California **Water Plan**
Update 2009

Sacramento-San Joaquin River Delta

INTEGRATED WATER MANAGEMENT

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Volume 3

Regional Reports

North Central Region Office

The Division of Integrated Regional Water Management assists public and private agencies and the general public with water issues throughout the state. Four regional offices are located throughout California to maintain close contact with local interests to facilitate communication and to work on water-related matters. The offices are:

- Northern Region in Red Bluff,
- North Central Region in West Sacramento,
- South Central Region in Fresno, and
- Southern Region in Glendale.

Each of the regional offices offers technical guidance and assistance in water resource engineering, project management, hydrology, groundwater, water quality, environmental analysis and restoration, surveying, mapping, water conservation, and other related areas within the boundaries of their offices. Because of the regional offices' close ties with local interests, DWR regional coordinators in each office facilitate overall communication between DWR divisions and local partners to ensure coordinated efforts throughout all DWR programs and projects.

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Sacramento-San Joaquin Delta Region

Setting

The Sacramento-San Joaquin Delta (the Delta) and Suisun Marsh are at the confluence of the Sacramento River and San Joaquin River basins, which drain about 40 percent of California. The Delta covers about 1,315 square miles (Figure D-1) in portions of six California counties and is part of the largest estuary on the West Coast of the United States. The Delta serves as a hub for California's two largest water systems in the state, the federal Central Valley Project (CVP) and the State Water Project (SWP). In addition to being a source of California's water supply and the intersection for transportation corridors, utilities, and recreation, the Delta is an ecological treasure. The Delta Vision (2007) describes the Delta as a unique and valued area warranting recognition and special legal status.

The Delta faces multiple challenges. Several are noted below and are more fully described in Appendix B.

- Pelagic or open water fish have been declining in abundance;
- For the most part, the Delta's levees are un-engineered dirt structures that have weathered erosion for 150 years;
- The Delta is home to more than 250 non-native species;
- Projection from continued sea level rise presents a serious problem for the Delta;
- Flooding is a near-annual event in the Delta and can cause overtopping and erosion of levees; and
- California's population may hit 60 million by 2050.

There are a number of activities under way to address these challenges and will ultimately play a role in the area's future water supply and exports, water quality, ecosystem and flood protection. Some of these activities are noted below and several additional activities are noted in Appendix B.

- **Delta Vision.** A strategic approach to the sustainable management of the Delta.
- **Bay Delta Conservation Plan.** A comprehensive conservation plan for the Delta designed to protect and restore at-risk species in a manner that reliably delivers water supplies to 25 million Californians.
- **Water Boards' Strategic Workplan for Activities in the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary.** Actions to protect beneficial uses of water in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary.

Delta Vision: http://www.deltavision.ca.gov/

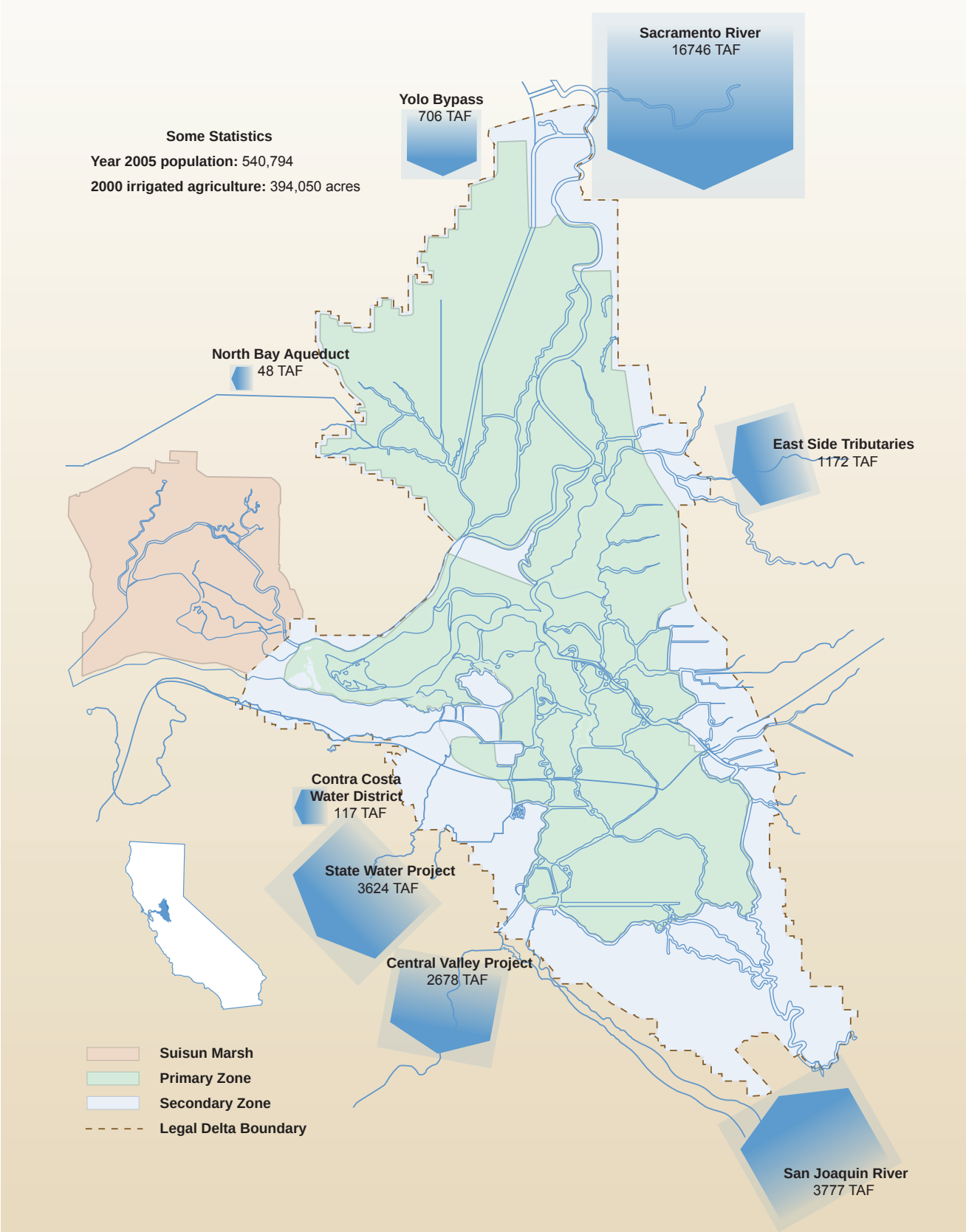
Bay-Delta Conservation Plan: http://www.resources.ca.gov/bdcp/

Strategic Plan: http://www.waterrights.ca.gov/baydelta/docs/strategic_plan/baydelta_workplan_final.pdf

Watersheds

The Delta watershed covers 40 percent of the state (Figure D-2). Many of California's major rivers converge on the Delta as tributaries of the Sacramento, the state's largest river, or the San Joaquin River. Entering the Delta separately are the Cosumnes, Mokelumne, and Calaveras rivers, the Yolo Bypass, and numerous smaller creeks and

Figure D-1 Sacramento-San Joaquin Delta and Suisun Marsh



Box D-1 Acronyms and Abbreviations Used in This Report

BCDC	San Francisco Bay Delta Conservation and Development Commission
CABY	Cosumnes, American, Bear and Yuba Region
Cal EMA	California Emergency Management Agency
CCC	Contra Costa Canal
CCF	Clifton Court Forebay
CCWD	Contra Costa Water District
CDEC	California Data Exchange Center
cfs	cubic feet per second
CRS	Community Rating System
CVFBP	Central Valley Flood Protection Board
CVP	Central Valley Project (federal)
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
DCC	Delta Cross Channel Canal
Delta	Sacramento San Joaquin Delta and Suisun Marsh
DFG	California Department of Fish and Game
DMC	Delta Mendota Canal
DPC	Delta Protection Commission
DRERIP	Delta Regional Ecosystem Restoration Implementation Plan
DRMS	Delta Risk Management Strategy
DWR	California Department of Water Resources
EIR	environmental impact report
EIS	environmental impact statement
ELPH	Equivalent Level of Public Health Protection
FEMA	Federal Emergency Management Agency
FIRM(s)	Flood Insurance Rates Map(s)
HCP	Habitat Conservation Plan
IEP	Interagency Ecological Program
ILRP	Irrigated Lands Regulatory Program
IRWMP	Integrated Regional Water Management Plan
LFPZ	Levee Flood Protection Zone
NBA	North Bay Aqueduct
NFIP	National Flood Insurance Program
NIMS	National Incident Management System
NWR	National Wildlife Refuge
NWS	National Weather Service
POD	pelagic organism decline
Regional Water Board	Regional Water Resources Control Board
SCWA	Solano County Water Agency
SEMS	Standardized Emergency Management System
SMSCG	Suisun Marsh Salinity Control Gates
SRCD	Suisun Resource Conservation District
State Water Board	State Water Resources Control Board
SWP	State Water Project
TDS	total dissolved solids
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey

sloughs. The Sacramento River is the single outlet to Suisun Bay. For more on these rivers, see other Volume 3 reports for the Sacramento River and San Joaquin River hydrologic regions.

Ecosystems

The Delta is a floodplain estuary that connects river to ocean and land to water. Floodplain estuaries are among the most productive ecosystems on the planet. The high productivity associated with floodplain estuaries is driven by the intimate relationship between land and water. However, compared to other estuaries, the Delta has very low levels of pelagic primary productivity in both the Suisun Marsh and the Delta (Box D-2).

Figure D-2 Sacramento-San Joaquin Delta watershed

Box D-2 Pelagic Organism Decline

Abundance indices calculated by the Interagency Ecological Program (IEP) through 2007 suggest marked declines in four pelagic fishes in the upper San Francisco Estuary (the Delta and Suisun Bay). These fishes include delta smelt, which is listed under State and federal Endangered Species acts as endangered and threatened, respectively and the longfin smelt protected under California's Endangered Species law as a threatened species. The IEP formed a Pelagic Organism Decline (POD) work team to evaluate the potential causes of the decline. Their work is ongoing. A recent synthesis of their efforts can be found at: POD Synthesis. Additional information about the POD efforts can be found at: http://www.science.calwater.ca.gov/pod/pod_index.html

Historically, the Delta consisted of hundreds of miles of tidally influenced sloughs and channels and hundreds of thousands of acres of marsh and overflow land. At one time, the Delta supported hundreds of species, including the grizzly bear, tule elk, and gray wolf. As land reclamation took place and levees were built, the ecosystem changed. More than 90 percent of the marshland was converted to farms (and more recently, urban uses). The grizzly bear and gray wolf no longer reside in the Delta, but a population of tule elk has been established in the Suisun Marsh. The numbers of birds using the Delta have declined as well due to land reclamation, although changes in cropping patterns have allowed populations of some species to increase. The Suisun Marsh is an important wintering and nesting area for waterfowl using the Pacific Flyway. The marsh also serves as a critical link for anadromous fish and is thought to be an important nursery for fish.

All aspects of the ecology of the Delta have been significantly and, in most cases, irrevocably altered by introduced (non-native) invasive species. Introduced species now dominate all habitats in the Delta. Among the introduced species of the Delta, the most visible is the aquatic weed *Egeria densa*, which often fills low-velocity channels in the central and southern Delta and reduces water turbidity. Two clams from Asia dominate the benthos of the Delta: the Asian clam, *Corbicula fluminea,* is most abundant in fresh water, and the overbite clam, *Corbula amurensis,* is abundant in brackish to saline water. Striped bass and largemouth bass, both deliberate introductions, are not only among the most abundant fish of pelagic and nearshore habitats, they are also predatory and probably have a negative effect on natives.

Another invasive species water hyacinth, *Eichhornia crassipes*, showed up in California more than 100 years ago. Water hyacinth was first reported in California in 1904 in a Yolo County slough. There were increased reports of water hyacinth in the Delta region during the 1970s; and by 1981, water hyacinth covered 1,000 acres of the Delta and 150 of the 700 miles of waterways.

Climate

The Delta has a mild Mediterranean climate where summers are virtually rainless. Most of the region's precipitation falls from December through March. Monthly rainfall can come all on the same day during winter storms. In the winter, after the rains begin, a

thick ground fog (tule fog) settles in the Delta. This phenomenon is named after the tule grass wetlands of the Central Valley. The region receives on average 14 to 20 inches of annual precipitation, depending on location, but the climate allows for a much wider variation from year to year. Summertime temperatures are moderated, particularly in the evenings, by the prevailing winds from the west. Average July temperatures are slightly higher in the east compared to the western Delta. Temperatures rarely reach freezing in the winter and tend to be no lower than the mid to low 40s.

Mean annual temperatures averaged over the Delta region have increased a little over 2 degrees Fahrenheit over the past 100 years, based on the Western Regional Climate Center's California Climate Tracker. This trend is based on stations from a wider area than just the Delta. Individual stations near the coast and through Carquinez Straits have actually exhibited a trend toward decreasing daily maximum temperatures during summer, which may be attributable to warmer Central Valley conditions pulling more cool air through that area during summer.

Demographics

Like the Delta ecosystem, the demographics for the region are interdependent upon the adjacent counties. Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties are in the Primary Zone of the Delta, and Alameda is located in the Secondary Zone (see Figure D-1).

There are 14 towns and villages in the Primary Zone and 6 in the Secondary Zone (see information under Current Land Use in the Land Use Patterns section). Data from the California State Census Data Center (CA Dept. of Finance) for areas within the legal Delta and Suisun Marsh indicate that about 470,000 people resided in the Delta region as of the 2000 Census.

Urbanization is occurring in the Delta, mostly in the Secondary Zone. Population in the Delta is projected to increase from about 26,000 to 67,000, and households will increase from 11,000 to 27,000 by 2030. None of this growth is expected to be in the protected Primary Zone of the Delta. A large share of this growth is associated with expansion of the Stockton metropolitan area and growth in the Sacramento-Stockton corridor onto Bishop, Sargent Barnhart, Stewart, and Shima tracts.

The demographics of the Suisun Marsh are currently stable. The permanent resident population in the primary marsh is fewer than 100 people, with a concentration on Grizzly Island Wildlife Area headquarters and resident managers on the private waterfowl hunting clubs. There may be an additional 50 full-time residents in the secondary marsh, living in historical farmhouses and residents on the upland areas around the marsh.

In 2006, the California Department of Water Resources (DWR) estimated that the annual value of Delta agricultural production over the 1998 to 2004 period averaged

$680 million in 2005 dollars. An evaluation of more recent data reported the average annual value of natural gas production in 2004 and 2005 was more than $300 million and recreation-related expenditures were estimated to be in excess of $500 million annually. Further, Roger Mann reported to the Delta Vision Committee (2007) that the Delta includes about 1,000 businesses with sales ranging from $500 million to $1 billion per year. Looking more broadly at areas protected from a 100-year flood within and near the legal Delta and Suisun Marsh, Mann estimated that there were 15,900 business having sales of some $35 billion annually.

Senate Bill 18 (Chapter 905, Statutes of 2004) requires cities and counties to consult with Native American Indian Tribes during the adoption or amendment of local general plans or specific plans. A contact list of appropriate Tribes and representatives within a region is maintained by the Native American Heritage Commission. The following is a list of the Tribes with historical or cultural ties to the Delta region, according to the commission.

