. The water source varies according to the water transfer category: crop fallowing (surface water or groundwater), shifting to a crop with a lower water demand (surface water or groundwater), groundwater substitution for surface water (surface water), direct groundwater transfers (groundwater), conserved water (surface water or groundwater), and stored water in reservoirs (surface water).

Potentially significant beneficial impacts are associated with the transferred water's destination, and include: 1) increasing agricultural acreage in areas with limited water supplies; and

Applied Water Reduction Versus Real Water Savings

With the exception of a negligible amount of water required for plant metabolic processes, agricultural applied water can be accounted for by various demand elements. The "consumptive" elements (crop evapotranspiration, on-farm evaporation, and conveyance consumption) are lost to the atmosphere and generally not recovered. The "non-consumptive" elements (tailwater, deep percolation, conveyance seepage, canal spill, and gate leakage) flow either to local surface or groundwater resources.

In theory, all losses are recoverable. In practice, however, losses that flow to very deep aquifers or excessively degraded water bodies may not be recoverable because of prohibitively expensive energy requirements (that is, they become non-recoverable). Determining recoverability varies with location and time as well as other factors.

Distinguishing between non-recoverable and recoverable losses is typically based solely on water quality considerations. This assumes that all losses to usable water bodies can be economically recovered. Principal water bodies that are regarded as non-recoverable include saline, perched groundwater underlying irrigated land on the west side of the San Joaquin Valley; Salton Sea, which received drainage from Coachella and Imperial valleys; San Francisco Bay; and the Pacific Ocean.

Real water savings can only be achieved by reducing non-recoverable losses because they are truly lost from the system. Water is considered "saved" when these losses are reduced. Such water savings are available for reallocation for other water supply users, including urban, agricultural, or the ecosystem.

Recoverable losses, on the other hand, often constitute a supply for downstream uses. Downstream uses can include groundwater recharge, agricultural and urban water use, and environmental uses, including wetlands, riparian corridors, and in-stream flows. Often, recoverable losses are used many times over by many downstream beneficiaries. Thus, reducing applied water when the losses are considered recoverable does not generate a new water supply for reallocation to other uses. However, other non-water supply benefits can be derived. These include improved water quality, modifications in the timing and/or location of diversions, and local instream benefits. More information can be found in Chapters 4 and 5 of the Water Use Efficiency Program appendix.

2) increasing habitat acreage in areas with limited water supplies.

Potentially significant adverse impacts are associated with the transferred water's origin, and include: 1) decreasing agricultural acreage due to crop fallowing; 2) decreasing agricultural acreage due to increased costs resulting from direct groundwater or groundwater replacement transfers; 3) causing land use changes that could be inconsistent with local agricultural objectives; and 4) decreasing habitat acreage.

Water transfers are not expected to have direct land use impacts; however, they could indirectly affect agricultural opportunities by changing availability of water in selling and receiving areas.

Bay Region

The compatibility and consistency of potential actions with land use plans is not evaluated in this programmatic-level analysis. However, inconsistency between applicable Alternative 1 Program elements with existing area city and county land use plans could result in a significant adverse land use impact.

Potential land use impacts to important agricultural land in the Bay Region are anticipated to be minimal and have not been quantified.

It is anticipated that agricultural water users in the Bay Region would receive some of the additional water supply developed by most of the configurations, ranging from about 60,000 to 700,000 acre-feet (annual average).

Sacramento and San Joaquin River Regions

Storage and Conveyance. Storage facilities could result in conversion of agricultural land in the foothill or mountain areas, a potentially significant and unavoidable adverse impact. Development of storage facilities could also conflict with local and regional plans regarding agricultural lands.

The compatibility and consistency of potential actions with county and city local general land use plans are not evaluated in this programmatic-level analysis. However, inconsistency between applicable Alternative 1 program elements with these plans could result in a significant adverse land use impact.

Between 18,000 and 32,000 acres of agricultural land could be affected by the program storage elements. But, because storage facility locations have not been chosen, the amount of important farmland affected is not known and will be determined in project-specific environmental documentation.

Because potential storage sites are primarily in the foothills and would affect dryland crops and grasslands, which are reliant on rainfall, applied water has not been estimated.

It is anticipated that agricultural water users in the Sacramento River and San Joaquin River Region would receive some of the additional water supply developed bymost of the configurations, ranging from about 60,000 to 700,000 acre-feet (annual average). However, under Configurations 1A and 1B, 2A, and 2D, and 3A, the Sacramento River Region would probably not receive additional water supply benefits.

Ecosystem Restoration. The Ecosystem Restoration Program could convert up to 34,000 acres of important farmland, primarily on the east side of the valley and the valley trough in the Sacramento Valley and up to 11,000 acres of important farmland, primarily east of the San Joaquin River in the San Joaquin Region.

Water Quality. As proposed in the Water Quality Program, approximately 35,000 to 45,000 acres of agricultural land with water quality problems (for example, due to selenium) may be idled in the Grasslands Subarea of the San Joaquin River Region as a measure to improve water quality in the region and the Delta. The location of these lands and, consequently, the types of crops that would be idled are not known. But up to 45,000 acres of agricultural land, including prime and unique farmland, could be affected.

Again, the location and mix of crops that would be retired as part of the Water Quality Program is unknown. But assuming an average of 3 acre-feet of applied water per crop acre and a maximum of 45,000 acres of drainage problem lands idled, approximately 135,000 acre-feet of water would not be applied. As discussed in the Delta Region Land and Water Use impact section, this reduction in applied water does not necessarily equate to new water. Some of this water would likely be recoverable in the San Joaquin River Region by downstream or in-basin users.

Water Use Efficiency. Potential Water Use Efficiency Program impacts would be similar to those discussed under the Delta Region.

Water Transfers. Potential Water Transfer Program impacts would be similar to those discussed under the Delta Region.

Coordinated Watershed Management. Potential watershed activities in the Sacramento River and San Joaquin River regions will be compatible with applicable agricultural land use plans and policies in their affected jurisdiction. Reduced grazing activities in the watershed could have potentially significant land use impacts in this region if they result in a loss of agricultural productivity.

SWP and CVP Service Areas Outside the Central Valley

Potential direct land use impacts to agricultural land in the SWP and CVP Service Areas Outside the Central Valley are anticipated to be minimal and have not been quantified.

It is anticipated that agricultural water users in this region would receive some of the additional water supply developed by most of the configurations, ranging from about 60,000 to 700,000 acre-feet (annual average).

Water Use Efficiency. Indirect changes in land use may result from the Water Use Efficiency Program. In some instances, agricultural land may be removed from production because of increased costs and decreased profitability which could result from required efficiency improvements or increased district water charges (for example, as part of tiered water pricing). Conversely, improved efficiency may allow the continued viability of agriculture in some areas. This will tend to maintain the existing uses of agricultural lands in some regions and reduce the amount that may go out of production or become urbanized. Efficiency improvements that result in greater water supply reliability but also higher annual cost may cause a shift in the types of crops grown. Conversion or loss of agricultural land would be a potentially significant adverse land use impact of the program. Improvement in the long-term viability of some agricultural lands would be a potential beneficial impact.

8.1.3.4 Comparison of Program Alternatives to Existing Conditions

Comparison of Program alternatives to existing conditions indicates:

- All significant adverse impacts identified when making a comparison to the No Action Alternative would still be significant when compared to existing conditions.

- CALFED is proposing actions for levee protection, storage and conveyance, and ecosystem restoration, which could result in additional large-scale land conversions impacting agricultural lands, particularly in the Delta. Adverse impacts resulting from the CALFED alternatives combined with the expected future conversion of agricultural lands when compared to existing conditions.

- The water supply reliability actions from the Water Use Efficiency, Water Quality, and Storage and Conveyance programs could improve the availability and quality of water for agricultural purposes above the existing conditions baseline. While CALFED is expecting an overall improvement in water supply reliability for agriculture relative to the No Action Alternative, there is still the potential that the benefits provided by the Program alternatives could be diminished by unforeseen future conditions such as extended drought. Consequently, while the benefits of

the alternatives were analyzed using reasonable approximations of future conditions, it should be acknowledged that water supply reliability could be worse than currently exists.

In summary, the conclusions regarding the significance of project effects on surface water quality when compared to existing conditions would be similar to those compared to No Action.

8.1.3.5 Land and Water Use Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

Avoidance or minimization strategies:

- Develop assurance measures to increase water supply reliability such as providing long-term water supply contracts;
- Site and align Program features to avoid or minimize impacts on agriculture;
- Examine structural and nonstructural alternatives to achieving project goals without impacting agricultural lands;
- Implement features that are consistent with local and regional land use plans;
- Work with local and regional jurisdictions to amend local plans and policies to bring Program features into compliance;
- Involve all affected parties, especially landowners and local communities in developing appropriate configurations to achieve the optimal balance between resource impacts and benefits;
- To the extent practicable, maintain the productivity and flexibility of California's agricultural resources.

Some examples of Ecosystem Restoration Program avoidance or minimization measures are:

- Restore existing degraded habitat first;
- Focus habitat restoration efforts first on developing new habitat on public lands;
- Absent public lands, restoration efforts will occur on lands acquired from willing sellers where at least part of the reason to sell is an economic hardship, that is, land that floods frequently or the levees are too expensive to maintain;
- Where small parcels of land are needed for waterside habitat, acquisition efforts will seek out points of land on islands where the ratio of levee miles to acres farmed is high;
- Obtain easements on existing agricultural land which would allow for minor changes in agricultural practices thus increasing the value of the agricultural crop(s) to wildlife;
- Floodplain restoration efforts would include provisions for continued agricultural practices on an annual basis;
- Water acquired for habitat purposes could be purchased using temporary or rotating contracts so that the same land or locality is not impacted every year; and
- Use a planned or phased habitat development approach in concert with adaptive management.

Some examples of avoidance and minimization measures from the Levee System Integrity Program include:

- In implementing levee reconstruction measures, work with landowners to establish levee reconstruction methods which avoid or minimize the taking of agricultural land;
- When planning subsidence control measures, work with landowners to establish Best

Management Practices (BMPs) which avoid or minimize changing land use practices while protecting levees from the effects of subsidence. Through adaptive management, modify BMPs to further reduce impacts to agricultural land;

- Protection of other agricultural land of equivalent productive potential for agricultural use without restrictions. This could be accomplished via easements;

- Implementation of erosion control measures to the extent possible during and after project construction activities. These erosion control measures can include grading the site to avoid acceleration and concentration of overland flows, using silt fences or hay bales to trap sediment, and revegetating areas with native riparian plants and wet meadow grasses;

- Protect exposed soils with mulches, geotextiles, and vegetative ground covers to the extent possible during and after project construction activities to minimize soil loss;

- Schedule construction activities in a manner so that current crops may be harvested prior to construction initiation;

- Develop agricultural infrastructure, buffers and other tangible support for remaining agricultural lands. These buffers should have vegetation compatible with farming and habitat objectives; and

- The CALFED benefits of water supply reliability should be provided to agricultural water users on an equitable basis considering the nature and extent of impacts to agricultural resources, including land and water.

8.1.3.6 Potentially Significant Unavoidable Impacts

Program actions associated with the Ecosystem Restoration, Levee System Integrity, and Water Quality programs, or storage and conveyance components could convert existing agricultural uses, including prime and unique farmland. Locally implemented water transfers could also convert existing agricultural land uses to other land uses, though not specifically CALFED Program uses.

8.1.4 Environmental Consequences: Agricultural Economics

8.1.4.1 Assessment Methods

Assessment variables for agricultural economic impacts are irrigated acres, agricultural water and land use, water quality, costs and revenues from agricultural production, and risk and uncertainty. Potential impacts are quantified based on existing estimates of land and water value, crop revenue per acre, and costs. Each configuration (1A, 1B, and so on) is evaluated as part of an alternative. All of the potential impacts described are based on review of and experience with other studies.

Estimates of water supply changes, land conversion, and costs are made using existing policy-level models, such as the Central Valley Production Model, and by interpolating or extrapolating estimates made in other studies.

Changes in water quality are modeled for a number of scenarios that correspond to various CALFED alternatives. Key measurement points in the Delta are used to indicate the TDS of water diverted for irrigation. TDS (measured in ppm) is converted into electrical conductivity (EC) measured as millimhos per centimeter, using the approximation that 1 mmho/cm equals about 640 ppm.

Potential impacts on crop yield are based on the standard Maas-Hoffman (MH) salinity threshold relationships. For a given crop, the MH relationship defines the soil water salinity at which crop yield begins to be affected, and shows the estimated rate at which yield declines as soil salinity increases beyond the threshold. Table 8.1.4-1 shows the threshold and rate of decline

Crop Category	Irrigated Acres (1,000 acres)	Threshold Salinity Level (Ece)	Percent Yield Decrease from the Threshold (%)
Pasture	37	5.0	10.0%
Rice	11	3.0	12.0%
Truck Crops	28	1.5	14.0%
Tomatoes	45	2.5	9.9%
Alfalfa	65	2.0	7.3%
Sugar Beets	15	7.0	5.9%
Field Crops	151	1.7	15.0%
Orchards	61	1.5	12.0%
Grains	60	6.0	7.1%
Grapes	36	1.5	19.0%

NOTE:
The salinity of the soil saturation extract is expressed as Ece, which is the electrical conductivity (in mmho/cm).
SOURCES:
1. Irrigated acreage is from Affected Environment and Environmental Impacts: Agricultural Production and Economics, CALFED Bay-Delta Program, September 1997.
2. Maas-Hoffman coefficients are described in United Nations, Food and Agriculture Organization Irrigation and Drainage Paper 29, "Water Quality For Agriculture," 1976.

Table 8.1.4-1. Major Crops in the Delta Region and Corresponding Threshold Salinity Level

due to salinity for major categories of crops grown in the Delta.

8.1.4.2 Significance Criteria

Criteria used to judge whether an impact of the Program is potentially significant to agricultural resources are described below. Significance criteria are applied only to adverse impacts.

- Permanent or long-term reduction in acres of irrigated land within a region would be considered significant.
- A change in water quality that would reduce crop yields.
- Changes in costs or revenues which change the economics of farming to an extent that land use, water use, and employment could be affected would be considered significant.

8.1.4.3 Comparison of No Action Alternative to Existing Conditions

The predominant changes between existing conditions and future conditions under the No Action Alternative that would affect agricultural economics are: changes in the markets for agricultural products, the supply and reliability of irrigation water, changes in water quality, development of water transfer markets, and the cost of water.

- **Changes in the Agricultural Market:** There will be an increasing demand for fruits and vegetables, resulting in a shift away from field crops and grain production.

- **Irrigation Water Supply:** Several important changes have occurred to water supply conditions for agriculture. The CVPIA reallocates up to 800,000 acre-feet of CVP water per year away from agricultural use for environmental restoration. Likewise, the 1994 Bay-Delta Accord reduces the amount of water pumped from the Delta and delivered for agricultural and municipal uses. Estimates of the impact on net agricultural revenues of the CVPIA range from a net gain of $2 million to a loss of $68 million. Since the CVPIA preferred alternative has not been selected, the net economic effect is uncertain.

- **Water Quality:** Reasonably foreseeable changes in water management are expected to affect water quality, and thereby will impact agricultural yields. As shown in Table 8.1.4-2, the expected TDS range is between 109 and 389 ppm or between an EC of 0.17 to 0.61 mmho/cm.

- **Water Transfers:** The use of water transfers will likely increase in the future, however, they have not been assessed in this report due to the uncertainty and speculation involved.

- **Cost of Water:** Implementing cost-of-service and tiered water pricing, plus the restoration charges and surcharges imposed by the CVPIA, will increase the cost of water by up to 100% in some CVP service areas. Also, districts looking for water to transfer are almost certain to spend more for that water than they have in the past.

8.1.4.4 Comparison of Program Alternatives to No Action Alternative

The impacts to agricultural economics resulting from the storage and conveyance program element will vary by alternative, as discussed below. Impacts to agricultural economics resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternative.

Delta Region

Storage and Conveyance

Alternative 1. Alternative 1 conveyance configurations would affect up to 400 acres of agricultural land. The economic impact would be less than significant.

Alternative 2. The major difference between Alternatives 1 and 2 is in the conveyance components. For all Alternative 2 configurations, conveyance options would require conversion of agricultural land producing crop revenues of between $1.9 and $6.2 million per year. Loss of his revenue would be a significant adverse economic impact.

Alternative 3. The major difference between Alternatives 1 and 2 and Alternative 3 is in the in-Delta storage and conveyance components. Conveyance and storage options would require conversion of agricultural land producing crop revenue of between $2.3 and $21 million per year. In-Delta storage would have potential negligible to minor beneficial effects on agricultural production in other parts of the Delta Region, by providing more reliability in flows and deliveries. Impacts to farm employment, agricultural suppliers, and other economic sectors are described in the next section. Impacts of water supply increases within the Delta Region would be small.

All Alternatives. Potential charges imposed on agricultural water use to recover costs of program components could lead to significant changes in agricultural activities (for example, land use, crop selection, water use).

Impacts of water quality changes on agriculture may be caused by changes in the salinity of water used for irrigation, measured as TDS. Potential impacts could arise because of reduced yields of salt-sensitive crops, additional water application and management costs due to salinity, or foregone revenue due to restricted crop selection. Several

components of the CALFED program could affect the TDS of water delivered for agricultural use, including flows associated with the ERP, storage and conveyance components, and BMPs or other components of the Water Quality Program.

In the middle Delta, irrigation water quality under all alternatives averages between 121 and 240 ppm, which converts to an EC range of 0.22 to 0.37 mmho/cm (Table 8.1.4-2). The average EC during the months of highest salinity ranges from 0.21 to 0.42. Assuming an effective leaching fraction of 15%, the soil salinity would be 1.5 x 0.42 = 0.63 under the worst case of Configuration 3D. The most sensitive vegetable crops begin to experience salinity effects at 1.0 EC. Therefore, no significant positive or negative impact is expected from water quality changes in the middle Delta.

TDS in the south Delta is substantially higher than in the middle Delta. As shown for the Old River at Middle River location in Table 8.1.4-2, average water quality ranges from 318 to 378 ppm, depending on the configuration. This converts to a soil salinity of 0.75 to 0.88, assuming an effective leaching of 15%. During months of the poorest water quality, salinity of applied water can be 450 ppm. This level of salinity approaches the yield threshold for several salt-sensitive truck crops, including beans and strawberries, and some care in water management is required to avoid yield losses. However, none of the alternative configurations show any significant change in salinity compared to the No Action Alternative; therefore no significant positive or negative impacts are apparent.

Ecosystem Restoration. Direct impacts of this program would be felt most in the Delta region where agricultural land would be taken out of production. The crops removed could range from a mix of field and forage crops (corn, grain, and pasture) to high-value orchards. The agricultural land would be purchased at a negotiated fair market value to reduce economic hardship on local farmers. These impacts would result in a gross revenue loss of $50 to $135 million per year. Some of this acreage and revenue would likely shift to other regions of the state, placing more demand on existing surface water and groundwater resources in those regions.

Water Quality. Control of upstream drain water quality and quantity from this program could reduce salinity of water diverted in the Delta for irrigation. Benefits could include reduced costs, higher yields, and more flexible crop selection. Water quality BMPs, if applied to Delta agriculture, could raise production costs.

Levee System Integrity. This program would benefit Delta agriculture by providing greater protection from inundation and salinity intrusion. Setback levees would require purchasing and converting agricultural land. The value of crops taken out of production could be between $6 and $13 million per year. This loss may be offset by lower flood risks to remaining agricultural lands.

Additionally, the loss of farmland may adversely affect the financial viability of local agencies, especially water and reclamation districts.

Water Transfers. Due to minimal in-Delta conveyance facility changes, conveyance capacity in Alternative 1 will continue to be the principle limiting factor to water transfers. The number and magnitude of water transfers will continue to be relatively small, except in critically dry years. Water transfers will influence only a fraction of Central Valley and Delta flows, generally increasing base flows but not exacerbating high flows. Alternatives 2 and 3 provide increasingly better water transfer opportunities than Alternative 1.

Bay Region

Storage and Conveyance. Potential charges imposed on agricultural water use to recover costs of program components could lead to significant changes in agricultural activities (such as, crop selection, water use).

Ecosystem Restoration. Impacts from the Ecosystem Restoration Program on important farmland are expected to be minor.

Selected Locations	In Total Dissolved Solids (TDS, in ppm)											
	No Action, 1A, 1B			Configuration 1C			Configuration 2B			Configuration 2D		
	Low	Average	High	Low	Average	High	Low	Average	High	Low	Average	High
Middle Delta	109	139	207	112	148	206	106	123	137	106	124	141
Delta Export Pumps	217	278	366	185	235	356	175	193	216	163	191	215
South Delta	282	331	389	226	320	395	221	318	395	247	326	395
Selected Locations	**Configuration 2E**			**Configuration 3A**			**Configuration 3B**			**Configurations 3E, 3H, 3I**		
	Low	Average	High	Low	Average	High	Low	Average	High	Low	Average	High
Middle Delta	104	121	135	132	185	254	134	186	254	179	240	270
Delta Export Pumps	164	190	214	112	149	185	112	143	176	100	127	177
South Delta	248	326	395	310	373	448	328	378	448	301	346	395
	In Electrical Conductivity (ED, in mmho/cm)											
	No Action, 1A, 1B			Configuration 1C			Configuration 2B			Configuration 2D		
Selected Locations	Low	Average	High	Low	Average	High	Low	Average	High	Low	Average	High
Middle Delta	0.17	0.22	0.32	0.18	0.23	0.32	0.17	0.19	0.21	0.17	0.19	0.22
Delta Export Pumps	0.34	0.43	0.57	0.29	0.37	0.56	0.27	0.30	0.34	0.25	0.30	0.34
South Delta	0.44	0.52	0.61	0.35	0.50	0.62	0.35	0.50	0.62	0.39	0.51	0.62
Selected Locations	**Configuration 2E**			**Configuration 3A**			**Configuration 3B**			**Configuration 3E, 3H, 3I**		
	Low	Average	High	Low	Average	High	Low	Average	High	Low	Average	High
Middle Delta	0.16	0.19	0.21	0.21	0.29	0.40	0.21	0.29	0.40	0.28	0.37	0.42
Delta Export Pumps	0.26	0.30	0.33	0.18	0.23	0.29	0.18	0.22	0.28	0.16	0.20	0.28
South Delta	0.39	0.51	0.62	0.48	0.58	0.70	0.51	0.59	0.70	0.47	0.54	0.62

NOTES:
1. EC = TDS/640 is used to convert TDS to EC.
2. Data for Configurations 2A are not available.
3. Middle Delta location is Prisoner's Point; South Delta location is Old River at Middle River. Tracy Pumping Plant is export location.
SOURCE: Status Reports on Technical Studies for the CALFED Alternatives, DWR, 1997.

Table 8.1.4-2. Estimated Salinity of Irrigation Water in Selected Locations, by Alternative (During Irrigation Season: April to September)

C-005498

C-005498

Water Quality. To the extent that they apply to areas non-tributary to the Delta, BMPs under the Water Quality and Water Use Efficiency programs could substantially increase production costs.

Water Transfers. Because of the water supply deficiencies in some agricultural areas, especially the San Felipe Division of the CVP, water transfers may be an important source of water in the future.

Sacramento River and San Joaquin River Regions

Storage and Conveyance. Agricultural lands in the Sacramento Region River and the San Joaquin River regions could be affected by the location of storage and conveyance facilities. The likely location of large storage facilities is in foothill or mountain areas, where land use is likely to be non-irrigated grazing. Impacts include permanent conversion and inundation and temporary disruption of agricultural activity during construction. Permanent conversion of farmland for facilities is a potentially significant impact. Impacts from improvements in water supply reliability are small in the Sacramento River Region.

Potential beneficiaries in the Sacramento River Region would be primarily CVP contractors, who would use the water to replace groundwater or supply lost from the CVPIA. According to an analysis completed for CVPIA, the direct value of this water to agriculture ranges from $30 to $40 per acre-foot, making it relatively costly. Much of the additional water in the San Joaquin River Region would be used to reduce groundwater overdraft, to increase in-stream flows, to support production of lands fallowed by supply restrictions of the CVPIA and Bay Delta Accord, and for agricultural production. The marginal value of this water for agricultural production is $60 to $100 per acre-foot. Some of this water could support acreage shifted out of the Delta Region due to land conversion.

Salinity of water diverted from the Delta for use in the San Joaquin Valley is measured at the Tracy Pumping Plant Intake as the measurement location. As seen in Table 8.1.4-2, average salinity ranges from 278 ppm in the No Action Alternative to a low of 127 ppm in Configuration 3D. The highest salinity months range from 366 ppm for the No Action Alternative down to 177 ppm in Configuration 3D. Soil salinity associated with these average values would range from 0.30 to 0.65. The highest salinity is estimated in the No Action Alternative, and the lowest in Alternative 3. Some areas receiving water from the Delta also have poor drainage, and some areas apply a mixture of groundwater and surface water. Therefore, the improvements to water quality, especially in Alternative 3, are potentially large enough to have some effect on crop selection, water management, and yields, and could provide a potentially significant benefit.

These estimates account for water quality changes due to water supply, conveyance, and operations changes. Impacts associated with the Water Quality Program and the Water Use Efficiency Program could potentially affect agricultural users, but the size and direction of these impacts are unclear. No estimates of changes in water quality for irrigation have been made for the Sacramento River Region.

Potential charges imposed on agricultural water use to recover costs of program components could lead to significant changes in agricultural activities (such as, crop selection, water use).

Ecosystem Restoration. This program would convert productive farmland in the Sacramento River and San Joaquin River regions for habitat restoration. The crop revenue loss associated with taking these lands out of production generally ranges from $500 to $1,000 per acre, resulting in a regional loss in crop revenue of between $13 and $34 million per year in the Sacramento River Region and between $25 and $50 million in the San Joaquin River Region. This would have a substantial adverse economic impact on farm revenues, income generation, and employment levels. Loss of production may also adversely affect the financial viability of local agencies, especially water and reclamation districts.

Any changes in water supply, such as purchase of water rights for in-stream flow, could result in

changes to crop patterns, potentially affecting crop value. Direct impacts to the landowner would not be significant because the transaction would be only with willing sellers. Changes in the quantity or pattern of in-stream flow could affect downstream agricultural users and could potentially be significant.

Water Quality. Best Management Practices for this program could lead to significant impacts (both beneficial and adverse) in land and water use patterns. Adverse impacts would more likely result from costs imposed. Beneficial effects include reduced salinity of irrigation, which could increase yields, reduce production costs, and provide more flexible crop selection.

More carefully monitored application of water can result in substantially increased yields and reduced chemical costs, irrespective of salinity. Lower applied water amounts can adversely affect drain water users (forcing them to search for another source of supply), raise groundwater pumping lifts and impair groundwater storage for conjunctive use.

Retirement of lands with water quality problems in the San Joaquin River Region would have a significant adverse impact on jobs similar in magnitude to the impact of the Ecosystem Restoration Program land conversion in the San Joaquin River Region.

Water Use Efficiency. The economic impact of this program is uncertain, and could range from little or no measurable effect to potentially substantial reductions in applied water. Based on preliminary estimates prepared for the CALFED Program, costs of achieving efficiency increases could range from $40 to $60 per acre-foot of reduced applied water in the Sacramento River Region and from $50 to $100 per acre-foot in the San Joaquin River Region. In the San Joaquin River Region, approximately $500 per acre-foot of net savings could be realized; however, because virtually all applied water losses are recoverable and reusable in the Sacramento River Region, no net savings in consumptive use or irrecoverable loss (that is, "real" water savings) are likely. Additional district-level costs could range from $5 to $12 per acre of land served in both regions.

Water Transfers. Water transfers would generally have the same beneficial and adverse impacts as identified for the Delta region. Reduced pumping costs due to receiving a water transfer could also occur. Similarly, other potential significant adverse impacts could occur. Water transfers due to direct groundwater pumping or groundwater substitution could cause a temporal or volumetric increase in groundwater pumping and increased costs associated with exacerbating groundwater overdraft; pumping from lowered groundwater levels; deepening wells; lowering pumps; and redrilling wells. These increased operating costs could reduce irrigated acreage at nearby farms that are not transferring water. Direct groundwater and groundwater substitution transfers could also cause a reduction in surface water flows due to induced seepage; reduce crop yields due to lower water quality; reduce demand for crop storage and processing; reduce demand for farm inputs; lower ground elevations, making affected areas more susceptible to flooding; and reduce habitat supported by surface seepage of groundwater.

Coordinated Watershed Management. Implementation of upper watershed enhancements could result in converting upper watershed agricultural lands located adjacent to waterways in order to restore riparian habitat, stabilize stream-channels, restore natural stream hydrology, and create a non-point source pollution buffer. Conversion of land use could have an adverse impact on net income and public finances, and result in foregone economic opportunities.

SWP and CVP Service Areas Outside the Central Valley

Impacts on agriculture in this region are expected to be small. Potential cost impacts from the Water Quality and Water Use Efficiency programs may occur if BMPs are applied to areas outside the Central Valley. Salinity intrusion avoidance benefits of the Levee System Integrity Program would also accrue to this region.

Substantial conversion of agricultural land in the Delta Region could shift some production to desert areas in southern California, such as the Imperial Valley. Additional water would be available to SWP contractors in the South Coast and Central Coast areas. However, it is unlikely that a significant amount of this water would be delivered for irrigation use.

SWP water delivered for irrigation in southern California would have the same quality changes as described for the San Joaquin River Region. Relatively little SWP water pumped into southern California is used for irrigation, and some of that gets mixed with other local water sources. The aggregate impact on agriculture in these areas is potentially beneficial but probably not significant.

Potential charges imposed on agricultural water use to recover costs of program components could lead to significant changes in agricultural activities (such as, crop selection, water use).

The Water Transfer Program benefits are related to the increased agricultural production, incomes, and employment opportunities associated with any transfer that uses the water for agricultural production outside of the Central Valley.

8.1.4.5 Comparison of Program Alternatives to Existing Conditions

Comparison of Program alternatives to existing conditions indicates:

- All significant adverse impacts identified when making a comparison to the No Action Alternative would still be significant when compared to existing conditions.

- CALFED is proposing actions for levee protection, storage and conveyance, and ecosystem restoration, which could result in additional large-scale land conversions impacting agricultural lands, particularly in the Delta. Adverse impacts resulting from the CALFED alternatives combined with the expected future conversion of agricultural lands when compared to existing conditions.

- The water supply reliability actions from the Water Use Efficiency, Water Quality, and Storage and Conveyance programs could improve the availability and quality of water for agricultural purposes above the existing conditions baseline. While CALFED is expecting an overall improvement in water supply reliability for agriculture relative to the No Action Alternative, there is still the potential that the benefits provided by the Program alternatives could be diminished by unforeseen future conditions such as extended drought. Consequently, while the benefits of the alternatives were analyzed using reasonable approximations of future conditions, it should be acknowledged that water supply reliability could be worse than currently exists..

8.1.4.6 Mitigation Strategies

As discussed in the introduction to this summary, mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

Strategies to minimize economic consequences include:

- Provide advice on how to stretch existing water supplies in cost-effective ways to keep water acquisition costs down;

- Provide advice on ways to increase the production yielded from a unit of water (through measures such as improvement in distribution uniformity), which will tend to keep production up even as acreage goes down;

- Provide cost-sharing and other financial assistance to reduce the indirect impacts potentially resulting from the cost of the Water Use Efficiency and Water Quality programs;

- Purchase water acquired for habitat purposes using temporary or rotating contracts so that the same land or locality is not impacted every year;

- Continue the flow of property tax revenues to the local counties, providing opportunities for alternative industries to develop (that is, recreation) and other economic incentives;

- Implement financial incentives to increase wildlife forage on agricultural lands (pay for inefficient harvest methods). Reduce unit charges for water when a farmer implements measures to control discharge of contaminants in excess of regulatory requirements;

- Alter water delivery schedules during shortages to reward farmers who implement measures to control discharge of contaminants in excess of regulatory requirements;

- Create a loan program to support construction of agricultural pollution control facilities;

- Provide technical assistance to farmers wishing to install pollution control facilities;

- Develop assurance measures to increase water supply reliability such as providing long-term water supply contracts;

- Create tax incentives for long-term agricultural zoning;

- Provide technical and financial assistance to develop a regional solution to the San Joaquin Valley drainage problem;

- Schedule construction activities in a manner so that current crops may be harvested prior to construction initiation;

- Pay fair market value for any crops destroyed or taken out of production on private or leased lands as a result of project construction;

- Compensate property owners for the value of their land and associated improvements, including dwelling units, in compliance with state regulations for providing relocation assistance to displaced persons or businesses; and

- Avoid fallowing or shifting crops that require high input and output expenditures.

8.1.4.7 Potentially Significant Unavoidable Impacts

Unavoidable impacts to agricultural economics that have the greatest potential to be significant are loss of prime and unique farmland to other uses, such as for habitat or levee setbacks. These impacts would be both direct, such as loss of farm revenue and production opportunities, and indirect, such as less labor demand and reduced farm spending for goods and services.

8.1.5 Environmental Consequences: Agricultural Social Issues

8.1.5.1 Assessment Methods

Social well being, for purposes of this analysis, is measured in terms of community stability. Community stability is a measure of a community's ability to absorb social and economic changes that may result from a proposed action such as the CALFED action. Assessment of community stability is based on changes in economic and social indicators that may occur as a result of a CALFED action. These indicators include median family income, per capita income, poverty rates and unemployment rates, as summarized by region in Table 8.1.2-4

> Section 8.11 provides a detailed, region-by-region discussion of related Environmental Justice issues.

Predicting the human behavior that could result from CALFED actions is a difficult task. Past studies of community stability and social conditions related to water supply projects have focused on social, economic, and land use changes resulting from short-term drought conditions. The

actual effects of implementation of long-term water supply programs cannot be predicted with complete assurance, but must be projected based on assumptions of human behavior, primarily the assumed actions of farm managers and land owners implementing long-term changes to farm operations. This analysis is based on the regional economics analysis and projected changes to regional employment. These findings have been applied to the analysis for farmers, farm workers, and agribusiness.

8.1.5.2 Significance Criteria

For purposes of this analysis, socioeconomic effects are measured in terms of adverse changes in community stability. Community stability is measured by several economic indicators. Economic indicators include median and per capita income, poverty rates, and unemployment. Adverse impacts to community stability could result from changes to any of these indicators that substantially exceed historical fluctuations.

8.1.5.3 Comparison of No Action Alternative to Existing Conditions

Future agricultural social conditions under the No Action Alternative are expected to be similar to existing conditions.

The key factors that would affect farmers under the No Action Alternative include changes in the markets for agricultural products; the supply and reliability of irrigation water; the development of water transfer markets; and the cost of water. Increasing demand for fruits and vegetables is expected to result in a shift toward production of these commodities, and away from field crops and grains. Decreases in water availability due to the Central Valley Project Improvement Act (CVPIA) and the Bay-Delta Accord would likely be made up with groundwater supplies, however, depending on the size of the deficit, groundwater may not be able to completely compensate.

The number of agricultural jobs may increase in areas due to projected changes in crop production to higher value and more labor intensive crops. However, agricultural employment would remain seasonal. There could be improvements in mechanization for picking and sorting crops and other improvements that could eliminate tasks that are currently labor intensive. Changes in irrigation technology also may occur that could change farm labor needs. Changes to the population, crop production, and technology resulting in a decrease in employment opportunities or the duration of employment may create an increased need for social services to provide food, health care, and housing for those facing economic hardship. These needs may be seasonal or could be year-around depending on the extent of the change and the education, training, and technical skills of the population in the area affected.

8.1.5.4 Comparison of Program Alternatives to No Action Alternative

The impacts to agricultural social issues resulting from the storage and conveyance program element will vary by alternative, as discussed below. Impacts to agricultural social issues resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a regions, the program element is not discussed.

Delta Region

Storage and Conveyance. The extent of impacts would vary due to the variation in water yield and the opportunity to shift agriculture to various parts of the Delta. The alternatives could result in a significant but perhaps mitigable impact to farmers, farm workers, and agribusiness as a result of agricultural land conversion due to the conveyance and in-Delta storage options. This conversion would result in changes in the number of jobs for farmers, farm workers, and agribusiness. The intensity of this adverse impact depends on the magnitude of job loss.

Please see Regional Economics, Section 8.6, and Chapter 5 for further discussion of these impacts.

Ecosystem Restoration and Levee System Integrity. Implementation of ecosystem restoration in the Delta would result in the conversion of agricultural lands to restored habitat. This conversion would result in changes in the number of jobs for farmers, farm workers, and agribusiness. This job loss would be a potentially significant adverse impact depending on the magnitude of the job loss and extent of mitigation efforts.

The most significant impact would be the concentrated loss of jobs for farm workers who tend to have limited skills. Stress may be put on existing social services, such as welfare and job training, to help provide transitions for displaced farm workers. Because the Delta Region is already experiencing high levels of unemployment and the labor force is primarily farm workers, the social and economic structure of these communities could be adversely affected. Examples may include higher demand for social services, increased crime, and loss of local small businesses such that customers may have to travel further to purchase supplies. Less technically skilled workers and those lacking basic education levels and English language skills may have more difficulty finding new employment.

Per capita income for displaced farmers and families may decline and could be mitigated by social service and support programs, such as welfare and job training. Farm managers may be required to travel farther to their place of employment or move to other areas to gain employment. The need to move or to be away from home and family for longer periods could add additional burden to family members.

It is anticipated that displaced farm managers and technicians could find work in other regions or other jobs related to agriculture. While there may be a temporary increase in the need for social services to provide training or economic assistance for a portion of these displaced workers, this need would not be expected to be significant.

Water Use Efficiency. During the drought of the early 1990s, many communities faced reduced employment resulting from significant reduction in irrigated acreage, which left farm laborers without jobs. To the extent that efficiency improvements would help improve water supply reliability, employment opportunities would be maintained. This would contribute to the stability of many local agricultural communities.

Job opportunities could be created by water use efficiency improvements. As irrigation management improves, so must the knowledge of those irrigating or scheduling irrigations. This would result in the need for more skilled labor, but at higher costs. In addition, the design and installation of new or improved on-farm or district water delivery systems would create more jobs for skilled laborers. It is conceivable that efficiency improvements, especially those that involve physical construction would add to local employment.

However, water use efficiency improvements also could have adverse impacts on farm labor. One benefit of improved irrigation efficiency that may be experienced by a farmer is a reduced need for labor, due either to less cultivation or changes in how crops are irrigated. The addition of pressurized irrigation systems would have the most substantial impact. With pressurized irrigation, what used to be the job of several workers could now be replaced by just one. It is estimated that, as technology advances, 30% less labor would be needed to perform the same amount of work. This means that two out of three farm workers may be employed once efficiency measures are implemented.

Improved water use efficiencies often translate to higher crop yields and better quality of farm products. Such advances can increase on-farm direct income, benefitting the farmer's net income. This often translates to additional economic activity. Increased income also can help the overall economy in total sales and

purchases and increase tax revenues that strengthen vital functions such as schools, roads, and social and health services.

Water use efficiency improvements also could result in improved crop yields. Improvements in the yield per acre-foot of applied water, even with possible reductions in water supply, would result in greater production of food and fiber on the same land. As populations continue to increase, not only in the state, but in the nation and globally, highly efficient food production would be an asset.

Bay Region

No significant impacts are anticipated to farmers, farm workers or agribusiness.

Sacramento River Region

Storage and Conveyance. The impacts of additional water supply could include the development of additional acreage for agriculture, increased water supply reliability resulting in greater farm investments, and shifts to higher water use and higher value crops. Other beneficial impacts include development of additional acreage shifted from the Delta due to land conversion, changes to higher water use and higher value crops, and additional farm worker jobs may become available if additional acreage is developed. The extent of this beneficial impact would vary and would be dependent on the ultimate cost of the water.

Development of the storage and conveyance facilities in Configurations 2B, 2D, and 2E; and 3B, 3E, 3H, and 3I, depending on the location, could require the conversion of agricultural lands resulting in a potentially significant impact to farmers. This impact could be offset by shifting acreage to other parts of the Sacramento River Region. Impacts to farm workers would depend on new acreage developed by farmers. Configurations 2A and 3A would likely result in minimal new jobs; however, Configurations 2B, 2D, and 2E; and 3B, 3E, and 3H could result in a significant number of jobs and a beneficial impact to farm workers as well as associated agricultural businesses.

Ecosystem Restoration. The impacts in this region for Alternatives 1, 2, and 3 would be similar in character to those described for the Delta Region. Ecosystem restoration could result in conversion or idling of productive agricultural land in the Sacramento River Region. Conversion or idling of agricultural lands would result in a loss of jobs for farmers, farm workers, and agribusiness. The severity of this impact would depend on the magnitude of farm worker job loss and the extent of mitigation efforts.

Water Use Efficiency and Water Transfers. The impacts from these programs are the same as discussed under the Delta Region. Additional adverse impacts to local groundwater pumping and facility costs could occur under some conditions of direct groundwater transfers or groundwater substitution transfers.

San Joaquin River Region

Storage and Conveyance. The impacts of additional water supply could include the development of additional acreage and increased water supply reliability, which may result in greater farm investments and shifts to higher water use and higher value crops. A significant amount of jobs could become available if additional acreage or higher labor demand crops were developed.

Development of the storage and conveyance facilities in Configurations 2B, 2D, and 2E; and 3A, 3E, 3H, and 3I, depending on the location, could require the conversion of agricultural lands, resulting in a potentially significant impact to farmers. This impact could be offset by shifting acreage to other parts of the San Joaquin River Region.

Impacts to farm workers would depend on new agricultural acreage developed by farmers. Configurations 2A and 3A would likely result in several new jobs. Configurations 2B, 2D, and 2E; and 3B, 3E, 3H, and 3I could result in a significant number of jobs and a beneficial impact to farm workers as well as associated agricultural business.

Ecosystem Restoration. Ecosystem restoration could result in conversion or idling of agricultural land in the San Joaquin River Region. The impacts would be similar in character to those described for the Delta Region.

Water Quality. Retirement of lands with water quality problems in the San Joaquin River Region would have a significant adverse impact on jobs similar in magnitude to the impact of the Ecosystem Restoration Program land conversion in the San Joaquin River Region.

Water Use Efficiency and Water Transfers. The impacts from these programs elements are the same as those discussed under the Sacramento Region.

SWP and CVP Service Areas Outside the Central Valley

Impacts on agriculture in this region are expected to be small. Substantial conversion of agricultural land in the Delta Region could shift some production to desert areas in southern California, such as the Imperial Valley. Water transfers would increase agricultural production, incomes, and employment opportunities associated with any transfer that uses the water for agricultural production outside of the Central Valley. The net change in jobs is expected to be minimal, with only minor effects on community stability.

8.1.5.5 Comparison of Program Alternatives to Existing Conditions

Comparison of Program alternatives to existing conditions indicates that:

- Under the No Action Alternative, economic conditions are expected to be similar to those for existing conditions with the exception of costs for irrigation water.

- Because of the uncertainty over the magnitude of future water costs under the No Action Alternative, it is difficult to predict whether cost of agricultural water relative to existing conditions will be higher or lower than what is expected under the No Action Alternative, but it is unlikely that water costs would be less expensive. Where water costs are lower than No Action but higher than existing conditions, this could result in a new significant impact when compared to existing conditions. If water costs are higher than those under the No Action Alternative, this would be an adverse impact of greater magnitude when compared to existing conditions.

8.1.5.6 Mitigation Strategies

As discussed in the introduction to this summary, mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

Strategies for minimizing the social/employment impacts as a result of agricultural land conversion include:

- Continuing the flow of property tax revenues to the local counties, providing opportunities for alternative industries to develop (that is, recreation) and other economic incentives, relocating facilities and shifting agriculture to new areas;

- Compensate local governments for increased demand for services resulting from labor displacement, compensate workers displaced by specific transfers through such actions as augmenting unemployment insurance benefits;

- Provide training and educational opportunities for unemployed individuals to reenter the workforce, job referral and placement services, and job retraining;

- Implement cost-sharing and other financial assistance to reduce the social/employment impacts potentially resulting from the cost of the Water Use Efficiency and Water Quality programs;

- Schedule construction activities in a manner so that current crops may be harvested prior to construction initiation;

- Pay fair market value for any crops destroyed or taken out of production on private or leased lands as a result of project construction; and

- Limit the amount of acreage that can be fallowed in a given area.

8.1.5.7 Potentially Significant Unavoidable Impacts

Farm worker job loss may result in significant adverse unavoidable impacts. In some cases jobs may be shifted to other areas; however, jobs also may be eliminated with no replacement. This would represent a significant unavoidable impact of the CALFED Program.

8.2 URBAN RESOURCES

Summary

Urban based land use, municipal and industrial water use economics, and utilities and public services are the primary urban resources assessed in this section. Implementing any of the CALFED alternatives would potentially displace existing residents, physically disrupt or divide an established community, and may be inconsistent with existing local or regional plans. Water transfers have the potential of adversely inducing growth that may not otherwise have a reliable water supply.

Potential impacts to utilities and public services have also been identified, especially in relation to development of new storage and conveyance facilities. A limited analysis of M&I water supply economics was conducted based on DWRSIM results and alternative costs. The analysis provided estimates of the value of changes in water supply and salinity of supplies.

Potential impacts of program elements are discussed briefly below and summarized by region in Tables 8.2-1, 8.2-2, and 8.2-3.

No Action Alternative. Under the No Action Alternative, reasonably foreseeable storage and conveyance facilities, would result in the conversion of localized land uses. This could displace residents, disrupt or divide existing communities, or be inconsistent with local and regional land use plans. The intensity and magnitude of specific urban land use impacts is not expected to be great, but would be dependent upon the actual location of project facilities. The No Action Alternative is expected to result in continued decline in the reliability of urban water supplies. Most of this decline is related to population increases and economic growth. Water supplies have been reduced, relative to the recent past, by actions such as CVPIA, the Mono Lake decision, and increased use of Colorado River water by upstream states.

Impacts to Urban Resources

- For the **No Action Alternative,** development trends would continue, causing potential displacement of some residents, disruption of some existing communities, local and regional land use plan inconsistencies, and increased demand for utilities and public services with corresponding decreases in water supply reliability and increases in supply costs.
- **Storage and Conveyance** features are expected to have development-related effects similar to No Action. In addition:

  Alternative 1 would have some beneficial effects on water supply and quality.

  For Alternative 2, all configurations are expected to provide additional water supply. Salinity reduction would reduce water supply costs.

  For Alternative 3, all configurations except 3A increase water supplies. Salinity reduction cost savings would be more pronounced than Alternative 2.
- **Ecosystem Restoration** is expected to have only negligible effects on urban land uses but could require relocation of major utility infrastructures.
- **Water Use Efficiency** is expected to increase the amount of urban water conservation.

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Displace Residents	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Physically Divide or Disrupt an Established Community	●	●	●	●	●	●	●	●	●	●	●	●
Inconsistency with Local and Regional Plans	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Changes in Landscape Materials and to the Pace and Location of Urbanization	○	○	○	○	○	○	○	○	○	○	○	○
Bay Region												
Inconsistency with Local and Regional Plans	○	○	○	○	○	○	○	○	○	○	○	○
Changes in Landscape Materials and to the Pace and Location of Urbanization	○	○	○	○	○	○	○	○	○	○	○	○
Sacramento River Region												
Displace Residents	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗
Physically Divide or Disrupt an Established Community	□	□	●	□	●	□	●	□	●	●	●	●
Inconsistency with Local and Regional Plans	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Short-term Construction Impacts to Developed Land Use	●	●	●	●	●	●	●	●	●	●	●	●
Changes in Landscape Materials and to the Pace and Location of Urbanization	○	○	○	○	○	○	○	○	○	○	○	○
San Joaquin River Region												
Displace Residents	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗
Physically Divide or Disrupt an Established Community	□	□	●	□	●	□	●	□	●	●	●	●
Inconsistency with Local and Regional Plans	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Short-term Construction Impacts to Developed Land Use	●	●	●	●	●	●	●	●	●	●	●	●
Changes in Landscape Materials and to the Pace and Location of Urbanization	○	○	○	○	○	○	○	○	○	○	○	○

Table 8.2-1. Summary of Environmental Impacts Related to Urban Land Use (page 1 of 2)

C-005509
C-005509

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
SWP and CVP Service Areas Outside the Central Valley												
Inconsistency with Local and Regional Plans	○	○	○	○	○	○	○	○	○	○	○	○
Changes in Landscape Materials and to the Pace and Location of Urbanization	○	○	○	○	○	○	○	○	○	○	○	○

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:

Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
○	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 8.2-1. Summary of Environmental Impacts Related to Urban Land Use (page 2 of 2)

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
*Changes in M&I Water Costs**	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Bay Region												
*Changes in M&I Water Costs**	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
Sacramento River Region												
*Changes in M&I Water Costs**	○	○	○	○	○	○	○	○	○	○	○	○
San Joaquin River Region												
*Changes in M&I Water Costs**	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+
SWP and CVP Service Areas												
*Changes in M&I Water Costs**	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+	◗/+

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

***The Water Quality Program would generally result in improved source water quality. Delta Ecosystem Restoration could result in higher organic carbon levels and changes in taste and odor, which would all affect treatment costs. The costs of the Water Use Efficiency Program are unknown, and as a consequence, the economic impacts on municipal and industrial water costs are also unknown at this time.**

LEGEND:
Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
○	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 8.2-2. Summary of Environmental Impacts Related to Urban Water Supply Economics

C-005511
C-005511

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Increase in Demand for Utilities	□	○	●	○	●	○	●	○	●	●	●	●
Increase in Demand for Public Services	□	○	◗	○	◗	○	◗	○	◗	◗	◗	◗
Relocation of Infrastructure Components	□	□	□	○	○	●	●	○	○	○	●	●
Bay Region												
Increase in Demand for Utilities	□	□	●	○	●	○	●	○	●	●	●	●
Increase in Demand for Public Services	□	□	○	○	○	○	○	○	○	○	○	○
Relocation of Infrastructure Components	□	□	□	□	□	□	□	□	□	□	□	□
Sacramento River Region												
Increase in Demand for Utilities	□	○	●	○	●	●	●	○	●	●	●	●
Increase in Demand for Public Services	□	○	○	○	○	○	○	○	○	○	○	○
Relocation of Infrastructure Components	□	□	●	□	●	●	●	□	●	●	●	●
San Joaquin River Region												
Increase in Demand for Utilities	□	○	●	○	●	●	●	○	●	●	●	●
Increase in Demand for Public Services	□	○	○	○	○	○	○	○	○	○	○	○
Relocation of Infrastructure Components	□	□	●	□	●	●	●	○	●	●	●	●
SWP and CVP Service Areas Outside the Central Valley												
Increase in Demand for Utilities	□	○	●	○	●	○	●	○	●	●	●	●
Increase in Demand for Public Services	□	○	◗	○	◗	○	◗	○	◗	◗	◗	◗
Relocation of Infrastructure Components	□	□	□	□	□	□	□	□	□	□	□	□

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:
Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
○	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 8.2-3. Summary of Environmental Impacts Related to Utilities and Public Services

C-005512
C-005512

Urban water management, facilities and programs, such as extraordinary conservation measures, conjunctive use, recycling, water transfers and added reservoir storage, will be developed regionally to manage reliability. These measures will have their own environmental impacts and these impacts could be avoided or delayed with the availability of CALFED water supplies.

Actions occurring under the No Action Alternative would also result in potentially significant adverse impacts by substantially increasing the demand for utilities and public services.

Storage and Conveyance. Program actions, including storage and conveyance that displace residents, physically disrupt or divide established communities, or are inconsistent with a local or regional plan, would be considered significant adverse land use impacts.

All configurations with storage, 1C, 2B, 2E, 3B, 3E, 3H, and 3I, are expected to have a significant beneficial impact on water supply for Central Valley Project (CVP) and State Water Project (SWP) M&I water providers. The relative size of impacts on individual providers depends on the share of these water supplies as part of their entire water supply mix and many other factors.

Average annual benefits of Configuration 1C, in terms of water supply costs avoided, are about $100 to $150 million annually under year 2020 development conditions. Additional gross yield in a year during the critical period (1928 to 1934 hydrology) is slightly more. Most of the benefits are obtained in the SWP Service Areas south of the Tehachapis.

Alternative 1 storage and conveyance are not expected to substantially affect economic benefits or costs associated with salinity or DBP precursors.

Due to increased activities, Alternative 1 would have more pronounced utilities impacts than the No Action Alternative, but impacts to public services would be less pronounced. In addition, the construction of water storage and conveyance facilities would likely require the relocation of existing utility infrastructure.

Configuration 2A would increase water supplies, but the amount of supply increase and the subsequent economic benefit is not substantial. Benefits, in terms of water supply costs avoided, are less than $50 million annually under year 2020 development conditions. Additional gross benefits in a year during the critical period are even smaller because the yield increase is less than average.

The increase in water supply under Configuration 2D is worth $50 to $100 million annually on average, and 2D provides slightly more water in the critical period than it does on average. Most of the benefits are obtained in the SWP Service Areas south of the Tehachapis.

Alternative 2 conveyance is expected to affect economics associated with salinity and DBP precursors. Reduced salinity costs amount to $100 to $175 million annually, depending on configuration. Economic costs associated with DBP precursors have not been evaluated, but bromide and organic carbon concentrations are increased at the North Bay Aqueduct. Bromides are decreased in Rock Slough and the Los Vaqueros intake. Bromide concentrations are reduced somewhat at Tracy Pumping Plant and Clifton Court Forebay, but organic carbons are slightly increased or about the same as the No Action Alternative. Mitigation for source water quality reductions could include relocation of intake facilities, improved treatment, or changes in water supply management.

Alternative 2 would have a greater number of actions than Alternative 1; therefore, it would have more pronounced significant adverse impacts on utilities and public services.

Benefits of Configuration 3A, in terms of water supply costs avoided, are expected to be more than $50 million annually under year 2020 development conditions. Benefits of all other variations of Alternative 3 are about $150 million annually under year 2020 development conditions. Additional gross benefits in a year during the

critical period (1928 to 1934 hydrology) are somewhat more because yield is more.

Alternative 3 conveyance is expected to affect economics associated with salinity and DBP precursors. Reduced salinity costs amount to roughly $100 million (Configuration 3A) to $200 million (3E) annually. Salinity in Configuration 3B is increased at Rock Slough, increasing salinity costs by roughly $8 million annually.

Economic costs associated with DBP precursors have not been evaluated, but concentrations have been evaluated for Configuration 3E. Bromide and organic carbon concentrations are increased at the North Bay Aqueduct. Bromides are somewhat decreased at Rock Slough and the Los Vaqueros intake, but organic carbon is increased. Bromide and organic carbon concentrations are reduced substantially at Tracy and Clifton Court Forebay where much of the M&I water supplies are taken. Mitigation for source water quality reductions could include relocation of intake facilities, improved treatment or changes in water supply management.

Ecosystem Restoration. The Ecosystem Restoration Program Plan would improve various areas of the Delta, Sacramento River, and San Joaquin River regions for habitat and ecosystem restoration. Displacing residents or disrupting or dividing an existing community for habitat and ecosystem restoration uses in these three regions would be a potentially significant land use impact. However, this program would primarily affect agricultural land and therefore would have only a negligible affect on urban land uses. Program activities are not anticipated to have an effect on urban land uses in the Bay Region or in the SWP and CVP Service Areas Outside the Central Valley.

The Ecosystem Restoration Program would likely require the relocation of major infrastructure components, resulting in potentially significant adverse impacts.

The Ecosystem Restoration Program could indirectly affect urban water treatment costs due to potentially higher TOC levels, taste, and odor of Delta water.

Water Quality. The water quality program focuses on source control and reducing pollutant releases into the Bay-Delta system and its tributaries. The program is not anticipated to have direct or indirect urban land use impacts in any of the five regions but would benefit M&I water suppliers and users.

An increase in water quality may increase use of recreation facilities. Increases in the demand for utilities and public services associated with this program are expected to be met by existing facilities and agencies.

Water Use Efficiency. The Water Use Efficiency Program is not anticipated to have direct land use impacts. Potential indirect adverse impacts to developed land uses generally would be limited to changes in landscape materials and would not be significant. Changes to the pace and location of urbanization would also be expected to be minimal and insignificant.

The water use efficiency program will require some expenditure to obtain conservation goals, but the magnitude of these costs in relation to No Action conservation costs is not clear. Economic impacts of the water quality, ecosystem restoration and levee system integrity programs have not been estimated. M&I water cost impacts of the levee system integrity program are expected to be insignificant. The net effect of the water quality program and ecosystem restoration on water supplies and quality and subsequent costs cannot be judged at this time.

Levee System Integrity. Improvements contemplated under the Levee System Integrity Program would primarily involve strengthening existing levees, but also to some extent acquiring new rights-of-way and constructing new setback levees in the Delta Region. Because this program would primarily effect agricultural land uses in the Delta, these improvements would have only a negligible effect on urban land uses. Relocation of utility infrastructure under this program would likely not result in significant adverse impacts.

Water Transfers. Water transfers could promote urban land use and development. Both short- and long-term water transfers can result in growth that otherwise may not have a reliable long-term water supply. If transfers become unavailable in the future as a result of growth within the selling region and subsequent reduction in the transferrable amount, the purchasing regions may be adversely impacted.

Increased treatment processes and pumping related to increased levels of water recycling is expected to have an adverse impact on power and energy requirements.

Coordinated Watershed Management. Disruption to local land uses from activities such as grading and planting vegetation in upland and in-stream areas could include temporary increased noise from operating excavation equipment, dust from earthwork, increased truck traffic on local streets, and potential utility disruptions. This program is not expected to have noticeable effects on utilities or public services.

8.2.1 Affected Environment/ Existing Conditions

8.2.1.1 Delta Region

Historical Perspective

Land Use. Accounts of urban land development (urban acreage calculations) in California were not recorded and, therefore, are not readily available prior to 1920. In general, urban development in the Central Valley began during the same period, following construction of the railroads when the San Francisco Bay and southern California geographic regions were developing into urban centers.

Between 1920 and 1950, urban land use expanded. Private water development projects by cities and utility districts assisted in the expansion of urban development throughout California.

The expansion of urban areas has continued since 1950. However, more recently, urban development has begun encroaching on agricultural land and reducing the total amount of agricultural land in the Delta.

Between 1976 and 1993, the areas where large acreages of agricultural land were reclassified to urban lands were the Brentwood and Oakley area in Contra Costa County, the Pocket area in Sacramento County adjacent to the Sacramento River, the West Sacramento area in Yolo County, and the Stockton and Tracy areas in San Joaquin County.

Between 1976 and 1993, urban land in the legal Delta increased by approximately 22,700 acres, again with the majority occurring in the Delta Secondary Zone. In 1993, there were about 44,400 acres of land classified as urban land, the majority of which were located in the Delta Secondary Zone and Delta Primary Zone, respectively. Since 1976, approximately 12,000 acres of native land, mostly in the Secondary Zone, was developed for urban uses.

Much of the residential development in the Delta is now part of the Sacramento and Stockton metropolitan areas, and other towns and developments provide housing for Central Valley or coastal city commuters. Until recently, most urbanization in California occurred near the coastal cities. In the last decade, there has been a relative shift in new development from the coast to more inland locations, such as the Delta.

Utilities and Public Services

Water Supply and Related Infrastructure. Most water conveyance facilities in the Delta have been developed under the authority of the federal government's CVP and California's SWP.

As part of CVP development, exportation of water from the Delta began in 1940 with the completion of the first unit of the CVP, the Contra Costa Canal. Other major federal units were completed during the early 1950s and included completion of the Delta Mendota Canal and construction of the

Delta Cross Channel. This canal transfers water across the Delta from the Sacramento River to the Tracy pumping plant, which serves the Delta Mendota canal. Additionally, numerous SWP facilities have been developed in the Delta: Harvey O. Banks Delta Pumping Plant, the California Aqueduct, and the North Bay Aqueduct.

Total M&I water use in the Delta has increased over time with the increase in population. Figure 8.2.1-1 shows population trends for some Delta M&I providers.

Electric Utility Infrastructure. Power transmission facilities have developed parallel to the population growth of various communities surrounding the Delta, much of which was made possible by the exploitation of water resources. Pacific Gas and Electric (PG&E) and the Western Area Power Administration (WAPA) have developed power transmission lines across Delta islands and waterways.

Natural Gas Infrastructure. Natural gas was discovered in the Delta Region in 1935. Since the 1940s, it has been developed into a significant source supply and depot for underground storage.

Existing Conditions

Land Use. Approximately 71,000 acres in the Delta Region are developed for urban uses, with most of the development located on the periphery of the Delta Region in Sacramento, San Joaquin, and Contra Costa counties. The majority of urban development is located in the legal Delta, with less than 1,800 acres of developed land in the Suisun Marsh and Bay Area. Urban development includes residential, commercial, industrial, and other urban uses. Table 8.2.1-1 summarizes the types and amount of urban development in the Delta Region.

Much of the urban development in the Delta Region is located in the incorporated cities (Antioch, Brentwood, Isleton, Pittsburg, Rio Vista, and Tracy are located entirely within the Delta; Sacramento, Stockton, and West Sacramento are located partially within the legal Delta) and in the 14 unincorporated communities within the legal Delta (Discovery Bay, Oakley, Bethel, Courtland, Freeport, Hood, Ryde, Walnut Grove, Byron, Terminous, Thornton, Hastings Tract, and Clarksburg).

Urban Development Type	Approximate Acres in Region (%)
Residential (one- and two-family units including trailer courts)	4,830 (0.6%)
Commercial (retailers, hotels, apartments, institutions)	1,660 (0.2%)
Industrial (manufacturing, extractive industries, sewage treatment plants)	6,340 (0.7%)
Other (freeways, airports, cemeteries, vacant land, undefined urban development)	58,510 (6.8%)

SOURCES:
DWR 1991, 1994d.

Table 8.2.1-1. Developed Lands in the Delta Region

Economics. For the purposes of economics, the specific groups of affected persons must be described. The term "provider" includes all persons having a direct economic stake in the water supply and costs of the provider. End-users of water, shareholders in private water utilities, and any public or private interests who pay any part of the costs or receive the benefits of water services qualify.

The Delta M&I providers include the cities of Pittsburg, Antioch, Tracy, Brentwood, Isleton, parts of Stockton and Sacramento, and a variety of small communities and residential users located around the Delta.

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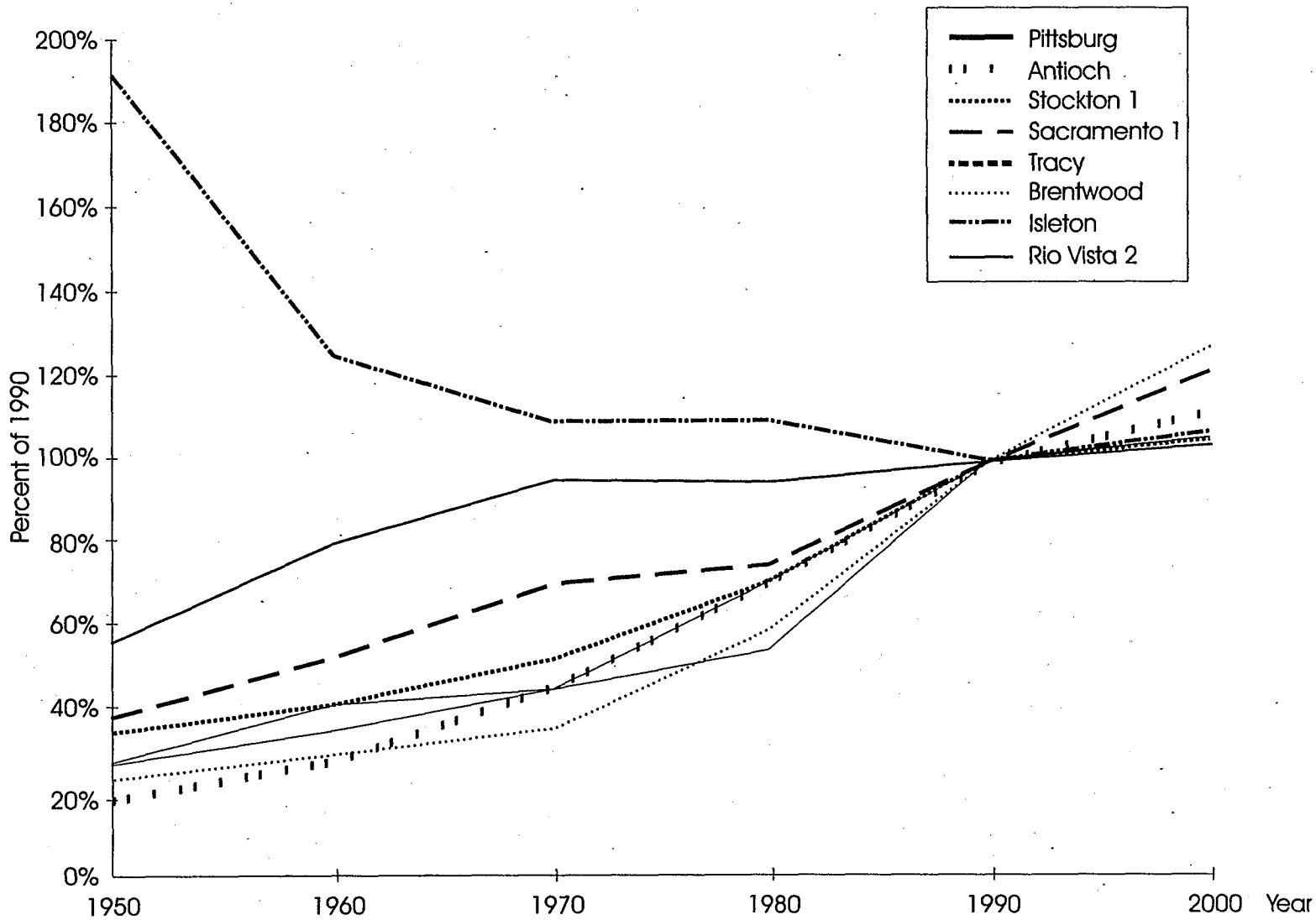

Figure 8.2.1-1. Population Trend for Some Delta Region M&I Providers as a Percentage of 1990 Population

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Table 8.2.1-2 shows population, water use, and cost data for some major Delta providers. Industrial use occurs within the Service Areas of these providers, and a few large industrial users divert a significant share of total M&I use within the Delta. Figure 8.2.1-2 shows 1980 to 1990 use by the Delta providers as a percentage of 1990 use. Costs of existing and additional water supplies for Delta providers differ substantially, depending on existing and potential sources of water. Existing raw water costs for Contra Costa Water District (CCWD) are influenced by CVP rate-setting policies and the CVPIA. The 1996 CVP contract rate was $32.35 per acre-foot. Water costs to wholesale buyers and at the retail level also are being affected by the Los Vaqueros Reservoir Project. In the future, new water costs probably will be affected by water reclamation and water transfer costs. Water costs near Sacramento and Stockton also are affected by CVP policies. In many locations, raw water costs will be affected by groundwater development and extraction costs.

The 1996 CVP contract rate for Tracy was $37.02 per acre-foot. In 1992, the city of Tracy filed a water rights application with SWRCB to divert water from the Delta in the vicinity of the Westside Irrigation District pump station on Wicklund Road. The City also may propose to convert existing agricultural rights to M&I uses as the land is developed and may propose to have both of these supplies wheeled through the Delta-Mendota Canal to its water treatment plant.

Utilities and Public Services

Water Supply and Related Infrastructure. Water conveyance infrastructure consists of a multitude of agricultural, industrial, and municipal diversions for supplying water to the Delta itself and for export by the SWP and CVP. Diversions and conveyance require canals, waterways, levees, siphons, pumps, radial gates, and other miscellaneous infrastructure.

Municipal and industrial demands in the Delta are met by conveying water through the Contra Costa Canal to the cities of Martinez, Antioch, and Pittsburgh and to numerous industrial complexes in the vicinity.

The city of Sacramento serves water to a section of the city within the Delta. Much of this area is commonly known as "the pocket." The Delta also includes part of south Sacramento. The city provides water from the Sacramento and American rivers and from groundwater. The city does not divert surface water from within the Delta Region.

West Sacramento serves M&I uses west of the Sacramento River and within the Delta. Data for West Sacramento are not available. Surface water and groundwater are used. Approximately 9,700 acre-feet were diverted into the system in 1995, of which approximately 9,000 acre-feet were surface water. Surface water is taken from the Sacramento River under water rights and a CVP contract at a point within the Delta just north of Interstate 80.

The city of Stockton is served by three purveyors: the California Water Service Company, the city of Stockton, and San Joaquin County. Each of these agencies serves parts of the Delta. The only direct diversion of water from the Delta is for several golf courses and small landscape uses. Most M&I water is from groundwater, from the Calaveras River through Stockton East Water District, and from the Stanislaus River through CVP. The share of supplies provided by surface water and groundwater varies according to hydrologic conditions. The city supplies a small parcel within the Delta with reclaimed water.

The City of Stockton has submitted an application to SWRCB to divert up to 45,000 acre-feet annually from the San Joaquin River downstream of its existing wastewater treatment plant. The diversion would recover "an amount of water equal to that discharged into the San Joaquin River at the City's Regional Waste Water Control Plant." The additional water would be brought into the city for treatment or would be provided to agriculture in exchange for groundwater currently used for agriculture.

Provider	Population (1995)	Population (1990)	Water into System (1990 mg)	Water into System (1990 af)	Service Connections (1990)	GPCD (1990)	Percent Purchased	Percent Metered	Percent Surface Water	Average Cost ($/af)
Pittsburg	50,400	47,564	3,066	9,411	12,313	176	100	99	100	$952
Antioch	69,500	62,195	3,823	11,734	18,801	168	64	100	100	$702
Stockton[a]	226,300	210,943	17,130	52,578	64,179	183	52	100	52	$311
Sacramento[a]	391,100	369,365	37,157	114,048	111,785	272	0	3	95	$165
Tracy	40,500	33,000	3,345	10,267	9,964	270	42	100	42	$485
Brentwood	9,675	7,563	532	1,633	2,278	193	0	100	0	
Isleton	870	833	83	255	353	273	0	100	0	
Rio Vista[b]		3,316	370	1,136	1,403	306	0	14	0	

NOTES:

mgd = Million gallons per day.

[a] Only part of the provider is located within the statutory Delta.
[b] Borders the statutory Delta.

Table 8.2.1-2. Characteristics of Some Delta Region M&I Providers

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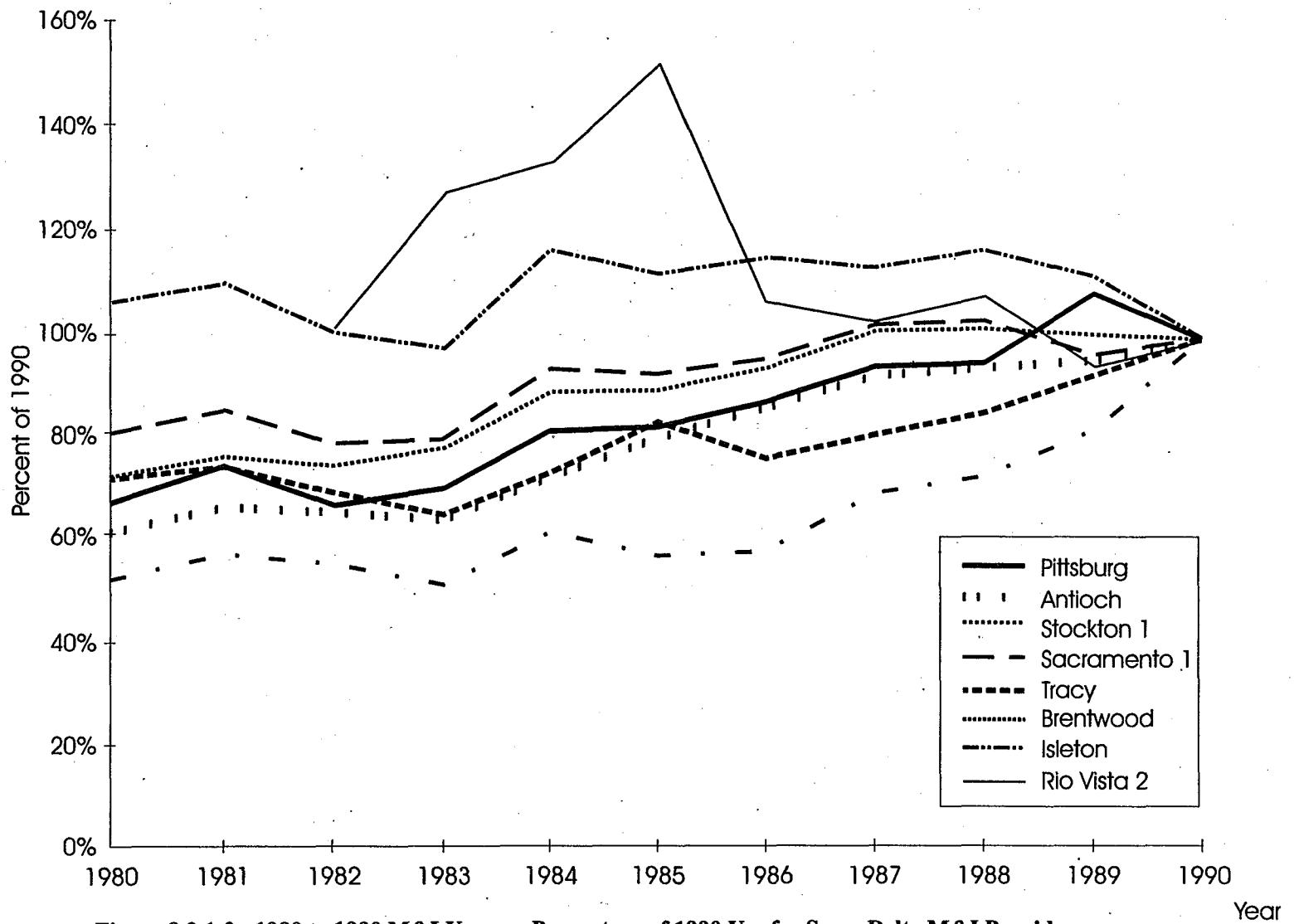

Figure 8.2.1-2. 1980 to 1990 M&I Use as a Percentage of 1990 Use for Some Delta M&I Providers

CCWD serves lands within and outside the legal Delta in Contra Costa County. CCWD currently provides municipal water within the Delta for the cities of Antioch and Pittsburg and in Oakley Water District. Most of CCWD's water is obtained through a 195,000-acre-foot contract for CVP water, which is pumped from the Delta into the Contra Costa Canal from Rock Slough. CCWD can also pump up to 26,700 acre-feet annually from Mallard Slough and has agreed to use up to 21,000 acre-feet per year of East Contra Costa Irrigation District (ECCID) water to serve M&I demands within ECCID.

The city of Antioch obtains its supply from CCWD and from a separate Delta diversion under a 7,670 acre-foot right. The diversion and treatment facility can handle up to 8.2 million gallons per day (9,300 acre-feet/year), but water quality limits that amount. The salinity of the water at the diversion determines when water will be diverted and, consequently, the share of the city's water provided by the diversion as opposed to that supplied by CCWD. Typically, diversion ceases when salinity reaches about 200 parts per million (ppm), but diversion may continue at higher salinity if water quality (as a function of the tidal cycle) is expected to improve. As suggested by Table 8.2.1-2, Antioch is able to supply about 35% of its water needs with this diversion.

The city of Brentwood currently relies on groundwater for its water supplies, but the city has an agreement with CCWD to acquire up to 7,000 acre-feet annually in the future. Some of this need will be met with the 21,000 acre-feet CCWD has agreed to distribute for ECCID.

Additional towns and communities in the Delta Region not included in Table 8.2.1-2 or in the discussion above include Bethany, Bethel Island, Byron, Collinsville, Cortland, Discovery Bay, Four Corners, Freeport, Hoods, Oakley, Ryde, San Joaquin City, Terminous, and Walnut Grove. Most of these towns are served by a larger provider, a small district, or individual groundwater wells. Oakley is served by Diablo Water District, which obtains raw water from CCWD. The city of Antioch is the purveyor for the Discovery Bay Area. Bethel Island residential users are served by several small water districts.

Other industrial users in the Delta divert water under individual water rights. CCWD lists the following industrial water users and their annual diversion right: Gaylord Container Corporation (28,000 acre-feet), El Dupont De Nemours & Co. (1,405 acre-feet), Tosco Corporation Lion Oil Division (16,650 acre-feet), and USS Posco (12,900 acre-feet). Dupont obtains most of its water needs through Diablo Water District. All of these users, except for Dupont, also obtain water through CCWD. Shell Oil also is an important industrial customer for CCWD, diverting about 10,000 acre-feet annually from the Contra Costa Canal. Total industrial water sales by CCWD ranged from 27,000 to 48,000 acre-feet between 1984 and 1993, accounting for about one-third of CCWD's raw water demand.

Electric Utility Infrastructure. As with many of the other infrastructure systems, many of the corridors lie within the periphery of the upland areas and avoid the central Delta. Power generating facilities are also absent from the central Delta, although several natural gas-fired plants are located on the Delta periphery.

Natural Gas Infrastructure. Gas fields, pipelines, underground storage areas, and related infrastructure are located in the Delta. Infrastructure consists mainly of pipelines and storage facilities owned by oil and gas companies, such as Chevron, public utilities, such as PG&E, and various independent leaseholders.

Public Services. Various departments within the cities and counties of the Delta Region provide fire protection, police protection, and emergency medical services to members of their respective communities.

8.2.1.2 Bay Region

Historical Perspective

Land Use. Prior to the 1940s, land uses in the Bay Region were principally urban in the City of San Francisco and rural in other portions of the region. Over the last 50 years, however, land uses throughout the region have become progressively more urbanized. Post-World War II urbanization in the metropolitan San Francisco area was the principal catalyst for this development, along with growth in the cities of Oakland and San Jose. Since the 1970s, the southern portion of the Bay Region has become a hub for companies providing high-technology products and services. Suburban sprawl, characterized by low-density residential and light manufacturing land uses, occupies much of the Bay Region outside the San Francisco area.

Economics. Early in the state's history, population growth along the coast outstripped the ability of the coast's small and seasonally dry watersheds to provide adequate water supplies. Urban providers built projects, such as Hetch-Hetchy, to bring water from more reliable supplies. Continued growth led to projects such as the SWP and CVP. The Bay Region includes areas served by any of four facilities that export water from the Delta for M&I use: Contra Costa Canal and the San Felipe Division of the CVP; and the North Bay Aqueduct and the South Bay Aqueduct of the SWP. In addition, some other areas are affected because of water exchanges that occur involving the Hetch Hetchy and South Bay aqueducts.

Figure 8.2.1-3 shows population in the Bay Region from 1963 to 1990 and projected population to 2000. The region's population increased from about 4.537 million in 1970 to 5.484 million in 1990, for an annual growth rate of 2.25%. The growth rate slowed between 1990 and 1995.

Increased real incomes and new water-using technologies increased per capita use. As urbanization spread eastward within the region, the warmer climate and increased average lot size increased average per capita use. More recently, urban water conservation measures have slowed these trends. Table 8.2.1-3 shows per capita water use in the Bay Region in 1968, 1980, and 1990. Since 1968, per capita use has increased slightly, probably due to new residential development in the warmer, more inland portions of the region

Year	All Uses
1990	193
1980	180
1968	179

SOURCES:
DWR 1994, 1983, and 1970.

Table 8.2.1-3. Per Capita per Day Water Use, San Francisco Bay Region, 1968 to 1990 (gallons)

Existing Conditions

Land Use. Land uses in the Bay Region are diverse and include the Napa Valley and Sonoma County wine industry; international business and tourism in San Francisco; technological development and production in the Silicon Valley; and urban, suburban, and rural living. Urban land accounts for about 23% (655,600 acres) of the land area. Major urban areas include the San Francisco, Oakland, and San Jose metropolitan areas.

Economics. The Bay Area currently relies on the SWP and CVP for about 30% of its urban water demands. Without the East Bay Municipal Utilities District (EBMUD), the share rises to about 40%. Table 8.2.1-4 shows recent imports into the region through SWP and CVP facilities. These data show the influence of drought and reduced water allocations, especially in 1991 and 1992. Most imported water is delivered through the Contra Costa Canal and the South Bay Aqueduct, with smaller shares delivered through the CVP's San Felipe Unit and the North Bay Aqueduct. Table 8.2.1-5 shows characteristics of some Bay Area M&I providers.

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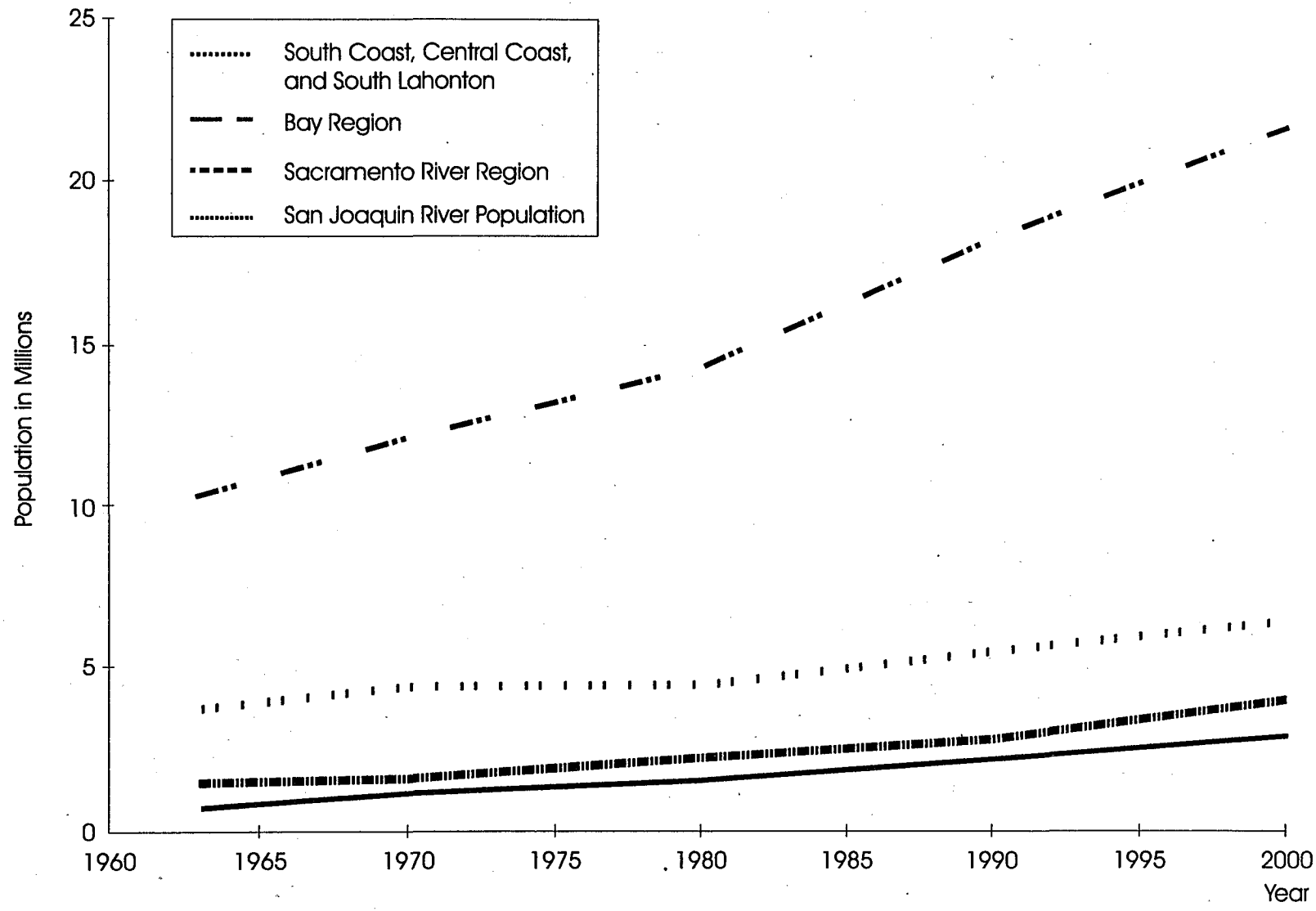

Figure 8.2.1-3. Bay Region Population Trends by Region, 1963 to 1990, and Predicted Population, 2000

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Water Source	1990	1991	1992	1993	1994
Central Valley Project					
Contra Costa Canal	186,679	153,363	109,576	93,267	134,903
San Felipe Unit	65,390	53,352	69,530	56,066	81,842
State Water Project					
North Bay Aqueduct	26,071	8,352	16,171	24,234	--
South Bay Aqueduct	156,737	50,259	76,661	124,180	--
Total	**434,877**	**265,326**	**271,938**	**297,747**	**216,745**

NOTES:
Does not include water rights deliveries or water transfers.
-- = Not available.

SOURCES:
Reclamation 1996, DWR 1996.

Table 8.2.1-4. M&I Water Delivered to the Bay Region from the Delta, 1990 to 1994 (in acre-feet)

Provider	Population (1990)	Water into System (1990 mg)	Service Connections (1990)	GPCD (1990)	Percent Purchased	Percent Metered	Percent Surface Water	$/af Average Cost
Vallejo	109,199	7,087	35,000	178	79	100	100	
Fairfield	77,211	5,405	19,088	192	100	100	100	
Vacaville	71,479	4,720	20,412	181	53	100	53	
San Francisco	723,959	31,685	164,892	120	0	100	100	$484
Palo Alto	56,000	4,465	18,912	218	100	100	100	
San Jose	873,714	41,154	201,150	129	47	100	55	$664
Santa Clara	93,800	7,988	23,031	233	38	100	38	
Sunnyvale	117,229	7,606	27,434	178	80	100	80	
Pleasanton	50,570	4,818	16,195	261	68	98	68	
Concord	190,000	12,107	54,538	175	100	100	100	

Table 8.2.1-5. Characteristics of Some Bay Region Providers

Costs of existing and future water supplies are affected by the mix of supplies and their costs. DWR estimated that groundwater for urban use in the region costs $85 to $330 per acre-foot. Costs of CVP supplies, which currently range from $32 to $95 per acre-foot, will be affected by the CVPIA. DWR estimated SWP unit water charges for North and South Bay contractors of $212 and $109 per acre-foot, respectively. Because local water supplies are generally fully utilized, future supply increases are likely to come from additional water imports or reclamation. The region generally has adequate water supplies during average conditions, but supply deficits are a problem in dry conditions. Water transfers and conservation were used during the recent drought to attain balance between supplies and demand, and this pattern could be expected to continue in the future.

Utilities and Public Services.

