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Volume 3

Chapter 12 Sacramento-San Joaquin Delta Region

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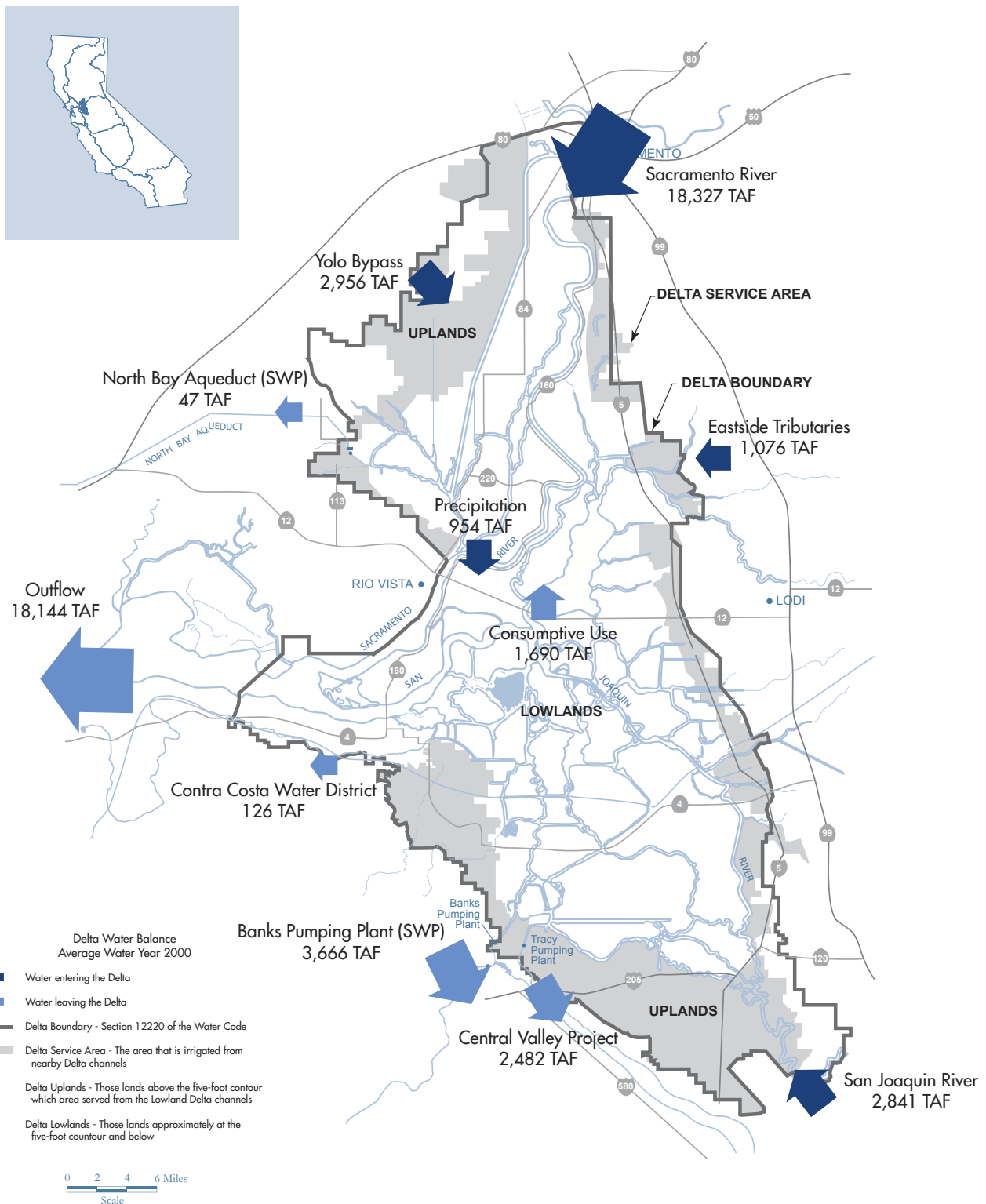
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Figure 12-1 Delta water balance for year 2000



Delta water balance for water year 2000 includes key annual Delta inflows, exports, precipitation, consumptive use, and Net Delta Outflow.

Chapter 12

Sacramento-San Joaquin Delta Region

Setting

Until 1850, the Sacramento-San Joaquin Delta (Delta) was wild, a tidal marsh with islands and river channels that changed according to nature's will. By the 1870s, settlers had built levees and turned marshland into farmland. Farming on a commercial scale became a way of life. The 1870s and 1880s saw the arrival of commercial fisheries that introduced nonnative species—striped bass and American shad. As decades passed, commerce grew, and ocean shipping began using Delta ports to transport goods between California and foreign markets. Along with international shipping came invasive aquatic species unintentionally carried to the Delta in the ballast water of these vessels. By 1951, with completion of the Delta-Mendota Canal, the Delta was forever changed. This federal project for moving water to California's Central Valley farms was the start of large-scale water supply infrastructure that would, with the addition of the State Water Project (SWP) and other smaller projects, evolve into today's multibillion dollar system.

The Delta was formally defined in the Delta Protection Act of 1959 (California Water Code Section 12220) and is composed of The Uplands Zone (lands above the 5-foot elevation contour) and the Lowlands Zone (lands at or below the 5-foot contour line). The statutory Delta Boundary that defines the Legal Delta is shown in Figure 12-1.

This massive network of canals, levees, pumps, and fish screens moves water to farms, industries, and residents hundreds of miles from the Delta. What was once a continually changing tidal marsh with a rich variety of thriving, native species is now a complex maze of natural and man-made resources providing multiple benefits to the California economy.

The challenge the region faces in the 21st century is how to sustain the viability of these resources while demand for them continues to grow.

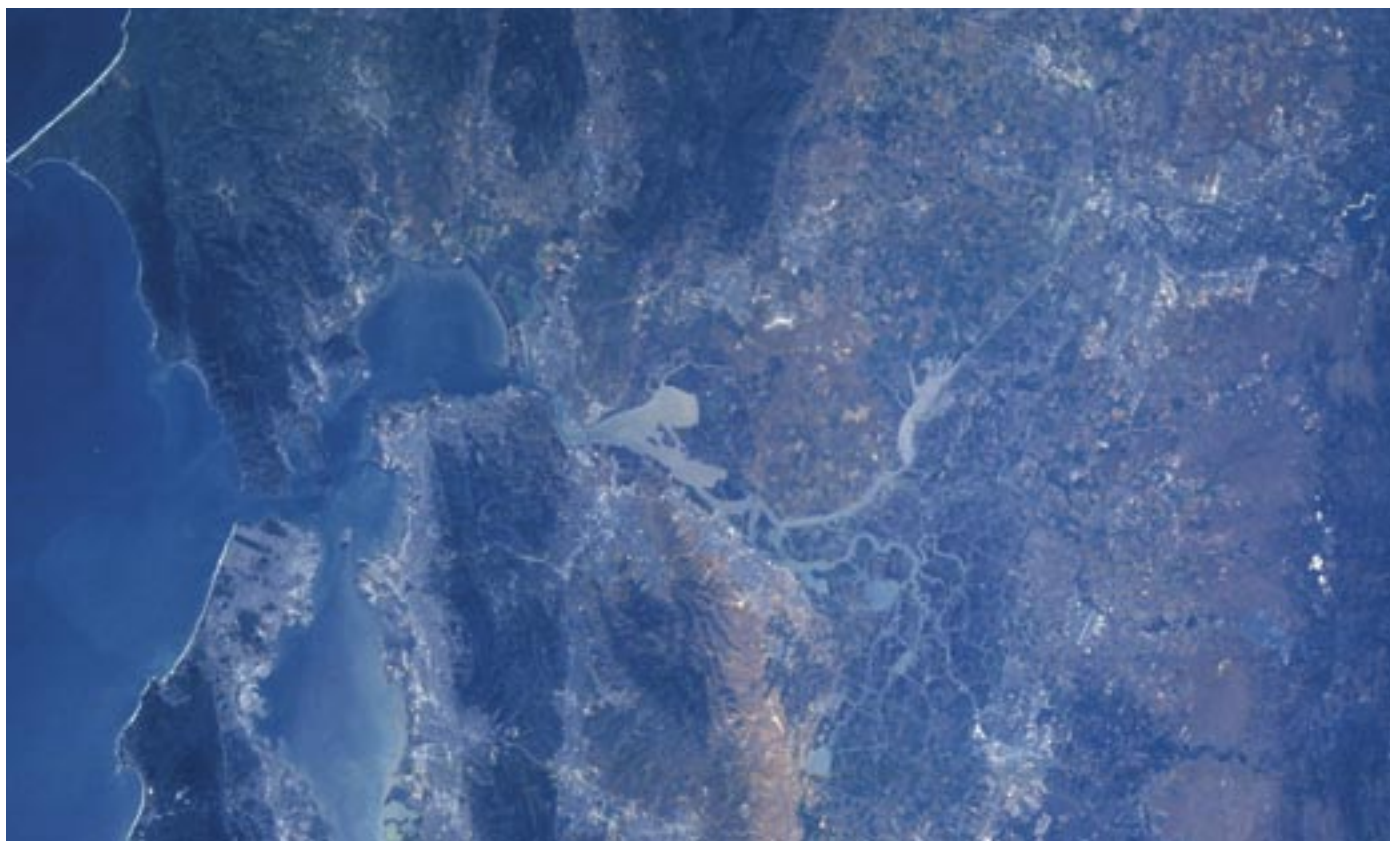
The region's resources must be managed for generations to come. The overarching challenge involves finding ways for all the interests who benefit from the Delta to integrate a vast array of projects intended to improve water quality, ecosystem health, levee stability, and water supply in ways that provide long-term, sustainable benefits at reasonable costs to everyone.

This regional report for the Delta Region is an overview of recent efforts to carry out actions that will help the region to continue to serve society's demand for farm products, fishing, recreation, and water—all while protecting the Delta's ecosystem and water quality. The intent of the profile is to give readers a sense of the region's water resource management priorities and outline major efforts to integrate water resource management activities in the Delta. For more detailed information about actions and projects mentioned in this profile, consult the selected references noted at the end of this chapter.

Topography and Climate

The Delta is a unique and valuable resource and an integral part of California's water system. Located at the confluence of the Sacramento and San Joaquin Rivers, the Delta is part of the largest estuary system on the West Coast and is the keystone to operation of the two largest water projects in California the SWP and the federal Central Valley Project (CVP). The region extends from the confluence of the two rivers inland to Sacramento and Stockton and spans roughly 750,000 acres. A large part of this land is below sea level, and relies on more than 1,100 miles of levees for protection against flooding along the hundreds of miles of interlaced waterways.