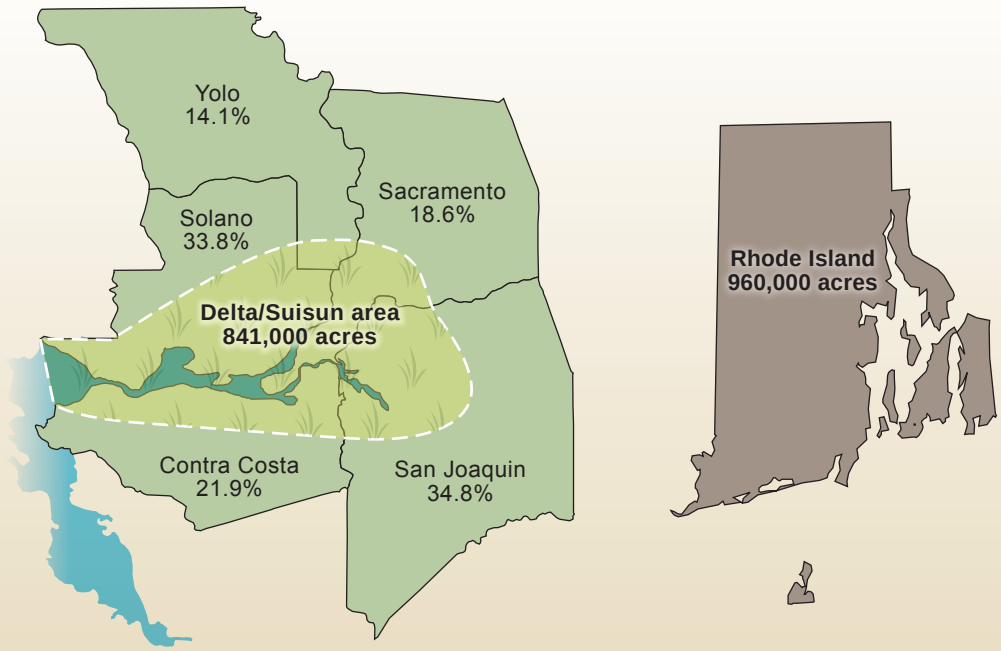
- California Valley Miwok Tribe
- Cortina Band of Indians
- Ione Band of Miwok Indians
- North Valley Yokuts Tribe
- Rumsey Indian Rancheria of Wintun
- Shingle Springs Band of Miwok Indians
- The Ohlone Indian Tribe
- United Auburn Indian Community of the Auburn Rancheria
- Wilton Rancheria

A Tribal Consultation Guideline, prepared by the Governor's Office of Planning and Research, is available online at: http://www.opr.ca.gov/programs/docs/09_14_05%20Updated%20Guidelines%20(922).pdf.

In addition to the cultural importance of the area to many Native Americans, the Delta region is important to the state because it includes vital transportation and conveyance facilities. It contains water aqueducts, highways, railroads and shipping routes, natural gas storage and transmission facilities, electric transmission pathways, and gasoline product distribution pipelines (Mann 2007). Most importantly, the Delta is a key conduit of the state's water supplies for both urban and agricultural uses. Approximately two-thirds of the state's population live and work in urban areas that receive at least some of their water supply from the Delta, and the Delta provides one quarter of the state's total urban water supply (Mann 2007).

A number of Congressional and State legislative districts crisscross the Delta. Congressional districts include the 1st, 3rd, 5th, 10th, 11th, and 18th, State Senate districts include the 1st, 2nd, 5th, 6th, 7th, 9th, and 14th. State Assembly districts include the 8th, 9th, 10th, 11th, 15th, 17th, and 26th. The district maps can be seen at http://calvoter.org/voter/maps/index.html.

Figure D-3 Counties in Delta region



Source: Context Memorandum: Land Use in the Delta-Suisun Region. July 13, 2007.
Elizabeth Patterson

Land Use Patterns

The Delta is not a region unto itself. As noted previously, the Delta is made up of six counties: Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo (Figure D-3). The Delta area totals approximately 1,315 square miles or about 840,000 acres.

Before 1850, the Delta was essentially a broad expanse of water-based habitat and natural channels. The Delta was a water highway between San Francisco and Sacramento and the Gold Country. The fastest and most direct means of travel between Sacramento and San Francisco was by ferryboat. Large-scale reclamation of the Delta for agriculture began in 1868, and by 1900, most of the lands with mineral-organic soils, around the Delta's exterior, were reclaimed. The final period of Delta reclamation occurred between 1900 and 1920 on lands in the Delta's interior. The result of these reclamation efforts is largely what is seen as the Delta today—approximately 700 miles of meandering waterways and 1,100 miles of levees protecting more than 538,000 acres of farmland, homes and other structures.

Today, the Delta is dominated by highly productive agricultural land. The main crops grown in the Delta are corn, alfalfa, pasture, tomatoes and grapes. Historically, asparagus, corn, pasture, alfalfa, and sugar beets were the dominant crops. In addition to changes in crops, the amount of urban and native lands has increased in the Delta, but agricultural lands have decreased.

Small communities and historic legacy towns within the Delta's Primary Zone serve as social and service centers for surrounding farms. These communities include Clarksburg, Courtland, Hood, Locke, Ryde, and Walnut Grove. A small portion of Rio Vista lies within the Primary Zone. Some communities within or just outside the Secondary Zone are the incorporated city of Isleton and portions of Stockton, Pittsburg, Antioch, Oakley, Sacramento, and West Sacramento.

The Delta was given a legal boundary (Section 12220 of the Water Code) in 1959 with the passage of the Delta Protection Act (see Figure D-1). Anticipating the potential effects of urban development on the Delta, the original Act was refined in 1992 to provide Primary and Secondary Zones within the previously defined legal Delta and the development of a Resource Management Plan for land uses within the Primary Zone. The Primary Zone (about two-thirds of Delta area) was intended to remain relatively free from urban and suburban encroachment to protect agriculture, wildlife habitat, and recreation uses. Urban development in the Secondary Zone (the remaining one-third) was intended to include an appropriate buffer zone to prevent impacts on the lands in the Primary Zone.

The Delta Protection Commission in the process of updating the 1995 Resource Management Plan. Its work can be seen at Management Plan Update, http://www.delta.ca.gov/. According to DPC staff, there are several policies and recommendations in the draft Resource Management Plan that appear to be applicable to the Water Plan. These include:

- **Water Policy 3.** "Water agencies at local, State, and federal levels shall work together to ensure that adequate Delta water quality standards are set and met and that beneficial uses of State waters are protected consistent with the CALFED (see Water code Section 12310(f) Record of Decision dated August 8, 2000)."
- **Recommendation 1.** "The Delta waterways should continue to serve as a primary transportation system moving water to the State's natural and developed water systems."
- **Recommendation 2.** "Delta water rights should be respected and protected."
- **Recommendation 3.** "Programs to enhance the natural values of the State's aquatic habitats and water quality will benefit the Delta and should be supported."

Historically, the Suisun Marsh consisted of 68,000 acres of tidally inundated islands separated by sloughs. Diking of Suisun Bay, primarily for livestock grazing, began around the mid-1860s. Shortly thereafter the first duck clubs were established around the marsh ponds. By the early 1900s, livestock grazing was giving way to other agricultural activities. Eventually, increasing salinity and land subsidence caused agricultural activities to fail and be replaced by duck clubs. Levees originally constructed for farming are now an integral part of the infrastructure of the duck clubs (URS 2007).

The Suisun Soil Conservation District was formed in 1963 (later named the Suisun Resource Conservation District). The SRCD is a special district of the State of California that represents private landowners in the Suisun Marsh on a variety of issues at federal, State, and local levels. The goals of SRCD are to achieve water supply of

adequate quality to promote preferred waterfowl habitat and retain wetland resource values through appropriate management practices.

In 1974, the California Legislature passed the Nejedly-Bagley-Z'berg Suisun Marsh Preservation Act. The Act directed the San Francisco Bay Conservation and Development Commission (BCDC) and the California Department of Fish and Game (DFG) to prepare the Suisun Marsh Protection Plan. The Suisun Marsh Protection Plan includes a Primary Management Area (see Figure D-1) encompassing 89,000 acres and a Secondary Management Area that includes approximately 22,500 acres of significant buffer lands. The BCDC has land use and development permitting authority in the Primary Management Area.

Currently, 90 percent of the wetlands in the Suisun Marsh are diked and managed as food, cover, and nesting habitat for wildlife. The balance of the Suisun Marsh is privately owned, with 150 individual waterfowl hunting clubs and numerous upland parcels for cattle grazing. DFG owns nearly 15,300 acres of managed and tidal wetlands. Urban encroachment has not occurred within the marsh, but conflicts and pressures are occurring with the increasing urbanization and industrialization up to the edges of the Suisun Marsh Secondary Management Area. Table DB-1 in Appendix B illustrates recent land use changes that have taken place in the Suisun Marsh.

The Delta is a magnet for a variety of public recreation uses, especially freshwater recreation. More than 2 million Californians come to the Delta every year. Annual visitor days are projected to grow from 6.5 million in 2000 to 7.8 million by the year 2020. Water-dependent (boating, fishing, rafting, and swimming) or water-enhanced (camping, picnicking, hiking, bicycling, hunting, and scenic/wildlife viewing) recreation comprise most of these existing recreation activities within the Delta (DPC 2006).

Stone Lakes NWR, http://www.fws.gov/stonelakes/

Cosumnes Preserve, http://www.cosumnes.org/

Yolo Wildlife Area, http://www.yolobasin.org/wildlife.cfm

Stone Lakes National Wildlife Refuge is in southern Sacramento County. The approved refuge is 17,640 acres. The Cosumnes River Preserve is in southern Sacramento and northern San Joaquin counties. The preserve encompasses more than 46,000 acres. The Vic Fazio Yolo Wildlife Area is in the Yolo Bypass. The wildlife area currently includes 16,000 acres. All three areas have similar goals of protecting and enhancing imperiled Central Valley fish and wildlife habitats.

The Stockton and Sacramento Deep Water Ship Channels were constructed in 1933 and 1963, respectively. Recent volume was 0.7 and 2.9 million metric tons in Sacramento and Stockton, respectively. The Port of Sacramento has seen an average decline in tonnage since 1994. This is related to reductions in agricultural and forestry shipments, which were the mainstay of operations at the port. Cargo levels through the Port of Stockton have continued to grow, and in 2005 Stockton became the fourth busiest port in California, after Los Angeles, Long Beach, and Oakland. Both ports are currently investigating the use of barges to move goods between California's coastal ports and the Central Valley.

Regional Water Conditions

Environmental Water

A diverse set of conditions in the Delta helped shape a unique ecosystem from which hundreds of aquatic species, many endemic to the system, evolved. Reclaiming and maintaining the Delta for agriculture, urban areas, transportation corridors and utilities and managing the Delta as a water conveyance and supply system altered many of these conditions in ways that continue to challenge management of the system.

Since development within the Delta began, operation and management of the water conveyance and supply system has continually evolved. History suggests that many of the management adjustments and changes that have been made over the years within the Delta have fallen short in addressing the environmental or water quality concerns these actions were designed to resolve.

Requirements of the State Water Resource Control Board (State Water Board) and the biological opinions for endangered species largely determine requirements for water quality, flow, and CVP/SWP project operations in the Delta and Suisun Marsh. On occasion, the State Water Board requirements are preceded by requirements set by other agencies such as the US Fish and Wildlife Service (USFWS). For example, in their middle 1990s Delta Smelt/Sacramento Splittail Biological Opinions, the USFWS set CVP/SWP operational criteria which were ultimately folded into the State Water Board's D-1641. Further, requirements outlined in contractual agreements such as those between DWR and the North Delta Water Agency play a role in Delta water quality, flow, and CVP/SWP project operations.

The SWP and the CVP coordinate project operations to maintain the standards established by D-1641 and the biological opinions, by releasing water from upstream reservoirs for in-Delta as well as Delta outflow requirements, by curtailing export pumping at the SWP Banks and CVP Tracy Pumping Plants during specified time periods and meeting salinity standards in the Suisun Marsh. A sampling of requirements imposed on project operations are further described in a subsequent Project Operations section as well as in Appendix B.

The Ecosystem Restoration Program Conservation Strategy for the Delta and Suisun Marsh Planning Area provides leadership for conservation and restoration in the Delta and Suisun Marsh. It is developed by DFG in collaboration with USFWS and National Marine Fisheries Service. The strategy reflects changing knowledge, conditions, and understanding of the system, and is intended to facilitate coordination and integration of actions among all resource planning, conservation, and management decisions affecting the Delta and Suisun Marsh.

Of the Delta counties, two have approved Habitat Conservation Plans (South San Joaquin Habitat Conservation Plan (HCP) and East Contra Costa HCP) that include land banking and other programs to set aside Delta land for conservation. Other counties have

HCPs under development (Solano, Sacramento, and Yolo). The Bay Delta Conservation Plan, also under development, will:

- provide the basis for permits under federal and State endangered species laws for the activities covered by the plan;
- streamline permitting for projects of agencies covered by the plan such as SWP, CVP, Metropolitan Water District, Kern County Water Agency, Santa Clara Water District, Zone 7, Alameda County Flood Control and Water Conservation District, Westlands Water District, San Luis and Delta Mendota Water Authority and Mirant Delta;
- provide for a comprehensive habitat conservation and restoration program for the Delta;
- provide new sources of funding and new methods of decision-making for ecosystem improvements; and
- provide for an adaptive management and monitoring program that will guide decision-making during implementation, be grounded in the best available science, and enable the plan to adapt as conditions change.[1]

Water Supplies

In an average water year like 2000, the largest source of water was the Sacramento River, which transported a little more than 21 million acre-feet into the Delta. Additional flows from the Yolo Bypass, San Joaquin River, and eastside tributaries such as the Mokelumne and Cosumnes rivers contributed just over 3.9 million acre-feet, with precipitation directly on the Delta adding about another 1 million acre-feet. Freshwater flows in the Delta are typically much less than those caused by tides. In addition to precipitation derived runoff, Pacific Ocean tides move into and out of the Delta, twice a day. Tidal rise and fall varies with location, from less than one foot in the eastern Delta to more than five feet in the western Delta.

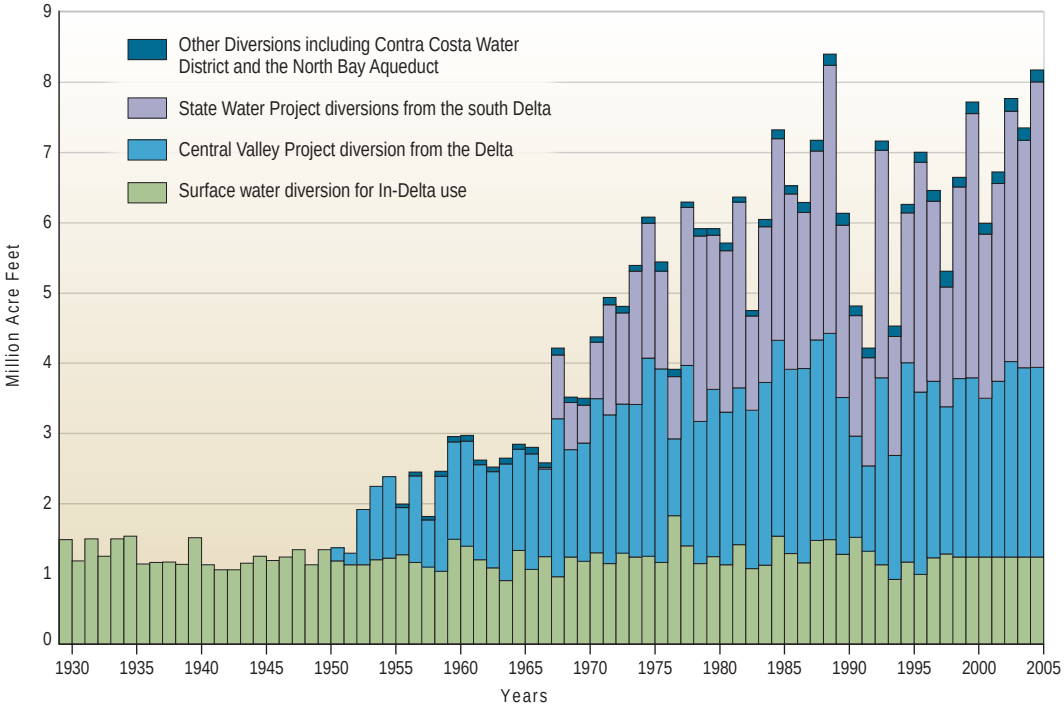
A sizable amount of water from the Delta's watershed is diverted and used before it reaches the Delta as Figures D-4 and D-5 illustrate. Figure D-4 depicts historical diversions from the Delta; Figure D-5 shows historical diversions before the Delta, in-Delta uses, and exports and outflows to the ocean.