Water Supply and Related Infrastructure. Three subregions within the Bay Region are internally independent in terms of water supply: the North Bay, the South Bay, and CCWD. The North Bay consists of SWP entitlement holders served by the North Bay Aqueduct of the SWP and others who have used or could use this facility in exchanges. Two water districts are served by the North Bay Aqueduct: Napa County Flood Control and Water Conservation District (NCFCWCD), and Solano County Flood Control and Water Conservation District (SCFCWCD). NCFCWCD serves SWP water in southern Napa County. SCFCWCD serves the cities of Vallejo, Vacaville, Fairfield, Benicia, and Suisun. The two districts have transferred water and obtained surplus water through the facility. In addition to SWP entitlement water, Vallejo receives water-rights water through the North Bay Aqueduct.

The South Bay is served by the South Bay Aqueduct, an SWP facility, and through CVP contract supplies supplied through the San Felipe Unit. Three SWP entitlement holders—Alameda County Water District, Alameda County Zone 7, and the Santa Clara Valley Water District (SCVWD)—are located in the South Bay. SCVWD is also served by the San Felipe Unit of the CVP and wholesales water in a large part of the south San Francisco Bay.

For purposes here, CCWD includes that portion of the district not within the Delta. This includes the cities of Concord, Walnut Creek, Pleasant Hill, and Martinez, and other areas south and west of the statutory Delta.

Per capita use is generally greatest in the southern and eastern parts of the region. Many providers are entirely reliant on water wholesalers for their supplies. Water users in the region are almost entirely metered, and groundwater is an important part of supply for some providers.

Electric Utility Infrastructure. Bay Region electric infrastructure consists of a large and complex grid of power plants, transmission lines, and substations. Generating facilities in the region are primarily fired with natural gas and oil.

Recreational Resources. Mild temperatures and brisk winds make San Francisco Bay favorable for boating. More than 150,000 recreational boats were registered in the Bay Area in 1987. Other water-related recreation includes sight-seeing, picnicking, fishing, nature walking, and camping. Wildlife areas host a variety of recreational activities ranging from hiking and bird watching to mountain biking. Recreational resources are further described in Section 8.3.

Public Services. Various departments within the cities and counties of the Bay Region provide fire protection, police protection, and emergency medical services to members of their respective communities.

8.2.1.3 Sacramento River Region

Historical Perspective

Land Use. Agriculture and open space have historically comprised the majority of land in the Sacramento River Region. Since the 1970s, however, urban land uses in the greater metropolitan Sacramento area have begun to

supplant some agricultural uses. Except for Sacramento County, the region generally contains large quantities of parklands, forests, and other open space and has preserved its traditionally rural nature.

Economics. This region includes the CVP Service Areas of M&I providers in the Sacramento Valley and a small SWP service area in the Feather River basin.

The first use of the Sacramento River Region was for grazing and trapping, but the first significant immigration into the region involved the Gold Rush period of 1849 through the late 19th century. Most of the population lived in mining communities in the foothills, and Sacramento grew first as a port for delivery of goods and people from San Francisco and later as the terminus of the first transcontinental railroad. Agriculture developed to serve the mining communities, and the designation of Sacramento as the state capitol led to additional growth. Economic patterns in the twentieth century have mirrored national trends as services, trade, and government have become larger shares of the economy; while mining and agriculture have declined in relative, if not absolute, terms.

The historic population trend in the Sacramento River Region from 1963 to 1990 and the projected population to 2000 is shown in comparison to other regions on Figure 8.2.1-3. Population increased from about 1.227 million in 1970 to 2.209 million in 1990, for an annual growth rate of 8.26%. The growth rate slowed between 1990 and 1995.

Table 8.2.1-6 shows per capita water use in the Sacramento River Region in 1968, 1980, and 1990. Since 1968, average per capita use has declined, possibly due to smaller lot sizes and conservation measures in new residential developments.

Year	All Uses
1990	301
1980	305
1968	351

SOURCES:
DWR 1994, 1983, and 1970.

Table 8.2.1-6. Per Capita per Day Water Use in the Sacramento River Region, 1968 to 1990 (gallons)

Existing Conditions

Land Use. Land uses in the Sacramento River Region are still principally agricultural and open space, with urban development focused in the City of Sacramento. More than half the region's population lives in the greater metropolitan Sacramento area. Other fast-growing communities include Vacaville, Dixon, Redding, Chico, and various Sierra Nevada foothill towns. Urban development has occurred along major highway corridors in Placer, El Dorado, Yolo, Solano, and Sutter counties and has taken some irrigated agricultural land out of production. Suburban ranchette homes on relatively large parcels surround many of the urban areas, and often include irrigated pastures or small orchards.

Economics. The region generally has adequate supplies, even during drought, and some providers have excess supplies in the form of unused contracts, water rights, and excess groundwater capacity. DWR estimated that urban groundwater in the region costs $50 to $80 per acre-foot. Some providers, however, are entirely dependent on CVP water service contract supplies for their water, and these supplies can be reduced in dry conditions. CVP contract supplies currently cost anywhere from $9 to $46 per acre-foot. For these providers, drought conservation and water transfers may be used in the future during a drought to obtain supply/demand balance.

Utilities and Public Services

Water Supply and Related Infrastructure. The Sacramento Valley has relatively abundant water supplies of good quality in comparison to the other regions. The region also differs from the other regions in that it does not use M&I water exported directly from the Delta. Rather, the region supplies its own M&I water.

The major M&I water use in the region occurs in the Sacramento metropolitan area. Most surface water use in the region is diverted from the American River. Direct diversions from the Sacramento River may provide a larger share of supplies in the future. Another large user is the City of Redding. The CVP provides municipal water service to a large number of small M&I providers in the area.

Table 8.2.1-7 shows recent diversions for M&I use for the Sacramento River Region delivered through CVP facilities. These data show the influence of drought and reduced water allocations, especially in 1991 and 1992. Most providers in the region have water service contracts that exceed their immediate needs; therefore, reductions in deliveries during the drought were not as noticeable as in some other regions.

Table 8.2.1-8 shows some characteristics of Sacramento area M&I providers. Per capita use rates are among the highest in the state, reflecting climate, landscaping, and pricing factors. Some providers are entirely reliant on the CVP for their supplies. A large share of water users in the region are not metered. Groundwater is the sole source of supply for some providers; however, some rely entirely on surface water deliveries, especially CVP water-service water. Water costs per acre-foot delivered are generally low in comparison to other regions.

Water resources in the Sacramento basin have been developed for local agricultural, municipal, and industrial needs; they are exported to the Bay Delta; and they are used to generate power at hydroelectric facilities. Most of the area's developed surface storage is contained in four major reservoirs: Lake Shasta on the Sacramento River (about 4.5 MAF), Oroville Reservoir on the Feather River (about 3.5 MAF), Folsom Lake on the American River (about 1.0 MAF), and Lake Berryessa in Putah Creek (about 1.6 MAF). An additional 2.2 MAF of flood-control storage is provided by a system of basins, levees, channels, and bypasses—including the Butte, Colusa, Sutter, American, and Yolo basins. Levees and bypasses extend more than 150 miles, from Red Bluff to Suisun Bay. Flood control is achieved by developing bypass overflows that act as auxiliary channels to the Sacramento River during high water periods.

Electric Utility Infrastructure. Infrastructure consists primarily of natural gas turbine and hydroelectric generating facilities, transmission lines, substations, and distribution lines.

Hydropower generation levels fluctuate significantly with reservoir releases that are in turn affected by droughts (and other climatic conditions), minimum stream flow requirements, flow fluctuation restrictions, and water quality requirements. For example, cold water has been released from Shasta Reservoir to control temperature and protect winter-run chinook salmon in the Sacramento River. Releases by-passed the power plant and generation levels were reduced, although engineering controls now allow such water to pass through the plant. Changes in power generation affect coordinated operations of both PG&E and CVP facilities.

Natural Gas Infrastructure. Pipelines, storage areas, and compressor stations exist in the Sacramento valley and other parts of northern California.

Public Services. Various departments within the cities and counties of the Sacramento River Region provide fire protection, police protection, and emergency medical services to members of their respective communities.

Water Source	1990	1991	1992	1993	1994
Central Valley Project					
Clear Creek Unit	1,451	659	2,460	2,076	2,329
Cow Creek Unit	3,342	1,817	3,206	5,342	6,674
Folsom Dam and Reservoir	27,454	40,743	23,360	20,895	30,693
Folsom South (SMUD)	5,829	3,600	3,564	1,673	1,727
Sacramento River	8,900	7,753	7,945	8,314	9,321
Shasta Dam and Reservoir	1,852	1,417	1,017	2,694	1,338
Spring Creek Conduit	638	337	777	885	688
Toyon Pipeline	2,471	2,071	2,537	2,164	2,479
State Water Project					
Feather River Area	1,448	866	2,128	3,476	--
Total	**53,385**	**59,263**	**46,994**	**47,519**	**55,249**

NOTES:
-- = Not available.
Does not include water rights deliveries or water transfers.

SOURCES:
Reclamation 1996, DWR 1996.

Table 8.2.1-7. M&I Water Delivered to the Sacramento River Region by the SWP and CVP

Provider	Population (1990)	Water into System (1990 mg)	Service Connections (1990)	GPCD (1990)	Percent Purchased	Percent Metered	Percent Surface Water	$/af Average Cost
Redding	66,462	6,890	21,112	284	70	100	70	$254
Sacramento, Citizens Utility	166,000	16,055	46,064	265	0	100	0	
Fair Oaks	38,005	4,949	12,641	357	95	6	95	
Roseville	44,685	4,642	17,249	285	100	10	100	
Sacramento, City of	369,365	37,157	111,785	276	0	2	95	$165
Orangevale/ Roseville	20,000	4,309	6,402	590	100	6	100	
Carmichael	38,550	4,191	10,830	298	60	5	60	

NOTES:
Metered percentage based only on available data for all service connections.
GPCD = Gallons per capita per day.

Table 8.2.1-8. Characteristics of Some Sacramento River Region Providers

8.2.1.4 San Joaquin River Region

Historical Perspective

Land Use. The European history of the San Joaquin Valley Region began with settlement by the Spanish for cattle ranching. By the mid-1800s, gold mining to the north and east created a demand for agricultural products and led to the first large irrigation developments in the region. Large areas of wetlands such as Tulare Lake were reclaimed for agriculture, and the advent of the railroad expanded agricultural markets to the rest of the nation. Many early irrigation developments were private, but the federal government played a larger role in this century with multi-purpose projects on the eastside rivers and valley floor.

Although agriculture and food processing are still the region's major industries, expansion from the San Francisco Bay Area and Sacramento over the past 30 years has resulted in the creation of major urban centers throughout the region. Open space uses, including national forest and park lands, state parks and recreational areas, and Bureau of Land Management and military properties, have historically comprised about one-third of the region.

Economics. The San Joaquin River Region includes only those M&I providers in the San Joaquin Valley with some current or planned use of CVP or SWP supplies exported from the Delta. CVP water service contracts in the region are served by the Delta-Mendota or San Luis canals. SWP entitlements are served via the California Aqueduct.

The historic population trend in the San Joaquin River Region from 1963 to 1990, and the projected population to 2000, are shown in comparison to other regions on Figure 8.2.1-3. Population increased from about 1.676 million in 1970 to 2.974 million in 1990, for an annual growth rate of 7.72%. The growth rate slowed between 1990 and 1995. Table 8.2.1-9 shows per capita water use in the San Joaquin River and Tulare Lake regions in 1968, 1980, and 1990. Since 1968, per capita use has declined, probably in response to smaller lot size, more use of modern conservation in new housing, and perhaps changing patterns of water use in industry and commerce.

Year	All Uses
1990	309
1980	355
1968	436

Table 8.2.1-9. Per Capita per Day Water Use, San Joaquin River, 1968 to 1990 (gallons)

Existing Conditions

Land Use. Land uses in the San Joaquin River Region are predominantly open space in the mountain and foothill areas and agricultural in the San Joaquin Valley area. Urban land usage in 1990 totaled 295,300 acres. Urban areas include the cities of Stockton, Modesto, Merced, and Tracy, as well as smaller communities such as Lodi, Galt, Madera, and Manteca. In contrast to the large valley urban centers, separated by flat agricultural fields and linked by freeways, the foothills are sprinkled with small communities connected by small two-lane roads. Off from the north-south trending Highway 49 is a series of roads that lead to Sierra Nevada mountain passes. The western side of the region, south of Tracy, is sparsely populated. Many small agricultural communities dot the eastern side of the southern San Joaquin Valley, with urban development and anticipated population growth focused in the cities of Fresno, Bakersfield, Visalia, and Tulare.

The region also contains thousands of acres of wildlife areas, preserves, and refuges managed by a variety of federal, state, county, and local government and private institutions. An example of some of the more prominent areas set aside for wildlife include the National Wildlife Refuges in Merced County, owned by the U.S. Bureau of Reclamation, Kesterson National Wildlife Refuge, and Cottonwood Creek, Los Banos, Mendota, and North Grasslands Wildlife Areas, owned by the California Department of Fish and Game.

Utilities and Public Services

Water Supply and Related Infrastructure. Table 8.2.1-10 shows recent imports into the region through SWP and CVP facilities. These data show the influence of the recent drought and reduced allocations, especially in 1991 and 1992. Most Delta water delivered into the region is provided to Kern County Water Agency (KCWA). This water is delivered for several uses within Kern County in exchange for groundwater pumped by the City of Bakersfield.

Table 8.2.1-11 shows characteristics of some San Joaquin Valley M&I providers. Per capita use rates are generally higher than in the coastal regions, reflecting climate and landscaping factors.

Local water supplies are unable to meet local demands, and supplemental water is imported from the Delta Region. SWP and CVP water is pumped from Clifton Court Forebay in the Delta and is transported into the region via the California Aqueduct and the Delta—Mendota Canal. Infrastructure in the region consists mainly of channels, aqueducts, reservoirs, and irrigation structures.

The largest CVP M&I water users in the San Joaquin River Region are Avenal, Coalinga, Huron, Westlands Water District, and Tracy, but small amounts of M&I water are taken by a number of other districts. Stockton East is included in this group, with a CVP contract of 38,000 acre-feet.

M&I water use in the Friant Division of the CVP is not included. The City of Bakersfield obtains SWP M&I supplies through KCWA.

Electric Utility Infrastructure. Infrastructure consists primarily of natural gas-fired and hydroelectric-generating facilities, transmission lines, substations, and distribution lines.

Natural Gas Infrastructure. Although gas fields and storage areas are not known to exist in the region, several major pipelines traverse the entire length of the San Joaquin Valley.

Public Services. Various departments within the cities and counties of the San Joaquin River Region provide fire protection, police protection, and emergency medical services to members of their respective communities.

8.2.1.5 SWP and CVP Service Areas Outside the Central Valley

Historical Perspective

Land Use. The development of SWP and CVP Service Areas Outside the Central Valley has steadily increased since the 1880s. Urban land uses grew quickly during and after World War II, as the combination of major industries (defense, tourism, entertainment), international trade, and an expanding interstate highway system brought thousands of new residents to the greater Los Angeles and San Diego metropolitan areas. Since the 1970s, suburban sprawl has grown to comprise the majority of coastal and inland valley land uses. Open space uses, including national forest and park lands, and state parks and recreational areas, historically have comprised about one-third of the region.

The first European use of the Central and South Coast regions involved Spanish settlement for trade and cattle production. After statehood, the region grew quickly as agriculture, business, and industry took advantage of the region's warm Mediterranean climate. The rapidly expanding South Coast population soon required water imports from outside the region, and the Los Angeles Aqueduct, the Colorado River Aqueduct, the San Diego Aqueduct, and the SWP were developed to meet this need. The Los Angeles metropolitan area is now the second largest in the nation.

Economics. The SWP and CVP Service Areas Outside the Central Valley include the service areas of all SWP entitlement holders south of Kern County. The single largest provider is Metropolitan in DWR's South Coast Region. The South Coast M&I water demand exceeds the demands of all other M&I regions combined. The

Water Source	1990	1991	1992	1993	1994
Central Valley Project					
Cross Valley Canal	459	407	297	0	0
Delta Mendota Canal	5,531	5,586	7,221	8,005	7,843
San Luis Canal	12,996	10,528	15,098	11,787	14,374
State Water Project					
Kern County Water Agency	127,837	33,122	56,305	94,220	--
Total	**146,823**	**49,643**	**78,921**	**114,012**	**22,217**

NOTES:
Does not include water rights deliveries or water transfers.
- - = Not available.

SOURCES:
Reclamation 1996, DWR 1996.

Table 8.2.1-10. M&I Water Delivered to the San Joaquin River Region from the Delta, 1990 to 1994

Provider	Population (1990)	Water into System (1990 mg)	Service Connections (1990)	GPCD (1990)	Percent Purchased	Percent Metered	Percent Surface Water	$/af Average Cost
Stockton	210,943	17,130	64,179	222	52	100	52	$311
Huron	4,766	284	621	163	100	N/A	100	
Coalinga	8,450	1,032	2,665	327	100	16	100	
Bakersfield, CA Water	172,800	20,222	51,641	321	15	24	15	$263

Table 8.2.1-11. Characteristics of Some San Joaquin River Region Providers

region includes Ventura, Los Angeles, and Orange counties and the western portions of San Diego, Riverside, and San Bernardino counties.

The SWP and CVP Service Areas Outside the Central Valley also include service areas receiving SWP water in DWR's Central Coast Region, the Antelope Valley and Mojave River planning subareas of the South Lahontan Region, and the Coachella planning subarea of the Colorado River Region. Central Coast SWP contractors are Santa Barbara County Flood Control and Water Conservation District (SBCFCWCD) and San Luis Obispo Flood Control and Water Conservation District. These districts are served by deliveries through the Coastal Aqueduct of SWP.

The historic population trend in portions of the SWP and CVP Service Area Outside the Central Valley from 1963 to 1990, and the projected population to year 2000, are shown in comparison to other regions on Figure 8.2.1-3. Figure 8.2.1-3 shows population in DWR's Central Coast, South Coast, and South Lahontan regions. This population increased from about 12.1 million in 1970 to 18.2 million in 1990, for an annual growth rate of 4.4%. The population growth rate slowed between 1990 and 1995.

Table 8.2.1-12 shows per capita water use in DWR's Central Coast, South Coast, and South Lahontan regions in 1968, 1980, and 1990. Since 1970, per capita use in the South Coast Region has increased slightly, probably due to new residential development in the more inland, hotter portions of the region. Per capita use in the Central Coast Region has declined, probably due to high water prices and more intensive water conservation in this region.

Year	All Uses
South Coast Region	
1990	211
1980	191
1968	179
Central Coast Region	
1990	189
1980	210
1968	194
South Lahontan Region	
1990	278
1980	280
1968	305

Table 8.2.1-12. Per Capita per Day Water Use, SWP and CVP Areas Outside the Central Valley, 1968 to 1990 (gallons)

Existing Conditions

Land Use. The South Coast is the most urbanized region in California. Of the approximately 7,000,000 acres in the region, about 1,700,000 acres are urban land. Most of the region's coastal plains and valleys are densely populated. The largest cities are Los Angeles, San Diego, Long Beach, Santa Ana, and Anaheim. Areas undergoing increased urbanization include the coastal plains of Orange and Ventura counties, the Santa Clarita Valley in northwestern Los Angeles County, the Pomona/San Bernardino/Moreno valleys, and the valleys north and east of the city of San Diego.

A little more to the north are the cities of Santa Barbara, Lompoc, Santa Maria, Morro Bay, and San Luis Obispo. Military installations include Vandenberg Air Force Base and Camp Roberts.

The eastern portion of Kern County, northeast portion of Los Angeles County, and western San Bernardino County contain many desert valleys and small mountain ranges. Although not densely populated, this region contains many growing urban areas, including the city of Lancaster and Principal urban areas in the SWP and CVP Service Areas are located in the Coachella Valley and include Palm Springs, Indio, Cathedral City, and Palm Desert. Vacation and resort facilities in these areas include hotels, country clubs, golf courses, and other residential communities.

This region comprises about 12,630,000 acres. About one-fifth of this acreage (2,525,000 acres) is estimated to lie in the region's SWP and CVP Service Areas. About 10% of this acreage (252,500 acres) is estimated to comprise urban and suburban land uses.

Economics. DWR estimated that groundwater for urban use in the South Coast Region costs $45 to $190 per acre-foot. There is little potential for new yield without intentional recharge or expensive treatment. DWR estimated an SWP unit water charge in the southern California area of $206 per acre-foot. The Integrated Resources Plan estimates the potential costs of future water supplies. Development, treatment, and distribution costs of new Colorado River Aqueduct supplies are expected to be about $250 per acre-foot, but the yield of these options is limited by the conveyance capacity of the Colorado River Aqueduct. Additional storage, low-cost transfers, and additional SWP supplies would cost around $300 per acre-foot, low-cost reclamation and high-cost transfers about $400 per acre-foot, high-cost reclamation about $600 per acre-foot, groundwater recovery about $700, and desalination would cost more than $1,400 per acre-foot.

Water Supply and Related Infrastructure. Table 8.2.1-13 shows recent imports into the SWP and CVP Service Areas Outside the Central Valley through

Water Source	1990	1991	1992	1993
State Water Project				
Metropolitan Water District of Southern California	1,396,423	391,447	707,311	1,408,050
Other southern California	189,483	51,249	105,090	193,092
Total	**1,585,906**	**442,696**	**812,401**	**1,601,142**

NOTE:
Does not include water rights deliveries or water transfers.

SOURCES:
Reclamation 1996, DWR 1996.

Table 8.2.1-13. M&I Water Delivered to the Central Coast and South of Kern County from the Delta, 1990 to 1993 (in acre-feet)

SWP facilities. These data show the influence of drought and reduced water allocations, especially in 1991 and 1992. SWP deliveries to Metropolitan declined 72% from 1990 to 1991 and did not recover until 1993. Similar delivery patterns were experienced by the other SWP M&I entitlement holders in the region.

DWR's Bulletin 160-93 estimated that the South Coast Region will experience a year 2020 supply deficit of 1.4 and 2.5 MAF in average and dry years, respectively, or enough to meet the demands of about 6.7 million persons in the average year. Most of this shortage would be eliminated with new supplies, especially reclaimed water and new yield from Colorado River, local and SWP improvements, and conservation. Still, a substantial supply deficit would remain.

Table 8.2.1-14 shows some characteristics of M&I providers in the region. Only those providers delivering more than 10,000 million gallons, or 30,700 acre-feet (AF), annually are included. In the South Coast Region, per capita use rates generally reflect distance from the coast. Most providers supply a mix of purchased and developed water, and almost all providers use a mix of surface water and groundwater supplies.

Metropolitan recently developed an Integrated Resources Plan as a policy guideline for future resource and capital development. The Preferred Resource Mix for year 2020 includes: 512,000 acre-feet annually of new conservation; 290,000 acre-feet of new water recycling; 40,000 acre-feet of groundwater recovery; dry-year yields of 220,000 and 400,000 acre-feet from existing reservoirs and the Eastside reservoir, respectively; 200,000 acre-feet of dry-year yield from conjunctive use; about 700,000 acre-feet of additional dry-year SWP supplies; and 300,000 acre-feet of water transfers from willing sellers.

Key SWP and CVP infrastructure includes reservoirs, aqueducts, power plants, and pumping plants.

Electric Utility Infrastructure. A complex system of generating facilities, substations, and transmission infrastructure exists in the southern California and Central Coast regions. Natural gas, nuclear, oil, hydroelectric, and other technologies are employed in producing power.

Natural Gas Infrastructure. Gas storage areas, pipelines, and compressor stations are present in southern California. Pipelines and compressor stations also are present in northern California.

Public Services. Various departments within the cities and counties provide fire protection, police protection, and emergency medical services to members of their respective communities.

Provider	Population (1990)	Water into System (1990 mg)	Service Connections (1990)	GPCD (1990)	Percent Purchased	Percent Metered	Percent Surface Water	$/af Average Cost
Central Coast Region								
San Luis Obispo	41,958	1,560	12,350	102	0	100	59	$890
Goleta	70,480	1,934	13,750	75	76	100	75	$1,381
Santa Barbara	85,571	3,079	24,146	99	61	100	68	$1,364
South Coast Region[a]								
Carson et al.	101,000	12,667	31,611	344	73	100	73	
Long Beach	429,433	24,448	87,923	156	65	100	65	$498
Los Angeles	3,485,398	218,809	635,698	172	73	100	89	$462
Glendale	180,038	10,144	32,778	154	93	100	93	$312
Pasadena	131,590	12,629	36,998	263	66	N/A	67	$331
Anaheim	266,406	24,064	55,500	247	49	100	49	
Fullerton	114,144	10,584	27,890	254	54	100	54	
Huntington Beach	181,519	12,530	48,571	189	53	100	53	
Santa Ana	293,742	16,665	43,491	155	25	N/A	25	
Riverside	226,505	22,217	66,348	269	8	100	8	$268
Ontario	133,179	12,101	28,019	249	46	100	46	
Rancho Cucamonga	101,409	13,810	32,567	373	46	100	59	
Fontana	75,000	10,411	28,000	380	100	100	30	
Mission Viejo	109,250	10,700	37,445	268	100	100	100	
El Cajon et al.	227,293	13,514	53,347	163	98	100	99	
San Diego	1,100,549	73,927	235,810	184	100	100	100	$576
Chula Vista and Vicinity	135,163	15,986	60,673	324	87	100	96	
South Lahontan Region								
Palmdale	68,842	6,073	19,626	242	43	100	44	$488

NOTE:
[a] Only those providers with 10,000 million gallons per year or more.

Table 8.2.1-14. Characteristics of Some Providers in the SWP and CVP Areas Outside the Central Valley

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8.2.2 Environmental Consequences: Urban Land Use

8.2.2.1 Assessment Methods

Urban land use impacts could occur in two main categories: direct and construction-related impacts and indirect and operational impacts.

Direct impacts are those changes in physical land uses, or in land use designations, which result from constructing new facilities or converting lands from one use to another. For purposes of this analysis, direct impacts of the CALFED program are those that would occur if any alternatives, or combination of alternatives, were implemented.

Indirect effects occur later in time and perhaps further removed in distance. Indirect land use effects would be changes in broad land use policies, resources, or economies which could result from changes in land uses, or in the long-term availability of water resources. Potential indirect and operational impacts of the program include long-term changes in the number of acres in developed use. Table 8.2-1, at the beginning of this section, provides a summary of impacts to urban land use.

As a Programmatic EIS/EIR, this assessment does not provide site-specific details or specific estimates of acreages or number of residences potentially affected for a given alternative.

8.2.2.2 Significance Criteria

The following impacts would potentially be considered significant urban or developed land use effects of the project:

- Displacement of residents;
- Displacement of current land uses;
- Conflict with applicable environmental plans or policies agencies with jurisdiction over the project;
- Conflict with general plan designations or zoning; or
- Disruption or division of the physical arrangement of any established community.

8.2.2.3 Comparison of No Action Alternative to Existing Conditions

The key changes between current conditions and No Action Alternative conditions that will affect land use involve converting land uses to accommodate storage and conveyance facilities associated with reasonably foreseeable future actions. The intensity and magnitude of specific urban land use impacts would depend upon the actual location of the modifications and improvements to be implemented under the No Action Alternative. Such projects could displace residents, disrupt or divide existing communities, or be inconsistent with local or regional land use plans.

8.2.2.4 Comparison of Program Alternatives to No Action Alternative

The impacts to urban land use resulting from the storage and conveyance program element will vary by alternative, as discussed below. Impacts to urban land use resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a regions, the program element is not discussed.

Delta Region

Storage and Conveyance

Alternatives 1 and 2. Under all the Alternative 1 and 2 configurations, conveyance components such as channel widening and island flooding could require relocating urban uses such as

highways/roads, spot commercial uses, and scattered residences. Scattered residences are often on island perimeters adjacent to the levees. Adverse land use impacts resulting from these modifications would potentially be significant.

The specific locations of improvements contemplated for Alternatives 1, 2, and 3 have not been identified for this programmatic-level analysis. Thus, the consistency of project alternatives with general plan land use designations or zoning are not evaluated herein. However, inconsistency with these plans could result in a significant adverse land use impact.

Alternative 3. Potential land use impacts in the Delta under Alternative 3 are anticipated to be similar to those described under Alternatives 1 and 2. The main differences among the alternatives involve the storage and conveyance components.

Land use impacts of developing new on- or off-stream storage could be significant if this action leads to displacement of residents or division or disruption of an established community. Additionally, short-term construction-related disruption to established urban land uses could result in a significant impact. Impacts could include increased noise, dust and truck traffic, disruption of utility service, and possible street closures. During the operational phase of the program, impacts could result from relocation of roads and utility lines. All construction and operational impacts would be considered potentially significant and mitigable. Operation of storage facilities could result in the beneficial impact of reduced flood potential in some locations.

Potential direct land use impacts under Alternative 3 would differ for an open channel versus a buried pipeline. Creation of an open channel isolated conveyance would lead to a significant adverse land use impact by permanently converting underlying land uses to open space. Construction of a buried pipeline isolated conveyance, however, would create a short-term, temporary adverse impact on surrounding land uses. Any urban land uses affected could resume after completion of pipeline construction. Potential impacts for all configurations under Alternative 3 include displacing residences and disrupting or dividing an established community.

Ecosystem Restoration. The Ecosystem Restoration Program recommends that a portion of the land in the Delta Region be converted to habitat and ecosystem restoration, levee setbacks, and floodways. Specific potentially significant impacts on urban land use would depend on the actual location of the modifications and improvements. However, it is anticipated that this program would most likely affect agricultural uses and therefore would have only a negligible effect on urban land uses.

Water Quality. The Water Quality Program focuses on source control and reducing the release of pollutants into the Bay-Delta system and its tributaries. The program is not anticipated to have direct or indirect land use impacts in the Delta or any of the other regions.

Water Use Efficiency. The Water Use Efficiency Program is not anticipated to have direct land use impacts. The program relies on incentives, technical assistance, and policies to be implemented by local agencies, rather than mandatory measures and targets for water use efficiency.

Indirect changes in land use may result from the Water Use Efficiency Program. However, potential adverse impacts to developed land uses generally would be limited to changes in landscape materials and would not be significant. Changes to the pace and location of urbanization would also be expected to be minimal and insignificant.

Levee System Integrity. The improvements contemplated under the Levee System Integrity Program would involve acquiring new rights-of-way and constructing new setback levees. However, it is anticipated that this program would primarily affect agricultural land and therefore would have only a negligible effect on urban land uses.

Water Transfers. The Water Transfer Program could have adverse impacts on urban land use and development. Both short- and long-term water transfers can result in growth that otherwise may not have a reliable long-term water supply. If transfers become unavailable in the future as a result of growth within the selling region and subsequent reduction in the transferable amount, growth within purchasing regions may be adversely impacted.

Bay Region

No Program alternatives are anticipated to have significant direct or indirect effects on urban land uses in the Bay Region.

The compatibility and consistency of potential CALFED actions with county and city general and local plans in the Bay Region are not evaluated in this programmatic-level analysis. However, all program elements will be designed to be consistent with all applicable plans.

Sacramento River and San Joaquin River Regions

The only significant impacts in the Sacramento and San Joaquin river regions would be related to water storage. The impacts attributable to storage would be similar to those discussed under Alternative 3 in the Delta Region.

The compatibility and consistency of potential CALFED actions with county and city general and local plans in the Sacramento and San Joaquin regions are not evaluated in this programmatic-level analysis. However, inconsistency between program elements and these plans could result in a significant adverse land use impact.

SWP and CVP Service Areas Outside the Central Valley

No Program alternatives are anticipated to have significant direct or indirect effects on urban land uses in SWP and CVP Service Areas Outside the Central Valley.

The compatibility and consistency of potential CALFED actions with county and city general and local land use plans are not evaluated in this programmatic-level analysis. However, all program elements will be designed to be consistent with all applicable plans.

8.2.2.5 Comparison of Program Alternatives to Existing Conditions

Comparison of Program alternatives to existing conditions indicates that:

- The potentially significant adverse effects to urban land use identified when comparing to the No Action Alternative are still significant when comparing to existing conditions.

- CALFED is proposing actions which could cause some adverse land use changes within urban communities. Under No Action urban development would continue and some adverse effects to existing communities could occur as result of that development. Adverse impacts resulting from the CALFED alternatives would be additive with other urban development effects that would occur under No Action. The combination of CALFED effects with other development effects represent the total changes with respect to existing conditions.

- The water supply reliability actions from the Water Use Efficiency, Water Quality and Storage and Conveyance program elements could improve the availability and quality of water for urban purposes above the existing condition baseline. While CALFED is expecting an overall improvement in water supply reliability for urban communities relative to the No Action Alternative, there is still the potential that the benefits provided by the Program alternatives could be insufficient to offset future conditions and the water supply reliability could be worse than currently exists.

8.2.2.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific

projects are approved by subsequent environmental review.

The following measures would be implemented to mitigate potentially significant land use impacts:

- Select and/or design program actions that minimize the displacement of existing residents.

- Select and/or design program actions that do not physically disrupt or divide established communities.

- To the extent practicable, select program actions that are consistent with local and regional land use plans. Consult and work with local jurisdictions affected by CALFED actions early in the Phase III planning and environmental review process.

- Provide advance notice of construction activities schedule to affected community members (such as residents, property owners, school officials, and business owners).
- Coordinate with the applicable jurisdiction to obtain necessary permits and assign an inspector to oversee construction activities.

- Coordinate with the applicable jurisdiction regarding future plans for projects in the area. Coordinate project design and construction with other planned projects to the greatest extent possible to avoid design conflicts and minimize construction disruption.

- Coordinate with the applicable jurisdiction and apply for a zoning or general plan change, if necessary.

- During construction, maintain access to homes, schools, and businesses.

- If necessary, compensate property owners for the value of their land and associated improvements, including dwelling units, in compliance with state regulations for providing relocation assistance to displaced persons or businesses.

- If necessary, aid in locating alternative dwelling units for displaced persons pursuant to the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970.

- Where applicable, compensate property owners for acquisition of permanent and construction easements for proposed pipelines.

- Where applicable, minimize the amount of permanent easement required for pipeline construction and select easement locations in consultation with property owners to minimize property disruption and fragmentation.

- If applicable and where feasible, relocate roads and utilities prior to project construction to ensure continued access and utility service through the project area.

- Prepare a detailed engineering and construction plan as part of the project's design plans and specifications and include procedures for rerouting roads and excavating, supporting, and filling areas around utility cables and pipes in this plan.

- Notify all affected persons in the project area of the construction plans and schedule. Make arrangements with residents and businesses regarding road detours and protection, relocation, or temporary disconnection of utility services.

- Verify utility locations through consultation with appropriate entities and field surveys (such as probing and potholing).

- Promptly reconnect disconnected cables and lines.

8.2.2.8 Potentially Significant Unavoidable Impacts

The following items have been identified as potentially significant land use impacts. Even after implementation of identified mitigation measures, these impacts may still remain significant.

- Program actions associated with the Ecosystem Restoration Program Plan, Levee System Integrity Program, or Storage and Conveyance components could displace existing residents in areas where those actions would be located.

- Program actions associated with the Ecosystem Restoration Program, Levee System Integrity Program, or Storage and Conveyance components could physically disrupt or divide established communities.

- Water transfers to urban areas resulting from program actions associated with water transfers could induce growth in urban areas that otherwise would not have adequate water supplies to support such growth.

8.2.3 Environmental Consequences: Urban Water Supply Economics

8.2.3.1 Assessment Methods

M&I water supply economics assessment variables include:

- Water supply benefits and costs,
- Water quality benefits, and
- Conservation benefits and costs.

Water Supply. The M&I water supply economics assessment uses preliminary results from DWRSIM and alternative costs to calculate the gross benefits of new CALFED water supplies (Table 8.2.3-1). No information on costs of CALFED alternatives is developed or used in the analysis; therefore, no judgment can be made about the potential benefit-cost relations of the alternatives.

Water supply benefits are any cost savings on water supplies acquired to meet future demands and to store supplies acquired for use during drought. The analysis considers historical hydrology and year 2020 demands. Preliminary analyses of the tradeoff between CALFED deliveries and the regional options displaced for the areas outside of the Central Valley suggests that fixed yield options like extraordinary conservation, water recycling, and ocean water desalting, which provide the same yield in every year, would be displaced by the CALFED alternatives. These analyses assumed that local planners incorporate least cost planning principles as part of their decision criteria. The cost savings from these displaced supplies, much of which is recycling, is assumed to average about $700 per acre-foot annually.

The fixed yield options are not displaced on a one-to-one basis, however, because of the hydrologic variability of the CALFED supply. The displacement ratio varies from about 1.6 to 1.3 to one, depending on the specific CALFED alternative and assumptions about the availability of water transfers.

Within the Central Valley, local reservoir storage options are the most likely to be replaced by the water supply provided by the CALFED alternatives. The cost of these new facilities is assumed to be about $400 per acre-foot annually. The benefit of the CALFED alternatives would therefore be manifested as avoided costs of additional storage in the Central Valley.

DWR has provided a preliminary least-cost planning analysis for the South Coast region. The analysis uses a system simulation framework to evaluate the value of imported water. The analysis calculates the percentage of local fixed yield that is no longer cost effective under CALFED water delivery scenarios. The analysis considers the marginal trade-off between the increment of supply made available by CALFED alternatives and the regional fixed yield options which would be built under the No Action Alternative. It also incorporates opportunities for conjunctive use and for shortage contingency water transfers.

Several other important assumptions of the M&I economic analysis are:

- No water transfers from the Central Valley are included as alternative supplies, except in the South Coast.

Region	Alternatives												
	No Action	Alt 1			Alt 2				Alt 3				
		1a	1b	1c	2a	2b	2d	2e	3a	3b	3e	3h	3i
Delta (CCWD)				Supply 33		Supply 33	Supply 17	Supply 33	Supply 10	Supply 54	Supply 54	Supply 54	Supply 54
Bay				Supply 10		Supply 10		Supply 10		Supply 33	Supply 33	Supply 33	Supply 33
Sacramento River				Supply 23		Supply 23		Supply 23		Supply 46	Supply 46	Supply 46	Supply 46
San Joaquin River				Supply 12		Supply 12		Supply 12		Supply 20	Supply 20	Supply 20	Supply 20
Other SWP and CVP Service Areas outside Central Valley				Supply 15	Quality	Supply (15) and quality	Quality	Supply (15) and quality		Supply 24	Supply (24) and quality	Supply 24	Supply 24

NOTES:
Any entry means that a significant effect has been identified. Supply = Water supply benefit, Cost = Water supply cost, Quality = Water quality benefit. The numeric entry after supply is the percent reduction in total drought costs. The lack of a symbol does not mean that the alternative will not have any impacts. Rather, it means that no decision has been reached, or information is not available.

Table 8.2.3-1. M&I Water Supply Economics by Region and Source

C-005540

C-005540

Water demands are based on DWR's Bulletin 160-93 year 2020 levels, except for the South Coast least-cost analysis which used Bulletin 160-98 demands and supplies.

The first factor tends to increase the value of new water significantly relative to existing and actual future conditions because water transfers have recently been, and should continue to be, a low-cost source of supplies.

In the M&I analysis, CVPIA Preliminary Environmental Impact Statement (PEIS) Alternative 1 M&I deliveries are the No Action condition used to evaluate the percent change in water supply due to CALFED alternatives. This is not the case for any other analysis. The DWRSIM preliminary runs used in the analysis, the corresponding alternatives, and the increase in critical and average M&I deliveries are shown in Table 8.2.3-2.

These M&I deliveries are equal to one third of the total increase in deliveries. The other two thirds were allocated to agricultural and environmental uses. This allocation of water is strictly hypothetical, and it should not be inferred that benefits should be assigned or costs allocated in relation to this yield allocation.

DWRSIM Run No.	CALFED Alternatives	TAF/Yr Increase in M&I Deliveries	
		Average	Critical
472	No Action, 1A, 1B	0	0
472B	2A	60	26
475	3A	90	69
498	2D	107	122
510	1C, 2B, 2E	185	235
500	3B, 3E through 3I	220	353

Table 8.2.3-2. Increase in M&I Water Supplies, by Alternatives.

The total increase in M&I deliveries was allocated to all SWP and CVP M&I users in the analysis according to their share of total contract or entitlement. The contract or entitlement amounts and shares are shown in Table 8.2.3-3.

Because of the programmatic nature of this document, the level of detail used for the analysis is necessarily preliminary in nature and the methods and principles described above were applied more conceptually than empirically at this point. The documentation for establishing a preferred alternative will be based on a much more detailed level of analysis.

Water Quality. Water quality constituents that are important to M&I water users include salinity and related by-products, organic carbon and related by-products, bromides, turbidity, and microbes. Water quality of M&I supplies may be affected by the quality of source waters, but changes in quantities of supplies are also important when a provider uses numerous supplies that vary in their quality. Some providers intentionally mix supplies of various qualities to obtain water quality goals.

The exact scope of water quality actions and the financing of the actions in terms of cost shares have not yet been determined; therefore, a comprehensive analysis of costs and benefits is not possible.

Water quality of Delta water exports is strongly affected by the configuration of Delta conveyance and export facilities. Also, the salinity in some provider's service areas can be improved with more Delta water supplies because Delta water is blended with other more saline supplies.

M&I Provider Group	TAF Contract or Entitlement	Share of CALFED Water (%)
CVP Shasta	37	1
CVP Sacramento	76	2
CCWD	167	5
CVP San Felipe	128	4
SWP North Bay	67	2
SWP South Bay	188	6
CVP San Joaquin	29	1
SWP San Joaquin	143	4
SWP Coastal Aqueduct	50	2
SWP South of Kern County	2,468	73
Total:	**3,353**	**100**

Table 8.2.3-3. Shares of Increased CALFED Water Supply for SWP and CVP M&I Users

This section includes an economic analysis of salinity damages in Delta export water users' service areas for some CALFED alternatives. The economic analysis of salinity must consider quality and quantity. The hypothetical M&I one-third yield increment was allocated to water users according to their share of CVP contracts plus SWP entitlements. For example, SWP entitlement holders south of the Tehachapis receive 74 % of any incremental M&I water yield, or about 25 % of all CALFED yield, that results from the CALFED alternatives. This yield increment is added to the No Action delivery from DWRSIM Run 472.

DWR provided estimates of end-of-month salinity at Clifton Court Forebay and Rock Slough for the water years 1976 to 1991 for Configurations 1A, 1C, 2B, 2D, 2E, 3A, 3B, and 3E. Configuration 1A salinity is believed to be representative for Configuration 1B, and Configuration 2B salinity is believed to be representative for Configuration 2A. All of these results are based on DWRSIM Run 472B hydrology, so monthly data on SWP exports under Run 472B hydrology at Banks Pumping Plant were obtained. Monthly salinities at Clifton Court Forebay were multiplied by monthly exports, and the products were summed and divided by total delivery over the period to obtain flow-weighted salinity. Salinity data from Rock Slough are used for CCWD. The annual salinity estimate in this case is the simple average of the monthly average salinities. Results are provided in Table 8.2.3-4.

In summary, analysis is possible for Configurations 1A, 1B, 1C, 2A, 2B, 2D, 2E, 3A, 3B, and 3E. Because deliveries and salinities for Configurations 1A and 1B are identical, nine analyses are conducted.

The salinity data account only for differences in salinity caused by the different geometry of Delta conveyance and intake configurations. Since the salinity data are all estimated from Run 472B hydrology, they do not account for any differences caused by different export amounts or storage configurations or the timing of exports or storage releases. Therefore, economic results account for only part of the impacts of the alternatives on salinity and salinity damages. Unfortunately, it is not known whether salinity damages would be more or less if storage and export amounts and timing were accounted for.

Water quality costs of these changes in water supply and its salinity were estimated using an economic model of salinity costs. The model is based on an earlier model of salinity damages for the entire lower Colorado River basin.

Alterna-tive	DWRSIM Run #	SCR Delivery (TBD)	Clifton Court TDS[a] (TBD)
No Action	472	1,597	269.02
1A, 1B	472	1,597	269.02
1C	510	1,707	281.43
2A	472B	1,632	180.55
2B	510	1,707	180.55
2D	498	1,661	181.86
2E	510	1,707	177.75
3A	475	1,650	Not available
3B	500	1,727	Not available
3E	500	1,727	125.95
3H through 3I	500	1,727	Not available

NOTE:
SCR = the South Coast Region
[a] All TDS estimates assume DWRSIM Run 472B hydrology.

Table 8.2.3-4. South Coast Region Delivery and Salinity Estimates Used for Salinity Damages Analysis

The revised model, obtained from Metropolitan Water District of Southern California, included all of the data required to run the model for the South Coast region and none of the data needed for the other regions included in the analysis. Data for the other regions were obtained from other sources. Bulletin 160-93 data were used to develop some data on demands and quantity of other (non-Delta) supplies. A survey of potentially affected providers was conducted, and responses provided useful information on demands, supplies, and salinity.

The model was configured to accept data for five other potentially affected regions: the South Lahontan, Contra Costa Water District, the South Bay, the San Joaquin Valley, and the Central Coast. The model obtained from Metropolitan with data for the South Coast region was altered to consider the CALFED alternatives in terms of quantity and salinity of SWP supplies for that region.

It is expected that economic analysis of changes in THM precursors and bromides under CALFED alternatives will be available in the future. Limited estimates of impacts based on modeled concentrations of these substances under CALFED alternatives are provided. The estimates were provided for Configurations 1A, 1C, 2B, 2D, 2E and 3E for the five intake locations used by M&I providers: Contra Costa Canal, North Bay Aqueduct, Tracy Pumping Plant, Clifton Court Forebay, and Los Vaqueros Intake.

Estimates for bromide were provided as an average for dry years 1985 and 1987 and as an average over 1985 through 1987, which includes the wet year 1986. For DOC, estimates were provided for the 1985 to 1987 period only. Some observers expect that economic benefits from reduction of THM precursors and bromides will exceed the benefits from salinity reductions.

Water Conservation. M&I providers are affected by the water conservation actions of others. They may finance other's water conservation actions, and others may participate in M&I water conservation in many ways. The Water Use Efficiency Program appendix provides general and specific state-wide assumptions, estimates of urban water use, and preliminary estimates of existing and future urban water conservation savings with and without the CALFED Water Use Efficiency Program.

In practice, each urban water provider would select conservation measures that are most economically feasible as part of their water supply and demand solutions.

Water conservation benefits are primarily water cost savings that depend on supply levels, and economic savings may also include end-user energy cost and wastewater treatment cost savings. Conservation costs include program costs and end-user costs. Utilities pay the program costs of conservation programs. End-users pay some additional costs for compliance with mandatory and voluntary provisions (e.g., costs of water-saving devices, time, and inconvenience).

The assessment of M&I water conservation economics is qualitative because quantitative information on the costs of water conservation is not available. Future impact analysis will consider quantitative information on these variables. Costs will be provided, and techniques will be developed to estimate benefits associated with water conservation.

8.2.3.2 Significance Criteria

The economic impacts are categorized as either adverse or beneficial. An economic impact might be considered adverse if its costs are expected to be larger than its benefits, and an impact might be considered beneficial if its benefits exceed its costs.

For purposes of this analysis, a substantial increase in water supply is considered beneficial. It does not imply that the net benefit is positive (that benefits exceed costs, or that the costs are less than alternative sources of supplies).

For water quality impacts, a reduction in TDS of Delta export water is considered beneficial if it is more than 20% of the No Action concentration and adverse if the increase is more than 20% of the No Action concentration. Impacts on disinfection by-product precursors were analyzed by inspection of bar graphs. Beneficial impacts are a reduction of approximately 20% or more of No Action levels.

8.2.3.3 Comparison of No Action Alternative to Existing Conditions

The No Action Alternative displays the state of water supply economics for a year 2020 level of development as opposed to the existing (current) conditions. The year 2020 level of development is expected to result in substantial increase in demand for M&I water because of the increase in population and urban water use over time.

Table 8.2.3-5 shows characteristics of M&I provider groups for the existing condition and the No Action Alternative. Water prices, costs, and estimates of year 2020 demands were obtained from DWR's Bulletin 160-93 and information provided by M&I water providers.

The No Action Alternative includes a number of projects that will reduce Delta export constraints, as discussed in the region-specific sections. Under existing conditions, there are times when Delta conveyance or pumping capacity limits exports. At other times, water is available in the Delta, and excess pumping capacity exists, but no immediate demand or storage space is available to utilize the water. New south-of-Delta Storage and Conveyance projects built between now and year 2020 will reduce the export constraints that are currently a limiting factor.

Delta Region. For purposes of preliminary impact analysis of water supply changes, economic impacts in CCWD are used to represent economic impacts of the alternatives in the Delta Region. The major reason for this assumption is that other M&I water supplies for most other providers in the Delta, for providers in Sacramento and Stockton, and for numerous small providers would not be affected by the alternatives in ways that can be measured at this time. In the following discussion, the term "Delta providers" is reserved for any and all providers actually located within the statutory Delta.

Table 8.2.3-5 shows some characteristics of CCWD in the existing and No Action conditions. Current demand is about 150,000 acre-feet, which includes 10,000 acre-feet of direct diversions by industrial customers. Retail cost to residential customers is currently about $700 per acre-foot and price, which does not include service charges, is about $450 per acre-foot. About one-third of demands are commercial and industrial. Demand is expected to rise to 175,000 acre-feet by year 2020, with slightly higher demands in dry years due to less natural precipitation and subsequent recharge of urban landscapes.

The No Action Alternative retail cost and price are higher than existing conditions because of conservation, CVPIA costs, and costs of new supplies. The average condition supply deficit is about 5,000 Acre-feet.

Condition Variable	Delta Region (CCWD)[a]	Bay Region (not CCWD)	Sacramento River Region	San Joaquin Region	Other SWP Service Areas
Existing Condition					
TAF average demand	150	707	566	337	3,784
TAF dry year demand	150	767	613	344	3,916
Typical retail cost, $/Af[b]	$700	$500-650	$100-300	$250-350	$450-1,350
Typical retail price, $/AF	$450	$350-500	$0-300	$100-150	$350-1,250
Percent industrial and commercial	31%	31%	41%	48%	26%
No Action Alternative					
TAF average demand	175	864	925	701	5,817
TAF dry year demand	178	960	1,003	710	6,032
Typical retail cost, $/Af[b]	$806	$575-700	$125-325	$275-350	$500-1,450
Typical retail price, $/AF	$502	$400-600	$0-250	$125-175	$420-1,350
Percent industrial and commercial	31%	31%	41%	48%	26%
Average cost of supplies[c]	$523	$152	$115	$207	$702
TAF shortage during drought	28	251	12	47	1,511
Mandatory conservation during drought	10	54	12	33	571
Average loss per AF from mandatory conservation[d]	$549	$451	$192	$195	$523
TAF supplies developed during drought	18	195	0	14	940
Average cost of drought supplies, $/AF	$876	$904	NA	$140	$729

NOTES:
a Includes major industrial direct diversions of 10,000 AF/yr.
b Average cost for residential customers including service charges. Costs and prices for providers with only CVP water are typically higher.
c Average cost of supplies avoided or saved (Bay Area) to achieve supply/demand balance in No Action.
d Net revenue loss plus consumer surplus loss.

Table 8.2.3-5. Characteristics of M&I Provider Regions, Existing Conditions and No Action Alternative

No Action projects that may reduce M&I supplies or that may increase costs relative to existing conditions include: The CVPIA dedication of 800,000 acre-feet of water for fish and wildlife and Level IV refuge supplies will reduce CCWD water supplies relative to existing conditions. The CVPIA also will affect other providers located within the statutory Delta, including the City of Tracy and potentially parts of Stockton and Sacramento.

No Action Alternative projects that are expected to increase supplies or reduce future costs, once completed, include Los Vaqueros Reservoir project. This project will improve the quality and reliability of CCWD M&I supplies.

Other Delta providers (not CCWD) are generally provided by larger water wholesalers, small districts, or individual wells. No specific actions have been identified that will affect them.

However, these small providers normally have plans and programs in place that will affect their future water supplies.

Bay Region. Table 8.2.3-5 shows some characteristics of the Bay Region in the existing and No Action conditions. Current demand is about 707,000 acre-feet. Retail cost to residential customers is currently about $500 to $650 per acre-foot; and price, which does not include service charges, is $350 to $500 per acre-feet. About one third of demands are commercial and industrial.

Demand is expected to rise to 864,000 acre-feet by year 2020, with slightly higher demands in dry years due to less recharge of urban landscapes. The No Action Alternative cost and price are higher than for existing conditions because of conservation, CVPIA restoration charge costs, and costs of new supplies. The region has a slight supply surplus in the average condition. The Bay Region has relatively unreliable supplies, so there is a substantial supply deficit in the dry condition.

This region is affected by any actions that affect the SWP or the CVP. No Action projects that may reduce M&I supplies or increase costs relative to existing conditions include: the CVPIA may reduce CVP supplies and increase costs for reasons described above.

No Action Alternative projects that are expected to increase supplies or reduce future costs, once completed, include: the CVPIA dedicated water may increase SWP supplies, depending on the amount of dedicated water that can be exported from the Delta.

Sacramento River Region. Table 8.2.3-5 shows some characteristics of the Sacramento River Region in the existing and No Action conditions. Current demand is about 566,000 acre-feet. Retail cost to residential customers is currently about $100 to $300 per acre-foot and variable price, which does not include service charges, is $0 to $300 per acre-foot. This price is zero in some areas because some use is not metered or priced volumetrically. About 40 % of demands are commercial and industrial.

Demand is expected to rise to 925,000 acre-feet by year 2020, with higher demands in dry years due to less recharge of urban landscapes. The No Action Alternative cost and price are higher than for existing conditions because of conservation and CVPIA restoration charge costs.

No Action projects that may reduce M&I supplies or increase costs relative to existing conditions include:

- The CVPIA dedicated water, may reduce CVP supplies and increase costs, for reasons described above.
- Interim reoperation of Folsom Reservoir, which could reduce M&I water supplies in the Sacramento area by dedicating more storage space to flood control.

San Joaquin Region. Table 8.2.3-5 shows some characteristics of the San Joaquin River Region group in the existing and No Action conditions. Current demand is about 337,000 acre-feet. Retail cost to residential customers is currently about $250 to $350 per acre-foot. Price, which does not include service charges, is $100 to $150 per acre-feet. About half the demands are commercial and industrial.

Demand is expected to double to 701,000 acre-feet by year 2020, with higher demands in dry years due to less recharge of urban landscapes. The No Action Alternative cost and price are higher than for existing conditions because of conservation and CVPIA costs.

No Action projects that may reduce M&I supplies or increase costs relative to existing conditions include: The CVPIA dedicated water may reduce CVP supplies and increase costs, for reasons described above.

No Action projects that are expected to increase supplies or reduce future costs, once completed, include:

- Monterey Agreement: This project revises the formula used to allocate SWP water, retires 45,000 acre-feet of agricultural entitlement, transfers 130,000 acre-feet of entitlement from agriculture to M&I, allows sale of the Kern Fan element of the Kern Water Bank to agricultural contractors, and changes allowable operations at Castaic Lake and Lake Perris.

- The CVPIA may increase SWP supplies for reasons described above.

- New Melones Conveyance Project: This project conveys water to Stockton East Water District and Central San Joaquin Water Conservation District for use near and within Stockton.

SWP and CVP Service Areas Outside the Central Valley. Table 8.2.3-5 shows some characteristics of the SWP and CVP Service Areas Outside of the Central Valley in the existing and No Action conditions. For M&I economics this area does not include any areas served solely by the CVP. The San Felipe Division of the CVP is included in the Bay Region.

Current demand is about 3,784,000 acre-feet in average years. Retail cost to residential customers is currently about $450 to $1,350 per acre-foot. The higher price is representative of the Central Coast area only. Price, which does not include service charges, is about $350 to $1,250 per acre-foot. About one quarter of the demands are commercial and industrial.

The year 2020 demand would rise to 5,817,000 acre-feet in average years. Demands are higher in dry years due to less recharge of urban landscapes. Without new supplies the region is expected to have a substantial supply deficit in year 2020, even in average years. The No Action Alternative cost and price are higher than for existing conditions because of conservation and costs of new supplies.

No Action projects that are expected to increase supplies or reduce future costs, once completed, include:

- The CVPIA may increase SWP supplies depending on the amount of dedicated water that can be exported out of the Delta.

- Coastal Aqueduct: This project will provide SWP water for M&I use in San Luis Obispo and Santa Barbara counties.

- The Monterey Agreement will change SWP water allocations for M&I use, for the reasons described above.

- The Metropolitan Water District's Eastside Reservoir Project: This project will provide emergency storage following an earthquake, supplies during drought, and supplies to meet peak summer demands.

- Semitropic Water Storage District (WSD) Groundwater Banking Project, which allows certain SWP entitlement holders to recharge and extract SWP water in the Semitropic WSD and will reduce overdraft and increase operational flexibility.

8.2.3.4 Comparison of Program Alternatives to No Action Alternatives

The impacts to urban economics resulting from the Storage and Conveyance program element will vary by alternative, as discussed below. Impacts to urban economics resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another

at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a regions, the program element is not discussed

Delta Region. Table 8.2.3-6 provides a summary of the impact analysis for the Delta Region. CCWD is used as a proxy for water supply and water quality analysis. It should be kept in mind that not all of CCWD is in the statutory Delta, and some urban water uses in the Delta are not served by CCWD. Water supply and water quality analysis are applied only to CCWD but other comments, especially those with respect to the CALFED programs, apply to all Delta providers. The operation of the Los Vaqueros intake has resulted in revised operations at Contra Costa Canal pumping plant number one and resulting water quality in Rock Slough.

Storage and Conveyance

Alternative 1. Because Configuration 1A would include no substantial changes in conveyance, no water supply benefits are expected. The potential impacts of relocating Delta intake structures include minor water quality improvements and cost effects. Preliminary DWRSIM study results suggest using No Action Alternative deliveries for Configuration 1A as well. There may be a small water supply increase from Configuration 1A, but it has not yet been measured. Preliminary water quality results are also the same as those provided for the No Action condition.

Preliminary DWRSIM study results suggest using No Action Alternative deliveries for Alternative 1B as well, so there is no measured effect on water supply. Preliminary water quality results are also the same as those provided for the No Action condition.

DWR has provided preliminary analysis of TDS for Configuration 1C. The salinity analysis does not consider differences in the amount of storage and in the amount and timing of exports between alternatives. Rather, only differences in conveyance and intake configurations are modeled using DWR Run 472B hydrology. The average of 12 monthly 1976 to 1991 average TDS levels is 294 ppm, not significantly different from the 300 ppm for the No Action condition.

Economic analysis of changes in salinity caused by changes in Delta conveyance configuration was conducted. Configurations 1A and 1B have water supplies and salinity identical to No Action levels, so there is no impact. In Configuration 1C, the annual economic benefit is not significant, estimated to be less than $1.0 million annually.

Limited information on bromide and organic carbon concentrations are available. For estimates at Contra Costa Intake and at Los Vaqueros Intake, Configuration 1C shows slightly lower concentrations of bromide and nearly identical concentrations of DOC in comparison to Configuration 1A. Configuration 1A should be similar to No Action. Based on this limited information, changes in DBP precursors in 1A and 1C should not be economically significant.

Configuration 1C would build on Configuration 1B by enlarging some Delta channels and by adding up to 5 million acre-feet (MAF) of new water storage facilities.

The amount and pattern of impacts from Configuration 1C would depend on how the new facilities are managed and operated and how costs are allocated. Configuration 1C should have little effect on water supplies for most Delta M&I providers because most providers do not receive CVP or SWP supplies. Conveyance and storage impacts on Delta M&I providers involve construction and displacement effects, as well as water supply and water quality.

Preliminary DWRSIM modeling studies and assumptions involving the allocation of increased yield imply that CCWD would gain about 9,200 acre-feet in average years and 11,700 acre-feet in a year during the critical period. These gains would provide for about 5% and 6% of demand in the average and dry year, respectively. The average year supplies are worth about $6 million relative to the cost of other supplies, and critical period yield is larger than the average.

Economic Parameter	Level by Alternative (millions of dollars per year)[a]													
	Existing Conditions	No Action[b]	Alternative 1[b]			Alternative 2[b]				Alternative 3[b]				
			1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
CALFED water supply costs[c]	0	0	No costs available											
Other water supply costs[c,d]	0	1.3	1.3	1.3	-3.2	0	-3.2	-1.4	-3.2	0	-3.9	-3.9	-3.9	-3.9
Total average costs[c]														
Drought conservation costs[e]	5	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Drought make-up supply costs[e]	0	15.4	15.4	15.4	8.4	15.4	8.4	11.9	8.4	13.2	4.1	4.1	4.1	4.1
Total drought costs[e]	5	21.1	21.1	21.1	14.1	21.1	14.1	17.6	14.1	18.9	9.8	9.8	9.8	9.8
Water quality costs[f]						S	S	S	S					
Water conservation costs														

NOTES:

CCWD impacts are used for water cost and water quality analysis.

[a] The lack of an entry does not mean that the impact is less than significant.

[b] Under the year 2020 development condition. Costs are additional costs to develop supplies or cost savings (-) from not needing available supplies.

[c] During a year of average delivery.

[d] Negative dollars in average years are cost savings from not needing available supplies.

[e] During a year of the critical period (1928 to 1934). Assumes supplies are allocated evenly over the period. Drought conservation costs include net revenue loss, consumer surplus loss and conservation program costs.

[f] See text. Significance calls relate only to differences in the configuration of Delta intake and conveyance facilities. An "S" denotes a probable benefit in some years.

Table 8.2.3-6. Summary of Impact Analysis for the Delta Region

Alternative 2. Preliminary DWRSIM modeling studies for Configuration 2A and assumptions involving yield allocation imply that CCWD would gain about 2,500 acre-feet in average years and 1,300 acre-feet in a year during the critical period. These gains would provide for about 1.4 % and 0.7 % of demand in the average and dry year, respectively. The average year supplies are worth about $2 million annually, but critical period yield is less than the average.

DWR has provided a preliminary analysis of TDS for Configurations 2A, 2D and 2E. The salinity analysis does not consider differences in the amount of storage and in the amount and timing of exports between alternatives. Rather, only differences in conveyance and intake configurations are modeled using DWR Run 472B hydrology. The average of 12 monthly 1976 to 1991 average TDS levels for Configuration 2A at Rock Slough is 166 ppm, almost half of the 300 ppm for the No Action condition.

For Configuration 2D, the average of 12 monthly 1976 to 1991 average TDS levels is 168 ppm, almost half of the 300 ppm for the No Action condition. For Configuration 2E, the average is 161 ppm.

Economic analysis of changes in CCWD salinity caused by changes in Delta conveyance configuration was conducted. Configurations 2A through 2E show salinity levels of 161 to 168 ppm as compared to the No Action condition of 300

ppm. Annual economic benefits are $13 to $14 million.

Limited information on bromide and organic carbon concentrations are available. For estimates at the Contra Costa intake and at Los Vaqueros intake, Configurations 2B, 2D and 2E show substantially lower concentrations of bromide than 1A. DOC concentrations, however, are slightly higher in Configurations 2B and 2D and slightly lower in 2E. Configuration 1A should be similar to No Action. Based on this limited information, reductions in bromides in Alternative 2 are significant. The economic consequences of this benefit cannot be estimated at this time.

Preliminary DWRSIM results and water supply benefits for Configuration 2B are the same as those discussed for Configuration 1C. Preliminary water quality benefits are the same as those discussed for Configuration 2A.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 2D imply that CCWD would gain about 5,300 acre-feet in average years and 6,100 acre-feet in a year during the critical period. These gains would provide for about 3.0 and 3.4 % of demand in the average and dry year, respectively. The average year supplies are worth about $4 million annually. Critical period yield is about the same as the average.

Alternative 3. Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 3A imply that CCWD would gain about 4,500 acre-feet in average years and 3,500 acre-feet in a year during the critical period. These gains would provide for about 1.4% and 2.0% of demand in the average and dry year, respectively. The average year supplies are worth about $3 million, but critical period yield is less than the average.

DWR has provided a preliminary analysis of TDS for Configurations 3A, 3B and 3E. Only differences in salinity due to different conveyance and intake configurations are modeled using DWR run 472B hydrology. The average of 12 monthly 1976 to 1991 average TDS levels for Configuration 3A is 317, not significantly more than the No Action level of 300.

For Configuration 3B, the average of 12 monthly 1976 to 1991 average TDS levels is 376, substantially more than the No Action level of 300. For Configuration 3E, the average of 12 monthly 1976 to 1991 average TDS levels is 294 ppm, not significantly different from the 300 ppm for the No Action condition.

Economic analysis of changes in salinity caused by changes in Delta conveyance configuration was conducted. Salinity in Configuration 3A is similar to but slightly more than No Action levels. Net economic costs are $2 million annually. In 3B, salinity is increased from 300 to 376 ppm, for a net economic cost of $8 million annually. In Configuration 3E, salinity is nearly identical to No Action levels, for a small net benefit of less than $1 million. The increase in salinity in Configuration 3B is considered a potentially significant adverse effect.

Limited information on bromide and organic carbon concentrations are available. For estimates at the Contra Costa intake and at Los Vaqueros intake, Configuration 3E shows somewhat lower concentrations of bromide than 1A, but DOC concentrations are somewhat higher than in Configuration 1A. Configuration 1A should be similar to No Action. Based on this limited information, bromide concentrations would be reduced somewhat, but DOC concentrations increased somewhat. No economic benefit or cost estimates are possible at this time.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 3B imply that CCWD would gain about 10,800 acre-feet in average years and 17,600 acre-feet in a year during the critical period. These gains would provide for about 6.2 % and 9.9 % of demand in the average and dry year, respectively. The average year supplies are worth about $8 million, and critical period yield is larger than the average.

No additional effects on M&I water use and costs are expected for Configurations 3E, 3H, or 3I in comparison to Configuration 3B.

Ecosystem Restoration. Ecosystem restoration actions are expected to have small or no effects on M&I water supplies and costs unless environmental flows reduce M&I supplies or M&I providers pay some of the costs of restoration. Water flows for fish and wildlife could increase M&I water supply if the water can be reused as M&I water exports or if the flows contribute to Delta water quality standards. Prices of water transfers may be increased by transfers for environmental purposes.

Some restoration actions may have beneficial effects on water quality in the Delta. Water quality improvements may occur through dilution caused by increased Delta inflow for restoration purposes, through reduced pollution loads caused by development and restoration of marsh and riparian habitats, and by increased immobilization of pollutants in these habitat types. Other water quality effects may be negative; for example, habitat restoration could increase organic carbon loads in Delta water, which would increase DBP levels in treated waters.

Restoration may reduce the uncertainty of M&I water supplies by enhancing recovery of special-status species. Because M&I providers acquire water supplies to protect against uncertainty, water supply costs could be reduced.

Water Quality. The actions would have benefits for M&I providers and their water customers with some offsetting costs. M&I costs are the M&I cost shares of the water quality measures. Currently, no monetary values have been estimated.

Water Use Efficiency. Generally, the Water Use Efficiency Program is intended to help local agencies make informed decisions selecting the next least costly increment of water supply to meet demand. Most actions in the Water Use Efficiency Program would be implemented by local agencies rather than CALFED. For M&I providers, the pace of implementation of urban conservation Best Management Practices (BMPs) would accelerate, and new practices would be added. Water reclamation (reuse) would be used to provide a larger share of supply, and policy measures to facilitate transfers would be developed.

The CALFED Water Use Efficiency Program appendix describes water conservation baseline levels and goals. Potential savings are described by region, but the Delta Region is not provided as a separate region.

Levee System Integrity. System integrity actions would have minor effects on Delta hydraulics and water quality. Very small effects on water supply and quality and associated costs are expected in normal conditions.

Bay Region. Table 8.2.3-7 provides a summary of the impact analysis for the Bay Region.

Storage and Conveyance

Alternative 1. Because Configuration 1A would include no additional storage or conveyance, no substantial water supply benefits are expected. Configuration 1B would include South Delta modifications to allow export pumps to operate at their physical capacity. For Configurations 1A and 1B, preliminary DWRSIM results suggest there will be no substantial change in water supply and water supply economics, and preliminary water quality analysis is the same as for the No Action condition.

DWR has provided a preliminary analysis of TDS for Configuration 1C. The salinity analysis does not consider differences in the amount of storage and in the amount and timing of exports between alternatives. Rather, only differences in conveyance and intake configurations are modeled using DWR Run 472B hydrology. Results, in terms of average salinity of exports from Clifton Court Forebay, are provided in Table 8.2.3-4.

Economic analysis of changes in salinity caused by changes in Delta conveyance configuration was conducted. Configurations 1A and 1B have water supplies and salinity identical to No Action levels, so there is no impact. In Configuration 1C, the average TDS of delivered water is increased slightly from 240 to 244 ppm, for an annual economic cost of $2 million.

Economic Parameter	Level by Alternative (millions of dollars per year)													
	Existing Conditions	No Action	Alternative 1			Alternative 2				Alternative 3				
			0	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
CALFED water supply costs	0	0	No costs available											
Other water supply costs	-14.0	-8.4	-8.4	-8.4	-15.0	-10.6	-15.0	-12.3	-15.0	-11.7	-16.1	-16.1	-16.1	-16.1
Total average costs														
Drought conservation costs	42.6	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3
Drought make-up supply costs	0	176.6	176.6	176.6	156.9	177.1	156.9	166.9	156.9	173.1	143.5	143.5	143.5	143.5
Total drought costs	42.6	202.9	202.9	202.9	183.2	203.4	183.2	193.2	183.2	199.4	169.8	169.8	169.8	169.8
Water quality costs						S	S	S	S			B		
Water conservation costs														

NOTE:
See notes from Table 8.2.3-6 .

Table 8.2.3-7. Summary of Impact Analysis for the Bay Region (CCWD not included)

Limited information on bromide and organic carbon concentrations are available. The South Bay obtains water from SWP and CVP south Delta exports. For estimates "at Clifton Ct" and "at Tracy PP," Configuration 1C shows slightly lower concentrations of bromide but slightly higher concentrations of DOC than 1A. Configuration 1A should be similar to No Action.

At the North Bay Aqueduct "at NBA intake," concentrations of bromides and DOC are about the same in Configuration 1C as compared to 1A.

Based on this limited information, changes in DBP precursors in 1A and 1C should not be economically significant.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 1C imply that the Bay Region would gain about 21,000 acre-feet per year in average years and 26,900 acre-feet per year in a year during the critical period. These gains would provide for about 2.4% and 2.8% of demand in the average and dry year, respectively. The average year supplies are worth $15 million annually in comparison to the costs of other supplies, and critical period yield is larger than the average.

Alternative 2. Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 2A imply that the Bay Region would gain about 6,800 acre-feet in average years and 3,000 acre-feet in a year during the critical period. These gains would provide for about 0.8% of demand in average and 0.3% in dry years. The average year supplies are worth about $5 million annually, but critical period yield is less than the average.

DWR has provided a preliminary analysis of TDS for Configurations 2A, 2D, and 2E. The salinity analysis does not consider differences in the amount of storage and in the amount and timing of exports between alternatives. Rather, only differences in conveyance and intake configurations are modeled using DWR Run 472B hydrology. Results, in terms of average salinity of exports from Clifton Court Forebay, are summarized in Table 8.2.3-4.

Configurations 2A, 2D and 2E all have lower TDS levels than No Action, both in source water and end user supplies. Economic analysis of changes in Bay Region salinity caused by changes in Delta conveyance configuration was conducted. Configurations 2A through 2E show end-user salinity levels of 212 to 213 ppm, as compared to the No Action condition of 240 ppm. Annual economic benefits are $11 to $12 million.

Limited information on bromide and organic carbon concentrations are available. The South Bay obtains water from SWP and CVP diversions in the south Delta. For estimates "at Tracy PP" and "at Clifton Ct," Configurations 2B, 2D and 2E show slightly lower concentrations of bromide and DOC than 1A. DOC estimates are slightly higher or the same. Configuration 1A should be similar to No Action. Based on this limited information, reductions or increases in DBP precursors in Alternative 2 do not appear to be economically significant.

At the North Bay Aqueduct "at NBA intake," concentrations of bromides and DOC are both increased slightly in Alternative 2. This may be an adverse effect, but no economic analysis is available.

Preliminary DWRSIM results and water supply benefits are the same for Configuration 2B as those discussed for Configuration 1C.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 2D imply that the Bay Region would gain about 12,100 acre-feet in average years and 13,900 acre-feet in a year during the critical period. These gains would provide for about 1.4% of demand in the average and dry year. The average year supplies are worth about $8 million annually, and critical period yield is more than the average.

Preliminary DWRSIM results and water supply benefits are the same for Configuration 2E as those discussed for Configuration 1C.

Alternative 3. Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 3A imply that the Bay Region would gain about 10,200 acre-feet per year in average years and 7,900 acre-feet per year in a year during the critical period. These gains would provide for about 1% of demand in the average and dry year. The average year supplies are worth roughly $7 million annually, but critical period yield is less than the average.

A preliminary analysis of salinity of water exported from Clifton Court Forebay is summarized in Table 8.2.3-4 for Configurations 3A, 3B, and 3E. In Configuration 3E, the concentration of TDS in water exported from Clifton Court Forebay would be reduced by over one half relative to the No Action Alternative.

Economic analysis of changes in salinity caused by changes in Delta conveyance configuration was conducted. Salinity of Configuration 3A end-user water deliveries is less saline (217 ppm) than No Action (240 ppm). Net economic benefits are $10 million annually. In 3B, salinity is reduced to 214 ppm for a net economic benefit of $11 million annually. In Configuration 3E, salinity is reduced to 195 ppm for a net benefit of $19 million in comparison to No Action.

Limited information on bromide and organic carbon concentrations are available. The South Bay obtains water from SWP and CVP diversions in the south Delta. For estimates "at Tracy PP" and "at Clifton Ct," Configuration 3E shows much lower concentrations of bromide and substantially lower concentrations of DOC than 1A. Configuration 1A should be similar to No Action. Based on this limited information, reductions in DBP precursors in the South Bay region in Alternative 3 appear to be economically significant.

At the North Bay Aqueduct "at NBA intake," concentrations of bromides and DOC are both increased in Alternative 3. This could be an adverse effect, but no economic analysis is available.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 3B imply that the Bay Region would gain about 24,900 acre-feet per year in average years and

40,300 acre-feet per year during the critical period. These gains would provide for about 2.9% and 4.2% of demand in the average and dry year, respectively. The average year supplies are worth about $17 million annually, and critical period yield is more than the average.

No additional effects on M&I water use and costs are expected for Configuration 3E in comparison to Configuration 3B.

No additional effects on M&I water use and costs are expected for Configuration 3H in comparison to Configuration 3B.

No additional effects on M&I water use and costs are expected for Configuration 3I in comparison to Configuration 3B.

Ecosystem Restoration. The nature and pattern of impacts are as described for the Delta Region, Alternative 1.

Water Quality. Water quality in the Bay Region could be affected by the quality of SWP and CVP exports as discussed below.

Water Use Efficiency and Water Transfers. The nature and pattern of impacts are as described for the Delta Region. Because the Bay Region generally has a high level of conservation, additional costs of conservation per unit of water saved may be higher than average. The Water Use Efficiency component technical appendix describes preliminary water conservation baseline levels and goals.

The potential for the Water Transfer Program to result in greater availability of water transfers could beneficially impact Bay Region water supply economics.

Sacramento River Region. The impact analysis for the Sacramento River Region is summarized in Table 8.2.3-8.

Storage and Conveyance

Alternative 1. Because Configuration 1A would include no additional storage or conveyance, no substantial water supply benefits are expected. Configuration 1B would include South Delta modifications to allow export pumps to operate at their capacity. For Configurations 1A and 1B, preliminary DWRSIM results suggest there will be no substantial change in water supply and water supply economics. There is also no effect on water quality since this region is upstream of the Delta.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 1C imply that the Sacramento River Region would gain about 6,200 acre-feet per year in average years and 7,900 acre-feet per year during the critical period. These gains would provide for about 0.7 % of demand in average and 0.8 % of demand in dry years. The average year supplies are worth roughly $2 million annually, but critical period yield is less than the average.

Alternative 2. Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 2A imply that the Sacramento River Region would gain about 2,000 acre-feet per year in average years and 900 acre-feet per year in a year during the critical period. These gains would provide for less than 0.1% of demand in the average and dry year. Some additional supplies, worth less than $1 million annually.

Preliminary DWRSIM results and water supply benefits are the same for Configuration 2B as those discussed for Configuration 1C.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 2D imply that the Sacramento River Region would gain about 3,600 acre-feet per year in average years and 4,100 acre-feet per year during the critical period. These gains would provide for less than 0.5% of demand in the average and dry year. The average year supplies are worth roughly $1 million annually, but critical period yield is more than the average.

Economic Parameter	Existing Conditions	No Action	Alternative 1			Alternative 2				Alternative 3				
			0	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
	Level by Alternative (millions of dollars per year)													
CALFED water supply costs	0	0	No costs available											
Other water supply costs	0	0.1	0.1	0.1	-1.2	0	-1.2	-0.9	-1.2	0	-1.4	-1.4	-1.4	-1.4
Total average costs														
Drought conservation costs	0	2.6	2.6	2.6	2.0	2.6	2.0	2.5	2.0	2.3	1.4	1.4	1.4	1.4
Drought make-up supply costs	1.9	0	0	0	0	0	0	0	0	0	0	0	0	0
Total drought costs	1.9	2.6	2.6	2.6	2.0	2.6	2.0	2.5	2.0	2..3	1.4	1.4	1.4	1.4
Water quality costs														
Water conservation costs														

NOTE:
See notes from Table 8.2.3-6.

Table 8.2.3-8. Summary of Impact Analysis for the Sacramento River Region

Preliminary DWRSIM results and water supply benefits are the same for Configuration 2E as those discussed for Configuration 1C.

Alternative 3. Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 3A imply that the Sacramento River Region would gain about 3,000 acre-feet per year in average years and 2,300 acre-feet per year during the critical period. These gains would provide for less than 0.5% of demands. The average year supplies are worth about $1 million annually, and critical period yield is less than the average.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 3B imply that the Sacramento River Region would gain about 7,300 acre-feet per year in average years and 11,900 acre-feet per year during the critical period. These gains would provide for about 1.0 and 1.2% of demand in the average and dry year, respectively. The average year supplies are worth roughly $3 million annually, and critical period yield is larger than the average.

No additional effects on M&I water use and costs are expected for Configurations 3E, 3H, or 3I in comparison to Configuration 3B.

Ecosystem Restoration. The Ecosystem Restoration Program would have no effect on M&I water economics in the Sacramento River Region, except as CVP water service contract supply amounts may be affected.

Water Quality. The Water Quality Program would have no effect on the Sacramento River Region, except as CVP water service contract supply amounts may be affected.

Water Use Efficiency and Water Transfers. The nature and pattern of impacts are as described for the Delta Region, Alternative 1. Because the Sacramento River Region generally has a low level of conservation under existing conditions, additional costs of conservation per unit of water saved may be lower than average. The Water Use Efficiency Program appendix describes preliminary water conservation baseline levels and goals.

San Joaquin River Region. Table 8.2.3-9 provides a summary of the impact assessment for the San Joaquin River Region.

Storage and Conveyance

Alternative 1. Any water quality improvements would affect the San Joaquin River Region through SWP and CVP exports.

Because Configuration 1A would include no additional storage or conveyance, no substantial water supply benefits are expected. Configuration 1B would include South Delta modifications to allow export pumps to operate at their physical capacity. For Configurations 1A and 1B, preliminary DWRSIM results suggest that there will be no substantial change in water supply.

Economic analysis of changes in salinity caused by changes in Delta conveyance configuration was conducted. Configurations 1A and 1B have water supplies and salinity identical to No Action levels, so there is no impact. In Configuration 1C, the average TDS of delivered water is increased from 315 to 325 for an annual economic cost of less than $1 million.

Limited information on bromide and organic carbon concentrations are available. For estimates "at Tracy PP," Configuration 1C shows slightly lower or the same concentrations of bromide and slightly higher concentrations of DOC than 1A. Configuration 1A should be similar to No Action. Based on this limited information, reductions in DBP precursors in 1A and 1C should not be economically significant.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 1C imply that the San Joaquin River Region would gain about 9,400 acre-feet per year in average years and 12,100 acre-feet per year during the critical period. These gains would provide for about 1.3% of demand in average years, and 1.7% of demand in dry years. The average year supplies are worth $4 million in comparison to the costs of other supplies and critical period yield is larger than the average.

Alternative 2. Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 2A imply that the San Joaquin River Region would gain about 3,000 acre-feet per year in average years and 1,400 acre-feet per year during the critical period. These gains would provide for less than 0.5 %of demand in the average and dry year. The average year supplies are worth roughly $1 million in comparison to the cost of other supplies, but critical period yield is less than the average.

Economic analysis of changes in San Joaquin Region salinity caused by changes in Delta conveyance configuration was conducted. Configurations 2A through 2E show end-user TDS levels of 237 to 240 ppm as compared to the No Action condition of 315 ppm, as an average over 16 years. Annual economic benefits are around $1 million.

Limited information on bromide and organic carbon concentrations are available. For estimates "at Tracy PP," Configurations 2B, 2D and 2E show somewhat lower concentrations of bromide but slightly higher levels of DOC than 1A. Configuration 1A should be similar to No Action. Based on this limited information, reductions in DBP precursors in Alternative 2 should not be economically significant.

Preliminary DWRSIM results and water supply benefits are the same for Configuration 2B as those discussed for Configuration 1C.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 2D imply that the San Joaquin River Region would gain about 5,400 acre-feet per year in average years and 6,300 acre-feet per year during the critical period. These gains would provide for about 0.8% of demand in average years, and 0.9% of demand in dry years. The average year supplies are worth roughly $2 million in comparison to the cost of other supplies and critical period yield is larger than the average.

	Level by Alternative (millions of dollars per year)													
			Alternative 1			Alternative 2				Alternative 3				
Economic Parameter	Existing Conditions	No Action	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
CALFED water supply costs	0	0	No costs available											
Other water supply costs	0	-1.7	-1.7	-1.7	-3.4	-2.2	-3.4	-2.6	-3.4	-2.5	-3.7	-3.7	-3.7	-3.7
Total average costs														
Drought conservation costs	0	7.0	7.0	7.0	6.6	7.0	6.6	6.8	6.6	7.0	6.4	6.4	6.4	6.4
Drought make-up supply costs	8.5	2.1	2.1	2.1	1.4	2.1	1.4	1.7	1.4	1.9	1.0	1.0	1.0	1.0
Total drought costs	8.5	9.1	9.1	9.1	8.0	9.1	8.0	8.5	8.0	8.9	7.4	7.4	7.4	7.4
Water quality costs						S	S	S	S			B		
Water conservation costs														

NOTE:
See notes from Table 8.2.3- 6.

Table 8.2.3-9. Summary of Impact Analysis for the San Joaquin River Region

Preliminary DWRSIM results and water supply benefits are the same for Configuration 2E as those discussed for Configuration 1C.

Alternative 3. Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 3A imply that the San Joaquin River Region would gain about 4,600 acre-feet per year in average years and 3,600 acre-feet per year during the critical period. These gains would provide for about 0.5% of demand in average years, and 0.7% in dry years. The average year supplies are worth $2 million in comparison to the cost of other supplies, but critical period yield is less than the average.

Economic analysis of changes in salinity caused by changes in the Delta conveyance configuration was conducted. Salinity of Configuration 3A water deliveries is less (250 ppm) than in No Action (315 ppm), as averaged annually over 16 years. Net economic benefits are $2 million annually. In Configuration 3B, salinity is reduced to 243 ppm, for a net economic benefit of $2 million annually. In Configuration 3E, salinity is reduced to 193 ppm for a net benefit of $3 million annually in comparison to No Action.

Limited information on bromide and organic carbon concentrations are available. For estimates "at Tracy PP," Configuration 3E shows much lower concentrations of bromide and substantially lower concentrations of DOC than Configuration 1A. Configuration 1A should be similar to No Action. Based on this limited information, reductions in DBP precursors in Configuration 3E should be economically significant.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 3B imply that the San Joaquin River Region would gain about 11,200 acre-feet per year in average years and 18,100 acre-feet per year during the critical period. These gains would provide for about 1.6 and 3.8% of demands in the average and dry year, respectively. The average year supplies are worth $4 million, and critical period yield is larger than the average.

No additional effects on M&I water use and costs are expected for Configuration 3E, 3H, or 3I in comparison to Configuration 3B.

Ecosystem Restoration. The nature and pattern of impacts are as described for the Delta Region, Alternative 1. Any water quality improvements would affect the San Joaquin River Region through SWP and CVP exports.

Water Quality. The nature and pattern of impacts are as described for the Delta Region, Alternative 1.

Water Use Efficiency and Water Transfers. The nature and pattern of impacts are as described for the Delta Region. Because the San Joaquin River Region generally has a lower than average level of conservation in the existing condition, additional costs of conservation per unit of water saved may be lower than average. The Water Use Efficiency Program appendix describes preliminary water conservation baseline levels and goals. No economic analysis of benefits or costs associated with this conservation is available.

The CALFED water transfer program will have impacts similar to the Bay Region.

SWP and CVP Service Areas Outside the Central Valley. Table 8.2.3-10 provides a summary of the impact analysis for the SWP and CVP Service Areas Outside the Central Valley.

Storage and Conveyance

Alternative 1. Because Configuration 1A would include no additional storage or conveyance, no substantial water supply benefits are expected. Configuration 1B would include South Delta modifications to allow export pumps to operate at their capacity. For Configurations 1A and 1B, preliminary DWRSIM results suggest that there will be no substantial change in water supply and water supply economics. Preliminary water quality results also suggest no quantifiable difference from No Action conditions.

DWR has provided a preliminary analysis of TDS of export water for Configuration 1C. The salinity analysis does not consider differences in the amount of storage and in the amount and timing of exports between alternatives. Rather, only differences in conveyance and intake configurations are modeled using DWR Run 472B hydrology. Results, in terms of average salinity of exports from Clifton Court Forebay, are summarized in Table 8.2.3-4.

Economic analysis of changes in salinity caused by changes in Delta conveyance configuration was conducted. Configurations 1A and 1B have water supplies and salinity identical to No Action levels, so there is no impact. In Configuration 1C, the average TDS of delivered water is increased from 1 to 2% depending on subregion, for an annual economic cost of $8 million. This adverse effect is not considered significant.

Limited information on bromide and organic carbon concentrations are available. For estimates "at Clifton Ct," Configuration 1C shows slightly lower concentrations of bromide but slightly higher DOC than in 1A. Configuration 1A should be similar to No Action. Based on this limited information, any change in DBP precursors in 1A and 1C should not be economically significant.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 1C imply that the SWP and CVP Service Areas Outside the Central Valley would gain about 138,100 acre-feet per year in average years and 176,700 acre-feet per year during the critical period. These gains would provide for about 2.4% of demand in average years and 4.5% of demand in dry years. The average year supplies are worth roughly $97 million in comparison to the cost of other supplies. During the critical period Configuration 1C would provide more water annually than during an average year.

DWR has estimated that, under least cost planning, each acre-foot of Configuration 1C annual average delivery would displace about .7 acre-feet of local fixed yield in the South Coast. With contingency transfers available, the ratio would improve to about .75.