The Delta's network of waterways conveys runoff toward San Francisco Bay and the Pacific Ocean from over 40 percent of California's land area. Major tributaries include the Sacramento, San Joaquin, Calaveras, Cosumnes, and Mokelumne rivers. These rivers plus their tributaries carry 47 percent of the state's total annual runoff.



The Delta is at the confluence of the Sacramento and San Joaquin rivers. Its network of waterways conveys runoff toward San Francisco Bay and the Pacific Ocean to the west. (Photo courtesy of NASA)

Land Use

The vast majority of the Delta land is agricultural (about 538,000 acres). These acres are among the most highly productive in the world. Open water covers about 60,000 acres, while urban and commercial property comprises approximately 64,000 acres. The remainder of the region presently consists of undeveloped natural plant vegetation.

Population

The legal Delta encompasses portions of six counties: Alameda, Contra Costa, Sacramento, San Joaquin, Solano and Yolo. According to the census figures used in the 1995 Sacramento-San Joaquin Delta Atlas, the population in the Delta was an estimated 410,000 in 1990. A more recent estimate was obtained using data from the California State Census Data Center for areas of these counties within the legal Delta, indicating that about 462,000 people resided in the Delta region as of the 2000 Census. Figure 12-2 shows a map of population

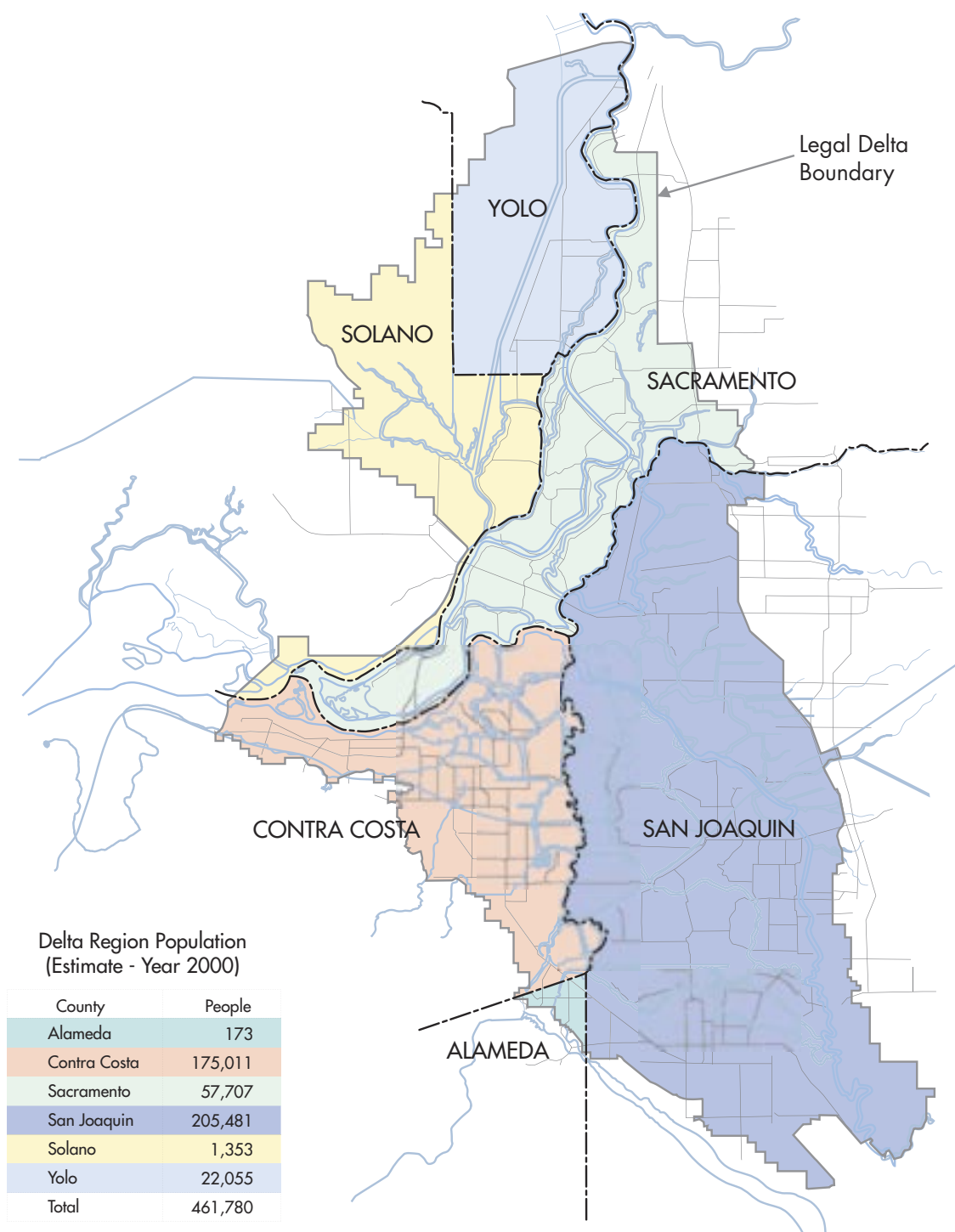
estimates for each of the county areas within the legal Delta. Rapid growth is occurring in urban areas in and surrounding the Delta, especially in Elk Grove (27.0 percent growth per year – the highest growth rate in California), Tracy (5.9 percent per year), Brentwood (12.3 percent per year), and Rio Vista (11.1 percent per year)¹.

Water Use

Water use in the Delta region is mostly agricultural, with over 4,000 cubic feet per second of surface water diversions used to irrigate crops during peak summer months. Irrigation diversions from about 1,800 sites in the Delta total about 1 million acre-feet annually. The main crops grown in the Delta are corn, alfalfa, other grains, tomatoes, and safflower. Grapes are being harvested in increasing numbers within the Delta region, and are quickly becoming one of the primary crops. Table 12-1 shows the approximate number of acres planted in various crops within the Delta Service Area and the associated applied water demand, as of year 2000.

¹ Growth rates are for the period between Jan. 1, 2003, and Jan. 1, 2004, and are from the California Department of Finance, E-1 City Population Estimates, May 5, 2004.

Figure 12-2 Delta region population



Data from California Department of Finance provide decadal population from 1960 to 2000 and population projection for 2030 for Sacramento-San Joaquin Delta.

Table 12-1 Crop Acreage and Applied Water Demand in the Delta Service Area as of 2000 (DWR Central Dist. 2004)

Crop	1,000 Acres	Applied Water (TAF)
Corn	113.2	325
Alfalfa	55.1	298
Other Grains	47.2	51
Processed Tomatoes	36.2	117
Safflower	33.8	26
Pasture	32.4	192
Vine Crops (grapes)	23.6	42
Other Truck Crops (strawberries, chili, etc.)	21.4	56
Other Deciduous Crops (apples, etc.)	18.3	78
Dry Beans	10.2	26
Other Field Crops	9.2	24
Fresh Market Tomatoes	6.6	16
Sugar beets	6.5	28
Cucurbits (cucumbers, gourds, melons, pumpkins)	4.7	10
Potatoes	3.9	12
Almonds, Pistachios	1.8	7
Rice	0.9	5
Onion and Garlic	0.6	2
Subtropical Crops (citrus, kiwis, etc.)	0.1	0.3
TOTAL¹	425.7	1,315.3

¹ The total crop acreage listed here (425,700 acres) is less than the 538,000 acres of agricultural land listed in the Delta Atlas (1991 land survey) for several reasons. The 2000 level in Table 12-1 only includes planted irrigated acres while the 1991 number includes other types of agricultural land, and the 2000 data is for the Delta Service Area – a smaller area than the Legal Delta used in the Delta Atlas. Urbanization of agricultural lands and weather conditions at the time of surveys are among the other reasons.

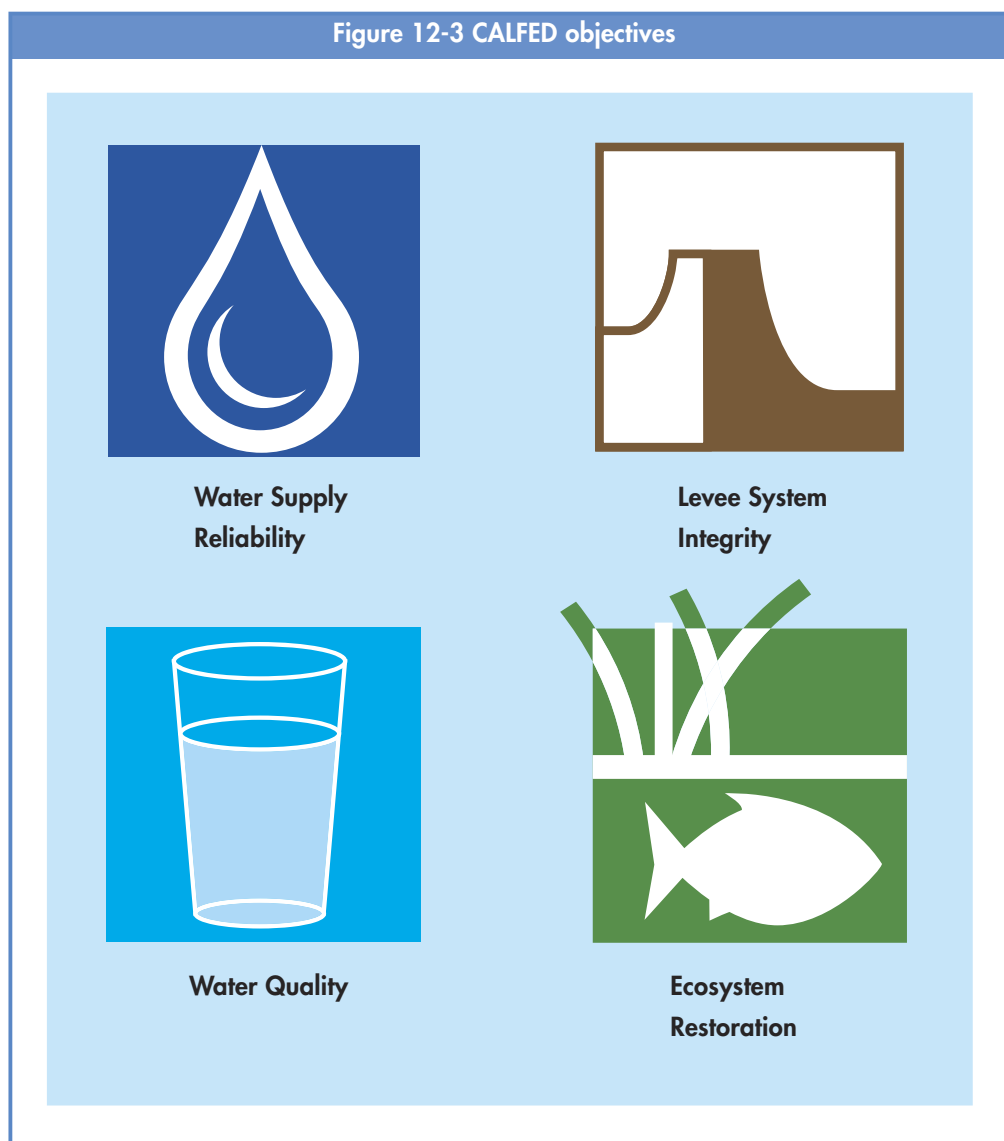
Most Delta farms use water taken directly from Delta sloughs and rivers under riparian water rights, and drainage water from the islands is pumped back into the Delta waterways. Small communities in the Delta primarily use groundwater wells for their water needs, and urban water use in the Delta only accounts for a small percentage of the total developed supply². The remaining portion of water in the Delta is either used by other forms of evapotranspiration or contributes to Delta outflow, through which it can provide wildlife habitat and salinity control benefits. Recreation water uses do not have a large affect on the Delta water balance, but are still important in the Delta, with an estimated 12 million “user days”³ recorded each year for recreation purposes.