The Suisun Marsh is a brackish marsh. Salinities vary seasonally with higher salinities in the summer and fall, and lower salinities in the winter and spring. There is always an east to west salinity gradient in the Suisun Marsh. During periods of local rainfall numerous creeks provide fresh water inflow to the northern areas of the marsh, seasonally decreasing the salinities of these regions. These creeks are Denverton, Union, Laural, Ledgewood, Suisun, Green Valley, Jameson Canyon and American Canyon.

A water balance is a good way to get an overview of the major flows into and out of the Delta. Figure D-1 displays Delta inflow and outflow during water year 2005.

1 California Natural Resources Agency accessed August 12, 2008: http://resources.ca.gov/bdcp/docs/Brochure.pdf%20Accessed%20August%2012

Figure D-4 Historical diversions from within the Delta



Source: Delta Vision Blue Ribbon Task Force. 2008. Final Report.

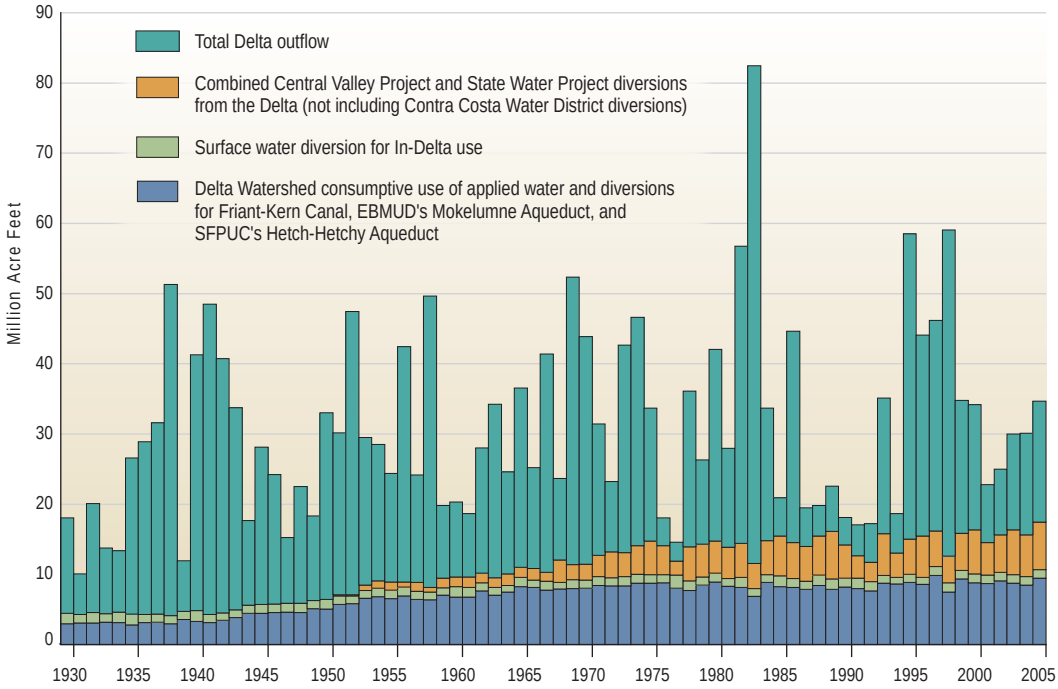
Figure DB-2, depicting the variation in Delta inflows and outflows during three water year types and text explaining the figure, can be found in Appendix B.

Groundwater supplies in the Primary Zone of the Delta are continually recharged due to flows in Delta channels and the soft, deep soils of Delta islands. The water table is relatively shallow. A number of groundwater basins/subbasins touch on the Secondary Zone including Sacramento Valley/Solano Subbasin; San Joaquin Valley/Eastern San Joaquin and Tracy Subbasins; and the Suisun-Fairfield Valley Basin. Groundwater levels in most basins have declined as a result of agricultural and urban development. The Eastern San Joaquin Subbasin has been characterized as severely overdrafted with significant depressions east of Stockton and Lodi. Groundwater levels fluctuate with droughts, development, delivery of surface waters to the region, and periods of "wet" years.

Water Uses

Water use in the Delta region is mostly agricultural. Irrigation water is taken directly from the channels and sloughs through approximately 1,800 diversions, which together divert up to 5,000 cubic feet per second (cfs) during peak summer months. Though the primary water users in the Delta are individual farming operations, formal institutions have been established to manage Delta water. For instance, in November 1965, DWR and the US Bureau of Reclamation reached agreement with some Delta interests on the quality of agricultural water to be maintained by the SWP and the CVP at various

Figure D-5 Historical diversions before the Delta, in-Delta uses and exports from the Delta, plus outflows



Trends in Destinations and Uses

Period	Average Annual Total (MAF)	Outflow	in-Delta	Exports	Delta Watershed
1930 to 1949	25.80	81%	5%	0%	14%
1990 to 2005	31.71	67%	4%	4%	24%
1950 to 1969	34.34	51%	5%	15%	29%
1970 to 1989	32.85	48%	4%	17%	31%

Source: Delta Vision Blue Ribbon Task Force. 2008. Final Report.

locations in the Delta. There was, however, no legal entity to sign the related contracts. As a result, the California Legislature created the Delta Water Agency. This agency was replaced with three separate agencies in 1973 – the North Delta Water Agency, the Central Delta Water Agency, and the South Delta Water Agency. Contra Costa County Water District, East Contra Costa Irrigation District, Byron-Bethany Irrigation District, the city of Antioch, and various industrial corporations are the remaining local water users within the Delta.

Most Delta farms use water under riparian and appropriative water rights, and drainage water from the islands is pumped back into the Delta waterways. A general discussion of Delta water rights, including Delta area of origin rights is presented in Appendix B. In 2000, Delta agriculture used about 1.3 million acre-feet of water to irrigate about 476,000 acres of crops (Tully and Young 2007). In-Delta residential water is generally

drawn through private wells or provided through community public water systems, such as the Contra Costa Water District. The remaining portion of water in the Delta is either used by the various 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 effect on the Delta water balance, but are still important in the Delta, with an estimated 12 million "user days" recorded each year for recreation purposes.

Most Suisun Marsh managed wetlands begin flooding in the fall around October 1 in preparation for the fall migration of waterfowl. At the end of waterfowl season, water manipulation for habitat development may continue through July. Typically the water remaining in the wetlands is drained in June or July to allow vegetative growth and to perform routine maintenance activities during the summer work season.

Power generation plants at Antioch and Pittsburg are cooled with water diverted from the Delta. Combined, the two power plants' pumps can divert 3,240 cfs. The SWP's North Bay Aqueduct (NBA) and the CVP's Contra Costa Canal deliver water to Bay Area cities. In 2004, the SWP diverted a total of 53,203 acre-feet into the NBA (DWR 2005). Contra Costa Water District withdraws about 126,000 acre-feet in an average year.

The federal C.W. "Bill" Jones Pumping Plant (formerly the Tracy Pumping Plant) can export about 4,600 cfs, primarily to CVP agricultural land south of the Delta. It also supplies some water to urban areas and to wildlife refuges. The SWP's Banks Pumping Plant has a physical export capacity of 10,500 cfs, but is currently permitted to generally divert only up to 6,680 cfs from the Delta into the pumping plant's Clifton Court Forebay. Diversions, first by the CVP in the 1950s and then the SWP starting in the 1960s have steadily increased over the years. The SWP provides water primarily to urban areas, but also supplies some water for agricultural uses. The SWP has contracts to divert 4.2 million acre-feet annually. The CVP has contracts to divert 3.3 million acre-feet annually from the Delta. The projects generally are not able to deliver their full contract amounts because the projects are also operated for Delta water quality requirements and fish protections. On average, the projects together have exported about 5 million acre-feet annually.

There is little known about groundwater use from the basins within the Delta's Secondary Zone with the exception of the East San Joaquin Subbasin. Various estimates place groundwater use in the East San Joaquin Subbasin at 730,000 to 800,000 acre-feet per year. The CALFED Programmatic EIS/EIR (2000) estimated that average annual groundwater withdrawals range from 100,000 to 150,000 acre-feet in upland areas of the Delta.

Water Quality

The Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary establishes objectives for the protection of the estuary's beneficial uses from the effects of salinity (from saltwater intrusion and agricultural drainage) and water

project operations (flows and diversions). This plan supplements other water quality control plans and policies adopted by the State Water Quality Control Board and the Central Valley and San Francisco Regional Boards. The CALFED Program fostered the idea of Regional "Equivalent Level of Public Health Protection" (ELPH) Plans. The Delta Region Drinking Water Quality Management Plan uses an "in-Delta" version of the ELPH conceptual model to present water quality solutions for Contra Costa Water District (CCWD), Solano County Water Agency (SCWA) and the city of Stockton. In-Delta ELPH can be found at http://www.ccwater.com/files/DeltaRegion.pdf.

Workplan: http://www.waterrights.ca.gov/baydelta/docs/strategic_plan/baydelta_workplan_final.pdf

More than half of Californians rely on water conveyed through the Delta for at least part of their water, which underscores the importance of carefully managing a wide range of water quality issues in the region. In recognition of the importance of the drinking water to California and the challenges facing the Delta, the Central Valley, San Francisco and the State Water Boards collectively developed a strategic workplan that prioritizes actions, establishes time schedules for implementing actions, and identifies existing and needed resources. The workplan was adopted by the State Water Board in July 2008.

Salinity. The Sacramento River Hydrologic Basin is estimated to provide over 2 million tons of salt to the Delta, and the San Joaquin River supplies just about 1 million tons of salt. (See Salt and Salinity Management resource management in Volume 2 of Water Plan Update 2009.) Estimates of net movement of salt out of the Delta into the San Francisco Bay are difficult as the water becomes brackish from seawater intrusion. Significant quantities of both salt and water are diverted from the Delta system. The California Aqueduct exports about 1 million tons of salt per year and the Delta Mendota Canal (DMC) exports about 900,000 tons of salt per year. The NBA and the Contra Costa Canal (CCC) annually about export 4,000 tons and 41,000 tons of salt, respectively.

South Delta Program: http://baydeltaoffice.water.ca.gov/sdb/

In-Delta agricultural water users, particularly those in the Central and South Delta are influenced by the salinity changes associated with CVP and SWP export operations, and San Joaquin River runoff. Numerous regulatory efforts have been initiated to try to limit the impact of highly saline water from the San Joaquin River that is drawn through the South Delta when the project pumps are exporting water at a sufficient rate. DWR is involved in a number of actions and proposed actions geared toward improving water quality in the Delta.

The Central Valley Regional Water Board has gathered stakeholders to form a salinity policy group to work on solutions to the Central Valley salinity problem. The goal of the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) efforts is to maintain a healthy environment and a good quality of life for all Californians by protecting the state's water.

DWR and the US Bureau of Reclamation operate several facilities in the Suisun Marsh to provide lower salinity water to managed wetlands. One of these, the Suisun Marsh Salinity Control Structure began operation in 1988 to limit the tidal influx of saltwater into Suisun Marsh. The salinity control structure operates from September through

May to keep salinity in Montezuma Slough low throughout the managed wetland flooding season.

Bromide. Bromides associated with seawater lead to the formation of brominated compounds (suspected carcinogen) when Delta water is disinfected for drinking water supply. Recognizing the importance of bromide, CALFED established a goal of 0.050 mg/L bromide or ELPH in source water. Some local water supplies exceed the CALFED goal for bromide. The SCWA source in the NBA varied from 0.025 to 0.080 mg/L in 2003. Bromide in CCWD supplies, averaged 0.459 mg/L at Rock Slough and 0.256 mg/L at Old River (based on 1990 to 2003 weekly samples). The Central Valley Regional Water Board is developing a drinking water policy to address bromide. The work plan for the drinking water policy including bromide (Bromide Policy) can be found at http://www.waterboards.ca.gov/centralvalley/water_issues/drinking_water_policy/.

Pesticides. The Central Valley Regional Water Board Toxic Hot Spots Clean-up Plan (California Water Code section 13394) identified diazinon from orchard dormant spray runoff in the entire Delta, diazinon and chlorpyrifos from urban stormwater runoff in Morrison Creek in the city of Sacramento and Mosher Slough, 5 Mile Slough, the Calaveras River, and Mormon Slough in the city of Stockton and chlorpyrifos from irrigation tailwater in French Camp Slough, Duck Slough, Paradise Cut and Ulatis Creek as toxic hotspots in the Delta. The Central Valley Regional Water Board has adopted amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) to incorporate control programs for pesticides in the Delta. The Water Board's workplan identifies an action that would characterize discharges from Delta Islands and implement control strategies. Pesticides are one of many constituents to be quantified, monitored and control. Some of the pesticide impairments are from legacy pesticides, such as DDT. The Central Valley Regional Water Board's Irrigated Lands Regulatory Program (ILRP) implements the basin plan amendments and addresses the agricultural sources of pesticide impairments.

Health Hazards: http://www.oehha.org/index.html

Another source of pesticides to the Delta is urban runoff. The storm water permits for the Sacramento and Stockton urban areas include requirements to develop and implement pesticide pollution prevention plans. Many of the pesticide impairments are due to chlorpyrifos and diazinon. The recent ban on residential uses of chlorpyrifos and diazinon should reduce the potential for water quality effects from these pesticides in urban areas.

Nitrates. The primary sources of nitrate in groundwater are application of nitrogen fertilizers, disposal or reuse of animal waste at confined animal production facilities, and disposal of human sewage either in community sewer systems or individual sewer systems (septic systems).

The Central Valley Regional Water Board adopted general waste discharge requirements in May 2007 to control the discharges from the 1,550 existing milk cow dairies in the Central Valley. The board found that many dairies in the region have affected

groundwater quality with salt and nitrates. As of July 2008, there were 16 dairies with about 12,000 cows in the Delta region.

The Central Valley Regional Water Board has prohibited discharge in problematic service areas. In the Delta, the board has adopted two prohibitions of discharge from individual sewage disposal systems; Contra Costa County Sanitation District No. 15 in 1974 and Courtland in 1975. Currently, both areas are served by community sewage systems.

Mercury. The Delta is downstream of mercury mining activities in the Coast Range and gold mining activities that used mercury to amalgamate gold in the Sierra. Mercury mine waste enters the Delta from mine-affected Coast Range creeks such as Cache, Putah, and Marsh creeks. On the Sierra side, principal gold mining areas that discharged mercury were the Yuba, Bear, Cosumnes, Stanislaus, Tuolumne, and Merced rivers. About 98 percent of identified total mercury loading to the Delta comes from tributary inputs; within-Delta sources are a very small component of overall loading.

Methylmercury is the most toxic form of mercury and accumulates in successive levels of the food chain. Within-Delta methylmercury sources contribute 42 percent of the average annual methylmercury inputs to the Delta. The Regional Water Board has identified the Delta as impaired due to mercury levels in fish and the Central Valley Regional Water Board Toxic Hot Spots Clean-up Plan (California Water Code section 13394) identified mercury in the entire Delta as a toxic hotspot. The Regional Water Board is developing a methylmercury control program for the Delta.

The Delta is a popular location for sport and subsistence fishing. Concern has been expressed about fish tissue contamination (e.g., with mercury and/or PCBs) in this region and the negative health effects on subsistence fishermen who catch and eat contaminated Delta fish to supplement their diet. California's Office of Environmental Health Hazard Assessment has developed sport fishery consumption advisories, in several languages, for water bodies where chemical contamination in fish poses a health concern. The advisories include several for locations in the Delta.

Toxic Hot Spots. The Bay Protection and Toxic Cleanup Act requires regulatory attention to prevent the creation or maintenance of toxic hot spots hotspots.

- In 2001, the Regional Water Board Toxic Hot Spots Clean-up Plan (California Water Code section 13394) identified the following toxic hotspots in the Delta.
    - Mercury in the entire Delta and the Cache Creek watershed including Clear Lake
    - Low dissolved oxygen concentrations in the San Joaquin River in the vicinity of the city of Stockton
    - Diazinon from orchard dormant spray runoff in the entire Delta
    - Diazinon and chlorpyrifos from urban stormwater runoff in Morrison Creek in the city of Sacramento and Mosher Slough, 5 Mile Slough, the Calaveras River, and Mormon Slough in the city of Stockton

  - Chlorpyrifos from irrigation tailwater in French Camp Slough, Duck Slough, Paradise Cut and Ulatis Creek.
- The following toxic hotspot was identified in Suisun Bay:
  - Silver, cadmium, copper, selenium, zinc, polychlorinated biphenyls, chlordane, dichlorodiphenyldichloroethylene, and pyrene effects to aquatic life in Peyton Slough.