Economic Parameter	Existing Conditions	No Action	Level by Alternative (millions of dollars per year)											
			Alternative 1			Alternative 2				Alternative 3				
			0	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
CALFED water supply costs	0	0	No costs available											
Other water supply costs	-91	601	601	601	466	556	466	521	466	534	442	442	442	442
Total average costs														
Drought conservation costs	63	310	310	310	310	310	310	310	310	310	310	310	310	310
Drought make-up supply costs	0	685	685	685	535	680	535	608	535	650	451	451	451	451
Total drought costs	63	995	995	995	845	990	845	918	845	960	761	761	761	761
Water quality costs					B	B	B	B	B			B		
Water conservation costs														

NOTE:
See notes from Table 8.2.3-6.

Table 8.2.3-10. Summary of Impact Analysis for Other SWP and CVP Service Areas Outside the Central Valley

Alternative 2. Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 2A imply that the SWP and CVP Service Areas Outside the Central Valley would gain about 44,600 acre-feet per year in average years and 19,800 acre-feet per year during the critical period. These gains would provide for about 0.8% of demand in average years, and 0.3 % in dry years. The average year supplies are worth roughly $31 million in comparison to the cost of other supplies. During the critical period, Configuration 2A would provide less water annually than during an average year.

DWR has estimated that, under least cost planning, each acre-foot of Configuration 2A annual average delivery would displace about .65 acre-feet of local fixed yield in the South Coast. With contingency transfers available, the ratio would improve to about .75.

DWR has provided preliminary analysis of TDS of exports for Configurations 2A, 2D and 2E. Results, in terms of average salinity of exports from Clifton Court Forebay, are summarized in Table 8.2.3-4.

Economic analysis of changes in SWP and CVP Service Areas Outside of the Central Valley salinity caused by changes in Delta conveyance configuration was conducted. Configurations 2A through 2E show end-user salinity levels reduced by 9 to 25%, as compared to the No Action condition, depending on subregion. Annual economic benefits are $112 to $122 million.

Limited information on bromide and organic carbon concentrations are available. For estimates "at Clifton Ct," Configurations 2B, 2D and 2E show somewhat lower concentrations of bromide and slightly higher concentrations of DOC than 1A. Configuration 1A should be similar to No Action. Based on this limited information, reductions in bromides in Alternative 2 may be economically significant, but increases in DOC are probably not significant. No economic analysis is available.

Preliminary DWRSIM results and water supply benefits are the same for Configuration 2B as those discussed for Configuration 1C.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 2D imply that the SWP and CVP Service Areas Outside the Central Valley would gain about 79,300 acre-feet per year in average years and 91,700 acre-feet per year during the critical period. These gains would provide for about 1.4% of demand in average years and 1.5% of demand in dry years. The average year supplies are worth roughly $56 million. During the critical period Configuration 2D would provide slightly more water annually than during an average year.

DWR has estimated that, under least cost planning, each acre-foot of Configuration 2D annual average delivery would displace about .6 acre-feet of local fixed yield in the South Coast. With contingency transfers available, the ratio would be about the same.

Preliminary DWRSIM results and water supply benefits are the same for Configuration 2E as those discussed for Configuration 1C.

Alternative 3. Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 3A imply that the SWP and CVP Service Areas Outside the Central Valley would gain about 66,900 acre-feet per year in average years and 52,100 acre-feet per year during the critical period. These gains would provide for about 1.2% of demand in average years and 0.9% in dry years. The average year supplies are worth roughly $47 million annually. During the critical period, Configuration 3A would provide less water annually than during an average year.

DWR has estimated that, under least cost planning, each acre-foot of Configuration 3A annual average delivery would displace about .6 acre-feet of local fixed yield in the South Coast. With contingency transfers available, the ratio would improve to about .7.

DWR has provided preliminary analysis of TDS of exports for Configurations 3A, 3B and 3E. Results, in terms of average salinity of exports from Clifton Court Forebay, were summarized in Table 8.2.3-4.

Economic analysis of changes in salinity caused by changes in Delta conveyance configuration was conducted. Salinity of Configuration 3A water deliveries to end-users is reduced by 7 to 21 %, depending on subregion, in comparison to No Action. Net economic benefits are about $100 million annually. In 3B, salinity is reduced by 8 to 24% for a net economic benefit of $115 million annually. In Configuration 3C, salinity is reduced by 14 to 41% for a net benefit of $180 million annually in comparison to No Action.

Limited information on bromide and organic carbon concentrations are available. For estimates "at Clifton Court Forebay," Configuration 3E shows much lower concentrations of bromide and substantially lower concentrations of DOC than Configuration 1A. Configuration 1A should be similar to No Action. Based on this limited information, reductions in DBP precursors in Configuration 3E should be economically significant, but no quantitative analysis is available.

Preliminary DWRSIM modeling studies and yield allocation assumptions for Configuration 3B imply that the SWP and CVP Service Areas Outside the Central Valley Region would gain about 163,600 acre-feet per year in average years and 265,200 acre-feet per year during the critical period. These gains would provide for about 2.8% of demand in average years, and 4.4% in dry years. The SWP and CVP Service Areas Outside the Central Valley Region in the year 2020 average condition would require new water to meet demands, so the average year supplies are worth roughly $115 million annually. During the critical period, Configuration 3B would provide more water annually than during an average year.

DWR has estimated that, under least cost planning, each acre-foot of Configuration 3B annual average delivery would displace about .7 acre-feet of local fixed yield in the South Coast. With contingency transfers available, the ratio would be about the same.

No additional effects on M&I water use and costs are expected for Configuration 3E in comparison to Configuration 3B.

No additional effects on M&I water use and costs are expected for Configuration 3H in comparison to Configuration 3B.

No additional effects on M&I water use and costs are expected for Configuration 3I in comparison to Configuration 3B.

Ecosystem Restoration. The nature and pattern of impacts are as described for the Delta Region, Alternative 1.

Water Quality. There is no water quality program targeted to these regions because none of the regions' watersheds drain to the Bay or Delta. However, water quality improvements in the Delta would affect the CVP and SWP Service Areas Outside the Central Valley through SWP exports. Costs and cost shares are currently unknown.

Water Use Efficiency and Water Transfers. The nature and pattern of impacts are as described for the Delta Region. Because the SWP and CVP Service Areas Outside the Central Valley generally have a higher than average existing level of conservation, additional costs of conservation per unit of water saved may be higher than average. CALFED Water Use Efficiency component technical appendix describes preliminary water conservation baseline levels and goals. The economic benefits or costs of this conservation have not been considered in this analysis.

The CALFED water transfer program will have impacts similar to those described for the Bay Region.

8.2.3.5 Comparison of Program Alternatives to Existing Conditions

Comparison of Program alternatives to existing conditions indicates that:

- The potentially significant adverse socioeconomic effects identified when comparing to the No Action Alternative are still significant when comparing to existing conditions.

- CALFED is proposing actions which could cause some economic disruption of urban communities. Under No Action urban development would continue and some adverse socioeconomic effects to existing communities could occur as result of that development. Adverse impacts resulting from the CALFED alternatives would be additive with other urban development effects that would occur under No Action. The combination of CALFED effects with other development effects represent the total changes with respect to existing conditions.

- The water supply reliability actions from the Water Use Efficiency, Water Quality and Storage and Conveyance program elements could improve the availability and quality of water for urban purposes which could result in some socioeconomic benefits above the existing condition baseline. While CALFED is expecting an overall improvement in water supply reliability for urban communities relative to the No Action Alternative, there is still the potential that the benefits provided by the Program alternatives could be insufficient to offset future conditions and the water supply reliability could be worse than currently exists.

8.2.3.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

This analysis has identified some potentially significant adverse impacts involving water quality. The hydrology and hydrodynamic analyses on which these findings are based are preliminary and subject to change. Mitigation strategies can be developed once these results are confirmed. Potential mitigation strategies include

relocation of water supply intakes, water treatment, alternative water supplies, or changes in operations.

8.2.3.7 Potentially Significant Unavoidable Impacts

This analysis has identified no potentially significant unavoidable impacts.

8.2.4 Environmental Consequences: Utilities and Public Services

8.2.4.1 Assessment Methods

Impacts to the following components of existing infrastructure are evaluated by comparing the spatial distribution of infrastructure to areas of potential construction or land-use changes that would result in displacement or modification of the existing infrastructure:

- Electrical facilities and supply;
- Water conveyance facilities;
- Natural gas fields and storage reservoirs;
- Underground pipelines;
- Communication facilities; and
- Police, fire, and emergency services.

For the purpose of this section, "infrastructure" refers to all the elements presented above, except police, fire, and emergency services.

Because specific sites have not been selected for development of storage and conveyance facilities, any locations discussed are examples to illustrate the type of facility being considered.

In the assessment process, the following related resource analyses may be utilized:

- Land use;
- Power production economics;
- Water facilities and operations;
- Recreation resources;
- Regional economics; and
- Flood control.

Due to the programmatic level of detail for the project alternatives, the impacts presented in this section are general in nature. Additional information would be needed for more specific conclusions.

8.2.4.2 Significance Criteria

To determine the thresholds at which impacts become significant, draft threshold criteria have been developed.

Significance criteria for identifying impacts to utilities and public services are based on the displacement or modification of facilities and services due to either water-related facility development or economic stimulation. The facilities and services which may be impacted include the infrastructure discussed above and police, fire, and other emergency services.

Threshold criteria associated with water-related facility development include:

- Demand for utilities that exceeds the capacity and outputs of existing infrastructure and requires new infrastructure or utility facilities;
- Demand for public services that substantially exceeds the capacity of public service agencies;
- Intersection with major infrastructure components requiring relocation of the components; and
- Increase in the anticipated risk of gas line rupture, especially to gas lines crossing exterior levees.

8.2.4.3 Comparison of No Action Alternative to Existing Conditions

This alternative would have potentially significant adverse impacts on utilities and public services.

Delta Region

The year 2020 level of development will result in an increase in population throughout the state, including the Delta Region. Population increases could require construction of additional power-generating facilities and additions or reconfiguration of the existing power distribution grid (such as transmission lines, substations). The projected population increase would likely require public services substantially exceeding the capacity of existing public service providers, resulting in a potentially significant adverse impact.

Development of water supply projects could have indirect effects on the Delta Region. The Delta is a hub for statewide water supply development. No Action Alternative water supply developments outside the Delta Region could necessitate development of in-Delta infrastructure (for example, greater water conveyance capacity). This could, in turn, require development of utility capacity and power distribution grids to accommodate greater pumping demands.

Presently, more power is used statewide to convey water than is generated by hydroelectric facilities. Water supply developments could have a positive or a negative effect on the current power-load deficit.

Bay and Sacramento River Regions

The effects of population growth discussed above for the Delta Region are applicable to the Bay and Sacramento River regions.

San Joaquin River Region

The potential effects of population growth and water supply development discussed for the Delta Region are relevant to the San Joaquin River Region. Additionally, the Kern Water Bank would increase the demand for pumping, in turn increasing the demand for power.

Land retirement could have potentially significant impacts. Replacement by either urban or industrial development would likely increase power demands (in terms of electricity and infrastructure). New generating facilities and distribution infrastructure could be required. Conversion to recreational use could result in a greater demand for public services, possibly exceeding existing capacity.

SWP and CVP Service Areas Outside the Central Valley

The effects of population growth and water supply development discussed above for the Delta Region are likely to be applicable to these areas.

Development of the coastal aqueduct could spur M&I development requiring construction of additional power-generating facilities and other infrastructure.

8.2.4.4 Comparison of Program Alternatives to No Action Alternative

The impacts to utilities and public services resulting from the Storage and Conveyance program element will vary by alternatives, as discussed below. Impacts to utilities and public services resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternatives to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternatives. In those cases where no environmental impacts have been associated with a program element within a regions, the program element is not discussed.

Delta Region

Storage and Conveyance

Alternative 1. Under Alternative 1, reoperation of pumps for conveyance at full capacity is likely to require additional electrical power. Fisheries improvements could boost recreational activities, which in turn could require additional public services. However, neither of these outcomes would be expected to require services in excess of existing capacity.

Alternative 2. Implementing Configurations 2A and 2B could impact some minor infrastructure, depending on how improvements would be constructed. Minor electric transmission lines could be displaced by river widening or improving through-Delta channels. Impacts to major infrastructure would not be expected. Significant impacts are not likely.

Implementing Configuration 2D could affect existing infrastructure. Floodways, setback levees, intake structures, and removal of a portion of the Bouldin Island levee could displace infrastructure. Power transmission lines may need to be relocated, depending on how new developments would be constructed. Relocation of major transmission lines would be a potential significant impact.

Implementing Configuration 2E could involve constructing setback levees, developing interties and intake structures, and flooding areas to create habitat. Infrastructure is likely to be affected. Other potential infrastructure impacts are likely to be similar to those described for Configuration 2D.

Alternative 3. Possible direct effects (Configurations 3B, 3E, and 3I) could include displacement and relocation of power lines. Major transmission lines, gas fields, and storage areas are not likely to be affected.

While public services would likely be affected by Alternative 3 development, demand likely would be within existing capacity. Minor effects in terms of economic growth stimulation or downward pressure are also possible. For additional details on both of these subjects, see discussion for Alternative 2.

Conveyance components for Configurations 3A and 3B are the same as those proposed for Configurations 2A and 2B, with the exception of the isolated facilities/intakes and open channel proposed in Alternative 3. Hence, impacts to infrastructure are expected to be similar to those for Configurations 2A and 2B.

The additional impacts associated with the open-channel isolated facility include the crossing of minor infrastructure, including power lines and gas pipelines.

Implementing Configuration 3H would have effects similar to those described for Configuration 2D.

Under Configuration 3I, power lines would be intersected by proposed conveyance channels. This would be considered a potentially significant adverse impact.

Levee System Integrity. Implementation of the Levee System Integrity Program under all alternatives may require the displacement or modification of utility infrastructure, including electric transmission lines. Such effects could result from the modification and relocation of existing levees. These actions are not expected to affect major infrastructure components.

Bay Region

The program will not result in any affects in the Bay Region.

Sacramento and San Joaquin River Regions

Storage and Conveyance. The potential impacts associated with the development of groundwater storage include increased energy consumption for pumping and relocation of minor infrastructure.

For additional upstream surface storage, several types of actions on the Sacramento River tributaries are under consideration, such as raising existing dams to increase capacity of existing reservoirs and developing off-stream or new on-stream storage.

Surface storage projects under consideration could have a range of significant impacts to existing utilities and public services. The majority of impacts would be related to hydropower output modifications, storage facility construction phases, and the potential stimulation of M&I development.

Greater storage could also facilitate habitat rehabilitation and perhaps recreation by increasing the availability of flows necessary to develop these activities. Although the demand for public services is likely to increase under such circumstances, it is not likely to exceed existing capacity.

During construction of storage facilities, infrastructure could be displaced. New structures could require relocating or modifying transmission lines and other major infrastructure, resulting in potential significant adverse impacts.

Development of M&I facilities, because of opportunities created through water-related facilities, is possible but uncertain at the programmatic level. The potential effects of development include increased demand for utilities and public services.

SWP and CVP Service Areas Outside the Central Valley

Storage and Conveyance. Although storage facilities are not proposed for areas outside the Central Valley, indirect effects to utilities are possible because electric power, possibly generated in these areas, is used to convey water throughout different areas of the state and because the operation of additional water storage facilities and conveyance infrastructure could affect the amount of power required and the amount available.

The impacts of the following program elements are common to all alternatives and all regions.

All Regions

Ecosystem Restoration. Implementation of the Ecosystem Restoration Program could result in the following potential impacts to utilities and public services:

- Increased electricity requirements for water pumping;
- Relocation or modification of electrical transmission lines and substations;
- Relocation or modification of gas pipelines and water conveyance infrastructure;
- Additional public services required for new parks and refuges; and
- Increases in recreational fishing stocks and waterfowl, possibly resulting in a greater number of fisher/hunter days per year and an increase in the need for some public services.

Modifications and realignment of existing major utility infrastructure would be considered potentially significant adverse impacts. These changes are not expected to require construction or development of additional utility capacity. Program actions are not expected to require public services in excess of current regional capacity.

Water Quality. Implementation of the Water Quality Program could result in the following activities and consequences, all of which could impact utilities and public services:

- Relocation of water supply intakes and conveyance infrastructure;
- Upgrades to treatment processes, especially in treatment plants;
- Land conversion to avoid creation of salt drainage;
- Construction of Delta barriers;
- Upgrades to stormwater systems; and
- Installation of treatment facilities requiring unknown quantities of electricity, and water conveyance infrastructure.

Increased utility demands are possible but are expected to be met by existing capacity. The program would be expected to increase recreational use by reducing pollutant loadings (lower toxic levels for humans and wildlife, for example); any increase in the need for public services is not likely to exceed existing capacity.

Water Use Efficiency and Water Transfers. Because the Water Use Efficiency Program is policy-based and highly variable in outcome, effects to utilities and public services are difficult to foresee. However, given that actions are generally driven by incentives and are extremely unlikely to require additional utility or public service capacity, impacts to utility infrastructure or public services would not be expected. Potential decreases in water usage would reduce the amount of water conveyed, thus reducing the power demand. This would be a beneficial impact to utilities. However, increased levels of water recycling could result in increased treatment processes and greater energy requirements. In addition, distribution systems would be needed to provide recycled water to potential customers.

8.2.4.5 Comparison of Program Alternatives to Existing Conditions

Comparison of Program Alternatives to existing conditions indicates that:

- All potentially significant adverse impacts that were identified when compared to the No Action Alternative would still be considered significant when compared to existing conditions.
- No additional significant environmental consequences have been identified when Program effects are compared to existing conditions as opposed to No Action.
- The beneficial effects of the Program would still be beneficial when compared to existing conditions.

8.2.4.7 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

To reduce the amount of energy required to operate the water storage and conveyance facilities, the facilities could be designed to minimize the amount of energy required for their operation and to maximize the amount of energy created through their operation. This reduction in energy requirements would reduce the need to construct additional power-generating facilities.

The potential increase in the demand for public services substantially above the existing capacity of public service agencies could be mitigated by hiring additional personnel and acquiring additional equipment.

Relocation of major infrastructure components could be mitigated by siting project facilities to avoid existing infrastructure. If this is not possible, these facilities could be designed to avoid or minimize their effect on existing infrastructure. This could include constructing overpasses, small bridges, or other structures to accommodate existing infrastructure.

8.2.4.8 Potentially Significant Unavoidable Impacts

All alternatives would have the potential to physically divide or disrupt an established community in the Delta Region. Likewise, there could be significant impacts to developed land use in the Sacramento River and San Joaquin River regions from short-term construction. No significant urban land uses are expected in the Bay and SWP and CVP Service Areas Outside the Central Valley. No significant economic impacts are expected in any of the regions for any alternative.

While the design and operation of storage facilities may reduce energy requirements, they would likely not avoid the construction of additional power-generating facilities. This significant adverse impact would be unavoidable.

If mitigation measures are not successful in avoiding the relocation of major infrastructure components, the significant adverse impact would be unavoidable.

8.3 RECREATIONAL RESOURCES

Summary

Implementing any of the CALFED alternatives would potentially result in a gain in open space/habitat uses, benefitting recreational opportunities. Additional opportunities would be obtained with the creation of new storage facilities, such as reservoirs. While storage facilities provide water-based recreation, they could displace existing shoreline recreational facilities, requiring them to be relocated outside of the new inundation zone. Potential impacts of program elements are summarized by region in Table 8.3-1.

No Action Alternative. The No Action Alternative would result in potentially significant impacts to recreation due to increased use from an increased population. Within the Sacramento River Region, impacts would vary depending on changes in flow regimes.

Storage and Conveyance. Raising the height of dams in the Sacramento River and/or San Joaquin River regions to increase storage capacities in existing reservoirs would increase water surface elevations, thereby inundating new land areas around the reservoir perimeters. There could be significant adverse land use impacts to existing shoreline recreational facilities. New surface storage facilities could permanently modify or eliminate existing recreational uses in the reservoir site and surrounding area, but would provide new recreational opportunities.

The reader is referred to Chapter 5, Sections 5.2.2, 5.2.3, 5.2.4, and 5.2.5 for a more detailed discussion on the extent of acreage potentially impacted.

Short-term impacts to recreation would result during the construction periods for new storage and conveyance facilities. Impacts would result from facilities that would be closed to users during the construction period and from noise and visually disruptive activity that would diminish the recreational experience.

Any recreation facilities displaced due to construction of storage and conveyance projects in the Sacramento River and San Joaquin River regions could adversely impact recreation resources and result in loss of recreation-related jobs. The severity of the loss of jobs would

Impacts to Recreational Resources

- **No Action Alternative.** As the population increases, existing recreational resources would be stressed.
- **Storage & Conveyance.** New storage and conveyance facilities would create recreational opportunities while displacing some existing opportunities. Development of conveyance facilities could permanently close or displace recreation facilities in the eastern portion of the Delta. These closures or displacements could result in a significant impact to recreational opportunities and recreation employment.
- **Ecosystem Restoration Program** could convert existing open space uses in the Delta, Sacramento River, and San Joaquin River regions. Several key fishery species would benefit, improving commercial and sport fishing opportunities in the Bay, Delta, San Joaquin River, and Sacramento River regions, resulting in increased jobs.
- **Levee System Integrity Program** may result in beneficial impacts by creating beach slopes associated with new levees and reduced exposure to flooding for existing recreation facilities. Some facilities could be closed or relocated depending on the location of the levee improvements.

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IMPACT ISSUES	Alternative 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Inconsistency with Local and Regional Plans	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Recreational Opportunities along New Conveyance Facilities	□	□	□	□	□	□	□	+	+	+	+	+
Increase in Population Without an Appropriately-Sized Recreation Base	+	+	+	◗	◗	◗	◗	◗	●	●	●	●
Increase in Wildlife Viewing, Fishing, and Hunting Opportunities Associated with Habitat Restoration, "Stressor Elimination," and Species Recovery	+	+	+	+	+	+	+	+	+	+	+	+
Loss of Recreational Areas/Open Space to Habitat Restoration	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Increased Access to Waterfront Land	+	+	+	+	+	+	+	+	+	+	+	+
Closure of Recreation Areas During Construction	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Decreased Circulation and Cruising Patterns from Temporary, Seasonal or Permanent Closure of Delta Waterways	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Reduction in Boat Traffic and Speed in Wake Damage Areas	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
More Stringent Regulation of Boat Discharges	+	+	+	+	+	+	+	+	+	+	+	+
Reductions in Waterfowl Habitat from Water Use Efficiency Program and Water Transfers	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Impact of Improved Water Quality on Water Contact Recreation	+	+	+	+	+	+	+	+	+	+	+	+
Impact of Water Transfers to Instream and Reservoir Recreation (e.g., Fishing)	+	+	+	+	+	+	+	+	+	+	+	+

Table 8.3-1. Summary of Environmental Impacts Related to Recreational Resources (page 1 of 4)

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IMPACT ISSUES	Alternative 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	'3E	3H	3I
Reduced Risk to Land from Levee Breeching	+	+	+	+	+	+	+	+	+	+	+	+
Alteration of Existing Flows Related to New Operation and Storage Facilities	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Modifications in the South Delta and Improvements to the CVP and SWP	+	+	+	◗	◗	◗	◗	◗	◗	◗	◗	◗
Recreation and Fishing Employment and Revenue	o	o	o	o	o	+	+	◗	◗	◗	◗	◗
Bay Region												
Inconsistency with Local and Regional Plans	□	□	□	□	□	□	□	□	□	□	□	□
Increase in Population Without an Appropriately-Sized Recreation Base	+	+	+	◗	◗	◗	◗	+	+	+	+	+
Increase in Wildlife Viewing, Fishing, and Hunting Opportunities Associated with Habitat Restoration, "Stressor Elimination," and Species Recovery	+	+	+	+	+	+	+	+	+	+	+	+
Loss of Recreational Areas/Open Space to Habitat Restoration	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Creation of New Shorelines	+	+	+	+	+	+	+	+	+	+	+	+
Closure of Recreation Areas During Construction	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Increased Sport Fishing Opportunities	+	+	+	+	+	+	+	+	+	+	+	+
Recreation and Fishing Employment and Revenue	o	o	o	o	o	+	+	◗	◗	◗	◗	◗
Sacramento River Region												
Inconsistency with Local and Regional Plans	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Recreational Opportunities at New Storage Facilities	□	□	+	□	+	□	+	□	+	+	+	+
Storage and Drawdown Impacts	◗	◗	◗	◗	◗	◗	◗	o	o	o	o	o

Table 8.3-1. Summary of Environmental Impacts Related to Recreational Resources (page 2 of 4)

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IMPACT ISSUES	Alternative 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Recovery of Fish Populations	+	+	+	+	+	+	+	+	+	+	+	+
Increased Sportfishing Opportunities	+	+	+	+	+	+	+	+	+	+	+	+
Increase in Spending and User Benefits	+	+	+	+	+	+	+	+	+	+	+	+
Temporary Closure of Recreation Areas due to Construction	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Change in Water Temperature	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Alteration of Downstream Flows	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Recreation and Fishing Employment and Revenue	○	○	○	○	○	◗	◗	◗	◗	◗	◗	◗
San Joaquin River Region												
Inconsistency with Local and Regional Plans	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Increase in Available Land	+	+	+	□	□	□	□	○	○	○	○	○
Recovery of Fish Populations	+	+	+	+	+	+	+	+	+	+	+	+
Increased Sportfishing Opportunities	+	+	+	+	+	+	+	+	+	+	+	+
Increase in Spending and User Benefits	+	+	+	+	+	+	+	+	+	+	+	+
Temporary Closure of Recreation Areas due to Construction	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Change in Water Temperature	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Alteration of Downstream Flows	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Restoration of Habitat for Wildlife Viewing	+	+	+	+	+	+	+	+	+	+	+	+
Recreation and Fishing Employment and Revenue	○	○	○	○	○	◗	◗	◗	◗	◗	◗	◗
Recreational Opportunities at New Storage Facilities	□	□	+	□	+	□	+	□	+	+	+	+

Table 8.3-1. Summary of Environmental Impacts Related to Recreational Resources (page 3 of 4)

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IMPACT ISSUES	Alternative 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
SWP and CVP Service Areas Outside the Central Valley												
Inconsistency with Local and Regional Plans	□	□	□	□	□	□	□	□	□	□	□	□
Improved Water Quality	+	+	+	+	+	+	+	+	+	+	+	+
Recreation and Fishing Employment and Revenue	U	U	U	U	U	U	U	U	U	U	U	U

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:
Level of Impact

- ● = Significant and unavoidable
- ◗ = Significant and mitigable
- o = Less than significant
- □ = None
- + = Beneficial
- U = Unknown

Table 8.3-1. Summary of Environmental Impacts Related to Recreational Opportunities and Economics (page 4 of 4)

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depend on the magnitude of loss and the extent of mitigation efforts.

Ecosystem Restoration. The Ecosystem Restoration Program would improve various areas of the Delta for habitat and ecosystem values. Converting open space land in these three regions for habitat and ecosystem restoration uses increases potential recreational use from increased opportunities for hunting, wildlife viewing, and sport fishing. This program is not anticipated to have a significant effect on recreational land uses in the other regions.

Inundation from the Ecosystem Restoration Program should result in improved fishery populations; restoration and creation of riparian habitat, aquatic habitat, and wetland habitat should provide increased opportunities for shoreline fishing, hunting, and wildlife viewing. Although the overall impact of habitat restoration would be positive, restoration activities may result in some adverse impacts to recreation, primarily during construction activities.

Implementation of ecosystem restoration would result in the elimination of some jobs but would probably create others.

Reallocation of water supplies from agricultural uses to fish and wildlife habitat uses may result in improved recreation opportunities and additional income generated from hunters, birders, and sport fishermen visiting the wildlife refuges and streams. In addition, there could be improvements to aesthetic values in rivers and refuge lands and environmental benefits resulting in an increase in recreation jobs that is difficult to quantify at this programmatic level.

Water Quality. Improved water quality may increase the recreation value of the Delta and SWP or CVP canals and reservoirs receiving exported water.

Levee System Integrity. Depending on the location of new levees, existing recreation facilities may be displaced, resulting in a loss of recreation opportunities and a potential loss of recreation jobs. These effects may be either temporary during construction or permanent. The impacts are expected to be less than significant. Over the long term, improved levees would protect existing recreation facilities and create sloped beaches on new levee improvements.

Water Use Efficiency. The Water Use Efficiency Program may have a beneficial, though minor, impact to instream and reservoir recreation. Reduced diversions may provide for potential reoperation of some reservoir releases.

Some adverse impacts may occur if incidental habitat areas lose their source of water as agricultural water use efficiency improves. Additionally, some water use efficiency measures may reduce the amount of agricultural lands flooded during winter months to provide waterfowl habitat, especially in the Sacramento River Region.

Water Transfers. Depending on the timing, magnitude, source of water, and pathway, water transfers can also provide beneficial recreational impacts.

Coordinated Watershed Management. Potential watershed activities would be compatible with applicable environmental and land use plans and policies in their affected jurisdiction, potentially increasing recreational opportunities.

8.3.1 Affected Environment/ Existing Conditions

Recreation resources in the CALFED study area include water-based and land-based activities and their supporting infrastructures. This section describes the existing recreational resources that may be affected or enhanced by CALFED programmatic actions. The discussion is organized around two broad issue areas:

- Recreational opportunities and
- Recreation economics.

8.3.1.1 Delta Region

Historical Perspective

Recreational Opportunities. Prior to the 1850s, the Delta was an extensive tidal marsh that was subject to seasonal flooding. Since the 1950s, the land use trends in the Delta Region have included a reduction in agricultural acreage, an increase in urban development and acreage, and the continued loss of open space lands.

Between 1976 and 1993, a significant amount of natural open space land (about 25,000 acres) was reclassified to agricultural land, two-thirds of which occurred in the Primary Zone. A similar amount of acreage was reclassified from agriculture to native land, with the majority occurring in the central part of the Delta.

Although current agricultural practices include some cattle grazing and limited dry farming of grain crops where suitable soils exist, most of the reclaimed marshland in Suisun Marsh has been converted to private duck clubs and state wildlife areas, both of which use the levee systems developed for agriculture as a management tool to provide habitat for wildlife.

Recreation use of the Delta has increased substantially over the past 45 years. In 1958 and again in 1963, recreation use was estimated at approximately 2.5 million recreational visitor days (RVDs), with a visitor-day representing one person spending a day or portion of a day in one particular type of activity. By 1978, recreation use in the Delta was estimated at 7 million. Hunting, sport fishing, boating, and other water-based activities have continued to be the most important recreation activities in the region.

Before 1960, the majority of facilities available to boaters and other nonconsumptive-use recreational users centered on the use of commercial marinas and a limited number of city or county public access areas. Delta yacht or ski clubs were popular at this time and became instrumental in organizing and promoting waterborne recreation in the Delta. By the late 1950s, the number of available Delta recreation facilities had grown to approximately 127 different facilities, including 110 privately owned commercial resorts, four publicly owned parks, and 13 private clubs.

The increasing demand for more Delta recreation opportunities spurred the state to establish Brannan Island State Recreation Area (SRA) in 1965 and Franks Tract SRA in 1966. Development of these SRAs enabled the state to collect fees for use of the areas.

Prior to World War II, the majority of waterfowl and pheasant hunting occurred on private farmland. After the war, the popularity of this sport brought an increasing number of hunters to private farmland. As Delta marshlands were drained and converted to agricultural use, land use conflicts with farmers spurred the development of alternative hunting areas, including Grizzly Island Wildlife Management Area (WMA), Joice Island WMA, and Sherman Island WMA, in addition to a variety of state cooperative hunting areas. Although private duck clubs and WMAs have remained popular hunting areas, the state cooperative hunting areas declined in popularity during the 1960s.

The Suisun Bay and Suisun Marsh portions of the Delta historically have been popular areas for waterfowl hunters. Past estimates of total annual waterfowl hunter-days in the marsh, including use of public hunting areas, range from approximately 48,000 to 62,000 per hunting season.

Recreational sport fishing historically has been a major activity in the Delta area, occurring throughout the year from shore locations, piers, and boats. Important sportfishing species included striped bass, shad, black bass, catfish, and steelhead. Although commercial fishing for striped bass was abolished in 1935, a sport fishery was allowed to continue. By the early 1960s, most of the bass angling was concentrated in the Delta. Sport-catch records indicate a declining trend, with an average annual catch ranging from a high of 750,000 fish during the 1960s to a low of approximately 150,000 during the early 1980s.

American shad has long been a popular sport fish; however, a sport fishery for this species did not become well established until 1957. Although historical statistics on the shad sport fishery in the Delta are lacking, one operator in the Delta estimated a catch of 30,000 fish by 2,500 anglers in 1954.

In 1954, following a 35-year moratorium on sport fishing for sturgeon, a sport fishery in the Bay-Delta was reestablished. Most of the fishery is concentrated in San Pablo Bay. Although exact sport-catch data are not available, the catch rate for sturgeon is estimated to have increased by 40% over the last two decades. This increase may indicate that fishing for sturgeon has become more popular as stocks of other game fish, such as striped bass, have declined.

Recreation Economics. Recreational use of the Delta has been estimated at 11.9 million RVDs from 1977 to 1978, and 12.9 million RVDs for 1985. Average expenditures per person per day have been estimated to be approximately $16.50 for visitors to the Delta and $7.90 for residents of the Delta. Annual recreation expenditures have been estimated to total approximately $185.2 million. Estimated annual recreation benefits have been estimated to range from $550 to $686 million.

Other estimates put the number of visits to the Delta for freshwater recreation at 6.4 million RVDs for 1977 to 1978 and 6.95 million RVDs in 1985. The economic value of freshwater recreation in the Delta in 1985 based on travel-cost (out-of-pocket expenses and nonmonetary travel-time costs) was estimated to be $222 million. Net recreation benefits were estimated to be $193 million, based on a net benefit per recreation day of $27.72.

Commercial Fisheries. Crayfish have been commercially harvested in the Delta and sold locally for many years, and some species have been harvested for commercial consumption and sold as bait; however, harvest levels and related economic activity generated by commercial harvests have represented a minor segment of the regional economy.

Existing Conditions

Recreational Opportunities. Fishing and boating are the most popular activities in the Delta, accounting for approximately 70% of total use.

More than 75% of the recreational users using the Delta live in Contra Costa, San Joaquin, Sacramento, Alameda, and Solano counties. The majority of the remaining visitors live within a 100-mile radius of the Delta. Delta use patterns indicate that a majority of the visitors stayed one day or less in the Delta. Use varies from season to season. The peak recreation period occurs from May through September. Spring and summer (March to September) account for an estimated 75% of total annual use.

Delta recreation facilities tend to be close to each other and concentrated near major roadways. Popular access points for boating, waterskiing, and personal watercrafting include Windmill Cove near State Route 4; King Island, Paradise Point, and Herman & Helens near Eight Mile Road; Tower Park near SR 12; and Dels Boat Harbor near the city of Tracy. Houseboating also is concentrated along Eight Mile Road. Wind surfing, a fast-growing sport in the Delta, typically occurs along SR 160 between Sherman Island and Rio Vista and at Windy Cove. Windy Cove is a new facility constructed at Brannan Island SRA and is the only formal wind surfing site in the study area. The limited number of boating access points across the Delta and the lack of readily available rentals for ski boats and personal watercraft continue to be issues for recreational users.

During the past 10 years, hunting has continued on private lands, as well as in public areas, waterways, and on various small Delta islands. Popular areas include Sherman Island WMA, Twitchell Island, Franks Tract SRA, and Clifton Court Forebay. In addition, the state owns 15,000 acres in Suisun Marsh at the western edge of the Delta, including approximately 6,000 acres of

public hunting areas that compose the Grizzly Island WMA.

Fishing access in the Delta primarily occurs from four designated access areas and from a variety of roadside locations and levee banks. Of all Delta species, striped bass was the most popular, with an average annual sport catch of 18,900, followed by American shad, salmon, and sturgeon.

Approximately 23 public recreation facilities are located in the legal Delta. Three state agencies, the California Department of Parks and Recreation (DPR), the California Department of Water Resources (DWR), and the California Department of Fish and Game (DFG), maintain five recreation areas in the Delta. The remaining recreation areas are operated by county and city agencies.

Recreation areas managed by DPR include Brannan Island SRA, Franks Tract SRA, and Delta Meadows River Park. Since 1986, annual attendance at all DPR facilities has averaged approximately 213,000 total visitors.

Overall, use of the SRAs has been declining since the early 1990s. Annual attendance at all DPR recreation areas has dropped since 1989. Possible factors contributing to this decline include drought conditions in the Delta area, a higher overnight camping fee, and a ban on alcohol consumption.

Sherman Island WMA is located in Sacramento County and managed by DWR and DFG. Hunting use information is limited; however, approximately 870 hunters were selected to participate in the 1995 hunting season on this Delta island.

Clifton Court Forebay, managed by DWR and DFG, has a maximum capacity of 30 hunters and approximately 15 boats. Available use records indicate sporadic but increasing attendance at the forebay from 1971 to 1980. Implementation of a self-registration system at the Forebay made use records after 1980 unreliable. Records after 1985 are unavailable because of repeated acts of vandalism, which forced the elimination of the self-registration system.

Marinas account for most recreation facility types in the Delta totaling approximately 120. Marinas provide many services in addition to boat berthing and boat fuel. These services include ski boat and houseboat rentals; boat services, such as boat launching and marine supplies; camping and picnicking facilities; guest docks and fuel stations; and food and beverage services.

Marinas are not equally distributed throughout the Delta and are concentrated in a handful of locations. The most heavily used areas include Bethel Island in Contra Costa County and Lower Andrus Island in Sacramento County. Bethel Island is very congested, with resorts and 33 marinas providing 1,185 berths. In addition to marina berths, the private facilities at Bethel Island include a large number of support and service facilities. Andrus Island, by comparison, is more rural but provides nearly 1,700 berths.

Much of the open space in the Delta is used for public parks and wildlife refuges. DPR owns 5,000 acres in the Delta, including Brannan Island, an SRA since 1954; Franks Tract (flooded) for recreation; Delta Meadows, a scenic waterway near Locke, popular with boaters; and over 1,000 acres in the Stone Lakes Wildlife Refuge.

Significant amounts of acreage in the Delta Primary Zone have been purchased in recent years by state, federal, and nonprofit agencies for enhancement and management as wildlife habitat. For example, DFG owns 8,080 acres of land in the Delta Primary Zone, including underwater land in the Lower Sherman Island Wildlife Area, portions of the Yolo Bypass, Woodbridge Ecological Reserve, Calhoun Cut Ecological Reserve, and Webb Tract Berms and Islands.

Recreation Economics. Recreational use of the Delta generates spending in the regional economy and reflects the value over and above what recreational users actually spend in travel and to use recreation areas.

Recreational use of the Delta annually generates an estimated 7.1 million RVDs. Recreational users visiting the Delta for sport fishing, boating, waterfowl hunting, and other recreation activities purchase goods and supplies at food stores, eating and drinking places, and service stations; stay at hotels, motels, and campgrounds; and use various recreation services. Recreational users spend an estimated $254.2 million annually to visit the Delta, including $226.6 million within the five-county Delta Region. Sport fishing in the Delta and Suisun Bay generate the largest portion of total spending by recreational users, accounting for 53% of total spending.

Based on existing use of the Delta, recreation benefits annually accruing from Delta recreational users are estimated at $160 million. Boaters and others engaged in nonconsumptive recreation activities account for the majority of recreation benefits.

Commercial Fisheries. The Delta supports the commercial harvest of crayfish and bait-fish species, such as bay shrimp and shad. Other species are harvested incidentally. Crayfish harvesting is the largest commercial fishing activity in the Delta Region. Crayfish are harvested in various locations throughout freshwater areas of the Delta, although most are offloaded at Stockton. Most crayfish are sold for human consumption, and a portion of the harvest is exported. Most of the harvest for bait is sold locally. Based on commercial landing data for 1986 and 1995, the commercial crayfish harvest in the Delta has remained relatively stable at about 12,000 pounds per year over the past 10 years.

8.3.1.2 Bay Region

Historical Perspective

Recreational Opportunities. The San Francisco Bay Estuary supports the principal sport fisheries for salmon and striped bass in California. Important sport fishing use trends for these species in the Bay Region are:

- Sport catch of chinook salmon reached major peaks in 1995, 1968, and 1972;
- Sport catch of chinook salmon searched lows in 1957, 1960, and 1978; and
- Sport catch of white sturgeon fluctuated from a high in 1967 to a low in 1977 and back to a high by 1985.

A sport fishery for striped bass was allowed to continue after 1935; however, by the early 1960s, most of the south San Francisco Bay was no longer producing striped bass and much of the bass angling effort had shifted to the Delta area.

In 1954, following a 35-year moratorium on commercial and sport fishing for sturgeon, a sport fishery in the Bay Region was reestablished. Most of this fishery was centered in San Pablo Bay. Between 1954 and the mid-1960s, most sturgeon were taken incidentally by striped bass anglers. By the mid-1960s, the sport harvest of sturgeon began to increase dramatically.

Although exact sport-catch data for white sturgeon are not available, the catch rate for sturgeon is estimated to have increased by 40% over the last two decades. This increase suggests that fishing for sturgeon has become more popular as stocks of other game fish, such as striped bass, have declined. In response to increased angler success, catch regulations were modified.

Angling success for sturgeon was considered high from the mid-1960s through 1969. Total white sturgeon catch aboard commercial passenger-carrying fishing vessels (CPFVs) ranged from a low in 1964 to a high in 1967. Sturgeon fishing aboard CPFVs was not as successful in the 1970s, when total catch ranged from a high in 1970 to a low in 1977. In 1984 and 1985, total catch of white sturgeon was estimated at approximately 8,500 and 12,000 fish, respectively, based on abundance estimates.

The salmon sport fishery in California did not become important until after World War II, long after the commercial salmon fishery was

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established. Historically, the sport fishery has harvested approximately 14% of the salmon landed within the subregion, with commercial fishing accounting for 86%.

Commercial sport fishing vessels have played an important role in the history of ocean sport fishery, accounting for an estimated 65% of the total sport harvest of salmon in the subregion. Most of these vessels originated from the San Francisco Bay area.

Salmon landings data between 1940 and 1985 show that salmon fishing activity reached major peaks in 1955, 1968, and 1972. These data also indicate that fishing activity reached lows in 1957, 1960, and 1978.

Chinook has been the most important salmon species caught in the California Coast subregion, accounting for 79% of the total salmon sport catch. San Francisco has been the most important subarea, yielding 67% of total sport landings between 1979 and 1985.

The coastal area outside the San Francisco Bay is also considered in this discussion of the Bay Region. Salmon sport fishing declined substantially in the coastal area between 1971 and 1975. For example, average annual days spent salmon sport fishing off the California coast decreased by 31% from 1976 to 1980 compared to the period from 1971 to 1975. Fishing days decreased by an additional 14% from 1981 to 1985. These declines were shared approximately equally between charter boat fishing and private boat fishing. Ocean salmon sport fishing activity increased from 1986 to 1990, roughly meeting the 1971 to 1975 average level of effort.

Except in the central coastal subregion, total pounds of salmon landed declined through the period from 1981 to 1985, compared with the period from 1971 to 1975. During the most recent period (1986 to 1990), pounds landed increased in all the subregions. Pounds landed increased the most (151%) in the San Francisco coastal subregion.

Recreation Economics. Overall, recreation use related to sport fishing in the Bay Region has been declining over the historical period. Consequently, recreation expenditures and benefits associated with sport fishing also have decreased in their contribution to the local and regional economy. Subsequent declines in economic activity associated with potentially affected sport fisheries also is indicated by historical reductions in the number of CPFVs operating in the Bay Region.

Commercial Fisheries. Commercial landings of striped bass ceased after 1935 (when the commercial fishery for this species was closed), and American shad landings ceased after 1957 (when the Sacramento and San Joaquin rivers were closed to all commercial fishing). Salmon has dominated the anadromous fish harvest, even in years when other anadromous species were landed in significant numbers.

The ocean salmon fishery in California began operating in the 1880s in Monterey Bay. On average, approximately half of all commercial fishing vessels in California land salmon (56% during 1969 to 1993, 49% during 1982 to 1993). Since a limited-entry program was established for salmon in 1982, about 77% of all California vessels have been in possession of a salmon permit and 63% of all permit holders have actually landed salmon (landings are not required to retain the permit).

Between 1916 and 1943, ocean landings of chinook salmon in California ranged from 2.2 to 7.2 million pounds and averaged 4.5 million pounds per year. Landings experienced a general upward shift during 1944 to 1982, from 3.7 to 10.3 million pounds. Important factors contributing to this upward shift were the termination of gill-netting in inland waters in 1957 and the development of fish hatcheries in the American and Feather rivers in the 1960s. Annual chinook salmon harvest averaged 6.6 million pounds between 1967 and 1993, equivalent to approximately 575,000 fish.

Since 1983, the California chinook salmon fishery has experienced record high and low landings. Landings in 1983 (one of the most severe El Niño years of the century) were the lowest since 1939, totaling 2.4 million pounds. Landings subsequently increased to a record high of 14.8 million pounds in 1988 and declined to a new record low of 1.6 million pounds in 1992. Although landings increased to 2.6 million pounds the following year, 1993 was still one of the lowest landing years in the history of the chinook salmon ocean fishery (rivaled only by 1938 to 1939 and 1983). Landings, however, always comprise a substantial proportion of the chinook salmon population.

Approximately 10 to 20% of the fish caught in the commercial chinook salmon fishery in Oregon are from the Central Valley. Between 1952 and 1993, commercial landings of chinook salmon in Oregon, where the fishery is much smaller than in California, ranged from 53,000 to 530,000 pounds; California coastal landings over the same period ranged from 1.6 million to 14.8 million pounds. Landings in Oregon have been subject to wide fluctuations, similar to the variability of California landings. Oregon commercial salmon landings averaged 212,500 pounds during the 1967 to 1993 period.

A change that has occurred over the years has been the disappearance of spring-run chinook salmon from the ocean harvest. The preponderance of fish caught today in the commercial harvest are fall-run chinook salmon.

Another change has been an increasing proportion of hatchery fish in the catch, with recent estimates ranging from 30 to 40% overall, and as high as 86% on rivers with terminal hatcheries. Although this has served the hatcheries' initial purpose (to offset the loss to the populations of fish that would have spawned above major impoundments), it may contribute to the instability recently seen in ocean catch, with a boom-and-bust pattern of harvest dependent on survival of broods from a few major facilities.

During the most recent period (1986 to 1990), the nominal ex-vessel value (expressed in current-year dollars) of all salmon sold in the California Coast Region exceeded sales in the period from 1976 to 1980 by $5.4 million; however, real values declined compared with real values of the period from 1976 to 1980, averaging about $4.0 million less for the period from 1986 to 1990.

Existing Conditions

Recreational Opportunities. The Bay Region extends east from the Golden Gate Bridge and includes San Pablo Bay and San Francisco Bay. Although numerous recreation activities occur in San Francisco and San Pablo bays, this report focuses on sport fishing and water-dependent recreation. Other recreation activities are not addressed in detail because they are not expected to be substantially affected by CALFED actions.

Lakes and reservoirs are popular day-use destination sites for local residents. These lakes and reservoirs and the surrounding parks accommodate recreation activities year-round because of their proximity to major metropolitan areas. Those operated by the San Francisco Water District do not substantially contribute to recreation use in the Bay Region because of access restrictions.

As elsewhere in California, the quality of recreation at lakes and reservoirs in the Bay Region depends largely on surface water levels. During severe drawdown conditions, access to boat ramps and swimming areas is substantially reduced or eliminated. Water-enhanced activities, such as picnicking and hiking, also can be affected as water levels fall.

Large undeveloped areas of land are found in the western, northern, and southern parts of the Bay Region. Federal and state parks and reservoirs make up a small portion of the total region.

Recreation Economics. Sport fishing activity in the Bay Region is associated with abundance, migration patterns, and fishing regulations. Sport fishing in the region occurs year-round from

private vessels, from CPFVs, and along the shore. The popularity of shore and boat fishing is associated with the type of sport fish being sought. Most fishing occurs aboard private vessels. CPFV operators indicate a sustained decline in the popularity of fishing aboard these vessels.

Saltwater sport fishing for salmon in the subregions composing California coastal areas accounted for an estimated 127,000 visitor days of recreation in 1992. Nearly 50% of the expenditures generated by sport fishing occurred in the San Francisco subregion. Total use resulted in an estimated $10.4 million in trip-related expenditures. Annual recreation benefits associated with this salmon sport fishing are estimated at $8.7 million, based on an average benefit of $70 per day.

Striped bass is the most important sport fish caught in San Francisco Bay. Fishing for striped bass occurs aboard private vessels and CPFVs or from shore. An estimated 65% of total catch is made aboard private vessels, 21% from shore, and 14% from CPFVs.

Most of the catch of striped bass in California occurs in the Bay-Delta, including San Francisco Bay (35%), San Pablo Bay and Carquinez Strait (21%), Suisun Bay (6%), and the Delta (20%). An estimated 15% of the total catch occurs in the Sacramento River upstream from Courtland; the remaining 3% occurs in the ocean just outside the Golden Gate Bridge and in the San Joaquin River.

The quality of striped bass angling in the Bay-Delta depends on location, abundance, and regulations. During winter, striped bass are relatively inactive and fishing success is relatively low. Fishing increases in spring as the fish begin to move up the Delta to spawn. The abundance of striped bass in the region probably is associated with Delta water diversions, Delta outflows, and water quality. Although not directly affecting fishing success, size and possession limits can restrict total angling efforts for striped bass.

White sturgeon is one of the popular game fish sought in the Bay-Delta. Although both green and white sturgeon are found, white sturgeon are more abundant because green sturgeon spend a greater portion of their lives in the ocean.

Sturgeon are popular game fish because of their large size; however, they have one of the lowest catch rates per hour of angler effort for sport fish in the region.

Fishing trips for sturgeon are taken aboard both private vessels and CPFVs. An estimated 92% are caught aboard private vessels.

Sturgeon fishing continues year-round in San Pablo Bay, Suisun Bay, and the Delta. Fishing success in each area probably is associated with the movement of the fish in response to changing salinity conditions in the Bay-Delta, which is influenced by river flows into the Delta. Sturgeon are more likely to be found in the Suisun Bay area during dry years and in San Pablo Bay during wet years.

Although salmon support a large sport fishery in the ocean, the salmon sport fishery in the Bay is small. Salmon typically are caught in the area around the Golden Gate Bridge and upstream of Carquinez Strait.

Commercial Fisheries. Of all the anadromous fish species addressed in this report, only chinook salmon continues to support a commercial fishery. Commercial fishing for striped bass, sturgeon, and steelhead trout ended before development of the CVP. The commercial fishery for American shad officially ended in 1957 when most commercial fishing in the Bay and Delta was banned by the state legislature.

In 1992, the North Coast Subregion accounted for less than 1% of the fishing effort, 1.3% of pounds landed, and 1.1% of the ex-vessel value of all salmon landed at ports in the three California coastal subregions. (Salmon fishing in the North Coast subregion was severely restricted to protect salmon populations in 1992.) The San Francisco subregion accounted for 32% of the fishing effort,

61% of the pounds of salmon landed, and 62% of ex-vessel value of all salmon landed at ports in the Pacific Coast Region. The Central Coast subregion accounted for 68% of the fishing effort, 37% of the pounds of salmon landed, and 37% of the ex-vessel value of all salmon landed at ports in the California Coast Region.

Two important indicators of the economic importance of the commercial salmon fishing industry are the relative poundage and ex-vessel value of salmon landed in proportion to the total pounds and value for all commercial seafood landed at ports in each subregion. In 1992, salmon accounted for 0.03% of the total pounds of seafood landed and 0.13% of the total ex-vessel value of seafood landed in the North Coast subregion. Salmon accounted for 2.0% of total pounds of seafood landed and 8.0% of the ex-vessel value of all seafood landed in the San Francisco subregion. Salmon accounted for 0.83% of the total pounds of seafood landed and 4.2% of the ex-vessel value of all seafood landed in the Central Coast subregion.

In 1993, the number of salmon fishing permit holders in California was 2,740, a 54 percent reduction from the 5,964 permit holders at the inception of the limited entry program in 1982. The percentage of salmon permit holders who actually fished for salmon also has declined over time, and the size of the fleet has declined to record low levels. The decline has been particularly acute for vessels that obtain a relatively significant amount of income (more than $5,000 annually) from salmon fishing, which accounts for 85% of the total revenue generated from the fishery.

A gradual aging of the fleet has occurred since the early 1980s, perhaps due to declining fishing opportunities. The state's limited entry program has also contributed to this aging by restricting the entry of new vessels into the fishery.

The relative amount of personal income generated by the salmon industry also indicates the economic importance of the industry to the region. In 1992, the salmon industry (including harvesting and processing activities) in the North Coast subregion generated $100,000 in personal income, which accounted for less than 0.01% of the total personal income generated in this subregion. In the San Francisco subregion, the salmon industry generated $5.9 million in 1992, which accounted for approximately 0.01% of the total personal income generated in this subregion and 66% of all income generated by the salmon industry in the three California coastal subregions.

In the Central Coast subregion, the salmon industry generated $2.9 million in 1992, approximately 0.01% of the total personal income generated in this subregion and 33% of all income generated by the salmon industry in the three California coastal subregions.

Fishing-dependent communities, as a whole, varied in the ability to adjust to the decline in anadromous fish populations. Communities in the southern and inland regions of the study area adjusted to the decline by turning to other industries for economic growth. However, communities in the northern region of the study area have had the most difficulty in making the transition to other industries.

8.3.1.3 Sacramento River Region

Historical Perspective

Recreational Opportunities. Recreation opportunities in the Sacramento River Region have been shaped by the construction of large reservoirs and the alteration of major rivers. Construction of Shasta Lake, Whiskeytown Lake, Lake Oroville, Folsom Lake, New Bullards Bar Reservoir, and Englebright Lake provided extensive flatwater recreation opportunities. At the same time, historical recreation activities on the Sacramento, Feather, Yuba, and American rivers were affected as flows, water temperatures, and fisheries were altered by operation of the reservoirs.

Important reservoirs in the Sacramento River Region were completed between 1941 and 1970. Shasta Lake was the CVP's first major multipurpose facility in 1945. Initial recreation

use did not occur until 1948, when the reservoir was filled. The U.S. Forest Service (USFS) began developing and managing flatwater and shoreline recreation resources at Shasta Lake after the Whiskeytown-Shasta-Trinity National Recreation Area (NRA) was established. Historically, Shasta Lake has been the most popular recreation reservoir.

Whiskeytown Lake, constructed in 1963, also is located in the NRA, with recreation facilities managed by NPS. Between 1970 and 1985, annual recreation use at Whiskeytown Lake ranged from a low of 804,000 recreation days in 1974 to a high of 1.6 million recreation days in 1976 and then declined through the early 1980s.

Folsom Lake, completed in 1955, was the second major lake or reservoir constructed by Reclamation in the region. DPR manages the lake's recreation facilities. Visitation is not well documented between 1955 and 1970. After 1970, visitation declined from approximately 2 million to less than 1 million recreation days in 1977 but increased to nearly 2.8 million recreation days in 1985.

Lake Oroville, a part of SWP, was completed in 1968, with recreation facilities operated by DPR. Since 1968, visitor use has fluctuated substantially, ranging from 288,000 visitors in 1968 to 939,000 visitors in 1981. Visitation declined substantially in 1985 to 771,000 visitors.

Other major lakes or reservoirs in the region include Englebright Lake and New Bullards Bar Reservoir. Visitation at both has increased steadily from 1941 to 1985. Because Englebright Lake was constructed to control mining debris, recreation use did not begin until new techniques for controlling debris were developed in the early 1960s. From 1970 to 1985, annual visitation at Englebright Lake increased from 66,000 to nearly 116,000 visits. Recreation use at New Bullards Bar Reservoir increased steadily from 1970 to 1985, although historical records appear to understate the total amount of recreation known to have occurred at this facility.

Recreation activities along rivers in the Sacramento River Region were modified with the construction of dams on the Sacramento and Feather rivers. Before major dams were constructed, flows and water temperatures fluctuated seasonally. Low flows and relatively high water temperatures occurred in summer, and high flows and low water temperatures occurred in winter. In some instances, modification to river flows resulted in substantial changes to sport fisheries.

Before Shasta Lake was built, summer flows in the Sacramento River were low, water temperatures rose above optimum ranges for salmon, and only warm water species were present below the dam site during summer. The most common summer game fish in the river before construction of the lake were striped bass and catfish.

After Shasta Lake was constructed, water temperatures and flows in the river were altered to such a degree that a year-round salmonid sport fishery was created. Chinook salmon, steelhead trout, and rainbow trout made the greatest contribution to the fishery. Its popularity is indicated by the growth in the number of recreation-related support services.

On the reach of the river between Orland and Redding, the number of boat landings to serve the growing sport fishery increased from zero in 1945 to 11 in 1949. An estimated 46 establishments (such as resorts and bait shops) serving the sport fishery were in operation along the river in 1949.

Between May 1948 and February 1949, an estimated 8,000 salmon and 3,800 rainbow trout and steelhead were caught on the reach of the river between Orland and Redding. Between 1968 and 1975, an estimated annual average of 17,500 salmon were landed in the entire river.

The Feather River below Lake Oroville and the Yuba River below Englebright Lake continued to support an important anadromous fishery, although not as extensive as that on the Sacramento River. Changes in water flow and

temperature in the Feather River after completion of Lake Oroville did not substantially alter the number of fish species present in the lower portion of the river. Averages based on angler surveys conducted from 1968 to 1974 indicate that 530 striped bass were caught annually, 1,800 steelhead trout were caught annually, and 644 chinook salmon were caught each year.

Wildlife refuges in the Sacramento River Region provide consumptive and nonconsumptive recreation opportunities. Opportunities for nonconsumptive recreation, which includes wildlife viewing, are provided at Sacramento and Colusa National Wildlife Refuges (NWRs) and Gray Lodge WMA. Opportunities for consumptive recreation, which includes fishing and waterfowl hunting, are provided at all wildlife refuges in the region.

Gray Lodge WMA, the first wildlife refuge in the Sacramento River Region, was established in 1931. Historically, Gray Lodge WMA has been the most popular of the five refuges in the region, accounting for approximately 61% of total use at all refuges in the region between 1973 and 1985. Use at the refuge increased by approximately 95% between 1973 and 1985.

Sacramento NWR, established in 1937, historically has been the second most popular refuge in the Sacramento River Region. Nonconsumptive uses accounted for approximately 73% of total use during 1973 and 1985.

Colusa NWR, established in 1944, has been the third most popular refuge in the region, with an annual average of 8,000 visitors between 1973 and 1985. Nonconsumptive and consumptive uses historically have been equally popular at the refuge, each accounting for 50% of total use.

Sutter and Delevan NWRs, established in 1944 and 1963, respectively, have been used almost exclusively for hunting. Between 1973 and 1985, annual hunting activity averaged approximately 2,500 visitors at Sutter NWR and 5,500 visitors at Delevan NWR.

Agriculture and open space historically have comprised the majority of land in the Sacramento River Region. Since the 1970s, however, urban land uses in the greater metropolitan Sacramento area have begun to supplant some agricultural uses.

Existing Conditions

Recreational Opportunities. Major recreation sites in the Sacramento River Region are the lakes and reservoirs, rivers and streams, and federal wildlife refuges and state WMAs. Waterfowl hunting on private lands is also a leading form of recreation in the region.

Overall, recreation use at important reservoirs, rivers, and wildlife refuges in the Sacramento River Region has paralleled increased population growth in the region. Consequently, recreation expenditures and benefits associated with increased use by visitors to the recreation areas have become an important contributor to the local and regional economy.

Major reservoirs in this region include Shasta Lake. The following tributaries to the Sacramento River could be affected by CALFED actions through implementation of stream restoration measures: Cottonwood, Cow, Deer, Bear, Battle, Mill, Paynes, Antelope, Butte, Big Chico, Thomes, and Elder creeks and Colusa Basin Drain. Recreation use along these streams was not addressed because data concerning potential impacts of CALFED actions on flows and fisheries are not available. Land uses in the Sacramento River Region are principally agricultural and open space, with urban development focused in the city of Sacramento. More than half the region's population lives in the greater metropolitan Sacramento area. Except for Sacramento County, the region generally contains large quantities of parklands, forests, and other open space and has preserved its traditionally rural nature.

Recreation Economics. In 1992, recreation use at the 10 recreation areas in the Sacramento River Region totaled approximately 3.6 million visitor

days. Recreation benefits are estimated at $40.8 million for 1992.

8.3.1.4 San Joaquin River Region

Historical Perspective

Recreational Opportunities. CVP reservoirs and non-CVP reservoirs, rivers, and wildlife refuges in the San Joaquin River Region support a variety of recreational activities, including sport fishing, hunting, boating, camping, swimming, picnicking, and sightseeing. Most of the reservoirs supporting recreational uses in the San Joaquin River Region were completed in the 1960s and 1970s. Overall, recreation use data are limited.

Important use trends at CVP facilities in the San Joaquin River Region are as follows:

- Recreation use at San Luis Reservoir increased from an estimated 33,000 visits in 1967 to an estimated 282,000 visits in 1985.
- Annual recreation use at Millerton Lake increased from an estimated 574,000 visitor days in 1970 to an estimated 667,000 visitor days in 1985.
- Annual recreation use at New Melones Reservoir, completed in 1979, increased from an estimated 250,000 visitor days in 1980 to an estimated 499,000 visitor days in 1985.
- Annual use at Lake McClure increased from an estimated 167,700 visits in 1969 to an estimated 428,000 visits in 1985.
- Recreation use at New Don Pedro Reservoir increased from an estimated 300,000 visits to an estimated 501,000 visits in 1985.
- Recreation use at New Hogan Lake increased from an estimated 5,100 visitor days in 1963 to an estimated 262,000 visitor days in 1985.

In 1962, DFG estimated that the Stanislaus River chinook salmon run supported an average annual use of 10,000 angler days of sport fishing. Although no other information or use data on angling or nonconsumptive recreation for the Stanislaus River and other important rivers in the San Joaquin River Region has been located, the river most likely supported other nonconsumptive recreation pursuits such as swimming, boating, camping, and picnicking.

Important wildlife refuges in the San Joaquin River Region include Los Banos and Volta WMA and Kern, Kesterson, Merced, Mendota, Pixley, and San Luis NWRs. Historical use data for NWRs are not available; however, overall use trends as the NWRs probably resemble trends at the WMAs. Recreation opportunities for both nonconsumptive and consumptive activities are provided at all wildlife refuges in the region. Recreation use at Los Banos WMA and Volta WMA increased from an estimated 36,400 visitor days in 1973 to an estimated 69,305 visitor days in 1985.

Recreation activities associated with rivers in the San Joaquin River Region were modified as dams were constructed on the San Joaquin, Stanislaus, Tuolumne, Merced, and Calaveras rivers. Millerton Lake on the San Joaquin River modified the flows and temperature of the river. During the irrigation season the river was diverted substantially, creating hazards for chinook salmon, steelhead trout, striped bass, American shad, and sturgeon.

The Stanislaus River downstream of Goodwin Dam historically supported resident populations of warm water game species, including largemouth and smallmouth bass, channel and white catfish, black crappie, bluegill, and green sunfish. Historical anadromous fish populations below Goodwin Dam included chinook salmon, steelhead trout, striped bass, American shad, and sturgeon. Salmon production in the Stanislaus River contributed to sport and commercial catches in the ocean and lower San Francisco Bay.

The Tuolumne River historically supported a significant trout fishery in the upper cold water reaches of the river. Rainbow, brown, brook, and

golden trout ranged as far downstream as the present location of New Don Pedro Reservoir.

Largemouth and smallmouth bass, bluegill, white catfish, and other warm water fish species were common in the lower foothill and valley reaches of the river. Before impoundment of the lower reach, the Tuolumne River supported steelhead and annual chinook salmon runs of up to 100,000 fish. No information or use data on angling or nonconsumptive recreation before the construction of New Don Pedro Reservoir has been located.

The Merced River historically supported populations of spring- and fall-run chinook salmon that average 12,000 fish per year. The salmon run on the Merced River declined and was in poor condition for at least 20 years before the construction of Lake McClure. Operation of the dam has improved the project flow conditions, and salmon habitat improvement projects have effectively maintained chinook salmon populations. As with other rivers in the San Joaquin River Region, the Merced River also supported an unknown number of dispersed water-dependent and water-enhanced recreation pursuits, such as swimming, boating, camping, and picnicking.

No recreation or fisheries data are available for the Calaveras River before the construction of New Hogan Lake. Recreation activities are assumed to be similar to those of other rivers in the region.

Recreation Economics. Overall, recreation use at important reservoirs, rivers, and wildlife refuges in the San Joaquin River Region has been increasing since the 1940s. Consequently, recreation expenditures and benefits associated with increased use by visitors to the recreation areas have been increasing and have become an important contributor to local and regional economies.

Existing Conditions

Recreational Opportunities. Major lakes and reservoirs in the San Joaquin River Region are San Luis Reservoir, Millerton Lake, New Melones Reservoir, Lake McClure, and New Don Pedro Reservoir. Major rivers in the region include the San Joaquin, Merced, Tuolumne, and Calaveras. Other potentially affected lakes and reservoirs in the region include Bethany Reservoir, O'Neill Forebay, New Hogan Lake, Camanche Reservoir, and other reservoirs located upstream of major reservoirs.

The San Joaquin River Region includes federal and state wildlife refuges and private hunting clubs, and the SWP's California Aqueduct and Reclamation's Delta-Mendota Canal provide limited recreation opportunities in the region.

Wildlife refuges in the San Joaquin River Region provide both consumptive and nonconsumptive recreation opportunities. Nonconsumptive recreation opportunities, which include wildlife viewing, are provided at San Luis, Merced, and Kern NWRs, and Volta and Los Banos WMAs. Consumptive recreation opportunities, which include fishing and waterfowl hunting, are provided at Volta and Los Banos WMAs and Kern NWR.

Land uses in the San Joaquin River Region are predominantly open space in the mountain and foothill areas, and agricultural in the San Joaquin valley area. The Sierra Nevada range includes the El Dorado, Stanislaus, and Sierra national forests, and Yosemite National Park. Public lands amount to about one-third of the region. The region's foothills border Kings Canyon and Sequoia National Parks and Sierra National Forest.

Recreation Economics. In 1992, recreation use at the seven reservoirs, four rivers, and five wildlife refuges in the San Joaquin River Region totaled approximately 2.9 million visitor days. Trip-related expenditures resulting from this use reached an estimated $56.8 million.

Commercial Fisheries. There is no commercial fishery in the San Joaquin River Region.

8.3.1.5 SWP and CVP Service Areas Outside the Central Valley

No recreation-related program actions are proposed in this region. Therefore, existing recreational resource conditions are not discussed.

8.3.2 Environmental Consequences

8.3.2.1 Assessment Methods

Programmatic impacts on recreation resources include both short-term construction-related impacts and long-term operational impacts. These may be either direct or indirect.

Direct impacts are those that have an immediate cause and effect relationship to a program action. Indirect effects typically occur later in time or are further removed in distance from the program action.

Recreational Opportunities. Both qualitative and quantitative methods can be used to assess changes in recreation opportunities. Where recreation opportunity thresholds (for example, reservoir level at which boat ramps become unusable, streamflows where rafting becomes infeasible) and necessary input data exist, they will be used to assess the effects of CALFED actions on recreation opportunities. However, for this programmatic analysis, the primary methods used are qualitative methods based on historical use data; availability and accessibility of recreation sites; and the abundance of fish, waterfowl and support facilities (for example, boat launches and marinas).

Recreation Economics. Each of the CALFED Program elements could result in changes in costs and benefits associated with recreational use of resources.

The analysis is based on estimating the net economic benefits (or costs) associated with CALFED program actions. The net benefit (or costs) may theoretically be derived from subtracting the costs of recreation from the benefits of recreation. Recreation costs include the cost of providing additional recreational opportunities relative to baseline levels (both existing conditions and No Action Alternative conditions) and the costs associated with any loss in recreational opportunities that may result from program actions. In many cases, economic values associated with both the costs and the benefits of recreational opportunities are either unknown, are only partially known, or are intangible and cannot be assigned a dollar value.

Due to the inherent difficulties in assigning economic values to all recreational costs and benefits, the analysis of economic impacts of the CALFED Program on recreational resources was assessed qualitatively, based on selected indicators of the economic costs and benefits.

For example, the economic benefits of recreational opportunities are partially represented by recreation-related spending by visitors or users of recreational resources. Spending data representing current conditions are presented in the preceding section of this chapter. For the No Action Alternative, spending values were estimated by adjusting the values for existing conditions by the percentage change in population between 1995 and 2020.

The values of the economic variables in the No Action Alternative were then adjusted to reflect the predicted magnitude of change in recreation-related spending for each of the alternative configurations.

Other economic variables are discussed qualitatively, due to lack of relevant quantitative data.

Social Well-Being. Social well-being is a measure of community standards and attitudes of contentment, which may be influenced by recreational opportunities and employment.

When possible, the evaluation of impacts on social well-being is based on the regional economics analysis and projected changes to regional employment related to recreational activities. However, much of the data needed to infer the effects on employment and other measures of social well-being are not available at the programmatic level. Therefore, this issue is treated qualitatively.

8.3.2.2 Significance Criteria

Both water-based and land-based recreational opportunities may be affected by CALFED Program actions. Changes in land use or water resource conditions may have direct impacts on recreational opportunities. In addition, program activities that affect fish and wildlife or aquatic resources may indirectly impact recreational opportunities. The effects of program actions on these resources are discussed in each of the individual resource sections of the report. However, the significance of these effects on recreational opportunities are described here.

Program actions may have both beneficial and adverse impacts on recreational opportunities.

Program actions would have a significant adverse impact on recreational opportunities if they resulted in a substantial reduction in the recreational use of a resource or facility. Although professional judgment must be relied upon in evaluating the significance of an impact on recreational opportunities, a conservative approach has been used, in which any reduction in recreational opportunity associated with program actions is considered potentially significant unless otherwise noted.

Conversely, if the program actions could increase the potential recreational opportunities associated with a resource or facility, the impacts are considered beneficial.

Among the types of Program-induced effects that could result in significant impacts on recreational opportunities are:

- Fluctuation in lake or reservoir water levels;
- Changes in freshwater flows in rivers and the Delta during the recreational season;
- Changes of river temperature which reduce recreational swimming, tubing, canoeing, kayaking, and rafting;
- Temporary restriction of recreation activities due to construction;
- Conversion of recreation facilities to other uses;
- Changes in aesthetic conditions that could affect visitor appreciation of an area;
- Reduction of opportunities for one activity resulting in increase in recreation use-days for other recreational uses in the Delta (shifting activities);
- Change in fishing or hunting opportunities; and
- Changes in accessibility to recreation sites.

Economic impacts are considered significant if they are expected to result in a substantial decrease in the net benefit associated with a given recreational resource. For purposes of this analysis, a substantial decrease is estimated to be a decrease of at least 10%.

8.3.2.3 Comparison of No Action Alternative to Existing Conditions

Delta Region

Recreational Opportunities. Historical land use trends are expected to continue through year 2020. Population in the Primary Zone of the Delta is expected to continue to decrease, while population density in the Secondary Zone and in adjacent urban areas will continue to expand, replacing agricultural land uses with urban land uses. Since most recreational visitors to the Delta come from within a 40-mile radius of the Delta, the increased

population is expected to result in increased stress on existing recreational resources. Adverse impacts on fisheries and wildlife habitat noted in other sections of this report will result in potentially significant reductions in the recreational opportunities associated with these resources. Increased development of land-based recreational facilities (such as parks, camping and picnic areas, and pedestrian and cycling facilities) and water-based activities (such as boating and marinas, fishing, swimming, and water-skiing) may place additional stress on terrestrial and aquatic habitat, leading to further reductions or trade-offs in available recreational opportunities. However, implementation of the CVPIA may offset all or some of these impacts.

Conversion of existing land uses from agricultural or other uses to dedicated fish and wildlife uses under provisions of the CVPIA may result in a shift from hunting to wildlife viewing opportunities in some areas and would probably result in a net increase in open space recreational opportunities elsewhere.

Recreation Economics. Implementation of the CVPIA could affect future recreation use within the Delta by improving fishing conditions for anadromous species in Delta waters. With fishery habitat improvements implemented under CVPIA, changes in recreation spending and benefits related to sport fishing could be relatively large (more than 10%).

Based on additional recreation use generated by regional population growth and increased use associated with CVPIA, spending within the region related to recreational use of the Delta is projected to total approximately $400 million by year 2020. Benefits accruing to Delta recreational users are projected to total $270 million under No Action Alternative conditions.

Commercial Fisheries. Commercial fishing for crayfish and baitfish species in the Delta and Suisun Bay would not change appreciably under No Action Alternative conditions relative to current resource conditions. Harvest revenue and net income generated by commercial fishing have not been estimated but are assumed to be minor in the context of the regional economy.

Bay Region

Recreational Opportunities. Declines in anadromous fish stocks are expected to continue under the No Action Alternative. This may result in a significant adverse impact on recreational fishing opportunities and potential adverse impacts on supporting recreational infrastructure elements that depend on fisheries (tourist facilities, fishing charter companies). As described for the Delta Region, increased recreational use of Bay waters and shoreline areas may result in adverse impacts on recreational value of terrestrial and aquatic resources if facilities are not expanded or managed to prevent degradation from overuse.

Recreation Economics. Economic activity associated with sport fishing for anadromous species in Bay and coastal waters could increase under no action conditions from implementation of CVPIA.

Implementation of CVPIA could result in small (less than 4%) increases in recreation expenditures and benefits in the North Coast subregion and large (more than 10%) increases in the San Francisco and Central Coast subregions relative to current levels.

Based on additional recreation use generated by regional population growth and increased use associated with CVPIA, spending within the Bay Region (including outer bay and nearshore areas) related to ocean salmon sport fishing is projected to total approximately $23 million by year 2020. Benefits accruing to ocean salmon sport fishing anglers are projected to total $28 million under No Action Alternative conditions.

Commercial Fisheries. Economic activity associated with commercial fishing for anadromous species in bay and coastal waters could increase under no action conditions due to implementation of the CVPIA. (Regional population growth, while adding pressure on the fishery, would not necessarily result in increased fishery-related economic activity because catch is regulated by

state and federal resource management agencies.) Improvements in fishery habitats under the CVPIA could substantially increase ocean commercial harvest values and net income derived from the catch of salmon.

Sacramento River Region

Recreational Opportunities. Impacts associated with increased intensity of use of streams and riparian areas would be similar to those described for the Delta Region. Declines in fisheries and terrestrial and aquatic habitat described in other resource sections of this report are expected to have significant adverse impacts on recreational opportunities involving fishing and nature interpretation.

Reoperation of the Folsom Reservoir could result in impacts to existing recreation activities at the reservoir. The extent and type of impacts would vary depending on the amount of flood storage required. Impacts would result from drawdown of the reservoir in late fall for flood protection. Similarly, benefits to recreation could be realized downstream of the reservoir if releases are greater than current conditions.

Trends not related to population growth, such as the conversion of crops that are associated with wildlife habitat (for example, rice) to other types of crops, may also affect recreation related to hunting and wildlife viewing in the Sacramento River Region.

Recreation Economics. Under the No Action Alternative, recreation-related expenditures and benefits would increase substantially as a result of the 69% increase in population projected for the Sacramento River Region between 1995 and 2020. Additionally, a number of projects and actions, including reoperation of Folsom Reservoir, development of the Stone Lakes NWR, and implementation of CVPIA, could affect recreation-related economic activity within the Sacramento River Region under No Action conditions.

The net effect of Folsom Reservoir reoperation on recreation spending and benefits would most likely be small (reduced by less than 4%).

The Stone Lakes NWR provides opportunities for nonconsumptive recreation activities, such as nature walks and wildlife viewing. Ultimate development of the wildlife refuge would generate a moderate (5 to 9%) increase in spending and benefits associated with wildlife-related recreation within the Sacramento River Region.

Implementation of CVPIA could result in large (more than 10%) increases in use of recreational resources such as fisheries in the Sacramento, Feather, American, and Yuba rivers and small (1% or less) decreases in use of reservoirs such as Shasta and Oroville. Wildlife refuges in the region could experience large (10% or more) increases in use because of improved wildlife habitat conditions in refuges related to CVPIA.

Based on population growth and effects of projects under No Action Alternative conditions, 2020 levels of recreation-related expenditures and benefits are projected to total $129 million and $70 million, respectively, within the Sacramento River Region.

San Joaquin River Region

Recreational Opportunities. If agricultural lands are retired on the westside of the San Joaquin River Region, conversion of these lands to recreational uses would be a positive impact in the region.

Recreation Economics. Under No Action Alternative conditions, economic activity generated by recreation use of regional resources would increase as a result of the 68% increase in population projected for the San Joaquin River Region between 1995 and 2020.

Implementation of CVPIA would also affect economic activity associated with recreational use of many of the region's rivers, reservoirs, and wildlife refuges. Changes in economic activities related to reservoirs would most likely be small (less than 4%) and would be related to reductions in use. Spending and benefits generated by use of

the region's rivers would probably increase by a small amount (4% or less). Spending and benefits generated by visitation at the region's wildlife refuges would most likely increase by a large (10% or more) amount relative to existing levels.

Based on regional population growth and likely effects of CVPIA, No Action levels of recreation-related expenditures are projected to total $102 million and $68 million, respectively, within the San Joaquin River Region.

SWP and CVP Service Areas Outside the Central Valley

Recreational Opportunities. Recreational use of existing facilities is expected to increase under the No Action Alternative.

However, no significant adverse impacts to recreational opportunities are anticipated.

Recreation Economics. Spending and benefits associated with recreational use of reservoirs in the SWP and CVP Service Areas could be affected by population growth and projects such as CVPIA and the Metropolitan Water District's (MWD's) Eastside Reservoir. Important lakes that could be affected include Castaic, Pyramid, Silverwood, and Perris.

Based on the 46% increase in population growth projected for counties containing these lakes, recreation spending and benefits could annually total a projected $193 million and $178 million, respectively, by year 2020.

8.3.2.4 Comparison of Program Alternatives to No Action Alternative

The impacts to recreational resources resulting from the storage and conveyance program element will vary by alternative, as discussed below. Impacts to recreational resources resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a region, the program element is not discussed.

Delta Region

Storage and Conveyance

Recreational Opportunities

Alternative 1. No storage facilities are proposed within the Delta Region for Alternative 1. However, Configuration 1C does include surface storage and groundwater storage upstream of the Delta. Depending on the operation of these upstream storage facilities, impacts to recreation in the Delta Region could result from alteration of existing flows or changes in water temperature. Based on the analysis presented in Section 6.1, these impacts are expected to be less than significant in the Delta Region.

Construction of improvements for Configurations 1B and 1C may temporarily restrict recreation activities including boating, fishing, hunting and wildlife viewing in the vicinity of the construction area.

Operation of these improvements would result in improved fishery resources and therefore potentially would increase the visitor use for fishing activities.

Operation of fish control barriers in the southern Delta could negatively impact boating circulation patterns in that area.

Alternative 2. In Alternative 2, construction of the Mokelumne River Floodway modifications and flooding of Bouldin Island to improve conveyance in Configurations 2D and 2E may result in temporary recreation impacts during construction. Operation of these configurations would permanently displace any land-based recreation opportunities currently ongoing at Bouldin Island. The inundation of Tyler Island in Configuration 2E would have similar adverse impacts.

Inundation of Bouldin and Tyler islands should result in an increase in aquatic related recreation opportunities including fishing, wildlife viewing and boating.

Alternative 3. In Alternative 3, new storage in the Delta may also result in significant impacts to existing recreation due to inundation or other related construction impacts.

Construction of the open channel isolated conveyance facility on the east side of the Delta included in Configurations 3A, 3B, 3E, 3H, and 3I would likely result in significant impacts to existing recreation resources.

The open channel isolated conveyance facility would be constructed in the vicinity of several existing recreation areas including Stone Lakes National Refuge, fishing and boating access areas along several sloughs, and several trails and parks in San Joaquin County. Depending on the exact location of the conveyance facilities, construction would require temporary disruption of existing facilities. Operation may result in closure of several existing facilities to allow for construction of the various pumps, siphons, access roads, storage buildings and utilities. This would be a significant adverse impact.

Recreation Economics

Alternative 1. South Delta modifications are expected to have minor beneficial effects on recreation spending and user benefits in the Delta Region resulting from increases in sport fishing opportunities.

Alternative 2. Under Configurations 2B, 2D, and 2E, some minor indirect effects on recreation spending and user benefits could result from development of surface storage upstream of the Delta on Sacramento River and San Joaquin River tributaries and south of the Delta off the aqueduct. The overall effect of these enhancements on recreation spending and user benefits in the Delta Region is expected to be minor.

Under Configurations 2D and 2E, habitat created as part of conveyance modifications could generate new waterfowl hunting opportunities, resulting in increased spending and user benefits in the Delta Region.

Under Configuration 2E, small to moderate benefits related to sport fishing for anadromous fish are expected. Moderate to large economic benefits related to water-based recreation activities along Delta channels is expected under Alternative 2 configurations.

Other habitat improvements/setback levees included in Alternative 2, which serve to improve conveyance of water, would have temporary construction impacts to recreation but are expected to provide long-term benefits to recreation.

Alternative 3. In Alternative 3, the conveyance modifications, including a 5,000 cfs open channel and north Delta and south Delta modifications, would result in minor, if any, effects on recreation spending and user benefits in the Delta Region.

Under Configurations 3B, 3E, and 3I, surface storage would be located within the Delta. In-Delta storage would provide minor, if any, new recreational opportunities and generate little, if any, new recreational benefits.

Under Configuration 3H, conveyance modifications, including modifications near Tyler Island, a floodway along the Mokelumne River, and south Delta modifications, would result in a minor effect on recreation spending and user benefits because of new waterfowl hunting opportunities.

Under Configuration 3I, storage modification would include new in-Delta storage on Holland Tract, which could generate increased hunting recreation use, spending, and benefits within and near the Delta. The conveyance modifications, including three isolated conveyance channels, new intakes, and south Delta modifications, would result in a minor, if any, effect on recreation spending and user benefits.

Large increases in recreational spending and user benefits are expected due to sport fishing and

other water-based recreation activities along Delta channels under Alternative 3 configurations.

Other habitat improvements/setback levees included in Alternative 2, which serve to improve conveyance of water, would have temporary construction impacts to recreation but are expected to provide long-term benefits to recreation.

Social Well-Being. Additional recreation jobs are expected to result from the habitat improvements and associated increased recreational use of the Delta. The increased recreational opportunities and potential for increased net employment opportunities is expected to result in a beneficial impact on social well-being.

Ecosystem Restoration

Recreational Opportunities. In general, the impacts of the Ecosystem Restoration Program are expected to be beneficial because they would increase recreation opportunities involving wildlife viewing and fishing.

Many of the areas targeted for habitat restoration are currently used for recreation activities including boating, hunting, wildlife viewing and sport fishing. Other areas are currently used for agriculture and would be converted to uses which would be more compatible to recreation. For example, the development of new deep water areas and tidally-influenced channels would create new recreation opportunities for boaters. The restoration of freshwater marshes and tidal wetlands may create new opportunities for hunters.

Although the overall impact of habitat restoration would be positive, restoration activities may result in some adverse impacts to recreation. For example, during construction activities some areas may be temporarily closed to the public. Some recreation facilities, such as piers or marinas, would be temporarily or permanently closed following restoration.

Temporary, seasonal, or permanent closure of Delta waterways could impact boating access.

Restoration actions are expected to result in increased visitation by birds and other wildlife. The impact to recreation would also likely include expanded opportunities for wildlife viewing, particularly birds, resulting in increased visitor days, compared to the No Action Alternative.

The Ecosystem Restoration Program includes potential actions for the construction of fish control barriers. Construction of the barriers could adversely affect boat traffic, thereby reducing recreational opportunities. This is considered a significant adverse impact.

The Ecosystem Restoration Program includes a provision to reduce boat traffic and boat speeds in areas where levees or channel islands and their associated shallow water and riparian habitat are susceptible to wake damage. Reduction of boat traffic in some areas could result in an increase in traffic in other areas causing congestion during peak use days in the summer months. Additionally, mandatory reduction in speed in some areas would create a change in recreation activities from the existing condition. There is currently no speed limit in the Delta except surrounding marinas where speed limits are 5 mph. Although the ERP does not currently specify proposed speed requirements, it could be assumed that the new regulations would alter personal watercraft and boat behavior and could decrease the number of use-days for boating in the Delta. This would be a potentially significant impact.

Recreation Economics. Larger populations of anadromous fish species are expected to lead to increased recreational fishing, generating positive changes in recreational spending and associated benefits in the Delta Region.

The Ecosystem Restoration Program is also expected to result in large, positive changes in populations of bird species important for wildlife viewing and hunting. This impact is expected to have a corresponding positive effect on recreation spending and user benefits in the Delta Region.

Social Well-Being. Implementation of the ERP in the Delta would result in the conversion of agricultural lands to restored habitat. In

Alternative 1 this conversion could result in a change in the number of jobs for workers in recreation-related industry (tourism, food service and lodgings, sales).

A loss in farm-related jobs could occur in conjunction with an increase in recreation-related jobs. These changes would affect different segments of the population. Displaced farm workers may not easily be absorbed by increased recreational or short-term construction-related employment opportunities, resulting in a potentially significant impact to the social well-being of the farm worker community.

Commercial Fisheries. Commercial fishing for crayfish and baitfish species in the Delta and Suisun Bay would not change appreciably under the Program Alternatives relative to no action conditions. Harvest revenue and net income generated by commercial fishing have not been estimated but are assumed to be minor in the context of the regional economy.

Water Quality

Recreational Opportunities. The Water Quality Program is intended to provide improved water quality for all users of water from the Delta, including recreational uses. Improved water quality for the Delta would have several indirect beneficial impacts on recreation. Existing health hazards related to ingesting raw water from the Delta during recreational activities would diminish. Water clarity should improve, resulting in improved aesthetics. None of the actions required to implement the Water Quality Program are expected to negatively impact recreation.

Recreation Economics. Elements of the Water Quality Program could result in improved fishery conditions, river recreation conditions, and wildlife refuge conditions throughout the Delta Region. Improved water quality in rivers and the Delta should lead to healthier anadromous fish populations and improved conditions for water-contact recreation in the Delta Region, resulting in increased spending and user benefits.

Social Well-Being. Improved water quality in the Delta is expected to result indirectly in more jobs for recreation workers, as described for the ERP.

Levee System Integrity

Recreational Opportunities. In general, the Levee System Integrity Program is expected to result in beneficial impacts to recreation facilities and opportunities. The development of beach slopes associated with levees should result in increased recreational opportunities and facilities and result in an overall positive impact on recreation. The development of new beach areas may also result in an increase in recreation use.