Water Exported from the Delta

The Delta is the major source of fresh water to the San Francisco Bay and provides a portion of the water supply for many other communities in the bay region. Water from the Delta supplies drinking water for over two-thirds of the state’s population (over 23 million people) and irrigation water for more than 3-million acres of farmland statewide. The largest source of water for the Delta is the Sacramento River, which transports about 18.3 million acre-feet into the Delta in an average year. Additional flows from the Yolo Bypass and the San Joaquin River bring in an average of 5.8 million acre-feet, with precipitation adding about another 1 million acre-feet. Larger diversions in the Delta include the SWP (Banks Pump-

² One important exception is the Contra Costa Water District, which provides treated Delta surface water to roughly 500,000 people, but not all of the serviced population is within the Legal Delta.

³ A “user day” is a measure of the number of people visiting or using a site over part or all of a given day. Since some recreation users will visit recreation areas more than once each year, the total number of people using recreation facilities over a year in the Delta is less than 12 million.



ing Plant and the North Bay Aqueduct), CVP (Tracy Pumping Plant), and Contra Costa Water District, which withdraw about 3.7 million, 2.5 million, and 126 thousand acre-feet in an average year, respectively. Figure 12-1 shows the primary locations and amounts of Delta inflows, outflows and exports, as they occurred in water year 2000. Table 12-2 summarizes the Delta water balance for years 1998 (wet), 2000 (average), and 2001 (a dry year) and identifies the major water inputs and outputs for the Delta.

Water Standards

Requirements of the State Water Resource Control Board (SWRCB) govern the release of upstream flows and curtailment of export pumping to maintain Delta water quality and outflow

requirements for the San Francisco Bay. The first water quality standards for the Delta were adopted in May 1967, when the State Water Rights Board (predecessor to the SWRCB) released Water Right Decision 1275, approving water rights for the SWP while setting agricultural salinity standards as terms and conditions. These requirements were altered in 1971 under SWRCB Decision 1379 (D-1379), which added standards that the CVP and SWP are to meet for non-consumptive uses (water dedicated to fish and wildlife), along with agricultural, municipal, and industrial consumptive use standards. In 1978, the SWRCB issued D-1485 and the 1978 Delta Plan, which together revised flow and salinity standards and required the US Bureau of Reclamation (USBR) and Department of Water Resources (DWR) to reduce pumping, release stored water upstream, or both when needed to meet the standards.

Table 12-2 Water Balance for the Delta Region (IEP Dayflow Data TAF)

Water Entering the Region	1998 (wet)	2000 (average)	2001 (dry)
Precipitation	1,421	954	762
Sacramento River	28,964	18,327	10,499
Yolo Bypass (incl. Sac. Weir spill and South Putah Cr.)	8,980	2,956	366
San Joaquin River	8,441	2,841	1,729
Cosumnes River	785	372	116
Mokelumne River	969	360	127
Misc. Eastside Tribs.	339	344	128
Total	49,899	26,155	13,727
Water Leaving the Region			
Consumptive Use (Gross Channel Depletion for Ag, M&I, Wetlands, ET)	1,688	1,690	1,688
SWP Exports			
Banks Pumping Plant	2,111	3,666	2,599
North Bay Aqueduct	39	47	45
CVP Exports	2,470	2,482	2,328
Contra Costa WD Exports	160	126	104
Outflow to Bay/Ocean	43,430	18,144	6,963
Total	49,899	26,155	13,727

In 1986, Congress passed the CVP-SWP Coordinated Operation Agreement (Title I of Public Law 99-546), requiring that the CVP be operated in coordination with the SWP to meet state water quality standards. Also in 1986, the Supreme Court upheld the Racanelli Decision, which recognized SWRCB authority and discretion over water rights and water quality issues, including authority over CVP operations. As a result of increasing use of Delta waters combined with escalating environmental and fishery problems, the SWRCB adopted a new Bay-Delta Plan in 1991, which included objectives for salinity, dissolved oxygen, and temperature. The United States Environmental Protection Agency (EPA) followed with federal standards for the Estuary through EPA regulations in 1994. In December of 1999, the SWRCB issued a new Decision 1641 as a part of the 1995 Bay-Delta Water Quality Control Plan, which replaced earlier Delta standards and conditioned the water rights permits of the SWP and CVP to implement the new objectives. The requirements set in D-1641 covered Phases 1 – 7 of the Bay-Delta Water Rights Hearings. In April of 2001, the SWRCB went on to adopt Water Rights Order 2001-05, which facilitates negotiations to settle the responsibilities for implementing and maintaining the 1995 WQCP.

Currently the SWP and the CVP coordinate project operations to maintain the standards established by D-1641, by

releasing water from upstream reservoirs for Delta outflow requirements, and by curtailing export pumping at the SWP Banks and CVP Tracy Pumping Plants during specified time periods. This combination of Delta outflow requirements and export pumping limitations impose the most difficult challenges to the process of transporting water from upstream reservoirs to meet water needs in the San Joaquin Valley, San Francisco Bay Area, and Southern California.

CALFED Bay-Delta Program

The mission of the CALFED Bay-Delta 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 Sacramento – San Joaquin Bay-Delta system. The plan was adopted by CALFED agencies when they signed the Record of Decision on August 28, 2000, approving a 30-year comprehensive plan. The ROD identifies priorities for implementing the plan for the first seven years and describes additional actions complementary to the plan. Since the ROD was adopted, CALFED agencies have been investing in collaborative regional projects that provide local benefits while helping achieve overall program objectives.

Some of the major water-related challenges facing the Delta have been summarized by the Bay-Delta Authority as “priorities and issues” for the region:

- Restore healthy ecosystems to benefit native species.
- Preserve a viable agricultural base.
- Maintain strong levees.
- Protect water quality for agricultural and urban water users in and around the Delta.
- Protect and increase recreational opportunities.

These goals incorporate the four broad CALFED resource management objectives of water supply reliability, water quality, ecosystem restoration, and levee system integrity, and respond to concerns expressed by stakeholders in the Delta and other regions of the state (Figure 12-3).

Authorized by the Delta Protection Act of 1992, the Delta Protection Commission (DPC) is the regional entity charged with protecting the natural, agricultural, and recreational resources of the Delta. The Act required the DPC to develop and adopt a resource management plan for the primary zone of the Delta (defined in Public Resources Code Section 29728). The DPC’s mission is to guide the protection of the Delta’s unique natural quality, cultural viability, economic viability, and recreational opportunities using three main objectives:

- Protection, maintenance, and enhancement and restoration of the overall quality of the Delta environment including agriculture, wildlife habitat, and recreational activities;
- Assurance of orderly, balanced conservation and development of Delta land resources; and
- Improvement of flood protection to ensure an increased level of public health and safety.

The CALFED Program, its implementing agencies, and the DPC recognize that activities of the CALFED Ecosystem Restoration, Conveyance, Storage, and Levee System Integrity program elements must be in concert with the Delta region’s land use and recreation objectives. Therefore, CALFED and the DPC coordinate activities on a regular basis.