In addition, there is concern that a number of emerging pollutants could affect beneficial uses such as heavy metals and other naturally occurring elements, pharmaceuticals and endocrine disrupting compounds, and blue-green algae blooms. Sources of these contaminants include agricultural, municipal and industrial wastewater, and urban stormwater discharges, discharges from wetlands and channel dredging activities.

Groundwater. In general, groundwater quality throughout most of the region is suitable for some urban and agricultural uses with only local impairments. The primary constituents of concern are high total dissolved solids (TDS), nitrate, boron, chloride, and organic compounds. According to the San Joaquin County Public Works Department (2004), groundwater extraction in the Eastern San Joaquin Subbasin has increased the flow of saline water from the west. There is a concern that the eastward migration of saltwater will degrade portions of the basin rendering the groundwater unsuitable for urban and agricultural purposes.

The Delta is a major source of natural gas for the state. Improperly abandoned wells are potential conduits for contamination to spread throughout an aquifer. The US Geological Survey (USGS) has collected preliminary information in eastern San Joaquin County near the saline groundwater intrusion front in south Stockton that suggests that saline groundwater at drinking water well depths share similar hydrocarbon signatures with oil and gas wells often drilled thousands of feet deeper. The data warrant further exploration of the issue before concrete conclusions can be reached.

Project Operations

The CVP Delta facilities include the CCC, the C.W. “Bill” Jones Pumping Plant, the DMC, and the Delta Cross Channel Canal (DCC). The CCC and DMC convey water from the Delta to Contra Costa County and the DMC and San Luis service areas. The DCC is a controlled diversion channel between the Sacramento River and Snodgrass Slough. The C.W. “Bill” Jones Pumping Plant’s diversion capacity is about 4,600 cfs.

The SWP facilities in the Delta include the NBA, Clifton Court Forebay (CCF), John E Skinner Fish Facility, the Harvey O. Banks Pumping Plant, the Suisun Marsh Salinity Control Gates (SMSCG), several Suisun Marsh distribution systems (Roaring River and Morrrow Island) and up to four temporary barriers in the south Delta. The NBA conveys water to Napa and Solano counties. Maximum pumping capacity is 175 cfs. The CCF, Skinner Fish Facility, and Banks pumping plant, divert and convey water to SWP service areas south of the Delta including the South Bay. Daily diversions into the CCF are

Suisun Marsh Facilities: http://iep.water.ca.gov/suisun/facts/physicalFacilities.html

governed by an agreement with the US Army Corps of Engineers (USACE) (Public Notice 5820A). The current permitted daily diversion capability of the CCF is 6,680 cfs. The SMSCG are operated to meet marsh water quality standards. The Suisun Marsh water distribution systems are designed to provide lower salinity water to public and private managed wetlands and to discharge drainage water.

As noted in the Environmental Water section, the operations of the SWP/CVP are subject to many State and federal laws, agreements, biological opinions, contract requirements, flood operations, etc. that are designed to protect water quality, water supplies, wetlands, anadromous and native fisheries, migratory birds, threatened and endangered species, prevent flooding, etc. Table DB-4 (Actions affecting CVP and SWP operation in the Delta) in Appendix B lists several of these operational criteria and provides a summary description.

Water Governance

More than 200 public agencies—federal, State, regional, and local—dot the Delta and Suisun Marsh waterways and claim partial responsibility for governance, planning, facilities, or resource protections that utilize and safeguard the ecosystem. These diverse public agencies, and the legal requirements that guide them, form a complicated patchwork of governance with a complex history and an uncertain future. Box D-3 is a partial listing of the more than 200 local, State, and federal agencies that have some jurisdiction and authority in governing water in and through the Delta. Table DB-4, in Appendix B, contains a more extensive listing of public agencies with interests in the Delta.

The Delta Vision Committee recommended "An improved governance system that has reliable funding, clear authority to determine priorities and strong performance measures to ensure accountability.

Delta Vision: http://www.deltavision.ca.gov/

As this report was being written, the Governor and Legislature signed a comprehensive water package that among other things established the framework to achieve the co-equal goals of providing a more reliable water supply to California and restoring and enhancing the Delta ecosystem. The co-equal goals are to be achieved in a manner that protects the unique cultural, recreational, natural resource, and agricultural values of the Delta. Specifically, SB 1 creates the Delta Stewardship Council, consisting of seven members with diverse expertise providing a broad statewide perspective. It also establishes the Sacramento-San Joaquin Delta Conservancy to implement ecosystem restoration activities within the Delta. For more information on the 2009 Comprehensive Water Package, go to Volume 4 Reference Guide.

Box D-3 Partial Listing of Jurisdictions/Authority Governing Water in Delta

Federal

Army Corps of Engineers (USACE)
Bureau of Reclamation (BLM)
Coast Guard
Department of Defense (Defense Depot S.J. & Travis AFB)
Department of Homeland Security
Department of Transportation (DOT)
Environmental Protection Agency (EPA)
Federal Emergency Management Agency (FEMA)
Fish and Wildlife Services (USFWS)
Geological Services (USGS)
National Marine Fisheries Service (NMFS)
USDA – Natural Resources Conservation Service (NRCS)

State

Business, Transportation and Housing Agency (BTH)
California Bay-Delta Authority (CBDA)
CALTRANS
Delta Protection Commission (DPC)
Dept. of Boating and Waterways
Dept. of Conservation
Dept. of Fish & Game
Dept. of Food and Agriculture (CDFA)
Dept. of Water Resources (DWR)
California Emergency Management Agency (Cal EMA)
SF Bay Conservation & Development Commission
Office of Planning and Research (OPR)
State Coastal Conservancy (BCDC)
State Insurance Commission
State Lands Commission
State Parks and Recreation
State Reclamation Board
State Water Boards

Counties

Alameda
Contra Costa
Sacramento
San Joaquin
Solano
Yolo

Local cities

Delta cities (Primary & Secondary Zone): Bethel Island, Brentwood, Clarksburg, Courtland, Franklin, Freeport, Isleton, Lathrop, Locke, Lodi-Hood, Manteca, Oakley, Orwood, Rio Vista, Ryde, Stockton, Thornton, Tracy, Walnut Grove

Conservation districts, fire departments and fire districts, police departments, reclamation districts

Cities outside Delta-Suisun

Bay Area Cities
Central Valley Cities
LA Basin Cities
Sacramento Valley Cities

Regional air quality districts

Agriculture Commissioners
Flood Control Associations
Governmental/County Associations
Water Conservation Districts
Water Quality Control Boards

Other interested parties/NGOs/landowners

Chambers of Commerce
Conservation Leagues
Environmental Justice Groups
Farm Bureaus
Farmers
Hunters/Fishers
Labor Unions
Land Trusts
Local Residents
Ports
Public Health Groups
Recreational Users
Scientific and Education Organizations
Sportsman's Organizations
Suisun Resource Conservation District
Tourism Industries
Utility Companies/Providers
Wildlife Conservation Groups

Water purveyors/special districts

City, County, & Regional Water Districts & Agencies
Flood Control Agencies
Irrigation Districts
Utility Districts
Water Conservation Districts
Water Contractors

Flood Management

Flood Hazards

Throughout the Delta, levees originally constructed from material dredged from adjacent channels and since improved in various places, hold back river and tidal waters. These levees are subjected to damage from rodents, piping, and possibly, foundation movement. These effects may lead to sudden failure at any time of the year.

Winter storms bring both high inflows and windy conditions. In combination with annual and daily high tides, this may cause waves to wash over and damage Delta levees, potentially leading to failure. When an island floods, the fetch is increased to the full width of the island. The waves may cause extensive damage to unprotected interior levee slopes.

Historic Floods

Floods in the San Joaquin Delta region are caused by levee failure, rainfall, high tides and winds. Recent notable floods are listed here.

- February 1986, failure of Tyler and Dead Horse Islands and McCormack-Williamson and New Hope tracts.
- January 1997, storms
- June 2004, the Lower Jones Tract levee failure
- Late December 2005, storms.

For more information on these floods see Appendix A, Flood Management. Flood records for the selected tributaries to the Delta are listed in Appendix A in Table DA-1.

Flood Governance

Flood management is a cooperative effort in which federal, Tribal, State, and local governments all play significant parts. The principal participants are listed in Box D-4, Flood Management Agencies. For more information on the agencies' roles, see Table DA-2, Flood management participants, in Appendix A.

Flood Risk Management

Flood risk management includes a wide variety of projects and programs, which may be grouped as Structural Approaches (constructed facilities, coordination and reservoir operations, maintenance), Land Use Management (regulation, flood insurance), and Disaster Preparedness, Response and Recovery (information and education, event management).

Structural Approaches

Constructed Facilities. Protecting the 76 islands and tracts in the region are 825 miles of private levees and 275 miles of USACE levees, including 165 miles sponsored by

Box D-4 Flood Management Agencies

Federal

- Federal Emergency Management Agency
- National Weather Service
- Natural Resources Conservation Service
- US Geological Survey
- US Army Corps of Engineers

Tribal

- Tribal governments of the region

State

- California Conservation Corps
- California Emergency Management Agency
- Central Valley Flood Protection Board
- Department of Corrections
- Department of Forestry and Fire Protection
- Department of Water Resources

Local

- County emergency services units
- County planning departments
- County building departments
- Local flood maintenance organizations
- Local conservation corps
- Local emergency response agencies
- Local initial responders to emergencies
- Specific Initiative Organizations
- Delta Protection Commission
- Delta Vision Commission
- FloodSAFE California

Central Valley Flood Protection Board (CVFPB). Most levees originated in the mid-19th century and vary widely in composition and integrity.

Private Delta levees are supported by State subvention programs administered by DWR. CVFPB-sponsored USACE levees in the northern Delta are on the Sacramento River, Steamboat, Miner, Elk, Georgiana, Thirteen Mile, Cache, and Lindsey sloughs. The southern Delta's CVFPB/federal levees are on the San Joaquin, Calaveras and Old Rivers, Bear Creek, Paradise Cut, and French Camp Slough. In general, these levees predate federal participation and are generally of the same original construction as the private levees, though many miles have been improved. Separate USACE projects are the Sacramento River Deep Water Ship Channel and its appurtenant levees, and the Stockton Deep Water Ship Channel.

In the early years of the 20th century, the Sacramento River was dredged and partially realigned to facilitate river traffic and improve flood capacity. The San Joaquin River was deepened and realigned for the same purposes beginning in the 1950s. In the late 20th and early 21st centuries, some federal Sacramento River Flood Control Project levees and various private Delta levees were strengthened using federal and State funding.

The flood control and multipurpose reservoirs of the Sacramento River and San Joaquin River systems contribute to flood protection in the Delta. For tabulation of these reservoirs, see Appendix A for Sacramento River Hydrologic Region and Appendix A for San Joaquin River Hydrologic Region.

Coordination and Reservoir Operations. Control of flooding in the Delta is strongly dependent on operation of the upstream reservoirs in the Sacramento River and San Joaquin River regions. During high-water periods operators of reservoirs upstream of the Delta coordinate with DWR and USACE during daily operations conferences at the State-Federal Flood Operations Center in Sacramento. These conferences often lead to voluntary modifications of individual schedules that would benefit the Delta. For information on operations of upstream reservoirs, see Volume 3 regional reports, Sacramento River Hydrologic Region and San Joaquin River Hydrologic Region.

The proposed forecast-coordinated operations on the Feather River will be beneficial to Delta flood management.

Maintenance. Maintenance of flood control works is a critical activity that preserves the integrity of the facilities, ensuring continued protection for the public. This effort is made more difficult by two factors: (1) Lack of adequate financing for many installations is the result of tax-management efforts of the late 20th century which have placed controls on former sources of revenue, and (2) heightened public awareness of the environment has resulted in new regulations making the permitting process lengthy and expensive. Compounding the problem, deferred maintenance can cause establishment of new habitat which then must be protected.

Maintenance of flood control facilities is usually the responsibility of the local maintaining agency, which is usually the local sponsor, or if there is none, the constructing agency. The CVFPB has agreed to maintain USACE levees in the Delta, but subsidiary agreements have passed maintenance to local maintaining agencies. The local constructing agency maintains non-federal levees.

Land Use Management

Regulation. Counties are the main agencies responsible for designating and regulating floodways. All six counties within the region regulate floodplain development with countywide zoning ordinances. General plans for all counties provide strategic goals for minimizing future flood risks in the context of increasing development and population growth. All local land use jurisdictions must adopt a floodplain management ordinance identifying 1 percent floodplains and floodways, in order to qualify for FEMA flood insurance.

Adopting designated floodways facilitates enforcement of floodplain building ordinances. The CVFPB has adopted designated floodways on the Cosumnes and Mokelumne rivers from their confluence upstream to the region's boundary.

Flood Insurance. The National Flood Insurance Program (NFIP) is administered by FEMA. It enables property owners in participating communities to purchase insurance as protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. About 97 percent of California communities participate in the NFIP. Of those, approximately 12 percent

participate in the Community Rating System (CRS) Program, which encourages communities to go beyond minimum NFIP requirements in return for reduced insurance rates. Quality mapping is critical to administering an effective flood insurance program, developing hydrologic and hydraulic information for determining floodplain boundaries and allocating flood protection project funds.

The Federal Emergency Management Agency (FEMA) has provided Flood Insurance Rate Maps (FIRMs) for virtually all areas within the region. As of June 2009, maps in four of the region's six counties are new, and one more is scheduled to be updated by 2010. One county had a partial update in 2008.

CRS rates communities from 1 to 10 on the effectiveness of flood protection activities. The lower ratings bring larger discounts on flood insurance. Of the six counties and 11 cities in the hydrologic region, five counties and three cities participate in CRS. As of May 2009, Sacramento County and Sacramento are in CRS Class 5; Contra Costa County and San Joaquin County, Class 6; Alameda and Solano County, Class 7; Lathrop and Stockton, Class 8; and Yolo County's application to participate is pending. See http://www.fema.gov/business/nfip/crs.shtm for more information on the CRS system.

Disaster Preparedness, Response and Recovery

Information and Education. The California Data Exchange Center (CDEC) provides real-time and historical hydrometeorological data for hundreds of stations statewide, as well as real-time data on releases, spill rates, and elevations of many reservoirs. For listings of real-time stream and reservoir data stations, see Volume 3 reports, Sacramento River Hydrologic Region and San Joaquin River Hydrologic Region, including Appendix A for each report. For access to CDEC data, see http://cdec.water.ca.gov.

The USGS maintains and publishes statistics for stream gages nationwide. USGS gages are the source of data for the six stations listed in Appendix A, Table DA-1, Record floods for selected streams. For access to USGS gage data, see http://waterdata.usgs.gov/nwis.

DWR's Awareness Floodplain Mapping program provides an easy-to-use computer interface for viewing areas vulnerable to flooding by the flood having a 1 percent probability of occurrence. The program applies to areas not already covered by FEMA FIRMs. For this region, maps have been drawn for all counties, but coverage of some areas may have been deferred. By 2015, all areas expected to develop over the next 25 years will have mapped floodplains. In 2009, DWR provided Levee Flood Protection Zone (LFPZ) maps, which show lands inundated to a depth of 3 feet or more in the event of a levee failure, for levees of the Sacramento River Flood Control Project and the San Joaquin River Flood Control System.

Accurate hydrologic and hydraulic models inform the design of effective flood control structures and emergency actions before, during, and after floods. The National Weather Service's (NWS) Advanced Hydrologic Prediction Service uses historical hydrologic

data, current river and watershed conditions, and near-term meteorological outlooks to forecast river flows. The service is publicly available for certain streams of the Delta. Locations are given in Appendix A, Table DA-5.