Some levee projects may require that existing recreation facilities or use be redirected both temporarily or permanently. However, until it is clear what current activities and facilities are proposed to be redirected, it is not possible to state what the impacts to recreation would be. Impacts could include elimination of an existing opportunity in a specific portion of the Delta, such as boat ramps, piers or marinas. If this occurs, specific recreation enhancements would be required for mitigation.

The Levee System Integrity Program is intended to reduce the risk to land uses from catastrophic breaching of Delta levees. Currently, many recreation areas within the Delta, such as camping facilities and boat launches, are at risk of damage if a levee in the vicinity were to be breached. The Levee System Integrity Program would reduce this risk.

During levee repairs and strengthening, some temporary impacts to recreation activities could occur. Additionally, it is possible that in some locations the repair or modification of a specific levee could encroach on an existing recreation facility, resulting in a decrease in size or function of the facility or an elimination of the facility completely.

Recreation Economics. The enhancement of opportunities for levee-associated recreation in the Delta Region under the Levee System Integrity Program could increase sport fishing from banks

and increase other types of recreation along rivers in the Delta, resulting in an increase in recreation spending and user benefits.

Water Use Efficiency

Recreational Opportunities. To the extent that efficiency improvements reduce wetlands or riparian areas that depend upon existing irrigation losses and to the extent that changes in irrigation pricing act to induce crop changes or act as a disincentive to after-harvest flooding of fields (especially rice), waterfowl habitat may be reduced. This could have adverse impacts on the availability of lands for recreational hunting or for bird watching. These impacts are not expected to be significant in the Delta Region.

Recreation Economics. The Water Use Efficiency Program would probably not result in substantial effects on recreation economic variables in the Delta Region.

Bay Region

Storage and Conveyance

Impacts on recreational resources in the Bay Region due to the storage and conveyance features are expected to be negligible.

Ecosystem Restoration

Recreational Opportunities. The ERP includes several actions involving restoration in the Bay Region. In general, these actions are similar to those proposed for the Delta Region described above and are anticipated to have similar impacts on recreation activities in the Bay Region.

Recreation Economics. The Ecosystem Restoration Program contains a number of programmatic actions that could improve spawning, rearing, and survival conditions for sport species, including chinook salmon. Improved spawning, rearing, and survival conditions should lead to increased populations of sport fish in the Bay Region. Larger populations could lead to increased recreational fishing, generating positive changes in recreational spending and benefits in the Bay Region.

Commercial Fisheries. CALFED actions could lead to larger ocean populations of chinook salmon originating from the Central Valley river system. It is difficult to assess the extent of the economic benefit to the commercial fishing industry. Ocean populations are comprised of salmon originating from various systems along the Pacific Coast, including Klamath and Snake River salmon whose populations are protected by catch restrictions. Because populations are intermingled, restrictions on the catch of Klamath and Snake River salmon can severely restrict the harvest of Central Valley chinook salmon. Assuming commercial and recreational salmon harvest restrictions are eased in the future for protected stocks, increases in populations of Central Valley chinook would lead to substantially increased salmon catch levels, spending, and net benefits.

Water Quality

Elements of the Water Quality Program could result in improved fishery conditions, river recreation conditions, and wildlife refuge conditions in the Bay Region. Improved water quality in the Bay should lead to healthier anadromous fish populations and improved conditions for water-contact recreation in the Bay Region, resulting in increased spending and user benefits.

Water Use Efficiency

The Water Use Efficiency Program would have minor impacts on recreational resources in the Bay Region.

Coordinated Watershed Management

Potential restoration activities in the Bay Region's upper watershed areas could result in short-term impacts during construction and deconstruction. Vegetation and habitat restoration activities ands channel improvements (e.g., bio-technical bank stabilization) in the upper watershed areas of the Bay Region could result in both positive (beneficial) and negative (adverse) impacts to

recreation resources. For example, restoring freshwater marshes and tidal wetlands may create new recreation opportunities for hunters. To the extent that restoration actions result in increased visitation by birds and other wildlife, the effect on recreation would likely include expanded opportunities for wildlife viewing.

Restoration and channel improvement activities may result in some adverse impacts to recreation resources as a result of construction activities. During construction, recreation areas may be temporarily closed to the public and some recreation facilities, such as piers or marinas, could be temporarily or permanently closed. This could be considered a significant impact.

Potential road improvement would not adversely affect recreation opportunities, although road removals could limit access to recreation areas within the watershed.

Sacramento River and San Joaquin River Regions

Storage and Conveyance

The different conveyance configurations are not expected to impact recreational resources in the Sacramento and San Joaquin River regions. A similar range of storage options is included in each of the alternatives, and their consequences on recreational resources would be similar.

The impacts to recreation associated with raising the height of existing dams would result in inundation of some existing recreation facilities. These would generally be short-term temporary impacts, since similar recreational opportunities would be developed around the new shoreline. An enlarged reservoir would have greater surface area, potentially providing additional area for boating, and a longer shoreline, providing a larger area for lakeside camping facilities, boat launches, marinas, and resorts.

The nature and significance of impacts associated with the development of new off-stream storage reservoirs would depend greatly on the location of the reservoir, the existing facilities in the area of inundation and the quality of the habitat inundated. In general, there would be an irretrievable loss of some land-based recreational opportunities. A new reservoir could attract many visitors to the vicinity, further impacting recreational values in the surrounding area. A new reservoir would provide new recreation opportunities for boating, swimming, fishing, camping, and other land and water-based activities.

New on-stream storage reservoirs would have potentially much greater irretrievable impacts to recreation than off-stream reservoirs. In addition to any land area which would be inundated, a new on-stream reservoir would also inundate some length of existing free-flowing river which, depending on the river and the location, may be an existing recreation resource for rafting, kayaking, and fishing and other water-related activities. Additionally, operation of an on-stream reservoir could result in altered downstream flows and higher or lower water temperatures, both of which could impact existing recreation. A new on-stream reservoir would create new recreation opportunities; however, reservoir recreation could not fully mitigate for recreation activities occurring within a free-flowing river channel.

Impacts from off-aqueduct storage would depend on the location and area to be inundated. Impacts would probably be similar to off-stream reservoirs, as described above.

The development of 250 TAF of groundwater storage within the Sacramento River Region is not anticipated to result in significant impacts to recreation.

As a result of the smaller amount of surface storage in the San Joaquin River Region, the recreational benefits of surface storage are expected to be somewhat less than in the Sacramento River Region.

Recreation Economics. The range of economic impacts in the Sacramento River Region due to storage and conveyance options is expected to be similar for each alternative. Moderate economic benefits are expected to result from increased recreational opportunities associated with storage.

Moderate, positive changes in these levels of spending and user benefits are predicted under Alternative 1 configurations.

Ecosystem Restoration

Recreational Opportunities. A large number of the ERP actions planned for the Sacramento River Region have been developed to recover declining fish populations.

There would likely be an increase in sport fishing opportunities once fish populations recover and reach target levels. The conversion of existing agricultural lands to riparian habitat may also increase recreation opportunities for sport fishing by providing additional area for shoreline access.

An additional impact to recreation could result from temperature changes of Nimbus Dam releases. Depending on the timing and extent of temperature changes, if water is significantly cooler than the existing conditions, recreation use for activities such as swimming, tubing, canoeing, kayaking, and rafting could be reduced.

Recreation Economics. The Ecosystem Restoration Program contains a number of programmatic actions that could improve spawning, rearing, and survival conditions for sport species, including chinook salmon. Improved spawning, rearing, and survival conditions should lead to increased populations of sport fish in the Sacramento River Region. Larger populations could lead to increased recreational fishing, generating positive changes in recreational spending and benefits in the Sacramento River Region.

Although these actions could lead to larger ocean populations of chinook salmon originating from the Central Valley river system, it is difficult to assess the extent of the economic benefit to the recreational fishing industry in the Sacramento River Region. Ocean populations comprise salmon originating from various systems along the Pacific Coast, including Klamath and Snake River salmon, whose populations are protected by catch restrictions. Because populations are intermingled, restrictions on the catch of Klamath and Snake River salmon can severely restrict the harvest of Central Valley chinook salmon. Assuming recreational salmon harvest restrictions are eased in the future for protected stocks, increases in ocean populations of Central Valley chinook salmon could lead to substantially increased salmon catch levels, spending, and net benefits in the Sacramento River Region.

Water Quality

Elements of the Water Quality Program could result in improved fishery conditions, river recreation conditions, and wildlife refuge conditions throughout the Sacramento River Region. The economic benefits to the recreation fishing industries of improved water quality are difficult to judge; however, improved water quality in rivers should lead to healthier anadromous fish populations and improved conditions for water-contact recreation.

Water Use Efficiency

The Water Use Efficiency Program could result in reduced opportunities for waterfowl hunting and wildlife viewing and associated reductions in spending and net benefits from potential reductions in wetlands and riparian areas that depend on irrigation runoff and after-harvest field flooding. These adverse impacts on spending and net benefits are not expected to be significant.

Alternatively, the Water Use Efficiency Program could lead to reduced diversions, which would provide more water for in-stream purposes. This impact could provide greater opportunities for water-dependent recreation activities, both along affected rivers and at reservoirs. Recreation use at affected rivers and reservoirs and associated spending and net benefits could increase.

Coordinated Watershed Management

Potential impacts on recreation resources from vegetation and habitat restoration activities, as well as channel improvements, would generally be the same as those described above for the Bay Region. Road improvements would similarly not adversely affect recreation resources in these

areas, although road removals could limit access to recreation areas within the watershed.

SWP and CVP Service Areas Outside the Central Valley

Storage and Conveyance

Alternatives 1 and 2 would have negligible beneficial impacts on recreational resources due to improved water quality.

In Alternative 3, water quality delivered is expected to be greatly improved because of operations of the isolated facilities. This is expected to result in beneficial impacts on water-based recreational opportunities at receiving reservoirs and canals.

Water Use Efficiency

The Water Use Efficiency Program may provide an opportunity to reoperate some reservoirs, which could change the availability of water to support recreation activities. It is expected that implementing more stringent conservation measures would help conserve existing supplies to meet a greater future demand. This action could reduce the flexibility to delay drawdown of reservoirs and could negatively affect opportunities for reservoir recreation. This impact, which is not expected to be significant, could reduce spending and user benefits at reservoirs in the SWP and CVP Service Areas.

8.3.2.5 Comparison of Program Alternatives to Existing Conditions

Comparison of Program Alternatives to existing conditions indicates that:

- All potentially significant adverse impacts that were identified when compared to the No Action Alternative would still be considered significant when compared to existing conditions.
- No additional significant environmental consequences have been identified when Program effects are compared to existing conditions as opposed to No Action.
- The beneficial effects of the Program would still be beneficial when compared to existing conditions.

8.3.2.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

A comprehensive recreation planning program would be developed concurrent with the development of detailed ecosystem and levee restoration and storage and conveyance projects. This recreation program would address existing deficiencies in recreation, particularly in the Delta, as well as provide for appropriate modifications and additions to recreation facilities that may be required to accommodate other CALFED projects.

Comprehensive recreation planning would serve to mitigate potential impacts to boating access. Comprehensive planning would include an overall assessment existing recreation deficits and projected modifications due to the ERP and other CALFED programs. This planning effort would result in proposed recreation projects which, when implemented, would act as mitigations for impacts to recreation resulting from habitat restoration activities.

The following mitigation measures would be implemented to minimize impacts to existing recreation use:

- Construction required for storage, conveyance, ecosystem restoration projects and levee system integrity, which could affect nearby recreation, would be conducted outside of the recreation peak-season, to the extent possible.

- In-kind facilities would be provided when existing facilities are temporarily or permanently eliminated.

- The fluctuation of water levels of existing and new reservoirs would be minimized.

- If boating circulation in the Delta is to be modified due to temporary, seasonal or permanent channel closures, comprehensive analysis of boating circulation must be conducted to assure that appropriate alternative routes are identified and clearly marked.

- If program actions require the permanent closure of a recreation facility, mitigation should include the relocation of a similar facility in a nearby location with similar amenities.

- To the extent possible, the restoration and redesign of existing levees and the design of new levees should accommodate vehicular access and parking for shoreline fishing, boat launching, swimming, hiking, bicycling, and wildlife viewing. Also, if levee projects are designed to provide access to waterfront parcels of useable land on island edges, then opportunities for day use boating and camping can be created.

8.3.2.7 Potentially Significant Unavoidable Impacts

No potentially significant unavoidable impacts were identified.

8.4 FLOOD CONTROL

Summary

One objective of the CALFED Program is to manage the risk of losing existing land uses due to deterioration of existing Delta conveyance and flood control facilities, since loss of these facilities could result in the catastrophic inundation of Delta islands.

Table 8.4-1 summarizes the impacts of the Program alternatives on flood control.

No Action Alternative. Expected annual losses under the No Action Alternative could be as much as $400 million.

Storage and Conveyance. Flood stages would generally be similar to existing levels. Localized south Delta stage increases could result during the non-flood season due to minor flow impediments, but would not significantly affect the flood control system. Seepage through levees would continue as an ongoing process, especially in the Delta Region.

Under Alternative 1, increases in shallow flooding for habitat would increase the possibility that seepage could be an impact when comparing configurations. Inspection, maintenance, and repair of the flood control system would be easier than under existing conditions because setback levees would be designed to facilitate these tasks. However, emergency response capabilities would not be significantly changed until the Levee System Integrity Program is fully implemented.

Wind-generated wave erosion would increase near setback levees and on flooded islands, as greater expanses of water would be subject to wind-fetch.

Less-than-significant increases in sedimentation could result from generally reduced velocities in shallow flooded areas established for habitat. Increased settlement is expected for levees that could be set back as far as 500 feet from the current levee locations, requiring long construction periods and increased initial maintenance, but is not considered a significant impact if planned as part of construction and monitored over the long term. Channel capacities would be similar to existing conditions, with less-than-significant decreases possible where sedimentation accompanies slow velocities.

Flood Control Impacts

- Under the **No Action Alternative** land and property values in the Delta Region are expected to increase, but flood protection levels would slightly decline. The Delta Region may have up to $400 million annual expected losses to land and property. The Sacramento River and San Joaquin River regions would have potential increased levels of flood protection resulting from ongoing programs, but may have an increased value of resources at risk of flooding.
- **Storage and Conveyance**

  Alternative 1. Storage in the Sacramento River and San Joaquin River regions would provide small potential benefits or costs to flood control.

  Alternative 2 is expected to have benefits from Delta channel improvements as well as these described for Alternative 2.

  Alternative 3 isolated conveyance facility improvements are expected to provide additional benefits to those described for Alternative 2 as well as those described for Alternative 2.
- **Ecosystem Restoration, Water Quality and Levee System Integrity** program actions are expected to have beneficial impacts on flood control.

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Flood Protection	+	+	+	+	+	+	+	+	+	+	+	+
Bay Region												
Flood Protection	+	+	+	+	+	+	+	+	+	+	+	+
Sacramento River Region												
Flood Protection	+	+	+	+	+	+	+	+	+	+	+	+
San Joaquin River Region												
Flood Protection	+	+	+	+	+	+	+	+	+	+	+	+
SWP and CVP Service Areas Outside the Central Valley												
Flood Protection	□	□	□	□	□	□	□	□	□	□	□	□

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:

Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
o	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 8.4-1. Summary of Environmental Impacts Related to Flood Control

Subsidence would continue to occur where peat soils degrade.

In Alternatives 2 and 3, flood stages would decrease in the north Delta Region. Localized south Delta stage increases could occur during the non-flood season due to minor flow impediments, but would not significantly affect the flood control system.

Levee scour would be reduced at locations where channel widening is planned, with less-than-significant adverse increases in sedimentation associated with slower flow velocities. Channel widening would improve floodflow conveyance capacities.

Under all alternatives, annual loss is estimated to decline by as much as 65%, to about $140 million on an expected annual basis.

Costs associated with flood control are also estimated to be substantial. Depending on how these costs are allocated to beneficiaries, they could induce changes in land use, water use, property values, and regional economic activity.

Additional changes in costs and benefits could occur in the Sacramento River and San Joaquin River regions due to reoperation for Ecosystem Restoration Program (ERP) flows and diversion of water to offstream storage. Existence of offstream storage sites could provide flood control benefits to downsteam residents, and could allow some reoperation of existing reservoirs for potential flood control benefit. No CALFED actions are expected to influence flood control costs or benefits in the Bay Region or in the SWP and CVP Areas Outside the Central Valley.

8.4.1 Affected Environment/ Existing Conditions

The flood control systems described here are governed by federal, state, and local agencies. Levee systems are referred to as federal project levees or local non-project levees. The San Joaquin River and Sacramento River Flood Control Projects, built by the Corps and turned over to the state for maintenance, provide flood control for the lower reaches of these rivers and into the Delta.

Project levees are associated primarily with conveying floodflows and maintaining the Sacramento Deep Water Ship Channel. The project levees work in conjunction with upstream reservoirs and bypass systems to protect adjacent lands against flooding, and to maintain flow velocities adequate to carry out sediments that might impede navigation. Project levees within the Delta are maintained to federal standards by the state or by local landowners under state supervision.

Non-project levees are levees constructed and maintained by local reclamation districts. Non-project levees constitute about 65% of levees in the Delta flood control system. Maintaining non-project levees is largely financed by landowners, and the costs are shared with the state. Non-project levees often are maintained to widely ranging and less stringent standards than those applied to project levees.

Flood management operations are coordinated by an integrated team of representatives from federal, state, and local agencies.

In general, reservoir water level management is governed by an approved flood control diagram. This diagram essentially defines the amount of space that should be available to store flood waters at various times of the year. Each reservoir has a unique flood control diagram that is based on the following criteria:

- The flood response characteristics of the basin,
- Agreements for the level of flood protection to be provided by the reservoir,
- Obligations for water conservation, and
- Requirements necessary to maintain environmental conditions in the downstream water courses.

The primary issues of concern to upper watersheds are particular land use practices that can cause

reductions in the retention and storage time of flows from the upper watershed areas, possibly resulting in increased peak runoff events and excessive erosion of hill slopes, streambanks and streambeds, and subsequent sedimentation in reservoirs.

8.4.1.1 Delta Region

Historical Perspective. Until the 1850s, the Delta region was mostly a tidal marsh, part of an interconnected estuary system that included the Suisun Marsh and San Francisco Bay. During the flood season, the Delta became a great inland lake, and when the floodwaters receded, the network of sloughs and channels reappeared throughout the marsh. Early settlers avoided the Delta for two reasons. First, the attempts at levee construction were hampered by high costs and lack of mechanical equipment. Second, there were inadequate laws giving landowners clear title to wetlands and seasonally flooded lands. The discovery of gold at Sutter's Mill in the foothills of the Sierra Nevada resulted in a large inflow of people. The growing population increased the demand for food. Congress passed the "Arkansas Act" in 1850, which warranted title of wetlands and flooded lands to private ownership. The higher demand for food and clear ownership laws accelerated land reclamation in the Delta.

Land surveys were the first step in developing the Delta. The Delta channels were surveyed in 1841 and again in 1849. These surveys facilitated transportation and helped open the Delta and upstream communities to increased trade with the San Francisco Bay Area. Already experiencing a population boom because of the Gold Rush, Delta and northern California communities expanded even more as travel to the area became easier and less expensive.

Development of the Delta began in late 1850 when the Federal Swamp Land Act conveyed ownership of all swamp and overflow land, including Delta marshes, from the Federal Government to the State of California. Proceeds from the state's sale of swampland were to go toward reclaiming them, primarily for conversion to agricultural land.

In 1861, the State Legislature created the Board of Swamp and Overflowed Land Commissioners to manage reclamation projects. In 1866, the board's authority was transferred to county boards of supervisors. The first reclamation projects began in 1869, when developers constructed 4-foot-high by 12-foot-wide levees on Sherman and Twitchell islands using the peat soils of the Delta. Since then, levee construction has improved and expanded to 1,100 miles throughout the Delta to protect agricultural and urban lands against flooding.

Shortly after the completion of the levees in 1913, the construction of a complicated series of human-made waterways and water development facilities began in the Delta. The purpose of constructed waterways was to provide navigation, improve water circulation, or to obtain material for levee construction. Water development facilities were constructed to ship water from the Delta to other parts of the State for agricultural, urban, and other uses.

Since reclamation, each of the 70 major islands or tracts have flooded at least once. (Table 8.4.1-1) About 100 failures have occurred since the early 1900s. Except for Big Break, Little Franks, Franks, and Little Holland tracts, and Little Mandeville, Lower Sherman, and Mildred islands, flooded islands historically have been restored even when the cost of repairs exceeded the appraised value of the land.

Flooding of reclaimed Delta lands was a frequent result of levee erosion and overtopping during high-flow events. Since construction of the CVP and SWP, the frequency of levee failure due to overtopping has decreased. Delta levees still fail, but the most frequent cause is either high hydrostatic pressure, resulting in piping and stability failures, or overtopping due to high tides and high winds.

With the advent of the large state and federal water projects that allow more control over floodflows, flooding generally has been restricted to inundation of individual islands or tracts resulting from levee instability or overtopping. Since 1950, the construction of upstream dams has allowed dam

and reservoir managers to detain flows. This management ability and control of flood waters have further reduced the threat of overtopping. Between 1950 and 1986, 60% of levee failures have been due to mass instability, commonly caused by a combination of subsidence and hydrostatic pressure, and 40% has been due to overtopping.

In the study area, the extensive levee system, constructed waterways (the Contra Costa Canal and Stockton Deep Water Channel), water development facilities, groundwater development, and railroads enabled irrigated agriculture and urban communities to extend deeper into the Delta. Between 1920 and 1950, irrigated agriculture development increased rapidly from 2.7 million acres to over 4.7 million acres for the entire Central Valley. During the same period, urban land use also expanded. Private water development projects by cities and utility districts assisted in the expansion of urban development throughout California.

Existing Conditions. The flood control facilities that protect the Delta Region include the following elements:

- Levees
- Delta Cross Channel (DCC) Control Gates
- Suisun Marsh Salinity Control Gates

An additional resource at work in the Delta Region is the system of gates that protects the Suisun Marsh from salinity intrusion during low-flow periods. They also provide minimal incidental flood protection.

The Delta levee system initially served to control island flooding during periods of high flow. Because of island subsidence due to peat oxidation, however, it is now necessary for the levee system to prevent inundation during normal runoff and tidal cycles. About 1,100 miles of levees in the Delta provide flood protection to the 76 islands and tracts located there. Figure 8.4.1-1 shows the general locations of the federal project levees and local non-project levees in the Delta.

Year	Acres Inundated (1,000)
1900	12.9
1901	20.8
1902	14.7
1904	75.9
1906	63.1
1907	114.7
1908	12.4
1909	43.5
1911	9.2
1925	11.8
1926	3.4
1927	2.2
1928	8.9
1932	3.0
1936	5.1
1937	3.0
1938	19.0
1950	20.9
1955	11.5
1958	11.2
1969	10.9
1972	13.0
1980	15.7
1982	9.4

SOURCES:
Data for 1900 to 1958, Association of State Water Project Agencies 1976.
Data for 1969 to 1982, DWR 1984.

Table 8.4.1-1. Historical Floods in the Sacramento-San Joaquin Delta, 1900 to 1982

The major factors influencing Delta water stage include high flows, high tide, and wind. Historically, the highest water stages usually have occurred from December through February, when high runoff combines with high tides and wind-generated waves. Floodflow-carrying capacity of rivers and channels surrounding the Delta islands year flood stage elevations, which generally range from 6.5 to 7.5 feet above mean sea level (msl) in the western and central Delta where the most tidal influence is present. However, the 100-year flood stage ranges from 14.0 to 17.0 feet above msl in the north Delta (near New Hope Tract and Courtland, respectively); and in the south Delta (near Stewart Tract on the Old and Middle river channels), where the stream flows become

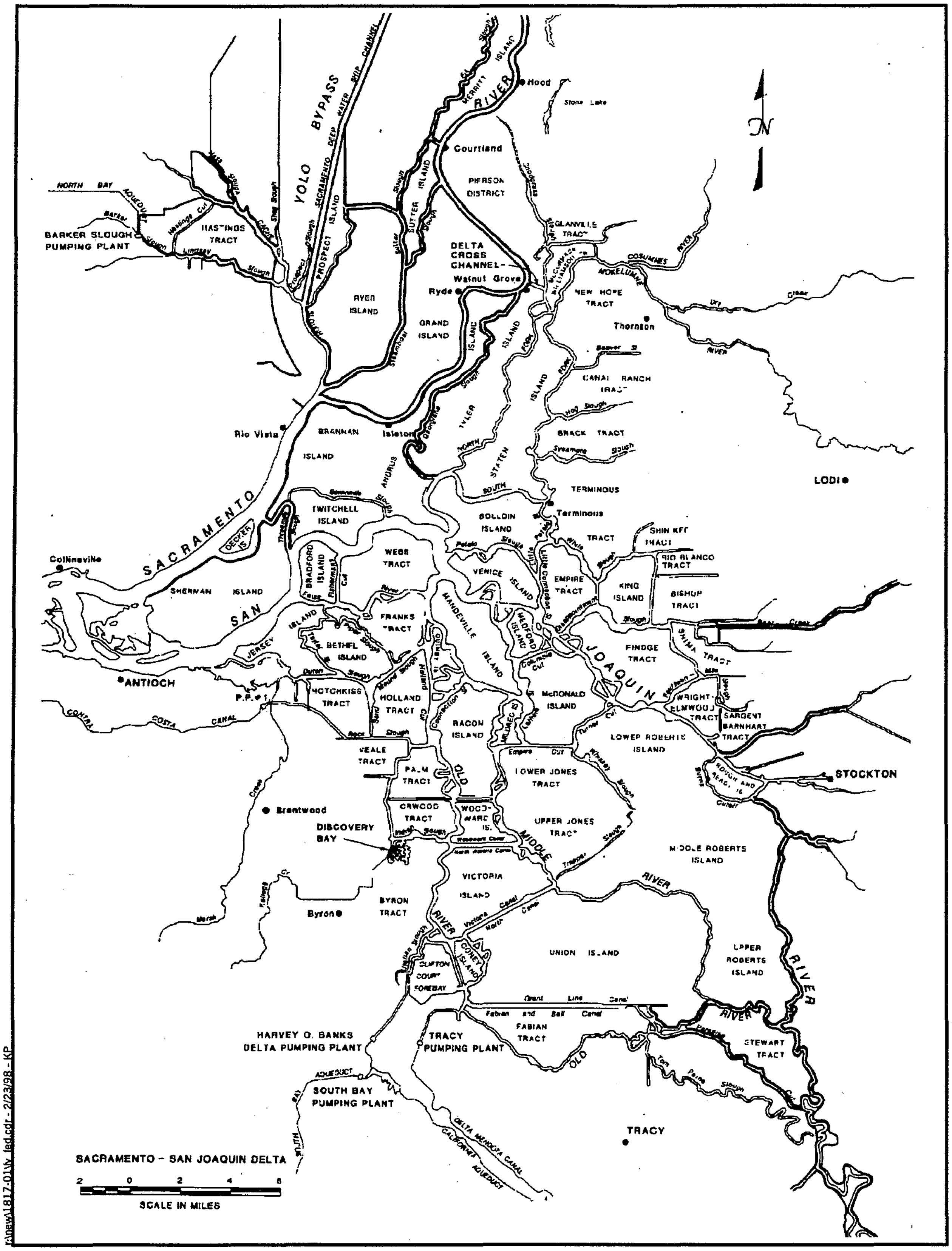

Figure 8.4.1-1a. Federal Flood Control Project Levees

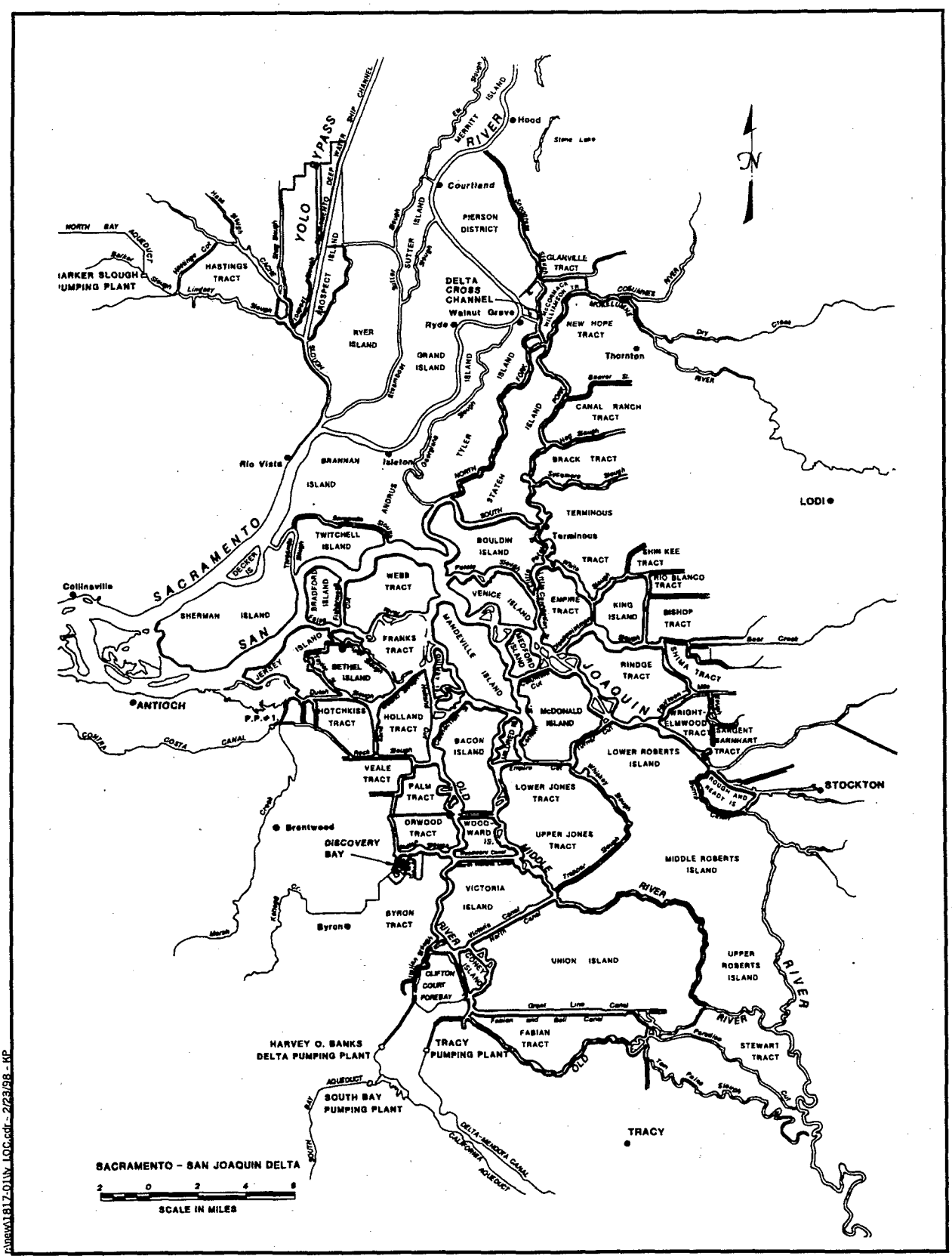

Figure 8.4.1-1b. Local Non-Project Levees in Delta

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dominant during large floods. These flood stage ranges (6.5 to 17.0 feet above msl) emphasize the importance of maintaining levees to varying heights and strengths throughout the Delta to protect against flooding where channel geometry and flow conditions can cause rapid stage increases during storms.

The stability of a levee depends on the strength of its foundation materials and its internal strength. If used in the proper proportions and engineered correctly, sands, silts, and clays can be used to build stable levees. High percentages of sands or peat within or beneath a levee, however, can weaken its stability. East Delta levees generally are supported by foundation materials composed of clay, silt, and sand, but some central and western Delta levees primarily rest on peat with some alluvial clay, bay mud, sand, and silt layers. While inorganic materials (sands, silts, and clays) provide adequate foundations, uncompressed peat is highly deformable and unstable.

Levees can fail by three often interrelated mechanisms: overtopping, seepage and piping, and instability. Several other factors can damage levees and eventually lead to levee failure. These include erosion, seismic movements, rodent burrows, wind and wave action, dead or decaying roots from levee vegetation (living vegetation also can provide some protection against levee erosion by reducing wave and wind action), and subsidence. Subsidence of some Delta Islands has been measured at rates of up to 1 to 3 inches per year, and some areas in the central and western Delta are more than 15 feet below sea level.

The Delta is subject to seismic activity from several faults. The San Andreas Fault System has the greatest potential to impact Delta seismicity. The Hayward Fault is closer to the Delta and has the second highest potential to impact Delta seismicity with perhaps a slightly decreased level of shaking than could result from the San Andreas Fault. Other faults, including the Healdsburg-Rogers Creek Fault, the Maacama Fault, the Coast Range Sierra Nevada Boundary Zone, and Green Valley-Cordelia and Concord faults could impact Delta seismicity to a much lesser level of shaking and/or duration.

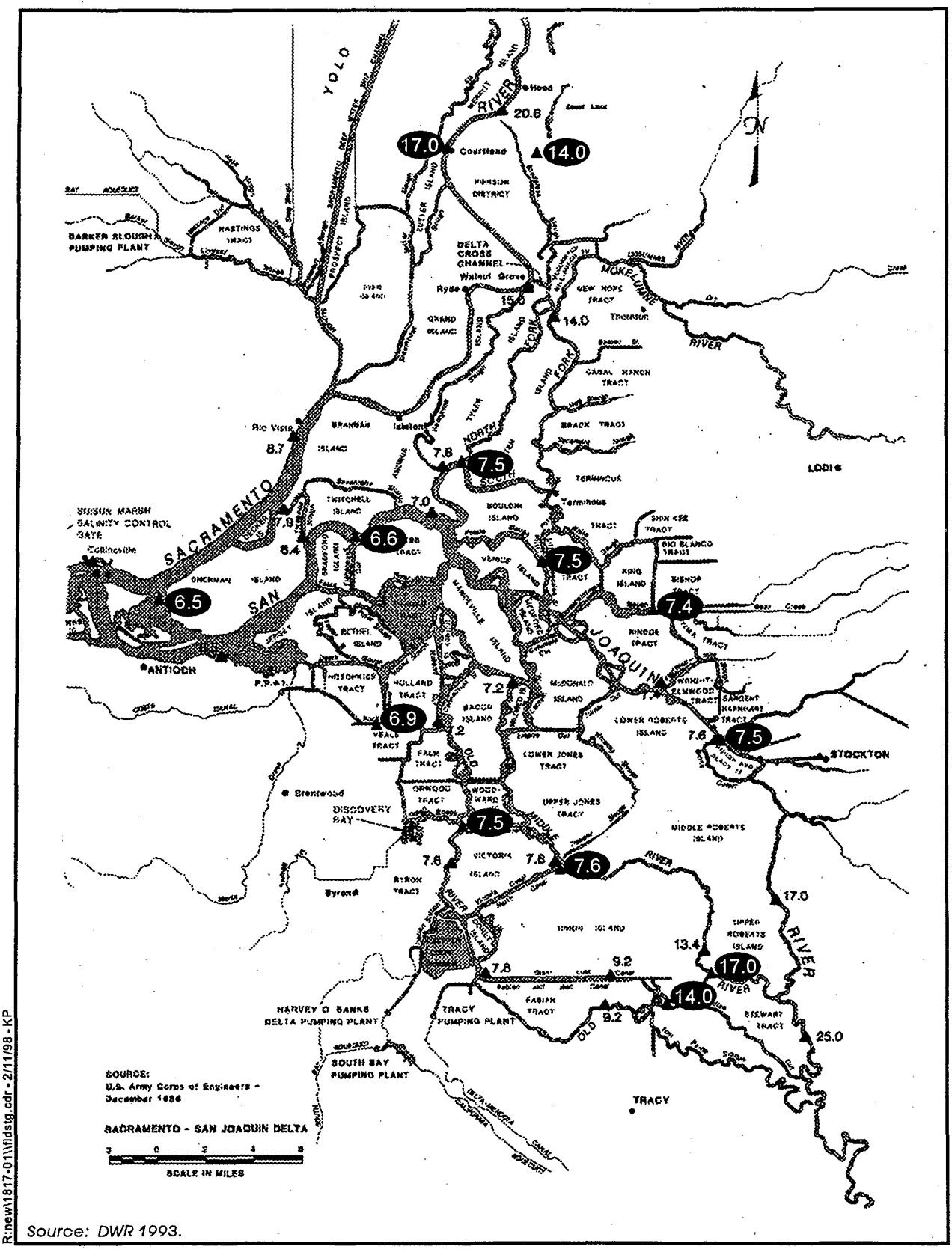
Delta Cross Channel control gates are closed during high flows and floods on the Sacramento River. During floods, when stages on the Sacramento River exceed those on Mokelumne river channels, the gates prevent water from spilling out of the Sacramento River into the Mokelumne River and flooding leveed and non-leveed lands. If storms hit central California while the river stages are lower on the Sacramento River, the DCC gates can be opened to spill high flows out of the Mokelumne system and to reduce stages on the north and south forks of the Mokelumne. This transfers floodwater from the non-project levees of the Mokelumne River to the Sacramento River, which is protected with project levees.

The Suisun Marsh Salinity Control Gates project was implemented in 1988. The gate system works primarily to protect the marsh from the saline waters of the Bay during periods of low delta outflows. The Suisun Marsh salinity control gates do not play a specific role in flood control but are part of the affected environment that should be considered during CALFED solution evaluation.

The Yolo Bypass carries five-sixths of the volume of the Sacramento River at peak floodflows. The lower end of the bypass is in the Delta and provides significant spawning habitat for Delta smelt.

Unlike the system of reservoirs and weirs that control the magnitude of flooding on the rivers upstream of the Delta, the flood control system in the Delta (aside from the DCC control gates) operates passively. However, the levee system does require maintenance, monitoring, and improvement, particularly during floods, to maximize the level of protection provided by the levee system.

Of the Delta lowlands, approximately 380,000 acres primarily consist of peat soil. When exposed to air the peat oxidizes into a fine dust, which is easily eroded by wind and water, resulting in land subsidence. Cultivation accelerates the oxidation of peat soils. Land subsidence is a serious problem in the Delta because it jeopardizes the stability of the levees, which, in turn, causes flooding. From



Source: DWR 1993.

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Figure 8.4.1-2. Flood Stage Elevations in the Sacramento - San Joaquin Delta

1950 to 1986, there were 15 stability-failure floods and eight overtopping floods in the region. Levees used to fail from overtopping, but now they tend to fail from instability.

Approximately 71,000 acres of the Delta are developed for urban uses, with most of the development located on the periphery of the Delta in Sacramento, San Joaquin, and Contra Costa counties. The majority of urban development is located in the legal Delta, with less than 1,800 acres of developed land in the Suisun Marsh and Bay area. Urban development includes residential, commercial, industrial, and other urban uses.

Much of the urban development in the study area is located in the incorporated cities (Antioch, Brentwood, Isleton, Pittsburg, Rio Vista, and Tracy are located entirely within the Delta and Sacramento, Stockton, and West Sacramento are located partially within the legal Delta), and the 14 unincorporated communities within the legal Delta (Discover Bay, Oakley, Bethel, Courtland, Freeport, Hood, Ryde, Walnut Grove, Byron, Terminous, Thornton, Hastings Tract, and Clarksburg).

Costs of maintaining and repairing the levee system in the Delta are substantial. In some instances, the expenditures exceeded the appraised value of the island or tract being protected. The average annual cost of levee maintenance on non-project levees in the Delta ranged from $3,000 to $165,000 per levee mile, averaging $11,800 per levee mile between 1981 and 1991. From 1981 to 1991, $63 million was spent to repair levees. Beginning in 1988, state cost-sharing authorization was increased to 75% of costs exceeding $1,000 per mile under the Delta Flood Protection Act of 1988. The act provided $60 million over 10 years to control subsidence and rehabilitate levees on eight western Delta islands and an additional $60 million for Delta-wide levee maintenance and upgrades.

Emergency expenditures by federal and state governments under the Federal Emergency Management Act (FEMA) and the Natural Disaster Assistance Act, respectively, from 1980 to 1986 was 137.3 million ($65 million FEMA, $26.5 million Natural Disaster Assistance Act, and $45.8 million by local sponsors). The cost per island acre of these repairs ranged from less than $410 to $4,000. Additionally, the Corps has spent up to $120 million in 1997 under their PL 84-99 flood fight and rehabilitation authority.

Although flooded islands can be drained by pumping floodwaters from the island after the levees are closed and reinforced, the cost can be substantial. According to DWR estimates, the total emergency cost resulting from levee failures was $97 million between 1980 and 1986. In addition, Delta levee maintenance program expenditures were estimated at $64 million between 1981 and 1991.

8.4.1.2 Bay Region

Historical Perspective. The land in the Bay Region has historically suffered little from flooding emanating from the Sacramento-San Joaquin River system. Extensive local flooding has occurred in the Bay Area; however, this flooding has been a result of waters emanating from sources other than the Delta.

Bay water is usually saline to brackish, making reclamation of the surrounding marshlands unattractive for agricultural purposes. Thus, improvements to control flooding have been minimal and now are directed mainly toward ecological habitat creation and preservation.

The upper watersheds of the San Francisco Bay Region are characterized by small, steeply sloping watersheds, and rapid runoff. The eastern slopes of the coastal hills once contained redwood forests that were largely logged off by the end of the 19th century. Most of the urban development and road building in upland areas has occurred since World War II.

Existing Conditions. The broad, deep channels and large bays present downstream from the Suisun Marsh have not demonstrated significant variability in water level beyond that which occurs as a result of natural tidal fluctuations (except for sea level rise). Historical records indicate that the sea level has the potential to affect long-term

flooding, water quality, and water management in the Delta. Potential sea level changes associated with climate change are discussed in Chapter 11, (Section 11.2.13).

Average annual precipitation in the upper watershed areas ranges from 25 to 50 inches. Average annual runoff ranges from 10 to 20 inches (Rantz 1968). Flooding is generally confined to reclaimed marshland along the Bay Margin, and occurs when high runoff conditions are combined with high tides in the Bay. Besides direct flooding, flood-related problems include insufficient capacity of some municipal wastewater treatment plants that must discharge.

No significant flood control resources are at work in the Bay Region to control floods emanating from the Delta.

8.4.1.3 Sacramento River Region

Historical Perspective. The bottomlands of the Sacramento River Region consisted of tule marshlands prior to the Gold Rush of the mid-19th century. Before the beginning of agricultural development in the Sacramento Valley, large portions of the valley were subject to periodic inundation by floodflows from the Sacramento River and its tributaries. The floodplain varied in width from 2 to 30 miles.

Individual landowners began flood control system development in the mid-1800s when the Gold Rush increased demands for food. By 1884, many miles of levees had been completed, and some areas had formed flood protection districts. These first levees were constructed by hand and were demonstratively inadequate, based on the damage that occurred during high-flow periods.

This damage was exacerbated by hydraulic mining in the mountains. The mining activities resulted in large volumes of silt, sand, and gravel being deposited into the rivers of the Sacramento Basin. These sediments were deposited in the channels and increased the flood stages associated with high-flow events by reducing channel capacity.

In the upper watersheds of the Sacramento River Region, fire has historically been the principal mechanism by which nutrients in forest material were recycled. However, since the late 1800s, the frequency of fires has been reduced in the upper watershed, with the effect that less frequent fires burn larger areas with higher intensity and greater environmental damage. Catastrophic wildfires produce more intensive and extensive changes in watershed conditions that any other form of disturbance. As a consequence of fire suppression and logging practices during the last century, the character of forests has changed dramatically, and there has been a large increase in dead wood fuels near the forest floor. Severe fires accelerate runoff from the watershed by reducing organic matter in soil and forming impervious soil layers.

Improper location and construction of roads and culverts may be the most significant cause of accelerated erosion in western montane forests.

Past grazing policies may have affected land in the Sierra Nevada. Loss of streamside vegetation from grazing has promoted soil compaction and erosion. Removal of riparian vegetation by livestock in headwater valleys of the North Fork Feather River, for example, has led to rapid channel widening and massive sediment loads.

Federal flood control activities were initiated in 1917 when Congress authorized the Sacramento River Flood Control Project (SRFCP). This project consisted of a comprehensive system of levees, overflow weirs, outfall gates, pumping plants, leveed bypass floodways, overland floodway areas, enlarged and improved channels, and dredging in the lower reach of the Sacramento River. The effectiveness of the SRFCP was increased by the completion of multipurpose reservoirs that provide flood control storage. The reduction of the flood hazard has encouraged extensive development in the protected areas and has prevented billions of dollars in flood damage since project completion.

Existing Conditions. Multi-purpose reservoirs and a system of weirs and bypasses contribute to the flood control system in the Sacramento Basin by storing or diverting water during periods of high

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runoff, thereby reducing the ultimate load placed on the levee system during floods.

Rapid runoff due to poor timber and grazing practices, combined with increased urban development, has increased the local flood hazard and exposure in some upper watershed areas. Accelerated erosion increases the rate of reservoir sedimentation, reducing reservoir capacities available for flood control downstream.

Levees. Stability issues affecting the project levees in the Sacramento River Region include settlement, erosion, and seepage. These issues are the same as those discussed for the Delta Region; additional detail may be found in the Flood Control supporting document.

Although non-project levees are present in the Sacramento River Region, these levees are not significant to the overall level of flood protection.

Major reservoirs that provide flood protection to the Sacramento River Region are:

- Folsom Lake,
- Lake Oroville, and
- Shasta Lake.

Other important reservoirs include:

- Black Butte Reservoir,
- Camp Far West Reservoir,
- Union Valley Reservoir,
- French Meadows Reservoir,
- Clear Lake,
- East Park Reservoir,
- Englebright Reservoir,
- Lake Almanor,
- New Bullards Bar Reservoir,
- Rollins Reservoir,
- Stony Gorge Reservoir,
- Whiskeytown Reservoir, and
- Berryessa Reservoir.

The reservoirs were constructed and are maintained by state, federal, and local agencies that cooperate in their funding, administration, operation, and maintenance.

A system of weirs and bypasses was constructed by the Corps on the Sacramento River. The system includes five bypasses: the Butte Basin, Sutter Bypass, Yolo Bypass, Tisdale Bypass, and Sacramento Bypass. Moulton and Colusa weirs feed floodwaters into Butter Basin Bypass, Tisdale Weir flows into Sutter Bypass, and Fremont Weir and Sacramento Bypass flow into the Yolo Bypass.

The bypasses are large tracts of undeveloped or minimally developed land. Development within the bypasses typically is limited to agricultural activities that require minimal infrastructure. Water released to the bypass system flows south into the Delta, in effect creating a short-term storage system for the floodwaters. Additionally, a significant volume of the water released to the bypass system infiltrates into the ground, recharging groundwater supplies, although this volume is small compared to the total volume of a flood.

When a flood occurs, reservoirs can restrain the high-volume flows and store water for later release back into the river. The system allows flood waters to be transported downstream in a controlled manner starting days before and continuing until weeks after a flood.

By varying the amount of water kept in reservoirs during different times of the year, the system can be modified to maximize flood control capabilities during the early part of the flood season and to maximize water storage later as the flood risk abates. The water stored in the reservoirs can be used to maintain fisheries flows during dry periods and supply power to municipalities and industries.

When flooding occurs, the weir and bypass system diverts water to protect the levee system and frees flood storage capacity in the reservoirs. The weir system works by diverting floodwaters in the leveed rivers into the bypasses.

8.4.1.4 San Joaquin River Region

Historical Perspective. Work on flood control projects in the San Joaquin River Region began early in the 20th century. Improvements have included the construction of levees and bypasses,

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maintenance or improvement of stream channels, and completion of a system of reservoirs. These projects have been completed primarily to provide flood control and to augment agricultural opportunities.

Existing Conditions. The flood control resources currently employed in the San Joaquin River Region include levees, reservoirs, weirs, and bypasses.

Stability issues affecting the project levees in the San Joaquin Basin include settlement, erosion, and seepage. One major issue for the San Joaquin system is inadequate flood carriage capacity. On many of the tributaries, such as the Stanislaus River, non-project levees are very important for the flood system.

Reconnaissance studies conducted by the Corps on levees on both banks of the San Joaquin River, from Friant Dam downstream to Old River, Mariposa Bypass, Eastside Bypass, and Chowchilla Bypass, indicated that materials used to construct levees on the San Joaquin River mainstem generally range from clay to silty sand. Evaluations of levee reaches ranged from "fair" to "acceptable and well-maintained" to "good." Overall, the flood control project features were summarized as "adequate." The primary problem is a lack of maintenance. Local bank protection is needed. Setback levees in some reaches may be needed in the future. Because the levees were inspected during relatively low summer water levels, seepage conditions could not be fully evaluated.

Major reservoirs that protect the San Joaquin River Basin from floods include:

- Hensley Lake,
- H. V. Eastman Lake,
- New Exchequer Reservoir,
- New Melones Lake,
- Friant Reservoir,
- Terminus Reservoir,
- Success Reservoir,
- Pine Flat Lake, and
- Tuolumne River Reservoir (Cherry Valley and New Don Pedro lakes).

A system of weirs and bypasses has been established on the San Joaquin River system. The system includes three bypasses (the Mariposa, Eastside, and Chowchilla bypasses) fed by weirs. The San Joaquin bypass system operates similarly to the Sacramento bypass system during flood events.

The levee and reservoir system in the San Joaquin River Basin is operated to control floods using the same methods as described for the Sacramento River Region. Historically, the San Joaquin Valley basin has been subject to floods occurring during late fall and winter months, primarily as a result of prolonged rainstorms; and to floods occurring during spring and early summer months, primarily as a result of unseasonable and rapid melting of the winter snowpack in the Sierra Nevada.

8.4.2 Environmental Consequences: Flood Control

8.4.2.1 Assessment Methods

The discussion of assessment methods is separated into three sections: flood management operations, levee system, and flood control economics. The flood management operations discussion focuses on the flood control system's ability to handle floodflows under the project alternatives from a conveyance and storage perspective. The analysis of the levee system focuses on the system's ability to handle the floodflows from a structural perspective. The economics of flood control involves the comparison of flood control benefits with flood control costs.

For those Program actions that generally involve north Delta modifications, the North Delta Program Draft EIS/EIR was reviewed. Flows and elevations from the 1984 flood and a predicted 100-year flood were analyzed. For the south Delta modifications, the Interim South Delta Program (ISDP) EIS/EIR was reviewed.

To provide an additional measure of the relative flood control importance of Program actions, data on large flood events in the Sacramento and the

San Joaquin rivers were used. For the Sacramento River, daily flow data from the flood of February 1986 were used. For the San Joaquin River, daily flow data from the floods of 1980, 1983, and 1997 were used. For each alternative, proposed additions to storage were compared to the measured floodflows for these large events. These comparisons were then used to determine if the additional storage proposed for each alternative would substantially increase flood management capabilities relative to expected floodflows.

Simulated changes in conveyance capacity resulting from channel widening were analyzed using the Corps HEC-RAS model. This model simulates water surface elevations for a given channel geometry and flow rate. Using this model, different channel configurations in the alternatives were compared to the base case to determine if these configurations would significantly change conveyance capacity in the potentially affected channels.

Potential impacts to the levee system were assessed using literature, and interviews with geotechnical specialists to develop the existing conditions and No Action Alternative trends, and to identify potential impacts and mitigation strategies.

Flood control benefits are damages and losses avoided in the future that are expected as a result of the flood control project. Flood control costs are those necessary to implement and maintain the project under evaluation. Costs are generally well determined for specific flood control projects for which engineering design studies have been completed. Benefits, however, must be estimated because they depend on the improved performance of the levee to prevent future damages to agriculture (soils and crops), buildings or facilities, the timing and severity of which must also be estimated.

Direct benefits include: avoided damages to soils, crops, buildings and their contents, and infrastructure; avoided functional losses, including building rent; avoided business income losses; and avoided loss of public/nonprofit services. Benefits are those expected future benefits that are estimated over the useful lifetime of the flood control project and discounted to present values.

Procedures for the economic assessment of flood control impacts include:

- An inventory and estimated values of land, crops, buildings, associated uses and infrastructure;
- Estimates of the effectiveness of the project to reduce damages and functional losses; and
- Estimates of the flood risk associated with the project.

Secondary economic benefits and costs also arise from flood control projects. Secondary economic effects result when local firms purchase production inputs and sell products to other firms in the region. Indicators of secondary benefits (and costs) are changes in related asset values, incomes, employment, and population. Secondary economic benefits and costs can be calculated using existing data after the direct economic effects are estimated.

8.4.2.2 Significance Criteria

The description of flood management system impacts are qualitative because of the general level of definition of the programmatic alternatives. Since this evaluation is still at the programmatic stage, an impact on flood management system operations is considered significant if it has the potential to either: (1) raise flood stage elevations, or (2) increase the frequency of flooding. Actions are considered to have less-than-significant impacts on flood management system operations if they do not substantially raise flood stage elevations, or increase the frequency of flooding.

An action is considered to have a potentially significant adverse impact on the levee system if it would substantially increase:

- Seepage,
- Island subsidence,
- Levee settlement,
- Wind erosion,
- Flood stage hazards

- Scour, or
- Sedimentation.

An action is also considered to have a potential significant adverse impact on the levee system if it would substantially decrease:

- Levee stability;
- Inspection, maintenance, or repair capabilities;
- Levee slope protection;
- Emergency response capabilities;
- Channel capacity; or
- The ability of levees to withstand seismic loading.

Economic criteria can be used to judge the significance of physical changes to the environment. Costs and expected benefits are described for each alternative, and quantified where possible. Changes that exceed 10% in either costs of flood control or expected benefits are considered potentially significant for this analysis.

Values for the significant flood control parameters were projected for the No Action Alternative and the three proposed alternatives. These values were then used to develop the expected annual cost of levee failure and the annual cost of flood protection. The expected annual cost of levee failure is an indication of potential flood control benefits assuming that the levee system is 100% effective to the design elevation. The annual cost of flood protection represents the level of effort with the assumption that levees would be effective to their designed level of effectiveness. An annual cost of $15 million is used. If the flood protection program was 100% effective, the benefit cost ratio for the program could be calculated by dividing the annual potential benefits by the annual cost.

8.4.2.3 Comparison of No Action Alternative to Existing Conditions

Delta Region. Under the No Action Alternative, continued deterioration of the levees and diminished ability to handle floodflows is expected. As with other public infrastructure, funding is inadequate to eliminate the maintenance backlog. The inadequacy of funding is expected to continue.

The inability to compete for limited funding could cause some participants to delay or forego paying for levee repairs. As more participants delay repairs, more levees could deteriorate, resulting in decreases in overall levee system stability and integrity. It is likely that some Delta islands with less valuable resources would not be reclaimed if they became flooded due to levee failures.

Much of the immediately foreseeable levee improvement funding is expected to be spent for levee stability and habitat improvements to protect valuable economic, water quality, and habitat resources. Levees surrounding western Delta islands define major Delta channels in the area where freshwater and saltwater mixes. Levee failure and island flooding could result in undesirable saltwater intrusion and other adverse water quality impacts.

In other locations, funding could be adequate to improve existing levees, or to construct new ones. For example, levee assessments and funding may increase in areas where urbanization continues. Levees could be eligible for federal funds as part of cost-sharing for post-flood assistance if they have been: (1) maintained to the PL 84-99 criteria requiring that levees be restored to the geometry and level of protection provided prior to a flood event, and (2) approved prior to a flood that has been declared a national disaster.

Physical processes cause gradual deterioration of levees and/or increased pressures on the levees. These processes include subsidence and settlement, erosion from waves and current scour, burrowing from small mammals, and internal levee and foundation erosion. All of these processes could lead to an increased risk of levee overtopping and stability failures, especially during flood events.

As subsidence continues under the No Action Alternative, the ability of the system to handle peak flows would be increasingly jeopardized. In addition, long-term settlement of levees due to ongoing consolidation or migration of foundation

soils, especially peat, would reduce the levees' crest elevation. Scour and erosion could cause loss of levee material. If supporting material is lost at the base, or water-side "toe," of a levee slope, stability failures could result. Internal erosion, or piping, is frequently exacerbated by animal burrows and decaying tree roots, which could also lead to instability or overtopping.

Delta dredging is limited to 45 days, from August 1 to September 15 by regulatory constraints and species considerations, making the Delta a limited source of dredged borrow material. Future Delta dredging is expected to remain limited.

Coordinated habitat restoration efforts would probably continue. Senate Bill (SB) 1065, enacted in 1991 (California Water Code Sections 12306, 12307), required habitat protection as part of levee maintenance work. Senate Bill 1065 directed future mitigation associated with levee maintenance to result in no net long-term loss of habitat. California Water Code Section 12987(d) requires the California Department of Fish and Game to make a written determination, as part of its review and approval of a plan or project, that program expenditures are consistent with a net long-term habitat improvement program and have a net benefit for aquatic species in the Delta.

Urbanization pressures from the perimeter of the Delta Region could continue. Residents and users of new developments could accelerate levee deterioration through increased access, boat-wake induced erosion, and vandalism (for example, unauthorized recreational driving on levee slopes, and disturbance or removal of rock protection). As urbanization continues in and around the Delta, and near its tributary streams and rivers, runoff is expected to increase. Increasing runoff could lead to increased river stage in the Delta.

The overall effect of the interim reoperation of Folsom Dam and Reservoir on the Delta flood control system is beneficial. Interim reoperation delays the timing of floodflows and consequently reduces the possibility that flood peaks from the American River watershed could reach the Delta. Interim reoperation of Folsom Dam and Reservoir could continue to require release of more water than usual in the fall to create reservoir space for spring runoff from the American River watershed. The ability of Folsom Dam and Reservoir to detain a much greater volume of runoff than has been historically possible under traditional flood curve operating criteria is important. During a flood, detention could allow flood managers to maintain safe flows on the American River through the city of Sacramento to its confluence with the Sacramento River. The reoperation, however, increases the risk of not filling Folsom Lake, reducing the available water supply.

Levee reconstruction along the Sacramento River and the Colusa Basin Drain as a part of the Sacramento River Flood Control Project could beneficially reduce the risk of flood stage hazards in the Delta Region. However, some accidental upstream levee failures have acted as beneficial safety valves by unintentionally causing the release of waters before they could otherwise have flooded the Delta. After these accidental upstream releases, the reduced flow volume in the Sacramento River channel resulted in lower flood stages and hazards in the Delta. Future flood risk hazards in the Delta could therefore increase if upstream levee repairs are made at these "safety valve" locations before repairs are made to downstream Delta levees.

The occurrence of the Loma Prieta Earthquake in 1989 has intensified concerns relating to the stability of levees in the Sacramento-San Joaquin Delta.

The DWR has provided preliminary assessments of the susceptibility of Delta levees to damage from future earthquakes, and an evaluation of the opportunity for that damage to occur.

The real value of land, buildings, and related contents is estimated to increase by 25% in all use categories by the year 2020 (see Table 8.4.2-1). This increase is based on extrapolation of recent trends in land uses, including increased orchard and vineyard acreage, and more intensive residential, commercial, and recreational uses. The value of habitat, wetland, open water, and annual expected flood losses are also projected to increase by 25%. The annual cost of flood prevention, which is measured in the State Subvention

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Flood Control	Existing Conditions		No Action	
Economics Parameter	Assumptions	Values	Assumptions	Values
Residential Land Values	5k acres @ $20,000	$100,000,000	25%	$125,000,000
Commercial Land Values	2k acres @ $30,000	$6,000,000	25%	$7,500,000
Industrial Land Values	6k acres @ $10,000	$60,000,000	25%	$75,000,000
Irrigated Land	465k acres @ $3,000	$1,395,000,000	25%	$1,743,750,000
Non-irrgated Land	90k acres @ $1,000	$90,000,000	25%	$112,500,000
Residential Building & Contents Values	5k acres @ $200,000	$1,000,000,000	25%	$1,250,000,000
Commercial Building & Contents Values	2k acres @ $300,000	$600,000,000	25%	$750,000,000
Industrial Building & Contents Values	6k acres @ $100,000	$600,000,000	25%	$750,000,000
Ag Building & Contents Values	550k acres @ $750	$412,500,000	25%	$515,625,000
Infrastructure Value	60k acres @ $100,000	$6,000,000,000	25%	$7,500,000,000
Native Vegetation	35k acres @ $1,000	$35,000,000	0%	$35,000,000
Riparian & Wetland Vegetation	100k acres @ $3,000	$300,000,000	0%	$300,000,000
Open Water	90k acres @ $3,000	$270,000,000	0%	$270,000,000
Expected Annual Cost of Levee Failure	3% * Total Value	$317,955,000	25%	$397,443,750
Annual Cost of Flood Protection	Average State subvention costs in Delta	$10,000,000	0%	$10,000,000

Table 8.4.2-1. Delta Region, Value of Potentially Affected Resources, No Action Alternative

Program expenditures, is assumed to remain constant.

Continued subsidence and deterioration of levee systems would occur between now and the year 2020.

It is possible that some levee failures could occur between now and the year 2020 and that some of these failures may be judged uneconomical to repair. This would reduce the value of property remaining to protect in the year 2020. Also, since the less reliable levees are likely to fail first, the average reliability of remaining levees would probably increase.

Bay Region. Existing and No Action Alternative flood control resources are, with few exceptions, located upstream of the Bay Region and would not affect flood control in the Bay Region.

Sacramento River and San Joaquin River Regions. The Sacramento River and San Joaquin River regions include a large amount of flood-prone lands upstream of the statutory Delta on the Sacramento and San Joaquin rivers and their tributaries. Assessments of flood control needs and potential actions have recently been conducted by the Corps. It is anticipated that some or many of these actions will be undertaken between now and the year 2020, but specific projects and their impacts on flood control economics have not been identified. Therefore, some improvement in flood control protection and reduction of risk is likely between now and year 2020.

Concurrently, the real value of resources susceptible to flood damage is expected to increase. Trends causing the increase include the long-term shift toward permanent and vegetable crops, continued residential and other urban development, and increased demand for recreational and environmental resources. Costs of flood protection are also expected to increase. Both regions contain a wide range of flood control resources including levees, weirs, bypasses, and reservoirs.

Current maintenance and repair policies are assumed to continue through the year 2020. With this assumption, the levees can be expected to perform adequately through the year 2000. The

levees in the Sacramento and San Joaquin River regions are subjected to five forces that affect their performance: settlement, slope stability, overtopping, seepage, and erosion. In general, these forces can be handled through the currently authorized maintenance and emergency response mechanisms.

Weirs and bypasses are covered by federal and state agreements, and would continue to operate under the No Action Alternative as they do today. Likewise, the reservoirs are covered under a variety of federal, state, and cooperative agreements which ensure that they will operate effectively through the year 2020.

SWP and CVP Service Areas Outside the Central Valley. The performance of flood control facilities could have an adverse effect on the SWP and CVP Service Areas Outside the Central Valley. As discussed for the Delta Region, the flood control system in the Delta could continue to deteriorate. Depending on the actual circumstances, deterioration of the floodway, which is also the conveyance for water to SWP and CVP facilities, could reduce or interrupt the quantity and/or quality of water supplied outside the Central Valley.

8.4.2.4 Comparison of Program Alternatives to No Action Alternative

The impacts to flood control resources resulting from the storage and conveyance program element will vary by alternatives, as discussed below. Impacts to flood control resources resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternatives to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternatives. In those cases where no environmental impacts have been associated with a program element within a regions, the program element is not discussed.

Delta Region

Storage and Conveyance. For all configurations involving increased storage, new water storage reservoirs may provide flood control benefits downstream if space is dedicated for flood control, and some benefit may occur even without dedicated space. However, four potential reservoirs are located offstream in small watersheds, so flood control benefits would be relatively small.

Improvements in conveyance and setback levees under Configuration 2A would likely result in significant reductions in the 100-year flood stages throughout the north-Delta area.

An HEC-RAS model of the Mokelumne River using flow and cross-section data from the North Delta Program EIS/EIR was used to determine if levee setbacks alone would result in the benefits obtained with the North Delta Improvements. The HEC-RAS results indicate that about half of the reduction in flood stage reported in the North Delta Program EIS/EIR is due to the levee setback and about half is due to the dredging of the North Fork Mokelumne River. Therefore, based on these HEC-RAS results and the North Delta EIS/EIR model results, the 100-year flood stage is expected to be reduced by about 1 to 2 feet near the McCormack-Williamson Tract due to the proposed levee setback alone. No significant reduction in flood stages is expected at the confluence of the North and South forks of the Mokelumne River. This impact applies also to Configurations 2B; and 3A, 3B, 3E, and 3I.

Configuration 2D includes several sets of setback levees. These setbacks would significantly increase the floodplain width and result in lower flood stages.

Since these setbacks would be significantly wider than those included in Configuration 2A, flood water surface elevations are expected to drop further. Portions of levees would be removed to flood islands. Aside from increasing conveyance capacity, the levee setback and levee removal alternatives would lower local water surface elevations and reduce peak flows. This effect

would likely propagate a few miles upstream in the north Delta.

Levee setbacks and removals would have two additional impacts. First, lower water surface elevations would result in a steeper hydraulic gradient and higher flow velocities immediately upstream of the levee removal location. The maximum increase in these velocities is expected to be on the order of 1 to 2 feet per second. Second, lower water surface elevations would change the flow distribution, possibly increasing the volume of water that discharges through the South Fork of the Mokelumne River.

Island flooding associated with Configuration 2E would provide only limited flood control benefits, as they would reduce peak flow rates, but are not expected to significantly lower water surface elevations.

When compared to Configuration 2D, Configuration 2E would result in more water flowing to the North Fork of the Mokelumne River and proportionately less to the South Fork.

An open-channel isolated facility, located from Hood or Freeport on the Sacramento River to Clifton Court Forebay, would not have a significant effect on reducing floodflows.

The larger isolated facility (15,000 cfs) could lower floodflows for small floods (10-year and smaller), but would not have a significant effect on large floods (100-year and larger). If the 100-year floodflows downstream of Hood or Freeport could be reduced by 15,000 cfs, they would be equivalent to about a 20-year event. This would still be large enough to cause considerable flooding.

If the isolated facility were constructed to prevent floodflows into, over, under, or around it, the facility could act as a dam during similar flooding events. This could cause increased flooding to the east of the facility and lengthen the time needed for pooled water to drain after the flood wave passes. This impact also applies to Configurations 3B, 3E, 3H, and 3I.

The in-Delta storage is not allocated for flood control and is small relative to the floodflows that pass through the Delta during large storm events. It is therefore not expected to have a significant impact on flood management.

Gate structures located within channels could reduce their floodflow conveyance, resulting in increased stage upstream of the structures and possibly decreased stage downstream. The amount of increase (or decrease) would depend upon the final design of the structures. This impact applies to all alternatives, except Configurations 1A and 3I.

Enlargement of the Old River channel would increase the conveyance capacity of this channel. This could result in some localized reductions in flooding. This impact applies to Configurations 2A, 2B, and 2D; and 3A, 3B, 3E, 3H, and 3I.

The storage option with potential beneficial flood impacts in the Delta would be additional surface storage in the Sacramento or San Joaquin valleys. Groundwater and off-aqueduct storage would not significantly capture and attenuate substantial stormwater runoff flows, and therefore would not impact floodflows. This impact applies to Configurations 1C, 2B, and 2E, and 3B, 3E, 3H, and 3I.

A dam failure could result in severe flooding. However, this is not considered to be a significant impact because storage projects would be constructed and operated to reduce the potential for dam failure to less than significant levels.

Storage available for flood control would be incidental only. If only a small amount of storage was available for flood control, flooding in the Delta would not be significantly impacted.

Construction of roads, structures, or other facilities within stream channels could result in increased potential for downstream flooding if the construction activity reduces the carrying capacity of the channel but does not provide an adequate mechanism for controlled release of resulting impounded water. This impact is not expected to be significant because the construction design

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would include flow diversion and control structures at dams and stream crossings.

Table 8.4.2-2 shows Delta Region resource elements that might be impacted by flood-related actions.

Ecosystem Restoration. Reduced levee and berm vegetation management practices may result in significant and adverse long-term impacts to levee stability. Reduced pruning and clearing would allow more deep roots to penetrate levees, and more dense vegetative canopies on levee surfaces. Dense vegetation could substantially reduce inspection capabilities by hiding rodent holes, cracks, or other potential causes of levee degradation. Thick understory vegetation would also limit access to levee side slopes, thereby reducing maintenance, repair, and emergency response capabilities.

Habitat restoration using conservation easements along riparian corridors could significantly and adversely reduce levee stability. Over time, deep-rooted and dense riparian trees and shrubs could increase the opportunity for roots to penetrate levees. Increased cracking and fissures could allow water to enter the levee interior, resulting in reduced structural stability. Small cracks, fissures, and root voids could also allow increased seepage beneath the levee, which could increase levee instability.

Shallow flooding of Delta islands susceptible to subsidence could significantly and adversely increase seepage on adjacent islands, and lead to substantial flooding due to seepage-induced failure. The amount of seepage depends on soil permeability, seepage paths through the levee and its foundation, and the water stage.

Island flooding results in significant increases in wind-fetch and wave erosion on landside levee slopes. Waterside slopes could also experience significant erosion from increased wind-fetch and waves if the existing levees are not left intact. This may be a gradual problem with impacts not detected until there has been significant removal of levee slope material.

Under the Ecosystem Restoration Program, the construction of new setback levees to increase the conveyance of selected Delta channels would have a beneficial impact relative to the No Action Alternative.

The construction of overflow basins and conversion of leveed lands to wetlands would reduce peak floodflows to areas downstream of the overflow basins. The sizes of the overflow basins have not yet been determined; therefore, the reduction in floodflows cannot be quantified.

However, given the flood sizes that have occurred in the north Delta, the impacts to the flood control system are expected to be small or localized unless insufficient area is made available for flood storage.

Widening and providing floodplain areas along Delta channels would have a beneficial impact on the flood control system. The impacts of restoring riparian corridors to flood control would be similar to those described for setback levees. The relative impacts would be somewhat minor on large channels and greater on small channels.

Increased density of shallow-rooted grasses and vegetation could beneficially increase erosion protection on levee side slopes. Shallow roots protect levees against erosion by binding soil particles.

Establishing and enforcing no-wake boating zones would beneficially impact the flood control system by reducing wave run-up and erosion.

Restoration of shallow water habitat would have beneficial long-term impacts to Delta levee stability. Flooding of islands with elevations below sea level would reduce oxidation rates of peat soils, which would reduce settlement and related flood stage hazard risks.

Slight flood control benefits from urban and industrial runoff control measures could be realized. Design of storm drainage systems targeting maximum stormwater infiltration or stormwater sedimentation facilities would

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Resource Element	Flood-Related Actions	Significant Impact on Flood Management
Stream Flows	Provide pulse flows.	No
Delta Channel Hydraulics	Reduce flows in selected channels. Construct network of channels and reduce constrictions in the Yolo Bypass.	Yes No
Water Temperature	None.	No
Floodplain Inundation and Sediment Retention	Convert selected leveed lands to tidal marsh/slough complexes, construct setback levees, connect dead-end sloughs, construct overflow basins.	Yes
Food Web	None.	No
Levees and Bank Protection	Modify levee and berm vegetation management practices on water side of levee.	Yes
Dredging	None.	No
Exotic Species	None.	No
Predators	None.	No
Unscreened and Poorly Screened Diversions	None.	No
Contaminants	None.	No
Boat Wake Erosion	Reduce boat traffic in selected channels.	No
Illegal and Legal Harvest of Fish and Wildlife	None.	No
Shallow Water Habitat	Flood selected islands, primarily with land elevations between 5 and 9 feet below sea level.	Maybe. Volume provided by additional storage too small (for example, 10-70,000 AF) relative to size of Delta (for example, over 700,000 acres) and duration of flood events (several days). However, could provide localized flood control benefits.
Non-tidal Perennial Aquatic Habitat	Acquire and develop deeper open-water areas within restored saline emergent wetland habitats.	No - Too small an area
Tidal Slough Habitat	Restore tidal slough habitat.	No - It is assumed the new sloughs would not contribute significantly to conveyance in Delta.
Seasonal Wetland Habitat	Restore and manage additional acreage.	No - Largest restoration would be in designated floodplain expansion areas
Riparian Scrub Habitat	Obtain conservation easements or purchase land needed to restore riparian habitat from willing sellers.	Yes
Riparian Woodlands	Purchase riparian woodland property or easements.	No
Tidal Emergent Wetland Habitat	Develop tidal wetlands.	Yes
Non-tidal Emergent Wetland Habitat	Restore non-tidal emergent wetland habitat.	No - However, could have local flood control benefits
Mid-channel Islands	Protect and improve existing channels in the Delta.	No

Table 8.4.2-2. Delta Region Resource Elements and Impacts of Actions on Flood Management

beneficially impact the Delta flood control system. Increased detention and infiltration would reduce the volume of surface flooding. Although stormwater basins would not detain substantial volumes of floodwaters, their storage function could slightly reduce local flood stage hazard risks.

Water Use Efficiency. No action items in the Water Use Efficiency Program would significantly impact the flood control system in the Delta Region.

Levee System Integrity. Raising levee heights, widening levee crowns, flattening levee slopes, and constructing stability berms as part of the Delta levee base level protection and special improvement plans would improve Delta levee system stability. When levees meet PL 84-99 criteria, they may qualify for post-flood federal funding assistance.

Providing slope protection, relocating irrigation ditches, and installing drainage systems or slurry cutoff walls as part of the Delta levee base level protection plan would improve Delta levees by reducing erosion and seepage. Implementing these actions in compliance with uniform levee maintenance criteria and uniform guidelines for habitat enhancement and protection would reduce degradation of the levee system and prevent long-term habitat loss.

Improving channel configurations for floodflows, constructing cutoff levees, and creating bypass systems consistent with Delta levee special improvement projects would benefit system flood conveyance capacity by allowing flood inflows to safely pass into the Delta. Improved floodflow conveyance capacity into the Delta would reduce the incidence of instability and overtopping failures in the north Delta.

Purchasing conservation easements adjacent to levees and reducing the intensity of agricultural practices near landside levee slopes as part of the Delta island subsidence control plan would improve levee stability by reducing subsidence. Easements and less intense agricultural practices, as nonstructural improvements to the flood control system, would have no adverse impacts on ecosystem restoration activities.

Preparing updated flood risk assessments and arranging for advance equipment contracts, participation agreements, and levee repair materials as part of the Delta Levee Emergency Management Plan would improve flood control system integrity by reducing levees' vulnerability to catastrophic failure. Improved emergency preparedness through multi-agency participation would minimize the extent and severity of flood damage and thereby reduce post-disaster recovery funding needed from the FEMA and other disaster-relief agencies.

Preparing updated seismic risk assessments and ground motion mapping, and performing dynamic testing of levee material properties and levee stability analysis would improve the understanding of Delta levee performance during an earthquake. This improved understanding would allow preliminary identification of the locations where levees may be most susceptible to earthquake damage. Understanding and identifying these levees will provide guidance for future cost-effective expenditure of funds used for strengthening those levees most susceptible to failure during an earthquake.

Special levee stabilization projects based on island resources could beneficially impact the Delta flood control system. Habitat improvement and levee stabilization projects could be implemented according to their potential to improve Delta water quality, agricultural production, life and personal property, recreation, cultural resources, ecosystem, infrastructure, and adjacent island functions and values. These projects could improve levee stability, increase freeboard, and reduce scour and seepage potential at important locations across the Delta Region. Existing levees could be rehabilitated and set back in some locations to make these improvements.

Water Transfers. Water transfers could have beneficial and adverse impacts to flood control, depending on the source of water for the transfer, the timing, the magnitude, and the pathway of each transfer. If a transfer involves releasing water from

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a reservoir during summer months, additional space to store inflow and reduce the threat of downstream floodflows may result. More detailed discussion of impacts associated with water transfers can be found in the Flood Control supporting document.

Bay Region

There would be no significant impacts to flood control in the Bay Region. However, the Ecosystem Restoration Program includes several actions that would modify flows within the Bay Region, including the establishment of shallow water habitat, open water habitat, tidal sloughs, seasonal wetlands, and riparian/shaded riverine habitat. None of the other programs include actions related to flooding in the Bay Region. The proposed modifications to flows in the Ecosystem Restoration Program are minor relative to the volume of water in the Bay Region.

Sacramento River Region

Storage and Conveyance. Increased storage on Sacramento River tributaries could provide localized flood control. The additional surface storage could provide localized flood control if it is made available when a large storm event occurs. However, since the additional storage would not be dedicated to flood control it would have to be considered unreliable as a flood control measure. This impact applies to Configurations 2B and 2E; and 3B, 3E, 3H, and 3I.

Water Transfers and Water Quality and Levee System Integrity. Effects of each on flood control are discussed for the Delta Region.

Ecosystem Restoration. Restoring the 50- and 100-year floodplains would provide positive flood control benefits. The level of benefit would depend on the existing flood conveyance capacities of the stream channels chosen for improvements. The protection of existing floodplains would provide no benefits over existing conditions, but to the extent that future development is prevented in the floodplain, flood benefits would be positive relative to the No Action Alternative.

Removing diversion structures and other obstructions to flow in the Sacramento River tributaries could increase the level of flooding downstream of these diversions. The level of increase would depend on which diversions and obstructions are removed and the total number of obstructions removed. The relative increase in flooding would probably be small for large flood events (for example, 100-year) and relatively larger for small flood events (for example, 10-year). The change in flood levels would depend upon how much attenuation of floodflows the existing structures provide. Common flood management measures, such as dredging, levee maintenance, and snag removal would benefit flood control.

Vegetating stream banks could increase flood stages along streams due to increases in the roughness of the stream channel. On wide channels, the increase in roughness of the stream banks would probably have only a minor impact on flood stage. On small streams, the increase could be significant. Vegetative banks, however, would provide stabilization, thereby benefitting flood control.

Water Use Efficiency. Some actions under this program could affect flood control in the Sacramento River Region. These impacts, described below, also apply to the San Joaquin River Region.

Installation of on-farm efficiency improvements, such as drip and micro-irrigation systems, may require more frequent deliveries from surface water sources or may result in an increased reliance on groundwater. Even at reduced overall volumes, as farmers seek to increase their access to irrigation water, they may need to turn to groundwater pumping if surface water deliveries are unavailable. Increased groundwater pumping may lead to localized ground subsidence. Pumping and subsidence occurring near levees or other flood control facilities could cause settlement of the underlying substrate, resulting in levee slumping, cracking, or more significant damage.

Construction and installation of on-farm water use efficiency improvements, including tailwater recovery ponds or pressurized irrigation systems,

could beneficially impact the flood control system by reducing the volume of sediment transported to flood control channels. As sediment load in the receiving channel decreases, the conveyance capacity of the downstream channels is maintained. Further, a lower rate of sediment loading into these channels would require less dredging, thereby reducing flood control system maintenance costs.

Water Transfers. Impacts associated with water transfers would be similar to those discussed for the Delta Region.

San Joaquin River Region

Storage and Conveyance. Off-stream storage components could provide some flood control benefit, both by providing additional storage space for flow in the San Joaquin River or Delta, and by providing protection to property downstream of the reservoir site. These potential impacts are expected to be minor since additional storage would not be dedicated to flood control. However, they could be important at a local, project-specific level.

Ecosystem Restoration. Reestablishing riparian habitat or preventing the removal of riparian vegetation would result in increasing the roughness of the stream channel and could increase flood stages. On wider channels, the increase in roughness of the stream banks would probably have only a minor impact on flood stage. On smaller streams, the increase could be significant.

Restoring the floodplains along the San Joaquin River south of Vernalis would provide flood control benefits. Presently, the probability of levee failures is high during large storm events in the San Joaquin River Region. By creating a large floodplain, flood stages would be lowered, thereby reducing the pressure on downstream levees. The level of additional protection provided by the floodplain would depend on the size of the floodplain and its location relative to the most vulnerable levees.

Water Use Efficiency. Impacts would be similar to those discussed for the Sacramento River Region.

Water Transfers. Impacts would be similar to those discussed for the Sacramento River Region.

SWP and CVP Service Areas Outside the Central Valley. There are no actions that would affect flood control in the SWP or CVP Service Areas Outside the Central Valley.

All Regions. Most of the economic benefits of flood control are embodied in the provisions of the Ecosystem Restoration Program and Levee System Integrity Program with the specific objective to improve all levees to PL 84-99 standards. Generally, the alternatives are projected to increase the acreage of native vegetation, riparian and wetland habitat and open water at the expense of agricultural land. The values of commercial, industrial, and residential land are projected to increase slightly due to improved flood control effectiveness.

The installation of flow control barriers is projected to increase the value of agricultural, industrial, and commercial land values resulting from improved water quality (Configuration 1B), increasing the value of flood control.

In Alternatives 2 and 3, proposed north Delta improvements, levee setbacks, and island flooding may impact the economics of flood control by reducing the amount of agricultural land. The South Delta Improvements should not affect the economics of flood control.

Configurations 2B, 2D, and 2E; and 3B, and 3E are expected to increase the value of agricultural land due to more abundant irrigation water and better flood control.

In Alternative 3, small and large isolated open- and closed-pipe conveyance facilities and island flooding for water conveyance will affect the economics of flood control.

Flood control economics are not affected in any manner by the upper watershed enhancement actions.

8.4.2.5 Comparison of Program Alternatives to Existing Conditions

The Program effects on flood control would still be beneficial when compared to existing conditions instead of the No Action Alternative.

8.4.2.6 Mitigation Strategies

Although the CALFED Program is expected to be beneficial to flood control, some less than significant adverse effects have been identified. The mitigations strategies presented in this programmatic document are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

These strategies include a design and maintenance program to allow reasonable clearing of deep-rooted trees and shrubs from levee side slopes to increase levee stability, support inspection, maintenance, repair, and emergency response, while preserving some habitat values. Implementation and mitigation monitoring could reduce this impact to a less than significant level.

Implementation of this mitigation measure would not cause significant adverse affects on ecosystem restoration along levees. The general ecosystem restoration target for levees would be to reduce or eliminate adverse effects on ecological processes, habitats, and dependent species to the extent possible, and in a manner consistent with flood control. It is assumed that the increase in the quantity and quality of riparian habitat resulting from implementation of the Ecosystem Restoration Program would replace marginal habitat values now provided by vegetation growing on levees. Further, the Levee System Integrity Program proposes a long-term goal of upgrading Delta levees to PL 84-99 design standards, which would require extensive clearing and subsequent maintenance to protect upgrade investments. These erosion protection and wave force dissipation measures would be coordinated with the Ecosystem Restoration Program implementation to minimize adverse impacts to vegetation restoration.

Another strategy would identify locations potentially susceptible to seepage-induced failure on Delta islands that may be intentionally flooded, implement a seepage monitoring program on non-flooded islands adjacent to potential shallow-flooded islands, develop seepage control performance standards to be used during island flooding and storage periods to determine net seepage caused by shallow flooding, and improve levees to withstand expected hydraulic stresses and seepage. Implementation and mitigation monitoring could reduce this impact to a less than significant level, and would not significantly affect levee integrity or ecosystem restoration objectives.

Protection measures may be designed to minimize or eliminate wave splash and run-up erosion. Use of riprap or another suitable means of slope protection would dissipate wave force. Large voids in the riprap would relieve excess hydrostatic pressures caused by waves washing against the slope. Construction of large wind/wave breaks within the flooded islands would reduce wind-fetch and erosion potential. Implementation and mitigation monitoring could reduce this impact to a less-than-significant level.
These erosion protection and wave force dissipation measures would be coordinated with implementation of the Ecosystem Restoration Program to minimize adverse impacts to revegetation.

Issues regarding beneficial reuse of dredge material would be investigated and identified. Beneficial Bay dredge material reuse studies would be continued in the Delta for potential water quality impacts related to salinity, metals mobilization, and other environmental and health hazards. Cost-effectiveness and safety of using sediment traps as a source of borrow could be investigated. All potential sources of borrow may be identified and the cost-effectiveness of each source's use for levee rehabilitation and construction calculated. Appropriate stockpile locations and management techniques for stabilizing stockpiles against erosion would be identified. A borrow plan would be

prepared that includes future costs and options for obtaining adequate quantities of borrow needed for implementation of the Levee System Integrity Program. A monitoring program would ensure subsidence does not reduce the existing level of flood control.

Reduced floodflow conveyance due to gate structures located in channels could be mitigated if the structures are designed to minimize the loss of channel conveyance at the structure.

Increased level of flooding downstream of removed diversions could be mitigated by widening streams downstream of the structure to increase conveyance capacity.

Raised flood levels due to vegetation along stream banks could be mitigated with proper design that incorporates flood control criteria. For example, by increasing the width of vegetated sections to maintain conveyance capacity, the net effect of the vegetation on flood control would be negligible.

Existing or planned wells that could affect groundwater and substrate conditions underlying nearby levees or flood control facilities would be identified. Incentives would be provided to either terminate the use of the well, reduce its pumping volume to safe withdrawal levels as they affect substrate stability, or otherwise replace it with sources that could not affect levee stability. Implementation of this mitigation strategy would not have any further adverse environmental effects because the water that would have been pumped from the well is replaced from another source. Mitigation might have beneficial consequences if the replacement source provides a more efficient delivery than the former well.

8.4.2.7 Potentially Significant Unavoidable Impacts

No significant unavoidable impacts are expected to flood control under any alternative or in any of the five study areas.

8.5 POWER PRODUCTION AND ENERGY

Summary

The study area consists of those areas where the major types of potential power- and energy-related impacts could occur as a result of implementing the CALFED alternatives. Table 8.5-1 provides a summary of environmental impacts related to power production and energy.

Power production and energy assessment variables relevant to the CALFED project involve facilities that are mainly associated with the SWP and the CVP. These variables include available power capacity and energy generation at hydroelectric power plants, energy use by SWP and CVP facilities, capacity and energy sales, power production and replacement costs, impacts on power customers, power payments to the CVP Restoration Fund, net power costs, and power rates. Power generation from both projects is used to meet pumping energy requirements. CVP energy available in excess of CVP project use requirements is sold to preference power customers by Western.

The CALFED Program alternatives would cause many power production and energy impacts. Some of these impacts would be significant, and mitigation strategies have been developed.

The California DWR system operational model (DWRSIM) was used to define changes in available capacity and energy generation at affected state and federal hydroelectric facilities. Impacts on the capacity of CVP hydroelectric facilities and energy generated at such facilities would be significant and adverse if such impacts increase associated Western Area Power Administration (Western) power rates to levels that are higher than the cost of other available sources in a deregulated power market. This would be a significant impact on Western and its power customers because:

- The repayment capability of the CVP would be adversely affected as Western's power customers leave and switch to cheaper power sources;

Power Production and Energy Impacts

- **Common Program elements** may affect power production and energy but would not significantly impact CVP and SWP hydroelectric generating capacity, power production economics or energy generation
- **No Action Alternative** would impact power and energy resources, due to changes in water demand, conveyance and pumping strategies
- **Storage and Conveyance**
- Configuration 1C is expected to increase average and dry year energy generation and capacity as new hydropower facilities are added. It would increase project energy use as operations change, decrease the amount of CVP energy available for sale, and increase the SWP's net energy requirement. Western's composite energy rate could increase significantly under this alternative, DWR net power costs would increase because the increase in project energy use would be greater than the increase in generation. **Configurations 1A and 1B** would not cause any of these impacts
- Each of the **Alternative 2** configurations would cause the same types of impacts as Configuration 1C.
- Each of the **Alternative 3** configurations, with the exception of 3A, would cause the same types of impacts as Configuration 1C and Alternative 2. **Configuration 3A** would cause a minor decrease in dry year energy generation.