State of the Region

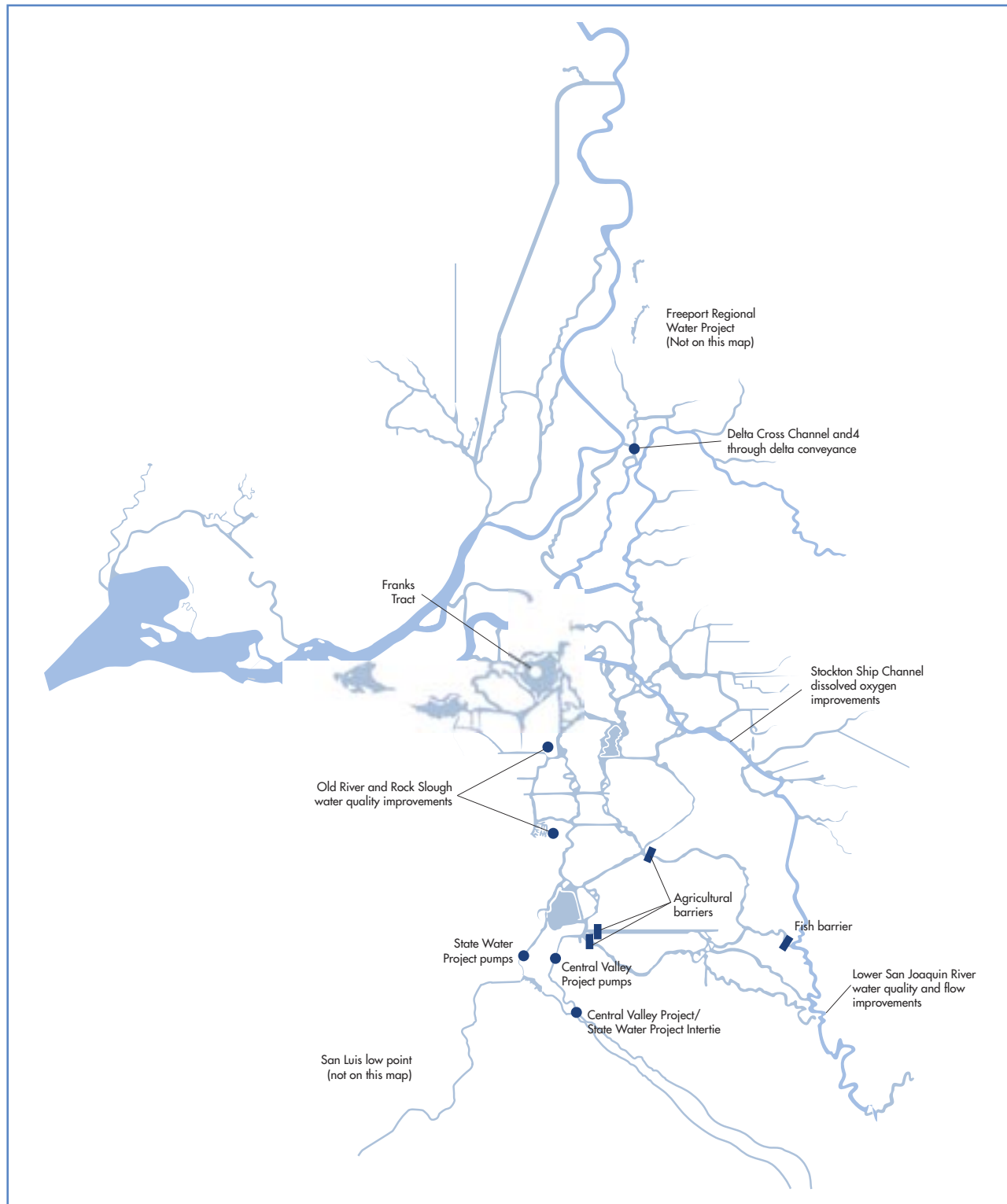
The Delta is a focal point for water management, ecosystem restoration, land use planning, and other major initiatives in California. The Delta Improvements Package, which has been identified as a critical CALFED implementation mechanism, is focused on actions within the Delta. Over \$155 million has already been spent on ecosystem projects, studies, and acquisition within the Delta through this Bay-Delta Program. Urban encroachment in the Delta is becoming a critical issue, and some of the fastest growing communities in the state can be found within and around the Legal Delta. Concerns over increased water diversions from northern to southern California are based on pumping operations within the Delta. The Delta is, and will likely continue to be, a hot spot for both controversy and innovation in terms of resource management.

Two of the agencies identified with key planning roles in the Delta are the California Bay-Delta Authority and the Delta Protection Commission (DPC). The Bay-Delta Authority is responsible for implementing the Bay-Delta Program (Box 12-1). The DPC comments on applications for CALFED ecosystem restoration grants that affect the Delta and participates in meetings with other CALFED agencies to provide input to CALFED Program management decisions. DPC staff also provides input to the following BDPAC subcommittees: Working Landscapes Subcommittee (created to pursue partnerships with private landowners in meeting CALFED ecosystem, water quality, levee, and water supply reliability goals); the Delta Levees and Habitat Advisory Committee; and the Ecosystem Restoration Subcommittee. Many projects and programs are being carried out to address local and statewide needs related to the Delta. The stakeholders involved in Delta implementation issues are increasingly aware of how complex and interrelated solutions must be to avoid adverse impacts to other stakeholders and to provide long-term, comprehensive management of Delta land and water resources. Some of the major implementation issues and achievements to date are summarized below.

Box 12-1 California Bay-Delta Authority

The California Bay-Delta Authority officially became a State agency in January 2003. The authority oversees implementation of the CALFED Bay-Delta Program to improve water supplies in California and the health of the San Francisco Bay–Sacramento/San Joaquin River Delta. The organization and focus of this Authority is being reviewed and changed in 2005.

Figure 12-4 Proposed Delta gates map



Water Supply Reliability

Because water users within the Delta divert directly from adjacent channels running through the Delta, they normally have immediate access to water. However, water levels in these channels are influenced by river inflows, ocean tidal levels, and CVP and SWP operations, especially diversions at the south Delta export pumps. Lower water levels in the south Delta channels can make it difficult for local irrigators to pump or siphon the water from the channels to their farmlands. In addition, the flow of water to the export pumps can sometimes draw water with a higher salinity into the south Delta from the western Delta.

To help address these water level problems, CALFED agencies provide assistance in creating temporary barriers in portions of the Delta to raise water levels and improve water quality for irrigators. The Environmental Water Account helps improve water supply reliability by acquiring water from willing sellers to compensate for lost supplies during periods of export pumping curtailment for fish protection.

Longer-term solutions involving the installation of flow control gates are being analyzed as part of the South Delta Improvements Program (see figure 12-4), which would eventually make possible increased pumping operations at Banks Pumping Plant to 8,500 cubic feet per second during acceptable periods of the year. Design and environmental reviews of the SDIP are ongoing. Other water supply activities in the Delta currently under investigation by CALFED include: adding an intertie between the CVP and SWP canals south of the Delta; re-operating the Delta Cross-Channel (DCC) for the benefit of fish and water quality; and feasibility studies for an in-Delta storage project. Thus far, modeling studies for the CVP-SWP intertie and two years of research experiments on DCC re-operation have been completed. In addition, a draft report about the engineering feasibility of the in-Delta storage project has been published for review and consideration.

Water Quality

The Delta is a source of drinking water for over 23 million Californians, which underscores the importance of carefully managing water quality in the region. Key drinking water constituents that are of concern are bromide and organic carbon, because they are known to contribute to the production of trihalomethanes (THMs) during the drinking water chlorination process. There are a wide range of water quality issues in the Delta, and several different initiatives have been organized in response.

Salinity

The impact of salinity on water quality in the Delta is important and directly related to water supply reliability. The balance between ocean tides, river outflows, salinity input from agricultural and urban drainage, export pumping rates, and other factors directly impacts aquatic health in the Delta and the public health of those who use Delta drinking water. One problematic component of water salinity is bromide, which is known to produce trihalomethanes (THMs) during drinking water chlorination. THMs are known carcinogens and are subject to strict federal drinking water quality standards. South Delta agricultural diversions are often faced with high levels of water salinity, which can damage crops and reduce productivity. DWR's South Delta Temporary Barriers Project is designed to limit saltwater intrusion into areas with agricultural diversions, while also raising Delta water levels (Figure 12-5).

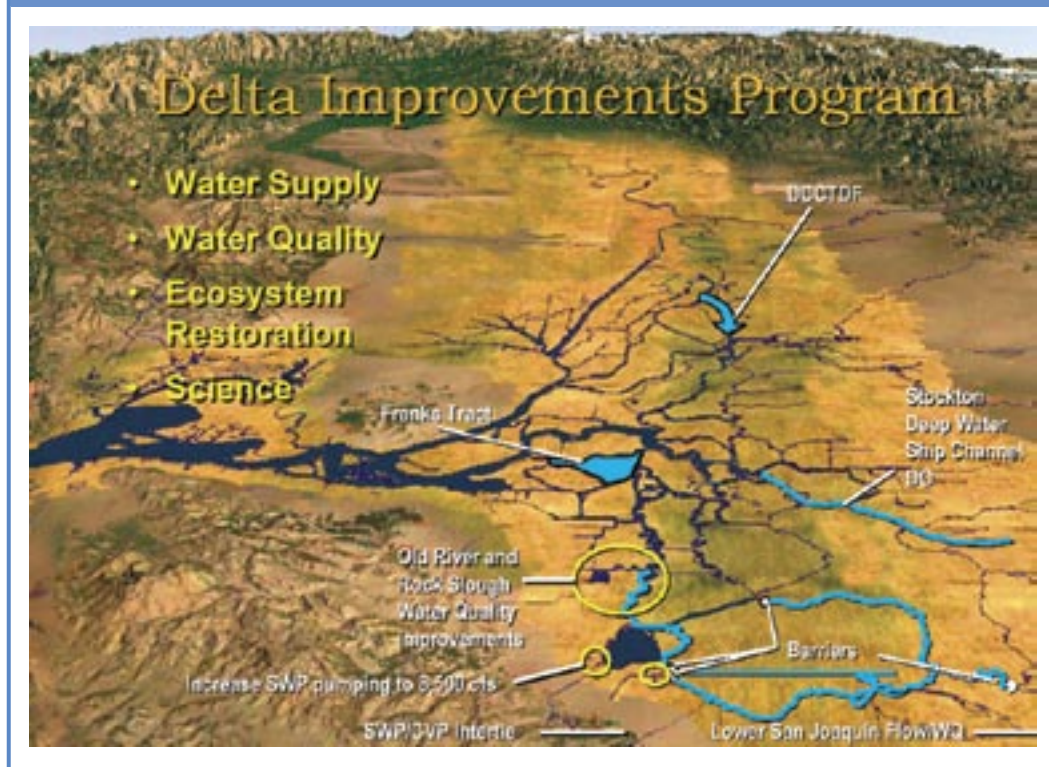
Mercury

Mercury can be found in waterways throughout the Delta as a result of historical mining activities that were widespread throughout the Sacramento Valley, such that the entire Delta is presently on the SWRCB's 303(d) list⁴ for sources of mercury. Miners used mercury to separate gold from rock in the Coast Range, and abandoned gold and mercury mines continue to leach mercury today. While mercury in its natural form is usually not easily transmitted into living organisms, some natural processes encourage conversion to methyl mercury, which is a powerful neurotoxin that accumulates in fish tissue and is harmful to animals and humans. Restoration of wetlands has faced increasing scrutiny because the conversion of mercury to methylmercury (that is, methylation) may be encouraged by certain natural wetland processes.

In response to this threat, research is now under way to study mercury transport, how to reduce the risks associated with human exposure, and potential methods to reduce methylation—particularly in restoration activities. The CALFED Ecosystem Restoration Program (ERP) has invested over \$4 million in two research projects that investigated a wide variety of mercury issues, and culminated in a "mercury strategy" developed by a team of independent mercury experts. The new strategy includes recommendations for how to carry out future restoration work while minimizing methylation impacts. A more intensive follow-up study is now under way to expand on this knowledge and reduce the levels of uncertainty.