The NWS has also used Sacramento Soil Moisture Accounting and Anderson Snow models to study changes in hydrographs for the Sacramento, Feather, and American rivers due to climate change. DWR and the USGS have developed models that use hydrologic parameters such as snowpack and evapotranspiration to predict streamflows for the Feather River Watershed above Oroville Dam.

The Delta Risk Management Study is expected to lead to strategies to manage Delta levee failure risk and to improve management of State funding for Delta levee maintenance and improvement. For more information, see Delta Risk Management Strategy later in this report.

Event Management. Under the Standardized Emergency Management System (SEMS) and the National Incident Management System (NIMS), initial flood emergency response is made by the responsible party at the site. When its resources are exhausted, the county emergency management organization (Operational Area) provides support. If necessary, additional support is coordinated by a region of the California Emergency Management Agency (Cal EMA). Through the Cal EMA region and Cal EMA headquarters, help can be obtained from any State agency. Cal EMA coordinates with federal agencies and private organizations as well. The State-Federal Flood Operations Center (a joint facility of DWR and the Sacramento Weather Office and California-Nevada River Forecast Center, both units of NWS) is normally called early in the flood to provide weather and river forecasts, facilitate information flow, provide field situation analysis, and give flood fight expertise. Severe situations that require Cal EMA involvement may also require emergency response by USACE, which is obtained by request of DWR. Table DA-4 in Appendix A lists specific response organizations.

Recovery after a flood event may involve the funding and construction services of USACE if the facilities are parts of federal projects. Availability of resources to repair local and private facilities; remove floodwater; and restore housing, businesses, and infrastructure often depends on the severity of the event and the allocation of event-specific federal or State funds.

Flood preparedness and mitigation efforts are promoted and funded by many organizations, including city and county governments, Cal EMA, DWR, NWS, and USACE.

Relationship with Regions

Covering only about 1 percent of California's area, the Delta contributes much more to the state than one might expect from its size. A large part of the state is dependent upon water exported from the Delta to meet much of its agricultural and urban needs.

The Delta is a key conduit of the state's water supplies. Approximately two-thirds of the state's population live and work in urban areas that receive at least some of their water supply from the Delta. About 3 million acres of agricultural land are irrigated with exported water. On average, the CVP and SWP together export about 5 million acre-feet annually. The San Francisco Bay, San Joaquin, Tulare, and South Coast regions receive the lion's share of the exported water. In addition to providing water for farms, homes, and industry, water exported from the Delta provides significant water supplies to California's vital wetlands. Water from the Delta's watershed is also used within various areas upstream of the Delta and exported to areas around the State without going through the Delta.

The Delta region is also important to the state because of its vital transportation and water conveyance facilities, ecosystem functions, and wide range of recreational opportunities. The Delta contains highways, railroads and shipping routes, natural gas storage and transmission facilities, electric transmission pathways, and gasoline product distribution pipelines. Eighty percent of the state's commercial fishery species live in or migrate through the Delta. In addition, the Delta provides world renowned boating, hunting, fishing and nature viewing opportunities, with 12 million user-days annually.

Seven Integrated Regional Water Management (IRWM) plans touch on the Delta as well as the General Plans of all Delta Counties.

Failure of Delta island levees, in either the Sacramento River region or the San Joaquin River region, increases salinity in San Pablo Bay, the Carquinez Strait, and Suisun Bay due to the sudden upstream flow of water into the damaged island. For information about interregional cooperation to meet this threat, see Coordination and Reservoir Operations in this report.

As noted in the Setting discussion, a number of Delta initiatives are being undertaken, the outcome of which will affect both the Delta region and regions across the state. Most, if not all, of these activities will have a role in developing the region's as well as other region's response strategies for meeting future water supplies and exports, water quality, ecosystem and flood protection.

Regional Water and Flood Planning and Management

The counties making up the Delta region have their own General Plans for future development and conservation efforts. The Delta region includes part of seven IRWM plans (American River Basin, Eastern San Joaquin, East Contra Costa, Mokelumne, Amador and Calaveras, Sacramento Valley, Solano County and Yolo County). In addition to these efforts, a number of initiatives are under way in the Delta. Delta Vision, Bay-Delta Conservation Plan, the Water Boards' Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary and Drought and Flood Planning are discussed here. Several others are noted in Appendix B.

General Plans. County general plans list land use and economic development goals and objectives for the Delta. For the five Delta counties in the Primary Zone, their goals and objectives are very similar for the region: provide flood protection and public safety; slow urbanization on prime agricultural land; preserve ecological and habitat resources; enhance transportation, including Highway 16, ports, and waterways; and provide and protect water resources, including water quality, diversions, groundwater, and controlled exports. The ongoing activities within the Delta (Delta Vision, BDCP, State Water Board's Strategic Plan, etc.) have and are taking these plans into consideration as their respective strategies are developed. One or more of these ongoing activities might eventually call for some adjustment in the goals and objectives set out in the various General Plans.

Integrated Regional Water Plans. There are no IRWM plans written specifically for the Delta region. Some, like the American River Basin Plan, do not mention the Delta by name, but acknowledge that water supply goals and objectives are consistent with the larger statewide goals and objectives outlined by the CALFED Program. Others, like the Cosumnes, American, Bear, and Yuba Region (CABY) IRWM Plan and the Sacramento Valley IRWM Plan, explicitly tie specific goals, objectives and actions to helping meet the CALFED goal of improving the Delta. These actions include water conservation, water quality improvement, and ecosystem restoration. Not surprisingly, the IRWM plans share many of the themes mentioned in the general plans. The most common and prevalent themes are water quality and flood control.

Three other Delta-related issues most common in these IRWM plans are levee system improvement, new or enlarged surface storage, and upstream ecosystem restoration. Land use, and its accompanying water use, is another aspect explored in the IRWM plans. In many cases, the IRWM plans see land use and changes in water use as potentially affecting both quality and flow to the Delta.

Emerging issues such as the effect of climate change including greenhouse gas emissions will be addressed in future IRWM plans.

The Yolo County IRWM Plan lists several specific actions for areas in the Delta. Actions include foundational efforts such as monitoring water quality or subsidence, mercury remediation in the Cache Creek system and Yolo Bypass, Clarksburg levee improvement, and Sutter Slough erosion control.

Delta Vision. Executive Order S-17-06 established a Blue Ribbon Task Force and directed the Task Force to "develop a durable vision for the sustainable management of the Delta" with the goal of "… managing the Delta over the long term to restore and maintain identified functions and values that are determined to be important to the environmental quality of the Delta and the economic and social well being of the people of the state." The vision and strategy for implementing the vision can be seen at http://www.deltavision.ca.gov/.

Bay-Delta Conservation Plan. The BDCP is a collaborative effort by State and federal agencies and stakeholder groups to develop a conservation plan for the Delta aimed at addressing the current conflict between the protection of at-risk fish species and water supply. While the BDCP is focusing on the fish/water supply issues in the context of broad ecosystem protection principles, it is also addressing water conveyance alternatives, habitat restoration and management, other ecological problems including invasive species and toxic pollutants. A public draft of the BDCP and the environmental assessment documents are scheduled for release in late 2009/early 2010.

BDCP: http://resources.ca.gov/bdcp/

For a view of the alternative conveyance alignments visit: http://www.water.ca.gov/deltainit/maps0309.cfm

Delta Risk Management Strategy. The DRMS is expected to lead to development of strategies to manage the risk of Delta area levee failure and to improve management of State funding supporting Delta area levee maintenance and improvement. DWR is directing the study, which is sponsored by DWR, DFG, and USACE, guided by 20 subject experts from federal, State, local, and private organizations, and performed by about 30 consultants in appropriate fields. The DRMS is in two phases. Phase 1, completed in 2007, identified three risks to Delta area levees (earthquake, high water, and levee and foundation deterioration) and evaluated the consequences in terms of cost, water quality effects, ecosystem effects, and public health and safety. Phase 1 concluded that the annual probability of an island being flooded is less than 1percent to more than 7 percent, depending on the location. Phase 2 evaluates long-term risk-reduction options for Delta area levees and describes a discrete set of actions that can be taken to reduce the risks and consequences of levee failure. The draft Phase 2 report was made available for public review in 2009.

For more information, see the DRMS Web Portal at http://www.water.ca.gov/floodmgmt/dsmo/sab/drmsp.

Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. The strategic workplan describes a suite of priority activities the State and Regional Water Boards will pursue over the next five years to address the water supply and environmental crisis in the Bay-Delta. Workplan activities are responsive to priorities identified by the governor and Delta Vision, and touch on a wide range of flow-related and water quality actions to better protect the Bay-Delta. Staff will provide quarterly updates to the State and Regional Water Boards on implementation of the strategic workplan.

Strategic Workplan: http://www.waterrights.ca.gov/baydelta/docs/strategic_plan/baydelta_workplan_final.pdf

Recent Accomplishments

Accomplishments are noted below and in Appendix B.

General Plans. A major accomplishment is that all five Delta counties agreed to include a Delta region element in their revised, or soon to be updated, general plans. The DPC recommended that Delta counties include this element in their general plans, using the DPC's Land Use and Resources Management Plan as a guide. Another accomplishment is that the five counties, along with DWR and DPC, are developing a comprehensive flood emergency response plan that addresses both the technical (e.g., levee repair) and sociological (e.g., evacuations) aspects of Delta floods. All counties are also engaged in various climate change efforts to address the potential effects changes in timing and intensity of water flow may have in the Delta.

Integrated Regional Water Management Plans. The IRWM plans list a wide range of strategies they intend to use to accomplish the goals and objectives. These strategies range from water conservation and recycling, best management practices for agriculture and urban areas, and watershed management to reduce containments or large amounts of sediment from entering the waterways. Conjunctive use of ground and surface water is another strategy to help with both water quality and water flow objectives for the Delta.

Many plans conscientiously connect the various ongoing or planned projects that member agencies are doing with the larger regional and statewide goals. Flood protection and preparedness accomplishments include building storm water retention basins and creating regional disaster plans. Other listed accomplishments include developing off-stream or groundwater storage, restoring water channel capacity by eradicating *Arundo donax*, improving water supply pipelines, carrying out interregional conjunctive use projects, and enlarging existing reservoirs.

Delta Vision. The task force completed its "vision" in November 2007 and its Delta Vision Strategic Plan for accomplishing the vision in October 2008. The vision outlined 12 integrated and linked recommendations for the sustainable management of the Delta. The Strategic Plan sets out 7 goals and 17 related strategies necessary to meet the vision's recommendations. The Governor's Delta Vision Committee reviewed the task force's work and submitted their implementation recommendation to the governor in January 2009. The committee accepted all the goals proposed by the task force. They also accepted all strategies save two regarding governance for which they proposed modifications. The Delta Vision Task Force's Vision and Strategic Plan and the Delta Vision Committee's report can be accessed at http://www.deltavision.ca.gov/.

Draft overview: http://www.resources.ca.gov/bdcp/docs/12.19.08_HO_BDCP-Overview_of_Conservation_Strategy_With_Core_Elements.pdf

Bay Delta Conservation Plan. The BDCP process began in late 2006, and in 2007 agreed on the most promising approach for achieving its goals of conservation and water supply. In January 2009, it issued an "Overview of the Draft Conservation Strategy for the Bay Delta Conservation Plan" and in May 2009, it released a draft report describing the application of the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) Scientific Evaluation Process to the draft conservation measures being considered for inclusion in the Bay Delta Conservation Plan (BDCP). It can be found at the following site: http://www.resources.ca.gov/bdcp/docs/5.22.09_BDCP-DRERIP_Summary_with_Appendices.pdf. Finally, the reader can track the latest draft documents in the development of the BDCP at the following site: http://www.resources.ca.gov/bdcp/bdcp_annotated_outline.html.

Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. Implementation efforts are noted in status updates located at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/.

Hazard Mitigation Plans. The federal Disaster Mitigation Act of 2000 amended existing law with regards to hazard mitigation planning. The act emphasizes pre-disaster mitigation and mitigation planning. In order to receive federal hazard mitigation funds in the future, all local jurisdictions must now adopt a hazard mitigation plan identifying

hazards, risks, mitigation actions and priority and providing technical support for those efforts. Between 2004 and 2007, Alameda, Contra Costa, and Solano counties annexed to the ABAG multi-jurisdictional hazard mitigation plan and Sacramento and Yolo counties adopted hazard mitigation plans. All subsequently received Cal EMA approval.

Constructed Facilities. For descriptions of constructed facilities, see Structural Approaches in this report.

Regional Flood Control. Two regional flood control agencies have been organized to sponsor and coordinate flood protection projects and other aspects of flood management: Sacramento Area Flood Control Agency, established in 1989, and the San Joaquin Area Flood Control Agency, set up in 1995.

Challenges

Challenges are noted below and in Appendix B.

General Plans. Four of the five Delta counties have completed updates to their general plans; a draft of the San Joaquin County general plan update is scheduled for completion in 2010. All five counties have agreed that their respective Delta planning would be consistent with the DPC Land Use and Resource Management Plan, which is also being updated.

Understandably, each county has specific issues regarding that part of the Delta over which it has jurisdiction. There are, however, significant common issues between all five. Below are eight common challenges each of the five Delta counties face as they carry out their plans for the Delta:

- Preserving and protecting the natural resources in the Delta
- Supporting the long-term viability of agriculture in the Delta
- Limiting inappropriate development in the Delta
- Maintaining Delta levees
- Protecting water quality in the Delta
- Meeting transportation and utility infrastructure needs in the Delta
- Plan and carry out emergency response in the Delta
- Maintaining the unique character of the Delta while allowing for economic and population growth

A ninth common challenge for all of the Delta counties is ensuring consistency with the DPC's Delta management plan.

Integrated Regional Water Management Plans. The primary challenge is water supply, specifically, how to handle conflicts between water agencies, both within a region and outside of the region. Urbanization in areas upstream of the Delta presents an additional challenge because water use in areas of origin is likely to increase. This urbanization presents an additional challenge to water quality because more rural areas

may not have adequate wastewater treatment facilities. Mercury contamination and sediment control is another challenge for upstream regions.

The challenges listed in these IRWM plans are a subset of those besetting the Delta: conflicts between water users in different parts of a region, sediment control, infrastructure, habitat restoration, mercury contamination, flood management, water exports outside of the region, and urbanization. While most IRWM plans acknowledge that their region has a role to play in meeting the statewide goals for the Delta, as expressed in the CALFED Programmatic EIS/EIR, few have specific objectives or actions addressing those goals. The Yolo County IRWM Plan, however, is the exception.

Delta Vision. In describing the challenges, the Delta Vision Committee's Report states, "The Delta ecosystem is experiencing a steep decline. This condition, in addition to increasing seismic risk, added year-round water demand and the impacts of climate change have already caused severe reductions in the Delta-dependent water supply and in the reliability of that supply. These reductions impact our economy, our food security and our quality of life. The stakes are high, and Californians must come together now to take fundamental actions to preserve and protect the many uses of the Delta."

Bay Delta Conservation Plan. An early draft of "An Overview of the Draft Conservation Strategy for the Delta Conservation Plan," listed challenges facing the BDCP effort. It notes that a primary challenge facing the BDCP process is how to comprehensively address the conflict between the ecological needs of at-risk Delta species and natural communities while providing for adequate and reliable water supplies for people, communities, agriculture, and industry. It also recognizes that the actions being contemplated in the proposed Conservation Strategy have raised concerns within the Delta communities about the potential effects of such actions. Examples of potential effects of BDCP actions (largely conveyance) expressed at the California Water Plan Delta Regional Report Workshop in May 2009, included affecting groundwater, increasing salinity, and degrading the local economy and recreational boating.

Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. Efforts will be challenged by climate change and its effects on water availability and quality; population growth and its demands on water supplies and effects on water quality including increased wastewater discharges; sea level rise and its potential to overtop or fail levees affecting water quality and availability; and the myriad of ongoing Delta projects and activities

Flood Protection. The definitive challenge in the Delta is to preserve, rehabilitate, and improve the 1,100 miles of private and public levees. A desirable goal is to raise the level of protection to an appropriate standard, such as the level required for federal emergency reconstruction under Public Law 84-99, the level for FEMA support, or a higher standard for key levees protecting water quality, the ecosystem, life and personal property, agricultural production, cultural resources, and local and statewide infrastructure. Development of funding for these improvements is an important part of the challenge.