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
All Regions												
Total Available CVP or SWP Summer Capacity	□	□	+	+	+	+	+	+	+	+	+	+
Total CVP or SWP Energy Generation	□	□	+	+	+	+	+	+	+	+	+	+
Total CVP or SWP Project Energy Use[1]	□	□	○	○	○	○	○	○	○	○	○	○
Total Western Energy Available for Sale[1]	□	□	○	○	○	○	○	○	○	○	○	○
Total SWP Net Energy Requirement	□	□	○	○	○	○	○	○	○	○	○	○
Western or DWR Power Production and Replacement Costs[1]	○	○	○	○	○	○	○	○	○	○	○	○
Western Composite Energy Rate	□	□	◗	○	◗	◗	◗	○	◗	◗	◗	◗
DWR System Energy Rate	□	□	◗	○	◗	◗	◗	○	◗	◗	◗	◗
Net Cost of CVP or SWP Energy Generation and Project Energy Use	○	○	○	○	○	○	○	○	○	○	○	○
Impacts on Western	□	□	□	●	○	●	◗	○	◗	◗	◗	◗
Impacts on DWR	□	□	□	○	○	◗	◗	○	◗	◗	◗	◗
Impacts on DWR Power Customers	□	□	○	○	○	○	○	○	○	○	○	○
Impacts on Western Power Customers	□	□	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:

Level of Impact

- ● = Significant and unavoidable
- ◗ = Significant and mitigable
- ○ = Less than significant
- □ = None
- + = Beneficial
- U = Unknown

Table 8.5-1. Summary of Environmental Impacts Related to Power Production and Energy

[1] These impacts would not be significant by themselves, but could lead to rate impacts that could be significant to Western and its preference power customers. DWR's water customers may also be significantly affected by the expected increase in SWP power costs.

- Most of Western's preference power customers are utilities that would likely have to pass on the increase in Western rates to their own customers, thus adversely affecting their competitiveness in a deregulated market and causing their customers to leave; and

- Western's preference power customers would experience an increase in power costs and other negative economic impacts since Western's rates have historically been relatively inexpensive and lower than those found on the open market or from other sources.

- Western's preference power customers would not experience supply disruptions from a reduction in CVP energy available for sale because any reduction in power available for sale from the CVP could be replaced with power from other, more expensive sources at market prices.

The significance of SWP power-related impacts are measured by the magnitude of increases in net power costs, and by how they affect DWR's system energy rate and the net energy requirement of the SWP. Impacts to DWR's system energy rate and the SWP net energy requirement would be significant if they cause SWP water rates to increase significantly. The significance of SWP water rate impacts is addressed by the agricultural economics and municipal and industrial economics resource areas. The significance of potential energy use impacts during and after construction will be addressed by subsequent project-level studies. Increases in the obligation of CVP power customers to fund the CVP Restoration Fund would be significant and adverse if such increases caused Western's power rates to exceed competitive market prices.

No Action Alternative. The No Action Alternative includes several conditions that may impact power and energy resources within the overall study area, including changes in water demand, conveyance, and pumping strategies. These factors can affect hydroelectric generation and capacity by changing reservoir operations, reservoir levels and streamflows.

Storage and Conveyance

Alternatives 1 and 2. Additional storage associated with Configuration 1C would require energy to construct and fill the additional facility and energy for operation. If increased storage was obtained by expansion of existing hydroelectric generating facilities, a minor and temporary impact would occur due to the disruption of power production during construction. Energy generation, capacity and project use loads are expected to increase under Configuration 1C and all Alternative 2 configurations. Configurations 2B and 2E impacts would be the same as Configuration 1C and Configurations 2A and 2D would be less than Configuration 1C. Configuration 1C also would decrease the amount of CVP energy available for sale, and would increase the SWP's net energy requirement. Western's composite energy rate could increase significantly under this alternative, while DWR's system energy rate may increase slightly. The significant increase in Western's rates would cause significant impacts to Western and its preference power customers. Western and DWR net power costs would increase because the increase in project use would be greater than the increase in generation. Configurations 1A and 1B would not cause any of these impacts. None of the Alternative 1 configurations have the potential to cause significant changes in power payments to the CVP Restoration Fund, or related significant impacts on power customers.

Alternative 3. North of Delta, South of Delta, and In Delta storage are all included in Alternative 3. Each of the five configurations include new conveyance facilities, resulting in the highest energy expenditures during construction for this alternative. Configuration 3B would also cause the highest level of water transfers and the largest increase in CVP and SWP exports and deliveries. Each of the Alternative 3 configurations would cause the same types of impacts as Configuration 1C and Alternative 2. The magnitude of the impacts caused by Configuration 3A would be

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Western rate-related, the other Alternative 3 configurations would cause significant impacts due to the significant increase in Western's power rates.

Ecosystem Restoration. Implementation of the ecosystem restoration elements of the program would change stream flows for habitat restoration and may alter capacity and generation at CVP and SWP hydroelectric power plants. Energy use would likely increase during implementation of this program due to construction related to restoration activities. Energy use would decrease on lands retired from agricultural uses. However, additional energy would be used to deliver water for environmental purposes.

Water Quality. Temporary increases in energy use to implement source control measures would likely occur with implementation of this program. Long-term beneficial impacts would occur as water quality improvements reduce treatment requirements.

By reducing "stressors" and damaging land use practices, watershed management would indirectly reduce the amount of energy used by related land use practices.

Coordinated Watershed Management. Power production and energy resources would not be affected in any manner by the upper watershed management coordination efforts.

Levee System Integrity. This program could cause direct energy impacts during construction as levee system modifications are relatively energy-intensive activities during their construction phases. However, they could avoid long-term levee maintenance procedures resulting in beneficial impacts.

Water Use Efficiency. This program would indirectly reduce the power costs of water customers that experience an increase in water use efficiency. It also could indirectly impact hydroelectric capacity and generation as water use changes. An improvement in urban water use efficiency would likely decrease long-term energy use, while agricultural efficiency measures could increase energy use as gravity-fed irrigation systems are replaced with sprinkler systems. Increased levels of water recycling in urban areas would result in greater energy demands from additional treatment processes and new distribution facilities.

Water Transfers. Water transfers would increase energy use at surface water and groundwater pumping plants, and could affect capacity and generation at some hydroelectric facilities.

8.5.1 Affected Environment/ Existing Conditions

The interrelated nature of the power facilities within the SWP and CVP prevents the development of useful analyses on a regional basis. This section provides quantitative analyses of the SWP and CVP on a system-wide basis only.

8.5.1.1 Historical Perspective

SWP. Water deliveries from the SWP were initially provided in 1962 to Alameda and Santa Clara counties through the South Bay Aqueduct. Power generation from SWP facilities was first realized in 1968 with the operation of the Hyatt-Thermalito facilities downstream of Lake Oroville. The primary purpose of the SWP power generation facilities is to meet energy requirements of the SWP pumping plants. To the extent possible, SWP pumping is scheduled during off-peak periods, and energy generation is scheduled during on-peak periods. Although the SWP uses more energy than it generates from its hydroelectric facilities, DWR has exchange agreements with other utilities, and has developed other power resources. When available, surplus power is sold by DWR to minimize the net cost of pumping energy. Excess power was first sold commercially in 1968.

CVP. CVP power generation facilities were initially developed based on the premise that power could be generated to meet project use

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loads. The Reclamation Act of 1939 provided for surplus power to be sold first to preference customers, including irrigation and reclamation districts, cooperatives, public utility districts, municipalities, and large educational or government facilities. Surplus commercial firm power may be sold to non-preference utilities. The first commercial power generated by the CVP was sold in 1945.

System-Wide SWP and CVP Capacity and Energy Generation. The historic system-wide energy generation attributable to the SWP has ranged from about 600,000 megawatt hours (MWh) in 1968 to 5.4 million MWh in 1983. Total CVP energy generation and supplemental energy purchases (which are made to support sales to preference power customers) have ranged from 2.1 million MWh in 1992 to 8.8 million MWh in 1983. Nameplate CVP capacity was approximately 630 megawatts (MW) in 1960, increasing to approximately 2,220 MW in 1995. SWP nameplate capacity was approximately 1,340 MW in 1968, and 1,670 MW in 1995.

System-Wide SWP and CVP Project Energy Use. The SWP's historic system-wide project energy use has ranged from approximately 600,000 MWh in 1968 to 8.4 million MWh in 1990. The CVP's project energy use has ranged from approximately 320,000 MWh in 1963 to 1.7 million MWh in 1976.

Western Energy Sales. Historical energy sales from the CVP have ranged from approximately 2 million MWh in 1960 to 7.9 million MWh in 1992. Historical revenue from firm CVP energy sales has ranged from approximately $10 million in 1960 to $269 million in 1987.

DWR's power program is designed to meet the pumping energy requirements of the SWP. Unlike Western, DWR does not serve preference power customers.

SWP and CVP Power Rates. CVP capacity rates historically have ranged from $750/MW per month in 1960 to $7,440/MW per month in late 1991 through early 1993. The rate in 1996 was $4,320/MW per month.

CVP energy rates have ranged from $3.00/MWh in 1960 through early 1978 to $31.44/MWh in late 1986 through early 1988. In 1994, the energy rate went to a base and tier system. The base rate in 1996 was $15.83/MWh and the tier rate was $26.27/MWh.

The SWP is a water delivery project and does not sell capacity to its water customers. Since they do not charge for capacity in the traditional sense, no capacity rate is calculated. The SWP system energy rate has ranged from a low of $18.4/MWh in 1993 to a high of $32/MWh in 1986.

8.5.1.2 Existing Conditions

System-Wide SWP and CVP Capacity and Energy. CVP and SWP hydroelectric generation facilities have a total nameplate capacity rating of approximately 3,678 MW. The CVP has a nameplate rating of 2,220 MW and the SWP has a nameplate rating of 1,458 MW. Under current conditions (1995 level of development), 1,679 MW of the CVP capacity is estimated to be available on average (over the 73-year hydrologic record used for this EIS/EIR) and 1,427 MW is estimated to be available during dry conditions. 1,490 MW of SWP capacity is available on average during the summer and 1,357 MW of SWP capacity is available during dry conditions.

The CVP generates an estimated annual average of 5,265 gigawatt hours (GWh) under existing conditions. The SWP generates an estimated annual average of 4,362 GWh under existing conditions. The Power Production and Energy Impact Analysis Technical Report provides additional details on the estimated monthly pattern of CVP and SWP generation.

System-Wide SWP and CVP Project Energy Uses. Current annual CVP project energy use averages 1,563 GWh, while annual SWP project energy use averages 8,412 GWh. Most of this energy is used

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to power the surface water pumping facilities of these projects.

Western Energy Sales. Western's net energy available for sale under existing conditions is estimated to average 3,702 GWh per year. As with the other CVP-related data in this section, this number is projected using DWRSIM output based on 1995 level of development conditions, and is the average sales volume over the entire 73-year hydrologic record used in this analysis. Western sells available capacity and energy to its preference customers after all CVP project energy use requirements are met.

SWP and CVP Power Rates. The SWP is a net consumer of power because its project energy use exceeds the amount of energy generated at its hydroelectric facilities. Therefore, the SWP's net energy requirement, before considering DWR's off-aqueduct power resources, is the appropriate assessment variable to measure. The SWP's net energy requirement under existing conditions is estimated to average 4,050 GWh over the 73-year hydrologic record. DWR meets its net energy requirement by purchasing energy from a variety of sources.

Western's current composite power rate is $20.6/MWh. DWR's existing system energy rate is 23.8 mills per kilowatt hour.

8.5.2 Environmental Consequences: Power Production and Energy

This section defines the potential impacts of the Program alternatives on power production and energy resources. A region-by-region assessment of potential power production and energy resource impacts is not appropriate. Therefore, a description of potential impacts in the overall study area is provided.

8.5.2.1 Assessment Methods

This section defines the methods used to assess impacts related to the power production and energy assessment variables. Conditions associated with the CALFED Program were compared to No Action Alternative conditions to define the impacts of the Program. The significance criteria described below were applied to determine if mitigation would be required.

Ranges of impacts were defined to represent the types of impacts that could result from the CALFED Program. Examples of potential alternative components were used to develop the representative ranges of impacts because the specific components of the CALFED Program have not been defined for the purpose of this programmatic review. This range of components covers all potential impacts.

It is not known at this time how the changes in capacity, energy generation and project energy use caused by the CALFED action alternatives (and related cost impacts) would be allocated between the CVP and SWP. Therefore the full range of related impacts on the CVP and SWP have been defined to reflect this uncertainty. Although unlikely, the capacity, energy generation and project energy use impacts described in this report could all be experienced by the CVP at one extreme, or by the SWP at the other extreme. It is more likely these impacts would be shared by the CVP and SWP.

Power plants which may be modified were identified and the existing and proposed nameplate capacities were defined in megawatts. Changes in capacity and energy generation were defined when determining the impacts of changes in operation. These changes in operation would be caused by 1) the proposed physical modifications to the plants included in the CALFED action alternatives, 2) the projects in the No Action Alternative, and 3) the proposed system operational changes included with full implementation of the CALFED Program.

The operational impacts assessed included changes in available average and dry year capacity, available average and dry year energy generation, and potential to provide ancillary

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services, such as regulation and reserves. Changes in annual and monthly project energy use were also assessed.

The California DWR system operational model (DWRSIM) was used to define changes in available capacity and energy generation at affected state and federal hydroelectric facilities. Estimates of pumping energy at certain CVP facilities, and monthly capacity for all generating facilities, were estimated using a spreadsheet post-processor to manipulate DWRSIM estimated reservoir levels and flows. (Note to reader: DWRSIM is being enhanced to directly incorporate the U.S. Bureau of Reclamation PROSIM power module.) A total of eight operational scenarios have been defined to characterize the range of results for the CALFED alternatives. These same model scenarios also were used to define potential project energy use and related power economics impacts. Results of this study are included in the Power Production and Energy supporting document.

The incremental impacts of the CALFED Program alternatives were determined by comparing the average and dry year model results under each alternative to related conditions under the No Action Alternative.

The direct impact of the CALFED Program on the power production costs of the SWP and CVP was estimated based on available information regarding variable costs of operation and maintenance, and operating costs of facility modifications required by the CALFED alternatives. The production costs of new facilities are estimated based on available cost information and typical allowances for operation and maintenance.

It was assumed that Western's preference power customers and DWR would obtain replacement power from other sources as the amount of power available for sale decreases and the net energy requirements of the SWP increase. The value of DWR's replacement power was estimated based on market prices that are expected to be present under a deregulated market, because of the long-term perspective of the CALFED process.

The following steps were taken to project the future price of power in California's power markets. First, publicly available analyses of future power values in the restructured industry were evaluated, together with market power analyses prepared by the California investor-owned utilities and the California Energy Commission. These were used to develop an estimated range of values for the Power Exchange.

Re-operation of the affected hydroelectric facilities may result in changes to energy production and distribution, including production shifts to ancillary services. Re-operation will also affect reservoir levels, changing the peak capability of hydroelectric facilities with storage. The potential to provide ancillary services is represented by the difference between the peak capability (adjusted for reservoir storage levels) and actual energy output at a given time.

The value of the impacts of the CALFED alternatives on the capability to provide ancillary services will depend on many complex factors, including bidding strategy and scheduling flexibility within each month. Consequently, it is too speculative to assign values to the relative impact of the alternatives on ancillary services based on changes in available capacity.

In order to determine changes in revenues from power sales upon implementation of the CALFED alternatives, a range of long-run market clearing prices (MCP) was developed. The range covered the full cost of a new combined cycle facility to the projection of the wholesale MCP. Because the timing of energy generation affects its value, price variances during peak loads were considered in the MCP analyses.

In determining the long-term power value forecast, it was assumed that base-load combined cycle projects will be needed. Therefore, the full, all-in cost of a modern combined cycle facility was used for the long-term power value forecast.

The range of long-term average power prices established for this analysis was approximately 15% and was based on the historical relationship between on- and off-peak incremental rates for PG&E. The ranges utilized for the low and high forecast are $0.0225/kilowatt hour (kWh) (off peak) to $0.026/kWh (on peak), and $0.03/kWh (off peak) to $0.034/kWh (on peak), respectively, in 1998 terms. The mid-point of the range of off-peak prices was used to estimate the value of incremental pumping energy, and the mid-point range in on-peak prices was used to estimate the value of changes in generation.

The rate impacts on Western's customers were estimated by developing a "composite energy rate" which is the total revenue requirement to be recovered from capacity and energy sales, divided by the amount of energy sales. This is in contrast to the actual capacity and energy rates set by Western, and was used as a proxy for estimating the impacts of the alternatives.

The DWR rate impacts were estimated by calculating a "system energy rate", which is the net SWP cost of power divided by the SWP energy requirements.

Energy use impacts (other than project energy use) during and after construction were assessed qualitatively. These types of impacts are described but will be assessed in more detail during subsequent project-level studies when more detailed information about construction procedures and conservation measures is available.

8.5.2.2 Significance Criteria

The following significance criteria have been used to gauge the significance of potential impacts caused by the CALFED action alternatives.

- **Impacts on Capacity, Energy Generation, Production Costs, and Related Rates.** Impacts on the capacity of CVP hydroelectric facilities and the amount of energy generated at such facilities would be significant and adverse if such impacts increased Western's cost of power and associated rates to levels that are higher than rates available in open-market conditions. This would increase customer power costs for Western's preference power customers to a point where Western power customers would likely switch power providers, and could threaten repayment of CVP capital and operating costs in a competitive market. Western's preference power customers also would be significantly affected if Western's rates are higher than open market rates because they would experience negative economic impacts, including higher power costs and the possible loss of retail customers that may switch to cheaper sources if they have the opportunity. The significance of SWP power-related impacts is measured by how they affect DWR's system energy rate and the net energy requirement of the SWP. Impacts to DWR's system energy rate and the SWP net energy requirement would be significant if they cause DWR's water rates to increase significantly. The significance of DWR water rate impacts is addressed by the agricultural economics and municipal and industrial economics resource areas.

- **Energy Use Impacts During and After Construction.** The significance of energy use impacts will be assessed in subsequent project-level studies. Subsequent studies will have more detailed information about the specific construction projects, changes in operations that would be required, and proposed energy conservation measures to be followed during and after construction.

- **CVP Restoration Fund Power Revenues.** The contribution of power customers to the CVP Restoration Fund is to be in proportion to the CVP repayment obligation assigned to power, unless increased to make up for a reduction in contributions by water customers. Therefore, the key issue is whether Western's power customers would experience a rate increase caused by an overall increase in the total funding obligation of power customers to the CVP Restoration

Fund. This could happen if the total revenue from CVP water users (the other major funding source for the fund) is reduced. The significance of potential power rate increases from the power customer's standpoint is addressed by the next criterion.

If Western is forced to raise power rates due to an increase in the overall power funding obligation to the Restoration Fund, Western's customers could switch power providers. This type of impact would be significant if rates increase to levels that are higher than rates available in open-market conditions. This would increase the power costs of Western's customers to a point where they would likely switch power providers; this in turn could threaten repayment of CVP capital and operating costs.

- **Impacts on DWR and Western Power Customers.** Western and its preference power customers would experience significant and adverse impacts if Western's rates increase to the point that they exceed the rates available on the open market. Such a situation would cause Western's customers to experience negative economic impacts as their power costs increase and their customers leave to find cheaper sources of power. DWR power customers rely on a range of alternative sources of power supply, and purchases from DWR do not represent a major long term resource to such customers.

8.5.2.3 Comparison of No Action Alternative to Existing Conditions

The No Action Alternative conditions are similar to the existing conditions; however, they reflect the expected state of power production and energy economics under a year 2020 level of development.

In addition to conditions described in the affected environment section, the No Action Alternative would include:

New water demand, conveyance, pumping, and other types of facilities. These facilities would change the existing capacity and energy conditions as defined in the Affected Environment section of this document. Tables 8.5.2-1 and 8.5.2-2 summarize existing and No Action Alternative capacity and energy resource conditions.

Differences in the estimated values for the key assessment variables between existing conditions and the No Action Alternative are in part attributable to enhancements to DWRSIM and changes in assumptions that are reflected in the No Action Alternative results. Enhancements to DWRSIM include modifications to 1) more accurately estimate south-of-Delta deliveries, 2) better represent the San Joaquin River Basin, and 3) recognize other details regarding the Bay-Delta system. Assumptions have been revised from existing conditions assumptions to recognize increased SWP and CVP demands consistent with year 2020-level development.

The Western composite energy rate and the SWP system energy rate in the existing conditions case are consistent with recent estimates published by Western and DWR. The value of supplemental sales reflected in this estimate was revised to be consistent with the value used to assess the impact of changes in the CVP net energy available for sale. In developing the No Action Alternative case, supplemental purchases were deleted from the analysis. This occurs because Western's marketing plans for year 2004 and beyond do not call for Western to purchase any power for re-sale to preference customers, except at the specific request of individual customers, in which case the cost of such purchases is paid by the requesting customer. The subsequent estimate of Western's composite energy rate under the No Action Alternative is 21.59 mills/kWh.

The DWR system energy rate estimate for the No Action Alternative was also adjusted to reflect a consistent assumption regarding the unit price of power purchases. In contrast to the increase in the estimate of Western's composite energy rate, this

Assessment Variables	Affected Environment (Existing Conditions)	No Action Alternative (2020 Conditions)	CALFED Action Alternatives (2020 Conditions)							
			Alternative 1		Alternative 2			Alternative 3		
			1A, 1B	1C	2A	2B, 2E	2D	3A	3B, 3H	3E, 3I
			Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8
Total Available Summer Capacity (MW)										
- Average Conditions	1,679	1,682	1,682	1,682 to 1,829	1,682 to 1,686	1,682 to 1,829	1,682 to 1,809	1,682 to 1,706	1,682 to 1,853	1,682 to 1,853
- Dry Conditions	1,427	1,464	1,464	1,464 to 1,536	1,464 to 1,489	1,464 to 1,536	1,464 to 1,532	1,464 to 1,484	1,464 to 1,520	1,464 to 1,520
Total Annual Energy Generation (GWh)										
- Average Conditions	5,265	5,248	5,248	5,248 to 5,751	5,248 to 5,346	5,248 to 5,751	5,248 to 5,622	5,248 to 5,369	5,248 to 5,819	5,248 to 5,819
- Dry Conditions	2,875	2,893	2,893	2,393 to 3,590	2,893 to 2,994	2,893 to 3,590	2,893 to 3,292	2,893 to 3,082	2,893 to 3,920	2,893 to 3,920
Total Annual Project Energy Use (GWh)										
- Average Conditions	1,563	1,577	1,577	1,577 to 3,699	1,577 to 2,117	1,577 to 3,699	1,577 to 3,026	1,577 to 2,410	1,577 to 4,204	1,577 to 4,204
- Dry Conditions	1,252	1,159	1,159	1,159 to 3,097	1,159 to 1,364	1,159 to 3,097	1,159 to 2,145	1,159 to 1,648	1,159 to 4,640	1,159 to 4,640
Total Annual Energy Available for Sale[1] (GWh)										
- Average Conditions	3,702	3,671	3,671	3,671 to 3,228	3,671 to 2,053	3,671 to 2,053	3,671 to 2,597	3,671 to 2,959	3,671 to 1,615	3,671 to 1,515
- Dry Conditions	1,723	1,734	1,734	1,734 to 1,630	1,734 to 493	1,734 to 493	1,734 to 1,147	1,734 to 1,433	1,734 to (720)	1,734 to 720
Western Composite Energy Rate (mills/kWh)		21.59	21.59	21.59 to 56.61	21.59 to 23.43	21.59 to 56.11	21.59 to 35.67	21.59 to 24.97	21.59 to 73.55	21.59 to 73.55

[1] Energy available for sale is equal to CVP maximum project generation minus CVP maximum project energy use. Negative values represent a net energy requirement.

Table 8.5.2-1. Comparison of Range in Potential CVP Power Production and Energy Conditions

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Assessment Variables	Affected Environment (Existing Conditions)	No Action Alternative (2020 Conditions)	CALFED Action Alternatives (2020 Conditions)							
			Alternative 1		Alternative 2			Alternative 3		
			1A, 1B	1C	2A	2B, 2E	2D	3A	3B, 3H	3E, 3I
			Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8
Total Available Summer Capacity (MW)										
- Average Conditions	1,490	1,475	1,475	1,475 to 1,622	1,475 to 1,479	1,475 to 1,622	1,475 to 1,602	1,475 to 1,500	1,475 to 1,646	1,475 to 1,646
- Dry Conditions	1,357	1,362	1,362	1,362 to 1,434	1,362 to 1,388	1,362 to 1,434	1,362 to 1,431	1,362 to 1,382	1,362 to 1,419	1,362 to 1,419
Total Annual Energy Generation (GWh)										
- Average Conditions	4,362	4,898	4,898	4,898 to 5,401	4,898 to 4,996	4,898 to 5,401	4,898 to 5,273	4,898 to 5,020	4,898 to 5,469	4,898 to 5,469
- Dry Conditions	2,853	2,987	2,987	2,987 to 3,684	2,987 to 3,088	2,987 to 3,684	2,987 to 3,386	2,987 to 3,176	2,987 to 4,014	2,987 to 4,014
Total Annual Project Energy Use (GWh)										
- Average Conditions	8,412	10,682	10,682	10,682 to 12,804	10,682 to 11,222	10,682 to 12,804	10,682 to 12,130	10,682 to 11,515	10,682 to 13,309	10,682 to 13,309
- Dry Conditions	6,212	6,777	6,777	6,777 to 6,982	6,777 to 6,982	6,777 to 8,715	6,777 to 7,763	6,777 to 7,267	6,777 to 10,259	6,777 to 10,259
Total Net Energy Requirement[1] (GWh)										
- Average Conditions	4,050	5,784	5,784	5,784 to 7,402	5,784 to 6,226	5,784 to 7,402	5,784 to 6,858	5,784 to 6,496	5,784 to 7,840	5,784 to 7,840
- Dry Conditions	3,359	3,791	3,791	3,791 to 5,031	3,791 to 3,894	3,791 to 5,031	3,791 to 4,377	3,791 to 4,091	3,791 to 6,245	3,791 to 6,245
System Energy Rate (mills/kWh)		26.69	26.69	26.69 to 33.60	26.69 to 27.57	26.69 to 33.00	26.69 to 30.36	26.69 to 28.11	26.69 to 33.87	26.69 to 33.87

[1] The SWP's net energy requirement is equal to SWP maximum project energy use minus SWP maximum generation.

Table 8.5.2-2. Comparison of Range in Potential SWP Power Production and Energy Conditions

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adjustment yielded a reduction in the estimated SWP system energy rate. The estimates of Western's composite energy rate and the SWP system energy for the No Action Alternative case provide a consistent benchmark for evaluating the rate impacts of the CALFED action alternatives.

8.5.2.4 Comparison of Program Alternatives to No Action Alternative

All Regions

The impacts to power production and energy resulting from the storage and conveyance program element will vary by alternative, as discussed below. Impacts to power production and energy resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a region, the program element is not discussed.

Storage and Conveyance

Alternative 1

SWP and CVP Capacity, Energy Generation. Alternative 1 may include new water storage facilities if Configuration 1C is chosen. Configurations 1A and 1B do not include new storage facilities. If Configuration 1C is implemented, new hydroelectric capacity would be added to existing or new storage sites in the Sacramento River Region. It is not known at this time what reservoir sites would be selected under this alternative. So long as a reasonable amount of discretion exists for scheduling pumping and generation at these new facilities on a daily basis, a positive impact on capacity resources would result. Energy would be required to fill these additional storage facilities, and although energy would be recovered when water is released, operation of such facilities may increase energy use.

A minor and temporary adverse impact would occur during construction if a storage site with existing hydroelectric facilities is selected. Temporary disruptions of hydrogeneration would be necessary during construction as new hydroelectric capacity is added or as the dams at existing storage sites are enlarged.

During operation, both energy generation and project use loads are estimated to increase under Configuration 1C as compared to the No Action Alternative. However, the increase in energy generation is much smaller, estimated to be approximately 500 GWh annually, while the increase in project use loads is approximately 2,100 GWh on an average annual basis, resulting in a potential reduction in net energy available for sale for Western, or an increase in net energy requirements for the CVP, of about 1,600 GWh. The net reduction in dry years is estimated to be about 1,200 GWh.

Project use loads are projected to increase throughout the year. Generation also increases, but more modestly, in all but the summer months, when on-peak generation is likely to be most highly valued.

Configuration 1C includes the addition of storage north of the Delta. The net effect is an increase in estimated dry year capacity in each month, with relatively larger increases in the fall and winter, smaller increases in the summer, and the smallest increases in early spring. Additional storage yields both increased capacity and increased energy generation.

CVP and SWP Power Production and Replacement Cost Impacts. Western or DWR could experience changes in power production and replacement costs as they incur capacity and generation impacts, or have to replace lost capacity or energy. Changes in power production costs would likely have to be passed on to power customers via rate changes.

Western's Preference Power Customers and DWR. In the short term, power providers are expected to

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replace lost capacity and energy with power from the open, or "spot," market. This will help minimize adverse and short-term production cost impacts caused by the CALFED alternatives since power rates on the open market may remain relatively flat for some time as the transition to a competitive electric market continues. The staff of the California Energy Commission forecasts a decline in real market clearing energy prices from 1998 to 2001, with prices not returning to 1998 levels until 2007 (California Energy Commission 1997). By minimizing their production and replacement costs, power providers such as Western and DWR can delay rate increases for as long as possible. In the long term, after current surplus power conditions end, power rates are expected to reflect the costs of constructing and operating the most economic generation projects.

Some indirect and adverse environmental impacts could occur as Western's power customers and DWR obtain replacement power sources. These replacement sources would be needed by Western's customers as the amount of energy available for sale by Western declines under this CALFED alternative. DWR would need to obtain replacement sources as the SWP's net energy requirement increases. Some of the replacement power could be from fossil fuel plants. An increase in the use of fossil fuels could cause adverse air quality and other environmental impacts. The potential significance of these impacts is addressed in the discussion of air quality environmental consequences (Section 6.6).

There is no impact on power production and energy values under Configurations 1A and 1B. Configuration 1C yields both increased generation benefits and increased pumping energy expenses, with the net effect being an increase in estimated production and replacement costs of approximately $40 million per year.

Western and DWR Power Rate Impacts. The potential impact of Alternative 1C on the Western composite energy rate, as compared to the No Action Alternative, could be an increase of as much as 108%. The change in the SWP system energy rate is projected to be an increase of approximately 18%. Alternatives 1A and 1B would not cause power rate impacts.

The allocation of joint use costs and power costs between the CVP and SWP systems, and the contribution of CVP project use power to meet the cost of additional pumping energy requirements, may impact these results.

Impacts on Western and DWR Power Customers. Western power customers would experience significant impacts under this alternative. These impacts would be caused by the expected increase in Western power rates described above. The rate increase would increase the power costs of Western's customers, and many of the power customers that are utilities could experience a competitive disadvantage since they would likely need to increase their rates to their own customers. The mitigation strategies described in Section 8.7.2.5 would avoid these significant impacts.

DWR power customers would not experience significant impacts from the expected increases in DWR rates. These customers purchase power from a variety of sources and they do not have firm contracts with DWR. However, the water customers of the SWP could incur increases in their water charges to cover increases in power costs required to deliver their allocations of SWP water. The significance of the potential impact on SWP water charges is addressed in Section 8.6.

Impacts on Power Payments to the CVP Restoration Fund. Each Alternative 1 configuration is estimated to result in the same or greater water deliveries to agricultural and M&I water users, as compared to the No Action Alternative. This would allow the overall target contribution to the Restoration Fund from water users to be met under this alternative. If water deliveries decreased under the alternative, and given the water rate cap in effect, the overall contribution of power users to the fund would need to increase to make up for the shortfall in total water revenues to the fund. This potential impact on power users is not expected since the total funding obligations

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of water users are expected to be met under this alternative.

Under Alternative 1C, in a worst case scenario where all increased project use is allocated to the CVP, and Western's composite rate were rendered uneconomic in a deregulated market, Western may be unable to sell energy and recover costs, including payments to the Restoration Fund.

Each Alternative 1 configuration is estimated to result in the same or greater water deliveries to agricultural and M&I water users, as compared to the No Action Alternative. As a result, a shortfall in contributions by CVP water customers to the CVP Restoration Fund is not expected. Therefore, no negative impact on power users is expected under Alternative 1.

(Note: If costs allocated to CVP water customers decrease their ability to pay their target share of contributions to the Restoration Fund, then the obligations of CVP power customers may be increased, even without application of the rate cap. Until costs are allocated, it is too speculative to estimate whether changes in the CVP water customers' ability to pay would affect CVP power customers' Restoration Fund obligations.)

Ecosystem Restoration. Energy use would likely increase during implementation of this program due to construction activities related to wetlands creation and other restoration activities. Some increase in energy use to maintain restored areas is likely, including pumping to deliver water to restored wetlands.

Energy use would decrease on lands retired from agricultural uses under this program. Many types of energy-consuming agricultural practices would no longer occur on these lands, including tilling, harvesting, and applying fertilizer and pesticides. These energy savings would occur on approximately 130,000 to 190,000 acres in the Delta Region and on about 35,000 to 100,000 acres in the Central Valley.

Water Quality. A primary focus of the Water Quality Program is source control, in which mine drainage, urban and industrial runoff, and agricultural drainage are addressed. These elements may have indirect energy impacts, depending on the specific measures that are eventually implemented. These impacts would primarily include temporary increases in energy use to implement source control measures. Examples of implementation procedures that would use energy include earthwork with heavy vehicles, and equipment necessary for installing structural water quality controls. Long-term beneficial impacts would occur as water quality improvements reduce treatment requirements.

Water Use Efficiency. Water conservation actions that are implemented as a result of the program are expected to lead to reductions in M&I water and energy use, but may lead to increases in agricultural power use. The specific water efficiency measures would be determined by local water districts and users. While specific M&I measures and their impacts can not be defined at this time, it is likely that the amount of energy used directly and indirectly by water users would be reduced as their water use declines. Examples of the types of energy-related impacts that would likely occur once the measures are successfully implemented are listed below.

- Urban water users would experience reductions in water heating requirements as their water use declines. Most of the energy savings would be in the form of reductions in the amount of natural gas that is used to power water heaters.

- Reductions in urban water demands would reduce pumping and treatment requirements for M&I water districts, thus saving additional energy.

- More efficient use of environmental diversions would reduce pumping requirements in certain areas and would lead to more energy savings.

- The water recycling element of the program would potentially delay the construction of new supply projects and related energy use during construction, operation, and maintenance of the projects. On the other hand, water recycling projects would increase the use of energy if they require increased treatment and new pressurized distribution systems. This would occur in areas where recycling plants are at the "tail-end" of water systems, or downhill from end-users that use the recycled water.

- Agricultural water users may increase energy use as they switch from gravity-fed irrigation systems to sprinkler systems.

In the short term, energy use would increase during the implementation phase of the specific conservation measures. Over the long term, the installation of conservation devices and other efficiency measures may decrease overall energy use in the study area, depending on the extent to which increased agricultural pumping in support of sprinkler irrigation is implemented.

Levee System Integrity Program. This program would cause direct energy impacts during construction. Levee system modifications are relatively energy-intensive activities during their construction phases as energy is needed to power construction equipment, worker vehicles, pumps, and other equipment. While the levee modifications would require the use of energy in the short term, they could avoid long-term levee maintenance procedures that would have to be conducted without major improvements to the system. This would be a beneficial impact in the long term and could help offset the additional use of energy in the short term.

Water Transfers. Energy use would increase in areas receiving new water supplies under the Water Transfer Program if the water deliveries result in new urban or agricultural uses that could not occur without the deliveries. Water transfers also may increase energy use at pumping and treatment facilities if the transfers require an increase in pumping or treatment requirements.

Coordinated Watershed Management. In the short term, Coordinated Watershed Management would require relatively minor amounts of energy compared to the amount required to construct the major storage, conveyance, and levee improvement elements of the other programs. Some energy would be required to implement activities in both the upper and lower watersheds as fish migration barriers are removed, unstable levees are repaired, stream banks are stabilized, and riparian habitat is improved.

The minor, temporary, and adverse energy impacts would be outweighed by the positive and long-term reductions in energy use. The related improvements in water quality could reduce water treatment requirements and associated energy requirements at treatment plants. By reducing "stressors" and damaging land use practices, watershed management would indirectly reduce the amount of energy used by related land use practices. Examples of damaging land use practices include harmful aspects of logging, agricultural pesticide and fertilizer applications, and livestock grazing.

Alternatives would likely change flows in streams below CVP and SWP facilities. This in turn would likely affect available capacity and energy generation at hydroelectric facilities that are not part of the CVP or SWP, but that are located downstream in the same watershed. These other hydroelectric facilities may include a city of Redding plant on Clear Creek, Oakdale, and South San Joaquin Irrigation District plants in the Stanislaus River basin, Friant Power Authority plants on the San Joaquin River, and the Monticello Power Plant at Lake Berryessa.

Specific impacts on these other hydroelectric facilities could be beneficial or adverse and cannot be defined at this time. A wide range of CVP and SWP operational changes are currently being assessed during the CALFED study. Until more specific information about the potentially affected facilities and timing and magnitude of

CVP- and SWP-related operational changes on specific stream reaches are available, it is too speculative to define the related impacts on other hydroelectric facilities. The magnitude of capacity and energy impacts on other hydroelectric facilities would vary on a case-by-case basis, depending on the nature of any re-operation, including how such re-operation changes with water-year type, and the projected seasonal, weekly, and daily variations. The impacts on other facilities would be influenced by not only the hydrology changes caused by the CALFED alternatives, but also by the amount of water in storage at affected facilities when the hydrology changes occur, by utility-specific water, power, and environmental demands that are in place at the time of the hydrology changes, and by the daily, weekly, and monthly operational characteristics of the affected facilities.

Alternative 2

SWP and CVP Capacity, Energy Generation and Project Energy Use Impacts. Configurations 2B and 2E of this alternative include new surface water storage projects that would be located in both the Sacramento River and the San Joaquin River regions. Configuration 2D would involve additional storage in the San Joaquin River Region only. Therefore, if one of these configurations is implemented it could cause the same types of impacts to existing hydroelectric facilities described in Alternative 1.

During operation, both energy generation and project use loads are estimated to increase under Configuration 2A as compared to the No Action Alternative. However, the increase in energy generation is much smaller, estimated to be approximately 100 GWh annually, while the increase in project use loads is approximately 540 GWh on an average annual basis, resulting in a potential reduction in net energy available for sale for Western, or an increase in net energy requirements for the CVP, of about 440 GWh. The net reduction in dry years is estimated to be about 100 GWh.

Project use loads are projected to increase slightly throughout the year with slightly larger increases in the late fall, and smaller increases in winter with Configuration 2A. Generation also increases during most months, but more modestly. In the summer months, when on-peak generation is likely to be most highly valued, a slight increase in generation is estimated for July, and a slight decrease for August.

A substantial increase in project use loads during most months of the year would result from Configurations 2B and 2E. Generation also increases during most months, but is nearly the same during the summer months, when on-peak generation is likely to be most highly valued.

Project use loads are projected to increase substantially throughout the year under Configuration 2D. Generation also increases during most months, but only slightly.

There is no significant new storage in Configuration 2A. However, average reservoir levels are generally projected to be higher in a dry year, potentially resulting in an increase of available capacity.

Significant additional storage is planned in Configurations 2B and 2E, and increased available capacity is projected during all months.

Additional storage is planned only south of the Delta in Configuration 2D. Increased available capacity is projected during all months.

CVP and SWP Power Production and Replacement Cost Impacts. Configurations 2A, 2B, 2D, and 2E would all yield some benefits of increased generation but these are overshadowed by increases in the cost of additional pumping energy requirements, resulting in a net increase in power production and replacement costs. Configuration 2A, which has no significant new storage, would result in an increased net cost of about $11.2 million annually. Configurations 2B and 2E would cause an annual net increase in costs of approximately $40.6 million. Configuration 2D

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would cause an annual net increase in costs of $26.8 million.

The other types of power replacement impacts described for Alternative 1 also would apply to this alternative.

Western and DWR Power Rate Impacts. The estimated impact of Configuration 2A on the Western composite energy rate, as compared to the No Action Alternative, could result in an increase of 9%. Configurations 2B and 2E could result in an increase of 162% and Configuration 2D could result in an increase of 65%.

The allocation of joint use costs and power costs between the CVP and SWP systems, and the contribution of CVP project use power to meet the cost of additional pumping energy requirements, may impact these results.

Impacts on Western and DWR Power Customers. Western and DWR power customers, and SWP water customers, would experience the same types of impacts under this alternative as described above in the power customer impacts section for Alternative 1.

Impacts on Power Payments to the CVP Restoration Fund. Each Alternative 2 configuration is estimated to result in the same or greater water deliveries to agricultural and M&I water users, as compared to the No Action Alternative. Therefore, for the same reasons explained in the Alternative 1 section, Alternative 2 does not have the potential to increase power-related Restoration Fund funding requirements. It would thus not cause related adverse impacts on Western's power customers.

As discussed with Configuration 1C, however, the potential for Western's composite rate to increase to the point where Western's energy is no longer economically competitive in a deregulated environment exists. In this worst case, the cessation of Western power sales would result in a subsequent cessation of payments to the Restoration Fund.

The energy use impacts of the Ecosystem Restoration, Water Quality, Water Use Efficiency, and Levee System Integrity programs included in this alternative would be very similar to the impacts caused by the similar programs included in Alternative 1.

Alternative 3

SWP and CVP Capacity, Energy Generation and Project Energy Use Impacts. Configurations 3B, 3C, 3H, and 3I of this alternative include new surface water storage projects that would be located in the Sacramento River and San Joaquin River regions. Therefore, if one of these configurations is implemented it could cause the same types of impacts to existing hydroelectric facilities described in Alternative 1.

Both energy generation and project use loads are estimated to increase under Configuration 3A as compared to the No Action Alternative. However, the increase in energy generation is much smaller, estimated to be approximately 120 GWh annually, while the increase in project use loads is approximately 830 GWh on an average annual basis, resulting in a potential reduction in net energy available for sale for Western, or an increase in net energy requirements for the CVP, of about 710 GWh. The net reduction in dry years is estimated to be about 300 GWh.

Pumping energy requirements are projected to increase in the spring and fall, with smaller increases in the winter, and very little change in July and August under Configuration 3A. Generation also increases notably in the summer months, when on-peak generation is likely to be most highly valued, with more modest impacts the rest of the year.

With Configurations 3B, 3E, 3H, and 3I, substantial increases in pumping energy requirements are projected through the year, with slightly smaller increases in July and August. Energy generation also increases in most months, but some decrease in July energy is projected, with little change in other summer months. As shown in Table 8.5.2-1, CVP generation may be

insufficient to meet the pumping energy requirements of Configurations 3B, 3H, 3E, and 3I.

There is no significant new storage in Configuration 3A; however, slightly higher reservoir levels result in a small increase in estimated dry year summer capacity.

New storage both north and south of the Delta included in Configurations 3B, 3E, 3H, and 3I provide substantial increases in capacity during the fall and winter, with somewhat smaller increases during the summer, when capacity is most valuable.

CVP and SWP Power Production and Replacement Cost Impacts. Configurations 3A, 3B, 3E, 3H, and 3I would yield slight increases in the value of generation, but they are overshadowed by increases in the cost of additional pumping energy requirements, resulting in a net increase in power production and replacement costs. Configuration 3A, which has no significant new storage, would result in an increased net cost of about $18.2 million annually, while Configurations 3B, 3E, 3H, and 3I would cause a net increase in costs of approximately $51.8 million per year.

The other types of power replacement impacts described for Alternative 1 also would apply to this alternative.

Western and DWR Power Rate Impacts. The estimated impact of Configuration 3A on the Western composite energy rate, as compared to the No Action Alternative, could result in an increase of 16%. All other Alternative 3 configurations could result in an increase of 241% in the Western composite energy rate.

The allocation of joint use costs and power costs between the CVP and SWP systems, and the contribution of CVP Project Use power to meet the cost of additional pumping energy requirements, may impact these results.

Impacts on Western and DWR Power Customers. Western and DWR power customers, and SWP water customers, would experience the same types of impacts under this alternative as described above in the power customer impacts section for Alternative 1.

Impacts on Power Payments to the CVP Restoration Fund. Each Alternative 3 configuration is estimated to result in the same or greater water deliveries to agricultural and M&I water users, as compared to the No Action Alternative. Therefore, for the same reasons explained in the Alternative 1 section, Alternative 3 does not have the potential to increase power-related Restoration Fund funding requirements. It would thus not cause related adverse impacts on Western's power customers.

As discussed with Configuration 1C, however, the potential for Western's composite rate to increase to the point where Western's energy is no longer economically competitive in a deregulated environment exists. In this worst case, the cessation of Western power sales would result in a subsequent cessation of payments to the Restoration Fund.

The energy use impacts of the Ecosystem Restoration, Water Quality, Water Use Efficiency, and Levee System Integrity programs included in this alternative would be very similar to the impacts caused by the related programs included in Alternative 1.

8.5.2.5 Comparison of Program Alternatives to Existing Conditions

Comparison of Program Alternatives to existing conditions indicates that:

- All potentially significant adverse impacts that were identified when compared to the No Action Alternative would still be considered significant when compared to existing conditions.

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- No additional significant environmental consequences have been identified when Program effects are compared to existing conditions as opposed to No Action.

- The beneficial effects of the Program would still be beneficial when compared to existing conditions.

8.5.2.6 Significant Impacts and Mitigation Strategies

The significant and adverse impacts of the CALFED alternatives on Western and its power customers would be caused by Western's rates increasing to the point that they would be higher than open market rates. Therefore, Western's rates would no longer be competitive and Western's customers would no longer enjoy rates that have historically been less expensive than other sources.

The following mitigation strategies are designed to help reduce the magnitude of Western's rate increases under the CALFED alternatives and to keep Western's rates below open market rates.

- Costs allocated to CVP Project Energy Use are covered by revenue received from CVP water users, natural resource agencies and other environmental beneficiaries. Consistent with current practice for projects authorized under Reclamation Law, rate impacts have been estimated assuming that these beneficiaries of increased Project Energy Use pumping requirements pay approximately 30% of the estimated cost of replacement energy, and that preference power customers make up the difference through increased rates. If the rates paid on behalf of these beneficiaries of increases in project use energy were based on the market cost of that energy, then Western rate impacts could be reduced to insignificant levels. This mitigation strategy may require that beneficiaries of the CALFED alternatives (natural resource agencies, other environmental beneficiaries, and water users) would pay a greater share of the cost increases associated with implementing the alternatives.

- Assigning costs associated with additional pumping requirements to the beneficiaries of such increased pumping is also a potential mitigation strategy for reducing the impact on the DWR system energy rate and on customers of the SWP.

- Other mitigation strategies include other options for avoiding significant Western rate increases. For example, federal legislation could be passed to reduce Western's share of CVP repayment obligations, thereby reducing Western's revenue requirements and the rates that Western must charge its preference customers.

It should be noted the results of this analysis and conclusions regarding impact significance could change once joint use costs are defined and allocated to power, and the power-related costs of the CALFED action alternatives are allocated among the CVP and SWP.

8.6 REGIONAL ECONOMICS

This chapter reviews the regional economies that could be affected by implementation of the CALFED Program. Implementation of CALFED program elements could cause changes in land uses and in the use, price, and availability of water. These changes would affect production, consumption, and investment decisions in the agricultural, fishing and recreation, municipal and industrial (M&I), and hydropower sectors. In turn, this would change the demand for goods and services, thereby directly and indirectly impacting employment, income generation, and public finance.

Agriculture, resource extraction (timber harvesting and mining), animal husbandry, and recreation are dominant industries for much of the upper watershed study areas, influencing employment rates, income generation, local government finances, and regional economic output. These industries are located on both private and public lands, as administered by the U.S. Forest Service, Bureau of Land Management, and state resource agencies.

Each of the program elements could potentially affect agricultural economics and production, although the Coordinated Watershed Management Program would have negligible effects until implemented on large scale. In addition, the quantity, reliability, and cost of water provided by Storage and Conveyance components would affect agricultural users. Most adverse impacts are the result of converting agricultural land to other uses, such as for habitat or for levee setbacks, or a change in water use or quality that reduces production or increases costs. Improved flood control could benefit affected land values in the Delta.

Overall, potentially substantial adverse impacts for income, employment, and public finance are projected to occur within the Delta Region, primarily due to Program effects on the agricultural sector. Negligible-to-moderate adverse effects are expected in the Sacramento River and San Joaquin River regions, and although some adverse impacts are likely to occur within the other study areas and within other industries, they are expected to be negligible to minor in magnitude. Areas of export will benefit from improved water supply reliability. Impacts to Regional Economics are summarized on Table 8.6-1.

Impacts to Regional Economics

- **No Action** conditions are forecast to be similar to existing conditions adjusted for population growth.
- **Storage and Conveyance**
  Alternative 1 is expected to have adverse impacts from loss of agricultural production and beneficial effects from increased recreation and water supply and reliability.

  Alternative 2 would have similar impacts as Alternative 1, but provide more beneficial effects on recreation and water supply and reliability.

  Alternative 3 would have similar impacts as Alternative 2, but provide greater water supply reliability to M&I users as a result of additional conveyance flexibility.
- **Ecosystem Restoration Program and Levee System Integrity Programs** would remove agricultural lands from production, resulting in adverse economic impacts, but can also lead to beneficial economic impacts from increased recreational opportunities. Beneficial impacts also include improved flood control and increased water supply, quality, and reliability.
- The **Water Use Efficiency Program** could improve the long-term viability of some agricultural lands, but may ultimately result in conversion of some crop mixes. Water transfers may result in some temporary land fallowing during critically dry periods.

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Employment	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Bay Region												
Employment	o	o	o	o	o	o	o	o	o	o	o	o
Income Generation	o	o	o	o	o	o	o	o	o	o	o	o
Public Finance	o	o	o	o	o	o	o	o	o	o	o	o
Sacramento River Region												
Employment	o	o	o	o	o	o	o	o	o	o	o	o
Income Generation	o	o	o	o	o	o	o	o	o	o	o	o
Public Finance	o	o	o	o	o	o	o	o	o	o	o	o
San Joaquin River Region												
Employment	o	o	o	o	o	o	o	o	o	o	o	o
Income Generation	o	o	o	o	o	o	o	o	o	o	o	o
Public Finance	o	o	o	o	o	o	o	o	o	o	o	o
SWP and CVP Service Areas Outside the Central Valley												
Employment	o	o	o	o	o	o	o	o	o	o	o	o
Income Generation	o	o	o	o	o	o	o	o	o	o	o	o
Public Finance	o	o	o	o	o	o	o	o	o	o	o	o

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:

Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
o	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 8.6-1. Summary of Environmental Impacts Related to Regional Economics

No Action Alternative. No Action conditions are expected to be similar to existing conditions, adjusted for population growth. Current economic trends are projected to continue.

Storage and Conveyance

Alternative 1 would convert farmland, terrestrial, and aquatic habitat for ecosystem restoration, levee rehabilitation, and surface storage and conveyance features, resulting in adverse economic impacts. Total revenue losses across all regions would be between $120 and $240 million. This would be a substantial impact in the Delta Region, and negligible to moderate impacts in other regions. There would be minor increases in recreational and fisheries sector expenditures, between $29 and $103 million per year, creating employment opportunities and stimulating regional spending. Configuration 1C would involve north-of-Delta storage facilities, thereby improving the reliability of water flows. This would increase benefits to recreation and fisheries, and provide savings up to $149 million per year for M&I water users. Construction and operation of storage facilities would generate new economic activity within the region during the construction phase, resulting in moderate beneficial impacts to income, employment, and expenditures. Most of these effects would be short term.

Alternative 2 would have similar impacts as Alternative 1. This would result in a loss of agricultural revenues between $140 and $280 million. The north- and south-of-Delta storage facilities would stimulate recreation and fisheries spending, between $24 and $123 million per year, and provide up to $149 million per year in M&I savings.

Configurations 2B and 2E would have similar construction and operational impacts from north-of-Delta storage facilities as Configuration 1C. Configurations 2B and 2E would also provide south-of-Delta storage. Construction and operation of storage facilities would generate new economic activity within the region during the construction phase, resulting in moderate beneficial impacts to income, employment, and expenditures. Most of these effects would be short term.

Alternative 3 would have similar impacts as Alternative 1. This would result in a loss of agricultural revenues of between $143 and $285 million. The additional storage facilities would stimulate recreation and fisheries spending, from $60 and $156 million per year, and provide up to $175 million per year in M&I savings.

Configurations 3B, 3E, 3H, and 3I would have similar construction and operational impacts from north- and south-of-Delta storage facilities as discussed for Configuration 1C, 2B and 2E. Configurations 3B, 3E, and 3I also include in-Delta storage facilities. Construction and operation of storage facilities would generate new economic activity within the region during the construction phase, resulting in moderate beneficial impacts to income, employment, and expenditures. Most of these effects would be short term.

Ecosystem Restoration. Implementing the ecosystem restoration program elements would withdraw agricultural lands from production, resulting in substantial adverse effects to employment, revenue generation, and public finance in the Delta Region, and minor to moderate effects in the other regions.

Water Quality, Water Use Efficiency, and Water Transfers. Components of these program elements would have beneficial effects for most regions. Improved water quality and reliable water flows from water efficiency measures and new storage/conveyance facilities would result in substantial savings for M&I water users. Likewise, these elements would increase business opportunities in the recreation and fisheries sector, resulting in an increase in employment and regional spending. Water use efficiency improvements in agriculture could help support the long-term viability of production agriculture in some regions, providing a beneficial impact to rural communities and regional economies. Water Transfers, to the extent they may involve temporary land fallowing or groundwater substitution, could adversely impact local

economies if adequate protections are not provided.

Levee System Integrity. The levee system integrity program elements would convert agricultural lands from production, resulting in adverse economic impacts. The increased flood protection would have long-term economic benefits for farmlands set below water levels.

Coordinated Watershed Management. Coordinated watershed management measures would have beneficial impacts to fisheries and M&I water users through improved water quality. Enhancement activities that remove farming, cattle grazing, mining, and timber harvesting opportunities in the upper watershed areas, would likely have a negative effect on public finances and result in foregone economic opportunities. The magnitude of the impact, however, is expected to be minor given the limited amount of acreage, animal-unit months (AUMs), and mining sites affected. Over the long term, this would result in negligible changes in employment, income, or economic output. Additionally, improved land management practices could increase yields in these natural resource industries.

8.6.1 Affected Environment/ Existing Conditions

8.6.1.1 Delta Region

Historical Perspective. From 1940 to 1985, the population growth rate of the counties within the Delta Region exceeded that of the state as a whole. Contra Costa County had the largest increase (611%), and San Joaquin County had the smallest (211%). The average annual growth rate in the Delta Region counties was approximately 4%.

In 1940, agriculture was the largest single employment sector in the Delta Region (21%), followed closely by manufacturing (19%). By 1985, the largest proportions of employment had shifted to the government, trade, and service sectors.

Total personal income in the Delta Region counties has increased from 1970 to 1985. Farm income as a portion of total personal income has decreased since 1980 while income associated with service and retail sectors has increased.

Existing Conditions. Existing economic output, employment, income, and population data are presented in Table 8.6.1-1.

The population in the Delta Region grew by 24% during 1986 to 1995 at a rate similar to the state average. Most of this growth occurred in urban centers. As of the 1990 U.S. Census, Caucasians continued to compose the largest proportion of the population, although the relative proportion of all other ethnic groups has continued to rise.

The composition of employment within the Delta Region counties has remained virtually unchanged since 1986. Services (including recreation based), government, and trade accounted for approximately 70% of total employment in the Delta Region counties in 1995. Agricultural employment also remained unchanged at an estimated 2% of total employment.

Since 1986, total personal income in the Delta Region counties has increased, dominated by the service sector. Median family incomes range from $35,000 in San Joaquin County to $52,000 in Contra Costa County. Poverty rates in the individual counties vary widely, from 7% in Contra Costa County to 17% in Yolo County.

Total county property tax revenues for the Delta Region counties increased steadily from the 1985/86 fiscal year ($349 million) until the early 1990s ($485 million). Property tax revenues for the 1993/94 fiscal year ($332 million) indicate a substantial reduction in the amount collected by the individual counties due to the Education Reinvestment Augmentation Fund of 1992 (ERAF).

Region/Industry	Final Demand (billion dollars)	Total Industry Output (billion dollars)	Employ Compens. Income (billion dollars)	Property Income (billion dollars)	Place of Work Income (billion dollars)	Total Value Added (billion dollars)	Employ-ment (1000s of Jobs)
Delta Region							
Agriculture, Forestry, Fisheries	0.4	0.5	0.1	0.1	0.2	0.2	11
Mining	0.2	0.2	0.0	0.1	0.2	0.2	0
Construction	1.1	1.2	0.3	0.1	0.5	0.5	13
Manufacturing	2.9	3.5	0.8	0.6	1.4	1.5	20
Transportation, Comm., Utilities	0.6	1.1	0.3	0.3	0.5	0.6	8
Wholesale, Retail Trade	1.3	1.6	0.8	0.2	1.1	1.3	39
Finance, Insurance, Real Estate	1.4	1.9	0.4	0.9	1.3	1.5	16
Services	1.9	2.6	1.2	0.5	1.7	1.7	53
Govt. Enterprise & Special Industry	1.2	1.4	1.1	0.1	1.2	1.2	34
Total	11.1	14.1	5.0	2.9	7.9	8.5	194
Population, 1000s						**348**	
Bay Region							
Agriculture, Forestry, Fisheries	1.2	1.5	0.4	0.3	0.7	0.7	29
Mining	3.6	3.7	0.3	1.5	1.8	2.5	5
Construction	14.8	16.9	5.2	1.6	6.8	6.8	165
Manufacturing	66.0	79.8	20.6	14.2	34.8	35.8	437
Transp., Comm., Utilities	13.9	20.9	5.9	5.0	10.9	11.5	150
Wholesale, Retail Trade	23.3	29.1	14.6	4.2	18.9	23.4	626
Finance, Insurance, Real Estate	24.9	34.4	7.0	16.5	23.6	27.3	262
Services	35.3	51.3	22.9	10.3	33.2	33.8	969
Govt. Enterprise & Special Industry	15.1	16.6	13.7	0.6	14.0	14.0	406
Total	198.2	254.1	90.6	54.2	144.5	155.9	3,049
Population, 1000s						**4,916**	
Sacramento River Region							
Agriculture, Forestry, Fisheries	1.8	2.6	0.3	0.6	0.9	0.9	55
Mining	0.7	0.8	0.1	0.5	0.6	0.6	2
Construction	8.4	9.4	2.4	0.8	3.2	3.3	100
Manufacturing	9.2	11.6	2.6	1.9	4.6	4.9	79
Transportation, Comm., Utilities	2.9	5.5	1.5	1.4	2.9	3.1	43
Wholesale, Retail Trade	7.9	9.4	4.9	1.2	6.2	7.5	254
Finance, Insurance, Real Estate	8.9	11.8	2.1	5.5	7.6	9.3	103
Services	11.1	14.5	6.4	2.7	9.2	9.3	314
Govt. Enterprise & Special Industry	11.2	12.3	9.1	1.2	10.3	10.3	294
Total	62.1	77.9	29.5	15.8	45.3	49.4	1,244
Population, 1000s						**2,352**	

Table 8.6.1-1 Existing Regional Economic Conditions

Region/Industry	Final Demand (billion dollars)	Total Industry Output (billion dollars)	Employ Compens. Income (billion dollars)	Property Income (billion dollars)	Place of Work Income (billion dollars)	Total Value Added (billion dollars)	Employ-ment (1000s of Jobs)
San Joaquin River Region							
Agriculture, Forestry, Fisheries	9.1	12.5	1.4	2.4	3.8	3.9	249
Mining	4.0	4.4	0.2	2.3	2.6	3.1	5
Construction	7.1	8.4	2.1	0.6	2.7	2.8	89
Manufacturing	15.9	19.3	3.5	2.6	6.1	6.6	112
Transportation, Comm., Utilities	3.5	6.0	1.6	1.4	3.0	3.2	53
Wholesale, Retail Trade	6.9	8.8	4.7	1.2	5.9	7.2	240
Finance, Insurance, Real Estate	6.5	9.2	1.5	4.6	6.1	7.5	77
Services	9.5	12.1	5.3	2.2	7.5	7.6	264
Govt. Enterprise & Special Industry	6.7	7.1	6.1	0.3	6.5	6.5	212
Total	69.3	87.9	26.4	17.7	44.1	48.4	1,302
Population, 1000s						2,759.0	
SWP and CVP Service Areas							
Agriculture, Forestry, Fisheries	7.4	9.9	1.9	2.0	3.9	4.0	200
Mining	7.2	7.6	0.6	2.7	3.3	4.9	13
Construction	48.6	55.6	15.1	5.3	20.5	20.7	578
Manufacturing	153.3	189.0	48.3	35.3	83.6	85.5	1,384
Transportation, Comm., Utilities	25.0	47.0	12.7	11.6	24.4	26.0	365
Wholesale, Retail Trade	69.3	85.7	41.5	12.2	53.6	68.1	2,044
Finance, Insurance, Real Estate	76.1	104.6	18.9	52.6	71.5	84.0	803
Services	106.4	153.8	66.8	30.0	96.8	98.7	2,884
Govt. Enterprise & Special Industry	46.5	51.8	41.6	1.6	43.1	43.1	1,329
Total	540.0	705.0	247.5	153.4	400.8	435.0	9,600
Population, 1000s						**16,612**	

Table 8.6.1-1 Existing Regional Economic Conditions (Continued)

8.6.1.2 Bay Region

Historical Perspective. The population of the Bay Region increased from about 4.54 million in 1970 to 5.48 million in 1990, for an annual growth rate of 2.25%. The growth rate slowed between 1990 and 1995.

The largest employers in the Bay Area region in 1940 were services, wholesale and retail trade, and manufacturing sectors, respectively. Agriculture, forestry, and fishing accounted for 3.8% of total household employment in the region. By 1992, agriculture, forestry, and fishing accounted for only 0.4% of wage and salary employment in the region.

The San Francisco and Central Coast including upper watershed areas subregions show a very small percentage of income from the salmon industry compared with total personal income. The relatively large populations within these subregions help explain the relatively small percentages. Personal income from commercial salmon fishing in the North Coast Subregion approached 2% of total personal income in the region during the period from 1976 to 1980 but then fell more than 70% to 0.5% during the most recent period (1986 to 1990).

Existing Conditions. Table 8.6.1-1 shows economic variables estimated for the Bay Region. The population in 1991 was estimated to be 4.92 million persons, of which 3.05 million were employed. Primary employers were services, trade, and manufacturing. Total industrial output was estimated to be $254 billion. Total employee compensation was about $91 billion and property income was $54 billion.

8.6.1.3 Sacramento River Region

Historical Perspective. The population increased from about 1.227 million in 1970 to 2.209 million in 1990 for an annual growth rate of 8.26%. The growth rate slowed between 1990 and 1995.

In 1940, agriculture was the largest single employer in the Sacramento River Region, providing 20.8% of total household employment in the region. By 1992, agricultural production provided 3.7% of total wage and salary employment in the area, or about 37,000 jobs.

From 1940 to 1992 the share of manufacturing employment fell from 12.2% to 7.8%. Transportation, communications, and utilities (TCU) fell from 9.1% to 4.5%. Conversely, during the same period, wholesale and retail trade increased from 18.4% to 23.2%, services increased from 17.7% to 23.6%, and government increased from 8.2% to 26.9%. Currently, the largest proportions of wage and salary jobs in the region are in the government, services, and wholesale and retail trade sectors, respectively.

Patterns of employment growth in the Sacramento River Region reflect the changing rural and urban complexion of the region. While production agriculture provides less than 4 % of wage and salary employment, the percentage varies widely among the counties. In 1992, production agriculture accounted for 33% of employment in Colusa County, 19% in Glenn County, and 16% in Yuba County. However, it accounted for less than 1% in Sacramento, Placer, and Nevada counties.

Most upper watershed lands were rural, and supported predominately natural resource based industries including farming, livestock, grazing, timber harvesting, road construction, and mining. Open space and natural resource extraction have historically dominated the majority of land in the upper watersheds of the Sacramento River Region. With the Gold Rush and World War II, more land was grazed or brought into cultivation, making it a dominant industry in the area.

Existing Conditions. Table 8.6.1-1 shows economic variables estimated for the Sacramento River Region. In 1991, the regional population was estimated to be 2.35 million persons, of which 1.24 million were employed. Primary employers were services, government, trade, and finance/insurance/real estate. Total industrial output was estimated to be $78 billion. Total employee compensation was about $30 billion and property income was $16 billion. Most of the economic activity in the region is located in the

Sacramento area and near Redding. Many small communities are largely dependent on agriculture.

Open space, agriculture, and resource extraction remain the dominant features of the upper Sacramento River watershed basin. The lifestyle is relatively rural, with most urban development in towns along major transportation corridors.

8.6.1.4 San Joaquin River Region

Historical Perspective. The population increased from about 1.676 million in 1970 to 2.974 million in 1990, for an annual growth rate of 7.72%. The growth rate slowed between 1990 and 1995.

In 1940, agriculture was the largest single employer in the San Joaquin River Region. At that time, agricultural production provided about one-third of total household employment in the region. By 1992, agricultural production provided less than 10% of total wage and salary employment in the area, or about 93,000 jobs. Currently, the largest proportions of wage and salary jobs in the region are in the services, wholesale and retail trades, and government sectors, respectively.

Open space and agriculture, with small farming communities, dominated the upper watersheds of the San Joaquin region until the 1960s. Although agriculture, food processing, and natural resource extraction remained the main industries of the upper watersheds, urban development began to change the landscape following the 1960s.

Existing Conditions. Table 8.6.1-1 shows economic variables estimated for the San Joaquin Region. In 1991, the regional population was estimated to be 2.76 million persons, of which 1.3 million were employed. Primary employers were services, agriculture/forestry/fisheries, trade, and government. Total industrial output was estimated to be $88 billion. Total employee compensation was about $26 billion and property income was $18 billion.

Agriculture and open space are the predominant land uses in the upper San Joaquin River watershed, with agriculture and natural resource extraction industries contributing most to the economy. Economic uses of the open space includes cattle grazing, timber harvesting, mining, and recreation. About one-third of this upper watershed land is public, being national forest and park lands, state parks, and recreation lands, and Bureau of Land Management property.

8.6.1.5 SWP and CVP Service Areas Outside the Central Valley

The study area also includes service areas receiving SWP water in DWR's Central Coast Region and the Antelope Valley and Mojave River planning subareas of the South Lahontan region. Central Coast SWP contractors are in Santa Barbara and San Luis Obispo counties. These two counties are served by deliveries through the Coastal Aqueduct of SWP. This region is economically influenced by Los Angeles and San Diego.

Historical Perspective. The first European use of the Central and South Coast regions involved Spanish settlement for trade and cattle production. After statehood, the region grew quickly as agriculture, business, and industry took advantage of the region's warm Mediterranean climate. The Los Angeles metropolitan area is now the second largest in the nation.

The population increased from about 12.1 million in 1970 to 18.2 million in 1990, for an annual growth rate of 4.4%. The population growth rate slowed between 1990 and 1995.

Existing Conditions. Table 8.6.1-1 shows economic variables estimated for the SWP and CVP Service Areas Outside the Central Valley. The 1991 population was estimated to be 16.61 million persons, of which 9.6 million were employed. Primary employers were services, trade, manufacturing, and government. Total industrial output was estimated to be $705 billion. Total employee compensation was about $247.5 billion and property income was $153 billion.

8.6.2 Environmental Consequences: Regional Economics

8.6.2.1 Assessment Methods

The four economic sectors most likely to be directly affected by the CALFED Program are agriculture, M&I (urban) water consumers, commercial fishing and recreation, and hydropower. Specific economic impacts for each sector are addressed in Sections 8.1, 8.2, 8.3, and 8.5, respectively. This section applies the projected economic changes of each sector to assess the general magnitude of direct and indirect impacts on regional economies. The primary economic indicators assessed are employment, personal income, and public finance.

The following assumptions were made for the analysis:

- Gross revenue per farmed acre is between $500 and $1,000 per year, considering all agricultural lands potentially impacted by the program (rangeland, pasture, and cropland).
- 50 direct jobs are created per 1 million dollars of agricultural revenue.
- Nonresidents spend 80% of their recreation expenses in the region of destination, and nonresidents account for 25% to 40% of expenditures depending on the region.

Employment multipliers were obtained from the input-output Impact Analysis for Planning (IMPLAN) database to estimate secondary, or indirect, impact to employment levels.

The programmatic nature of this analysis does not support complete estimation of specific changes in economic values resulting from Program actions within each of the identified study areas. For this analysis, the evaluation methodology has identified the overall level of magnitude and direction of potential regional economic impacts based on the description of Program actions for each alternative and an estimate of the degree to which each Program action or component affects water and land use within each region.

8.6.2.2 Significance Criteria

Levels of impact are identified for employment and income on the basis of potential changes in sectoral employment within each region. The significance of employment impacts on social well-being is discussed in Section 8.2.4.

8.6.2.3 Comparison of No Action Alternative to Existing Conditions

The No Action Alternative regional economic structure is assumed to remain similar to existing conditions. It is assumed that the present structure of the California economy will continue with fast growth rates in the service and high-tech sectors, and slight declines in the heavy manufacturing, mining, and agriculture sectors. It is also assumed that overall baseline levels of production will continue to grow over the next two decades at a rate similar to the forecasted rate of population growth.

The No Action Alternative economic data for each region are provided in Table 8.6.2-1. These data were obtained from the IMPLAN 1991 database and adjusted to account for the 2020 population forecasts issued by the California Department of Finance.

8.6.2.4 Comparison of Program Alternatives to No Action Alternative

The impacts to regional economics resulting from the storage and conveyance program element will vary by alternative, as discussed below. Impacts to regional economics resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequence associated with other program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a region, the program element is not discussed.

Region/Industry	Final Demand (billion dollars)	Total Industry Output (billion dollars)	Employ Compens. Income (billion dollars)	Property Income (billion dollars)	Total Place of Work Income (billion dollars)	Total Value Added (billion dollars)	Employ-ment (1000s of Jobs)
Delta Region							
Agriculture, Forestry, Fisheries	0.5	0.7	0.1	0.1	0.2	0.2	14
Mining	0.3	0.3	0.0	0.2	0.2	0.2	0
Construction	1.4	1.6	0.4	0.1	0.6	0.6	16
Manufacturing	3.7	4.5	1.1	0.7	1.8	1.9	26
Transportation, Comm., Utilities	0.8	1.3	0.4	0.3	0.7	0.7	10
Wholesale, Retail Trade	1.7	2.1	1.1	0.3	1.3	1.7	50
Finance, Insurance, Real Estate	1.8	2.4	0.5	1.2	1.6	1.9	20
Services	2.4	3.3	1.5	0.6	2.1	2.2	67
Govt. Enterprise & Sp. Industry	1.6	1.7	1.4	0.1	1.5	1.5	44
Total	14.1	18.0	6.3	3.7	10.1	10.9	248
Population, 1000s						**445**	
Bay Region							
Agriculture, Forestry, Fisheries	1.5	2.0	0.5	0.4	0.9	0.9	37
Mining	4.6	4.7	0.3	1.9	2.3	3.1	6
Construction	18.9	21.5	6.6	2.1	8.6	8.7	210
Manufacturing	84.2	101.8	26.2	18.1	44.4	45.7	558
Transp., Comm., Utilities	17.8	26.6	7.5	6.3	13.8	14.7	191
Wholesale, Retail Trade	29.7	37.1	18.7	5.4	24.1	29.9	799
Finance, Insurance, Real Estate	31.8	43.9	9.0	21.1	30.1	34.9	334
Services	45.0	65.5	29.3	13.1	42.4	43.1	1,237
Govt. Enterprise & Sp. Industry	19.3	21.2	17.5	0.7	17.8	17.8	518
Total	252.9	324.3	115.6	69.2	184.4	198.9	3,891
Population, 1000s						**6,273**	
Sacramento River Region							
Agriculture, Forestry, Fisheries	3.1	4.5	0.5	1.0	1.6	1.7	97
Mining	1.3	1.4	0.1	0.9	1.0	1.1	3
Construction	14.8	16.4	4.3	1.3	5.6	5.7	176
Manufacturing	16.1	20.4	4.6	3.3	8.0	8.6	138
Transportation, Comm., Utilities	5.1	9.6	2.6	2.5	5.1	5.5	76
Wholesale, Retail Trade	13.9	16.5	8.6	2.2	10.8	13.2	445
Finance, Insurance, Real Estate	15.6	20.6	3.7	9.6	13.3	16.4	181
Services	19.5	25.5	11.3	4.8	16.1	16.4	550
Govt. Enterprise & Sp. Industry	19.6	21.6	16.0	2.1	18.1	18.1	515
Total	108.9	136.5	51.8	27.7	79.5	86.5	2,181
Population, 1000s						**4,123**	

Table 8.6.2-1 No Action Alternative Economic Levels, Year 2020, 1992 Dollars

Region/Industry	Final Demand (billion dollars)	Total Industry Output (billion dollars)	Employ Compens. Income (billion dollars)	Property Income (billion dollars)	Place of Work Income (billion dollars)	Total Value Added (billion dollars)	Employ-ment (1000s of Jobs)
San Joaquin River Region							
Agriculture, Forestry, Fisheries	19.6	26.9	3.0	5.2	8.2	8.4	533
Mining	8.6	9.4	0.5	5.0	5.5	6.7	11
Construction	15.3	17.9	4.5	1.3	5.9	5.9	192
Manufacturing	34.0	41.3	7.5	5.6	13.2	14.2	240
Transp., Comm., Utilities	7.5	12.8	3.4	3.0	6.4	6.9	114
Wholesale, Retail Trade	14.7	18.9	10.0	2.6	12.6	15.3	513
Finance, Insurance, Real Estate	14.0	19.8	3.2	9.8	13.0	16.0	166
Services	20.3	26.0	11.3	4.7	16.0	16.3	566
Govt. Enterprise & Sp. Industry	14.4	15.3	13.1	0.7	13.8	13.8	455
Total	148.4	188.3	56.6	37.9	94.5	103.6	2,790
Population, 1000s						**5,911**	
CVP & SWP Service Areas							
Agriculture, Forestry, Fisheries	11.2	15.1	2.9	3.1	5.9	6.0	305
Mining	11.0	11.6	0.9	4.2	5.1	7.5	20
Construction	74.0	84.6	23.0	8.1	31.2	31.4	879
Manufacturing	233.3	287.6	73.5	53.8	127.3	130.1	2,106
Transp., Comm., Utilities	38.1	71.5	19.4	17.7	37.1	39.6	556
Wholesale, Retail Trade	105.5	130.4	63.1	18.5	81.6	103.6	3,111
Finance, Insurance, Real Estate	115.8	159.1	28.8	80.0	108.8	127.8	1,221
Services	161.9	234.1	101.7	45.6	147.4	150.3	4,389
Govt. Enterprise & Sp. Industry	70.8	78.8	63.2	2.4	65.6	65.6	2,022
Total	821.7	1,072.8	376.6	233.4	609.9	661.9	14,608
Population, 1000s						**25,279**	

Table 8.6.2-1 No Action Alternative Economic Levels, Year 2020, 1992 Dollars (Continued)

Delta Region

Storage and Conveyance

Alternative 1. Implementation of Alternative 1 would have substantial economic impacts to employment, income, and public finance. The conversion of productive farmland, terrestrial and aquatic habitats for levee system integrity, and storage and conveyance (Configuration 1C) would reduce farm revenues and labor requirements. Revenue lost is projected between $58 and $148 million per year, representing from 8% to 21% of regional agricultural revenue. Direct and indirect job loss would be between 2,900 and 7,400, representing 1.2% to 3.0% of regional jobs. The loss of property taxes would have a substantial negative effect on public finance for county and municipal jurisdictions within the area.

Construction and operation of storage facilities would generate new economic activity within the region during the construction phase, resulting in moderate beneficial impacts to income, employment, and expenditures. Most of these effects would be short term.

The reader is referred to Chapter 5, Section 5.2 for a more detailed discussion on the extent of acreage potentially impacted.

Additional storage and improved conveyance facilities would increase the supply and reliability of surface water flows. This could also benefit agricultural users and increase production levels. The effects on public finance and regional economics from the financing of storage and conveyance are currently unknown.

Alternative 2. Implementation of Alternative 2 would have impacts similar to Alternative 1; however, more agricultural land may be converted for conveyance and storage facilities. This could increase the total regional loss of agricultural revenues to $178 million per year, representing 25% of the regional total. Approximately 8,900 jobs, or 3.6% of regional employment, may be affected. Recreational and fisheries expenditures could increase from $28 (Configuration 2A) to $56 million per year (Configuration 2E), creating between 250 and 1,300 new jobs.

Alternative 3. Implementation of Alternative 3 would have impacts similar to Alternative 2, except lost farm revenue could approach $184 million under Configuration 3H. Under this scenario, more than 9,000 jobs may be lost. Due to increased business opportunities, the recreation and fisheries industries are expected to spend more under all Alternative 3 configurations than under the other alternatives. The forecasted amount would be between $39 and $80 million, creating up to 1,900 jobs. Configurations 3B, 3E, and 3I include additional storage.

Ecosystem Restoration. The Ecosystem Restoration Program would directly affect land and water resources used for agricultural production within the Delta area. There will be substantial losses to farm revenues, regional economics, and employment. Some of these effects would be offset anywhere from less than 10% to more than 30% by increased jobs and spending in the recreational and fisheries sectors. M&I water users could also realize up to $2.6 million in annual savings from improved water quality and supply.

Water Quality. Potential regional economic impacts from the Water Quality Program are expected to be negligible to low. Improved water quality and improved supply reliability through new storage and conveyance facilities (as proposed in Configuration 1C) would have beneficial effects on fishing and recreation industries, and for many Delta M&I water users. The costs associated with any additional water availability are unknown at this time; however, it is estimated that up to $2.3 million could be saved by M&I industries. Recreational and fishery industries could increase regional spending from $14 million to $36 million per year, creating between 300 and 850 jobs.

Water Use Efficiency. Water use efficiency could help support the long-term viability of production agriculture in the Delta, providing a beneficial

impact to rural communities and regional economies dependent on agriculture.

Water Transfers. The voluntary transfer of water that may occur out of the Delta region would not be expected to result in any significant economic impacts to this region.

Bay Region

None of the program elements are expected to produce long-term adverse economic effects on land and water resources within the Bay Region. Therefore, only negligible adverse impacts would occur to the regional economy. Public finances are not expected to be adversely impacted.

Implementation costs associated with the Water Quality and Water Use Efficiency programs would have short-term impacts on income generation. Over the long term, income generation might increase as a result of better regional water quality and supply.

Improved water quality and efficiency would benefit commercial fishing and recreation industries, and M&I water users. The resulting increase in fishing and recreational opportunities is expected to generate from $3 to $5 million in new spending under Alternatives 1 and 2, and from $8 to $12 million under Alternative 3. These expenditures would increase employment by a small amount: 0 to 50 persons in Alternatives 1 and 2, and 80 to 120 persons in Alternative 3.

Additional water supplies created under Configurations 1C; 2B and 2E; and 3B, 3E, 3H, and 3I, could save M&I users from $8.9 to $10.3 million per year. Impacts from water quality and power production have not been estimated.

Water Transfers. Water transfers may allow water to be imported into the Bay Region, augmenting existing supplies and providing future water supply reliability. This can benefit the regional economy as long as the source continues to be available. If the transfer is terminated, adverse economic impacts could occur as a result of the dependence on this water source.

Coordinated Watershed Management. There would not be any long-term detectable changes in employment, income, or economic output in the upper watersheds of the Bay Region. Restoration and structural improvement activities would produce temporary direct and indirect jobs and spending in the region, resulting in a negligible to minor beneficial economic impact. Once the projects are complete, employment, income, and economic output would return to near pre-project levels.

Sacramento River Region

Storage and Conveyance

Alternative 1. Implementation of Alternative 1 would have low to moderate impacts to employment, income, and public finance. Agricultural land would be converted under Configurations 1A and 1B, and slightly more acres under Configuration 1C. Farm revenue loss is projected between $13 and $34 million per year under Configurations 1A and 1B and between $22 and $66 million under Configuration 1C. About 1% of the regional agricultural revenues could be affected. Between 650 and 3,300 jobs might be lost, representing less than 1% of all regional jobs. Since agricultural spending and income are a small share of total regional spending and income, the net effect on personal income, employment, and public finance would be negligible.

Some of the agricultural job losses will be mitigated by the construction and operation of storage and conveyance facilities under Configuration 1C. Construction and operation of storage facilities would generate new economic activity within the region during the construction phase, resulting in moderate beneficial impacts to income, employment, and expenditures. Most of these effects would be short term.

Additional negative regional economic impacts could result from costs of the Water Quality and Levee System Integrity programs, and storage and conveyance. Costs are not yet available, so regional economic impacts cannot be quantified.

Improved water quality and improved supply reliability would benefit recreation and fisheries industries. Regional spending from these sectors would increase from $3 to $17 million per year, generating between 50 and 290 new jobs. The greatest benefit would be realized under Configuration 1C. Configuration 1C would also save M&I water users up to $1.7 million.

Alternative 2. The only economic difference between Alternatives 1 and 2 is that Configurations 2A and 2D would provide between $0.1 and $0.8 million in M&I water supply savings, compared to none under Configurations 1A and 1B.

Alternative 3. Alternative 3 would have similar impacts as Alternative 1. Configuration 3A would convert fewer acres from production, while the other four configurations of Alternative 3 would each convert proportionally more. These resulting economic impacts would be similar to Alternative 1, Configurations 1A and 1C, respectively. Recreational and fisheries industries would benefit from increased opportunities, generating from $8 to $28 million in new spending. This would create between 90 and 330 new jobs.

Coordinated Watershed Management. Restoration and structural improvement activities would produce temporary direct and indirect jobs and spending in the region, resulting in negligible to minor beneficial economic impact. Once the projects are complete, employment, income, and economic output would return to near pre-project levels.

Implementation of upper watershed enhancements would result in retiring agricultural lands located adjacent to waterways in order to create a non-point source pollution buffer. Similarly, mining activities and cattle grazing would be restricted near waterways. Removal of land from productive use would likely have a negative effect on public finances and result in foregone economic opportunities. The magnitude of the impact, however, is expected to be minor and non-significant given the limited amount of acreage, AUMs, and valid and patented mining sites affected. There would not be any long-term detectable changes in employment, income, or economic output.

Water Use Efficiency. Water use efficiency impacts are similar to those discussed for the Delta Region.

Water Transfers. Increased levels of water transfers within or out of the region could have significant beneficial or adverse impacts, depending on the magnitude, timing, source of water, and pathway used to transport the water. Revenues generated by water transfers could augment local economies if the transfer proceeds are spent within the region. The transfer of water within the basin can help improve the reliability of water for local lands or communities that are water short. When temporary land fallowing or groundwater substitution is used as a source of water to transfer, adverse impacts could occur. These impacts would be minimal if appropriate protections are in place.

San Joaquin River Region

Storage and Conveyance

Alternative 1. Implementing Alternative 1 would have similar impacts in the San Joaquin River Region as the Sacramento River Region. The primary difference is that less agricultural land would be converted. The loss in revenue would be between $5 and $27 million, represent less than 0.1% of the regional total. Job loss would be between 200 and 1,350, also representing less than 0.1% of regional jobs. Therefore, effects to the regional economy would be negligible to low.

From $3 to $17 million in new spending would occur from the recreational and fisheries industry, generating between 50 and 300 new jobs. The greatest benefits would be realized under Configuration 1C.

Alternative 2. Alternative 2 would be similar to Alternative 1, except that more productive agricultural land might be converted for ecosystem restoration and new storage and conveyance facilities. This additional loss in production would affect 0.1% of the total regional

agricultural revenues and affect 0.1% of regional jobs. These effects are considered to be low to moderate adverse economic impacts.

Some of the job loss and reduction in regional spending would be mitigated from the construction and operation of storage and conveyance facilities under Configurations 2B and 2E. Construction and operation of storage facilities would generate new economic activity within the region during the construction phase, resulting in moderate beneficial impacts to income, employment, and expenditures. Most of these effects would be short term.

From $3 to $17 million in new spending would occur from the recreational and fisheries industry, generating between 50 and 300 new jobs. The greatest benefits would be realized under Configurations 2B and 2E.

The San Joaquin River Region stands to gain more than most regions from new water supplies since the region is relatively water scarce and the cost is relatively expensive. M&I water supply may generate up to $1.7 million per year.

Alternative 3. Alternative 3 would have similar impacts as Alternative 2, Configurations 2B and 2E.

Coordinated Watershed Management

Upper watershed effects would be similar to those in the Sacramento River region.

SWP and CVP Service Areas Outside the Central Valley

SWP and CVP Service Areas Outside the Central Valley would experience a pattern of impacts similar to that discussed for the Sacramento River and Bay regions. The main differences are that water quality changes would be more important and beneficial, and potential benefits from fisheries and recreational fishing would be less.

There would be no identifiable effect on agricultural lands, and effects on recreation and related employment range from 20 to 200 jobs annually. Impacts related to M&I water supply saving would be up to $2 million per year.

8.6.2.5 Comparison of Program Alternatives to Existing Conditions

Comparison of program alternatives to existing conditions indicates:

- All potentially significant adverse impacts that were identified when compared to the No Action Alternative would still be considered significant when compared to existing conditions.
- No additional significant environmental consequences have been identified when program effects are compared to existing conditions as opposed to No Action.

In summary, the conclusions regarding the significance of project effects on regional economics when compared to existing conditions would be similar to those compared to No Action.

8.6.2.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

None of the economic impacts would be considered significant; however, there would be substantial adverse effects from agricultural land conversion in many areas. The following measures would minimize the magnitude of adverse agricultural impacts:

- Phase project elements to allow local economies to gradually adjust to new conditions.
- Minimize or avoid fallowing or shifting crops that require high input and output expenditures.

- Limit the amount of acreage that can be fallowed in a given area.

- Promote conjunctive use of surface and groundwater resources to encourage maintenance of agricultural production in selling regions without adversely impacting groundwater resources.

- Limit the proximity and/or capacity of wells that can be used to develop water either for a direct groundwater transfer or groundwater substitution transfer.