⁴ The Clean Water Act requires that states and territories identify impaired and threatened water bodies that are not expected to meet water quality standards, as outlined in Section 303(d) of the Act. These lists result in the development of Total Maximum Daily Loads (TMDLs), which establish the maximum amount of pollutants the water body can receive while still meeting water quality standards.

Figure 12-5 Delta Improvements Program



The Department of Conservation with assistance from ERP has created two workgroups to deal with mercury source issues related to abandoned mines. A “fish consumption workgroup” has also been organized to coordinate funding and management efforts between the various agencies in order to educate people about reducing consumption risks resulting from mercury contamination. Other agencies and organizations working to address mercury include the Delta Tributary Mercury Council, the Central Valley Regional Water Quality Control Board, the San Francisco Bay Regional Monitoring Program, the Office of Environmental Health Hazard Assessment (OEHHA), the Department of Health Services, the San Francisco Bay Regional Water Quality Control Board, EPA, the Sierra Trinity Abandoned Mine Lands Agency Group, and the Bay-Delta Public Advisory Subcommittee on Environmental Justice.

Dissolved Oxygen (DO)

Current water quality standards call for at least 5 milligrams per liter of dissolved oxygen in Delta water to protect aquatic organisms (including fish), allow for successful fish reproduction and juvenile rearing, and prevent odor problems. Discharges into the San Joaquin River and the Delta sometimes contain material with a high biochemical oxygen demand or a high

nutrient level, which can encourage algae growth and trigger subsequent oxygen depletion. These discharges, along with depleted freshwater flows, channel configuration, and water temperatures, have resulted in isolated areas in the Delta with DO levels below the current standard. On the San Joaquin River, low DO levels may pose a barrier to fall-run salmon migrating upstream to spawn.

The DO problem is not a new phenomenon, and has been studied for some time. DWR and the Inter-agency Ecological Program (IEP) have maintained monitoring efforts on the San Joaquin River and the Stockton Deep Water Channel since the 1980s. CALFED ERP expenditures of about \$4 million have been spent on monitoring and research activities related to DO, including development of models to better understand thermal stratification in the San Joaquin River. ERP has also begun a feasibility study for using water aeration techniques to increase DO levels, and several aeration and nonaeration methods are under development.

Organic Carbon (TOC)

Organic carbon is itself not a harmful constituent—In fact it is essential for aquatic life (Box 12-2). Problems occur when water containing high levels of organic carbon is treated in

drinking water treatment plants, which use chemicals to inactivate harmful pathogens. Some forms of organic carbon react with these beneficial disinfection agents, such as chlorine, and produce potentially carcinogenic disinfection byproducts (for example, trihalomethanes). Since wetland restoration efforts could potentially increase the level of vegetation and organic carbon in Delta water supplies, there may be conflicting objectives between ecosystem restoration and water quality initiatives, as is also the case with mercury.

Because some organic carbon processes are still poorly understood, much of the current work is focused on investigating how carbon is used in the aquatic food web and how natural and anthropogenic factors affect the type and amount of organic carbon released into the system. As part of approximately \$10 million in funds designated for CALFED ERP organic carbon projects, one research project, funded jointly with the CALFED Drinking Water Quality Program, is attempting to determine if coagulants could be used to remove organic carbon from Delta island drainage. The U.S. Geological Survey (USGS) is spearheading much of the organic carbon efforts, working in conjunction with ERP. The CALFED DWQ Program is also involved, investing \$1.7 million in 2003 in four drinking water quality projects to monitor and assess organic carbon sources and processes in the Delta. DWR's Municipal Water Quality Investigations (MWQI) Program has also funded organic carbon projects in the Delta, including real-time monitoring, source assessment, and studies of byproduct formation potential.

Selenium

Selenium enters the Delta region from multiple sources, including groundwater discharges from selenium-containing soils, agricultural runoff, and refinery water input from the San Francisco Bay. Selenium, like mercury, bioaccumulates in aquatic life and has been shown to have negative effects on fish and waterfowl. High selenium concentrations could cause disruptions in drinking water and agricultural water deliveries, and are often correlated with high salinity levels as well.

CALFED's ERP is currently implementing several projects to study the sources, transport, and biological affects of selenium in the Delta. One ERP project is also examining the potential for using bacteria to reduce selenium contamination in agricultural return water. The DWQ Program is also coordinating projects that focus on selenium in irrigation drainage water from the San Joaquin Valley.

Other agencies involved with the selenium issue include the USGS, which has worked on ERP projects and other initiatives to forecast selenium discharges and study its affects on the aquatic environment. In the San Joaquin Valley, USBR and the San Luis & Delta Mendota Water Authority have successfully developed the Grasslands Bypass Project to reduce selenium loads in agricultural drainage water before it enters the San Joaquin River. Both the Central Valley and San Francisco Regional Water Quality Control Boards are now developing Total Maximum Daily Loads (TMDLs) for the San Joaquin River and San Francisco Bay, respectively. The University of California, Davis has also participated in selenium research, particularly with bioaccumulation and the use of microalgae to treat agricultural drainage water.

Pesticides

Pesticides include insecticides, herbicides, fungicides, and other substances used to prevent, destroy, repel, or prevent pests. In the Delta, several types of chemical pesticides are widespread, including organophosphates, organochlorines, and pyrethroids. Each of these materials has certain risks for humans and aquatic organisms because they are, by design, meant to disrupt biological processes⁵.

Organophosphates (also called organophosphorous pesticides) affect the nervous system and were used in World War II as nerve agents in addition to being used as insecticides (such as chlorpyrifos and diazinon). While usually not persistent in the environment, organophosphates have been found in the Bay-Delta watershed and could impact the distribution and abundance of aquatic species. Organochlorines, which

Box 12-2 Organic Carbon

Organic carbon can be found in different forms in nature, including dissolved organic carbon (DOC) and particulate organic carbon. Total organic carbon (TOC) is a measurement of all forms of organic carbon, and is usually primarily made up of DOC. The sources and fate of DOC and TOC are nearly identical, and the terms are often used interchangeably.

⁵ Much of the pesticide information is taken from U.S. EPA Pesticide Program Web site (www.epa.gov/pesticides).

include DDT and chlordane, were used extensively in the past but now are much less widely used because of their toxicity and persistence. Like mercury, organochlorines accumulate in fish tissue and could contaminate humans and animals who consume them. Pyrethroids are synthetic versions of a naturally occurring pesticide in chrysanthemums, and some forms can be extremely toxic to the nervous systems of fish and invertebrates. Pyrethroids are becoming more widely used, but current monitoring equipment is unable to measure concentrations in the environment.

Several projects are now under way to evaluate practices that could reduce pesticide and fertilizer use in the Delta, limit urban pesticide applications in Sacramento and Contra Costa counties, and to study the impact of pesticides on aquatic life. CALFED ERP is involved with many of these efforts, along with a study to develop water quality criteria for the organophosphates diazinon and chlorpyrifos.

Toxicity of Unknown Origin

In addition to the above described constituents that are known to impact organisms in the Delta, there is the possibility that other substances yet to be identified may be contributing to toxicity problems. The CALFED ERP is funding several projects to monitor and attempt to identify the source of certain episodes of toxicity in the Delta. Studies regarding splittail and delta smelt exposures to unknown toxics are being conducted as part of the ERP projects. An implementation plan is also being developed to reduce toxicity associated with these as-of-yet unknown materials.

There are many other constituents and issues related to water quality that are important in the Delta region. Like some forms of organic carbon, bromide, which is a component of salinity, can produce disinfection byproducts when treated with certain, necessary disinfection processes used in domestic water treatment plants. Various pathogens are also present in Delta waterways, and the CALFED DWQ Program is leading several projects to assess pathogen fate and transport from human and animal sources, including animal feeding operations and recreational water use. DWR's MWQI Program is also funding pathogen studies related to hydrostatic pressure, pathogen survivability, and confined animal feeding operations. Sediment is another issue of concern, particularly with respect to dredging operations to maintain the Stockton and Sacramento deepwater ports, which may re-suspend contaminants (from sediment) that are toxic to aquatic life. The US Forest Service has been involved in projects to reduce sediment

loading, along with the CALFED watersheds, DWQ, and ERP programs. In addition, studies are under way to model and evaluate water quality improvements that could be achieved from proposed Delta conveyance and storage alternatives.

Ecosystem Restoration

Over the past century, the health of the Delta ecosystem has declined in response to the reduction of habitat for both aquatic and terrestrial biota. Remaining habitat quality has also declined due to several factors including water diversions, toxic pollutants, and the introduction of exotic species. In fact, few aquatic ecosystems in North America have been invaded and changed by as many exotic species as those in the Bay-Delta. The Delta no longer provides the broad diversity or quality of habitat necessary to maintain ecological functions and support healthy populations of native plants and animals. Conversion of agricultural land to accommodate ecosystem improvements under the Bay-Delta Program could provide some relief, but these actions are also a major concern for Delta agricultural interests, who rely on the land for their economic survival.

During the past several decades, as water diversions and the recognition of environmental water needs have increased, so have the conflicts among different interests. Water flow and timing requirements have been established for certain fish and wildlife species in response to declining fish and wildlife populations. These requirements restrict the amount of water that can be diverted from the Delta, and constrain the time over which these withdrawals can be made. Over the past decade, a number of other protective actions have been implemented to protect fish and wildlife, including the Central Valley Project Improvement Act (CVPIA) and the 1994 Bay-Delta Accord. While the programs that have resulted have helped provide flows and habitat essential to endangered and threatened species, they have also reduced the ability of the CVP and SWP to meet the water demand of their contractors at the time of year that supplies are needed. This timing issue has contributed to the false perception of a zero-sum game, in which ecosystem or water supply interests can only benefit to the other's detriment, and has created heightened tension between various groups.

To address ecosystem health issues, the CALFED ERP has invested in cooperative projects such as wildlife-friendly agricultural practices, which have shown that different interest groups do not have to compete against each other to prosper in the Delta. Other ecosystem efforts underway include wetlands protection studies, invasive species eradication initiatives, and fish studies to monitor the effects of pesticides on aquatic health. About \$155 million has been spent on 107 ecosystem projects

in the Delta, representing one of the largest investments in ecosystem restoration in the United States. The ERP has also funded major studies to examine the effects of pesticides on fish in the Bay-Delta system and the release of dissolved organic carbon and methyl mercury from restored wetlands.