Other Delta flood control issues are assessment of the condition of levees; quantification of the risks and consequences of earthquakes, storm damage, rodent and other calm-weather damage, seepage, and subsidence; identifying and establishing practices to control subsidence of the land surface; responding to the effects of sea level rise; development and implementation of watershed-based programs for reducing the effect of high water, and promoting cooperation among the many stakeholders.

Effective preparedness for flood events depends on accurate evaluation of the risk, adequate measures for mitigation of flood damage, sufficient preparation for response and recovery activities and coordination among local, State, and federal agencies. Two actions that help meet the challenge of response and recovery preparedness are organization for emergency management and formal agreement on responsibilities for emergency actions and funding.

Local funding for flood maintenance and construction projects has become less effective in recent years because of several factors: Heightened public awareness of the need to protect the environment has increase the cost of upkeep and improvement; concern for endangered species has made scheduling more complex; both environmental and endangered species conditions have made permits more difficult to obtain; measures to reduce taxation, especially on property, have rendered revenue increases difficult to achieve; and inflation has increased costs. Meeting the requirements of these new restraints has become a high-profile local challenge.

Drought and Flood Planning

Two of the six counties in this region have adopted hazard mitigation plans, and three have annexed to the ABAG Multi-Jurisdictional Local Hazard Mitigation Plan. For more information, see Recent Accomplishments in this report.

FloodSAFE is a strategic initiative of DWR that seeks a sustainable integrated flood management and emergency response system throughout California that improves public safety, protects and enhances environmental and cultural resources, and supports economic growth by reducing the probability of destructive floods, promoting beneficial floodplain processes, and lowering the damages caused by flooding. FloodSAFE is guiding development of regional flood management plans. These plans will encourage regional cooperation in identifying and addressing flood hazards, and will include flood-hazard identification, risk analyses, review of existing measures, and identification of potential projects and funding strategies. The plans will emphasize multiple objectives, system resiliency, and compatibility with State goals and IRWM plans.

FloodSAFE is responsible for the Central Valley Flood Management Planning Program, the purpose of which is to improve integrated flood management in the Sacramento and San Joaquin valleys. The program study area includes the watersheds of the Sacramento and San Joaquin rivers. The program is charged with development of three documents: the State Plan of Flood Control Descriptive Document, describing the flood management facilities, land, programs, conditions, and mode of operations and maintenance for

the State-federal flood protection system in the Central Valley, published in the spring of 2010; the Flood Control System Status Report, assessing the status of facilities in the State Plan of Flood Control, identifying deficiencies, and making recommendations for improvement, anticipated by December 31, 2010, and the Central Valley Flood Protection Plan, required by law by January 1, 2012, describing a sustainable, integrated flood management plan that reflects a system-wide approach for protecting areas of the Central Valley currently receiving protection from flooding by the existing facilities of the State Plan of Flood Control. Updates of the Central Valley Flood Protection Plan are required every five years. Additional information may be accessed at Floodsafe.

Looking to the Future

Climate Change

The current expectations for future changes in California's climate include the following.

- Mean temperature increases from 2 to 6 degrees C. California's complex terrain will modulate the value locally.
- Unknown change to precipitation totals, but an increase in extreme wet and dry conditions. More precipitation will fall as rain than as snow in higher elevations.
- Decreased snowpack particularly in the northern Sierra (up to 90 percent by 2100) and earlier melt time.
- Less mountain block recharge from snowpack expected with implications for long-term support of regional aquifers.
- Annual runoff concentrated more in winter months with more variability and greater extremes.
- Ecosystem challenges increased due to exacerbation of existing threats from above changes.

In addition to these projected changes, land surfaces in the Delta are subsiding slowly. The combination of subsidence and the historical sea level rise at the Golden Gate result in estimates of Delta sea level rise rates on the order of 0.7 feet per century. However, due to continued trends in global warming, sea level rise has been predicted to potentially reach 55 inches by the end of the 21st century.

These changes will increase the vulnerability of water resources infrastructure including flood control, water supply, and wastewater treatment and disposal. The changes will challenge operations procedures for water resources infrastructure and impact the planning for new projects and further stress ecosystems. Many mitigation strategies are under way to reduce greenhouse gas emissions (AB 32), but adaptation strategies such as those in DWR's climate change white paper (2008) will be needed to accommodate changes caused by climate change.

Future Scenarios

As noted earlier, the Delta is faced with significant risks and challenges. In its report to the governor, the Delta Vision Committee offered the following perspective on the Delta's risks and challenges:

> "California's Delta has long been at the center of competing demands, both as the hub of the state's water system and the heart of the largest estuary on the Pacific Coast. But it is much more than that: home to about 500,000 residents, an agricultural center, a recreational draw from around the state, and a crossroads for many of California's utility and transportation corridors.
>
> "Long-standing conflicts arising from these often competing uses are compounded by new scientific information suggesting increased risks to the Delta as we know it—from climate change which is causing both sea level rise extending into the Delta and the potential for increased flooding along Delta rivers. This new science also indicates the risk of major seismic events, potentially causing devastating effects on public health, safety and welfare, is greater than previously understood.
>
> "The Delta ecosystem is becoming severely degraded. Court decisions, closure of the salmon fishery in 2008 and a procession of listings of species as threatened or endangered (winter-run Chinook salmon, Delta smelt, Central Valley spring-run Chinook salmon, and Longfin smelt) are evidence of this degradation.
>
> In addition, the Delta is rapidly becoming more urban. Despite the recent downturn in the housing market, millions more people are expected to inhabit the five Delta counties by the middle of this century. Wise land use decisions that preserve public safety, promote ecosystem restoration, and permit long-term climate change adaptation are essential."

Response Strategies

Resources management strategies are detailed in Volume 2 of Update 2009. A number of these strategies will be useful in improving the management of water for use within the Delta as well as tackling other challenges. Table D-1 lists the resource management strategies that appear applicable in the Delta based on regional studies. Several efforts under way may potentially implement a number of these resource management strategies.

Water Board's Strategic Workplan for Activities in the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary. In addition to implementing these response management strategies, the Delta plans, programs and actions noted in Table D-1 will implement additional measures that will further address the Delta risks and challenges ultimately leading to a sustainable Delta.

Table D-1 Resource management strategies and Delta actions

Resources Management Strategies	Actions						
	Delta Vision	BDCP	Strategic Plan	CALFED	Suisun Marsh	General Plans	IRWMP
Reduce Water Demand							
Agricultural Water Use Efficiency	√		√	√		√	√
Urban Water Use Efficiency	√		√	√		√	√
Improve Operational Efficiency and Transfers							
Conveyance Delta	√	√		√			
Conveyance Regional/Local	√	√		√	√	√	√
System Re-operation	√	√	√	√	√		√
Water Transfers	√	√	√	√		√	√
Increase Water Supply							
Conjunctive Management and Groundwater Storage	√	√	√	√	√	√	√
Desalination – Brackish and Seawater	√			√			√
Recycled Municipal Water	√		√	√		√	√
Surface Storage - CALFED	√			√			√
Surface Storage – Regional/Local	√			√		√	√
Improve Water Quality							
Drinking Water Treatment and Distribution	√		√	√	√	√	√
Groundwater Aquifer Remediation	√			√		√	√
Matching Quality to Use			√	√		√	√
Pollution Prevention	√	√	√	√	√	√	√
Salt and Salinity Management		√	√	√	√	√	√
Urban Runoff Management		√	√	√	√	√	√
Practice Resource Stewardship							
Agricultural Lands Stewardship	√	√		√		√	√
Economic Incentives	√		√	√		√	√
Ecosystem Restoration	√	√	√	√	√	√	√
Forest Management				√			√
Land Use Planning and Management	√	√	√	√	√	√	√
Recharge Area Protection	√	√	√	√		√	√
Water Dependent Recreation	√		√	√	√	√	√
Watershed Management	√	√	√	√		√	√
Improve Flood Management							
Flood Risk Management	√	√		√	√	√	√

Note: BDCP = San Francisco Bay Delta Conservation and Development Commission; IRWMP = Integrated Water Management Plans

Spanning all of these efforts and crucial to ensuring a sustainable Delta is the direction and accelerated implementation of the Delta Vision Committee's recommendations. The Delta Vision Committee, drawing on the detailed recommendations in the Delta Vision Blue Ribbon Task Force's Strategic Plan, outlined the following "fundamental actions" that need to be undertaken to achieve a sustainable Delta and to avoid catastrophe.

- A new system of dual[2] water conveyance through and around the Delta to protect municipal, agricultural, environmental, and the other beneficial uses of water;
- An investment commitment and strategy to restore and sustain a vibrant and diverse Delta ecosystem including the protection and enhancement of agricultural lands that are compatible with Plan goals;
- Additional storage to allow greater system operational flexibility that will benefit water supplies for both humans and the environment and adapt to a changing climate;
- An investment plan to protect and enhance unique and important characteristics of the Delta region;
- A comprehensive Delta emergency preparedness strategy and a fully integrated Delta emergency response plan;
- A plan to significantly improve and provide incentives for water conservation – through both wise use and reuse – in both urban and agricultural sectors throughout the state;
- Strong incentives for local and regional efforts to make better use of new sources of water such as brackish water cleanup and seawater desalination; and
- An improved governance system that has reliable funding, clear authority to determine priorities and strong performance measures to ensure accountability to the new governing doctrine of the Delta: operation for the coequal goals. Completion of this fundamental action is absolutely essential to the sustained operation and maintenance of all of these recommendations.

In addition, the Delta Vision Committee's Report lists a number of strategies set forth by the task force to support the fundamental actions. As noted in the report, these strategies are a significant part of a comprehensive approach to achieve a sustainable Delta, but they do require additional development and perhaps additional authority. Greater detail including a timeline for implementing the fundamental actions along with the strategies that will support the "fundamental actions" can be found at http://www.deltavision.ca.gov/.

2 Dual – The Delta Vision Strategic Plan defines dual water conveyance to mean a combination of through Delta and isolated facility (i.e., conveyance around the Delta) improvements.

Appendix A. Flood Management

Historic Floods

Flood Parameters

Table DA-1, Record floods for selected streams, in the Delta region is based on US Geological Survey records. The stations were selected from all USGS gaging stations in the region, according to the criteria in Box DA-1.

Box DA-1 Selection Criteria

- The watercourse must be a natural stream with a watershed of at least 100 square miles.
- The station must have a reasonably continuous record of discharge from 1996 to the present.
- The station must be far enough from other stations on the same river to reasonably represent a separate condition.
- Stations in well defined watercourse locations such as deep canyons are omitted, unless particularly important to the overall flood situation.

Flood Descriptions

Early Floods. Levee failures are not rare in the Delta. Each of the 70 islands has flooded at least once since reclamation. Between 1930 and 1969, 18 islands or tracts flooded in a total of 28 events.

1972. The failure of Andrus Island was the only event ever to result in significant seawater intrusion, though the threat remains.

January-February 1980. A combination of high tides and flood-level flows caused breaches in and rapid deterioration of private levees. Approximately 11,300 acres of agricultural land were inundated on Webb and Holland tracts and Prospect and Dead Horse islands.

September 1980. An Old River levee failed causing the 5,200-acre Lower Jones Tract to flood.

October and November 1981. Heavy storms raised river levels, leading to another failure of the Prospect Island levee and failure of Little Franks Tract, 200 acres, in December.

Table DA-1 Record floods for selected streams in the Delta region

Stream	Location	Mean annual runoff (taf)	Peak stage of record (ft)	Peak discharge of record (cfs)
Sacramento R	at Freeport	17,270[2]	129.6[1,3]	117,000
San Joaquin R	near Vernalis	3,308	34.9[1]	79,000
Cosumnes R	at Michigan Bar[4]	362	18.5	93,000
Mokelumne R	at Woodbridge[4]	403[2]	23.3[1]	5,340
Yolo Bypass	near Woodland[4]	2,340[2]	34.9	374,000
Putah Cr	near Winters[4]	349[2]	19.6	18,700

taf = thousand acre-feet; ft = feet; cfs = cubic feet per second

1 Different date than peak discharge

2 Most recent but less than period of record

3 Water Years 1946-1977

4 Located upstream of the legal Delta

January and February 1982. High water on the Cosumnes River in January breached private levees, flooding farmland and damaging roads and bridges. These areas flooded again when the Cosumnes rose in February.

August 1982. The McDonald Island levee failed, inundating 5,800 acres of farmland.

November 1982. High tides and winds contributed to the failure of Venice Island.

January 1983. Levees failed at Mildred Island, Shima Tract, Fay Island, Little Frank's Tract, and Prospect Island. Bradford Island failed in December 1983.

February 1986. Record high tides and record Sacramento River inflow both occurred, leading to failure of Tyler and Dead Horse islands and McCormack-Williamson and New Hope tracts.

January 1997. Storms caused one of the worst floods of the century. McCormack-Williamson Tract and Dead Horse Island levees failed again. Particularly high flows in the San Joaquin River led to failure of a levee at Mossdale, flooding that area and Stewart Tract, and the nearby Paradise Cut levee breach flooded the Pescadero District.

June 2004. The Lower Jones Tract levee failed, inundating the island.

Flood Governance

Many federal, State, and local agencies have responsibilities in the overall effort to manage floods. The principal participants in the Delta region and their activities are listed in Table DA-2. Most listed activities are self-explanatory. Descriptions of some follow.

- **Flood project development.** Performing feasibility studies, planning, and design of constructed facilities.
- **Encroachment control.** Establishing, financing and operating a system of permitting and enforcing permits to encroach on constructed facilities.
- **Floodplain conservation or restoration.** Any overt activity causing part of a floodplain to remain in effect or to be reinstated as a watercourse overflow area.
- **Flood insurance administration or participation.** Contribution to the management of or acting as a sponsor and cooperator in the National Flood Insurance Program including the Community Rating System.
- **Hydrologic analysis.** Hydrologic or statistical analysis of collected hydrometeorological data.
- **Flood education.** Informing the general public about any aspect of flood management; publishing or broadcasting collected hydrometeorological data or other flood-related material.
- **Recovery operations.** Financing or performing any activity intended to return flood-impacted facilities or persons to normal status.
- **Event management system administration.** Oversight of the National Incident Management System/Standardized Emergency Management System (NIMS/SEMS) as applied to California.

Table DA-2 Flood management participants

	Structural approaches						Land use management								Preparedness, response, and recovery										
	Flood projects						Floodplains			Flood insurance			Regulation		Data management				Event management						
	Financing	Development	Construction	Operation	Encroachment control	Maintenance	Conservation	Restoration	Delineation	Administration	Participation	FIRM mapping	Building permits	Designated floodways	Data collection	Hydrologic analysis	Data station maintenance	Flood education	Preparedness	Response management	Response personnel	System administration	Recovery funding	Recovery operations	Mitigation
Federal agencies																									
Federal Emergency Management Agency										●		●											●		●
National Weather Service															●	●	●	●	●	●	●				
Natural Resources Conservation Service	●	●	●															●							
US Geological Survey															●	●	●								
US Army Corps of Engineers	●	●	●	●	●	●									●	●	●	●	●	●	●		●	●	●
State agencies																									
California Conservation Corps																				●	●				
Central Valley Flood Protection Board					●	●								●											
Department of Corrections																					●				
Department of Forestry and Fire Protection																				●					
Department of Water Resources	●	●	●	●	●	●			●	●		●			●	●	●	●	●	●	●		●	●	
California Emergency Management Agency (Cal EMA)																			●	●	●	●	●		●
Local agencies																									
County emergency services units																			●	●	●				
County planning departments														●											
County building departments													●												
Local flood maintaining agencies				●	●	●																			
Local conservation corps																				●	●				
Local initial responders to emergencies																			●	●	●				
Specific initiatives																									
Delta Protection Commission		●					●													●					
Delta Vision		●					●																		
DWR Delta Levees Flood Protection Program	●	●																							
DWR Delta Risk Management Strategy																●		●	●	●			●		
FloodSAFE California		●					●													●					
USACE Sacramento-San Joaquin Delta Islands and Levees Feasibility Study		●																							
USACE CALFED Levee Stability Program	●	●																							

Flood Risk Management

Disaster Preparedness, Response, and Recovery

Management of flood emergencies is the responsibility of many organizations and individuals. Response is required by law to conform to SEMS, under which action is taken by levels of organization. It is begun by the person or organization on the site. That entity resists personal injury and property damage to the best of its ability, only calling on the next level when its resources become insufficient, and succeeding levels follow the same procedure. Table DA-3 indicates the responsible entities at successive levels of response.