- Operate a groundwater level monitoring program to determine whether pumping should be shifted, terminated, or reduced in any of the transferring pumps.

Mitigation measures for recreation sector employees are:

- Configure transfers to minimize effects on reservoir recreation.

- Ensure that all existing minimum instream flow requirements on affected rivers and reservoir minimum pools on affected reservoirs are met.

Mitigation measures for both agricultural and recreation sector employees are:

- Minimize job loss to the extent possible by relocating facilities and shifting agriculture to new areas.

- Provide job referral and placement services, and job retraining.

- Compensate local governments for increased demand for services resulting from labor displacement.

- Compensate workers displaced by specific transfers through such actions as augmenting unemployment insurance benefits.

- Promote geographically broad-based water transfers and ensure that no one localized area is involved in a disproportionately large amount of transfer activity.

8.6.2.7 Potentially Significant Unavoidable Impacts

No significant economic impacts are expected. Substantial effects on farm revenues and employment may occur as agricultural lands are converted to other uses.

8.7 CULTURAL RESOURCES

Summary

Cultural resources consist of prehistoric and historic resources and traditional cultural properties. Prehistoric resources are physical properties resulting from human activities that predate written records. Prehistoric resources can include village sites, temporary campsites, lithic scatters, roasting pits/hearths, milling features, petroglyphs, rock features, and burials.

Historic resources consist of physical properties, structures, or built items resulting from human activities that post-date written records. Historic resources include both archeological sites and architectural structures. Historic archeological site types can include townsites, homesteads, agricultural or ranching features, mining-related features, and refuse concentrations. Historic architectural resources can include houses, barns, and community structures such as churches, schools, stores, post offices, and meeting halls.

Traditional cultural properties are sites, locations, or features that are associated with cultural practices or beliefs of a living community that are (a) rooted in that community's history and (b) that are important in maintaining the continuing cultural identity of the community. Traditional cultural properties are most often associated with Native American practices and beliefs; however, other communities or cultural groups may acknowledge traditional cultural properties of their own. Traditional cultural properties may be listed on the National Register of Historic Places (NRHP). Table 8.7-1 provides a summary of environmental impacts related to cultural resources.

Delta Region. Cultural resources in the Delta Region would experience minor to moderate adverse impacts from ecosystem restoration projects and from levee stabilization and setback efforts. Structural features associated with the Water Quality Program may affect cultural resources.

Impacts to Cultural Resources

- **No Action.** Additional development could impact cultural resources.
- **Storage and Conveyance** could have some adverse effects on cultural resources within all regions except the SWP and CVP Service Areas Outside the Central Valley.
- Impacts associated with the Alternative 3 isolated facility are expected to be the most severe.
- **Ecosystem restoration** could adversely effect cultural resources in all regions except the SWP and CVP service areas outside the Central Valley.
- Levee stabilization could adversely affect cultural resources in the Delta.

Conveyance actions proposed for the Delta Region under Alternative 1 involve minor modifications of existing facilities or only short connectors. Disturbance is expected to be limited, and adverse impacts are rated as minor.

Conveyance under Alternative 2 increases the proposed actions and potential for adverse impacts. Levee setbacks are viewed as a potential moderate impact because of extensive earth movement and the sensitivity for cultural resources located near water sources. Finally, other adverse impacts to cultural resources include flooding of certain tracts, the acquisition of land along the Mokelumne River, and the relocation of certain facilities.

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Impacts to cultural and historic resources due to construction activities and land use conversions.	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Bay Region												
Impacts to cultural and historic resources due to construction activities and land use conversions.	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Sacramento River Region												
Impacts to cultural and historic resources due to construction activities and land use conversions.	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
San Joaquin River Region												
Impacts to cultural and historic resources due to construction activities and land use conversions.	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
SWP and CVP Service Areas Outside the Central Valley												
Impacts to cultural and historic resources due to construction activities and land use conversions.	□	□	□	□	□	□	□	□	□	□	□	□

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:

Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
○	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 8.7-1. Summary of Environmental Impacts Related to Cultural Resources

Alternative 3 contains projects that carry the potential for major adverse impacts to cultural resources in the Delta because of the action's magnitude and the area's archeological sensitivity. Various conveyance alternatives exist to transport water from Hood to the Clifton Court Forebay. The alignment is potentially sensitive since it partly falls outside peat soils, and numerous waterways are crossed where cultural resources are likely to exist. Six previously recorded prehistoric sites and one historic site are found along the route. The route has not been inventoried and unrecorded sites are undoubtedly present. Finding buried archeological sites during construction also is possible.

Alternative 3 also includes new water storage within the Delta Region. The types of construction activities that could occur in the Delta during development of additional storage include reinforcement of levees, the construction of pump stations, siphons, and head differentials. All of these ground-disturbing activities could have a significant adverse effect on any NRHP-eligible properties or important cultural resources within the project area. Operation and maintenance activities that could occur at new storage facilities include maintenance of levees, pump stations, head differentials, and siphons. These activities may require limited construction, dredging and filling of soil and other ground-disturbing activities. All of these activities could have a significant adverse effect on NRHP-eligible properties or important cultural resources within the project area.

Bay Region. Cultural resources in Suisun Bay and San Francisco Bay may experience some adverse impacts from implementing portions of the ecosystem restoration program.

Sacramento River and San Joaquin River Regions. These regions are slated for a variety of projects under the Ecosystem Restoration Program. Habitat improvement, fish facilities, the relocation of water facilities and the upgrade of structures are types of projects that would have a minor and possibly moderate adverse impact to cultural resources.

Cultural resources within these regions would experience adverse impacts as a result of surface water and groundwater storage. New reservoirs represent significant surface disturbance with high construction and flooding adverse impacts. Groundwater storage offers some of the same adverse impacts because percolating basins are required, but the overall scope of such projects is often less than a new or enlarged reservoir.

The types of activities that could occur during the construction of a reservoir storage project include construction of dams, channels, canals, spillways, outlet works facilities, pumping plants, diversions, irrigation and road crossings, and access roads; flooding of areas; and dredging and filling of soil. All of these ground-disturbing activities could have a significant adverse effect on NRHP-eligible properties or important cultural resources within the project area.

The types of operation and maintenance activities that accompany a reservoir project include maintenance of dams, channels, canals, spillways, diversions, irrigation and road crossings, and access roads. These activities may require limited construction, dredging and filling of soil, and other ground-disturbing activities. All of these activities could have a significant adverse effect on NRHP-eligible properties or important cultural resources within the project area. Additional adverse impacts could occur to NRHP-eligible properties or important cultural resources within the project area from vandalism or looting of artifacts resulting from increased public access to the sites.

SWP and CVP Service Areas Outside the Central Valley. Implementing any of the alternatives would not result in direct adverse impacts to cultural resources within the SWP and CVP service areas outside the Central Valley. But the delivery of water to nonagricultural areas may cause growth above current projections. Resulting development may have adverse impacts on cultural resources within areas to be developed.

8.7.1 Affected Environment/ Existing Conditions

The historical perspectives, including prehistory, ethnohistory, and history, for each region are provided in the cultural resources supporting document. The following discussion is a summary.

8.7.1.1 Delta Region

The majority of the Delta Region has not been surveyed for cultural resources. Most of the early archeological work in the region focused on prominent prehistoric mounds, during which time additional prehistoric sites were identified. Documentation of historic sites has largely occurred only in the last 20 to 30 years.

At least 171 sites within the Delta Region have been listed in the NRHP as individual properties or as districts. Six sites in the region have also been listed as California Historical Landmarks and four are listed as California Points of Historical Interest.

Prehistoric Resources. Prehistoric site types that have been recorded in the Delta Region include village sites, temporary campsites, milling-related activity sites, and lithic scatters (Table 8.7.1-1). Locations of recorded prehistoric sites in the Delta Region have been entered into a Geographic Information System (GIS) for the region. This GIS layer reveals that prehistoric sites are not evenly distributed across the Delta Region. Although channel deposits, floodplains, and basins make up approximately 40% of the total acreage within the Delta Region, nearly 80% of prehistoric sites are located within these landforms. In contrast, those landforms identified as mucks, organic soils, and fans, basins, and terraces make up 25% of the study area landmass but contain less than 5% of the prehistoric sites. Furthermore, no prehistoric sites have been recorded in peat (>50% organics) or peaty mucks (25 to 50% organics). Former tidal wetlands may be sensitive areas for prehistoric resources where they contain sand dunes and mounds that have been occupied in prehistoric times.

The landscape of the Delta Region is radically different today than it was prior to farmland reclamation. Reconstructed watercourses, areas presently and formerly subject to tidal influence, and other features of surface geology were used as a basis for generating a predictive model of prehistoric settlement patterns in the south Delta Region. Further mapping of extinct watercourses can help define areas of sensitivity for buried prehistoric sites. Age-dating the sediments on which sites are found may be useful in predicting the location of sites from the same chronological period.

Much of the region has a long history of agricultural development. In these areas, intact surface or shallow subsurface deposits are unlikely to exist. Intact surface prehistoric resources are most likely to exist in areas relatively unaffected by development or agriculture, although subsurface deposits may exist below the plow zone or capped underneath pavement or structures.

Historic Resources. Potential historic resources in the Delta Region are largely related to agriculture; however, other types of resources also are present, including farmsteads, labor camps, landings for the shipment of agricultural produce, canneries, pumping stations, siphons, canals, drains, unpaved roads, bridges, and ferry crossings. Forty known historic sites coincide with prehistoric sites. Labor camps generally consist of at least one wooden bunkhouse or boarding house, a dining hall, a cookhouse, a washroom, and associated buildings. Landings, for the most part, are not elaborate, consisting of a few pilings or a dolphin. At least three ferry crossings are present in the study area.

Due to the extensive use of the land in historic times, architectural resources are likely to occur throughout the region. However, much of the region is still used for agricultural purposes where the ground surface is regularly plowed, raked, or tilled.

Landforms (Landform Code)	Area (x1000)	% Area	Prehistoric Site Codes[a] 01	02	04	07	16	15	15,09	09	Total Sites	% Sites
Channel Deposits (11)	82.1	10.3	11				7	23	14	12	67	34.9
Mucks: Delta/Marsh (12)	62.0	7.8							2		2	1.0
Floodplains (14)	59.1	7.4	4				5	3	8	8	28	14.6
Peat and Muds (15)	185.9	23.4	1				1	3	9	4	18	9.4
Organic Soils (16)	105.2	13.2	1				1	1		1	4	2.1
Basins & Basin Rims (22)	151.8	19.1	3	3			2	17	17	13	55	28.6
Interfan Basins (31)	8.2	1.0									0	0.0
Fans Basins Terraces(32)	36.9	4.6						1			1	0.5
Eolian Deposits (33)	14.6	1.8					1			1	2	1.0
Valley Fill (34)	38.3	4.8			1		2	1	2		6	3.1
Alluvial Fans (35)	9.2	1.1									0	0.0
Low Terraces (41)	25.5	3.2					2	1	1		4	2.1
Dissected Terraces (51)	4.4	0.5						1			1	0.5
Steep Uplands (62)	7.0	0.8				2		1			4	2.1
Mountain Slopes (63)	4.5	0.5									0	0.0
Total	**794.7**	**N/A**	**21**	**3**	**1**	**2**	**21**	**52**	**53**	**39**	**192**	**N/A**
Percentage of Site Types			10.9	1.5	0.5	1.0	10.9	27.1	27.6	20.3	N/A	N/A

NOTES:

N/A = Not applicable

a Prehistoric Site Types: 01 = Unknown; 02=Lithic Scatter; 04 = BRM/Milling Feature; 07 = Architectural Feature; 15 = Habitation Debris; 16 = Other; 15 and 09 = Habitation Debris with Burials; 09 = Burials.

Table 8.7.1-1. Distribution of Prehistoric Site Types by Landform Type in the Delta Region

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Traditional Cultural Properties. To date, no traditional cultural properties have been identified in the Delta Region.

Native American Groups. The primary Native American group known to have occupied the Delta Region is the Northern Valley Yokuts. No reservations or rancherias are located within the Delta Region. A review of the primary ethnographic literature for the Delta Region and contact with the Native American Heritage Commission has revealed no known traditional properties or sacred sites. However, several Native American burial and cremation sites have been discovered in the Delta Region and more are likely to occur. These types of sites may be of concern to Native American groups.

8.7.1.2 Bay Region

Considerable industrial and residential development in the Bay Region has taken a toll on archeological resources. Prehistoric and historic sites have been destroyed by urban development and by industrial construction. Archeological sites remain in areas that have not been fully developed. Subsurface deposits also can be found capped under asphalt and below buildings.

At least 407 sites within the Bay Region have been listed on the NRHP as individual properties or as districts. In addition, 176 sites in the region have been listed as California Historical Landmarks and 156 are listed as California Points of Historical Interest (Cultural Resources Supplemental Documents). Many of these are historic buildings located in urban areas. Historic preservation programs, societies, and organizations are active in the Bay Region.

Prehistoric Resources. Prehistoric site types recorded in the Bay Region include village sites, temporary campsites, milling sites, petroglyphs, lithic scatters, quarry sites, shell and ash middens, and burial sites. Permanent settlements were common in the Bay Region in prehistoric times, and prehistoric sites are likely to occur throughout the region. However, substantial commercial and residential development in the region has disturbed or destroyed many sites. Intact deposits are most likely to occur in undeveloped areas.

Historic Resources. Historic site types documented in the Bay Region include railroad grades and associated features, recreational sites, dams and culverts, mining-related sites, early military sites, refuse deposits, and architectural structures. Due to the extensive use of the land in historic times, historic resources are likely to occur throughout the region. However, extensive development has destroyed or disturbed many sites.

Traditional Cultural Properties. Mount Diablo and Mount Tamalpais are well-known landmarks in the Bay Area that are considered traditional cultural properties because of their religious and ceremonial significance to several Native American groups. Mount Diablo, located approximately 13 miles southeast of Suisun Bay and 22 miles east of San Francisco Bay, plays an important role in Native American mythology and is the focal point of the Costanoan creation myth and several Miwok legends. Additional myths are associated with Mount Tamalpais, located approximately 6 miles northwest of Sausalito.

Native American Groups. The primary Native American groups known to have occupied the Bay Region are the Costanoan, Eastern Miwok, and Patwin. There are no formal reservations or rancherias present in the Bay Region; however, a number of Native Americans live in the area. Mount Diablo holds mythic importance to the Costanoans as part of one of their creation myths. It also plays a prominent role in several Miwok legends. Mount Tamalpais also holds mythical importance for these groups. In addition, several Native American burial sites have been discovered in the Bay Region and more are likely to be found. These types of sites may be of concern to Native American groups who consider these locations sacred.

8.7.1.3 Sacramento River Region

The massive agricultural and urban development of the valley floor has significantly damaged many archeological sites. Prehistoric mounds have been leveled, and sites have been repeatedly tilled and plowed in agricultural fields. Nevertheless, intact archeological deposits may occur in buried contexts, beneath the plow zone, or under asphalt parking lots. The foothill regions of the Sacramento River Region contain undeveloped areas where prehistoric and historic sites may be found.

At least 294 sites within the Sacramento River Region have been listed on the NRHP as individual properties or as districts. In addition, 224 sites in the region have been listed as California Historical Landmarks, and 196 are listed as California Points of Historical Interest (see the Cultural Resources Appendix). Many of these properties fall outside areas of potential impact.

Prehistoric Resources. Prehistoric site types that have been recorded in the Sacramento River Region and that are likely to occur within the upper watersheds include village sites, temporary campsites, milling sites, petroglyphs, lithic scatters, quarry sites, and burial sites. Acorn processing sites are commonly found in the oak woodland. According to a site-density model prepared for the American River Water Resources Investigation, the foothills and granite-based upland areas contain a projected 3.5 and 2.8 sites per square mile. Habitation sites and bedrock mortar or other milling sites are the most common types found in these areas. Due to intensive occupation of the area in prehistoric times, prehistoric resources are common within the region. However, substantial agricultural development has disturbed or destroyed many sites. Intact sites are most likely to occur in areas that have not been fully developed or farmed or that may remain under plow zones.

Historic Resources. The majority of historic site types recorded in the Sacramento River Region and listed on the NRHP consist of local structures, such as houses, schools, libraries, churches, post offices, hotels, railroad stations or related features, mine sites, and bridges. Additional types of historic sites that have been recorded in the Sacramento River Region and that may be likely to occur within the upper watersheds include mining-related structures or features, railroad grades and associated features, dams and culverts, and refuse deposits. Historic site types recorded in the Sacramento River Region consist of mining-related structures or features, railroad grades and associated features, dams and culverts, refuse deposits, bridges, and architectural structures. Mining in the Sierra Nevadas was widespread in the second half of the 19th century, and numerous railroads were established throughout the region. In addition, attempts to irrigate the valley and bring potable water to San Francisco created many irrigation features in the region. Historic resources are likely to occur throughout the region.

Traditional Cultural Properties. Traditional cultural properties exist within the study area. Sutter Buttes is considered by the Konkow and Maidu to be the location where spirits of the dead left for the afterworld. Butte Mountain is a Nisenan ancestral ceremony site. The Nomlaki consider Lassen Butte to be the home of a mythical figure. Marysville Buttes and Mount Shasta are also of mythical importance to the Patwin and Wintu.

Native American Groups. The primary Native American groups known to have occupied the Sacramento River Region include the Achumawi, Atsugewi, Konkow, Maidu, Nisenan, Nomlaki, Yana, and Wintu. Nineteen reservations or rancherias are located in the counties that make up the Sacramento River Region. However, some of these reservations fall outside areas of potential impact. There are also an unknown number of public domain allotments within the region.

Some natural or geologic features are traditionally considered sensitive or sacred. As examples of the sacred natural landscape, the Konkow and the Maidu considered Sutter Buttes as the location

from which spirits of the dead left for the afterworld. Butte Mountain is the site of the first Hesi ceremony performed by ancestors of the Nisenan. The Nomlaki considered Lassen Butte to be the home of a mythical figure. Marysville Buttes and Mount Shasta are places of mythical importance to the Patwin and Wintu. Burial or cremation sites may also exist within the Sacramento River Region.

8.7.1.4 San Joaquin River Region

As in the Sacramento River Region, vast agricultural development in the San Joaquin River Region has destroyed many archeological sites. Remnants of sites still occur in agricultural lands, but they have been highly disturbed.

At least 156 sites within the San Joaquin River Region have been listed on the NRHP as individual properties or as districts. In addition, 111 sites in the region have been listed as California Historical Landmarks and 50 are listed as California Points of Historical Interest (see the Cultural Resources Appendix). Many of these properties fall outside areas of potential impacts.

Prehistoric Resources. Prehistoric site types that occur within the San Joaquin River Region and are likely to occur within the upper watersheds include village sites, temporary campsites, milling sites, petroglyphs, lithic scatters, quarry sites, and burial sites. Prehistoric sites are most commonly found along the San Joaquin River and its associated sloughs. Buried sites are possible in this region due to the high rate of sedimentation. Substantial agricultural development in the valleys has disturbed or destroyed many sites. Prehistoric sites are most likely to exist in areas not fully developed or farmed or may remain below plow zones.

Historic Resources. Historic site types that have been recorded in the San Joaquin River Region and that are likely to occur within the upper watersheds include mining-related structures and features, railroad grades and associated features, dams and culverts, roads, refuse deposits, and architectural structures. Agricultural development of the valley has occurred since the Gold Rush era, leading to the establishment of numerous rural communities. These communities may contain sites and structures of historical significance.

Traditional Cultural Properties. Table Mountain is a traditional cultural property because of its cultural importance to the Monache who believe that mythical beings visited the mountain. The Monache have several additional places of mythological importance located within the San Joaquin River Region that may also qualify as traditional cultural properties.

Native American Groups. The primary Native American groups known to have occupied the San Joaquin River Region include the Foothill Yokuts and Southern Valley Yokuts, Kawaissu, Kitanemuk, Monache, and Tubatulabal. Eight reservations or rancherias are located in the counties that make up the San Joaquin River Region, although some of these reservations fall outside areas of potential impact. There are also an unknown number of public domain allotments within the region.

The Monache have several places of mythological importance. Table Mountain near Friant was thought to be visited by mythical beings. Burial or cremation sites may also exist within the San Joaquin River Region.

8.7.1.5 SWP and CVP Service Areas Outside the Central Valley

The majority of the area has sustained extensive residential, urban, and industrial development, which has destroyed or damaged many archeological sites. Other sites may have been damaged from the limited agricultural development in the areas. Intact cultural deposits are most likely to occur in areas not fully developed or may lie buried beneath structures or the plow zones. Some portions of these two areas, especially in foothills, have not been substantially developed and may contain intact prehistoric and

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historic resources. Historically significant architectural resources may exist throughout the two service areas.

Prehistoric Resources. Prehistoric site types include village sites, temporary campsites, milling sites, petroglyphs, lithic scatters, quarry sites, and burial sites. Permanent settlements were common along the coast in prehistoric times, and interior valleys were traversed on a seasonal basis. Therefore, prehistoric sites are likely to occur within the service areas. However, substantial development has occurred in urban areas, and many sites have been disturbed or destroyed. Prehistoric sites may exist in areas that have not been fully developed or farmed or may remain buried under plow zones or capped under asphalt or structures.

Historic Resources. Historic site types that have been recorded in the area include mines and mining-related features, railroad grades and associated features, roads, trails, bridges, refuse deposits, and architectural structures. The California coast was heavily occupied in historic times, so historic resources are likely to occur in the service areas. However, these areas are also extensively developed.

Traditional Cultural Properties. Few traditional cultural properties have been identified within the area. The Martinez Historical District, located within the Torres-Martinez Indian Reservation in Riverside County (SWP Service Area), was listed in the NRHP in 1973. This district plays an important role in the history of the Torres-Martinez Band of Mission Indians and is therefore considered to be a traditional cultural property. Other properties of significance to cultural groups may exist within the area.

Native American Groups. The primary Native American groups known to have occupied the area are the Northern Valley Yokuts, Chumash, Cahuilla, Gabrielino, Luiseno, Ipai, Kumeyaay, Tataviam, and Serrano. The area contains 24 Native American reservations or rancherias. public domain allotments may also exist within the region.

8.7.2 Environmental Consequences: Cultural Resources

8.7.2.1 Assessment Methods

Impact assessments focus mainly on those properties listed or eligible for listing in the NRHP, or important archeological resources, as defined in CEQA Section 21083.2(g).

Section 106 of the National Historic Preservation Act (NHPA) (16 USC 470), as amended (PL 89-515), and its implementing regulation (36 CFR Part 800) require federal agencies to consider the effects of their actions on properties listed or eligible for listing in the NRHP. The regulations state that an undertaking has an effect on a historic property when that undertaking alters those characteristics of the property that qualify it for inclusion in the NRHP. An undertaking is considered to have an adverse effect on a historic property when it diminishes the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Adverse effects include, but are not limited to:

- Physical destruction, damage, or alteration of all or part of the property;
- Isolation of the property or alteration of the character of the property's setting when that character contributes to the property's qualifications for the NRHP;
- Introduction of visual, audible, or atmospheric elements that are out of character with the property or changes that may alter its setting;
- Neglect of a property resulting in its deterioration or destruction; and

- Transfer, lease, or sale of a property, without adequate provisions to protect the property's historic integrity.

Additional assessment methods are provided in the Cultural Resources supporting document.

8.7.2.2 Significance Criteria

Impact assessments for cultural resources are based on the type of the site, NRHP-eligibility status or importance as defined under CEQA Section 21083.2(g), the type of impact, and the extent of disturbance from the project. Impacts to prehistoric and historic resources are considered significant if the project could adversely affect those sites listed or eligible for listing in the NRHP or considered important under CEQA.

Impacts to cultural resources consist of ground-disturbing activities, modification and alteration to historic structures, visual intrusion to a historic setting, and artifact theft. Direct impacts are those that occur during project construction, development, or operation that directly impinge on or destroy cultural resources, such as all activities that entail earthmoving. Ground-disturbing activities may affect the physical integrity of cultural resources, destroying the research potential. Modification or alteration of historic buildings may disturb their architectural integrity that contributes to their NRHP eligibility or importance under CEQA.

Impacts can occur indirectly through the alteration of the character of the site setting, and the introduction of visual, audible, or atmospheric elements that change the character of a site or its setting, which may affect the eligibility of the site for inclusion in the NRHP. Additional indirect impacts may result from increased pedestrian activity in an area, which provides opportunities for artifact theft or vandalism of cultural resources.

Cultural resources are fragile, finite, and nonrenewable. Any type of physical damage results in a permanent loss of information. The importance of any given resource is closely related to its structural and/or depositional integrity. Once a site is disturbed, it may be stabilized and protected from further deterioration, but it cannot be restored to its original condition. Even the application of data recovery techniques involves some loss because data recovery is necessarily selective. Although the construction or development phase of a proposed project may be of relatively short duration, adverse effects to NRHP-eligible or important cultural resources would be long-term and permanent.

Additional significance criteria are provided in the Cultural Resources Technical Report.

8.7.2.3 Comparison of No Action Alternative to Existing Conditions

Several actions, either planned or under development will be implemented under the No Action Alternative. Impacts to cultural resources from these actions in each of the regions are being considered prior to implementation. For example, considerable inventory and the excavation of historic and archeological sites have been conducted in support of the Los Vaqueros Reservoir Project. Many other actions that will be implemented despite the Bay-Delta Program will not affect cultural resources.

Impacts from individual projects would be evaluated on a project-specific basis using 36 CFR Part 800 as a guide for complying with Section 106 of the NHPA. Impacts would also be evaluated using CEQA guidelines presented in Section 21083.2 (a-f).

8.7.2.4 Comparison of Program Alternatives to No Action Alternative

The impacts to cultural resources resulting from the storage and conveyance program element will vary by alternative, as discussed below. Impacts to cultural resources resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the

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discussions of environmental consequences associated with other program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a region, the program element is not discussed.

Table 8.7.2-1 summarizes Ecosystem Restoration and Levee System Integrity actions and impacts. Impacts in Tables 8.7.2-1 and 8.7.2-2 are generically described as Con\1 (minor construction), Con\2 (moderate construction), Flooding, Acquisition, or Modification. The tables also identify actions proposed for each region.

Table 8.7.2-2 summarizes storage and conveyance permutation of the three alternatives for each region. Actions are divided into conveyance alternatives for the Delta Region or storage options for the other regions. Anticipated impacts from each action are identified per methods described in the Cultural Resources supporting document.

Delta Region.

Storage and Conveyance

Alternative 1. Adverse impacts associated with conveyance configurations are minor construction and the modification of existing structures. The construction, for example, of a barrier at Old River under Configuration 1B represents a probable minor impact (Con\1). The disturbance is expected to be limited. The new Clifton Court intake proposed under Configuration 1C is an example of an adverse impact that represents modification of an existing facility. No cultural resources have been recorded in the Clifton Court APE, although formal inventories would be needed prior to project implementation.

Alternative 2. A series of facility upgrades or installations are proposed. The intakes proposed for Hood and Holland Tracts, for example, constitute minor adverse impacts (Con\1). Several of the configurations call for setback levees along various islands, sloughs, and rivers. Levee setbacks are viewed as a potential moderate adverse impact (Con\2) due to the extensive earth movement required, combined with the sensitivity associated with the proximity of water sources. In the Delta Region, prehistoric and historic sites are often clustered along water courses. As an example, levee setbacks along the North Fork of the Mokelumne River may affect six recorded prehistoric sites and two historic sites. The actual number of sites affected by this levee project, however, is contingent upon future cultural resources inventories of the entire area to be affected.

The flooding of several tracts is an option under this alternative. Breaching the levees at Bouldin Island, Brack Tract, and the Canal Ranch Tract to create aquatic and wetlands habitat is projected as a moderate adverse impact despite the fact that only one prehistoric site has been recorded in the area. Construction and flooding along potentially archeologically sensitive waterways may result in a moderate level of adverse impacts.

Proposed conveyance projects would have potential moderate adverse impact (Mod\2). One project near Roberts Island involves extensive construction and earth movement, but the bulk of this effort takes place in areas of as much as 10 feet of peat deposits. These areas hold a low potential for encountering archeological sites. The Roberts Island conveyance parallels Whiskey and Trapper sloughs as well as Victoria Canal, human-made conveyances. No archeological or historical sites are recorded along the route.

Additional adverse impacts involve flooding of certain tracts, the acquisition of land and the relocation of certain facilities.

Alternative 3. Moderate adverse impacts (Mod\2) are expected from storage of water on several islands and the setback levees along Old River.

Alternative 3 also contains possible projects that are considered to carry the potential for major adverse impacts (Con\3) to cultural resources.

Program: Ecosystem Restoration	Impacts	Region
Protect vernal pools	a. Con\1; b. Acq	Delta
Fish screens/passages; diversions & facilities upgrades	a. Con\1,2; b. Mod	Sacramento
Fish screen/weir	a. Con\1,2; b. Mod	San Joaquin
Program: Levee System Integrity	Impacts	Region
Rehabilitate; setback; shallow flooding	a. Con\1,2; Flo	Delta

NOTE:
(1) Con\1\2\3 refer to construction impacts:
\1 is minor
\2 is moderate
\3 is major
Acq: Acquisition impacts
Flo: Flooding impacts
Mod: Modification impacts

Table 8.7.2-1. Summary of Impacts to Cultural Resources as a Result of the Ecosystem Restoration and the Levee System Integrity Programs

Various conveyance alternatives exist to transport water from Hood to the Clifton Court Forebay. The alignment, the same for each alternative, is potentially sensitive since it falls outside peat soils and numerous waterways are crossed where cultural resources are likely to exist. The archeological records revealed that approximately six prehistoric sites and one historic site are in the vicinity of the route. Adverse impacts are considered major due to the sheer magnitude of the project, the presence of potentially sensitive archeological areas, and the amount of disturbance such an undertaking would entail. The route has not been inventoried and unrecorded sites are undoubtedly present. Encountering buried archeological sites during excavations is also a distinct possibility.

Ecosystem Restoration. A multitude of minor construction projects would take place under ecosystem restoration. Revegetation projects, improved fish passages, eradication of undesirable plant species, and establishment of shallow water habitat could have a relatively minor adverse impact to prehistoric and historic sites. Conversely, gravel replacement, new floodways, and levee setbacks may constitute a moderate adverse impact to cultural resources because of the proximity these activities have to waterways, areas of potentially greater prehistoric and historic sensitivity.

Coordinated Watershed Management

The types of projects that could be included in upper watershed restoration may involve construction, flooding of areas, dredging soil to restore streams or reduce erosion, and revegetation or use of controlled burns for wildfire prevention. Construction activities could be anticipated to have a significant adverse effect on NRHP-eligible or important cultural resources present within the construction areas. Flooding of areas would also result in significant adverse impacts to NRHP-eligible or important cultural resources present within the areas to be flooded. Dredging could result in impacts similar to construction impacts if NRHP-eligible or important cultural resources are present in the dredged soils or locations for fill deposition. Clearing or replanting of vegetation, if not performed with hand tools, could adversely

Conveyance: Delta Region			Storage: Range of Options		
Alt	**Actions**	**Impacts[a]**	**Surface Impacts**	**Groundwater Impacts**	**Region**
1A	None	None	None	None	None
1B	a. Barrier @ Old River b. Flow & stage control: Middle/Old R., Grant Line c. New fish screens: Skinner and Tracy d. Intertie: Tracy & Clifton Court	a. Con\1 b. Con\1 c. Mod d. Con\1	None	None	None
1C	a. New Clifton Court intake b. Channel enlargement c. See 1Ba and 1Bb[b]	a. Mod b. Con\1 c. See above	a. 3.0 MAF: Con\3, Flo b. 1.0 MAF: Con\3, Flo	a. 500 TAF: Con\2? b. 500 TAF: Con\2?	a. Sacramento a. San Joaquin
2A	a. Hood: Gated intake, fish screen, bypass b. Hood: Open channel, setback levee, relocate c. Hood: Breach McCormack Williamson d. 600 ft. corridor @ Mokelumne River e. Setback levees; remove levees, relocate f. 1Ca, 1Cb, 1Ba-1Bd[b]	a. Con\1 b. Con\2 c. Flo d. Acq e. Con\2 f. See above	None	None	None
2B	Same as 2A[b]	Same as 2A	Same as 2E	Same as 2E	Same as 2E
2D	a. 2Aa-2Ac[b] b. Setback levee: New Hope, Terminous, Staten Is. c. Remove levees: S.F. Mokelumne, Bouldin Island d. Setback levees: Old River e. 1Ca, 1Ba, 1Bc, 1Bd[b]	a. See above b. Con\2 c. Con\2 d. Con\2 e. See above	a. 2.0 MAF off-aqueduct: Con\2	a. None	a. San Joaquin
2E	a. Setback levee: Georgiana Slough b. Inflatable rubber dam c. Channel section control in Georgiana Slough d. Breach Tyler Island levee e. Riprap interior levees f. 2Ac, 2Db, 2Dc, 2De, 1Ba, 1Bc, 1Bd[b]	a. Con\2 b. Unknown c. Con\1 d. Con\1 e. Con\1 f. See above	a. 3.0 MAF: Con\3 b. 500 TAF: Con\2 c. 2.0 MAF: Con\3 (off-aqueduct)	a. 500 TAF: Con\2 b. 500 TAF: Con\2	a. Sacramento b. San Joaquin c. San Joaquin? (South of Delta)

Table 8.7.2-2. Impacts to Cultural Resources from Conveyance and Storage Projects (page 1 of 2)

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Conveyance: Delta Region			Storage: Range of Options		
Alt	**Actions**	**Impacts[a]**	**Surface Impacts**	**Groundwater Impacts**	**Region**
3A	a. 2Ad, 2Ae, 1Ca, 1Cb, 1Bb-1Bd[b] b. Screened intake & pumping plant @ Hood c. 2000 ft. alignment: Hood to Clifton d. 5000 cfs channel: Hood to Clifton	a. See above b. Con\1 c. Con\1 d. Con\3	None	None	None
3B	Same as 3A; spur links w/ Bay and E. Delta	See above, Con	Same as 2E, + 200 TAF	Same as 2E	See 2E, Delta
3E	a. 2Ad, 2Ae, 1Ca, 1Ba, 1Bc, 1Bd, 2Aa, 3Ac[b] b. 15,000 cfs channel: Hood to Clifton	a. See above b. Con\3	Same as 3B	Same as 3B	Same as 3B
3H	a. 2Ea-2Ee, 2Ac, 2Db, 2Dc, 1Ca, 1Ba, 1Bc, 1Bd[b] b. 2Aa, 3Ac, 3Ad[b] c. Setback levees @ Old River: 3000 ft. channel	a. See above b. See above c. Con\2	Same as 2E	Same as 2E	Same as 2E
3I	a. 2Aa, 1Ca, 1Bc, 1Bd[b] b. Siphons: under stream crossings; SJo River	a. See above b. Con\2	a. Same as 2E b. 50-100 TAF @ Holland	Same as 2E	a. Same as 2E b. Delta

NOTES:
(a) Con\1\2\3 refer to construction impacts:
\1 is minor
\2 is moderate
\3 is major
(b) Referenced alternatives are mentioned previously in the table.
Acq: Acquisition impacts
Clifton: Clifton Court Forebay
Flo: Flooding impacts
MAF: Million acre-feet
Mod: Modification impacts
Rel: Relocation impacts (see text for details)
SJo: San Joaquin
TAF: Thousand acre-feet
Tracy: Tracy Pumping Plant

Table 8.7.2-2. Impacts to Cultural Resources from Conveyance and Storage Projects (page 2 of 2)

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impact historic properties or important cultural resources located within the areas to be cleared or restored. Other impacts that could occur to cultural resources within the Delta Region include vandalism and looting of artifacts as a result of increased access to locations where cultural resources are present. Impacts from individual project would have to be evaluated on a project-specific basis.

Water quality and water use efficiency may have a minor adverse impact on cultural resources if canal lining, tailwater recovery ponds, or new water recycling plants are developed; however, specific projects implemented by local agencies would need to address this potential on a project specific basis. Adverse impacts in the Delta Region are rated as either Con\1 (minor construction) or Con\2 (moderate construction).

Bay Region. None of the alternatives involve construction activities that would affect cultural resources in the Bay Region. Some ecosystem restoration projects may affect cultural resources found at Suisun Marsh.

Sacramento River Region

Storage and Conveyance

The Sacramento River Region would experience adverse impacts. Options under these alternatives call for surface storage of up to 3.0 MAF and groundwater storage of up to 250 TAF (Table 8.7.2-2). New reservoirs represent significant surface disturbance with high construction adverse impacts (Con\3) and adverse impacts associated with flooding. Groundwater storage offers some of the same impacts since percolating basins are needed, but the overall scope of such projects would be less than a new or enlarged reservoir.

Ecosystem Restoration. These projects call for habitat improvement, fish facilities, the relocation of water facilities, and upgrade of structures. The potential adverse impacts to cultural resources from these actions include primarily minor and possibly moderate construction activity (Con\1,\2). Site-specific inventories and evaluations would be needed to fully evaluate adverse impacts from activities of the Ecosystem Restoration Program.

San Joaquin River Region

Storage and Conveyance

The San Joaquin River Region would experience adverse impacts. Options under these alternatives call for surface storage of up to 2.0 MAF and groundwater storage of up to 500 TAF (Table 8.7.2-2). New reservoirs represent significant surface disturbance with high construction adverse impacts (Con\3) and adverse impacts associated with flooding. Groundwater storage offers some of the same impacts since percolating basins are needed, but the overall scope of such projects would be less than a new or enlarged reservoir.

Ecosystem Restoration. The program calls for a variety of habitat restoration actions as well as modification of existing fish screens and weirs to better protect fish species. The potential adverse impacts to cultural resources from these actions include primarily minor and possibly moderate construction activity (Con\1,\2). Site-specific inventories and evaluations are needed to fully evaluate adverse impacts from activities of ecosystem restoration.

SWP and CVP Service Areas Outside the Central Valley. This program would not result in any direct adverse impacts to cultural resources located within the service areas outside the Central Valley. No structures, conveyance facilities, storage projects, or habitat improvements are planned. However, the delivery of water to nonagricultural areas may cause growth above current projections. Development associated with such growth may result in indirect adverse impacts to cultural resources located within areas to be developed. There would be slight differences in the flows of water in some streams, but these changes would not affect cultural resources.

8.7.2.5 Comparison of Program Alternatives to Existing Conditions

Future impacts to cultural resources under the No Action Alternative are expected to be similar to those under existing conditions.

8.7.2.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

A range of actions would be possible to mitigate adverse impacts to cultural resources resulting from implementation of the Bay-Delta Program. Once inventories are completed for specific Bay-Delta programs and resources have been evaluated for NRHP-eligibility or significance under CEQA, discussion of mitigation measures could begin for affected properties. The preferred mitigating alternative would be to simply avoid the historic property (that is, resource that is NRHP-listed or -eligible or is considered important under CEQA). This option would save money and preserve the resource for posterity. Routes could be diverted, facilities relocated, or projects redesigned to avoid adversely impacting historic properties. When avoidance is not feasible, mitigation becomes necessary.

Developing and implementing mitigation measures involve a series of steps. These are, in part, contingent upon the specific resource. Data recovery is a common measure undertaken to mitigate adverse impacts to historic properties. Data recovery typically includes record keeping, mapping, surface collections, and possibly excavations. These actions are preceded by research design and by a Memorandum of Agreement (MOA), in compliance with Section 106 of NHPA. Completing an MOA involves input from various federal and state agencies as well as potential input from interested members of the public. Mitigation is complete with the agency acceptance of a final report. Public reports summarizing the results of mitigation efforts are often employed to disperse the information gained from the data recovery. In addition to data recovery, mitigation may involve other long-term actions, such as fencing, monitoring, or maintaining a historic property.

Mitigating historic architectural properties is more involved. If a structure is determined eligible for inclusion in the NRHP, then an MOA is prepared, as described above. The actual level of documentation for a structure or engineering facility is determined in consultation with the National Park Service, which provides direction for recording the structure to standards found in the Historic American Buildings Survey or the Historic American Engineering Record.

Mitigating impacts to traditional cultural properties is more problematic due to the character and potential sensitivity of the resource. Development of a management plan for the property is one possibility. Conducting intensive ethnographic interviews and research would provide additional documentation, if appropriate. Fencing, project redesign, and limiting the season of use are all options. Mitigation measures should be developed in consultation with the cultural group with which the property is associated.

8.7.2.7 Potentially Significant Unavoidable Impacts

Implementation of the Bay-Delta Program would result in impacts to some cultural resources. The quantity and significance is unknown since an alternative has not been chosen and a detailed cultural resource inventory and evaluation for specific actions has not been conducted. However, these impacts may be adverse and unavoidable. If impacts to NRHP-eligible or important cultural resources in any region of the Study area can not be avoided through project design, significant impacts would occur.

8.8 PUBLIC HEALTH AND ENVIRONMENTAL HAZARDS

Summary

The public health and environmental hazards that could be affected by the CALFED Program include diseases transmitted by animal vectors, fire hazards, and hazardous materials and waste.

Table 8.8-1 provides a summary of environmental impacts related to public health and environmental hazards.

The CALFED Bay-Delta Program is intended to improve natural conditions in the Delta by leaving a greater amount of water in the Delta, restoring wetland habitat, and modifying other land uses. These changes could lead to an increase in suitable mosquito breeding habitat, which in turn could expose people to a greater risk of transmissions of certain diseases. Potential impacts also may occur as a result of changes in water quality or construction activities that may expose people to hazardous materials. The impact descriptions in this section reflect the level of detail in the alternative descriptions. In almost all cases, additional analysis would be required once project-specific information is available.

For all alternatives, most public health and environmental hazard effects result from changing the area of available mosquito breeding habitat. Additional effects include changes in water quality and construction activities that could expose people to hazardous substances. When required, mitigation measures are presented.

No Action Alternative. Actions occurring under the No Action Alternative would result in potential significant adverse impacts on disease transmission and hazardous materials and waste. This alternative would have potential beneficial impacts on fire hazards.

Storage and Conveyance. Due to increased activities, the storage and conveyance program element would have more pronounced potential impacts on disease transmission, fire hazards, flood hazards, and hazardous materials and waste than the No Action Alternative.

Ecosystem Restoration. The Ecosystem Restoration Program would have potential significant adverse impacts as increased mosquito populations increase the potential for disease transmission.

Water Quality. The Water Quality Program would have potential beneficial impacts as decreasing mosquito populations reduce the potential for disease transmission and potential beneficial impacts on fire hazards.

Water Use Efficiency. The Water Use Efficiency Program could have both potential adverse impacts and potential beneficial impacts on disease transmission, but none are expected to be significant.

Coordinated Watershed Management. Due to the remote nature of the upper watershed areas within the regions of influence and the low populations of these areas, public health hazards affect fewer

Impacts to Public Health and Environmental Hazards
• **No Action Alternative** is expected to have significant adverse impacts on public health and beneficial impacts on environmental hazards
• **Storage and Conveyance** All alternatives are expected to have significant adverse impacts on public health and beneficial impacts on environmental hazards The Ecosystem Restoration Program, Water Quality Program, and Levee System Integrity Program may each increase the amount of mosquito breeding habitat.

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IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Increase in Mosquito Breeding Habitat	□	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Increase in Fire Hazards	□	□	□	□	□	□	□	□	□	□	□	□
Increase in Flood Hazards	□	+	+	+	+	+	+	+	+	+	+	+
Increase in Releases of Hazardous Materials and Waste	□	□	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Bay Region												
Increase in Mosquito Breeding Habitat	□	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Increase in Fire Hazards	□	□	□	□	□	□	□	□	□	□	□	□
Increase in Flood Hazards	□	□	□	□	□	□	□	□	□	□	□	□
Increase in Releases of Hazardous Materials and Waste	□	□	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Sacramento River Region												
Increase in Mosquito Breeding Habitat	□	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Increase in Fire Hazards	+	+	+	+	+	+	+	+	+	+	+	+
Increase in Flood Hazards	□	□	○	□	○	○	○	□	○	○	○	○
Increase in Releases of Hazardous Materials and Waste	□	□	◗	□	◗	◗	◗	□	◗	◗	◗	◗
San Joaquin River Region												
Increase in Mosquito Breeding Habitat	□	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Increase in Fire Hazards	+	+	+	+	+	+	+	+	+	+	+	+
Increase in Flood Hazards	□	□	□	□	○	○	○	□	○	○	○	○
Increase in Releases of Hazardous Materials and Waste	□	□	◗	□	◗	◗	◗	□	◗	◗	◗	◗
SWP and CVP Service Areas Outside the Central Valley												
Increase in Mosquito Breeding Habitat	□	+	+	+	+	+	+	+	+	+	+	+
Increase in Fire Hazards	□	□	□	□	□	□	□	□	□	□	□	□
Increase in Flood Hazards	□	□	□	□	□	□	□	□	□	□	□	□
Increase in Releases of Hazardous Materials and Waste	□	□	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:

Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
○	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 8.8-1. Summary of Environmental Impacts Related to Public Health and Environmental Hazards

individuals and tend to be less pronounced than they would be if present in an urban setting. However, if natural habitat for vegetation and wildlife increases, environmental hazards may be more pronounced in the upper watershed areas.

Levee System Integrity Program. This program would decrease potential impacts associated with floodwaters such as increased mosquito habitat, infrastructure disruption, and emergency vehicle access.

8.8.1 Affected Environment/ Existing Conditions

8.8.1.1 Delta Region

Historical Perspective

Disease Transmission. As the population of California has increased, urban development has encroached on wetlands, watercourses, and irrigated agricultural lands. This encroachment has resulted in more-frequent human exposure to mosquitos and has increased the likelihood of transmission of mosquito-borne diseases. The area of mosquito breeding habitat and, consequently, mosquito populations, has been affected by land use changes in the Delta Region.

Although most prehistoric marshes in the Delta have been converted to agricultural land, suggesting a reduction in mosquito breeding habitat, agricultural infrastructure and practices (for example, irrigation ditches and flooding fields to provide habitat for wintering waterfowl and other wildlife) also create suitable mosquito-breeding conditions.

The California State legislature enacted the Mosquito Abatement Act in 1915. The act allows local mosquito abatement organizations to form into specific special districts that could levy a parcel tax on properties within their districts to support abatement programs. By 1973, 64 mosquito abatement districts (MADs) were established in California. The Delta Region has four abatement districts.

Hazardous Materials and Waste. Hazardous materials and waste sites that pose potential threats to public health include hazardous waste disposal sites, gas stations, and other commercial and manufacturing locations that handle hazardous materials and wastes. Several historical land use activities have contributed to the presence of hazardous waste sites in the Delta Region. Industries such as refineries and chemical petroleum industries were established in the Suisun Bay area, along with industrial activities such as auto wrecking, electrical substations, gas stations, and gas dehydrator stations. Military bases such as Concord Naval Station and Travis Air Force Base (AFB) were built. Metal mining development in the Delta Region includes the Penn and Newton mines on the Mokelumne River and other mines along the Cosumnes River and creeks tributary to the Yolo Bypass. Agriculture has also been a contributor.

Existing Conditions

Disease Transmission. This section describes current disease-vector production levels; disease transmission by mosquito, tick, and wildlife vectors; and mosquito abatement efforts.

Diseases carried by mosquitos are known as arboviruses. At least 18 arboviruses of particular concern to humans are present in California. The arboviruses of concern in the study area include western equine encephalomyelitis, St. Louis encephalomyelitis, malaria, and dog heartworm.

In the Delta Region, mosquito control efforts are focused on seven mosquito species that can transmit malaria and several types of encephalitis or cause a substantial nuisance in communities. The seven species include the floodwater mosquito (*Aedes melanimon*), the pasture mosquito (*Aedes nigrormaculis*), the encephalitis mosquito (*Culex tarsalis*), the western malaria mosquito (*Anopheles freeborni*), the pale marsh mosquito (*Aedes dorsalis*), the cool-weather mosquito (*Culiseta inornata*), and the house mosquito (*Culex pipiens*).

The floodwater mosquito and pasture mosquito are the primary nuisance species to humans and are potential vectors for western equine encephalomyelitis and St. Louis encephalomyelitis. These species typically breed in intermittently flooded agricultural areas.

The encephalitis mosquito is the primary carrier of several types of encephalitis and is considered the most important disease vector in California. It breeds in almost any area with standing freshwater.

The western malaria mosquito is the primary vector for malaria in the western United States. It breeds in algal mats that form in standing water.

The pale marsh mosquito is a suspected vector for California encephalitis and breeds in intertidal marshes.

The cool-weather mosquito is a vector for western equine encephalomyelitis; however, it has not been found to carry western equine encephalomyelitis in California. This species is most abundant in fall and spring.

The house mosquito is a vector for St. Louis encephalomyelitis; however, it is not considered a problem vector for St. Louis encephalomyelitis in California. This species breeds in waterbodies with a high organic material content.

Mosquito Breeding Conditions/Habitat. All species of mosquitos require standing water to complete their growth cycles. Any body of standing water that remains undisturbed for more than 3 days represents a potential mosquito-breeding site. Mosquitos are produced year-round on Delta islands, but mosquito production diminishes substantially during cooler weather, typically from late October through April.

Water quality affects the productivity of a potential mosquito breeding site. Typically, waterbodies with poor circulation, higher temperatures, and higher organic content produce greater numbers of mosquitos than waterbodies with good circulation, lower temperatures, and lower organic content. Additionally, irrigation and flooding practices may influence the level of mosquito production associated with a waterbody. Typically, waterbodies with water levels that slowly rise or lower produce greater numbers of mosquitos than waterbodies with water levels that are stable or that rapidly fluctuate.

Among the habitat types in the study area, two general classes of habitats, open water and flooded, provide suitable conditions for mosquito production. Open-water habitats in the study area include permanently inundated wetlands, ditches, sloughs, and ponds. Flooded habitats include managed wetlands and agricultural lands that may seasonally retain surface water.

Mosquito Control Methods. Compared with the historical prevalence of mosquito-borne diseases in humans, mosquito-borne diseases in California are under control. These diseases are still present, however, or could be readily reintroduced. Encephalitis naturally occurs in migratory bird populations and is easily transferred by mosquitos. Malaria is occasionally brought back into the country by travelers returning from tropical locations.

To reduce mosquito populations and, consequently, the likelihood of disease transmission to humans, MADs use a combination of various abatement procedures to control mosquitos, each of which may have maximum effectiveness under specific habitat conditions or periods of the mosquito life cycle. Mosquito control has shifted away from application of pesticides, kerosene, and diesel fuel since the late 1970s as a result of concern for the cumulative effects of pesticides on the environment. Mosquito control methods currently used by MADs in the Delta Region include:

- Biological agents (such as establishing mosquitofish, which are predators on mosquito larvae) in mosquito breeding areas;
- Source reductions (such as draining waterbodies that produce mosquitos);

- Pesticides; and
- Ecological manipulations of mosquito breeding habitat.

Approximately 103,700 acres of land in the study area are currently treated annually by Delta MADs. Actions such as better irrigation planning and monitoring of vector populations also have reduced the need for application of traditional pesticides.

Other Vectors and Host Populations. Other public health concerns related to animal-vectored disease in California include the transmission of Lyme disease by ticks, bubonic plague by fleas, and rabies by wildlife; however, none of these issues are considered a high risk to public health in the Delta Region.

Hazardous Materials and Waste. Hazardous waste sites associated with agricultural production activities include storage facilities and agricultural ponds or pits contaminated with fertilizers, pesticides, herbicides, or insecticides. Petroleum products and other materials may be present in the soil and ground water near leaking underground tanks used to store these materials. Leaking or abandoned pesticide storage containers may also be present on farmlands. Water from agricultural fields on which fertilizers and pesticides are applied may drain into ponds and rinse water from crop duster tanks and other application equipment is routinely dumped into pits. Evaporation can increase the concentration of chemicals in pond water and cause chemicals to be deposited on underlying soil. Percolation of surface water can pollute ground water and expand the area of soil contamination.

Spills and leaking tanks or pipelines from industrial and commercial sites also could be sources of contaminants, such as petroleum hydrocarbons and polychlorinated biphenyls from old electrical transformers. Contamination from metals and polycyclic aromatic hydrocarbons (PAHs) also could result from railroad operations. Metals such as cadmium, zinc, and mercury are present in inactive and abandoned mines and in streams in the study area.

A multitude of hazardous chemicals, such as petroleum hydrocarbons and chlorinated solvents, may be present at active and closed military bases. Because landfills accepted almost all kinds of waste until the 1980s, any closed landfills may contain hazardous waste. In the study area, naturally occurring elements such as metals may be found at concentrations and amounts that may be considered hazardous.

Illegal drug manufacture and distribution facilities are often located in secluded abandoned structures; these structures can include abandoned barns and other structures present on farmlands. Operation of these facilities can result in the improper storage and disposal of hazardous chemicals used during the manufacturing process.

Known hazardous materials and waste sites also include known disposal sites, gas stations, and any other facilities using or handling hazardous or toxic materials. Construction activities, which use petroleum fuels, oils, and other hazardous materials, are also evaluated in this section. When proposed actions and alternatives are defined in more detail at the project level, relevant known hazardous waste sites can be identified.

8.8.1.2 Bay Region

Historical Perspective. The historical perspective for disease transmission is similar to that described earlier for the Delta Region.

Hazardous Materials and Waste. Agricultural and industrial land uses have contributed to the presence of hazardous waste sites within the Bay Region. A notable degree of industry has developed along San Pablo Bay in Vallejo and on the east side of San Pablo Bay, including refineries and chemical petroleum industries. Other historical or current industries in the Bay Region include auto wrecking, electrical processes, gas stations, metal plating, and manufacturing. In addition, manufactured

gasoline plants historically operated primarily in the Bay Area and within the Sacramento River and San Joaquin River regions. Industries were sited along railroads, such as the Southern Pacific right-of-way in San Mateo County.

Commercial activities such as dry cleaning developed in the Bay Region, and military bases such as Mare Island in San Pablo Bay were established.

Landfills tended to be sited near industrial areas, which in turn tended to develop near coastal regions; thus, many landfills are sited in the Bay Region.

Fire Hazards. Prehistorically, fire was the principal mechanism by which the nutrients contained in forest material were recycled. Since the 1800s, fire suppression policies and large-scale grazing have been employed. This has caused the rate of material decomposition to decline dramatically and has led to the accumulation of fuel throughout most wildlands. Due to their infrequency, wildfires now burn at higher intensities and damage larger areas. Wildfires can affect the quantity, quality, and timing of flows from watersheds and are responsible for the most intensive and extensive changes in watershed conditions.

Through the removal of vegetation, burning of organic matter in soil, and creation of impervious soil layers, severe fires accelerate the amount of runoff. This runoff contains greater amounts of soil sediments and increases sedimentation of streams, particularly when riparian vegetation has been burned. With reduced water infiltration through the soil, mudslides also become more prevalent.

Fire suppression and logging of large conifers have resulted in forests dominated by small, shade-tolerant, and fire-sensitive tree species, such as white firs and incense cedars. These species have contributed to the large increase in the amount of live and dead wood fuels near the forest floor. The presence of these fuels allows fires to climb to the forest canopy, leading to large, severe wildfires. These changes have been greatest in the lower and middle elevations of the Sierra Nevada, the areas where human development has been most rapid. These two conditions have led to an increase in human populations and property threatened by fire.

Existing Conditions

Disease Transmission. The existing conditions for disease transmission is similar to that described earlier for the Delta Region.

Fire Hazards. In 1981, the California Department of Forestry and Fire Protection initiated its Vegetation Management Program to reduce wildfire damage and enhance resource values by reducing wildland fuel hazards. The Vegetation Management Program encompasses all major ecosystems in the state and a wide range of fuel management techniques. The California Department of Forestry and Fire Protection is also implementing a pre-fire management initiative to conduct pre-fire planning throughout the portions of the state for which the department has fire suppression responsibility. The United States Department of Agriculture Forest Service's forest health initiative has the goal of maximizing the amount of National Forest land periodically receiving fuel management treatment.

Current Hazardous Materials and Waste. Hazardous waste sites in the Bay Region include contaminated agricultural ponds, spills, and leaking tanks or pipelines from industrial sites. Groundwater pollution exists in the Bay Area primarily as a result of leaking fuel tanks. Currently, more than 7,500 fuel tanks have leaked in the Bay Area; most groundwater cleanup activities are for fuels leaked from underground storage tanks (USTs). At about 500 other sites, chemicals that usually are toxic industrial solvents have leaked into groundwater. Contamination from manufactured gasoline plants could include PAHs and petroleum hydrocarbons from USTs, as well as cyanide and phenols. Contamination from chlorinated solvents, such as trichloroethene from manufacturing and plating, occurs in San Jose.

Contamination also could result from railroad operations, along which many industries were located. Chlorinated solvents, such as stoddard solvent, have been found to result from commercial dry cleaning in the Bay Region.

Similar to the other regions, hazardous waste sites could be present in the Bay Region at historical or active military bases and in landfills that have been closed in the Bay Area since the 1980s.

8.8.1.3 Sacramento River Region

Historical Perspective

Disease Transmission. The historical conditions related to mosquitos and mosquito-borne diseases is described earlier for the Delta Region. .

The Sacramento River Region has a relatively high rate of encephalitis among the regions in the study area. Reported cases of encephalitis between 1969 and 1992 peaked in 1974 with 41. Since 1975, fewer than 10 cases per year have been reported, except in 1983 when 10 cases were reported.

Historically, the Sacramento River Region also has had the highest rate of malaria of any of the regions under investigation. During a major malaria epidemic in 1979 and 1980, 90 cases of encephalitis and eight cases of malaria were reported in the Sacramento River Region. Only a few cases have been identified as mosquito-borne, most of them in Sutter and Yuba counties.

Fire Hazards. The historical perspective for wildfires is similar to that described for the Bay Region. Dense, conifer vegetation is common in the upper watersheds of the Sacramento River Region and presents a serious wildfire risk. This region also contains vegetation that makes it susceptible to grass fires and brush fires, which can have effects similar to, but less intense than those from forest fires.

Hazardous Materials and Waste. Activities contributing to the presence of hazardous waste sites in the Sacramento River Region include manufacturing and support industries for agricultural activities, historical gasoline manufacturing plants, auto wrecking, electrical substations, and gas stations. Mining has occurred in the Upper Sacramento River and its tributaries. Major mines include Iron Mountain and Afterthought mines in the Redding area, Cherokee Mine in the Feather River Drainage, Manzanita Mine on Cache Creek, and Sulphur Bank Mercury Mine in Clearlake. Southern Pacific Railroad runs through the Sacramento River Region; thus, many industries were established along its route.

Commercial activities such as dry cleaning developed in the Sacramento River Region, and military bases were established. Landfills in California tended to be located in industrial areas, such as Sacramento.

Existing Conditions

Disease Transmission. The existing conditions for disease transmission discussed earlier for the Delta Region. .

Fire Hazards. The existing conditions for fire hazards are discussed under the Bay Region.

Hazardous Materials and Waste. Types of hazardous waste sites in the Sacramento River Region include contaminated agricultural ponds, spills, and leaking tanks or pipelines from industrial sites, railroad operations, commercial sites, and mining. Metals such as cadmium, copper, mercury, and zinc are present in inactive and abandoned mines in the Sacramento River drainage.

EPA Region IX Superfund National Priorities List includes Sulphur Bank Mercury Mine in Clearlake and Mather AFB, McClellan AFB, and Sacramento Army Depot—all of which are located in Sacramento. Landfills and naturally occurring deposits of metals also could constitute hazardous waste sites.

8.8.1.4 San Joaquin River Region

Historical Perspective

Disease Transmission. The historical conditions related to mosquitos and mosquito-borne diseases is described for the Delta Region.

The San Joaquin River Region has a moderate rate of encephalitis compared to other regions in this study. Cases between 1970 and 1992 were most numerous in 1970, with 35 cases reported. Very few of the cases are known to have been mosquito-borne.

Historically, the San Joaquin River Region has had a lower rate of malaria than the Sacramento River Region. During the 1979 to 1980 outbreak, 36 and 37 cases of malaria, respectively, were diagnosed in the San Joaquin River Region, most of them in Fresno County. In 1986, during a second epidemic, 57 cases were reported; 27 of these were identified as mosquito-borne.

Fire Hazards. The historical perspective for wildfires is similar to that described for the Bay Region.

Hazardous Materials and Waste. Activities contributing to the presence of hazardous waste sites in the San Joaquin River Region include historical gasoline manufacturing plants in the cities of Stockton and Fresno, auto wrecking, electrical substations, and gas stations. The principal mine in the San Joaquin River Basin is the New Idria Mine in San Benito County. In addition, Atlas Asbestos Mine is located in Coalinga. Metal plating and other industries developed in cities such as Stockton, where deep water ports were established along the San Joaquin River. Industries often developed along railroads, which frequently also were associated with large cities.

Commercial activities such as dry cleaning developed in the San Joaquin River Region. Military bases also were established. Landfills tended to be located in industrial areas, such as Stockton.

Existing Conditions

Disease Transmission. Current disease transmission conditions are the same as those discussed earlier for the Delta Region.

Fire Hazards. The existing conditions for fire hazards are discussed under the Bay Region and Sacramento River Region.

Hazardous Materials and Waste. Types of hazardous waste sites in the San Joaquin River Region include contaminated agricultural ponds, spills, and leaking tanks or pipelines from industrial sites, railroad operations, and mining. Pollution in the San Joaquin River drainage includes pesticides and solvents from heavy industries in Fresno and includes metals such as cadmium, zinc, and mercury from inactive and abandoned mines.

Contaminants from dry cleaning operations are present in the San Joaquin River Region. Castle AFB in Atwater is on the EPA Region IX Superfund National Priorities List. Hazardous waste sites also could be present in landfills and iron from naturally occurring metals in the San Joaquin River Region.

8.8.1.5 SWP and CVP Service Areas Outside the Central Valley

Historical Perspective

Disease Transmission. The historical conditions related to mosquitos and mosquito-borne diseases is similar to that described for the Delta Region. The St. Louis encephalomyelitis arbovirus has become especially active in southern California in recent years. In the late 1980s, the virus occurred in the urban southern California areas of Los Angeles, Orange, Riverside, and San Diego counties. During 1989, a total of 27 cases in humans was reported in the Central Valley and Los Angeles counties. Although only one case of

St. Louis encephalomyelitis in humans was reported in 1991, monitoring of sentinel chicken populations and isolations of the virus from pools of mosquitos continue to indicate widespread viral activity in southern California.

In recent years, cases of malaria have been contracted in Asia and transported to California, many of these to Los Angeles County. As of December 31, 1993, however, no additional introduced cases of malaria have been reported in California.

Fire Hazards. The historical perspective for wildfires is similar to that described for the Bay Region. As described in the Sacramento River Region, dense conifer vegetation is common in the upper watersheds of the San Joaquin River Region and presents a serious wildfire risk. This region also contains vegetation that makes it susceptible to grass fires and brush fires, which can have effects similar to, but less intense than those from forest fires.

Hazardous Materials and Waste. The discovery of gold in the mid-1800s led to population growth and agricultural and urban development throughout California. Many of the historical land uses in the SWP and CVP Service Areas Outside the Central Valley are similar to the land uses of the other CALFED regions and include contamination from agricultural, industrial, commercial, landfill development, and military land uses.

Existing Conditions

Disease Transmission. Mosquito breeding conditions, mosquito control methods, and public health concerns related to animal-vectored disease are similar to those discussed for the Delta Region. .

Fire Hazards. The existing conditions for fire hazards are discussed under the Bay Region.

Hazardous Materials and Waste. Many of the uses in the SWP and CVP Service Areas Outside the Central Valley are similar to the land uses of the other CALFED regions and include contamination from agricultural, industrial, commercial, landfill development, and military land uses.

8.8.2 Environmental Consequences: Public Health and Environmental Hazards

8.8.2.1 Assessment Methods

To identify impacts to public health and environmental hazards resulting from the CALFED alternatives, changes to the following variables were assessed:

- Amount of mosquito breeding habitat;
- Proximity of human populations to mosquito breeding habitat;
- Frequency and severity of large-scale wildfires; and
- Release of hazardous materials or waste.

CALFED actions could affect public health by creating conditions favorable to mosquito breeding, which could cause an increase in mosquito populations. An increase in these populations can increase the possibility of mosquito-human contact. Similarly, decreasing the distance between human and mosquito populations increases the likelihood of contact. More-frequent contact, in turn, increases the likelihood of disease transmission.

The more frequent and severe the occurrence of large-scale wildfires, the greater the amount of damage inflicted. In contrast, small-scale controlled wildfires may reduce the likelihood of large-scale catastrophic wildfires.

CALFED actions could increase the exposure of people and the environment to hazardous materials and waste. Hazardous materials include raw materials and products such as fuels and oils

that are commonly used in commercial activities and during construction activities. Known and unknown sites containing hazardous waste also can be present within a project area. Releases, and subsequent public exposure to hazardous materials and waste, could result from accidental spills, disturbance of subsurface sites, and flooding in areas where these substances are present.

8.8.2.2 Significance Criteria

A proposed action would have a significant impact if it would create a new public health or environmental hazard or substantially increase any existing hazard, such as the threat of wildfires.

A significant increase in an existing hazard could include:

- An increase in mosquito breeding habitat;
- A decrease in the distance between human and mosquito populations;
- An increase in the threat of wildfires;
- An increase in the risk of flooding; and
- An increase in releases or increased exposure to hazardous materials and waste.

8.8.2.3 Comparison of No Action Alternative to Existing Conditions

The No Action Alternative represents the implementation of existing plans and programs in the absence of the CALFED Program.

This alternative would have potential significant adverse impacts and potential beneficial impacts on public health and environmental hazards. Mitigation measures for potential significant adverse impacts are presented at the end of this section.

Delta Region. Wetland restoration at Stones Lake National Wildlife Refuge could increase the amount of mosquito breeding habitat. Construction activities could result in standing water, which could serve as mosquito breeding habitat.

These increases in mosquito breeding habitat represent potential significant adverse impacts.

Construction activities also could increase the exposure of people to hazardous materials and waste, resulting in a potential significant impact.

Sacramento River Region. No Action conditions would remain similar to existing conditions.

Existing government programs would continue to reduce the frequency and severity of wildfires.

San Joaquin River Region. The types of impacts would be similar to the other regions. However, in the San Joaquin River Region a minor decrease in mosquito breeding habitat may occur. If irrigation canals and other facilities are eliminated as agricultural land is retired in this region, ultimately resulting in a potential beneficial impact.

8.8.2.4 Comparison of Program Alternatives to No Action Alternative

Delta Region

Storage and Conveyance. Construction activities included in all alternatives could expose people to hazardous materials and waste. In addition, channel widening in Alternative 2, conveyance channels in Alternative 3, and island flooding with Alternatives 2 and 3 could create pockets of standing water that would provide mosquito breeding habitat.

Ecosystem Restoration. Actions associated with the Ecosystem Restoration Program could increase the amount of mosquito breeding habitat. For example, expansion of floodplains in the Delta, and increases in streamflow, could leave areas of shallow standing water when water levels decline.

The conversion of agricultural land to wetland habitat or other habitat and the seasonal flooding of agricultural land could also contribute to an increase in the amount of standing water present within the region.

These conditions would increase the amount of mosquito breeding habitat resulting in potential significant adverse impacts.

Water Quality and Coordinated Watershed Management. These program would have potential beneficial effects on public health and environmental hazards. They would reduce pollution of surface water, which would indirectly health risks from drinking water or contact with contaminated water. Improved surface water quality would also benefit waterfowl, fish, and other wildlife that depend on surface water. A reduction in surface water pollution would also decrease the presence of contaminants in fish, which would indirectly benefit the health of fish consumers. The effects of program actions on surface water quality are further discussed in Section 6.1.3.

The program also could have indirect effects on mosquito populations. If program actions decrease the amount of organic material present in the water, mosquitos may be discouraged from breeding.

Water Use Efficiency. Actions associated with the Water Use Efficiency Program may provide beneficial impacts to public health and environmental hazards. Reductions in the amount of irrigation water applied or left standing on agricultural fields or modification in the timing of wetland dewatering may reduce the amount of mosquito breeding habitat. If the timing of wetland dewatering is modified or the amount of water applied is reduced, the amount of mosquito breeding habitat may be reduced.

Agricultural efficiency improvements may reduce the level of contaminants in surface waters. Excess agricultural drainage water is typically laden with organic carbons, a major concern of public drinking water quality. Reducing excess drainage water through efficiency improvements may reduce the organic carbon loading into surface waters of the Delta. Also, a decrease in the amount of organic material present in the water may discourage mosquitos from breeding there.

Efficiency improvements may include an increase in long-term operation of pumping equipment for both existing and new groundwater wells. This may increase the risk of long-term contamination of groundwater sources. If this exposes more people to hazardous materials in drinking water, it would represent a significant impact. Groundwater impacts and mitigation measures are further discussed in Section 6.2.2.

Levee System Integrity. The Levee System Integrity Program would have beneficial effects on public health and safety by reducing the potential for flooding and, at the same time, reducing opportunities for mosquito breeding and exposure to hazardous materials.

Some levee reconstruction may create riparian and wetland habitat, and flooding of shallow islands to control subsidence may create wetland habitat. Reconstruction activities may result in standing water that increases mosquito breeding and the hazard of exposure to hazardous materials and waste.

Water Transfers. The Water Transfer Program overall would have a negligible effect on public health and environmental hazards under any of the alternatives. Some water transfers may involve providing water to wildlife refuges and other natural habitats, which could in turn provide expanded habitat for mosquitos, but the amount of water being transferred to these uses will likely remain small relative to other uses for transfer water.

Bay Region

Storage and Conveyance. Similar to the Delta Region, conveyance modifications and operations may change the timing or volume of flows into

the Bay Region. Fluctuating water levels could create isolated pockets of standing water.

Ecosystem Restoration, Water Quality, Water Use Efficiency, Water Transfers, and Coordinated Watershed Management. The effects of these programs would be similar to those described for the Delta Region.

Sacramento and San Joaquin River Regions

Storage and Conveyance. Configurations 1C; 2B, 2D, and 2E; and 3B, 3E, 3H, and 3I include increased surface water storage, which could increase the amount of mosquito breeding habitat. These configurations also include groundwater storage.

Additional surface water storage would have potential beneficial indirect impacts on fire fighting capabilities. While the proposed action would not decrease fire hazards, the facilities would provide additional sources of water available for fighting regional wildfires. This would reduce the amount of time required to transport water to the sites of wildfires, thereby limiting the amount of damage due to wildfires. This beneficial impact would be most apparent during drought years when fire hazards increase and the amount of available water decreases.

Ecosystem Restoration. Similar to the Delta Region, an increase in riparian habitat may increase the amount of mosquito breeding habitat. However, because only a small amount of wetland habitat would be created in the San Joaquin River Region, this region would experience fewer adverse effects than the Delta Region.

Water Quality. Similar to the Delta Region, improved water quality would have potential beneficial effects on public health and environmental hazards by reducing exposure to pollutants and reducing organic material, which promotes mosquito breeding. In addition, if irrigation canals and other facilities are eliminated as agricultural land is retired in the San Joaquin River Region, a minor decrease in the amount of mosquito breeding habitat may occur.

Water Use Efficiency and Water Transfers. The effects of these two programs would be similar to those described for the Delta Region.

Coordinated Watershed Management. If the program includes forest management activities in the upper watersheds, it could have a beneficial effect on fire hazards by reducing the frequency and severity of wildfires. These activities could reduce the amount of fuel available to fires through a variety of techniques, including controlled burns and removal of dead and dying vegetation. Additional potential benefits include increased water yield from restored meadows.

SWP and CVP Service Areas Outside the Central Valley

The effects of the Water Quality Program and the Water Use Efficiency Program are similar to those described for the Delta Region. The Ecosystem Restoration, the Levee System Integrity, and Storage and Conveyance program elements do not apply to this region.

8.8.2.5 Comparison of Program Elements to Existing Conditions

Comparison of Program Alternatives to existing conditions indicates that:

- All potentially significant adverse impacts that were identified when compared to the No Action Alternative would still be considered significant when compared to existing conditions.
- No additional significant environmental consequences have been identified when Program effects are compared to existing conditions as opposed to No Action.
- The beneficial effects of the Program would still be beneficial when compared to existing conditions.

8.8.2.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

Increases in the amount of available mosquito breeding habitat could be mitigated using various mosquito control methods. These methods include:

- Biological agents (such as establishing mosquitofish, which are predators of mosquito larvae);
- Chemical agents (such as hormone disrupters, pesticides); and
- Ecological manipulations of mosquito breeding habitat (such as reducing amount of standing water during construction, or introducing plant-consuming animals).

Each method works best under specific habitat conditions and periods of the mosquito's life cycle. A combination of different control methods should be used for maximum effectiveness (for example, mosquitofish and hormone disrupters).

There is some potential for mosquito control methods to have a negative impact on other parts of the ecosystem. Control methods that do not create additional stressors on ecosystems are available, however, and should be selected when possible. These methods include methoprene, a manmade chemical that disrupts hormones in juvenile mosquitos and is biodegradable.

The significant disease transmission impacts resulting from construction activities could be mitigated by removing or disturbing water that remains stagnant for more than three days; limiting construction to cool weather periods, when mosquito production is at its lowest; and limiting construction to periods of low precipitation.

The significant hazardous materials and waste impacts resulting from construction activities would be mitigated by the proper management of hazardous materials and investigation of potential hazardous sites discovered during construction. If site investigations confirm the presence of hazardous chemicals, permitted removal and disposal of contaminated materials would occur and certification of cleanup activities would be obtained from the applicable regulatory agencies.

The significant flooding hazard impacts could be mitigated by notifying downstream residents of any emergency releases and providing information on the dangers of releases and the procedures to avoid them.

8.8.2.7 Potentially Significant Unavoidable Impacts

Although mitigation measures are available for all potential significant adverse impacts, they may not be adequate to reduce impacts to less-than-significant levels.

This is particularly true for disease transmission impacts. Due to the potential widespread presence of new mosquito breeding habitat, effective management using the identified control methods may not be possible. However, further site-specific studies would be required to determine the specific level of impact, to study the correlation between increased habitat and increase disease transmission, and to determine the potential effectiveness of various control methods.

8.9 VISUAL RESOURCES

Summary

Visual impacts were assessed using the Visual Management System (VMS) developed by the United States Department of Agriculture (USDA) Forest Service. Variety Classes are a key component of the VMS and are used to classify visual features into "distinctive" (Class A) "common" (Class B) and "minimal" (Class C) categories based on a landscape's visual appeal and scenic quality. Variety Class A and B resources typically include state of federal park, recreation, or wilderness areas. Variety Class C resources would include more common and fewer scenic landscapes such as agricultural lands. Program effects are considered adverse if they result in obstruction or reduction in Variety Class of visually important features as viewed from visually sensitive areas or if they result in long-term changes or visual contrasts to the landscape as viewed from areas with high visual sensitivity within 3 miles and that persist for 5 or more years. Table 8.9-1 provides a summary of environmental impacts related to visual resources.

Impacts to Visual Resources

- **No Action Alternative** conditions could result in visual impacts in the Delta and Central Valley.
- **Storage and Conveyance** construction of dams and spillway structures at new storage facilities could have adverse visual impacts.
- **Ecosystem Restoration** is expected to have beneficial effects in the Delta and a mix of both beneficial and adverse effects in the Bay, Sacramento River, and San Joaquin River regions.
- **Levee System Integrity** could have temporary visual impacts in the Delta.

No Action Alternative. Changes in land use and development could produce visual impacts throughout the Central Valley. Also, the visual consequences of potential levee failures in the Delta could be significant.

Storage and Conveyance. In Alternative 1, south Delta flow control structures proposed under conveyance Configurations 1B and 1C could cause potentially significant visual impacts on boaters using Delta waterways. Proposed channel widening/enlargements in the Delta could also create extensive visual disturbances and contrasts to Delta boaters and other recreationists under Configuration 1C but these impacts would be mitigable.

Constructing storage facilities under Configuration 1C in the Sacramento River and San Joaquin River regions would result in short-term changes in visual character due to construction grading and removal of existing vegetation and habitat. Long-term adverse and not mitigable visual impacts could include the presence of unnatural linear and obtrusive features as well as view obstructions. In addition, the adverse effects of fluctuating water levels could create or increase the extent of an adverse shoreline "ring" impact, an impact that cannot be completely mitigated through revegetation or screening. These storage facility impacts would be the same for all three alternatives.

South Delta flow control structures proposed under Configurations 2A and 2B could have a potentially significant visual impact on sensitive sites in the Delta. Proposed channel widening/ enlargement activities proposed throughout the Delta could also have significant visual impacts.

Alternative 3 would create visual impacts similar to those identified under Alternative 2. Visual impacts to Delta boaters and other recreationists from the south Delta flow control structures would only occur under Configurations 3A, 3B, 3E, and 3I. There would be short-term and long-

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Newly Negotiated Flows	□	□	□	□	□	□	□	□	□	□	□	□
Agricultural Land Retirement and Habitat Restoration	+	+	+	+	+	+	+	+	+	+	+	+
Vegetation Removal	○	○	○	○	○	○	○	○	○	○	○	○
South Delta Flow Control	□	●	●	●	●	□	□	●	●	●	□	●
Channel Widening/Enlargements	○	○	◗	◗	◗	◗	◗	◗	◗	◗	◗	◗
Isolated Facility at Slough and River Crossings	□	□	□	□	□	□	□	◗	◗	◗	◗	◗
Short-Term Change in Visual Character from Storage Facility	□	□	□	□	□	□	□	□	◗	◗	□	◗
New Intake Pumping Stations	□	□	□	□	□	□	□	□	◗	◗	□	◗
Fluctuating Water Levels in Storage Facilities	□	□	□	□	□	□	□	□	●	●	□	●
Dam and Spillway Structures	□	□	□	□	□	□	□	□	●	●	□	●
Bay Region												
Vegetation and Habitat Restoration, Channel Improvements, Erosion Control, and Road Improvements	○	○	○	○	○	○	○	○	○	○	○	○
Set-Back Levees and New Channels	○	○	○	○	○	○	○	○	○	○	○	○
Sacramento River Region												
Newly Negotiated Flows	□	□	□	□	□	□	□	□	□	□	□	□
Vegetation and Habitat Restoration, Channel Improvements, Erosion Control, Road Improvements, Altered Timber Harvesting Practices, and Reduced Grazing	○	○	○	○	○	○	○	○	○	○	○	○
Gravel Replacement, Fish Screen Installation, Fencing along Creeks	○	○	○	○	○	○	○	○	○	○	○	○
Short-Term Change in Visual Character from Storage Facility	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗
New Pumping Plants and Conveyance Facilities	□	□	◗	□	◗	□	◗	□	◗	◗	◗	◗

Table 8.9-1. Summary of Environmental Impacts Related to Visual Resources (page 1 of 2)

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
New Intake Pumping Stations	□	□	□	□	□	□	□	□	◗	◗	□	◗
Fluctuating Water Levels in Storage Facilities	□	□	●	□	●	□	●	□	●	●	●	●
Dam and Spillway Structures	□	□	●	□	●	□	●	□	●	●	●	●
San Joaquin River Region												
Newly Negotiated Flows	□	□	□	□	□	□	□	□	□	□	□	□
Vegetation and Habitat Restoration, Channel Improvements, Erosion Control, Road Improvements, Altered Timber Harvesting Practices, and Reduced Grazing	○	○	○	○	○	○	○	○	○	○	○	○
Gravel Replacement, Fish Screen Installation, Fencing along Creeks	○	○	○	○	○	○	○	○	○	○	○	○
Short-Term Change in Visual Character from Storage Facility	□	□	□	□	◗	□	◗	□	◗	◗	◗	◗
New Pumping Plants and Conveyance Facilities	□	□	□	□	◗	□	◗	□	◗	◗	◗	◗
New Intake Pumping Stations	□	□	□	□	□	□	□	□	◗	□	◗	◗
Fluctuating Water Levels in Storage Facilities	□	□	□	□	●	□	●	□	●	●	●	●
Dam and Spillway Structures	□	□	□	□	●	□	●	□	●	●	●	●
SWP and CVP Service Areas Outside the Central Valley												
Changes to Visual Resources	□	□	□	□	□	□	□	□	□	□	□	□

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:

Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
○	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 8.9-1. Summary of Environmental Impacts Related to Visual Resources (page 2 of 2)

term adverse visual effects of new in-Delta storage facilities on Victoria Island.

Ecosystem Restoration. Implementing ecosystem restoration could have a beneficial effect on visual resources in the Delta due to proposed agricultural land conversion. This assumes that the viewer prefers native habitat to agricultural lands. This program would have a combination of both beneficial and adverse impacts in the Bay, Sacramento River, and San Joaquin River regions. Beneficial effects would be created through restoring natural landscapes in the Bay Region and adding visual variety in the Sacramento River and San Joaquin River regions. Potential but not significant visual effects would result from establishing fencing on creeks to protect riparian vegetation, replacing gravel, and installing fish screens (Sacramento River and San Joaquin River regions).

Water Quality. There would be no impacts from the Water Quality Program because proposed source control actions are not likely to change the landscape's visual characteristics.

Water Use Efficiency. The Water Use Efficiency Program would not have any significant visual impacts in any portion of the study area because the types of projects to be undertaken would not significantly alter views of visually sensitive areas.

Coordinated Watershed Management The visual landscape in the upper watersheds is dominated by dense forests in the Sierra Nevada mountains and oak woodlands in the foothills. The impacts of most watershed improvement projects on visual resources in the study area would generally be beneficial. Potential beneficial effects include preserving and improving the natural landscape through increased vegetation along waterways and in grazed areas.

Levee System Integrity. Channel improvements in the Delta, including levee construction, dredging, and channel widening and deepening would have temporary adverse impacts to visual quality in the Delta because vegetation would be removed during construction. However, it is expected that this impact would last less than 5 years and therefore it would not be significant. There would be no visual impacts from the Levee System Integrity Program outside the Delta Region.

8.9.1 Affected Environment/ Existing Conditions

8.9.1.1 Delta Region

Historical Perspective. The landscape of the Delta has changed dramatically since reclamation began during the 1850s. Large expanses of wetlands, riparian corridors, and open water have been replaced by agricultural lands in low-lying tracts surrounded by levees. By 1930, only a small amount of the natural landscape remained. Levee failures in 1930 resulted in islands flooding throughout the Delta, several of which have not been converted back to agriculture.

By the 1940s, only a few small settlements existed within the Delta. Following World War II, urbanization expanded along the edges of the Delta. From 1946 to 1964, commercial shipping and boating recreation use in the Delta increased, followed by marina development. From 1975 to present, urbanization has encroached on the Delta from cities in eastern Contra Costa County (Brentwood, Discovery Bay, and Stockton) and from Sacramento.

Existing Conditions. Most of the Delta is devoted to farming and is interlaced with a network of waterways and levees designed to protect the Delta's islands and tracts.

Major visual resources within the Delta Region include:

- Bethel Island/Hotchkiss Tract,
- Franks Tract State Recreation Area (SRA),
- Brannon Island SRA,
- Windy Cove SRA,
- Cliff House fishing access (private),
- Discovery Bay Yacht Club Marina (private),

- Sherman Island (private camping and marina),
- Stone Lake Wildlife Refuge,
- Cosumnes-Mokelumne River confluence wildlife preserve,
- Highway 160 (a state-designated scenic highway) from Antioch to Freeport, and
- Community of Brentwood.

Representative Variety Classes A and B resources viewed from the Delta include Mt. Diablo in Contra Costa County and the Vaca Mountains in Napa and Solano counties.

The main roads from which travelers can view the Delta are Highways 160, 4, and 12. In many portions of Highways 4 and 12, it is not possible to view the Delta waterways, but features such as Mt. Diablo are visible.

8.9.1.2 Bay Region

Historical Perspective. Prior to the 1930s, the Bay Area's visual character was dominated by the urban forms of the city of San Francisco, while the remainder of the region was more rural and less developed. A development pattern similar to that described for the Delta occurred in the Bay Region. By 1930, about half of Suisun Marsh had been converted to agricultural use. However, shortly thereafter, as upstream agricultural diversions created greater tidal intrusion of saline water, these agriculture lands were subsequently converted to managed wetland habitat for waterfowl use. Over the last 60 years, the Bay Region has become progressively more urbanized, although open space has been preserved along the major ridgelines that surround San Francisco Bay.

Existing Conditions. Heavy urbanization and industrial uses currently characterize the Bay Region, although major portions of the Suisun Marsh area remain undeveloped. Concurrently, there are heavy recreation pressures along this region's waterfronts, making this area more sensitive visually since recreationists as a group have a higher viewer sensitivity than others. Major visual resources in the Bay Region include:

- San Pablo Bay National Wildlife Refuge (NWR),
- Benicia SRA,
- Martinez Shoreline (East Bay Regional Park District [EBRPD]),
- Carquinez Strait Shoreline (EBRPD),
- China Camp State Park,
- Point Pinole (EBRPD), and
- Suisun Marsh and Grizzly Island Wildlife Refuge.

The most visually dominant feature from the east side of the Bay Region is Mount Diablo in southern Contra Costa County and the Diablo Ridge, which frames the southern half of the valley. Mount Diablo rises 3,849 feet above mean sea level and is also visible throughout the western half of the Sacramento Valley.

8.9.1.3 Sacramento River Region

Historical Perspective. Prior to the 1940s, the Sacramento River valley was made up of grasslands, scattered oak woodlands, and wetlands, vernal pools, and riparian areas were more prominent. Although there has been substantial new development along state and federal highways in the Sacramento River Region's upper watershed, these areas have remained predominantly oak woodland, grassland, forest, and rural, with small towns in the foothills and mountain area. These areas are framed by the forested ridgelines of the Sierra Nevada to the east, the Cascade Range to the north, and the Coastal Range to the west. This lack of urbanization has preserved the scenic qualities of these areas that include pristine wilderness, mountains, and other dramatic landscapes.

Existing Conditions. The historic change in the Sacramento River Valley from grasslands, floodplains, and extensive riparian areas to cropland, rice fields, and orchards has reduced visual variety. As a result, areas along Interstate 5 (I-5), Highway 99, SR 70, and other roads generally are Variety Class C.

Important visual resources that would be most likely inventoried as Class A features include the Sacramento, Sutter, and Colusa NWRs, Grey Lodge WMA. and the Colusa-Sacramento River SRA. Other important visual resources in the Sierra foothills include Lake Oroville, Folsom Lake, Auburn, and Lake Oroville SRAs.

North and east of this region, the topography becomes more strikingly varied. Much of the upper watershed of the Sacramento River Region is forested land that characterizes and blocks views for motorists traveling through these areas. Potential Class A visual features in this region include state and federal park and recreation areas, such as Plumas Eureka State Park, Whiskeytown Shasta Trinity National Recreation Area north of Redding, and Lassen Volcanic National Park. The Sutter Buttes, Mount Lassen, and Mount Shasta are prominent mountain features visible from a large geographic portion of the north Central Valley. Mount Lassen, with an elevation 10,457 feet above mean sea level, is a dominant visual feature in the northeast portion of this watershed, visible from throughout the northern Sacramento Valley. SR 70, which traverses Butte and Plumas counties, is eligible for scenic highway designation.