Closely associated with ERP, the CALFED Multi-species Conservation Strategy (MSCS) is a comprehensive regulatory plan for the CALFED Program developed in accordance with the federal Endangered Species Act (ESA), the California ESA (CESA), and the Natural Community Conservation Planning Act (NCCPA). The MSCS establishes the programmatic State and federal regulatory requirements for numerous species and habitat types within the MSCS-ERP Focus Area. By implementing and adhering to the MSCS, the CALFED Program can be implemented in compliance with the ESA, CESA, and NCCPA.

Levee System Integrity

The Delta levees confine flow to channels and protect Delta lands from daily flooding by the tidal fluctuations. Without the levees, the Delta would be a 740,000-acre brackish inland sea. In the late 1800s and early 1900s, levees were originally built using the peat soils native to the Delta. This material is weak and highly compressible, which has left many of the levees vulnerable to failure, especially during earthquakes or floods.

The high organic content in the soil contributes to rapid decomposition and settling, and decreases the integrity of the levee structures and their ability to hold back water flows. Delta island farmland, residential land and homes, wildlife habitat, and critical infrastructure could be flooded as a result of a levee failure. Flooding in the Delta has historically resulted in millions of dollars of damages. The State formed a partnership with local agencies in 1986 to improve the condition of the extensive Delta levee system. As a result of that partnership, a new levee maintenance assistance program was implemented, and incidents of levee failure from winter floods have decreased compared to prior years.

Levee failures during the summer (the most recent in June 3, 2004) or fall that inundate islands under non-flood conditions can also cause impacts by pulling salty water into the Delta from San Francisco Bay. The resulting increased salinity in the Delta could shut down CVP and SWP exports from the Delta until fresh water inflows return. Increased salinity in the Delta would be of particular concern in a low water year, when less freshwater is available to flush the salt out of the Delta. This damaging

scenario occurred in 1972, when the Brannan-Andrus Island levee failed, resulting in the depletion of about 400,000 acre-feet of water supplies and requiring the removal of about 50 tons of salt. Long-term flooding of specific Delta islands could also affect water quality over a longer time horizon by changing the rate of saltwater intrusion and the area of the mixing zone. A long interruption of water supply for in-Delta uses and exports would affect both urban and agricultural users, until the salt water could be flushed from the Delta channels.

CALFED's Levee System Integrity efforts work in conjunction with the DWR Delta Levees Program to maintain and strengthen the levee system. DWR in turn works with local groups and agencies, particularly with reclamation boards, to assist in the planning and funding of levee projects. Under Base Level Protection efforts, non-project levees⁶ are maintained and strengthened, with the ultimate goal of bringing all appropriate levees to a uniform base level of protection. DWR also provides partial funding and assistance for CALFED's Special Improvement Projects, which help establish protection above base level standards in regions with particular public interests – such as highly populated islands. Special cost share requirements are used with levee projects, which allocate costs between the local participants and the State, and DWR oversees two funding mechanisms that are used to provide the State contribution.

In addition to levee maintenance and enlargement, other levee-related efforts include levee subsidence studies, emergency response coordination (including the distribution of flood fight boxes containing emergency materials such as sandbags and hand tools), analysis of levee risks associated with seismic events, and dredged material management. The Levee System Integrity efforts have incorporated a number of ecosystem-related projects, such as the habitat development work currently underway at Decker Island, and certain provisions of the Program require that levee activities must result in net habitat improvement. Other agencies involved with the Delta Levee efforts include the U.S. Army Corps of Engineers and the California Department of Fish and Game, which serve along with DWR as Implementing Agencies of the Levee System Integrity Program.

Recreation

According to figures used in the 1995 Sacramento-San Joaquin Delta Atlas, the Delta is estimated to support more than 12 million recreational user days a year. According to surveys conducted in 1996 by the Delta Protection Commission (DPC) and the Department of Parks and Recreation (DPR), 23.5

⁶ A "non-project" levee is defined by State Water Code as "a local flood control levee in the delta that is not a project facility under the State Water Resources Law of 1945".

percent of registered boat owners and 23 percent of licensed anglers in the State of California participated in recreation activities within the Delta. Fishing, cruising, water skiing, swimming, and sailing are all popular ways of recreating in the Delta, as well as sightseeing and wildlife viewing. As a result of the growing population within the Delta and across the State, the popularity and use of the Delta as a major recreational location is expected to increase.

The DPC, DPR, and the Department of Boating and Waterways (DBW) have important oversight and regulatory roles for Delta recreation. In addition to the 1996 surveys, DBW cooperated with DPC's Recreation Citizen's Advisory Committee in December of 2002 to produce a Boating Needs Assessment, which inventoried existing recreational boating infrastructure in the Delta and projected future boating needs.

This assessment followed a 1995 Report conducted by DPC, which made recommendations to improve recreation conditions and access. A detailed Delta Recreation Master Plan is currently being prepared by the Delta Protection Commission, with assistance from DPR and the California Coastal Commission. The first phase of this study addresses Delta user and facility needs for water-based and water-enhanced recreation. The resulting estimates of recreation use in the Delta confirm that recreation is a key component in management of Delta resources. When completed, the second phase of this master plan will focus more on land-based recreation needs, and present a "big picture" summary of all recreation within the Delta. As a public resource and economic benefit, recreation opportunities in the Delta are highly valued.

Looking to the Future

On a long-term continuing basis, a wide variety of studies and projects are being undertaken to protect water quality, maintain and improve ecosystem health, maintain the stability of levees, and improve water supply reliability (Box 12-3). Most of these activities are being conducted by state and federal agencies in partnership with local landowners and Delta interests, and many of the major projects are critical to implementing the CALFED Bay-Delta Program Plan.

Efforts are continuing to develop major programs and projects that are intended to address long-standing Delta water management issues. Interest groups and government agencies are grappling with how to package interdependent actions and programs in a manner that will protect the Delta's water quality and ecosystem, and keep the levee system stable. Among the many challenges facing this effort is the issue of how to reconcile the engineering and technical realities with the economic and political realities.

CALFED implementing agencies, in conjunction with other Delta interests, are attempting to move critical projects forward through the Delta Improvements Package. These projects are outlined in the CALFED Bay-Delta Program Record of Decision (ROD), which calls for balanced implementation of CALFED program elements. In the Delta Region, implementation of the CALFED resource management objectives includes the following priorities: improving the environment so that threatened and endangered species populations can recover; making continual improvements in Delta water quality; increasing conveyance

Box 12-3 Ongoing Planning Efforts

- American Farmland Trust study of Delta agriculture.
- Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) for the Delta, lead by DFG.
- SAFCA study of new flood control projects for Sacramento and West Sacramento in Yolo Bypass.
- Yolo Flyway Center – proposed public education facility adjacent to Yolo Bypass.
- Delta Science Center – proposed public education facility at Big Break Regional Shoreline (East Bay Regional Park District).
- Rio Vista--proposed public education and recreation facility at former military property recently transferred to City of Rio Vista.
- New Research Facility proposed by CALFED Science Consortium at former military property recently transferred to City of Rio Vista.
- Delta Protection Commission study of Delta recreation
- California Bay-Delta Authority, various investigations for implementation of the Bay-Delta Plan

capacity of the Delta pumping plants (to improve water supply reliability statewide); assuring adequate water levels for agricultural diversers; and improving levee system integrity.

The Delta Improvements Package is a framework for moving forward in several of these areas simultaneously while making considerations beyond what is required by the ROD. For example, although the CALFED ROD did not require that Delta water quality improvements occur before increasing the pumping capacity of Delta pumping plants, DWR and USBR are working with Delta interests to improve salinity levels in the south Delta while proceeding with studies for the SDIP, which is included as a part of the overall Delta Improvements Package.

The following is a summary of major programs and actions that are critical to achieving desired benefits for the Delta region. In addition to listing major project milestones established for Stage 1 (years 1 through 7) of the CALFED Bay-Delta Program, other Delta initiatives, including recreation efforts, are also included.

Water Supply Reliability

Many of the proposed future water supply activities in the Delta are included as part of the Delta Improvements Package, while others are being considered independently as described below.

Delta Improvements Package

The Delta Improvements Package (DIP) could eventually include several components related to water supply reliability:

- South Delta Improvements Project/8,500 cfs – Under the SDIP, permitted pumping at Banks Pumping Plant would be increased to 8,500 cfs. To mitigate the affects of the higher pumping rate, interim actions would be taken to maintain water levels for South Delta agriculture, protect water quality, prevent fish entrainment, and comply with environmental obligations. More permanent mitigation measures would include the construction of permanent operable barriers, development of a comprehensive San Joaquin River Salinity Management Plan, construction of water quality projects for Old River and Rock Slough, complying with Natural Community Conservation Planning Act⁷ (NCCPA) and ESA requirements, and developing a long-term Environmental Water Account.

- SWP/CVP Integration Plan – Excess capacity at Banks Pumping Plant, part of the SWP, could be used to convey up to 50,000 acre-feet of Level 2 CVP refuge water in return for using up to 37,000 acre-feet of CVP water to meet SWP in-basin water quality and flow requirements. These quantities could be raised if pumping at Banks is allowed to reach 8,500 cfs.
- SWP/CVP Intertie – SWP and CVP operations could be more closely linked through the construction of an intertie between the California Aqueduct and the Delta-Mendota Canal just south of the Delta. This intertie would provide enhanced flexibility between the two systems, and create additional conveyance capacity for the CVP.

In-Delta Storage Project

DWR and USBR are also investigating the In-Delta Storage Project as part of the Bay-Delta Program. The Project would include two storage islands (Webb Tract and Bacon Island) and two habitat islands (Holland Tract and Bouldin Island), and could provide for about 217,000 acre-feet of new storage for a wide variety of potential uses, including exports and Delta outflow.