Regional Water and Flood Planning and Management

Integrated Regional Water Management

Although there are no Integrated Regional Water Management (IRWM) plans specifically for the Delta region, seven plans of the San Francisco Bay, Sacramento River, and San Joaquin River hydrologic regions include portions of the legal Delta. Of these seven, five address flood control issues that may affect the Delta. Although the Solano Agencies IRWM plan lists no flood control infrastructure to be constructed in the near term, it does discuss updating its flood control plan and flood-hazard maps; establishing more clearly its flood control duties with other agencies; and evaluating the safety of its major structures, such as Monticello Dam, which impounds Lake Berryessa. The East Contra Costa County IRWM plan emphasizes the relationship of flood control and ecosystem benefits, and identifies eight flood control projects. The American River Basin IRWM plan identifies 17 flood or storm water management projects and highlights five as flood control projects of the Sacramento Area Flood Control Agency. The Yolo County IRWM plan also addresses flood control issues. The Mokelumne/Amador/Calaveras IRWM plan suggests 14 projects that have direct flood control benefits and use diverse flood control strategies, such as reservoirs, channel modifications, and wastewater treatment facility, drainage, and culvert improvements.

Table DA-3 Flood emergency responders

Responder	Level	Comment
Person(s) or organization(s) on the site	0	Any emergency
Bethel Island Municipal Improvement District	1	Bethel Island, Contra Costa County
Brannan Andrus Levee Maintenance District	1	Brannan-Andrus Island, Sacramento County
Reclamation Districts 799, 800, 830, 2024, 2025, 2026, 2036, 2059, 2065, 2090, 2117, 2122	1	Delta islands and tracts in Contra Costa County
Reclamation Districts 3, 341,349, 551, 554, 556, 563, 1002, 1601, 2110, 2111	1	Delta islands and tracts in Sacramento County
Reclamation Districts 1, 2, 38, 346, 404, 524, 544, 548, 684, 756, 773, 828, 1007, 1614, 2021, 2023, 2027, 2028, 2029, 2030, 2033, 2037, 2038, 2039, 2040, 2041, 2042, 2044, 2058, 2062, 2072, 2074, 2089, 2090, 2107, 2113, 2114, 2115, 2116, 2118, 2119	1	Delta islands and tracts in San Joaquin County
Reclamation Districts 501, 1607, 1667, 2060	1	Delta islands and tracts in Solano County
Reclamation District 150	1	Merritt Island, Yolo County
Emergency services units of the 10 cities in the region	1	Any emergency
Emergency services units of the 6 counties in the region	1 or 2	Any emergency, and by request from level 1 responders
Department of Water Resources	2	Flood Operations Center, flood fight and Corps liaison
California Emergency Management Agency, Coastal Region	3	Any emergency, Alameda, Contra Costa, and Solano Counties, by request of county (operational area)
California Emergency Management Agency, Inland Region	3	Any emergency, Sacramento, San Joaquin, and Yolo Counties, by request of county (operational area)
US Army Corps of Engineers	3	Specified water-related emergencies, by request of DWR
California Conservation Corps	3	Personnel and equipment for flood fight
Department of Forestry and Fire Protection	3	Personnel and equipment for flood fight
California Emergency Management Agency Headquarters	4	All emergencies, entire hydrologic region, by request of Cal EMA Region

Appendix B. More Information

Setting

The Sacramento-San Joaquin River Delta (the Delta) faces many challenges:

- Pelagic or open water fish have been declining in abundance. Intensive research was initiated to determine the causes of decline and several factors have been identified such as lack of suitable habitat, competition with invasive species, toxicity, and water operations. The complexity of the issue has made solution elusive.
- For the most part, the Delta's levees are un-engineered dirt structures that have weathered erosion for 150 years. The Delta lies near major faults. On the basis of research conducted by the US Geological Service and other scientists, there is a high probability of an earthquake striking the bay region before 2032. Levee failure could result in the need to shut down exports from the Delta.
- The Delta is home to more than 250 non-native species. Invasive species now dominate all habitats accounting for 95 percent or more of the biomass. All aspects of the ecology of the Delta have been altered by invasive species. The changes are impacting important and protected native species.
- Over the last 100 years, sea level at the Golden Gate bridge has risen on average about 0.08 inches per year and now is about 7 inches higher than in 1920. Continued sea level rise presents a serious problem for the Delta, most of which has subsided between 5 to 25 feet below sea level.
- Flooding is a near-annual event in the Delta and can cause overtopping and erosion of levees. As climate changes, storm runoff is likely to become more intense and more precipitation falling in the mountains as rain rather than snow. Average winter flows to the Delta are expected to become larger, which could increase flooding.
- California's population may hit 60 million by 2050 and 90 million by 2100; the combined population of the Delta counties is expected to more than double by 2050. This growth will change the nature and timing of demand for water and result in more wastewater and urban runoff into the Delta. A growing population will increase pressure for urban development with subsequent conversion of agricultural lands and further extension of urban lands encircling and encroaching upon the Delta.

Many current activities address these challenges and will ultimately play a role in the area's future water supply and exports, water quality, ecosystem and flood protection. Some of these activities are noted here.

- **Delta Risk Management Strategy.** Evaluating Delta issues primarily from the perspective of the risks from levee failures and ways to reduce those risks;
- **CALFED Ecological Restoration Program Conservation Strategy.** A biological view of how the Delta could be configured to restore historic form and function.
- **Delta Vision.** Provides for the sustainable management of the Delta.

Find Delta Risk Management Strategy at http://www.drms.water.ca.gov/

Find CALFED Ecological Restoration Program Conservation Strategy at http://www.delta.dfg.ca.gov/erpdeltaplan/

Find Delta Vision at http://www.deltavision.ca.gov/

Figure DB-1 Potential project proposals in the Delta

Project Review and Comment

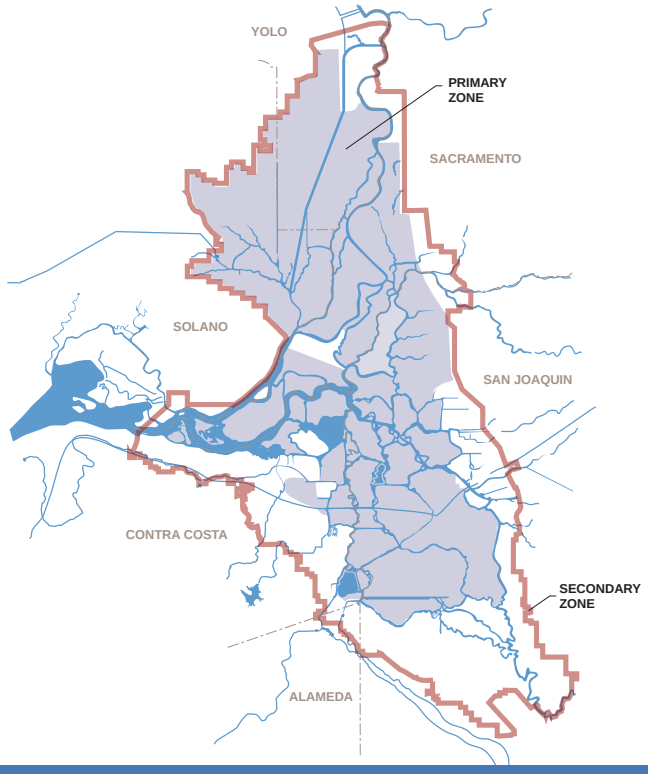
Project Proposals Initiated in 2005

County	Projects Reviewed	Primary Zone	Secondary Zone
Contra Costa	11	4	7
Sacramento	16	13	3
San Joaquin	5	3	2
Solano	2	1	1
Yolo	3	2	1
Multi-County	9	9	N/A

Project Proposals Initiated in 2006 (to date)

County	Projects Reviewed	Primary Zone	Secondary Zone
Contra Costa	19	2	17
Sacramento	17	9	8
San Joaquin	19	3	16
Solano	4	4	0
Yolo	3	0	3
Multi-County	4	3	1

Note: According to documentation from the Great Valley Center and CA Dept. of Finance, the population of the Central Valley is anticipated to double by the year 2040 to almost 10 million people.



Bay Delta Conservation Plan at http://www.resources.ca.gov/bdcp/

Strategic Plan at http://www.waterrights.ca.gov/baydelta/docs/strategic_plan/baydelta_workplan_final.pdf

Suisun Marsh Plan at http://iep.water.ca.gov/suisun/

POD at http://www.science.calwater.ca.gov/pod/pod_index.html

FWS Biological Opinion at http://www.fws.gov/sacramento/es/delta_smelt.htm

NOAA Bio Opinion at http://swr.nmfs.noaa.gov/ocap.htm

- **Bay Delta Conservation Plan.** A comprehensive conservation plan for the Delta designed to protect and restore at-risk species in a manner that reliably delivers water supplies to 25 million Californians.
- **State Water Resource Control Board's Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary.** Describes actions to protect beneficial uses of water in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary Strategic Plan.
- **The Habitat Management, Preservation, and Restoration Plan for Suisun Marsh.**
- **Pelagic Organism Decline.** Interagency Ecological Program evaluating the potential causes of the decline of pelagic organisms in the Delta.
- **Central Valley Project Operating Criteria and Plan Biological Opinions – both the Fish and Wildlife Service.** Fish and Wildlife Service and NOAA Fisheries have drafted new Biological Opinions in response to court rulings that invalidated the previous Opinions.

Demographics

See Figure DB-1 Potential project proposals in the Delta

Table DB-1 Land use changes in the Delta, 1950s to present [1, 2]

Land Use	Acres historic [3]	Acres (2007)	Change (historical-2007) in acres	Percent change (historical-2007)
Urban	26,888	91,950	65,062	242
Native	102,909	109,031	6,122	6
Agricultural	549,454	467,755	-81,699	-15
Irrigated [4 5]	440,900	387,419	-53,481	-12
Non-irrigated [6]	108,554	80,336	-26,218	-24
Water	57,336	66,230	9,894	17
Total [7]	**737,345**	**737,324**		

1 Based on DWR information memo "Delta and Suisun Marsh Land Use Survey" sent to John Kirlin, Delta Vision, November 19, 2007.

2 Does not include Suisun Marsh data.

3 Historical acreage is a composite of 1957, 1961, and 1976 land use data.

4 Values for irrigated and non-irrigated agricultural lands are a subset of Agricultural Land Use.

5 Includes cropped area (425,100 acres historical and 378,606 acres in 2007), fallow and idle land (14,597 acres historical and 8,471 acres in 2007), and new agricultural land (1,203 acres historical and 342 acres in 2007).

6 Includes cropped area (73,271 acres historical and 35,285 acres in 2007), fallow and idle land (4976 acres historical and 7799 acres in 2007), new agricultural lands (132 acres historical and 101 acres in 2007), and semi agricultural lands (30,175 acres historical and 37,150 acres in 2007).

7 Discrepancy in acreages (historical v. 2007) may be due to mapping techniques, changes in land use definitions between historical data sets and current information and locations where entry was denied.

Source: Delta Vision Blue Ribbon Task Force. 2007 Our Vision for the California Delta. State of California.

Table DB-2 Recent land use changes in the Suisun Marsh[1]

Land use	Acres (relatively recent[2])	Acres (2007)	Change in acres (relatively recent - 2007)	Percent change (relatively recent - 2007)
Urban	1,291	1,415	124	9
Native	77,258	74,389	-2,869	-4
Agricultural	1,668	4,743	3,075	184
Irrigated [3 4]	897	2,220	1,323	147
Non-irrigated [5]	771	2,523	1,752	227
Water areas	28,327	28,002	-325	-1
Total [6]	108,545	108,550		

1 Based on DWR information memo "Delta and Suisun Marsh Land Use Survey" sent to John Kirlin, Delta Vision on November 19, 2007

2 Relatively recent acreage is based on 2003 Solano County surveys.

3 Values for irrigated and non-irrigated are a subset of Agricultural.

4 Includes cropped area (813 acres in relatively recent and 658 acres in 2007); fallow and idle land (84 acres in relatively recent and 1,562 acres in 2007).

5 Includes cropped area (607 acres in relatively recent and 2,278 acres in 2007), fallow and idle land (45 acres in relatively recent and 31 acres in 2007), and semi-agricultural land (119 acres in relatively recent and 214 acres in 2007).

6 Discrepancy in acreages (relatively recent v. 2007) may be due to mapping techniques, changes in land use definitions between historical data sets, and current information and locations where entry was denied.

Source: Delta Vision Blue Ribbon Task Force. 2007 Our Vision for the California Delta. State of California.

Land Use Patterns

See Tables DB-1 Land use changes in the Delta and Table DB-2 Recent land use changes in Suisun Marsh.

Regional Water Conditions

Water Supplies

Water Balance. A water balance is a good way to get an overview of the major flows into and out of the Delta. Three recent years 1998 (wet year), 2000 (average year), and 2001 (dry year) demonstrate typical fluctuations in Delta inflows/outflows (Figure DB-2 Delta inflows/outflows, years 1998, 2001 and 2001). During these years, the water system was generally operated under the same rules as today. Some observations that can be made by looking at these three types of water years are:

- In-Delta consumptive use is similar most years
- Water export quantities show more variability but still are in a relatively narrow range
- The widest variability from year to year occurs in the outflow from the Delta. Net outflow to the bay/ocean in a wet year can be many times the outflow during a dry year.
- Water diversions and exports are a larger portion of the Delta inflow during a dry year.

The historical records show even larger flow ranges than represented in Figure DB-2. For example, during water year 1983 (October 1982 through September 1983), more than 60 million acre-feet (maf) of water passed through the Delta to the San Francisco Bay. During water year 1977, only about 5 maf passed through the Delta to the bay.