Distinctive visual features on the west side of the valley include Clear Lake, the largest natural lake in California.

Constructing dams and reservoirs substantially changed the visual landscape. Reservoirs that have added visual variety include Whiskeytown, Shasta, and Black Butte reservoirs. Viewer sensitivity is high in these areas because they are high recreation use areas with easy public access.

Major urban areas include Sacramento, Redding, Red Bluff, and Chico. A section of Highway 36 (in Tehama and Plumas counties, from Route 89 near Morgan Summit to Route 89 near Deer Creek) is eligible as a state-designated scenic highway. Trinity County is eligible for scenic designation, along with SR 70.

Federally-designated Wild and Scenic Rivers include the Middle Fork of the Feather River, the North Fork of the American River, and the American River reach that flows through Sacramento.

8.9.1.4 San Joaquin River Region

Historical Perspective. Prior to the 1940s, open grasslands and scattered oak woodlands, as well as wetlands, vernal pools, and riparian areas, were typical in the San Joaquin River Region. Human settlement was sparse, concentrated mostly in Fresno and Modesto. Rapid agricultural development and increased human settlement drastically changed the visual landscape by replacing grasslands with irrigated cropland and reducing extensive wetland, vernal pool, and riparian areas to scattered segments.

The upper watershed areas of the San Joaquin River Region have remained predominantly oak woodland, grassland, forest, and rural, with limited development over the past 150 years. These areas are framed by the forested ridgeline of the Sierra Nevada to the east. This lack of urbanization has preserved the scenic qualities of these areas, including the pristine wilderness and other dramatic landscapes discussed below. Over the past 30 years, increasingly developed viewscapes have encroached along the major roadways in this region.

Existing Conditions. Much of the land in the San Joaquin River Region is dedicated to agricultural use (Variety Class C). Much of the upper watershed of the San Joaquin River Region on the east side of the San Joaquin Valley, north of the city of Fresno, is forested land that blocks views for motorists traveling through these areas. The watershed areas on the west side of the San Joaquin Valley are made up of a mix of suburban areas surrounded by low-lying agricultural lands.

Major urban communities include Modesto, Stockton, Fresno, and Bakersfield. Major highways with high viewer sensitivity that provide access to Yosemite or Kings Canyon-Sequoia national parks include Highways 140,

120, 196, and 41. Most of the urbanized areas along I-5 and Highway 99 are Variety Class C.

Important (Variety Class A or B) visual resources in the Central Valley portion of this area include the San Luis NWR complex, Mendota and Volta Wildlife Refuges, and San Luis Reservoir. In the Sierra foothills, major visual resources include the Millerton Lake, Turlock Lake, and McConnell SRAs, and Don Pedro Reservoir. Other major visual resources include Colonel Allensworth State Historic Park, Tule Elk State Reserve, and the Pixley NWR.

Major (Class A) visual resources in the upper watershed areas west of the San Joaquin Valley include Yosemite National Park and several wilderness areas. The John Muir Wilderness, within the Sierra and Inyo national forests, encompasses 584,000 acres in the Sierra Nevada and is the largest designated wilderness area in California. Other smaller wilderness areas include Emigrant Wilderness, which covers approximately 117,600 acres adjacent to Yosemite National Park with elevations ranging from 6,000 to 12,000 feet above mean sea level.

Highways eligible for state scenic highway status include SR 33 (in Fresno County, from SR 198 near Coalinga to SR 198 near Oilfields), SR 168 (in Fresno County, from SR 65 near Clovis to Huntington Lake), and SR 190 and 198 (in Tulare County, from SR 65 in Porterville to the county line). Portions of I-5 have been designated as a Scenic Highway, and SR 152 is a Scenic Highway with views of San Luis Reservoir.

Federally-designated Wild and Scenic Rivers include the South Fork of the Merced River, the Middle Fork and South Fork of the Kern River, and the Tuolumne River.

8.9.1.5 SWP and CVP Service Areas Outside the Central Valley

The SWP and CVP service areas outside the Central Valley encompass the southern California coastal counties and portions of Kern, San Bernardino, Riverside, and Imperial counties. No program activities are proposed in the upper watersheds in the SWP and CVP service areas.

Historical Perspective. The areas consist of relatively arid landscape, with topography that ranges from steep, rugged coastal hills and mountains to the fertile plains of the San Fernando Valley. Historical growth was concentrated first along the coast, especially within San Diego and Los Angeles counties. With water supply development, the inland portions of this area developed into a highly productive agricultural region. Since the 1940s, expanding urban and suburban areas have dominated the landscape.

Existing Conditions. Much of this region is now urbanized, especially within Los Angeles, Orange, San Diego, San Bernardino, and Riverside counties. However, major undeveloped areas also provide significant visual resources, including the Los Padres National Forest and Ventura Wilderness, National Forest lands within the San Gabriel and San Bernardino mountain ranges, and lands within the Cleveland National Forest.

8.9.2 Environmental Consequences: Visual Resources

8.9.2.1 Assessment Methods

The impact assessment process was guided by the VMS developed by the USDA Forest Service. At this stage of assessment, impacts were described at a broad, regional level, focusing on known, sensitive resources and landscapes. The following methods were used:

- Identify visually sensitive areas. Sensitivity was considered highest for views seen by people driving to or from recreational activities, or along routes designated as scenic corridors. Views from relatively moderate to high-use recreation areas were also considered sensitive. For the purposes of this study, highly sensitive areas were defined as those recreation areas that received at least

10,000 recreation visitor days per year. An average of 27 recreation visitors per day represents moderate use.

- Consider the distance between the proposed actions or facilities and visually sensitive areas. Only impacts of those project actions that are 3 miles or less from identified areas were assessed. Generally, impacts occurring more than 3 miles away from visually-sensitive areas are not readily seen or distinguished at a level that would be considered sensitive. However, in some situations, depending on the nature of the facility and location-specific topography, the visibility of a proposed facility or action impact might exceed a distance of 3 miles.

- Focus the assessment on components of the program that could impact the visual environment. The impact analysis focused on the Ecosystem Restoration, Levee System Integrity, and Storage and Conveyance programs. The impact of other programmatic actions are assumed to be neutral or only slightly beneficial.

Variety classes are a key component of the VMS and are used to classify visual features into "distinctive" (Class A), "common" (Class B), and "minimal" (Class C) categories.

8.9.2.2 Significance Criteria

Two significance criteria were used for this analysis:

1. Will implementing program actions obstruct or permanently reduce visually important features that are in Variety Classes A and B that can be viewed from visually sensitive areas?

2. Will implementing program actions result in long-term (that is, persisting for 5 years or more) adverse visual changes or contrasts to the existing landscape as viewed from areas with high visual sensitivity within 3 miles? If so, how many viewing sites will be affected?

8.9.2.3 Comparison of No Action Alternative to Existing Conditions

Changes in land use and development could produce visual impacts throughout the Central Valley. Also, the visual consequences of potential levee failures in the Delta could be significant.

8.9.2.4 Comparison of Program Alternatives to No Action Alternative

The impacts to visual resources resulting from the storage and conveyance program element will vary by alternative, as discussed below. Impacts to visual resulting from other program elements, such as ecosystem restoration, do not vary substantially from one alternative to another at the programmatic level. Therefore, the discussions of environmental consequences associated with other program elements are not grouped by alternative. In those cases where no environmental impacts have been associated with a program element within a region, the program element is not discussed.

Delta Region

Storage and Conveyance

Alternative 1. Configuration 1A would not cause significant visual impacts.

Flow control barriers proposed in the south Delta as part of Configuration 1B are expected to be visually obtrusive to boaters using the Delta waterways (especially those originating from Discovery Bay Marina). Old and Middle rivers and Grant Line Canal would be directly affected. When operational, these barriers could also impede boater access to scenic areas.

Configuration 1C would produce the same impacts as 1B. In addition, proposed channel enlargements could have potentially significant impacts on Delta boaters and other recreationists, particularly in the short term.

Earthmoving disturbances can create extensive visual disturbances and contrasts, thus potentially significant visual impacts.

Alternative 2. Configurations 2A and 2B, facilities and modifications would be visible from visually sensitive areas in the Delta. Impacts of the south Delta flow control structures and Old River channel enlargements would be the same as for Configuration 1C. Also, the new intake structure would be visible at Clifton Court Forebay. Additional visual impacts would occur in the North Delta as a result of the Hood Intake Channel, diversion structures, and Mokelumne River channel enlargements.

Configuration 2D visual impacts would be the same as those of Configurations 2A and 2B, except that there would be no south Delta flow control structures. The more extensive habitat restoration in the north Delta (including East Delta Wetlands and Bouldin Island aquatic habitat) and in the south Delta (along Old River between Holland Tract and Clifton Court Forebay) would enhance the visual environment of those Delta areas over the long term. Elevating the Highway 12 roadway would improve its scenic qualities both in terms of foreground aesthetics and long-distance vistas of Classes A and B variety classes (Mount Diablo and the Vaca Range).

Configuration 2E visual impacts would be the same as those of Configuration 2D except that there would be additional impacts from converting Tyler Island into aquatic habitat and the setback of the Andrus Island levee. These changes would present opportunities for long-term visual enhancement.

Alternative 3. A storage facility could be constructed in the Delta Region under Configurations 3B, 3E, and 3I. For example, reservoirs could be built near the SWP-CVP intakes at Holland Tract (Configuration 3I) or possibly on Victoria Island as an enlargement of Clifton Court Forebay. Project construction of such reservoirs would create temporary adverse visual impacts, particularly from construction haul routes, night construction lighting, and construction laydown areas. Nearby views of project features under construction would impose temporary visual impacts caused by heavy equipment disturbing established topography and vegetation and generating dust. Proposed construction activities would be particularly noticeable and could cause a significant visual impact to nearby residences at Discovery Bay, recreationists from the Discovery Bay Marina, and motorists on Highway 4, a county-designated scenic route. Most of the construction areas for the proposed storage facility would be under water once filled; therefore, this impact would be short-term but still significant.

Reservoirs built in the Delta Region would inundate areas currently used primarily for agriculture. Although waterbodies in general are considered beneficial visual features, fluctuating water levels due to reservoir drawdown and replenishment could cause adverse visual impacts as a result of the shoreline "ring" effect in areas that are alternately inundated and exposed. Vegetation, such as emergent marsh grasses that can tolerate periodic flooding and drying, may be useful for mitigation; however, this type of effect cannot always be mitigated through revegetation and screening. In addition, new levees would visually dominate the surrounding flat and open landscape and could permanently change the visual quality and character of the project area. This would be a significant and not mitigable visual impact.

Conveyance facilities and modifications under Configurations 3A, 3B, 3E, 3H, and 3I would be visible from sensitive areas in the Delta. Impacts of the south Delta flow control structures and Old River channel enlargements would be the same as for Configuration 2B. Also, the new intake structure would be visible at Clifton Court Forebay. Additional visual impacts would occur in the north Delta as a result of the Hood Intake to the isolated facility, associated diversion structures, such as trash racks, fish screens, pumps and fish return facilities, and Mokelumne River channel enlargements.

The isolated facility would extend all the way around the Delta periphery, and visual impacts would occur at all the significant slough and river crossing sites (such as Mokelumne River, East-side streams, Disappointment Slough, San Joaquin River, Middle River, Victoria Canal, and Old River).

Configuration 3E visual impacts of this alternative would be the same as those of Configuration 3A, except there could be greater visual impacts on Delta waterways under low-outflow conditions if the larger capacity of the isolated facility is used to divert more flow, resulting in lower net freshwater outflows.

Configuration 3H visual impacts would be the same as those of Configuration 3A combined with Configuration 2D. The more extensive habitat restoration in the north Delta (including East Delta Wetlands, Tyler Island Wetlands, and Bouldin Island aquatic habitat) and in the south Delta (along Old River between Holland Tract and Clifton Court Forebay) would enhance the visual environment of those Delta areas over the long term.

Configuration 3I visual impacts would be the same as those of 3E, except that there could be greater visual impacts on Delta waterways under low-outflow conditions if the larger capacity of the isolated facility (with three alternative points of diversion) is used to divert more flow than would otherwise be possible, resulting in lower net freshwater outflows.

Ecosystem Restoration Program

Ecosystem restoration calls for converting land in the Delta Region from existing land uses to habitat, ecosystem restoration, levee setbacks and floodways. Most of this acreage is currently in agricultural use.

Estimated acreage affected by the Ecosystem Restoration program element is presented in Chapter 5, Section 5.2.

The visual impacts from this program would be primarily beneficial over the long term because restored natural habitats are generally perceived to be more scenically diverse and aesthetically pleasing than agricultural lands or lands used for other purposes.

Water Use Efficiency

Water use efficiency is not expected to cause any significant visual impacts. Changes in urban landscaping plants and materials and agricultural crops are anticipated, but they would involve substitutions, subtle changes, or beneficial changes to visual aspects that are not considered to be significant. In some instances, efficiency improvements may result in the loss of some incidental wetlands and riparian areas that survived off existing agricultural water use inefficiencies, but the extent is expected to be minor. If land fallowing occurs from temporary water transfers or from efficiency improvements, the changes are projected to improve visual diversity.

Levee System Integrity

Levee system integrity would involve levee rehabilitation and habitat creation within the Bay Delta. This program would result in temporary adverse impacts to visual quality in the Delta since existing vegetation would be removed during construction. However, these effects would diminish as vegetation is reestablished on the levees for habitat and levee protection. In most situations, this adverse effect would be expected to last less than 5 years and therefore it is not considered significant.

Water Transfers. Water transfers would have an overall negligible effect on visual resources under any of the alternatives. Localized increases or decreases in river flows or reservoir elevations could result, but all such changes are expected to be within historical ranges observed in these waterbodies during various water-year types.

Bay Region

Ecosystem Restoration

Ecosystem restoration actions could have a mix of long-term beneficial and short-term adverse impacts. Short-term construction impacts from creating setback levees and constructing new channels could have adverse visual effects if they are implemented. Since these actions are assumed to occur for less than 5 years, they would not be considered significant.

The long-term effects of ecosystem restoration would be beneficial, since they would restore a more natural landscape in an area that is highly developed (Variety Class C). Some areas would probably shift from Variety Class B to Class A.

Sacramento River and San Joaquin River Regions

Storage and Conveyance

Short-term adverse impacts to visual quality from proposed water storage projects could include construction grading and removal of existing vegetation and habitat.

Long-term adverse visual impacts from proposed water storage facilities include the presence of unnatural linear and obtrusive features (such as dams and spillways), as well as view obstructions.

Previously dry land would be inundated, or existing reservoir levels could be increased causing the inundation of new areas around the pre-existing shoreline. Unlike a natural lake, proposed reservoirs would lack naturally evolved shoreline vegetation and trees, and would become a prominent feature in the landscape. Fluctuating water levels due to alternate reservoir filling, drawdown, and replenishment could create or increase the extent of adverse shoreline "ring" impacts. This type of effect cannot be mitigated effectively through revegetation or screening.

Proposed construction activities for additional storage facilities may have temporary significant visual impacts. Descriptions of potential visual impacts are given for the Sites/Colusa, Montgomery and Los Vaqueros reservoirs as examples of potential new or modified existing reservoirs. Construction associated with the Sites/Colusa Reservoir Project would be particularly noticeable and would cause a temporary significant visual impact to nearby residents or motorists on Sites-Lodoga Road, a proposed County Road Scenic Route. However, most of the construction area would be screened from public view by intervening topography along Logan Ridge and other adjacent ridgelines. Conveyance facilities associated with the Site/Colusa Reservoir (such as Tehama-Colusa Canal Enlargement, Tehama-Colusa Canal Extension, and Chico Landing Intertie) could also have temporary adverse visual impacts to any nearby residences within 1/4-mile of the construction right-of-way.

The proposed Newville Reservoir would be situated between three ridgelines that would naturally screen construction activities from sensitive viewers to the west, north, and east, including nearby residents in the community of Paskenta and recreationists at Black Butte Lake. Constructing the conveyance canals and pumping-generating plants would generate short-term visual impacts that would be more noticeable in the flatter elevations of the project area near I-5.

Because of this topography, dam visibility at these north-of-Delta storage facilities would be localized to within about 1/4-mile of the sites. The project areas currently have minimal use; however, with the introduction of potential new recreation users at the reservoirs, the visual changes created by the proposed dams would have a potentially significant and not mitigable visual impact.

Potential construction activities at the Montgomery Reservoir would be particularly noticeable and would cause a temporary significant visual impact to residences in the nearby community of Snelling. The proposed main dam at Montgomery Reservoir could be visually disruptive, detracting from the natural landscape for nearby residents, as well as for new

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recreation users in the area. Therefore, the visual changes created by the proposed dam could have a significant and unavoidable impact on visual resources.

The proposed Los Vaqueros Reservoir would be situated in a canyon that would naturally screen construction activities from most sensitive viewers in the project area. In addition, most of the construction areas for the proposed reservoirs would be under water once the reservoirs are filled; therefore, this impact would be short term. Constructing pumping-generating plants and conveyance facilities for this project would generate short-term visual impacts that would be more noticeable in the flatter elevations of the project area, particularly near Bethany Reservoir State Recreation Area. These would be temporary but still significant visual impacts.

The 505-foot-high earthen dam proposed for the Los Vaqueros Reservoir would substantially change the visual character and quality of the landscape. The dam's massive engineered form and straight lines would contrast strongly with the surrounding rolling hills and undulating ridgelines. The dam and spillway would be visually disruptive, detracting from the natural landscape. Adverse visual impacts of views of the dam from the reservoir would be significant and unavoidable because the visible portion of the dam face would be covered with riprap, and the dam contour and reservoir water level would create a distinct break in the natural ridge line, which could not be buffered.

Views of the massive earthen dam and concrete spillway from downstream locations also could create visual impacts for recreation users. The dam face would strongly contrast in form, line, color, and texture with the surrounding landscape, thus creating a significant and not mitigable visual impact.

Ecosystem Restoration

Visual impacts could result from ecosystem restoration actions, such as gravel replacement (by creating borrow pits in visually sensitive areas) and from installing fish screens in areas with high visual sensitivity. These impacts could be mitigated through revegetation programs, would last less than 5 years, and are not considered significant.

Ecosystem restoration actions on the whole would be beneficial since they would add visual variety to the landscape and possibly would result in an upgrade of Variety Class. Some actions would be adverse, such as establishing fencing on creeks to protect riparian vegetation. These impacts could be significant if they persist for 5 years or more and occur in visually sensitive recreation areas. Assuming that vegetation could be used effectively to screen fences from passing recreationists' views, the impact could be mitigated and is not considered significant.

Watershed Management Coordination

Watershed management activities such as vegetation and habitat restoration, channel improvements, and erosion control efforts would generally have beneficial visual effects. In the long run, these types of activities would improve the natural landscape character of rivers and streams in both the upper watershed and lower watershed areas.

Altered timber harvesting practices could have beneficial visual effects on the landscape of this watershed if implemented over large areas. The overall visual effect of maintaining or enhancing these forested areas would be beneficial since it would preserve the natural landscape of this area. Reduced grazing in some areas could increase the amount of vegetative cover, which in turn would restore a more natural landscape character to denuded grazed areas.

Water Use Efficiency and Water Transfers

The effects of these programs would be similar to those described for the Delta Region.

SWP and CVP Service Areas Outside the Central Valley

There would be no direct or construction-related visual impacts in this area from any of the programs because there would be no direct activities or effects capable of significantly altering the visual landscape. However, visual impacts could occur in these areas if the proposed project leads to changes in growth. The types of visual impacts most likely associated with this would be a result of development of housing and retail structures. These impacts may or may not be significant, but there is insufficient existing information to make such an evaluation.

8.9.2.5 Comparison of Program Elements to Existing Conditions

The No Action Alternative differs from the existing conditions mainly in terms of future water demands; however, forecasted flows are generally similar to those for existing conditions. Therefore, the conclusions regarding the magnitude and significance of visual impacts would be the same when compared to existing conditions as when compared to the No Action Alternative.

8.9.2.6 Mitigation Strategies

Mitigations are proposed as strategies in this programmatic document and are conceptual in nature. Final mitigations would need to be approved by responsible agencies as specific projects are approved by subsequent environmental review.

At the programmatic level, the following onsite and offsite mitigation measures could be implemented to reduce significant visual impacts:

On-site measures:

- Revegetate disturbed areas within 2 years of construction;
- Time adverse changes in flow regimes to minimize "bathtub ring" effects during times of peak recreation use;
- Add visual variety through landscaping and habitat restoration efforts to areas considered Variety Class C;
- Minimize construction activities during the peak use recreation season;
- Locate visually obtrusive features, such as borrow pits and dredge material disposal sites, outside visually sensitive areas and observation sites;
- Where feasible, water areas where dust is generated, particularly along unpaved haul routes and during earthmoving activities, to reduce visual impacts caused by dust;
- Avoid, to the greatest extent feasible, unnecessary ground disturbance outside the area that would be eventually covered by a reservoir's water surface;
- Where revegetation occurs in natural areas, select vegetation type, placement, and density to be compatible with patterns of existing vegetation;
- Install landscape screening, such as groupings of trees and tall shrubs, to screen proposed facilities, such as pumping-generating plants, from nearby sensitive viewers, such as motorists and residents;
- Locate and direct exterior lighting for construction activities so that it is concealed to the extent practicable when viewed from local roads, nearby communities, and any recreation areas;
- If possible, site the proposed reservoir(s) to minimize required cut-and-fill and locate it on the flattest topographic section of the site to minimize its visibility;

- Establish native trees, bushes, shrubs, and ground cover at the base of dams and on hillsides near dams, at the base of pumping-generating plants, and along new and expanded canals and conveyance channels in a manner that does not compromise facility safety and access;

- Construct pumping plants with earth-tone building materials; and

- Mitigate the adverse visual impacts of channel widening with land sculpting and vegetation and provide opportunities for long-term visual enhancement.

Off-site measures:

- Create viewing opportunities of outstanding features (such as Mt. Diablo and the Vaca Mountains) through selective vegetation reduction or construct roadside viewing areas;

- Recontour and add vegetation to areas rated as "poor" in variety class; and

- In conjunction with new water storage and conveyance facility construction, flood visually unattractive areas, thus hiding adverse features and providing increased visual variety.

8.9.2.7 Potentially Unavoidable Significant Impacts

Unavoidable impacts are primarily those associated with program facilities and their construction since they are often difficult or impossible to harmonize with the natural environment, especially in the short term. Temporary structures under construction, heavy equipment, and piles of construction materials, dirt, and gravel would be particularly unsightly and therefore would represent a short-term significant unavoidable impact if located in the foreground and/or middle ground of visually sensitive areas. Unavoidable visual impacts may also be created by glare from night-time lighting of construction sites. During the day, fugitive dust may impair visibility in some areas. If these impacts persist more than 5 years, they are considered significant.

In terms of specific Delta facilities, large channels and/or pipelines and appurtenances on the north, east, and south sides of the Delta, especially Configurations 3E and 3I and in-channel flow control structures, have the greatest potential for creating long-term adverse impacts due to the high visibility of these changes. Their effects on Delta community residents are considered to be more severe than effects to recreational visitors to the Delta because of the greater potential exposure time.

8.10 ENVIRONMENTAL JUSTICE

Summary

Implementation of the CALFED alternatives and the No Action Alternative would not result in disproportionate adverse impacts to low-income or minority populations. Significant unavoidable environmental and human health impacts have not been identified for all of the alternatives and consequently, impacts would not be incurred disproportionately by any race or economic population.

Environmental justice impacts are best evaluated at the project-specific level where specific plans can be analyzed and specific populations affected by an action can be evaluated for disproportionate environmental or human health impacts.

The following analysis is programmatic in nature and serves to identify the environmental and human health impacts in this EIS/EIR that should be evaluated at the project-specific level for their potential to disproportionately impact low-income or minority populations or tribal resources. As specific plans are proposed, an evaluation of potential environmental justice impacts should be conducted.

This section summarizes baseline demographic data for low-income, minority, and tribal populations to be used in the analysis of environmental justice impacts. Environmental justice refers to the fair treatment of people of all races, cultures, and income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Executive Order 12898, signed by President Clinton in 1994, requires federal government agencies to consider the potential for their actions or policies to place disproportionately high and adverse human health or environmental effects on minority and low-income populations.

CALFED actions were evaluated to determine if one racial or economic group would be disproportionately impacted by an environmental or human health hazard. The affected environment for the environmental justice analysis includes the racial demographics within the CALFED study areas: the Delta Region, Bay Region, Sacramento River Region, San Joaquin River Region, and the SWP and CVP Service Areas Outside the Central Valley. Figure 8.10-1 shows the racial composition of the CALFED project area. Table 8.10-1 presents the percentage of the population below poverty level by region.

Impacts to Environmental Justice

- Some CALFED actions could have a disproportionate impact on minority and low income populations, including migrant workers.

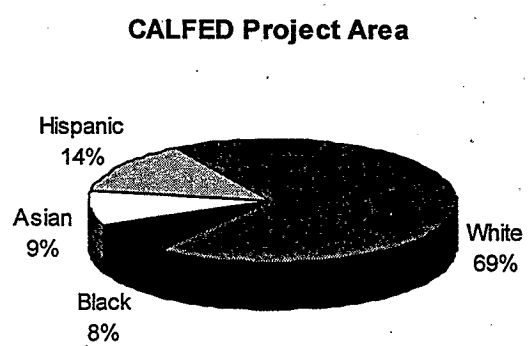

Figure 8.10-1. Racial Composition of CALFED Project Area

8.10.1 Affected Environment/ Existing Conditions

8.10.1.1 Delta Region

The racial distribution within each region is shown in Figures 8.10.1-1, -2, -3, -4, and -5. Within the Delta Region, approximately 69% of

Census Area	Total Population	Percentage of Population Below Poverty Level
Delta Region	1,572,342	11
Bay Region	5,037,527	9
Sacramento River Region	1,530,179	13
San Joaquin River Region	2,455,142	18
CVP and SWP Service Areas	17,307,700	13
State of California	29,760,021	12
Source: U.S. Bureau of Census, from http:// venus.census.gov/cdrom/lookup/CMD=LIST/DB=C90STF3A/		

Table 8.10-1. Percentage of Project Area Population Below Poverty Level (by Region)

the population is white, 8% is black, and 9% is Asian. Approximately 14% of the population is Hispanic, which is lower than the state percentage of 25%. Delta Region racial composition is identical to the CALFED project area. As shown in Table 8.10-1, the percentage of the Delta Region population below the poverty level is approximately 11%, which is slightly less than the state percentage of 12%.

8.10.1.2 Bay Region

The racial distribution within the Bay Region is shown in Figure 8.10.1-2. Within the Bay Region, approximately 61% of the population is white, 8% is black, and 15% is Asian. Approximately 16% of the population is Hispanic, which is lower than the state percentage of 25%. As shown in Table 8.10-1, the percentage of the Bay Region population below the poverty level is approximately 9%, which is less than the state percentage of 12%.

8.10.1.3 Sacramento River Region

The racial distribution within the Sacramento River Region is shown in Figure 8.10.1-3. Within this region, approximately 82% of the population is white, 4% is black, and 5% is Asian. Approximately 10% of the population is Hispanic, which is lower than the state percentage of 25%. As shown in Table 8.10-1, the percentage of the Sacramento River Region population below the poverty level is approximately 13%, which is slightly higher than the state percentage of 12%.

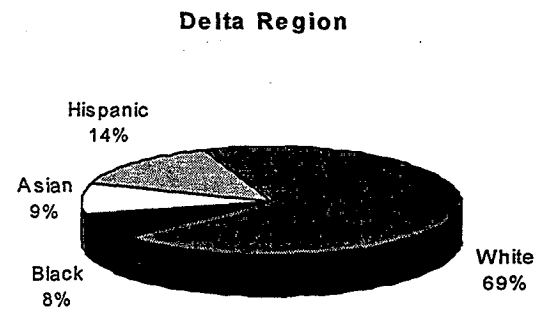

Figure 8.10.1-1. Racial Composition of the Delta Region

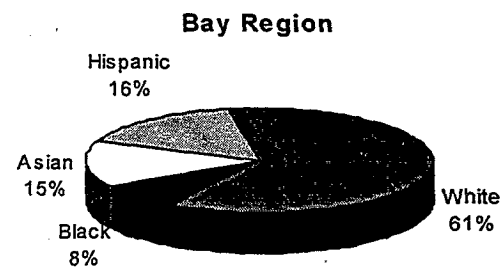

Figure 8.10.1-2. Racial Composition of the Bay Region

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8.10.1.4 San Joaquin River Region

The racial distribution within the San Joaquin River Region is shown in Figure 8.10.1-4. Within this region, approximately 62% of the population is white, 4% is black, and 6% is Asian. Approximately 30% of the population is Hispanic, which is higher than the state percentage of 25%. As shown in Table 8.10-1, the percentage of the San Joaquin River Region population below the poverty level is approximately 18%, which is higher than the state percentage of 12%.

8.10.1.5 SWP and CVP Service Areas Outside the Central Valley

The racial distribution within the SWP and CVP Service Areas Outside the Central Valley is shown in Figure 8.10.1-5. Within this region, approximately 52% of the population is white, 9% is black, and 9% is Asian. Approximately 30% of the population is Hispanic, which is higher than the state percentage of 25%. As shown in Table 8.10-1, the percentage of the SWP and CVP Service Areas population below the poverty level is approximately 13%, which is slightly higher than the state percentage of 12%.

8.10.2 Environmental Consequences: Environmental Justice

8.10.2.1 Assessment Methods

Environmental justice analyses include the identification of low-income and minority populations potentially affected by the proposed action and assessing whether these populations, if present, would incur disproportionate adverse human health or environmental impacts.

The method used to identify environmental justice impacts was adopted from the USEPA draft guidance for incorporating environmental justice concerns into NEPA documents. The USEPA draft guidance establishes a screening level analysis whereby a preliminary delineation of

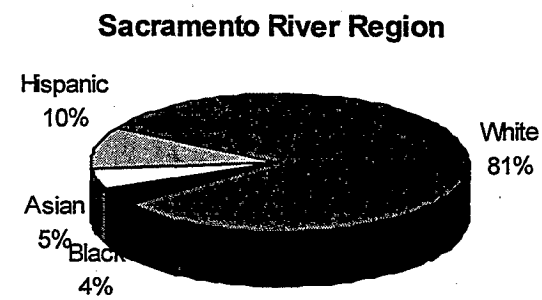

Figure 8.10.1-3. Racial Composition of the Sacramento River Region

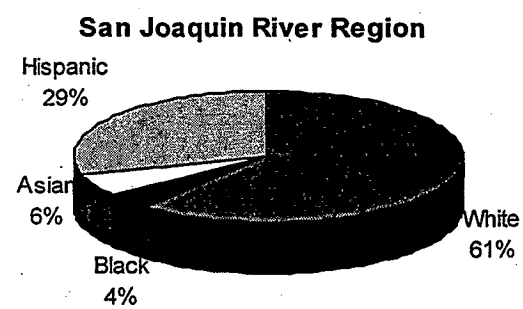

Figure 8.10.1-4. Racial Composition of the San Joaquin Region

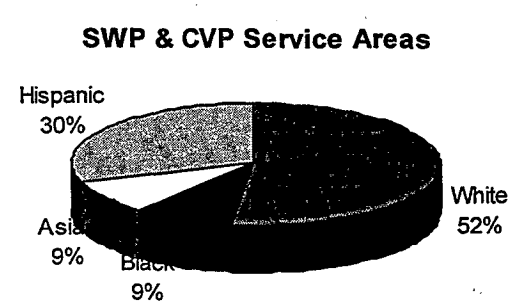

Figure 8.10.1-5. Racial Composition of SWP and CVP Service Areas Outside the Central Valley

both potential impacts and the potentially affected population is performed. The screening questions are as follows:

- Does the potentially affected community include minority or low-income populations or tribal resources?
- Are significant adverse environmental or human health impacts likely to fall disproportionately on minority and/or low-income populations and/or tribal resources?

Demographic data on race or low-income populations or tribal resources is provided in Section 8.10.1 to provide the baseline information required for the screening level analysis. Affected populations were considered to be minority or low-income "populations" when these populations exceeded 50% or where the minority or low-income population was meaningfully greater than the minority or low-income population percentage of similar geographic areas. Project-specific environmental justice analysis should further serve to identify potentially affected low-income or minority populations or tribal resources.

8.10.2.2 Significance Criteria

Significant environmental justice impacts would result if implementation of an alternative produces disproportionate significant adverse environmental or human health impacts to low-income or minority populations. Consideration of environmental justice issues is a federal requirement; there is no corresponding CEQA counterpart or significance criteria.

8.10.2.3 Comparison of No Action Alternative to Existing Conditions

Without implementation of the project, existing minority and low-income population concentrations are expected to persist.

8.10.2.4 Comparison of Program Alternatives to No Action Alternative

Storage and Conveyance. The conversion of agricultural soils could have a disproportionate impact on minority and low-income populations, including migrant agricultural workers. Minority and low-income populations may be composed of either a group of individuals living in geographic proximity to one another, or a geographically dispersed and/or transient sets of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect.

Development of conveyance facilities could permanently close or relocate recreation facilities in the eastern portion of the Delta. These closures or reallocations could result in a significant impact to recreational opportunities and recreation employment. Increasing storage capacity in existing reservoirs would increase water surface elevation, thereby inundating new land areas around the reservoir perimeters. The potential loss of recreation-related jobs could affect employment of minority and low-income populations. Depending on their existing uses, the inundation of new land area around the reservoir perimeters could affect minority populations who consider the open space to be a sensitive area.

The construction of off-stream storage facilities would result in the loss of stream fisheries. The loss of stream fisheries could affect minority and low-income populations disproportionately if they principally rely on fish for subsistence.

Ecosystem Restoration. The Ecosystem Restoration Program could affect groundwater resources indirectly through its effects on surface water supplies. Groundwater impacts could affect minority and low-income populations disproportionately if they rely on the use of well water in rural communities.

The Program would involve the development of storage and conveyance facilities, which would convert agricultural land to a different land use

and reduce crop revenues and employment. These impacts could disproportionately affect minority and low-income populations, including migrant agricultural workers.

The Ecosystem Restoration Program would haveonly negligible effects on urban land uses but could require relocation of major utility infrastructures. These relocations could be a significant adverse impact, depending on their location. If this displacement or disruption affects minority and low-income populations disproportionately, then there would be an environmental justice impact.

The Ecosystem Restoration Program could adversely affect Indian Trust Assets in all regions except the SWP and CVP Service Areas Outside the Central Valley. By its definition, all Indian Trust Assets impacts would have a disproportionate impact on a minority population.

Water Quality. The Water Quality Program would result in short-term reduced agricultural productivity and increased production costs; however, in the long term it would reduce production costs and create higher crop yields and greater crop selection flexibility. The short-term reduced agricultural productivity and increased production costs could have a disproportionate impact on minority and low-income populations.

The Water Quality Program could adversely affect Indian Trust Assets in all regions except the SWP and CVP Service Areas Outside the Central Valley.

Levee System Integrity. The Levee System Integrity Program would retire farmland, but provide greater protection of farmland from inundation and salinity intrusion. The retirement of farmland would affect local economies and social well-being because of changes in employment and income. This could disproportionately affect minority and low-income populations, including migrant agricultural workers.

The Levee System Integrity Program would displace existing recreation facilities, resulting in a loss of recreation opportunities and a potential loss of recreation-related jobs. The potential loss of recreation-related jobs could affect employment of minority and low-income populations.

Water Use Efficiency. The Water Use Efficiency program measures would result in increased crop yield for farmers, but could result in farm worker job loss. The loss of farm worker jobs could have a disproportionate impact on minority and low-income populations, including migrant agricultural workers.

Water Transfers. It is anticipated that water transfers could have an adverse or beneficial impact on surface water quality, depending on local conditions and how individual projects are operated. Reduced demand and accompanying reduction in storage release, if not accompanied by a decrease in contaminant loading, could result in increased contaminant concentrations in streams and in the Delta. The impacts to surface water resources could affect fish and water consumption among minority populations or low-income populations.

Water Transfers would adversely affect agricultural production at the source of the transferred water and benefit production in the water-receiving regions. This would affect local economies and social well-being because of changes in employment and income and could affect minority and low-income populations disproportionately, including migrant agricultural workers.

Watershed Management Coordination. Watershed management coordination efforts may have adverse short-term impacts on surface soil and channel erosion, but are expected to have beneficial long-term impacts on stream geomorphology by reducing sediment inputs from hillslope, bank, and channel erosion. To the extent that surface soil and channel erosion impacts reduce agricultural productivity and increase

production costs, there could be a disproportionate impact on the employment and income of minority and low-income populations.

The Watershed Management Coordination Program would alter land use practices in the upper watershed, resulting in foregone economic opportunities. Agricultural job losses would represent adverse economic and social well-being impacts. In addition, significant reductions in crop revenue could result from the conversion of prime farmlands. This could disproportionately affect the income and employment of minority and low-income populations, including migrant agricultural workers.

8.10.2.5 Comparison of Program Alternatives to Existing Conditions

Comparisons of environmental justice issues to existing conditions would be similar to the No Action Alternatives described above.

8.10.2.6 Mitigation Strategies

To ensure greater public participation, the Bay-Delta Program outreach program has been targeted specifically to minority and low-income communities. The outreach program is multicultural and includes issue identification, ethnic media outreach, public presentations and forums, and advertisements. On a continuing basis, media releases and Bay-Delta Program announcements have been issued to Armenian, Chinese, Japanese, Korean, Spanish, and Vietnamese newspapers, as well as publications that primarily reach African American and Native American readers. For more information on the public and agency involvement, see Chapter 12.

To further public participation efforts, the following mitigation measures shall be implemented:

- The views of the affected communities shall be elicited on mitigation measures;
- Key documents (notice, summaries, etc.) shall be translated into the languages of all affected communities;
- Public meetings shall be held in locations accessible by public transpiration;
- A toll-free telephone number (with options for various languages) shall be established for callers to leave recorded comments or to obtain up-to-date information about project activities; and
- A community oversight committee shall be established to identify potential minority or low-income populations concerns.

To reduce impacts to minority or low-income populations that are displaced:

- Relocation assistance shall be provided;
- An employment referral service shall be established; and
- Job relocation assistance for employees displaced because of the loss of agricultural land shall be provided.

8.11 INDIAN TRUST ASSETS

Summary

Indian Trust Assets are legal interests in assets held in trust by the Federal Government for Indian tribes or Indian individuals. Assets can be real property, physical assets, or intangible property rights. Indian Trust Assets cannot be sold, leased, or otherwise encumbered without approval of the United States government. A trust relationship is established through a congressional act or executive order as well as provisions identified in historic treaties.

The land associated with a reservation, rancheria, or public domain allotment is an example of an Indian Trust Asset. The resources located within reservations, including trees, minerals, oil and gas, and others, are also considered trust assets. Water rights as well as hunting and fishing rights may be Indian Trust Assets, although under P.L. 280 fishing and hunting are regulated under State law by the California Department of Fish and Game both on and off reservation. Table 8.11-1 provides a summary of environmental impacts related to Indian Trust Assets.

Impacts to Indian Trust Assets
• **No Action Alternative** impacts are associated with CVPIA activities.
• **Alternatives 1, 2, and 3** could have adverse affects on Indian Trust Assets in the Sacramento and San Joaquin River regions. Until specific actions are proposed, certainty of impacts cannot be determined.

8.11.1 Affected Environment/ Existing Conditions

8.11.1.1 Delta Region

There are no reservations or rancherias located within the Delta Region. It is unlikely that there are any public domain allotments located within this region.

8.11.1.2 Bay Region

There are no reservations or rancherias located within the Bay Region. There may be some public domain allotments located within this region.

8.11.1.3 Sacramento River Region

This region includes approximately 25 reservations and rancherias and an unknown number of public domain allotments. Each Indian reservation, rancheria, and allotment represents an Indian Trust Asset unless they have been specifically dropped from trust status.

8.11.1.4 San Joaquin River Region

Approximately 11 reservations or rancherias are located within the San Joaquin River Region. The number of Public domain allotments is unknown. Each Indian reservation, rancheria, and allotment represents an Indian Trust Asset unless they have been specifically dropped from trust status.

8.11.1.5 SWP and CVP Service Areas Outside the Central Valley

There are a number of Indian reservations, rancherias, and allotments found in this region. The SWP area contains approximately 24 Indian reservations or rancherias. Public domain allotments are also found within this region.

IMPACT ISSUES	ALTERNATIVE 1			ALTERNATIVE 2				ALTERNATIVE 3				
	1A	1B	1C	2A	2B	2D	2E	3A	3B	3E	3H	3I
Delta Region												
Construction activities affecting Native American Resources	□	□	□	□	□	□	□	□	□	□	□	□
Bay Region												
Construction activities affecting Native American Resources	□	□	□	□	□	□	□	□	□	□	□	□
Sacramento River Region												
Construction activities affecting Native American Resources	○	○	○	○	○	○	○	○	○	○	○	○
San Joaquin River Region												
Construction activities affecting Native American Resources	○	○	○	○	○	○	○	○	○	○	○	○
SWP and CVP Service Areas Outside the Central Valley												
Construction activities affecting Native American Resources	□	□	□	□	□	□	□	□	□	□	□	□

NOTE: Please refer to supporting text for a discussion of the degree to which the beneficial or adverse impacts vary from one configuration to the other.

LEGEND:

Level of Impact

●	=	Significant and unavoidable
◗	=	Significant and mitigable
○	=	Less than significant
□	=	None
+	=	Beneficial
U	=	Unknown

Table 8.11-1. Summary of Environmental Impacts Related to Indian Trust Assets

8.11.2 Environmental Consequences: Indian Trust Assets

8.11.2.1 Significance Criteria

The primary potential impact to Indian Trust Assets stems from those actions, activities, or projects that affect Indian lands. Construction activities associated with the implementation of program elements or alternatives may affect individual reservations or rancherias. Indian land located along rivers or in the vicinity of upland reservoir sites may be impacted. Any actions that impinge on water rights, water quality, or other rights associated with specific Indian Trust Assets would be an impact.

8.11.2.2 Assessment Methods

Identifying specific Indian Trust Assets is the first action to determine if an undertaking will affect trust assets. Project planners will examine areas of potential effect for possible conflict with Indian lands and Indian Trust Assets. The nature of the trust asset will be determined in consultation with the specific Indian tribe, Bureau of Indian Affairs, and through examining government documents.

8.11.2.3 Comparison of No Action Alternative to Existing Conditions

Projects such as the CVPIA may affect Indian Trust Assets. However, specific project locations and actions have not bee determined. Consequently, the effects of projects identified under the No Action Alternative on Indian Trust Assets are unknown.

8.11.2.4 Comparison of Program Alternatives to No Action Alternative

Delta Region. There are no reservations or rancherias within this region. It is unlikely that any program actions will affect Indian Trust Assets.

Bay Region. There are no reservations or rancherias within this region. There may be some public domain allotments within this region, although it is unlikely that any would conflict with the location of proposed projects. It is unlikely that any program actions will affect Indian Trust Assets, but an examination of land records held by the Bureau of Indian Affairs needs to be completed.

Sacramento River Region. There are approximately 25 reservations and rancherias located within this region. Few of these, if any, will be affected by program actions. Once specific projects are proposed, however, then the potential conflict between Indian Trust Assets, including public domain allotments, needs to be determined. Some of the actions, particularly those involved with ecosystem restoration, may have a beneficial effect on any trust assets associated with water or fishing rights.

San Joaquin River Region. There are approximately 11 reservations and rancherias located within this region. Few of these, if any, will be affected by program actions. Once specific projects are proposed, however, then the potential conflict between Indian Trust Assets, including public domain allotments, needs to be determined. Some actions, particularly those involved with ecosystem restoration, may have a beneficial effect on any trust assets associated with water or fishing rights.

SWP and CVP Service Areas Outside the Central Valley. There are over 24 Indian reservations and rancherias and an unknown number of public domain allotments within this region. It is unlikely that any Indian Trust Assets will be affected by program actions since no structures, conveyance facilities, storage projects, or habitat improvement projects are planned for this region.

8.11.2.5 Comparison of Program Elements to Existing Conditions

Comparison of Indian Trust Assets to existing conditions would be similar to the No Action Alternative.

8.11.2.6 Mitigation Strategies

The first strategy in mitigating impacts to an Indian Trust Asset is to avoid or minimize significant adverse impacts. If avoidance is not possible, then any form of mitigation must be developed in consultation with the Indian tribe or individual who possesses the trust asset. Specific mitigation is contingent upon the type of Indian Trust Asset and the nature of the impact. Agreements between federal action agencies and Indian trust owners may require approval from Congress or the Bureau of Indian Affairs.

8.11.2.7 Potentially Significant Unavoidable Impacts

There are at this time no known significant unavoidable impacts to Indian Trust Assets as a result of implementing provisions of the Bay-Delta Program.

9 CUMULATIVE IMPACTS

Cumulative impacts are defined as the impact upon the environment which results from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions undertaken by the same or other agencies or persons. It is recognized that the CALFED actions may be implemented in an interactive manner with other concurrent and subsequent projects. The non-CALFED actions implemented concurrently with CALFED may affect the results of implementation of the CALFED Program and may have impacts different than those associated with implementation of CALFED in isolation.

9.1 ACTIONS INCLUDED IN THE CUMULATIVE IMPACTS ANALYSIS

Actions that may contribute to cumulative effects include the following actions, which are described in the following section. A summary of the potential cumulative effects associated with these actions is presented in Table 9-1.

- American River Water Resource Investigation
- American River Watershed Project
- Central Valley Project Improvement Act (except 800,000 acre-feet, Level IV refuge water, and Shasta Temperature Control Device)
- Contra Costa Water District Multi-Purpose Pipeline Project
- Delta Wetlands Project
- Hamilton City Pumping Plant Fish Screen Improvement Project
- Interim South Delta Program
- Montezuma Wetlands Project
- Pardee Reservoir Enlargement Project
- Red Bluff Diversion Dam Fish Passage Program
- Sacramento River Flood Control System Evaluation (partial)
- Sacramento Water Forum Process
- Trinity River Restoration Program
- East Bay Municipal Utility District (EBMUD) Supplemental Water Supply Project

The following is a brief description of each of the projects included in the cumulative effects analysis.

9.1.1 American River Water Resource Investigation (Bureau of Reclamation)

The American River Water Resource Investigation (ARWRI) began in 1992 as a follow-up to the American River Watershed Investigation (ARWI). The project's focus is evaluation of potential alternative solutions to meeting water-related needs in portions of Sutter, Placer, El Dorado, Sacramento, and San Joaquin counties. The alternatives which have been analyzed in the Final EIS/EIR for the American River Water Resource Investigation include: conjunctive use (between groundwater and surface water sources); conjunctive use with new storage (possible reservoir sites include Clay Station, Deer Creek, Dutch Creek, Small Alder, South Gulch, Texas Hill, and the possible enlargement of the existing Farmington Reservoir); and the construction of a full-size Auburn Reservoir. In the Final EIS issued September 1997, the Bureau of Reclamation indicated that at that time it has not

identified a federal action associated with this program.

9.1.2 American River Watershed Project (Corps of Engineers)

The ARWI studies address the flooding and flood problems in the American River Basin. The ARWI focused on the system of levees, weirs, and bypasses along the Sacramento River and its tributaries in the vicinity of Natomas; Folsom Dam and the levees along the lower American River downstream from the dam; and the reach of the river above Folsom near the city of Auburn where flood storage capacity could be added.

The studies resulted in the 1991 American River Watershed Investigation Feasibility Report, which recommended construction of levee and related improvements in the Natomas area of Sacramento and a flood distribution dam on the North Fork American River upstream from Folsom Reservoir. Construction of the Natomas portion of the plan is complete. Further studies are now being conducted on the plans. Three plans were analyzed in detail in the American River Watershed Project Supplemental EIS (August 1995) to address flood protection below Folsom and Auburn: the Folsom Modification Plan, the Folsom Stepped Release Plan, and the Detention Dam Plan.

9.1.3 Central Valley Project Improvement Act (Bureau of Reclamation)

The CVPIA mandates changes in management of the Central Valley Project (CVP), particularly operation of the CVP to dedicate and manage 800,000 acre-feet/year of CVP water for the protection, restoration, and enhancement of fish and wildlife. The CVP is the system of reservoirs, powerplants, pumping plants, and canals managed by the federal Bureau of Reclamation in California. The combined storage capacity is about 12 million acre-feet, which accounts for approximately 25% of California's developed surface water supply. The Department of the Interior is developing policies and programs to modify the operations, management, and physical facilities of the CVP and to renew existing CVP water services and repayment contracts to comply with the purposes and goals of the CVPIA, which reduces deliveries to CVP water service contractors and the revised purposes of the CVP.

Physical measures to restore fish and habitat include: establishment of fish screening programs; development and implementation of measures at the Red Bluff Diversion Dam to minimize fish passage problems; expansion of the U.S. Fish and Wildlife Service's existing hatchery facility; modification of the Keswick Dam fish trap and spillway to prevent trapping of fish; development and implementation of a continuing program to restore and replenish lost spawning gravel in the upper Sacramento River; development and implementation of a program that provides for modified operations or new and improved control structures at the Delta Cross Channel and Georgiana Slough; and design and construction of a new fish protection structure at the Glenn County Irrigation District pumping facility near Hamilton City.

The draft CVPIA Programmatic EIS was released for public review in November 1997.

9.1.4 Contra Costa Water District Multi-Purpose Pipeline Project (Contra Costa Water District)

The Contra Costa Water District (CCWD) has proposed this project to supplement the Contra Costa Canal and provide adequate water transmission capacity to meet the projected demand for the CCWD through the year 2020. The proposed action is the construction and operation of two water pipelines and supporting pumping facilities. The project involves the following improvements:

- Multi-Purpose Pipeline (MPP)—This pipeline would supplement the capacity of the Contra Costa Canal with a treated water pipeline

extending approximately 22 miles from CCWD's Randall-Bold Water Treatment Plant in Oakley, east to CCWD's Treated Water Service Area in Concord. The pipeline would terminate near CCWD's Bollman Water Treatment Plant near Concord. CCWD is evaluating several pipeline route alternatives including: the canal right-of-way, local streets, and an active railroad corridor.

- Raw Water Pipeline—The project also includes approximately 4 miles of 36-inch, 36-million-gallons-per-day (mgd) raw water pipeline bypassing canal reach 4 from downstream of the Neroly Blending Facility to the canal near Antioch. The raw water pipeline could be installed parallel and adjacent to the MPP pipeline.

- Treated Water Pump Station—The project includes a proposed 25-mgd pump station at the Randall-Bold Water Treatment Plant to pump treated water from the plant through the multi-purpose pipeline.

- Raw Water Pump Station—A 36-mgd raw water pump station would be located downstream of the Neroly Blending Facility and upstream of the tunnel. The pump station would pump raw water from the canal through the raw water pipeline.

- Canal Gate Improvements and Neroly Blending Facility Improvements—The MPP Project includes modifications to six of the seven active check structures along the canal between pumping plant No. 4 and Mallard Reservoir at Bollman Water Treatment Plant. At each check structure, CCWD would install motorized gates that could be opened during periods of high flow rates, thereby increasing canal capacity. The Neroly Blending Facility would be expanded by widening the canal or raising the sides.

- MPP Enhancements—As part of the project, CCWD would install an emergency generator at the MPP treated water pump station, and construct emergency connections from the MPP to the canal and to the shortcut pipeline, thereby allowing the MPP to deliver water to functional portions of the canal that may be disconnected from eastern supply sources during an emergency such as an earthquake. A Notice of Intent to prepare an EIS for the project was published in September 1997.

9.1.5 Delta Wetlands Project (Delta Wetlands Corporation)

This project would improve and strengthen levees on two "reservoir islands" and two "habitat islands," and install two additional intake siphon stations and a new pump station on each of the reservoir islands. Fish screens would be installed on all new and existing siphons on the reservoir and habitat islands. The project would divert surplus Delta inflows, transferred water, or banked water onto the reservoir islands during periods of availability throughout the year to be stored later for sale and/or release for Delta export or to meet water quality or flow requirements for the Bay-Delta estuary during periods of demand.

The initial water storage capacity of the reservoir islands would be 238,000 acre-feet and increase to 260,000 acre-feet in 50 years due to soil subsidence. The mean annual diversion and discharge is estimated to be 222,000 to 225,000 acre-feet and 180,000 to 202,000 acre-feet, respectively. Both reservoir islands could be filled and emptied in approximately one month. The Delta Wetlands diversion could occur in any month but would only occur when the volume of allowable water for export is greater than the permitted pumping rate of the export pumps.

9.1.6 Hamilton City Pumping Plant Fish Screen Improvement Project (Reclamation/Corps/GCID/CDFG)

The Hamilton City Pumping Plant Fish Screen Improvement Project is proposed to address concerns over impacts to salmon and other fish species from water diversion operations at the

Hamilton City Pumping Plant. The project includes three alternatives which would minimize loss of all fish species in the vicinity of the pumping plant diversion while maximizing the Glenn-Colusa Irrigation District's (GCID) capability to divert the full quantity of water that it is entitled to divert to meet its water supply delivery obligations. The preferred alternative would include an extension of the existing fish screen, internal fish bypasses, improvements to the intake and bypass channel, and a gradient facility.

The EIR/EIS was released in January 1998.

9.1.7 Interim South Delta Program (California Department of Water Resources/Bureau of Reclamation)

The objectives of the Interim South Delta Program (ISDP) are to improve water levels and circulation in South Delta Channels for local agricultural diversions; improve South Delta hydraulic conditions to increase diversions into Clifton Court Forebay to optimize the frequency of full pumping capacity at the Henry O. Banks Pumping Plant; and improve fishery conditions for salmon migrating along the San Joaquin River.

The preferred alternative for the ISDP is comprised of selected channel dredging of a 4.9-mile reach of Old River from the northwest corner of the Clifton Court Forebay to North Victoria Canal; construction and operation of a new intake gate at Clifton Court Forebay; and construction and operation of four radial gate flow control structures in the south Delta, to increase water supply availability for local diverters and improve local fishery conditions. In addition, DWR is seeking a permit from the U.S. Army Corps of Engineers to divert up to 20,430 acre-feet of water per day on a monthly averaged basis from the Delta into Clifton Court Forebay. Collectively, these actions are intended to enhance the management of south Delta water resources to benefit local diverters, Delta fisheries and State Water Project water supply.

A Draft EIS/EIR and 404(b)(1) Analysis for ISDP was released for public review and comment in July 1996. The draft documents identified both beneficial and adverse impacts associated with the implementation of ISDP.

Potential adverse impacts upon aquatic resources included loss of habitat due to dredging of Old River; loss of habitat due to the construction of the proposed facilities; negative flows in channels leading to the South Delta due to the operation of the barriers; and increased straying, predation, and entrainment losses due to high SWP export pumping during the fall, winter, and early spring. The project could benefit San Joaquin River fall-run chinook because the spring and fall barrier at the head of Old River would reduce entrainment/predation loss of San Joaquin River salmon smolts at the Tracy and Harvey O. Banks Pumping Plant and improve dissolved oxygen levels in the San Joaquin River.

Water quality could be substantially improved in two ways and potentially degraded in one way. First, increased pumping would allow reductions in exports during critical seasons. This change in operation could lead to fewer conflicts among beneficial use of Delta waters. Secondly, the installation of barriers could improve water levels and circulation in the South Delta, and thereby enhance agricultural and municipal uses of the water. However, the operation of the barriers also could degrade water quality by rerouting relatively saline waters of the San Joaquin River away from the South Delta pumping plants, and towards the central Delta.

9.1.8 Montezuma Wetlands Project (Corps of Engineers/Solano County)

This project calls for constructing facilities to receive up to 20 million cubic yards of approved dredged materials from ports and navigation channels in the San Francisco Bay Estuary and to distribute the materials over a 2,394-acre diked bayland site near Collinsville in Solano County, adjacent to Suisun Marsh. After filling the subsided baylands, the levees would be breached

to enable tides and ebb to flow over the constructed foundation of tidal channels and low marsh plains. The marsh design includes high marsh and marsh ponds that would seldom be reached by tides.

The project would restore 1,822 acres of tidal wetlands on the bayland site. Project construction is proposed to be in four phases to minimize temporary losses of wetlands during construction and to facilitate engineered placement of the dredged materials. Each completed phase would be hydrologically independent with a single connection to Montezuma Slough or the Sacramento River.

9.1.9 Pardee Reservoir Enlargement Project (East Bay Municipal Utility District)

EBMUD's primary water supply is the Sierra-Nevada mountains, which is regulated by several projects, including two district reservoirs, Pardee Reservoir (210,000 acre-feet) and Camanche Reservoir (417,000 acre-feet). Water from Pardee Reservoir is conveyed 90 miles to the East Bay via EBMUD's Mokelumne Aqueducts. In January 1995, EBMUD initiated studies aimed at meeting the District's need for water by 2002, including joint project options with San Joaquin and/or Sacramento County interests involving EBMUD's American River entitlement, and surface storage options, such as the enlargement of Pardee Reservoir by 150,000 to 2,000,000 acre-feet.

The specific facility improvements associated with the Pardee Reservoir enlargement include: raising the main dam, modifying or replacing the spillway, modifying the powerhouse, raising or replacing a secondary dam near the existing Jackson Creek outlet, modifying or replacing the intake tower, modifying Pardee tunnel and Aqueduct facilities at Campo Seco, replacing the Highway 49 bridge over the Mokelumne River and making roadway modifications, and modifying or replacing existing recreational facilities. A key construction concern is the level, duration, and timing of any reservoir drawdown.

9.1.10 Red Bluff Diversion Dam Fish Passage Program (Bureau of Reclamation)

This program includes evaluating possible long-term solutions to fish passage and water delivery problems at the Red Bluff Diversion Dam. Operation of the Red Bluff Diversion Dam under the National Marine Fisheries Service Biological Opinion has substantially reduced, but not eliminated, fish passage problems and has created water delivery problems during planting and harvest seasons. Engineering and biological evaluations are continuing, and interim measures have been developed to supply water during the 8-month "gates up" period of operation. A research pumping facility was installed in 1994 to evaluate potential means of pumping water to ensure availability of sufficient water while using the existing drum screen. Field and laboratory studies of fish ladder alternatives and a hydrological study are in progress.

9.1.11 Sacramento River Flood Control System Evaluation (Corps of Engineers)

The Sacramento River Flood Control System includes 980 miles of levees and is designed to provide varying degrees of flood protection to lands adjacent to the Sacramento River from Chico Landing near Red Bluff south to Collinsville in the Sacramento-San Joaquin Delta, and the lower reaches of several tributaries including the American River. The purpose of the evaluation study is to determine if the system is functioning as designed or if remedial work is required to restore the levees to their previously established design and function.

The reevaluation is being conducted in five phases. Phase I, the Sacramento Urban Area Levee Restoration Project, was completed in 1994. Phase II focuses on the levee systems along the Feather and Yuba rivers in the cities of Marysville and Yuba City. Phase III focuses on the mid-valley area between Sacramento, Marysville-Yuba City, and the Yolo Bypass from

Fremont Weir to south of Putah Creek. Phase IV focuses on the levees in the Delta from Sacramento through Collinsville. Phase V concentrates on the levees of the upper Sacramento River north to Chico Landing.

9.1.12 Sacramento Water Forum Process (Local Governments and Water Districts)

The Water Forum began as a diverse group of business and agricultural leaders, environmentalists, citizen groups, water managers, and local governments in Sacramento County. In 1995 they were joined by water managers in Placer and El Dorado counties. The group was formed to address regional concerns of water shortage, environmental degradation, contamination, threats to groundwater reliability, limits to economic prosperity, and competition from other areas for water. The Water Forum has two co-equal objectives:

- Provide a reliable and safe water supply for the region's economic health and planned development through to the year 2030; and
- Preserve the fishery, wildlife, recreational, and aesthetic values of the lower American River.

In January 1997, the Forum made available their Draft Recommendations for a Water Forum Agreement for public review and comment. Within the Draft Recommendations are seven elements, each of which is necessary for meeting the Water Forum objectives. The seven elements are:

- Increased surface water diversion,
- Alternative water supplies to meet customers' needs while reducing diversion impacts on the lower American River in drier years,
- An improved pattern of fishery flow releases from Folsom Reservoir,
- Lower American River habitat mitigation,
- Water conservation,
- Groundwater management, and
- Water Forum success effort.

9.1.13 Trinity River Restoration Program (Bureau of Reclamation)

The Trinity River Restoration Program was established through PL 98-541 (since amended) to restore and maintain the fish and wildlife stocks of the Trinity River Basin to those levels which existed just prior to the construction of the Trinity River Division of the Central Valley Project.

The Trinity River Division was authorized by Congress in part to increase the supply of water available for irrigation and other beneficial uses in the Central Valley. Facilities were authorized for control and storage of water from Clear Creek and Trinity River flows. Water from the Trinity River is stored in Claire Eagle Lake behind Trinity Dam. Lewiston Dam regulates flows to meet the downstream requirement of the Trinity River Basin. Water from the Trinity River is diverted through J.F. Carr and Spring Creek power plants to the Sacramento River to meet the water demands in the Sacramento Valley and other areas of the CVP.

Since the Trinity River Basin Fish and Wildlife Management Act (PL 98-541) was enacted, a number of positive benefits have occurred, including:

- the modernization of the Lewiston Hatchery to provide fish for stocking programs, and the construction of the Buckhorn Debris Dam to effectively control sedimentation;
- 17,000 acres of highly eroded land in the Grass Valley watershed have been purchased and rehabilitated;

- spawning gravel below Lewiston Dam has been replaced;

- the River's meandering channels have been re-established; and

- the Trinity River's edges have been feathertaped to encourage natural fish spawning and rearing.

Reauthorization of the Act in 1995 continued the efforts of restoration of the South Forks Trinity River fish habitat and the implementation of a comprehensive wildlife management program for all affected species.

In addition, as part of the CVPIA, the Bureau of Reclamation in coordination with the U. S. Fish and Wildlife Service is responsible for the protection of the fishery resource of the Hoopa Valley Tribe, to meet fishery restoration goals of the Trinity River Basin Fish and Wildlife Restoration Act; develop in-stream flow recommendations for the Trinity River based on the best available scientific data; and provide a deadline to complete the Trinity River Flow Evaluation Study, which was implemented in 1984.

9.1.14 Supplemental Water Supply Project (East Bay Municipal Utility District)

This project will allow the East Bay Municipal Utility District (EBMUD) to take delivery of its Bureau of Reclamation contract entitlement for American River water.

Reclamation and EBMUD are considering the following alternatives for diversion and conveyance of American River water within the Supplemental Water Supply Project:

- A joint project between EBMUD, the city of Sacramento, and the Sacramento County Water Agency, which would involve the construction of a new intake-pumping facility and fish screens on the American River near its confluence with the Sacramento River, a pipeline from this diversion to the City's E.A. Fairbairn Water Treatment Plant, a pipeline henceforth to the Folsom South Canal (FSC), and a connection from the FSC to EBMUD's Mokelumne Aqueducts. This alternative would require a change in the point of delivery of water for EBMUD and an amendment to the existing Reclamation contract.

- A pipeline connection from the FSC at the current contract turnout location near Grant Line Road to the EMBUD Mokelumne Aqueducts. This alternative could be implemented without amending the existing Reclamation contract.

- A pipeline connection from the terminus of the FSC to the EBMUD Mokelumne Aqueducts near Clements, California. This alternative would require a change in the point of delivery of water for EBMUD and an amendment to the existing Reclamation contract.

- A pipeline connection from the terminus of the FSC to the EBMUD Mokelumne Aqueducts near Stockton, California. This alternative would require a change in the point of delivery of water for EBMUD and an amendment to the existing Reclamation contract.

9.2 CUMULATIVE IMPACT ANALYSIS

The following is an analysis of projects discussed in Section 9.1 and their potential cumulative impacts. In general, the analysis is qualitative. Impacts were based on identified resources potentially affected by each project extracted from available environmental documents/studies or based on knowledge of the generally expected kinds of effects of similar projects in the study area. Because of the preliminary phase of most of the projects (environmental reviews have not been initiated, drafted, or finalized), comparable environmental information for identifying cumulative impacts was not available.

Region	Actions Involved	Potential Cumulative Impacts
Delta Region	• American River Water Resource Investigation • American River Watershed Project • Interim South Delta Program • Central Valley Project Improvement Act	• Beneficial and detrimental impact to fisheries, terrestrial species, and species listed as threatened or endangered • Beneficial and detrimental impact to water quality and supply availability • Short-term impacts to water quality, aquatic resources, and fisheries
	• Delta Wetlands Project	• Adverse impacts to vegetation, aquatic, and biological resources • Beneficial impact from improvement in water supply availability • Beneficial impact from increase in fresh water marsh, waterfowl use, wading bird and raptor use, and recreation • Adverse impacts to export water quality
Bay Region	• Montezuma Wetlands Project • Contra Costa Water District Multi-Purpose Pipeline Project	• Beneficial impact from restoration of tidal marsh habitat • Short- and mid-term adverse impacts due to loss of seasonal wetlands • Adverse impact to threatened and endangered species • Adverse impact from the release of contaminants • Long-term adverse impact due to loss of marsh habitat if wetland restoration unsuccessful
Sacramento River Region	• American River Water Resource Investigation • American River Watershed Project • EBMUD Supplemental Water Supply Project • Sacramento River Flood Control System Evaluation • Sacramento Water Forum Process	• Adverse impacts to biological resources • Adverse impacts to water quality and circulation • Adverse impacts to cultural resources • Beneficial and/or adverse impacts to recreation • Beneficial impacts from improvement in water supply availability
	• Central Valley Project Improvement Act • Red Bluff Diversion Dam Fish Passage Program • Hamilton City Pumping Plant Fish Screen Improvement Project	• Beneficial impacts to riparian habitat • Adverse impacts to water supply availability • Beneficial impacts to fisheries • Beneficial impacts from improvement in water supply availability

Table 9-1. Summary of Cumulative Impacts (page 1 of 2)

San Joaquin River Region	• Pardee Reservoir Enlargement Project	• Short- and mid-term adverse impacts to water quality, water supply, fisheries, and recreation • Long-term adverse impacts to vegetation, wildlife, and cultural resources • Long-term beneficial impacts to water supply reliability, water quality, and fisheries
	• Interim South Delta Program	• Long-term beneficial impacts to water supply reliability, water purity, and fisheries
	• Central Valley Project Improvement Act	• Beneficial impact to riparian vegetation, special-status, and other wildlife species • Long-term beneficial impacts to water supply reliability, water quality, and fisheries • Adverse impacts to agricultural land use
	• EBMUD Supplemental Water Supply Project	• Long-term adverse impacts to water quality, fisheries, wetlands, vegetation, and wildlife • Beneficial impacts from improvement in water supply availability
SWP and CVP Service Areas Outside the Central Valley	• All Projects Analyzed	• Adverse impacts to water supply availability and quality

Table 9-1. Summary of Cumulative Impacts (page 2 of 2)

9.2.1 Delta Region

The American River Water Resource Investigation, the American River Watershed Project, and the CVPIA project operations may adversely affect fish production and survival in Delta waterways when combined with potential impacts associated with the Delta Wetlands Project. Potential affects would depend largely on the volume of water released, and the operation of the downstream releases. However, proposed new storage sites and modifications to existing sites (Auburn and Folsom Reservoirs) associated with the American River Water Resource Investigation and the American River Watershed Project within the Sacramento River Region could potentially benefit fisheries resources in the Delta by dampening the water-level fluctuations and improving water quality by increasing the concentration of dissolved oxygen. The Delta Wetlands Project could potentially add adverse effects to Delta water quality and circulation by the discharge of lower quality or potentially contaminated water to receiving waters. All four projects could benefit water availability and Delta exports.

The Delta Wetlands Project could also have potential adverse cumulative effects to aquatic and biological resources by increasing the potential for mortality and entrainment of Chinook salmon, stripped bass eggs and larvae, and smelt larvae. Operation of the reservoir islands could also have a potential for a net reduction in wetland, riparian, upland, and marsh habitat. Wildlife use of these habitats could be adversely affected and result in a population decline for some species.

The Delta Wetlands Project would increase freshwater marsh and exotic marsh habitat and could potentially benefit waterfowl, wading birds, raptors, recreational use, and water supply availability.

The Interim South Delta Program would have both beneficial and adverse cumulative impacts. Potential adverse impacts include the loss of aquatic resource habitat due to dredging and construction of intake and control structures; an increase in reverse flow in some channels under low flow conditions due to the operations of barriers; and increased straying, predation, and entrainment losses due to high SWP export pumping during the fall, winter, and early spring.

Beneficial cumulative water quality impacts on the Interim South Delta Program are expected. Increased pumping would allow reductions in exports during critical seasons. This change in operation could lead to fewer conflicts among beneficial uses of Delta waters. In addition, the installation of barriers could improve water levels and circulation in the south Delta, and thereby enhance agricultural and municipal uses of the water. However, the operation of either the Grant Line or Head of Old River barriers could degrade water quality by rerouting relatively saline waters of the San Joaquin River away from the south Delta pumping plant, and towards the central Delta.

9.2.2 Bay Region

The Montezuma Wetlands Project will have both beneficial and adverse cumulative impacts. Long-term cumulative benefits include the restoration of significant acreage of tidal marsh ecosystem, which could support increased wildlife and fish populations and diversity. Short-term and mid-term adverse cumulative effects include the loss of established seasonal wetlands, and potential loss of threatened and endangered species (salt marsh habitat mouse) within the reconstruction areas. More long-term cumulative adverse impacts would occur if the restoration to tidal marsh is not successful (for example, the design does not result in a successful, self-sustaining tidal march system, or appropriate vegetation establishment). In this case, the more significant adverse cumulative effect would be the potential release of contaminants to the region ecosystem and the long-term loss of substantial valuable ecological and functional marsh habitat.

The Contra Costa Water District Multi-Purpose Pipeline Project would have no significant and/or adverse long-term cumulative impacts to aquatic or terrestrial resources within the Bay Region. Potential adverse impacts from the project's pipeline route alternatives and the small additional pumping capacity on the Contra Costa Canal would be minor.

9.2.3 Sacramento River Region

Implementation of the American River Water Resource Investigation, the American River Watershed Project, and the EBMUD Supplemental Water Supply Project would result in cumulative adverse impacts to aquatic and terrestrial biological resources, water quality and circulation, and cultural resources. Cumulative impacts to recreation would also result from the two American River projects. Depending on the alternatives and project sub-components implemented, the recreation impacts could either be beneficial or adverse.

Creating new storage capacity and/or expanding existing storage under the American River Water Resource Investigation and the American River Watershed Project would have cumulative adverse impacts on vegetation (wetlands, riparian, and upland habitats) due to construction and inundation. Terrestrial wildlife and threatened and endangered species using this habitat would also be affected. This cumulative loss of habitat would be substantial without similar habitat replacement. The potential loss of elderberry shrubs and beetles would be included in the impacts to vegetation and a significant adverse cumulative impact. Proposed Sacramento River Flood Control System levee modifications along the Sacramento River and the lower American River would contribute to this loss. Changes in stream flows in the American River would also

change the hydrology and potential composition and diversity of the vegetation along the river.

Under some alternatives of the CVPIA project, restoration of a meander belt and other habitat restoration activities on the upper Sacramento River would benefit riparian habitat in the area.

Aquatic resources would be affected during construction and/or modification of storage facilities and by additive pumping of American River water. Stormwater runoff causing sediment transport and downstream siltation could potentially affect water quality and degrade aquatic resources. Cumulative adverse impacts to chinook salmon and steelhead trout could result from operation of the storage facilities by increasing the frequency-of-flow reductions during critical spawning and incubation periods. The new diversion of American River water would also add to cumulative fisheries impacts by increasing the potential for entrainment and mortality losses.

Reduced diversions to the Sacramento River as a result of the Trinity River Restoration Program could have impacts on flows in the Sacramento River. These impacts could include adverse effects on water quality, fisheries, aquatic and riparian habitat, and water supply and availability. Unless additional water releases are available from other sources, these diversions could affect the ability to meet CVPIA target flows.

The conditions for fisheries in the Sacramento and American rivers would generally improve with the CVPIA project as a result of increased flows and non-flow actions such as fish screen and fish passage improvements, habitat restoration, improved water quality, and predator control.

Cultural resources would be adversely affected by the construction and/or modification of reservoirs. Within the construction areas, cultural resource impacts can be mitigated; however, cultural resources located within the new or enlarged water areas would be lost and thus not amenable to mitigation. The loss of these sites would be a cumulative adverse impact to cultural resources within the Sacramento River Region.

The proposed increased storage and diversion incorporated within these three projects when combined with higher in-stream flow requirement in the lower American River could contribute to cumulative adverse impacts of future downstream water supply and demand.

Depending on the operation of storage reservoirs, recreation could be adversely affected by water levels and discharge/recharge cycles. New storage capacity would benefit recreation in the long term and have a cumulative beneficial impact on direct recreation activities and indirect activities by increasing water recreation opportunities within the region.

Increased diversion and storage would also have a cumulative adverse effect on river water quality and circulation. Circulation would be disrupted and changed permanently by new storage and further changed by modification of existing facilities and/or increased pumping. Circulation changes above and below these facilities could contribute to cumulative adverse impacts to aquatic resources and water quality. Water quality downstream of the storage sites would also be affected by operation (volume of water discharged and the method of operation). Depending on the season, water discharges could benefit water quality by increasing the concentration of dissolved oxygen and regulating temperature.

There are two additional projects within the Sacramento River Region which could contribute to cumulative effects: the Red Bluff Diversion Dam Fish Passage Program and the Hamilton City Pumping Plant Fish Screen Improvement Project. Both of these projects are expected to result in benefits to fisheries resources by reducing entrainment and mortality losses while maintaining water supplies.

9.2.4 San Joaquin River Region

The Pardee Reservoir Enlargement Project located within the San Joaquin River Region would have short-term and mid-term cumulative effects on water quality, fisheries resources, recreation, and

water supply reliability. To initiate and complete the construction, the reservoir would be drawn down, causing potential adverse cumulative water supply availability impacts downstream, water quality impacts due to sedimentation and restricted water control operation, and the loss of some recreational opportunities. Construction activities at the reservoir would directly impact vegetation and associated wildlife short term. Once modifications are completed, more long-term vegetation and wildlife adverse impacts would occur due to the flooding of the enlarged reservoir pool. Long-term potential benefits to recreation and fisheries resources within the reservoir itself would result after construction. Cultural resources would be cumulatively impacted by the loss of potentially sensitive sites within the reservoir inundation area. Potential long-term cumulative effects downstream would be beneficial to water supply reliability, water quality, and fisheries resources.

The Supplemental Water Supply Project proposed by EBMUD on the American River would also contribute to adverse cumulative long-term impacts within the San Joaquin River Region primarily associated with water quality and fisheries resources. These effects would be attributed to the altering of flows below Friant Dam. Adverse cumulative impacts to threatened and endangered species within the San Joaquin River Region as a result of the altered flows would potentially be associated with fisheries (the winter-run chinook salmon, the delta smelt, and the splittail). Other adverse cumulative impacts of the two EBMUD projects within the region include potential changes in wetland and riparian vegetation along the rivers and resulting changes to wildlife populations and diversity.

The Interim South Delta Project would have a beneficial cumulative impact on the San Joaquin River fall-run chinook salmon because the spring and fall barriers at the Head of Old River would reduce entrainment/predation loss of San Joaquin River salmon smolts at the Tracy and Harvey O. Banks pumping plant and improve dissolved oxygen levels in the San Joaquin River.

Special-status and other wildlife species in the San Joaquin River Region would benefit from the CVPIA project due to land fallowing and retirement, riparian restoration, increased spring flows, and refuge water supply increases for wetland habitat. The CVPIA land retirement program in the San Joaquin River Region, however, would have an adverse impact on agricultural land use by reducing the amount of available farmland.

Fisheries resources would benefit from the CVPIA by improved conditions along the lower San Joaquin River with respect to temperatures, proved habitat, reduced losses to diversion, and improved fish movement.

9.2.5 SWP and CVP Service Areas Outside the Central Valley

All of the projects analyzed for potential cumulative impacts which increase diversion or add substantially to upstream storage have the potential to contribute to adverse cumulative water supply availability and water quality impacts within the SWP and CVP Service Areas Outside the Central Valley. When combined with higher in-stream flow requirements and increased consumptive water use demands placed on water within the SWP and CVP service areas, the impacts on water supply availability may be significant. Potential water quality cumulative impacts would be adverse but not significant.

9.3 CUMULATIVE IMPACT MITIGATION STRATEGIES

Potential mitigation measures are still being identified by ongoing studies. In addition, there are a number of water management programs in place to address potential conflicts between agricultural and urban water use and ecosystem restoration activities. Many of the specific impacts will be identified in these studies and potential mitigation incorporated into the design and project specific environmental review conducted for each project. Some of the studies and management programs in place include: formation

of the federal/state Bay-Delta Advisory Council; the SWRCB Water Quality Control Plan; the formation of the Delta Protection Commission; The San Joaquin River Management Plan; the Sacramento River 1086 Plan; EPA's Comprehensive Conservation Management Plan for the Bay-Delta Estuary; the Striped Bass Recovery Plan; Native Fisheries Recovery Plan; Anadramous Fish Restoration Program; and the Interagency Ecological Program.

The mitigation strategies for potential adverse cumulative impacts due to the implementation and operation of the identified projects analyzed in this report generally consist of safeguards by law, regulations and water rights standards; contracts; physical measures; and studies and water management programs.

State and federal laws that provide safeguards include: Area of Origin Law; Delta Protection Act; California Environmental Quality Act; National Environmental Policy Act; National Fish and Wildlife Coordination Act; Clean Water Act; Central Valley Project Improvement Act; National Historic Preservation Act; Archaeological and Historical Preservation Act, Endangered Species Act; and provisions in congressional authorization of federal water projects.

General physical mitigation strategies to minimize, reduce, or eliminate potential significant cumulative fisheries and wildlife impacts include: adjustment of reservoir releases; installation of fish screens and return systems; habitat modification; fish stocking programs; purchase of replacement lands; capture and removal of threatened and endangered species; and replacement and/or re-establishment of critical habitat, riparian, wetland and upland habitat vegetation.

Specific mitigation measures for disturbance and loss of wildlife and vegetation from construction activities associated with pipeline, road, reservoir, and open canal project alternative components include the preparation and implementation of a construction mitigation plan. The project lead agency prepares the plan considering site-specific conditions. Construction mitigation plans are reviewed and approved by the USFWS and DFG prior to implementation. Measures included in the plans contain at a minimum:

- The use of silt fences, straw bales, or other erosion control devices to minimize sediment impacts to waters
- The use of setbacks and exclusion flagging in highly sensitive habitat areas and the establishment of construction equipment corridors
- Avoidance of material stockpiling in sensitive areas
- Retaining, stockpiling, and re-spreading of topsoil removed from pipeline corridors, canals, and other vegetated areas
- Revegetation and restoration with native plant species; conducting frequent on-site monitoring; avoiding to the extent practicable construction activities during the rainy season
- Watering of construction areas to reduce dust.

Specific mitigation to minimize impacts due to the reduction in populations of threatened and endangered species includes conducting plant and animal surveys in project areas before construction, and preparation and implementation of an operations mitigation plan. The DFG and the USFWS review and approve the mitigation plan prior to project site-specific permit approval. The operation mitigation plan includes measures that address the specific species and habitats potentially affected including:

- A survey to identify the size and distribution of the listed species populations, and use of the results to plan for avoidance or if possible relocation
- A program for compensation, which could include acquiring land supporting another population of the listed species, or the acquisition of lands bearing appropriate habitat to be used for relocation or restoration

- A description of a habitat improvement and monitoring program to ensure that habitat compensation goals are met

- Specification of funding sources for implementing and monitoring.

If actual "take" of listed species or designated critical habitat is involved, the lead agency will need to initiate formal consultation with the resource agencies and request approval of the mitigation plan from the USFWS and DFG as part of a Biological Opinion.

The potential loss of sensitive habitats and vegetation communities (Streamside Wetlands and Riparian Communities) and associated special-status plant and animal species would be mitigated by conducting surveys and delineating sensitive plant communities and habitats. Where avoidance would not be feasible, a mitigation plan would be prepared and implemented. The mitigation plan would conform with the USFWS policy for in-kind, offsite compensation and Region 1 policy goal of no net loss of wetlands. The mitigation plan would include a quantification of the acreage of habitat to be lost; a description of in-kind habitat compensation either through acquisition of lands for conservation or restoration at the appropriate replacement ratio; a description of a habitat improvement and monitoring program to ensure that habitat compensation goals are met; and a description of funding sources for mitigation, monitoring, and contingencies. The mitigation plan is reviewed and approved by the DFG and the USFWS prior to site-specific permit approval.

Potential impacts to local biodiversity within reservoirs because of reservoir drawdown could be mitigated by construction of small littoral dams within the perimeter of the drawdown zone, below the high-water line. The small areas of year-round inundation behind such dams would offer potential mitigation for fisheries, waterfowl and riparian-dependent wildlife, and general landscape diversity.

Potential mitigation to minimize impacts due to the reduction in streamflow downstream from reservoirs include preparation and implementation of a downstream mitigation plan. The plan would include provisions through streamflow management for maintaining downstream riparian vegetation, reducing stream bank incision, and maintaining adequate recharge for stream-associated wetlands such as sloughs. In addition, instream flow studies would be required to maintain the downstream fisheries in good condition. These studies would involve operation scenarios which would mimic natural conditions as closely as possible, and modeling to determine the required releases to maintain suitable temperatures for fisheries. Results of these studies would be used for scheduling downstream releases to benefit fisheries resources. Reservoir releases would also have to consider the mobilization and flushing of silt within the reservoir to maintain relatively silt-free gravel for spawning fisheries and to maintain channel morphology. When reservoirs limit the availability of spawning gravel, appropriate programs to restore suitable size spawning gravel would need to be initiated.

Impacts to fisheries resources from entrainment or impingement in water diversion structures can be minimized by designing and placing the intake structures to reduce the entrainment of fish, phytoplankton, and invertebrates. Diversion intake structure screens would meet the DFG's screening criteria. Mitigation measures to reduce impacts to fisheries resources due to inundation of riverine habitat from new reservoir construction or enlargement of existing reservoirs include evaluation by the lead agency of the quantity and quality of the habitat lost; development and implementation by the lead agency of a habitat improvement plan if the habitat provides critical habitat (for example, for spawning) or limits fish production; and development and implementation of a fisheries management plan in consultation with the DFG that addresses potential improvement and enhancement measures to offset the loss of habitat for native species.

Measures to mitigate cultural resource cumulative impacts include avoidance or removal of identified cultural resources where possible, and completing Phase 1 and 2 surveys of all potentially disturbed or areas proposed to be covered by reservoir construction and filling.

10 OTHER CEQA/NEPA TOPICS

10.1 GROWTH-INDUCING IMPACTS

Section 21100(b)(5) of CEQA requires that an EIR discuss the growth-inducing impacts of a proposed project. CEQA Guidelines Section 15126(g) clarifies this requirement, stating that an EIR must address "the ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly in the surrounding environment." In addition, under authority of NEPA, the CEQ NEPA Regulation require consideration of the potential indirect impacts of a proposed project within an EIS. Indirect impacts of an action include those that occur later in time or farther away in distance, but are still reasonably foreseeable (CEQ NEPA Regulation Section 1508.8(b)).

The CEQA Guidelines and the CEQ NEPA Regulation identify several ways in which a project could have growth-inducing impacts. In addition to the characteristics described above, projects that remove obstacles to population growth, and projects that encourage and facilitate other activities that are beyond those proposed as part of the project and that could affect the environment are considered growth-inducing (CEQA Guidelines Section 15126(g)).

The availability of adequate supplies of water is one of several potential obstacles to population growth, along with such things as: the availability of sewage treatment facilities; the availability of developable land; the types and availability of employment opportunities; housing costs and availability; commuting distances; cultural amenities; climate; and local government growth policies contained in general plans and zoning ordinances. Resource planners have long debated the role of water in population growth.

Section 1508.8(b) of the CEQ NEPA Regulations notes that indirect effects can include "growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystem."

Growth inducement may not be considered necessarily detrimental, beneficial, or of significance under CEQA. Induced growth is considered a significant impact only if it directly or indirectly affects the ability of agencies to provided needed public services, or if it can be demonstrated that the potential growth, in some other way, significantly affects the environment.

The growth-inducing impacts analysis is at the programmatic level (qualitative) and focuses on the major aspects of each of the three CALFED Program alternatives.

Analyses of environmental effects include a discussion of growth-inducing impacts and other effects related to changes in land use patterns, population density, or growth rate. The location, timing, and magnitude of economic and population growth within a region are determined by many interrelated economic, social, and political factors, including:

- Employment opportunities (both direct and indirect);
- Availability and cost of natural resources, including land, water, and energy;
- Availability and cost of housing;
- Adequacy of community infrastructure (such as transportation facilities, fire and police protection, schools, recreational facilities); and
- Local government policy concerning growth issues (such as zoning ordinances, general plans).

Region	Impacts
Delta Region	No substantial agricultural or urban population or economic growth trends are anticipated; however, the following factors may tend to enhance growth: • Improved water supply and quality • Reduced inundation threat • Potential increase in recreation The following may tend to inhibit growth: • Conversion of agricultural land to terrestrial habitat • Potential increase in the cost of agricultural production
Bay Region	No substantial population or economic growth
Sacramento River Region	Potential net loss in agricultural land would tend to be growth-inhibiting Other growth-related impacts similar to Delta Region
San Joaquin River Region	Potential net gain in agricultural land Potential net increase in urban population Economic growth
SWP and CVP Service Areas Outside the Central Valley	Increased water deliveries have the potential to enhance growth, particularly in urban areas of Southern California, although specific potential growth areas cannot be defined. Potential conversion of natural habitat to urban use

Table 10-1. Summary of Potentially Growth-Inducing Impacts

Since each of these variables influences growth, it is difficult to determine whether a change in one of them is sufficient to cause a significant change in community growth rates. Because minimal amounts of water are necessary to sustain life, water must be available if growth is to occur.

For the purposes of this Programmatic EIS/EIR the assumption is that the increased water supplies and improved supply reliability associated with the Program's alternatives will, along with the other factors mentioned above stimulate growth and remove barriers to growth, particularly in the SWP and CVP Service Areas Outside the Central Valley.

Changes in overall growth and growth patterns can be estimated at the programmatic level for the SWP and CVP service areas. Any differences beyond estimates provided in this programmatic EIS/EIR would be analyzed in future tiered CEQA/NEPA documents

Potentially growth-inducing impacts in each of the five regions considered are summarized in Table 10-1.