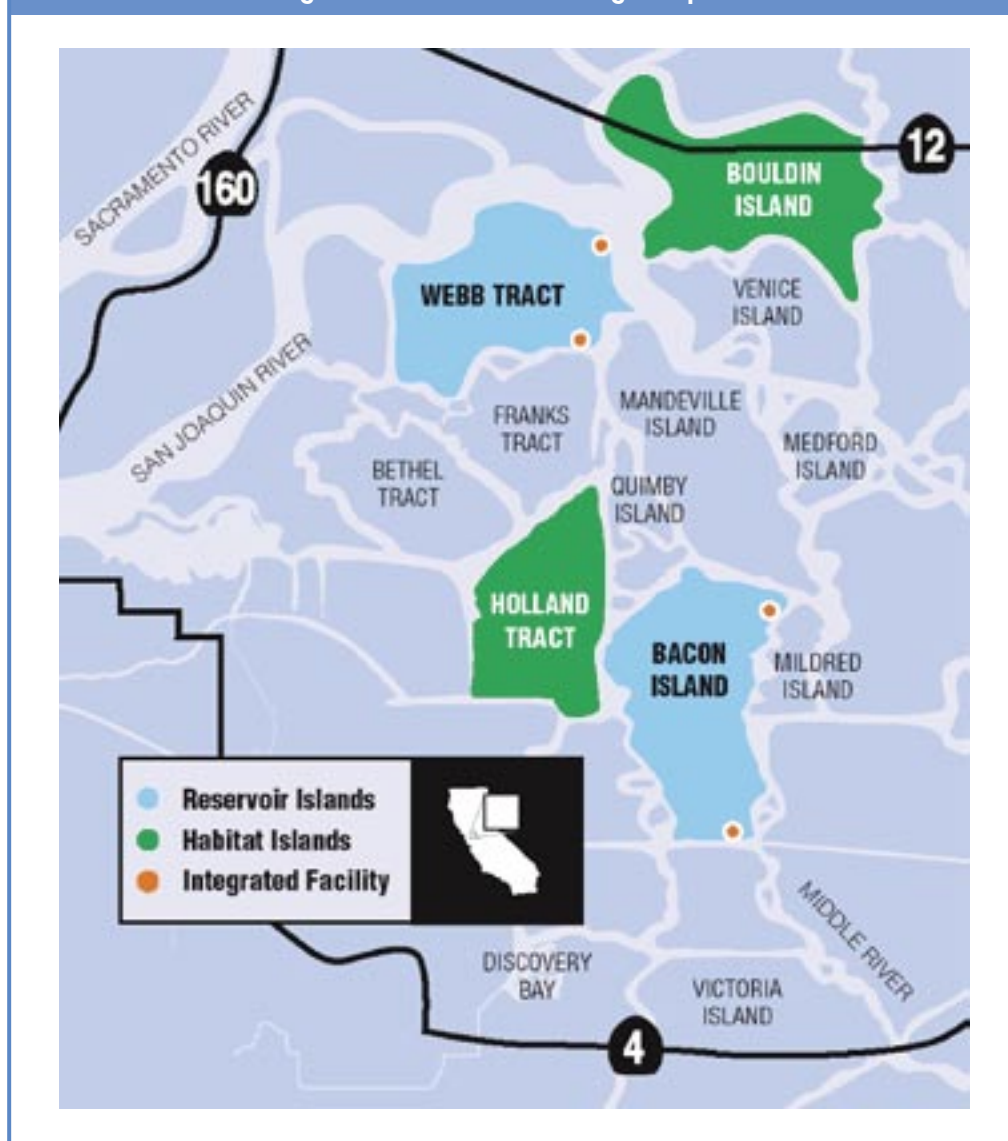
A State feasibility study for the project was completed in January 2004, and a final EIR/EIS is anticipated in December 2005. Initial estimates from the feasibility study showed an equivalent annual cost for the project of \$60 million, with annual water supply benefits between \$23 and 26 million and another \$2 million in annual recreation, flood damage reduction and avoided levee maintenance benefits. Evaluations on how In-Delta Storage would impact organic carbon and salinity levels in the Delta are ongoing, and will be important in determining the overall feasibility of the project.

Los Vaqueros Reservoir Expansion

Contra Costa Water District (CCWD) owns and operates Los Vaqueros Reservoir, a 100,000 acre-foot, offstream reservoir that, while located outside of the Legal Delta, diverts water from the Delta. Planning studies are underway to evaluate expansion of this reservoir's capacity up to a maximum of 500,000 acre-feet through the construction of a new, larger dam. Depending on how the reservoir would be operated, a portion of the storage at Los Vaqueros could be used by the Environmental Water Account. CCWD customers voted in March 2004 to continue planning studies for the project, and final feasibility studies and environmental documentation are scheduled for completion by the winter of 2007.

⁷ California Department of Fish and Game Code.

Figure 12-6 In - Delta Storage Project



Water Quality

Projects designed to improve Delta water quality are prominently included within the Delta Improvements Package, as well as in other initiatives. A few of the most important water quality efforts that can currently be identified as important to the future of the Delta are listed below.

Delta Improvements Package

A large number of water quality projects have been included in the Delta Improvements Package, some of which were included in the CALFED ROD and others that were more recently conceived.

- South Delta Improvements Package/Permanent Operable

Barriers – Permanent operable barriers would be required before full implementation of 8,500 cfs pumping capacity at SWP Banks Pumping Plant. One of the primary reasons for the barriers would be to improve water circulation and water levels within the south Delta.

- San Joaquin River Salinity Management Plan – To comply with the salinity requirements in SWRCB Water Right Decision 1641, DWR and USBR are developing a comprehensive plan, in cooperation with SWRCB and the Central Valley Regional Water Quality Control Board. The proposed San Joaquin River Salinity Management Plan would address agricultural drainage issues, salt load reduction from Salt and Mud Sloughs, recirculation of Delta exports into the San Joaquin River, voluntary water transfers for

- quality benefits, and real-time water quality monitoring.
- Vernalis Flow Objectives – Water Right Decision 1641 also included flow requirements at Vernalis on the lower San Joaquin River, which have also been addressed in the Delta Improvements Package. The USBR and DWR, along with the CALFED agencies in the Water Operations Management Team, would work together to meet flow requirements that protect fish and wildlife dependent on San Joaquin River flows.
- Old River and Rock Slough Water Quality Improvement Projects – Before any permanent operable barriers are used, agricultural drains on the Veale and Byron Tracts would be relocated. In addition, efforts would be made to reduce seepage into the Contra Costa Canal to protect the quality of the District's water supply.
- San Joaquin River Dissolved Oxygen – DWR and USBR, in coordination with other CALFED agencies and local participants, would develop a comprehensive strategy to alleviate dissolved oxygen problems in the Stockton Deep Water Channel. These improvements could go beyond water project obligations, and would be coordinated with SWRCB and Central Valley Regional Water Quality Control Board.
- Franks Tract – Salinity levels at the major export pumps in the Delta may be significantly reduced through water quality actions at Franks Tract (Box 12-4). Reconfiguration of levees and modification of water circulation are possible alternatives for the Franks Tract project.
- Delta Cross Channel Program – Building on completed studies of the Delta Cross Channel, USBR and other agencies would continue, under the Delta Improvements Package, to develop methods for improving central and south Delta water quality while encouraging fish passage around the channel.
- Relocation of CCWD Water Intake – If the Delta water quality improvements from the above measures do not provide acceptable continuous improvements in water quality, the State and federal agencies will evaluate alternatives to move the Contra Costa Canal intake to the lower part of Victoria Island. This project would require appropriate environmental review, as well as agreement on cost sharing requirements. CCWD is conducting studies to evaluate this location as an alternative point of diversion.
- Through-Delta Facility – As identified in the CALFED ROD, a screened diversion facility on the Sacramento River could be used to move 4,000 cfs of water through the Delta to the Mokelumne River to enhance water quality. The Through-Delta Facility (TDF) could also have water supply and environmental benefits, although Delta salinity impacts could be difficult to predict due to the complex flow regime of the Delta. Overall impacts on water quality in the Delta will be dependent on other projects and operational strategies, such as how the Delta Cross Channel would be managed in conjunction with the TDF.

Box 12-4 Franks Tract Description

Once a reclaimed tidal marsh, Franks Tract was flooded in 1938 following a levee breach, and has since become a focus of water supply and water quality initiatives in the Delta. Franks Tract is used for recreation purposes, and also plays an important role in Delta water circulation. Saline water from ocean tides tends to become “stuck” within the tract, creating water quality problems for the export pumps and the Delta as a whole. The proliferation of *egeria densa*, an invasive species known commonly as Brazilian waterweed, is also a problem in Franks Tract.

In response to these and other issues, DWR and the Bay-Delta Authority are conducting studies to see if levee modifications, salinity tidal gates, and other measures could be used not only to solve current problems, but to create additional benefits for the Delta. Recreation interests and state agencies have also identified potential sites for islands in the tract, which could be used for recreation and ecosystem habitat while providing erosion protection for the southern levees. The addition of trenches in certain segments could also enhance boating opportunities while limiting the spread of *egeria densa*, which requires shallow water for optimum growth.

The CALFED Science Program and DWR's Franks Tract Project are leading the way in developing alternatives to improve conditions in Franks Tract while providing new benefits for the Delta. CALFED efforts in the tract are ongoing, and a DWR-led feasibility study is now underway, with full implementation expected by 2011.

Delta Region Water Quality Management Plan

This plan is being developed by Solana County Water Agency, CCWD, and the City of Stockton, all three of which are interested in new water supply diversions from the Delta. In addition to evaluating the potential for additional Delta water intake structures, these entities are also investigating water treatment technologies and source water protection actions as part of management plan.

DWR MWQI Program

The Municipal Water Quality Investigations (MWQI) Program under DWR investigates water quality issues for State Water Contractors and other Delta water users. Issues that MWQI intends to pursue in the near future are greater use of real-time data in modeling and O&M applications, expanded investigations into organic carbon loading from wetlands, and greater coordination with the CALFED Bay-Delta Public Advisory Committee's Drinking Water Subcommittee.

CALFED Storage Projects

Investigations are currently underway to determine if CALFED storage projects could be used to enhance water quality conditions in the Delta by releasing water of the appropriate temperature and quantity at the beneficial times, or used in lieu of surface diversions to maintain the quality of Delta inflows. New reservoirs could also have negative water quality impacts, however, such as additional organic carbon input, and the overall affect will have to be considered for each project.

Ecosystem Restoration

Ecosystem restoration efforts will continue to be critical in the future for the Delta. Many of the efforts listed here will also benefit as better scientific information is obtained to develop specific, quantitative habitat objectives for ecosystem restoration. The population objectives that are being developed for listed species of anadromous fish (via processes under the Endangered Species Act) will also be of use towards measuring the success of restoration efforts.

Delta Improvements Package

The Delta Improvements Package includes several programs with ecosystem restoration components. While this list is still under development, a preliminary outline is included here.

- OCAP ESA Consultation – DWR and USBR have prepared a Biological Assessment for the Operations Criteria and Plan (OCAP), which provides a detailed explanation and analysis of the criteria and procedures used to coordinate operations of the SWP and CVP. USFWS and

NOAA Fisheries will later respond with Biological Opinions based on the OCAP Biological Assessment, and DWR and USBR will continue to work with the federal agencies and the California Department of Fish and Game to develop future policies for integrated CVP/SWP operations.

- SDIP ESA Consultation – DWR and USBR are also working on an Action Specific Implementation Plan (ASIP) for species covered under the CALFED ROD Multi-species Conservation Strategy (MSCS). USFWS and NOAA Fisheries will review the SDIP Preliminary Biological Opinions and the ASIP to determine if SDIP consultation should be reinitiated, and DFG will review the ASIP to consider if it should receive Natural Community Conservation Plan (NCCP) authorization.
- Update of CALFED ROD Programmatic Regulatory Commitments – The CALFED ROD required that USFWS, NOAA Fisheries, and DFG review and approve the programmatic regulatory commitments established in the ROD by September 30, 2004. A Notice of Determination for the Environmental Water Account EIS/EIR was signed in 2004, the Record of Decision was signed, and the Notice of Determination was issued in October 2004. Implementation of the EWA through 2007 has been authorized, and the EWA Operating Principles have been extended to December 31, 2007. The State and federal agencies that are signatories to the CALFED Multi Species Conservation Strategy ("Conservation Agreement") have also agreed to extend these regulatory commitments to December 31, 2007 to support protection and recovery of the covered species.
- Environmental Water Account – Work will continue on determining if and how a long-term Environmental Water Account (EWA) could be established beyond the short-term EWA set up for the CALFED Stage 1 period. DWR, USBR, USFWS, NOAA Fisheries, and DFG are the lead agencies working to develop a long-term EWA which will protect Delta fisheries while providing water supply reliability benefits to SWP and CVP exporters.
- Delta Regional Ecosystem Restoration Implementation Plan – The Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) is a long-term regional planning effort under the CALFED ERP to help examine the Program's actions, targets, and milestones for the Delta. The DRERIP process includes agency review and public input, and will be the primary forum for revising ERP targets. DRERIP is currently being prepared by the Department of Fish and Game in cooperation with the Bay-Delta Authority, USFWS, NOAA Fisheries, other CALFED agencies, academic institutions, science advisors,

and stakeholder scientists. Through DRERIP, the ERP expects to refine and prioritize actions, evaluate the scientific foundation for actions and milestones, and use adaptive management feedback. The Bay-Delta Public Advisory Committee's Ecosystem Subcommittee provides public input for DRERIP activities, and additional opportunities for future public participation in the Program will continue in the future.

- **Focused Study on South Delta Hydrodynamics and Fish** – As a science-related action, DWR, USBR, USGS, DFG and USFWS will study fish movement, distribution, and entrainment in the south Delta to better understand the impacts of the Delta export pumps and barrier operations.
- **South Delta Fish Facilities** – The fish facilities for both the SWP and CVP will be evaluated by USBR and DWR, and recommendations for modifying operations to better manage changing environmental conditions will be developed. Alternative facilities and intake locations will be included as options, and special consideration will be made for future SWP pumping operations.

Delta Region Farmland Preservation and Private Lands Stewardship Program

The DPC has partnered with the American Farmland Trust to prepare an inventory of Delta agriculture resources and their economic value. This inventory will help identify and preserve the best farmland in the DPC jurisdiction and the five Delta counties, while developing "wildlife friendly" practices on as much of the agricultural land as possible. The resulting DPC plan could help in the implementation of the CALFED ecosystem restoration goal of protecting and enhancing 45,000-75,000 acres of wildlife friendly agriculture in the Delta.

Other CALFED ERP Projects

While DRERIP represents ERP's focus for long-term regional ecosystem restoration planning, there are many other activities that the Program intends to carry forward into the future. The CALFED Programmatic EIS/EIR identified six strategic goals for the 30-year planning horizon of the Bay-Delta Program, which include issues such as endangered species recovery, invasive species, ecological processes, harvested species, habitats, and water and sediment quality. The CALFED ERP has developed multiple objectives for each of these goals, which include developing strategies for high priority topics, conducting a long-term program of milestone assessment for ecosystem-related CALFED programs, and identification of funding allocations to support a unified CALFED-wide restoration and recovery process.

Levee System Integrity

The future of levee management in the Delta is currently evolving, and several recent developments may play a role in future levee implementation activities. Key issues that will have a strong influence on future levee work can be grouped into three main categories: oversight, funding, and ecosystem integration.

Oversight

In recent history, levee maintenance and construction in the Delta has primarily been the responsibility of reclamation districts and, to a lesser extent, the U.S. Army Corps of Engineers. In the extreme northern part of the Delta near Sacramento, the Sacramento Flood Control Agency (SAFCA) was created in 1989 to manage levees in the Sacramento region as a joint powers agency, and it now has management responsibilities in the Delta as well. The Department of Water Resources has provided financing, planning, engineering, research and monitoring capabilities to assist local groups (reclamation districts), and the California Department of Fish and Game and Bay-Delta Authority have also played important management and oversight roles.

In the future, the form and magnitude of responsibility shouldered by the participating levee agencies could be modified. Recently proposed State legislation (AB 1983) could increase the responsibilities of the Reclamation Board, which monitors reclamation districts and collects their tax revenues. The CALFED Record of Decision (ROD) envisioned a larger federal role through the Army Corps in levee maintenance and improvements than has yet materialized, and the Corps has been discussing ways to play a greater role with other participating agencies. A recent court decision regarding the liability of the State in the event of levee failures is another driving force that could lead DWR and other agencies to reexamine how levee responsibilities and oversight are assigned within the Delta.

Funding

As already mentioned, the CALFED ROD recommended greater levels of federal participation, including financial participation, than has actually occurred. The majority of funding for Delta levees work over the last decade has come from State and local sources, with only a small amount of federal contributions. The federal government has historically identified flood protection as a national goal eligible for federal financing, and Delta interests could attempt to obtain more Congressional appropriations for future levee projects. Congress approved recent CALFED Legislation to authorize additional federal funds for levee programs, but very little of those funds have actually been appropriated by the federal budget process.

Following the CALFED principle of “beneficiary pays”, the sources for levee funding could also be modified to draw more contributions from those receiving benefits from Delta levees. Because of the location of the Delta levees and the important role they play in protecting the drinking water supply for the majority of Californians, some have argued that a greater portion of levee costs should be assigned to consumers of Delta water exports. The Bay-Delta Authority is currently conducting studies to attempt to quantify ranges of benefits associated with all CALFED Program Elements, including the Levee System Integrity Program. Potential alternative revenue sources identified by a draft Bay-Delta Authority “Finance Options” report include recreational boating fees and a state-administered water user fee assessed on CVP and SWP water users, with the possible inclusion of non-project water users as well.

Ecosystem Integration

The degree in which levee programs include ecosystem restoration activities could also be changed in the future. The same legislation that would increase the role of the Reclamation Board in levee improvement work (AB 1983) would also allow the Board to directly finance habitat restoration work, instead of having to partner with other state agencies as is currently required. While the legislation could potentially streamline required restoration work and allow levee maintenance and enlargement to move forward more quickly, it can also be argued that ecosystem responsibilities should be limited to agencies such as the Department of Fish and Game so that Reclamation Districts can focus on preventing and fighting floods. Delta levee initiatives in the future will have to consider what level ecosystem management should be involved in levee efforts, and what groups and agencies should participate in ecosystem activities.

The North Delta Flood Control and Ecosystem Restoration Project is an example of how the Department of Water Resources is addressing levee and ecosystem restoration issues in the North Delta. Also known as the North Delta Improvements Project (NDIP), the Project is considering several “wildlife-friendly” modifications to levees in the North Delta, including setback levees. A draft EIR/EIS for the Project is currently being developed, and alternatives have already been identified that include a number of levee-related initiatives.

Recreation

Recreation-related activities in the Delta will continue to be important in the future, and several new initiatives are being planned to better characterize current recreational resources

while developing a vision for future Delta recreation activities. One major effort is the Delta Recreation Master Plan. In 2003, DPC received funding for preparation of phase one of the Delta Recreation Master Plan, which has now been completed and addresses water-based recreation needs. The second phase of this plan will evaluate land-based recreation needs in the Delta, as soon as funding for the study is secured. The Master Plan intends to draw from existing Delta recreation studies and documents, use public outreach and stakeholder involvement, and include new GIS mapping technologies to produce a Delta-wide recreation plan.

Other Activities

Many other potential actions that could be taken by the California Bay-Delta Authority and others in the upstream Sacramento River and San Joaquin River hydrologic regions can benefit the Delta, especially with respect to water quality and flood flows. These actions may include improvements for conveyance, storage, levee stability, water quality, water use efficiency, and watersheds. A few of these additional initiatives are listed here.

- **WUE Agricultural and Urban Water Use Measurement**
 - One of the Bay-Delta Program’s Water Use Efficiency projects being developed throughout California is the Agricultural and Urban Water Use Measurement initiative. This program to produce consistent, complete, and compatible water measurement practices statewide is critical for monitoring and managing diversions and instream flows within Delta, and in other parts of the state as well. Considerable stakeholder input has been obtained for the WUE measurement efforts, and assistance from the State legislature will also be required for the project to be fully implemented.
- **Lower Sacramento River Regional Flood Control Project**
 - The Sacramento Area Flood Control Agency (SAFCA) is currently considering a project to expand the Yolo Bypass and use the Sacramento Deep Water Channel to convey floodwaters for the protection of urban areas. This project could potentially be integrated with CALFED activities, which have to date included studies on the modification of the Yolo Bypass to enhance fisheries, easement acquisitions, and modeling efforts led by the California Reclamation Board. Local governments, particularly the City of Rio Vista, would need to be included in planning and implementation to address downstream flooding concerns.

The above projects will provide incremental improvements in water supply, water quality, levees, and ecosystem, but will not totally achieve the desired goals for the Delta in themselves. To achieve the desired cumulative benefits, integration and linkage of these projects is essential. Coordination of the CALFED Program, its implementing agencies, local and regional stakeholders, and the Delta Protection Commission with adequate funding will help the region to continue to serve society's demand for farm products, fishing, recreation, and water—all while protecting the Delta's ecosystem and water quality.

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