10.1.1 Potentially Significant Impacts

In general, it is unlikely that any of the CALFED Program alternatives would result in substantial population or economic growth in the Delta, Bay, or Sacramento River regions. Water supply and quality would be improved by the implementation of the CALFED Program. These improvements in water supply, reliability, and quality could induce urban growth, particularly in the SWP and CVP

Service Areas Outside the Central Valley. While this will benefit urban areas it will come at the expense of increased adverse impacts on habitat essential to support sensitive plant and animal species found in the service areas. Even though the exact location of the growth may never be possible to identify, the local land use plans in those areas describe where growth will occur and most have adopted land conservation plans that target protection of high quality habitat and restoration of degraded habitat to help recover listed species found within their land use planning jurisdictions. A discussion of the assumed growth inducing impacts is contained in the section discussing vegetation and wildlife impacts. These improvements could allow additional agricultural land to be developed and allow a shift to higher value crops. It is possible that there would be a net gain in agricultural land in the San Joaquin River Region and it is possible that some of the CALFED Program alternatives could result in urban population and economic growth in that region.

10.1.2 Mitigation Strategies

Because growth-inducing impacts would primarily result from improvements in water supplies, the mitigation measures for potentially growth-inducing impacts generally consist of safeguards by laws, regulations, and water rights standards; contracts; and studies and water management programs. State and federal laws that provide safeguards include: Area of Origin Law; Delta Protection Act; California Environmental Quality Act; National Environmental Policy Act; National Fish and Wildlife Coordination Act; Clean Water Act; Central Valley Project Improvement Act; National Historic Preservation Act; Archaeological and Historical Preservation Act; Endangered Species Act; and provisions in congressional authorization of federal water projects.

State and federal regulatory agencies administering the laws include the State Water Resources Control Board, Regional Water Quality Control Boards, the United States Bureau of Reclamation, Environmental Protection Agency, the United States Army Corps of Engineers, United States Fish and Wildlife Service, and the National Marine Fisheries Service.

Contracts are negotiated between project operators and various interests to provide reliable water supplies and quantities while maintaining water quality, terrestrial wildlife and habitat, and fisheries resources. The Bureau of Reclamation and the California Department of Water Resources negotiate and execute contracts with various local and regional water agencies and utility districts that include specific measures to protect natural resources.

There are a number of water management programs in place to address potential conflicts between agricultural and urban water use and ecosystem restoration activities.

10.2 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

This section provides a resource-specific summary of the balance between the short-term uses of the project areas and the maintenance and enhancement of long-term productivity in those areas.

10.2.1 Short-Term Uses Versus Long-Term Productivity

Alternatives 2 and 3 have the potential for greater short-term impacts than Alternative 1 due to their additional conveyance and storage features. However, these alternatives could also result in greater long-term productivity than Alternative 1.

Adverse short-term impacts, primarily related to construction activities, were identified for most resources. However, overall benefits to long-term productivity generally outweigh the short-term adverse impacts.

The short-term, construction-related impacts would be small and would cease after construction was complete. Specific resources that could be affected include: surface water, groundwater, geology and soils, noise, transportation, air quality, fisheries and aquatic ecosystems, vegetation and wildlife, regional economics, agricultural resources, urban resources, recreational resources, flood control resources, cultural resources, power production and energy, public health and environmental hazards, visual resources, and environmental justice. Where possible, avoidance and mitigation measures would be implemented as a standard course of action to lesson impacts on these resources.

There would be adverse long-term impacts to geology and soils, agricultural resources, and cultural resources. There could be many long-term benefits.

Short-term uses versus long-term productivity for each resource considered are summarized in Table 10-2.

10.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible impacts are those which cause, through direct or indirect effects, use or consumption of resources so that they cannot be restored or returned to the original condition, despite mitigation efforts. If unavoidable, the potentially irreversible impacts are documented in this report. An irretrievable impact or commitment of resources occurs when a resource is removed or consumed. These types of impacts are evaluated to assure that consumption is justified.

The irreversible and irretrievable impacts for Alternative 1 would apply to all alternatives although additional conveyance projects associated with Alternatives 2 and 3 would increase some impacts.

Irreversible commitments of resources could result from the implementation of the Ecosystem Restoration Program and the Levee System Integrity Program, and the addition of storage and conveyance facilities. These resources could include: construction materials; labor; energy needed for construction, operation, and maintenance; and land conversion of agricultural, open space, and natural environments.

Specific resources that could be irreversibly and irretrievable committed as a result of the CALFED Program after all normal mitigation action efforts are exhausted could include: geology and soils, vegetation and wildlife, regional economics, agricultural resources, cultural resources, power production and energy, and visual resources. Where possible, avoidance and mitigation measures would be implemented as a standard course of action to lesson impacts on these resources.

The irreversible and irretrievable impacts associated with the proposed alternatives for applicable resources are summarized in Table 10-3.

Surface Water Resources	Short-term disruption in supplies, and short-term adverse impacts to water quality during construction Long-term improvement in availability and quality
Groundwater Resources	No short- or long-term impacts if recharge rate is not exceeded
Geology and Soils	Short- and long-term conversion of agricultural land and loss of soils Potential for new agricultural land and higher value crops
Noise	Short-term increase in noise levels during construction
Transportation	Short-term disruption in service due to road closure and traffic diversion Long-term creation of new roads
Air Quality	Short-term adverse impacts during construction
Fisheries and Aquatic Ecosystems	Short-term loss of habitat, entrainment, and spawning Long-term habitat restoration and improvement
Vegetation and Wildlife	Short-term loss of habitat Long-term habitat restoration and improvement, some loss of vegetation and wildlife, including special-status species
Agricultural Resources	Short- and long-term loss of agricultural productivity
Urban Resources	Short-term significant costs Long-term gains in productivity
Recreational Resources	Short-term loss of recreational facilities and areas Long-term gains in recreation opportunities
Flood Control Resources	Short-term (but mitigable) impairment Long-term improvement in flood control
Power Production and Energy	Short-term increase in energy use Long-term savings in energy use
Regional Economics	Short-term and long-term loss of agricultural productivity due to land conversion Long-term gains in productivity due to water supply reliability
Cultural Resources	Short- and long-term loss of cultural resources
Public Health and Environmental Hazards	Short-term (but mitigable) increase in hazards during construction Long-term improvement in public safety from flooding, potential long-term adverse health impacts from standing water and mosquitos in new habitats
Visual Resources	Short-term adverse impacts during construction Long-term beneficial impacts from restored habitat, but long-term adverse impacts from new structures
Environmental Justice	Short-term adverse impacts due to displacement of agricultural workers Long-term increase in agricultural and possible recreation employment
Indian Trust Assets	No determination can be made at this time

Table 10-2. Summary of Potential Short-Term Uses Versus Long-Term Productivity

Surface Water Resources	No irreversible or irretrievable impacts
Groundwater Resources	No irreversible or irretrievable impacts
Geology and Soils	Loss of agricultural soils and farmland
Noise	No irreversible or irretrievable impacts
Transportation	No irreversible or irretrievable impacts
Air Quality	No irreversible or irretrievable impacts
Fisheries and Aquatic Ecosystems	No irreversible or irretrievable impacts
Vegetation and Wildlife	Some loss of vegetation and wildlife, including special-status species
Agricultural Resources	Loss of agricultural production from inundation or construction
Urban Resources	No irreversible or irretrievable impacts
Recreational Resources	No irreversible or irretrievable impacts
Flood Control Resources	No irreversible or irretrievable impacts
Power Production and Energy	Increased demand on utility infrastructure and capacity
Regional Economics	Changes in agricultural production due to land conversion could adversely affect regional economy
Cultural Resources	Loss of cultural resources from inundation, construction, and habitat restoration
Public Health and Environmental Hazards	No irreversible or irretrievable impacts
Visual Resources	Restored habitat and new construction will permanently affect visual resources
Environmental Justice	No irreversible or irretrievable impacts
Indian Trust Assets	No determination can be made at this time

Table 10-3. Summary of Potentially Irreversible and Irretrievable Commitments of Resources

11 COMPLIANCE WITH APPLICABLE LAWS, POLICIES AND PLANS, AND REGULATORY FRAMEWORK

11.1 INTRODUCTION

This chapter is intended to give the reader an understanding of key steps, requirements, and decision points in the program level approval process for CALFED. It is also intended to serve as a reference for project planning, permit processing, and environmental documentation requirements which would occur in Phase III. It is necessarily general in nature and does not discuss all exceptions and variations to laws and regulations. Lastly, it identifies the regulatory framework that is part of the affected environment.

11.2 ENVIRONMENTAL COMPLIANCE AT THE PROGRAMMATIC LEVEL

11.2.1 National Environmental Policy Act/California Environmental Quality Act

The National Environmental Policy Act (NEPA) requires that an environmental impact statement (EIS) be prepared for all major federal actions. Similarly, the California Environmental Quality Act (CEQA) requires that state agencies prepare an environmental impact report (EIR). The draft Programmatic EIS/EIR is a joint federal and state document which was prepared pursuant to NEPA and CEQA and their implementing regulations.

The CALFED Program is a joint effort between federal and state government agencies. Therefore, the environmental document which has been prepared is a joint federal/state Programmatic EIS/EIR. The Programmatic EIS/EIR describes the alternatives and their potential impacts at a level of detail appropriate to a long-term planning document. The Programmatic EIS/EIR generally evaluates Program actions, not site-specific implementing actions, and therefore focuses on cumulative and long-term impacts. The document contains information on the no action alternative, an array of program alternatives, mitigation strategies, and potential benefits and adverse impacts resulting from the implementation of the proposed action(s). Decision-makers must consider these factors prior to undertaking proposed actions. In addition, the public and all interested parties are given an opportunity to comment. A detailed discussion of the purpose and organization of this document can be found in Chapter 1. A discussion of past and future CALFED public involvement efforts is in Chapter 12 of this document.

11.2.2 Federal/State Endangered Species Acts

CALFED has begun developing a process to comply with the California Endangered Species Act (CESA) and the federal Endangered Species Act of 1973, as amended (ESA), and will continue to develop that process during Phase II of the program. As a foundation for implementing the California and federal ESA compliance process, CALFED is developing a comprehensive conservation strategy. The conservation strategy is intended to integrate CALFED enhancement and mitigation actions to provide for improved species and habitat protection, increase assurances of overall program implementation, and streamline California and federal ESA take authorization for approved actions.

The regulatory mechanisms that will be used to authorize incidental take under the federal ESA include formal consultation pursuant to Section 7;

permit issuance pursuant to Section 10(a)(1)(B), which includes the development of one or more habitat conservation plans (HCP); and/or a special rule for threatened species under Section 4(d). The regulatory mechanisms which will be used to authorize take under CESA include Section 2835 of the California Fish and Game Code (the Natural Community Conservation Planning Act), which includes the development of a natural community conservation plan (NCCP); Section 2081 of the California Fish and Game Code; and/or Section 2090 or successor sections of the California Fish and Game Code. The conservation strategy will provide the basis for any and all of the above regulatory mechanisms and will remain constant regardless of which mechanism is used to authorize take (i.e. the strategy will specify the same measures whether take is authorized through Section 7, 10, or 4(d) of the ESA and Section 2835, 2081, or 2090 or successor sections of the CESA).

The conservation strategy will address all federally and state listed, proposed, and candidate species that may be affected by the CALFED Program; other species identified by CALFED that may be affected by the program and for which adequate information is available also will be addressed in the strategy. The term "covered species" is used to refer to all of the species that will be addressed by the conservation strategy. CALFED is currently developing the list of covered species. The strategy will address the effects of CALFED Program actions (beneficial, adverse, and neutral) on the covered species and the minimization and mitigation measures needed to offset the anticipated adverse impacts and allow for species recovery. The conservation strategy will also address the conservation and protection of habitats affected by the CALFED Program. In addition, the conservation strategy will include a monitoring and reporting program, will specify a process for adaptive management, and will address funding for implementation of the strategy and to address unforeseen circumstances. The conservation strategy, in the context of the CALFED comprehensive long-term plan, will allow for the recovery of listed species and the conservation of currently unlisted species.

Take authorization would be granted, to the appropriate implementing entity or individual, when adequate information is available to assess project effects on listed or other covered species and a determination is made that the appropriate findings or requirements under the California and/or federal ESA have been made or met. The conservation strategy will outline the criteria and process for determining the appropriate regulatory mechanism for implementing the strategy and authorizing incidental take associated with specific program actions. As noted above, federal authorization of incidental take associated with an action may be through formal consultation (Section 7), an incidental take permit and HCP (Section 10), or a special rule for threatened species (Section 4(d)); state authorization of incidental take may occur through an NCCP (Section 2835), an incidental take permit (Section 2081), or formal consultation (Section 2090).

The CALFED Bay-Delta Program is being conducted in a three-phase planning effort. Phase II will conclude with the selection of a preferred alternative, the development of an implementation strategy and conservation strategy, and the completion of a final programmatic environmental impact statement and report. Commitment to implementing the conservation strategy will be embodied in an appropriate mechanism, such as an implementing agreement.

While implementation of some of the program actions may begin during Phase II, implementation of many of the program actions will take place during Phase III of the Program. This period will include any additional site-specific environmental review and necessary permitting. Implementation is anticipated to occur over a period of years primarily because of the size and complexity of the alternatives in solving the problems. Much of the challenge will be to develop an effective implementation strategy that acknowledges this long implementation period and finds a way to keep participants committed to

the successful completion of all phases of implementation and all components of the program.

Based on what CALFED expects to complete during Phase II, actions that are likely to have completed California and federal ESA regulatory compliance and be permitted or conditionally permitted by the end of Phase II include some ecosystem restoration program plan (ERPP) actions, some levee integrity actions, some water quality actions, some conveyance actions within the Delta, and "interim" operating procedures (i.e., covering the transition from existing conditions through completion of the CALFED program) for water storage and conveyance, including the State Water Project and Central Valley Project.

11.2.3 Fish and Wildlife Coordination Act

Under subsection 2(a) of the Fish and Wildlife Coordination Act (FWCA), federal agencies are responsible for consulting with the USFWS for the purpose of conservation of wildlife resources by preventing loss and damage as well as providing for their development and improvement in connection with water-resource projects. Also within subsection 2(b) of the FWCA, the USFWS is required to report its recommendations for wildlife conservation and development and the results expected, and to describe the damage to wildlife attributable to the project and the measures proposed for mitigating or compensating for these damages.

Because of the nature of the draft Programmatic EIS/EIR, many of the specific impact analyses typical of FWCA reports will not be conducted at this time. Instead, these analyses will be provided for separate elements of the CALFED Program as they are being planned. For the programmatic FWCA report, the USFWS will focus on providing the public with their overall assessment of the effects of the CALFED Program and alternatives on fish and wildlife resources, providing recommendations for mitigation of adverse effects (where appropriate), and providing recommendations for implementing future (Phase III and beyond) CALFED Program actions.

The USFWS will complete this programmatic FWCA analysis and report its findings and recommendations prior to completion of a final Programmatic EIS/EIR for the CALFED Program. That report will become a part of the final Programmatic EIS/EIR.

11.2.4 Compliance with 404(b)(1) Guidelines

Section 404 of the Clean Water Act requires that a project proponent obtain a permit from the Corps of Engineers for activities that involve the discharge of dredged or fill material into waters of the United States (33 USC 1344). Section 404 requires that the issuance of a permit by the Corps comply with EPA's Section 404(b)(1) Guidelines (Guidelines). These guidelines provide direction and guidance for implementing Section 404.

EPA's Guidelines (40 CFR 230 et seq.), the Corp's regulatory guidelines (33 CFR 320 et seq.), and the National Environmental Policy Act (NEPA) and NEPA Guidelines (40 FR 1500 et seq.) provide part of the substantive environmental criteria and procedural framework used to evaluate applications for Corps permits for the discharge of dredged or fill material into waters of the United States, including wetlands and other designated special aquatic sites. Under the Corp's evaluation, an analysis of practicable alternatives is a screening mechanism used to determine the appropriateness of permitting a discharge. The Corp's evaluation also includes an analysis of compliance with other requirements of the 404(b)(1) guidelines, a public interest review and evaluation of potential impacts on the environment in compliance with NEPA.

According to EPA guidelines, an alternative is considered practicable if it is available and can be implemented given considerations of cost,

existing technology, and logistics in light of overall project purposes. Practicable alternatives may include siting a project in areas not owned by an applicant but that could be reasonably obtained by the project applicant to achieve the basic project purpose (40 CFR 230.10[a][2]).

Many features of CALFED have the potential to require the discharge of dredged or fill material into waters of the United States, which also may be designated special aquatic sites. The ERP contains many such actions, including the restoration of wetlands and channel islands, construction of fish barriers and fish screens, and restoration of riparian habitat. The Levee System Integrity Program contains actions, such as the creation of setback levees, improvements to levee maintenance, and the flooding of islands, that could require a Corps permit. The water supply reliability components contain actions, such as the creation of additional water storage capacity and the construction of conveyance facilities in the Delta. The Water Quality Program contains actions, such as the construction of water quality barriers, that would require a Corps permit. Section 404 Permits will be required during Phase III.

A 404 Permit is not required for Phase II of the CALFED process because selection of the Preferred Alternative will not authorize implementation of the projects composing the Preferred Alternative and therefore will not involve the discharge of materials into the waters of the United States. Nevertheless, the alternatives under consideration in the CALFED process are being analyzed in the light of the requirements of the 404(b)(1) guidelines so that when the Corps is required to determine whether particular Phase III projects comply with the 404(b)(1) guidelines, it will have the benefit of an analysis as to the consistency of the CALFED Preferred Alternative with the 404(b)(1) guidelines at a programmatic level.

During Phase I of this process, the problems of the Bay-Delta were identified, objectives were defined, a comprehensive list of actions for achieving the objectives were compiled, and preliminary alternatives were assembled. The remainder of Phase I consisted of an iterative process of analyzing and screening alternatives, leading to the selection of a Preferred Alternative. The initial screening of alternatives, beginning with 100 and selecting 10, was principally an effort to combine alternatives so that each, in keeping with the CALFED solution principles, provided balanced benefits to each to the problem areas. In screening from 10 to three alternatives, some were removed from further consideration; others were not eliminated, but became variations of the three main conveyance concepts: existing system conveyance, modified through-Delta conveyance, and dual-Delta conveyance (a combination of through-Delta and isolated conveyance). These three alternatives, and 12 variations associated with them, were carried forward for further refinement in Phase II. In Phase II, the three alternatives are being subjected to further analysis, resulting in further refinements, and will result in the eventual selection of the Preferred Alternative.

This process is consistent with the Section 404(b)(1) guidelines in that the screening of alternatives is intended to lead to the selection of the least environmentally damaging practicable alternative. Implementation of Phase III actions involving the discharge of dredged or fill material into waters of the United States may require site-specific documentation that specific proposals comply with EPA's Section 404(b)(1) guidelines.

This discussion cannot be fully formed until the selection of a preferred alternative. A program-level discussion of Section 404(b)(1) compliance will be made a part of the final Programmatic EIS/EIR.

11.2.5 The Coastal Zone Management Act

The Coastal Zone Management Act of 1972 (CZMA) requires federal agencies to preserve,

protect, and, where possible, restore and enhance the resources of the coastal zone (16 USC 1451 et seq.). Coastal states must develop coastal zone management programs to be reviewed and approved by the Secretary of Commerce through the National Oceanic and Atmospheric Administration (NOAA). Federal agencies are required to certify that any proposed activities within or affecting the coastal zone are consistent with the State of California program. The state notifies the federal agencies of its concurrence with or objection to the certification. If the state finds that the proposed activity is inconsistent with its program, the federal agencies must obtain an override from the Secretary of Commerce before action can commence.

San Francisco Bay Conservation and Development Commission (BCDC) oversees the San Francisco Bay segment of the coastal zone management program and has permit jurisdiction over projects at any location within 100 feet inland of the highest tidal action around San Francisco and Suisun bays. It has jurisdiction over projects within certain waterways up to the legally defined Sacramento-San Joaquin Delta (east of Chipps Island) that empty into the Bay and within specific saltponds and managed wetlands. In addition, BCDC has direct permit authority over all activities and land uses defined in the Suisun Marsh Preservation Act, specifically projects within the "primary management area," which includes all tidal waters and marshes, managed wetlands, and lowland grasslands. Any person or public agency proposing to deposit fill, extract materials, or change the use of water, land, or structures in or around San Francisco or Suisun bays must obtain a development permit from BCDC or, if in or around Suisun Marsh, a marsh development permit from BCDC.

For Phase II, CALFED will prepare a Programmatic Coastal Zone Management Act Consistency Determination for the CALFED Bay-Delta Program, which documents the possible effects of the Preferred Alternative on coastal resources and the actions that CALFED will take to ensure that implementation of the Preferred Alternative is carried out in a manner consistent, to the maximum extent practicable, with CZMA and the Coastal Act. This document will be presented to BCDC after selection of the Preferred Alternative for its concurrence and will be part of the final Programmatic EIS/EIR.

11.2.6 The National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) requires federal agencies and other entities spending federal funds to take into account the effect of an undertaking on historic properties. Regulations outline procedures to allow the Advisory Council on Historic Preservation an opportunity to comment on the effect the action will have upon historic properties. NHPA regulations require that a federal agency take the lead in complying with Section 106. In addition, CALFED has coordinated with the State Historic Preservation Office (SHPO).

The approach taken to comply with Section 106 of the NHPA for the CALFED Programmatic EIS/EIR is two-fold. The first consists of a Class I overview of cultural resources in the study area and an evaluation of the consequences attributable to each programmatic alternative. This information is presented in the Cultural Resource supporting document of the Programmatic EIS/EIR. In the second step, federal agencies will follow the procedures from 36CFR800 when they implement specific actions stemming from the selected program alternative. A complete discussion of NHPA can be found in Chapter 8 of the Programmatic EIS/EIR as well as the Cultural Resources Technical Report.

11.2.7 Memorandum on Farmland Preservation and the Farmland Protection Policy Act

The Farmland Protection Policy Act of 1981 (FPPA) and Memoranda on Farmland

Preservation, dated August 30, 1976, and August 11, 1980, from the U.S. Council on Environmental Quality to heads of agencies require federal agencies preparing EISs to include assessments of the effects of proposed projects on prime and unique farmlands. Before taking any action that would result in the conversion of designated prime or unique farmland for nonagricultural purposes, the federal agencies must examine the potential impacts of the proposed action and, if there are adverse effects on farmland preservation, consider alternatives to lessen those effects. Federal agencies must also ensure that their programs, to the extent practicable, are compatible with state, local, and private programs for the protection of farmlands. The Natural Resources Conservation Service (NRCS) is the federal agency responsible for ensuring that these laws and policies are followed.

An analysis of the impacts of the Program alternatives on prime and unique farmlands is provided in Chapter 5 and Chapter 8 of the draft Programmatic EIS/EIR under Agricultural Resources and in the Agricultural Resources supporting document.

11.2.8 The Federal Agriculture Improvement and Reform Act of 1996 and 1985 Food Security Act

The Federal Agriculture Improvement and Reform Act of 1996, also known as the 1996 Farm Bill, was signed into law in April 1996. Title III of the act includes conservation provisions designed to provide landowners with a variety of incentives programs and technical assistance for incorporating sound conservation practices into farming, grazing, and livestock operations. The 1996 Farm Bill replaces and incorporates portions of previous farm bills, including the Food Security Act of 1985 and the 1990 Farm Bill.

Under Title III, the Wetlands Reserve Program and the Conservation Reserve Program of the Food Security Act of 1985 are extended through year 2002. Changes in the programs, addressed in previous farm bills, provide landowners with more options for protecting wetlands and highly erodible lands. The wetland conservation provisions were modified to provide farmers with more flexibility to meet wetland conservation compliance requirements. Changes include expanding areas where mitigation can be used, allowing mitigation by restoration, enhancement, or creation, and changing the abandonment clause. Also addressed under Title III is a new Wildlife Habitat Incentives Program to help landowners improve wildlife habitat on private land. A Flood Risk Reduction Program was established to provide incentives to move farming operations from frequently flooded land. NRCS is the federal agency responsible for implementing the conservation provisions of the 1996 Farm Bill.

The analysis of the effects of the CALFED alternatives on agriculture was coordinated with NRCS and was performed in compliance with FPPA. A full discussion can be found in Chapter 8 of the Programmatic EIS/EIR as well as the Agricultural Resources supporting document.

11.2.9 Executive Order 11988 (Floodplain Management)

Executive Order 11988 is a flood-hazard policy for federal agencies. It requires that all federal agencies take action to reduce the risk of flood loss, to restore and preserve the natural and beneficial values served by floodplains, and to minimize the impacts of floods on human safety, health, and welfare.

A description of the effects of the alternatives on flooding and programmatic measures to mitigate any impacts is contained in Chapter 8 of the Programmatic EIS/EIR under "Flood Control Resources" and in the Flood Control Systems supporting document.

11.2.10 Executive Order 11990 (Protection of Wetlands)

Executive Order 11990 is an overall wetlands policy for all agencies managing federal lands, sponsoring federal projects, or providing federal funds to state or local projects. It requires federal agencies to follow avoidance, mitigation, and preservation procedures with public input before proposing new construction in wetlands. When federal lands are proposed for lease or sale to nonfederal parties, Executive Order 11990 requires that restrictions be placed in the lease or conveyance to protect and enhance the wetlands on the property. Executive Order 11990 can restrict the sale of federal lands containing wetlands; however, it does not apply to nonfederal projects where federal involvement is limited to the exercise of discretionary authority (other than funding).

The discussion of wetlands can be found in Chapters 6, 7, and 8 of the Programmatic EIS/EIR as well as the Ecosystem Restoration Program (ERP) Appendix and Vegetation and Wildlife supporting document.

11.2.11 Executive Order 12898 (Environmental Justice)

Executive Order 12898 requires federal agencies to identify and address disproportionately high and adverse human health and environmental effects of federal programs, policies, and activities on minority and low-income populations. Federal agencies are directed to ensure that federal programs or activities do not result, either directly or indirectly, in discrimination on the basis of race, color, or national origin. Federal agencies are required to provide opportunities for input in the NEPA process by affected communities and to evaluate significant and adverse environmental effects of proposed federal actions on minority and low-income communities during preparation of federal environmental documents. If a proposed federal action will not result in significant adverse impacts on minority and low-income populations, the environmental document must describe how Executive Order 12898 was addressed during the NEPA process.

Chapter 8 and the Agricultural Resources, Urban Resources, and Recreational Resources supporting document, describe the effects of the Program alternatives on minority and low-income populations. Besides the general outreach opportunities described in the overall public involvement plan, CALFED also developed a separate document detailing plans for multicultural public outreach. The plan's components include one-on-one outreach with a variety of ethnic community leaders throughout the state, a media relations campaign focusing on ethnic media and identification of speaking opportunities including public forums to be hosted by CALFED and various community-based organizations. Chapter 12 of the Programmatic EIS/EIR and the Public Involvement Plan describe the public involvement process undertaken by CALFED, including the opportunities for minority and low-income communities to provide input on the preparation of the Programmatic EIS/EIR.

Discussions of affects on the human population can be found in Chapter 8 of the Programmatic EIS/EIR and the Urban Resources, Agricultural Resources, and Regional Economics supporting documents.

11.2.12 Federal Clean Air Act

The purpose of the Clean Air Act (CAA) is to protect and enhance the quality of the nation's air resources so as to promote the public health and welfare and the productive capacity of its population. The CAA requires that any federal action be evaluated to determine its potential impact on the quality of the air in the project region. Specifically, the federal agency must make a conformity determination. The state of California has a corresponding law which must be considered during the EIR process. During Phase III of the CALFED Program, project proponents will be required to coordinate with the appropriate air quality management district as well as USEPA

to determine conformity with the Federal Implementation Plan (FIP) and State Implementation Plan (SIP).

Air Quality. Pursuant to the requirements of Section 176 of the Clean Air Act [42 U.S.C. Section 7506(c)], federal agencies are prohibited from engaging in or supporting in any way an action or activity that does not conform to an applicable state implementation plan. Conformity to an implementation plan means conformity to an implementation plan's purpose of eliminating or reducing the severity and number of violations of the national ambient air quality standards and achieving expeditious attainment of such standards. EPA has promulgated conformity regulations (codified in 40 CFR. Section 93.150 et seq.) A discussion of the applicability of conformity requirements for the CALFED Program Phase II and subsequent, tiered actions will be provided in the final Programmatic EIS/EIR.

The Programmatic EIS/EIR does discuss the potential impacts of the CALFED alternatives at a programmatic level of detail. The discussion of potential air quality impacts can be found in Chapter 6 of the Programmatic EIS/EIR.

11.2.13 Climate Change

The Federal Government recognizes that global climate change is a serious environmental concern which, given the current state of scientific knowledge, must be viewed under NEPA as a reasonably foreseeable impact of continued emissions and changes in sinks of greenhouse gases. Thus federal agencies must analyze the intent to which both their proposed and ongoing programs or other activities may influence such emissions and sinks, thereby contributing to, or reducing, the problems of global warming. Such analyses can best be done in the context of NEPA and should look at how federal actions may affect global climate change and, to the extent possible given the current state of scientific knowledge, how federal actions may be affected by global climate change.

The CALFED Bay-Delta Program is proposing significant investments to improve water quality, ecosystem quality, water supply reliability, and levee system integrity. The durability of the Program could be adversely impacted by future climate changes. Likewise, construction and operation of the Program would contribute somewhat to production of greenhouse gases that influence global climate change.

The geologic record shows evidence of past substantial changes in global and regional climates with the resultant marks from flooding and droughts. Sea level changes are obviously directly related to extremes in climate change. For example, sea levels were 2 to 6 meters higher than present levels during the last interglacial period of 125,000 years ago, and approximately 120 meters below present levels during the last Ice Age, 20,000 years ago. Sea levels have increased by 10 to 25 centimeters over the last century. Considering this wide range of sea level fluctuation, the Delta with sea levels near current levels, has likely existed for only small portions of the geologic history.

Future sea level changes are difficult to estimate because not enough is known about how the ice sheets in Greenland and Antarctica will react to global warming, and how much global warming may occur; warming may cause not only melting of ice sheets and land-based glaciers, but some thermal expansion of the sea water itself. If global warming causes increased precipitation at very high latitudes and resultant storage of water in the ice sheets, sea level could actually decrease.

Estimates of current sea level rise in the neighborhood of 1.5 millimeters per year is typical in the literature. One study estimates that global warming may cause further rise of about 18 centimeters (0.7 foot) by the year 2030. Also, if current trends in greenhouse gas emissions continue, the study estimates the rise could amount to 1 meter (3.3 feet) above current levels by the year 2100. A similar evaluation by the U.S. Environmental Protection Agency estimates that sea levels may rise globally approximately 20

inches (range of 6 to 38 inches) by the year 2100 and average global temperatures could increase by 2 degrees Celsius (range of 1 to 3.5 degrees Celsius). Each 1 degree Celsius of warming will shift temperature zones by about 100 miles northward (or 500 feet up in elevation). This shift in temperature could affect the distribution of species within the Bay-Delta system and the effectiveness of habitat restoration included in the Program. Considering the potential 1 to 3.5 degree Celsius increase in global temperatures by the year 2100, the greenhouse gases generated by the Program would make an infinitesimal contribution to the temperature rise compared with those generated on the global scale. However, the Program would be a contributor to the cumulative impacts of the potential temperature change.

Rising sea levels could have significant adverse impacts on the Delta system (including habitat, water supply, and Delta agriculture) if levees are overtopped or if substantial future investments are required to prevent overtopping. Higher sea levels would increase salinity levels throughout the Delta and for many miles inland. This would alter the effectiveness of Program habitats and likely change the entire ecosystem of the Delta. Water diversions dependent on taking water from the Delta channels would likely need to be abandoned and moved inland to areas of lowered salinity. While these changes are potentially significant over the long term (hundreds or thousands of years), they are unlikely to significantly alter Program facilities or operations within the foreseeable future (20 to 50 years).

The change in temperatures could result in more variability in precipitation and runoff from year to year and season to season. Higher flooding could become more frequent, increasing competition for remaining scarce water supplies. EPA estimates that California will experience an increase in winter runoff, a decrease in spring and summer runoff with resultant decrease in water supply and reliability in the Central Valley Basin.

11.2.14 State, Regional, and Local Plan Consistency

Without specific actions, a determination of consistency with state, regional, or local plans is not possible. Coordination will consist primarily of circulating the Programmatic EIS/EIR to recognized state and local clearinghouses, as well as to federal, state, and local elected representatives for review and comment, as per Executive Order 12372. In order to fully comply with NEPA and CEQA, the CALFED Program will coordinate with appropriate state and local jurisdictions within the study area during Phase III.

11.3 REGULATORY FRAMEWORK

Numerous existing laws and regulations affect the existing environment in California, and must be considered in assessing the potential for future actions. The regulatory and legal requirements applicable to CALFED follow. These are provided here rather than with the various resource descriptions to provide a complete picture of the laws and regulations in one place as well as to avoid repetition.

11.3.1 Delta Protection Commission

The Delta Protection Commission (DPC) is a state regional planning agency with authority over a 450,000 acre portion of the Legal Delta. The authorizing legislation was passed in 1992 (PRC Section 29700 et seq.) and the commission started meeting in January 1993. The DPC was charged with preparing a regional land use and resources management plan for the Primary Zone of the Delta to protect and enhance the three existing land uses: agriculture, wildlife habitat, and recreation. The plan was adopted in February 1995. Local governments are required to ensure that their general plans are in conformance with the regional plan; local general plan amendments were completed in March 1997. The DPC has

appeal authority over these local government amendments. The 19 member DPC includes six directors of state agencies, five county supervisors, three city council members, and five reclamation district representatives. The DPC is slated for completion on January 1, 1999.

11.3.2 The Delta Protection Act of 1959

The Delta Protection Act of 1959 requires adequate water supplies for multiple uses (for example, agriculture, industry, urban, and recreation) within the Delta and for export. Since the law was passed, various water quality and flow objectives have been established by the SWRCB and the Central Valley Regional Water Quality Control Board (CVRWQCB). These objectives are designed to ensure that the amount and quality of water in the Delta is sufficient to satisfy multiple uses. For example, water quality objectives require limiting Delta water supply operations, particularly the SWP and CVP, that affect the freshwater-saltwater balance in the Delta.

11.3.3 Porter-Cologne Act

In 1967, the Porter-Cologne Act established the SWRCB and nine regional boards as the state agencies with primary authority over the regulation of water quality and allocation of appropriative surface water rights in California. The Porter-Cologne Act is the primary state water quality legislation administered by SWRCB and provides the authority to establish water quality control plans that are reviewed and revised periodically, as well as statewide plans. The nine regional water quality control boards (RWQCBs) implement SWRCB policies and procedures throughout the state. Water quality control plans, also known as basin plans, designate beneficial uses for specific surface water and groundwater resources and establish water quality objectives to protect those uses. RWQCBs issue waste discharge requirements for the major point-source waste dischargers, such as municipal wastewater treatment plants and industrial facilities. In acting on water rights applications, the SWRCB may establish terms and conditions in a permit to carry out water quality control plans.

The SWRCB recently enacted the Enclosed Bays and Estuary Plan and the Inland Surface Waters Plan that set numeric and narrative criteria for toxic metals and organic compounds. Litigation brought against the plans in 1994 resulted in their revocation, and they are not being considered for readoption. The EPA is promulgating numeric objectives for metals and organic compounds through the California Toxics Rule. The SWRCB is developing an implementation policy to support this rule. The SWRCB and the RWQCBs also implement sections of the federal Clean Water Act (CWA), administered by the EPA, including the National Pollutant Discharge Elimination System (NPDES) permitting process for point and non-point sources of certain waste discharges.

Both numerical and narrative water quality objectives are established to protect beneficial uses. Water quality objectives are established to protect beneficial uses, including human health and aquatic life. Once approved by the EPA, the objectives become enforceable under the CWA.

The Delta is under the jurisdiction of the Central Valley (Region 5) and the San Francisco Bay (Region 2) RWQCBs, which implement policies and procedures adopted under their respective quality control plans. The most recent basin plan was adopted in 1995 (California Regional Water Quality Control Board 1995). Amendments to the basin plan for the control of agricultural subsurface drainage and lower San Joaquin River water quality objectives are currently being considered for adoption (California Regional Water Quality Control Board 1996).

11.3.4 D-1485 and the 1978 Water Quality Control Plan

In 1978, SWRCB adopted the Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh (1978 Delta Plan). At the

same time, SWRCB adopted Water Right Decision D-1485, replacing the previous Water Right Decision D-1379, which replaced D-1275. The D-1485 decision required compliance with water quality objectives in the 1978 Delta Plan, which were designed to protect natural resources by maintaining Delta conditions as they would exist in the absence of the CVP and SWP. D-1485 also required monitoring and study of Delta aquatic resources. The effect of the D-1485 decision was the amendment of Reclamation and DWR permits for operating the CVP and SWP. In 1978, legal challenges were brought against D-1485 and the 1978 Delta Plan. In 1986, the state was required to revise its water quality standards based on the "Racanelli Decision" (*United States v. State Water Resources Control Board* [1986] 182 Cal. App. 3d 82). Pursuant to that decision, SWRCB implemented a hearing process, known as the Bay-Delta hearings, to review and amend the 1978 Delta Plan. Following this hearing process, SWRCB issued revised water quality objectives in the 1991 Delta Water Quality Control Plan for Salinity, Temperature, and Dissolved Oxygen (1991 Delta Plan). The SWRCB conducted a water right hearing to receive evidence and recommendations on measures to protect fish and wildlife. After the hearing, the SWRCB released a draft water right decision, draft D-1630, that included interim water right terms and conditions. Actions taken by the NMFS and USFWS to protect winter-run chinook salmon and Delta smelt resulted in the withdrawal of D-1630 after the hearing without it being adopted. However, several new Delta water management concepts presented in D-1630 have been partially adopted in other actions taken by SWRCB, DWR, USBR, fishery protection agencies, and other regulatory agencies.

11.3.5 1995 Water Quality Control Plan

In March 1994, SWRCB initiated development of new water quality objectives and released a draft version on December 15, 1994, the same day the Bay-Delta Accord was signed. SWRCB subsequently released an environmental report that documented the effects of implementing the plan. The WQCP was adopted in May 1995 (1995 Water Quality Control Plan [WQCP]) and incorporated several elements of EPA, NMFS, and USFWS regulatory objectives for salinity and endangered species protection. The 1995 WQCP objectives are expected to be fully implemented with a new water-rights decision (to replace D-1485) in 1998. The major changes associated with the 1995 WQCP in relation to the 1978 and 1991 WQCPs and associated D-1485 requirements are as follows:

- Water-year classifications are based on the 40-30-30 Sacramento Valley Four-River Index and the 60-20-20 San Joaquin Valley Four-River Index. The outflow requirements from February through June depend on the previous month's Eight-River Index runoff volume.

- Delta outflow requirements are the combination of fixed monthly requirements and estuarine habitat requirements (expressed in terms of "X2," the position of the 2-parts-per-thousand [ppt] salinity gradient). Because the X2 requirements in the 1995 WQCP depend on the previous month's Eight-River index runoff, the required outflow must be calculated for each month.

- Combined SWP and CVP Delta exports are limited to a percentage of the Delta river inflow (which does not include rainfall). These percentages are in the range of 35% to 45% depending on the Delta inflow from February through June and 65% for the remainder of the year. Export pumping during the pulse-flow period was limited to an amount equivalent to the pulse flow during half of April and half of May.

11.3.6 Clean Water Act—Section 303(d)

Section 303(d) of the Clean Water Act requires that each state develop a list, known as a 303(d) list, of waterbodies that are impaired with respect

to water quality. The 303(d) list for each state identifies impaired waterbodies and sources of impairment, such as mine drainage, agricultural drainage, urban and industrial runoff, and municipal and industrial wastewater discharges. In 1996, the State of California identified approximately 90 impaired waterbodies in its 303(d) list. CALFED is using this list to make a preliminary assessment of existing environmental water quality problems in California's Central Valley and Bay-Delta.

11.3.7 Federal Guidance on Water Quality Criteria for Toxic Pollutants

The EPA has developed National Guidance on Water Quality Criteria (Clean Water Act Section 304[a]) for pollutants to protect human health and aquatic life. Relevant pollutants are identified under Section 307 of the CWA. These criteria were used by the State in developing the 1991 Inland Surface Waters Plan, which was subsequently invalidated by California courts.

11.3.8 Suisun Marsh Preservation Agreement

The Suisun Marsh Preservation and Restoration Act of 1979 and an associated agreement between federal and state agencies signed in 1987 were designed to mitigate the effects of CVP and SWP operations and other upstream diversions on water quality in the marsh. The agreement, which includes specific water quality objectives for salinity in Suisun Marsh channels, is being amended. The CVP and SWP will submit the amended agreement to the SWRCB for approval in the upcoming Bay-Delta Water Rights hearing. EPA proposed water quality criteria for priority toxic pollutants for California in the *Federal Register* on August 5, 1997. This proposal, called the California Toxics Rule, addresses parameters that were not covered for California in the original National Toxics Rule. The proposed rule will, when finalized, establish ambient water quality criteria for priority toxic pollutants for California inland surface waters, enclosed bays, and estuaries. A salinity control structure (tidal gate) was completed on Montezuma Slough in 1988. D-1485 also directed Reclamation and DWR to develop a plan to protect Suisun Marsh resources. D-1485 set water salinity standards for Suisun Marsh from October through May to preserve the area as a brackish water tidal marsh and to provide optimum conditions for plant production as food for waterfowl.

The SWRCB 1995 WQCP includes the SMPA normal and deficiency period standards for the western Suisun Marsh and recommends that the SMPA parties should "continue the actions, including facility plans, identified for implementation of the SMPA."

11.3.9 Water Rights

Water use in California is characterized by two basic types of water rights: riparian water rights and appropriative water rights. Riparian water rights are based on ownership of land adjacent to a waterbody, while appropriative water rights are unrelated to riparian land ownership and are based on the principle of "first in time, first in right."

Riparian water rights are not lost if unused and are not quantified unless they are adjudicated. Landowners with these rights can divert portions of a waterbody's natural waterflow for reasonable and beneficial use on their land, provided the land is located within the same watershed as the waterbody and on the smallest parcel adjacent to the waterbody. During times of water shortage, all riparian water rights holders must share the available supply according to each landowner's reasonable requirements and uses (California State Water Resources Control Board, 1989). Appropriative water rights account for the vast majority of water rights in California. These rights are based on the concept that the first to claim and beneficially use a specific amount of water has a superior claim to later appropriators.

Appropriative rights are quantified and may be lost if unused. Appropriate water rights obtained

after 1914 require permits and licenses issued by the SWRCB. All appropriations existing before 1914 have seniority based on the date when they were initiated. The SWRCB issues appropriative rights with conditions to protect other water rights holders, including Delta and upstream riparian water users, and to protect the public interest, including fish and wildlife resources. The quantity and quality of water used by existing riparian and senior appropriative users can only be limited by subsequent appropriations in limited circumstances where the senior rights are not legally injured (see Surface Water Resources and Groundwater Resources supporting documents.)

11.3.10 Drinking Water Standards

Drinking water regulations primarily define requirements for treated water quality versus the regulations/requirements noted above which define requirements mainly for discharges into receiving waters. Following are the regulatory water quality requirements for drinking water.

11.3.11 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) (PL 99-339) was enacted and signed into law in 1974. Through the SDWA, Congress gave the EPA the authority to set standards for contaminants in drinking water supplies. The SDWA was reauthorized in August 1996. Amendments were developed to provide more flexibility, more state responsibility, and more cooperative approaches. The law changes the standard setting procedure for drinking water and establishes a State Revolving Loan Fund to help public water systems to improve their facilities and ensure compliance with drinking water regulations. Under the provisions of the SDWA, the California Department of Health Services (DHS) has the primary enforcement responsibility. Title 22 of the California Administrative Code establishes DHS authority and stipulates drinking water quality and monitoring standards. To maintain primacy, a state's drinking water regulations cannot be less stringent that the federal standards.

11.3.12 National Primary Drinking Water Standards

The National Primary Drinking Water Standards or maximum contaminant levels (MCLs) are the maximum permissible levels of contaminants in water which enters the distribution system of a public water system. The federal and state MCLs are enforceable and must be met by appropriate public drinking water systems. The MCLs are generally derived by balancing the technologic and economic concerns that are directly related to the use of water for domestic supplies. Health effects information is developed in the risk assessment process as part of the derivation of the MCLs.

National maximum contaminant level goals (MCLGs) are the maximum levels of contaminants in drinking water at which no known or anticipated adverse effect on the health of persons would occur and which allow an adequate margin of safety. MCLGs are non-enforceable health goals and are strictly health-based. The derivation of MCLGs does not include a technological or economic evaluation.

Action levels (ALs) are health-based numbers which take into account analytical detection levels. They are interim guidance levels which may trigger mitigation action on the part of a water purveyor. Public notification is not always required when an AL is exceeded but may be recommended by the DHS. An AL is dropped once an MCL is promulgated and final.

The Phase I Rule was promulgated in 1987 and contains MCLs, MCLGs, and best available technologies (BATs) for eight volatile organic chemicals (VOCs). Phase II and IIB Rules were promulgated in 1991 and regulated an additional 16 synthetic organic chemical (SOCs), 10 VOCs, and seven inorganic chemicals (IOCs). Phase II & IIB Rules contain MCLs, MCLGs, and treatment techniques for these chemicals. The Phase V Rule was promulgated in 1992 and regulates 13 SOCs, five IOCs, and three VOCs. Phase V established

MCLGs, MCLs, laboratory criteria, and BATs for these 23 contaminants.

11.3.13 National Secondary Drinking Water Regulations

National Secondary Drinking Water Regulations (NSDWR), or secondary MCLs, were established by the EPA in 1979 and 1991. The secondary MCLs are maintained to protect public welfare and to assure a supply of pure, wholesome, and potable water. They are applied at the point of delivery to the consumer and generally involve protection of the taste, odor, or appearance of drinking water. Federal secondary MCLs are nonenforceable. However, state secondary MCLs are enforceable for all new systems and new sources developed by existing systems. In California, the DHS regulates and enforces secondary standards.

11.3.14 Trihalomethane Regulations

These regulations apply to all public water systems serving populations greater than 10,000. Large utilities were required to begin monitoring for total trihalomethanes (TTHMs) in November 1980. The regulation established an MCL of 100 micrograms per liter (μg/L) for TTHMs in the distribution system. TTHMs include the summation of chloroform, bromodichloromethane, dibromochloromethane, and bromoform concentrations. Because trihalomethanes (THMs) form as a result of the application of the disinfectant, compliance with the MCL is based on a running annual average of at least four representative sampling points for each treatment plant. Twenty-five percent of the samples are taken at locations within the distribution system which represent the maximum residence time of water in the system and at least 75% of the samples are collected from representative sites in the distribution system (considering number of persons served, sources of water, and treatment methods).

11.3.15 Federal Lead and Copper Rule

The final Lead and Copper Rule was promulgated by the EPA in 1991 (56 FR 26460). The first flush water samples from consumers' taps are to be monitored. If more than 10% of these samples contain greater than the AL of 0.015 milligrams per liter (mg/L) for lead, or 1.3 mg/L for copper, three required actions must initially be taken. These requirements are corrosion control treatment, source water treatment, and public education. The Lead and Copper Rule eliminated the lead MCL and the secondary copper MCL.

11.3.16 Federal Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) was promulgated by the EPA in June 1989 to protect against *Giardia lamblia*, *Legionella* viruses, and heterotrophic bacteria in United States surface drinking water sources and in groundwater sources influenced by surface water. These contaminants were included on the list of 83 contaminants to be regulated by the EPA, according to the 1986 SDWA Amendments. Water systems with clean and protected source waters meeting the source water quality and site specific criteria may not have to filter if they meet the disinfectant contact time criteria continuously. For those that must filter, June 1993 was the deadline to meet filtration requirements and performance criteria for both turbidity and disinfection.

The SWTR requires all utilities with a surface water supply, or a groundwater supply under the influence of a surface water supply, provide adequate disinfection and, under most conditions, provide filtration. Exemptions from filtration of surface water supplies are provided on rare occasions where the source water supply meets extremely rigid requirements for water quality and the utility possesses control of the watershed. Each utility must also perform a watershed

sanitary survey at least every 5 years, according to California state law.

EPA proposed an Enhanced Surface Water Treatment Rule (ESWTR) as an amendment to the SWTR in July 1995. The purpose of the amendment is to provide additional protection against disease-causing organisms, such as *Giardia lamblia*, *Cryptosporidium parvum*, and viruses in drinking water. The ESWTR outlines several alternatives for treatment requirements based on source water concentrations for these pathogens.

Disinfectants/Disinfection By-Products Rule. The 1986 amendments to the federal SDWA require that the EPA propose a rule for disinfectants and disinfection by-products. The rule must balance the need for protection from cancer-causing chemicals (the by-products) with the need for protection from pathogenic microbes (bacteria, viruses, and protozoans) that are killed by disinfection. In 1992, the EPA initiated a rule-making process. The negotiators consisted of state and local health and regulatory agency staff, elected officials, consumer groups, environmental groups, and representatives of public water systems. The "Reg-Neg" process resulted in a two-stage approach for regulation development.

Stage one of regulation is the draft Disinfectant/Disinfection By-Products Rule (D/DBPR), which was proposed by the EPA in 1994. Stage one regulations are expected to be promulgated in 1998. Compounds affected under the first stage of the D/DBPR are TTHMs, total haloacetic acids, total organic carbon, bromate, chlorine, chloramines, chlorine dioxide, and chlorite. This rule will require varying degrees of removal of total organic carbon from source waters prior to treatment with disinfectants, thereby indirectly affecting the amount of total organic carbon concentrations in source waters.

In stage two, the EPA will collect data on parameters that influence disinfection by-product (DBP) formation and occurrence of DBPs in drinking water through the Information Collection Rule process. Based on this information and new data collected from research, EPA will reevaluate the stage one regulations and make changes as necessary.

Federal Total Coliform Rule. The Total Coliform Rule became effective in 1990. The rule establishes microbiological standards and monitoring requirements which apply to all public water systems. Compliance is based on the presence or absence of total coliforms in a sample, rather than on an estimate of coliform density.

11.3.17 California Surface Water Treatment Regulations

State surface water treatment regulations are the result of a series of amendments to the National Primary Drinking Water Regulations. State regulations, which are found in Title 22 of the California Code of Regulations, became effective in 1991. Like the federal rule, the state required multi-barrier treatment for microbiological contaminants, which was effective June 1993. Unlike the federal rule, all public water systems in California must filter all their surface water and the part of their groundwater that is under the influence of surface water. Due to high implementation costs, this aspect of the regulation may be amended in the future to allow qualifying systems to avoid filtration.

11.3.18 California Total Coliform Regulations

California has analogous total coliform regulations which are found under Title 22, Chapter 15 of the California Code of Regulations. The DHS has set an enforceable drinking water standard for total coliforms, identical to that of the federal rule.

A list of contaminants currently regulated for drinking water by both the EPA and DHS is presented in the Affected Environment and Environmental Consequences sections of the Water Quality supporting document. The list

identifies the federal regulation and the section of the regulation, as well as the MCL or treatment technology, associated with each contaminant. At the state level, the California DHS has promulgated regulations for a number of contaminants at levels below the EPA MCLs.

11.3.19 California Nonpoint Source Program (CWA §319/CZARA §6217)

Two primary federal statutes, CWA §319 and CZARA §6217, along with the Porter-Cologne Act, establish a framework for addressing nonpoint source (NPS) pollution in California. As enacted by Congress in 1987, CWA §319 required California to develop an assessment report detailing the extent of nonpoint pollution and a management program specifying nonpoint source controls, in order to receive federal funding to implement nonpoint source controls. In 1990, Congress passed Section 6217(c)(1) of the Coastal Zone Act Reauthorization Amendments (CZARA) that requires the state to "develop and implement management measures for nonpoint source pollution to restore and protect coastal waters..." which is to serve as an update and expansion of the existing NPS program

The California Nonpoint Source Management Plan, adopted by the State Water Resources Control Board in 1988, outlines a systematic approach to management of nonpoint source pollution in the State. The three approaches that still form the basis for California's program are voluntary implementation of BMPs, regulatory-based encouragement of BMPs, and effluent limitations.

In February 1994, the State initiated a comprehensive process to consider the requirements of CZARA and update the existing statewide Nonpoint Source Program rather than create a separate program dealing exclusively with coastal waters. The State's updated program, as described by the Coastal Nonpoint Pollution Control Submittal (September 1995) and Initiatives in Nonpoint Source Management (September 21, 1995), calls for managing nonpoint sources on a watershed basis and focuses on nonpoint source problems associated with pesticides, grazing, urban runoff, hydromodification, and abandoned mines.

As of February 1998, California is still working to improve the nonpoint source program and to receive full program approval from the EPA in compliance with CZARA.

11.4 FEDERAL AND STATE COORDINATION FOR A DELTA SOLUTION

11.4.1 Bay-Delta Framework Agreement and Bay-Delta Accord

In June 1994, a Bay-Delta Framework Agreement was signed by the Federal Ecosystem Directorate and the Governor's Water Policy Council of the State of California. The framework established a comprehensive program in the Bay-Delta estuary for coordination and cooperation of environmental protection and water supply. It addressed three major areas of agreement including formulation of a new WQCP acceptable to both EPA and SWRCB, coordination of SWP and CVP operations in order to rapidly respond to environmental conditions in the Delta with an adaptive management approach, and implementation of a long-term management approach integrating objectives for water supply and environmental protection. The Principles for Agreement, or Bay-Delta Accord, was signed on December 15, 1994.

Category III. In addition, the accord calls for early implementation of certain ecosystem restoration projects—known as Category III projects—before the comprehensive solution is finalized. Funding for these projects has come from Proposition 204, passed by California voters in 1996; from the California Bay Delta Environmental Enhancement Act, passed by Congress in 1996; and from

voluntary contributions from urban water agencies.

11.4.2 California-Federal Operations Group

The 1994 Bay-Delta Framework Agreement established the California-Federal Operations Group (CALFED Ops Group) to coordinate SWP and CVP operations and recommend changes in combined Delta operations that might provide additional fish protection and allow Delta exports with reduced fishery impacts. The CALFED Ops Group was specifically charged with recommending operational changes based on real-time fish-monitoring results to minimize incidental take and satisfy other requirements of ESA biological opinions. The Ops Group was also charged with the exchange of information and the discussion of strategies to implement fish protection measures, satisfy 1995 WQCP water quality objectives, and cooperate with Interagency Ecological Program (IEP) to determine factors affecting Delta habitat and the health of fisheries and to identify appropriate corrective measures for CVP and SWP.

11.5 PUBLIC TRUST

The State of California has an affirmative duty to take the public trust into account in the planning and allocation of water resources, and to preserve, so far as consistent with the public interest, the uses protected by the trust. In common law, the public trust doctrine protected navigation, commerce, and fisheries uses in navigable waterways. However, the courts have expanded the application of the doctrine to apply to protection of tidelands, wildlife, recreation, and other public trust resources in their natural state for recreational, ecological, and habitat purposes as they affect birds and marine life in navigable waters. In the *National Audubon Society v. Superior Court* (1983) case, the California Supreme Court ruled that in administering water rights laws and approving water diversions, the state also has a duty of continuous supervision over the taking and use of appropriated water to protect these public trust uses.

11.6 AIR QUALITY

Pursuant to the requirements of Section 176 of the Clean Air Act [42 U.S.C. Section 7506(c)], federal agencies are prohibited from engaging in or supporting in any way an action or activity that does not conform to an applicable state implementation plan. Conformity to an implementation plan means conformity to an implementation plan's purpose of eliminating or reducing the severity and number of violations of the national ambient air quality standards and achieving expeditious attainment of such standards. EPA has promulgated conformity regulations(codified at 40 CFR Section 93.150 et seq.) A discussion of the applicability of conformity requirements for the CALFED Program Phase II and subsequent, tiered actions will be provided in the final Programmatic EIS/EIR.

11.7 WATER USE EFFICIENCY

The Urban Water Management Planning Act (California Water Code Section 10610 et seq.) requires every public and private urban water supplier that directly or indirectly provides water for municipal purpose to more than 3,000 customers, or supplies more than 3,000 acre-feet of water annually, to prepare, adopt, and submit to DWR an urban water management plan. A water supplier must update the plan at least once every 5 years.

An urban water management plan must include estimates of past, current, and future water use, must identify current conservation and recycling measures, and must analyze potential alternative conservation measures. A plan must include water shortage contingency provisions, and provisions for optimizing the use of recycled water in the water supplier's service area.

The Agricultural Water Conservation and Management Act (California Water Code Section

10520 et seq.) provides that agricultural water suppliers may institute water conservation or water management programs.

California Water Code Section 10904 directs the DWR to offer assistance to agricultural water suppliers to implement efficient water management practices to improve the efficiency of water use.

12 PUBLIC AND AGENCY INVOLVEMENT

12.1 PUBLIC INVOLVEMENT

Since the initial stages of the CALFED Bay-Delta Program, stakeholder outreach and education has been a primary focus of efforts in the shaping of the Program as well as in the development of the Programmatic EIS/EIR. Over the course of nearly three years, the Program has relied on ongoing input and involvement from individuals and groups with a stake in finding long-term solutions for the problems affecting the Bay-Delta system.

Participants representing rural, agricultural, municipal and industrial water users, fishing interests, environmental organizations, businesses, and the public have been asked to help define problems and evaluate alternatives for solving the challenges confronting the Bay-Delta system.

To date, thousands of Californians have contributed to the Program by participating in public meetings and workshops—volunteering time, sharing expertise, and expressing ideas and opinions.

This public involvement has been solicited and engaged through multiple public outreach methods and activities throughout the state:

- Public Workshops
- Public Meetings
- Multi-Cultural Public Outreach
- Speakers Bureau/Community Presentations
- Educational Materials/Direct Mail
- Media Contacts
- Legislative Briefings
- Project Public Information Line/Project Website
- CEQA/NEPA Public Participation
- Programmatic EIS/EIR Scoping Meetings
- Habitat Conservation Plan Scoping Meetings
- Public Comment Letters
- Scientific Review Panel
- Bay-Delta Advisory Council (BDAC)
- BDAC Workgroups

12.1.1 Public Workshops

Beginning in August 1995, a program of 12 day-long workshops was conducted in Sacramento over a 3-year period—four workshops in 1995, five in 1996, and three in 1997. Open to the general public, the intensive working sessions focused on providing a solid framework for the solution-finding process. Through brainstorming, informal debate, and analysis, an average of 100 participants at each workshop worked together to help identify the problems facing the Bay-Delta system, establish objectives for problem solving, and develop the actions necessary to achieve the objectives.

A vital part of the public outreach program, these workshops have provided an opportunity for the many different interests of the Bay-Delta system to share perspectives, reach common understandings, and develop cooperative solution alternatives.

12.1.2 Public Meetings

In addition to the public workshops, 28 open-house public meetings have been held to give the general public, who might not attend public workshops or other meetings, the opportunity to learn about the Program and to express their views and concerns. Each public meeting featured an informal, open-house session with displays and informational materials, followed by a prepared general presentation about the Program.

During Phase I of the Program, a total of 14 public meetings were held in 13 communities throughout California to identify problems in the Bay-Delta system — Redding, Red Bluff, Sacramento,

Walnut Grove, Stockton, Oakland (2), Los Banos, Fresno, Bakersfield, Pasadena, Long Beach, Costa Mesa, and San Diego. Between September 1995 and May 1996, another six public meetings were held to acquaint Californians with the Program, solicit early public comment on Bay-Delta possible solutions and gauge local public reaction to the 10 draft alternatives. In 1997, a total of eight more public meetings were held in communities from Chico down to San Diego to inform stakeholders and the public about the Program's progress and the process of identifying a preferred alternative, as well as to solicit input on the alternatives.

The public meetings were promoted through notices sent to the Program public outreach database, and packets were sent to all key agency staff and other target audiences. To further encourage statewide participation at the events, the Program ensured that heavy advance publicity was conducted prior to each meeting. Attendance ranged from 23 to 125 at each meeting, for a total of more than 2,000 participants.

12.1.3 Multi-Cultural Public Outreach

Because of the diverse population of California, an outreach program about the Program has been targeted specifically to minority communities. This program recognizes that in each cultural and ethnic community both the messages about the Program and the methods for disseminating the messages, and the approaches to soliciting involvement and input in the process, differ significantly.

CALFED's multi-cultural outreach program includes ongoing stakeholder research and issue identification, ethnic media outreach, and public presentations and forums. On an ongoing basis, media releases and Program announcements have been issued to Armenian, Chinese, Japanese, Korean, Spanish, and Vietnamese newspapers, as well as publications that reach primarily African-American and Native American readers.

In addition, where appropriate, translators have been available at public meetings and forums.

12.1.4 Speakers Bureau/Community Presentations

Since the beginning of the Program, CALFED representatives have spoken at more than 60 formal conferences and meetings sponsored by various stakeholder groups and agencies. In addition, CALFED has hosted a number of informal meetings with individuals and small stakeholder groups. As part of an organized CALFED Speakers Bureau program, the presentations allowed interactive discussions about the Program and included the availability of written materials and audiovisual elements where appropriate to increase outreach effectiveness.

A partial list of the organizations and conferences to which CALFED has provided formal presentations includes:

- Association of California Water Agencies
- Bureau of Reclamation Innovations Conference
- California Chamber of Commerce
- California Water Law Conference
- Continuing Legal Education Conference
- Environmental Water Caucus
- Interstate Council on Water Policy
- Metropolitan Water District of Southern California
- Mojave Water Agency
- Sacramento Valley Westside Canal Association
- San Francisco Estuary Project Implementation Committee
- Three Valleys Municipal Water Agency Symposium
- Water Reuse Association of California
- Western Water Policy Review Advisory Commission

- Bay Conservation and Development Commission
- California Association of Nurserymen
- California Water Clearinghouse
- Commonwealth Club of California
- Delta Protection Commission Ecological Indicators Workshop
- Los Angeles Chamber of Commerce
- Mid-Pacific Region Water Users Conference
- Restoration Roundtable
- Save San Francisco Bay Association
- Southern California Water Committee
- State Water Contractors
- Water Education Foundation
- Water Forum
- Water Policy

12.1.5 Educational Materials/Direct Mail

To help educate the public on the multiple issues and objectives associated with the Program, an extensive library of educational resources has been developed. Materials such as program newsletters, progress updates, fact sheets, brochures, a conference exhibit, and audiovisual materials, such as slide shows and videos, are routinely distributed to the public and made available at workshops and presentations.

Since the beginning of Program planning, a database of interested public and group participants has been identified and compiled through various public outreach events and meetings. To date, the Program's total mailing list exceeds 6,000 names of people throughout the state with known interest in Bay-Delta activities. Approximately every six weeks, some form of written material describing program aspects or soliciting public involvement is distributed to this Program database. In 1995 alone, an estimated 16,600 copies of written materials about the Program were distributed to interested groups and individuals.

Additionally, the Program routinely submits articles for publication by stakeholder organizations, such as the Southern California Water Committee, in their regular newsletters.

12.1.6 Media Contacts

Information about the Program has been publicized to hundreds of media outlets throughout California. Regular mailings of news releases, meeting and milestone announcements and Program updates were sent to water and environmental reporters covering Bay-Delta and related issues. While most of the releases are for English readers, the Program also has issued releases to Armenian, Chinese, Japanese, Korean, Spanish, and Vietnamese newspapers, as well as to publications that serve primarily African-American and Native American readers.

Additionally, the Program has personally contacted 40 major daily publications in California, requesting the opportunity to brief the editorial boards. Live or telephone interviews about the Program have been held with more than 50 television and radio stations, with program staff interviewed on extensive radio broadcasts such as National Public Radio, MONY Radio, and Farm Bureau Radio.

As additional outreach, formal media events have been coordinated surrounding the Program. The first event, held December 15, 1995, on the Delta King Riverboat in Sacramento, recognized the first anniversary of the Bay/Delta Accord. It featured presentations from Deputy Secretary of the Interior John Garamendi, Secretary for the California EPA James M. Strock, and EPA Assistant Administrator Bob Perciasepe.

12.1.7 Legislative Briefings

The Program has maintained regular liaison with members of the U.S. Congress, California state legislature, and appropriate subcommittees and local governments throughout the state. Staff

visited Washington, D.C., in November 1995, June 1996, and October 1997 to brief key legislators as well as CALFED agency personnel. Staff have also testified before several legislative committees, including the Congressional Subcommittee on Water and Power Resources, the California Senate Agriculture and Water Committee, and the California Senate Appropriations Committee. Additionally, staff have offered extensive input into the process of drafting California State Senate Bill 900.

12.1.8 Project Public Information Line/Project Website

The Program established a Project Information Hotline, (916) 654-9924, and a toll-free number, (800) 700-5752, as a way to encourage public input and involvement. The Information Hotline has been updated regularly and a response system developed to ensure expedient follow-up to questions from interested members of the public and groups. In addition, the Program has developed and marketed a website [http://calfed.ca.gov] with Program information in addition to technical documents and public information materials. This is a source for public information officers of stakeholder organizations who can download current information and distribute these materials to their audiences.

12.1.9 CEQA/NEPA Public Participation

In compliance with state and federal standards (California Environmental Quality Act [CEQA] and National Environmental Policy Act [NEPA]) for the development of environmental documentation, all requirements for public notices, public meetings, and scoping meetings were fulfilled and exceeded. A Notice of Intent/Notice of Preparation (NOI/NOP) for the original Programmatic EIS/EIR was issued in March 1996, and a supplemental NOI reflecting the expanded scope of the EIS/EIR, with inclusion of the Habitat Conservation Plan, was issued in August 1997. The Notice of Availability for the EIS/EIR was additionally posted in August 28, 1997. The requirements for scoping and public meetings during the formation of alternatives and prior to the Draft EIS/EIR were met and exceeded.

12.1.10 Programmatic EIS/EIR Scoping Meetings

As part of the Programmatic EIS/EIR process, a total of eight scoping meetings were held around the state to solicit input into the scope of the environmental review process. All scoping meetings were held in April 1996 in Oakland, Walnut Grove, Red Bluff, Long Beach, San Diego, Pasadena, Bakersfield, and Sacramento.

12.1.11 Habitat Conservation Plan Scoping Meetings

Additional scoping meetings were held surrounding preparation of the Program's Habitat Conservation Plan (HCP), designed to promote long-term habitat protection, and recovery of threatened and endangered species in the study area.

Five scoping meetings were held in 1997 in Redding, Sacramento, Los Banos, Irvine, and Berkeley to allow the public and stakeholders to provide input into the elements and scope of the HCP.

12.1.12 Public Comment Letters

As a result of the efforts to solicit public involvement and input, the Program has received hundreds of comment letters from individuals and organizations across California. Comment letters are logged and summarized in a database from which reports are provided regularly to technical staff and involved agencies. These comments were referenced in the development of the Programmatic EIS/EIR.

12.1.13 Scientific Review Panel

A Scientific Review Panel was created hosting eight nationally recognized scientists with broad expertise in landscape ecology, fisheries and aquatic biology, physical processes, and terrestrial

and wetlands ecology. The panel was formed to assess and evaluate the scientific validity and rationale, of the scientific concepts contained in the CALFED Program's Ecosystem Restoration Program (ERP).

A 4-day workshop was held from October 6 through 9, 1997, to allow a facilitated panel discussion with the Scientific Review Panel resulting in a written set of recommendations to CALFED for refining the ERP. Members of the public were invited to attend and to provide verbal and written comments on the process.

12.1.14 Bay-Delta Advisory Council

In addition to various efforts to involve the general public, a federally chartered advisory council was established to assist Program leaders. In May 1995, 31 representatives of stake holders, including water districts and utilities, environmental organizations, the California Farm Bureau, and sport fishing organizations from throughout California were appointed by the administration of Governor Wilson and President Clinton, through Secretary of the Interior Babbitt to serve as members of BDAC.

The group of citizen advisors helps define problems in the Bay-Delta system, assure broad public participation, comment on environmental reports, and advise on proposed solutions. Chartered under the Federal Advisory Committee Act (FACA), the BDAC advises CALFED on the Program mission, problems to be addressed, and objectives for the Program.

BDAC has gathered bimonthly for a total of 21 public meetings, and has provided a forum to help ensure public participation and to provide feedback on materials prepared by CALFED staff.

12.1.15 BDAC Workgroups

Six subgroups to BDAC were formed to provide input into specialized areas of the Program. Each has held regular public meetings to study a variety of specific Program areas.

Water Use Efficiency Workgroup. The purpose of the seven-member Water Use Efficiency Workgroup is to address policy issues related to efficient water use and water demand management. Categories to be considered by the group include urban water conservation, agricultural water conservation, water recycling, and temporary or permanent land fallowing.

Key questions of the workgroup include:

- What general approach is most appropriate to implement water use efficiency measures—regulatory, market, or a combination?
- How can water use efficiency be structured to complement other water supply components of each alternative?
- What is the appropriate level of effort for water use efficiency measures in each alternative, and how should the level be set?
- Should water use efficiency measures be specified in alternatives, or should a target level of reduced demand be specified and the selection of measure left to water users?

The workgroup produced summaries of each of these issues for BDAC to promote a better understanding and consideration by the full BDAC. Products developed by the group have been critical in Phase II of the Program as the process of analyzing, evaluating, and enhancing alternatives is carried out.

Ecosystem Restoration Workgroup. The purpose of the Ecosystem Restoration Workgroup is to identify and develop options to address policy issues related to the development of an effective ecosystem restoration strategy for the Program.

Key issues include:

- qualitative and quantitative goals for a comprehensive strategy to restore critical ecosystem structure and function,

- development of an adaptive management strategy, and
- institutional assurances/structure necessary to ensure restoration of ecosystem health.

Finance Workgroup. The workgroup has met regularly since April 2, 1996. The six-member Finance Workgroup has met to identify key financial issues and problems which must be addressed in order to successfully develop and implement the long-term solution; examine a range of alternative ways to address these issues and problems which could lead to building a workable consensus solution; and identify, review, and discuss the strengths and weaknesses of these alternative ways to address issues.

Assurances Workgroup. The Assurances Workgroup was formed to identify the assurance needs for each of the Program elements, and to identify ways in which these assurances can be provided. The group first met on August 15, 1996, and has convened on a regular basis to formulate, discuss, analyze, and recommend to BDAC appropriate mechanisms to assure implementation of the long-term solutions identified by the CALFED process.

Water Transfers Workgroup. The Water Transfers Workgroup is composed of BDAC members and invited participants to provide a balance of interests on transfer issues and questions. The function of the workgroup is to assist BDAC in providing advice to CALFED about the development of the water transfer element of the long term Bay-Delta solution. In addition, the group identifies concerns and may develop recommendations to CALFED agencies.

Ecosystem Roundtable. The Ecosystem Roundtable is a stakeholder forum established as a subgroup of BDAC. Members of this group represent a cross section of stakeholders interested in and affected by habitat restoration activities in the Bay-Delta system.

Meeting on a quarterly or as-needed basis, the Ecosystem Roundtable's role has been to provide advice and recommendations to BDAC and CALFED on the coordination of existing and anticipated state and federal habitat restoration programs.

12.1.16 Groundwater Outreach Program

Appropriate and effective groundwater management will be essential to the success of the CALFED Bay-Delta Program. As part of the storage and conveyance program to protect and enhance the Delta, CALFED is looking to facilitate additional conjunctive use and groundwater banking opportunities as one way to help maximize the overall water supply and protect groundwater resources. CALFED has initiated a groundwater outreach component to help identify and address stakeholder concerns about groundwater use and management with special emphasis on conjunctive use projects.

CALFED has contacted and met with dozens of individuals, including private citizens, water managers, water district board members, and elected officials to learn about local concerns regarding conjunctive use programs, and to determine which entities would be interested in participating in a locally controlled conjunctive use program. Additionally, CALFED has conducted workshops in both the Sacramento and San Joaquin valleys to present the status of the groundwater program and to solicit additional comments and concerns regarding conjunctive use.

12.2 AGENCY INVOLVEMENT

In addition to activities and programs to solicit public and stakeholder involvement, the Program has formed a number of subcommittees and teams to ensure the involvement of all interested and participating federal and state agencies in the process. Interagency teams are important in bringing the technical expertise of the agencies into the planning, and ensuring that the appropriate agency staff are reviewing and providing recommendations at each step of the process. In many ways, the agency involvement programs have interacted with and complemented public outreach efforts:

- CALFED Policy Group
- CALFED Management Team
- Interagency Development Team (IDT)
- Program Coordinating Team (PCT)
- Public Affairs Group
- Operations Coordination (Ops) Group
- CALFED Technical Teams
- CALFED Impact Analysis Teams

12.2.1 CALFED Policy Group

The CALFED Policy Group, made up of 32 members, is the decision-making arm of the CALFED Management Team. Starting in February 1996, the group has met monthly to review the Program's progress and deliberate on key issues identified by CALFED staff and the CALFED Management Team. Members include leadership from each of the CALFED agencies as well as the state Business and Transportation Agency and the Office of Planning and Research.

12.2.2 CALFED Management Team

Meetings of the CALFED Management Team started in May 1995 and continued monthly until August 1997 at which point they continued on a bi-monthly basis. The Management Team consisted of CALFED agencies to review the Program's progress and identify issues in need of policy deliberation.

12.2.3 Interagency Development Team

The IDT was formed in September 1997, and is comprised of a CALFED staff core group and an agency team of assigned representatives from each of CALFED's co-lead agencies. The IDT is charged with assisting with the preferred alternative development process, as well as responding to comments and helping revise the draft Programmatic EIS/EIR.

12.2.4 Program Coordinating Team

The PCT is composed of senior staff of the CALFED agencies. Monthly meetings are venues to allow Program staff to present updates on Program Team progress and summarize major issues raised at BDAC and management team meetings, public workshops, and other events.

12.2.5 Public Affairs Group

Public Information Officers of CALFED agencies and interested stakeholder groups meet to coordinate public involvement efforts and ensure broad dissemination of CALFED messages, and see that there is ample opportunity for public involvement from a wide and diverse cross section of interests. The groups have met periodically to provide input to CALFED staff on communications and public information strategies.

12.2.6 Operations Coordination Group

The CALFED Framework Agreement, along with the Principles of Agreement, established the CALFED Ops Group and defined the group's tasks and responsibilities. The group's purpose is to exchange information and facilitate the coordination of water project operations with requirements of the reasonable and prudent alternatives under the winter-run salmon and delta smelt biological opinions, the state and federal water quality standards, and the Central Valley Project Improvement Act.

Meetings of the Ops Group were initiated in August 1994, and held each month thereafter, and were open to the public. Co-chaired by the U.S. Bureau of Reclamation and the California Department of Water Resources, representatives include the U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Environmental Protection Agency, California Department of Fish and Game, and staff of State Water Resources Control Board. Deliberations are conducted in consultation with water users,

environmentalists, and fishery representatives, with recommendations made directly to CALFED.

12.2.7 CALFED Technical Teams

Several specialized teams were established to provide technical input to CALFED Program Managers.

Agency Ecosystem Restoration Technical Team. This team is composed of agency technical experts who provide analysis and recommendations on specific focused issues relating to the Ecosystem Restoration Program. The team is convened as often as needed to address specific issues.

Levees and Channels Technical Team. Provides technical advice to the CALFED Technical Systems Analysis Unit relating to Levees and Channels. This team consists of agency and technical experts.

Storage and Conveyance Technical Team. This team is an informal group consisting of the quarterly Storage and Conveyance Workshop attendees. The group is primarily made up of agency experts, however, the public has not been excluded from attending the publicly noticed meetings. The group reviews and comments on modeling issues. In addition, modeling results are posted on the DWR website for review by agencies, stakeholders and the public.

Water Quality Technical Team. The team has approximately 200 members. Members represent agencies, stakeholders, local government, industry, and academia. The team is divided into sub-teams which discuss specific water quality issues and provide scientific and technical advice to the Program. The Team meets roughly every second month.

12.2.8 CALFED Impact Analysis Teams

The CALFED Program established several multi disciplinary teams composed of CALFED staff, agency personnel, and consultants. The purpose of the teams was to identify the resource categories to be evaluated, prepare the no action description for the specific resource, evaluate potential adverse impacts, prepare the affected environment and environmental consequences components of the Technical Reports. These teams met weekly from March through September 1997. The list of teams is as follows:

- Environmental Team
- Economics Impact Analysis Team
- Flood Control Impact Analysis Team
- Water Quality Impact Analysis Team
- Hydrology and Water Management Impact Analysis Team
- Fish and Wildlife Impact Analysis Team

12.3 FUTURE CALFED ACTIONS

12.3.1 Scheduled Public Hearings and Meetings

The CALFED Program will conduct a series of formal public hearings throughout the state to provide information about the Program and solicit comments from the public and other interested parties on the content of the draft Programmatic EIS/EIR and supporting documents. These hearings are scheduled as follows:

- Ontario - Tuesday, April 21, 1998
- Fresno - Wednesday, April 22, 1998
- Oakland - Thursday, April 23, 1998
- Burbank - Tuesday, April 28, 1998
- Bakersfield - Wednesday, April 29, 1998
- Santa Cruz - Thursday, April 30, 1998
- Irvine - Tuesday, May 5, 1998
- Walnut Grove, Wednesday, May 6, 1998
- Chico - Thursday, May 7, 1998
- San Diego - Tuesday, May 12, 1998
- Antioch/Pittsburg - Wednesday, May 13, 1998

- Redding - Thursday, May 14, 1998

In addition, the public is invited to participate in several meetings during the public comment period for the Programmatic EIS/EIR. The scheduled public meetings are:

- BDAC Meeting - March 19-20, Burbank
- Supersession Orientation-April 3, Sacramento
- BDAC Meeting - May 14, Redding

12.3.2 Other Meetings and Workshops

CALFED staff plans to be available to conduct single-topic focused workshops throughout the state. These workshops will be designed to examine a specific CALFED Program component such as Water Transfers, Water Quality, or Ecosystem Restoration. These workshops will be conducted during the period from the release of the Programmatic EIS/EIR in March through the summer of 1998.

12.3.3 Outreach Resources

CALFED staff and consultants will prepare a variety of materials and formats designed to keep the public, agencies, and other interested parties apprised of events and developments in the CALFED process.

Website - CALFED maintains a website that contains current information on meetings and workshops as well as providing various reports, information, and presentation materials.

News Releases - CALFED staff will prepare and distribute news releases to a variety of media sources throughout the state, as appropriate.

Newsletters - Monthly newsletters are prepared discussing various aspects of the CALFED Program.

Fact Sheets - Staff will continue to update program fact sheets for distribution to interested parties.

Where to Find CALFED Program Public Outreach Information

- Program website - http:\\calfed.ca.gov
- Toll-free public information phone line (1-800-900-3587)
- CALFED *News*, *EcoUpdate*, and fact sheets are available from:

  CALFED Bay-Delta Program
  1416 Ninth Street, Suite 1155
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- BDAC and other public meetings (see Section 12.3.1).

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The technical supporting reports prepared during Phase I and II of the CALFED process represent the primary source material utilized during the preparation of this Programmatic EIS/EIR. Bibliographic references for the following resource areas can be found in these technical supporting documents which contain supporting analysis for the information provided in the Programmatic EIS/EIR:

- Agricultural Resources
- Cultural Resources
- Fisheries & Aquatic Ecosystem
- Flood Control
- Geology & Soils
- Groundwater Resources
- Power Production & Energy
- Recreational Resources
- Regional Economics
- Surface Water Resource
- Urban Resources
- Vegetation & Wildlife Resources
- Water Quality

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- Visual

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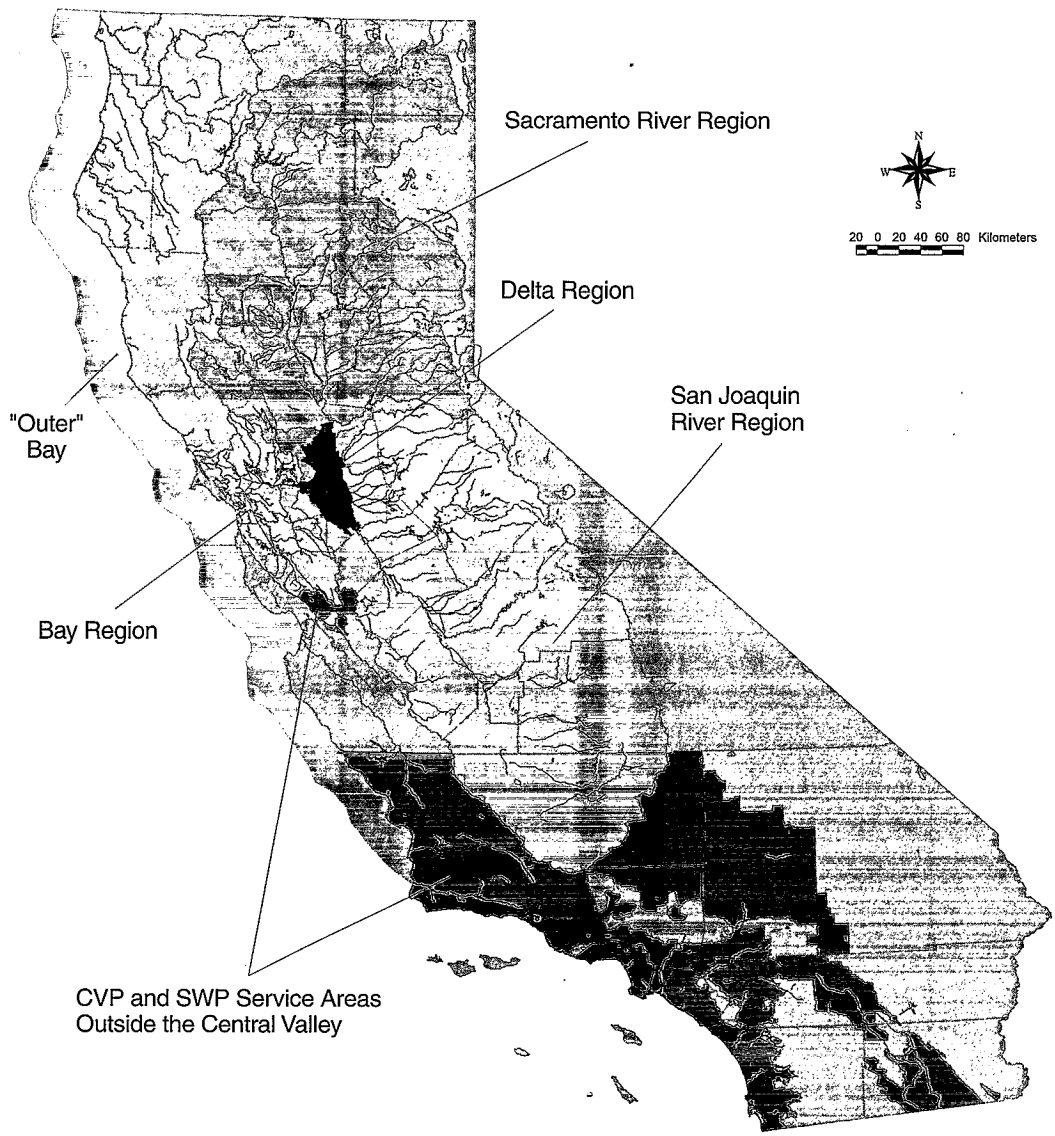

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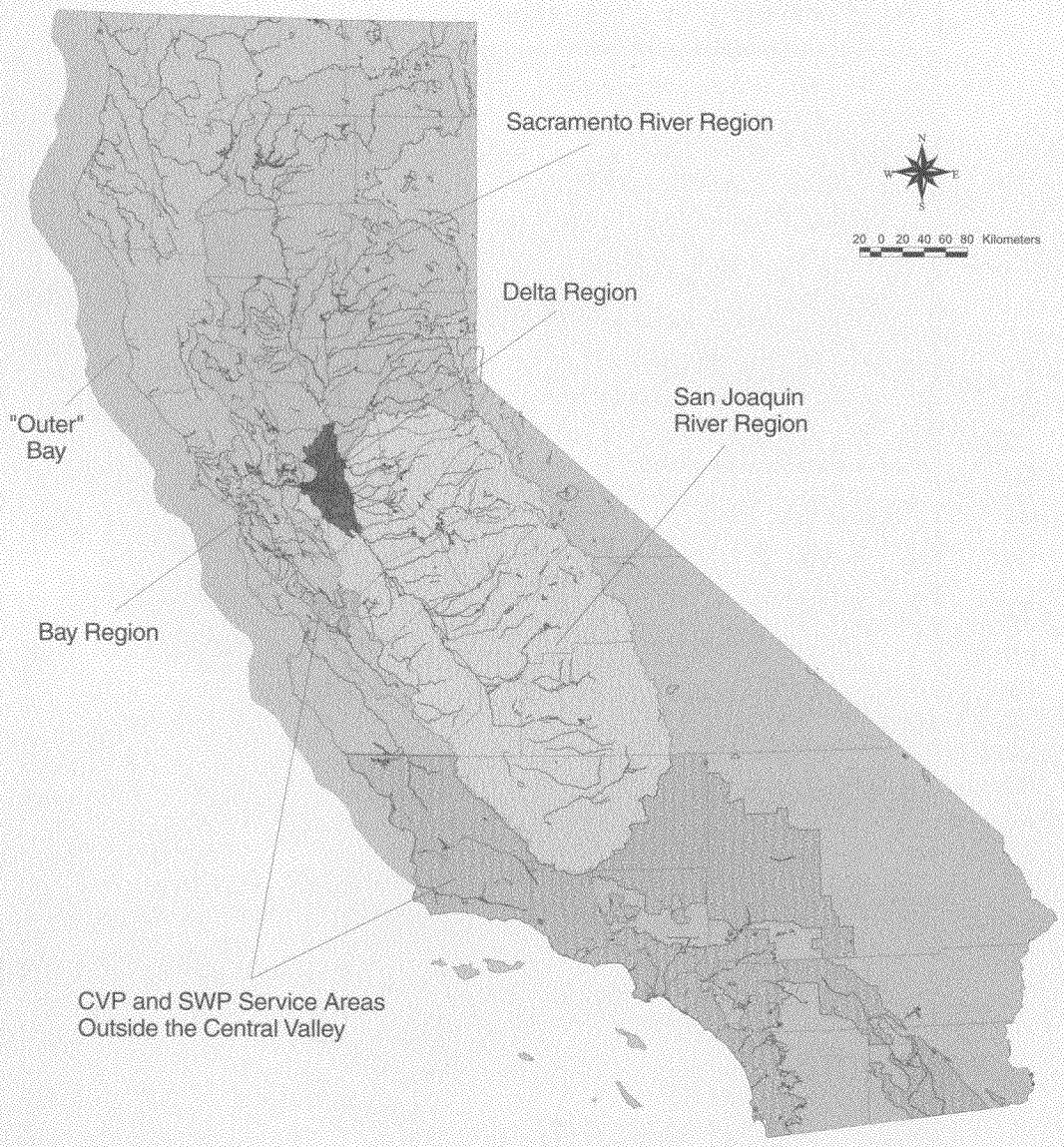

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