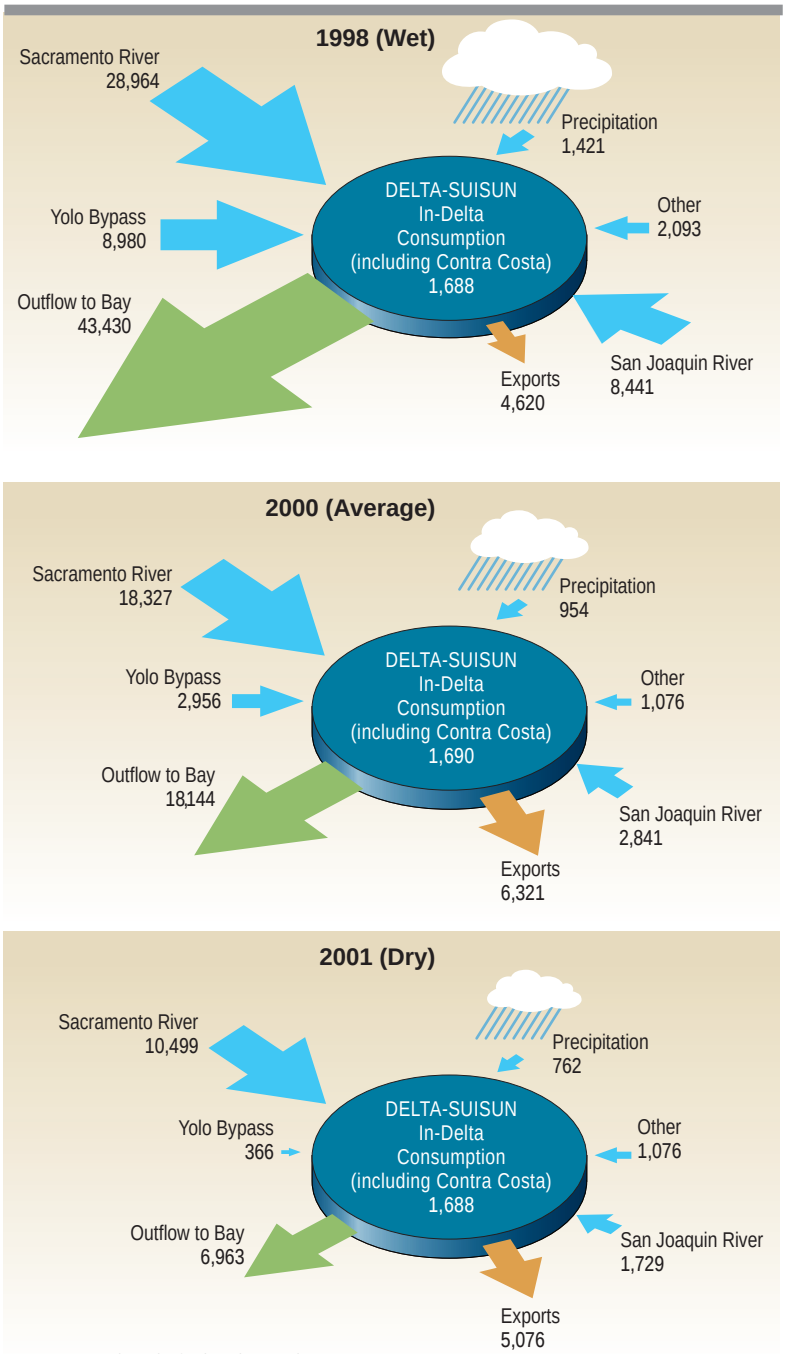
Water Rights. Riparian water rights are entitlements to water that are held by owners of land bordering natural flows of water. A landowner has a right to divert a portion of the flow for reasonable and beneficial use on their land within the same watershed. Natural flows do not include return flows from use of groundwater, water stored and later released (e.g., by the State Water Project (SWP) or the Central Valley Project (CVP) for Delta export) or water diverted from another watershed.

Appropriative rights are held in the form of conditional permits or licenses from the State Water Resources Control Board (State Water Board). Appropriative rights can be applied to both riparian and non-riparian lands provided the riparian rights on a given stream are satisfied. Additionally, whether an appropriative right was initiated before or after 1914 affects the priority and legal history of the right and thus the regulation of the right.

A body of water rights law includes the area of origin, county of origin, watershed of origin, and Delta protection statutes. These laws were developed to retain the priority to subsequent appropriative uses within an area, county, or watershed, as against out-of-basin permitted appropriations. Specifically, they were enacted to protect local water users from appropriations by the CVP and SWP Project for use in areas outside the area of origin or the areas immediately adjacent to the areas of origin. Thus, area of origin statutes consist of a priority right to satisfy current uses, as well as a prospective priority right to satisfy future beneficial uses within a specifically identified geographic area.

The Delta Protection Act (1959) incorporates the area of origin protection to the Delta. Specifically, the Act declares as a policy of the state "that no person, corporation or public or private agency or the State or the United States should divert water from the channels of the Sacramento-San Joaquin Delta to which the users within said Delta are entitled.

Figure DB-2 Delta inflows/outflows for years 1998, 2001 and 2001



source: *Status and Trends of Delta Suisun Services, DWR 2007*

Contract Rights. The State Water Board authorizes and regulates diversion and export of water from the Delta by the SWP and CVP. The State Water Board first issued water rights permits to Reclamation for the operation of the CVP in 1958 (Water Rights Decision 893 and to DWR for operation of the SWP in 1967 (D-1275 and D-1291). Entitlements to surface water supplies can be obtained through contracting with the SWP and the CVP. The CVP and SWP contractors' have contractual rights as specified in the contracts. DWR has entered into contracts with water agencies in the Delta such as the North Delta Water Agency (NDWA). In the case of the NDWA, their contract provides assurances that users within the NDWA boundary have the right to divert water of a specific quantity for reasonable and beneficial uses for agricultural, municipal and industrial purposes.

Groundwater Rights. The following general overview of groundwater rights in California can be found on the State Water Board's Web site at http://www.waterrights.ca.gov/html/wr_process.htm. In most areas of California, overlying landowners may extract percolating groundwater and put it to beneficial use without approval from the State Water Board or a court. California does not have a permit process for regulation of groundwater use. In several basins, however, groundwater use is subject to regulation in accordance with court decrees adjudicating the groundwater rights within the basins.

The California Supreme Court decided in the 1903 case *Katz v. Walkinshaw* that the "reasonable use" provision that governs other types of water rights also applies to groundwater. Prior to this time, the English system of unregulated groundwater pumping had dominated, but it proved to be inappropriate to California's semiarid climate. The

Supreme Court case established the concept of overlying rights, in which the rights of others with land overlying the aquifer must be taken into account. Later court decisions established that groundwater may be appropriated for use outside the basin, although appropriator's rights are subordinate to those with overlying rights.

Project Operations

See Figure DB-3 for location of SWP and CVP facilities in the Delta region.

Operational Criteria

The following provides an overview of several of the actions outlined in Table DB-3:

- **Coordinated Operations Agreement.** The CVP and SWP release previously stored water into the Delta where they redivert the stored water and also divert natural flow to users mainly south and west of the Delta. The CVP and SWP use the Delta as a common conveyance facility. Reservoir releases and Delta exports must be coordinated to ensure that each project achieves its share of water supplies and bears it share of obligations to protect resources.
- **Suisun Marsh Preservation Agreement.** The State Water Board's D-1485 directed the CVP and SWP to develop a plan to protect Suisun Marsh resources. An agreement was signed in 1987 with the goal to mitigate the effects of the CVP and SWP operations and other upstream diversions on water quality in the marsh.
- **Endangered Fish Species Biological Opinions.** The general decline of several fish, the Delta smelt and spring-run and winter-run salmon in particular, generated much concern resulting in a series of biological opinions from the NOAA Fisheries and US Fish and Wildlife Service (USFWS). These opinions ultimately established requirements to be met by the SWP and CVP to protect these species. These included requirements for Delta inflow and outflow, Delta Cross Channel gate closure, and reduced export pumping. Many of these fish protection requirements were incorporated into the 1995 water quality control plan (follows). As noted under "Setting – Current Situation" in this appendix, both USFWS and NOAA Fisheries have prepared new biological opinions associated with the Central Valley Project Operating Criteria and Plan.
- **1995 Water Quality Control Plan and Decision-1641.** The 1995 plan incorporated several changes recommended by the US Environmental Protection Agency (EPA), NOAA Fisheries, and USFWS to the objectives for salinity and endangered species protection. D-1641 implements the objectives in the 1995 Bay-Delta Plan, and it imposes flow and water quality objectives to assure protection of beneficial uses in the Delta. In essence, the requirements in D-1641 address standards for fish and wildlife protection, municipal and industrial water quality, agricultural water quality, and Suisun Marsh salinity. The decision added new provisions for X2, export/info ratio, and the Vernalis Adaptive Management Program (VAMP). Meeting the standards was accomplished through changes in the water rights of the CVP, SWP, and others. The State Water Board also granted conditional changes to the point of diversion for the CVP and SWP, in the southern

Figure DB-3 **Location of State Water Project and Central Valley Project facilities in the Delta-Suisun area**

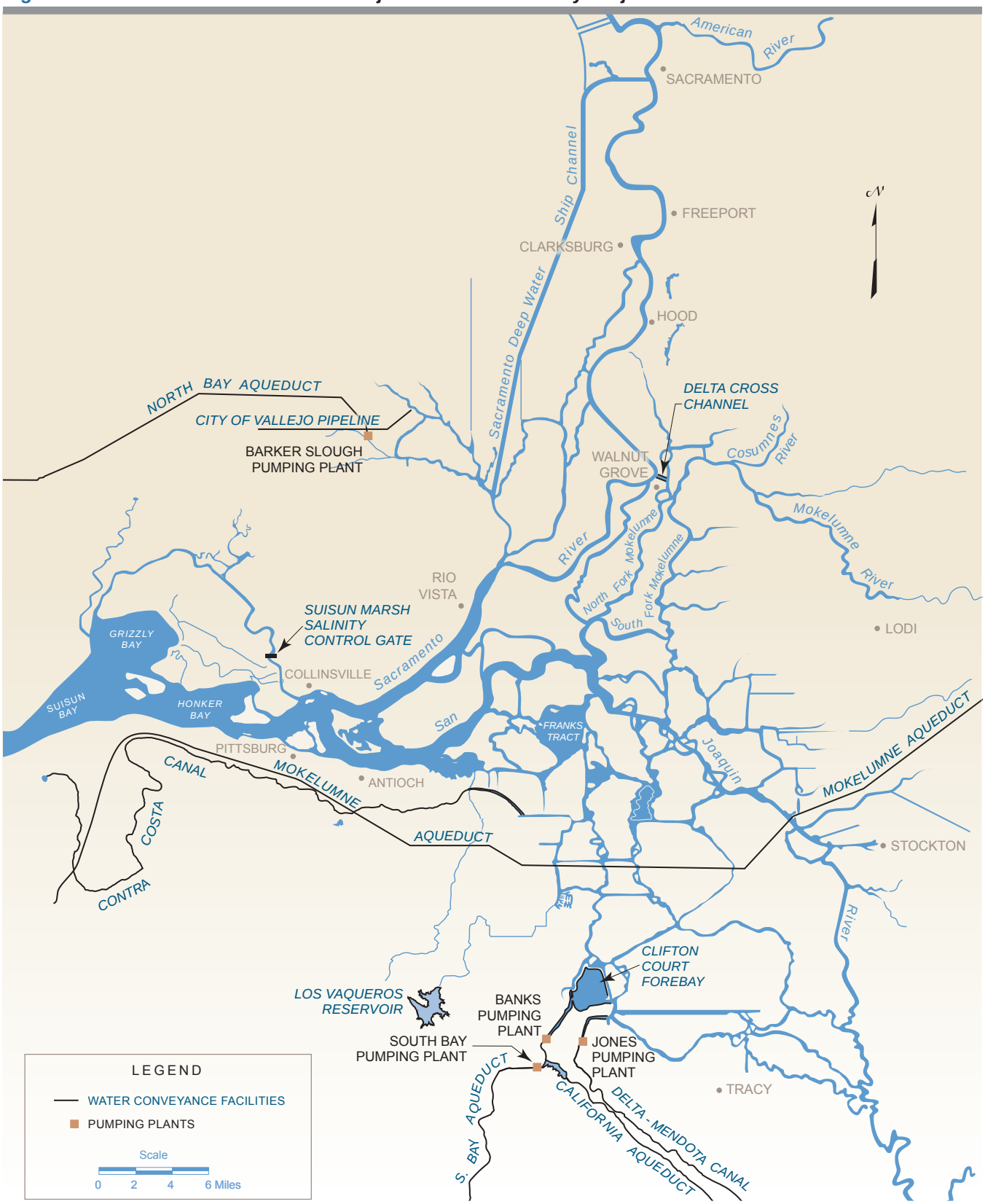


Table DB-3 Laws, directives, and orders affecting CVP and SWP operations

Delta Protection Act	1959	Ensures water is available for in-Delta beneficial uses
North Delta Water Agency	1981	Contract that ensures there will be suitable water in the Northern Delta for agriculture and other beneficial uses.
Coordinated Operating Agreement	1986	Agreement between the State and feds to determine the respective water supplies of the CVP and SWP while allowing for a negotiated sharing of Delta excess outflows and the satisfaction of in-basin obligations between the projects
SWRCB Orders 90-5, 91-1	1990, 1991	Modified Reclamation water rights to incorporate temperature control objectives in the Upper Sacramento River
NMFS BO for Winter-run Chinook Salmon	1992, 1993, 1995, 2009	Established operation to protect winter-run and provided for "incidental taking"
CVPIA	1992	Mandated changes to the CVP particularly for the protection, restoration and enhancement of fish and wildlife
FWS BO for Delta Smelt and Sacramento Splittail	1993, 1994, 1995, 2008	Established operational criteria to protect Delta Smelt
Bay-Delta Plan Accord and SWRCB Order WR 95-06	1994, 1995	Agreement and associated SWRCB order to provide for the operations of the CVP and SWP to protect Bay-Delta water quality. Also provided for development of a new Bay-Delta operating agreement (being pursued through CALFED)
Monterey Agreement	1995	Agreement between DWR and SWP contractors to manage contractor operations
SWRCB Revised Water Right Decision 1641	2000	Revised order to provide for operations of the CVP and SWP to protect Delta water quality
CALFED ROD	2000	Presented a long-term plan and strategy designed to fix the Bay-Delta
CVPIA ROD	2001	Implemented provisions of CVPIA including allocating 800,000 acre-feet of CVP yield for environmental purposes
NMFS BO for Spring-run Chinook Salmon and Steelhead	2001, 2002, 2004	Established criteria for operations to protect spring-run Chinook salmon and steelhead
SWRCB Order 2006-0006	2006	Draft Cease and Desist Order against DWR and Reclamation

(Table entries in part are excerpts from Table 1-1 of the June 2004 CVP-OCAP available at: http://www.usbr.gov/mp/cvo/ocapBA.html)

Delta, with D-1641 and approved a petition to change places and purposes of use in the CVP.

- **Environmental Water Account.** The Environmental Water Account (EWA) was implemented as a major fish protection program as part of the CALFED Program. The EWA is a cooperative water management program, the purpose of which is to provide protection to fish species of the Delta-Suisun without reducing water delivery reliability for water users.
- **North Delta Water Agency (NDWA).** In 1981, DWR and NDWA executed a contract that ensures that there will be suitable water available in the northern Delta for agriculture and other beneficial uses. Further, a 1998 memorandum of understanding provides that DWR is responsible for any obligation imposed on NDWA to provide water to meet Bay-Delta flow objectives so long as the 1981 contract remains in effect.
- **Delta Protection Act and Area of Origin statutes.** See discussion under Water Rights under subhead "Water Supplies."

Table DB-4 contains an extensive list of public agencies in the Delta Region. These agencies claim partial responsibility for governance, planning, 18 facilities, and/or resource protections.

Regional Water and Flood Planning and Management

The various general plans, for counties in the Delta's Primary Zone, can be accessed at

- Sacramento County: http://www.planning.saccounty.net/gpupdate/docs/2007/Public-Review-Draft-Elements-Policy-Section/Final-Draft-Delta-Protection-Element-2007-05-30.pdf
- Contra Costa County: http://www.cccounty.us/depart/cd/current/advance/GeneralPlan.htm
- Yolo County: http://www.yolocounty.org/Index.aspx?page=1620
- Solano County: http://www.solanocountygeneralplan.net/
- San Joaquin County: http://www.sjcgpu.com/

Integrated Regional Water Management

A list of the Integrated Regional Water Management plans that include strategies and objectives for the Delta follows along with online access information.

- American River Basin: http://www.rwah2o.org/rwa/programs/irwmp/
- Cosumnes, American, Bear and Yuba: http://caby.watershedportal.net/CABY_IRWMP_Final/CABY_IRWMP_Final_121506_LowRes_NoPrint.pdf
- East Contra Costa: no URL available.
- Eastern San Joaquin: http://www.gbawater.org/_pdf/GBA_IRWMP.pdf
- Mokelumne, Amador, Calaveras: http://www.ccwd.org/macirwmp.html
- Sacramento Valley: http://www.norcalwater.org/int_program/irwmp.shtml
- Yolo County: http://www.yolowra.org/irwmp_documents.html#1

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 Delta system.

CALFED: http://www.calwater.ca.gov/index.aspx

Suisun Marsh Plan

The Habitat Management, Preservation, and Restoration Plan for Suisun Marsh (Suisun Marsh Plan) will develop, analyze, and evaluate potential environmental benefits and impacts resulting from various actions while restoring habitat for tidal marsh-dependent sensitive species. Alternative plans are currently undergoing environmental review. Large-scale tidal marsh restoration in Suisun Marsh has been identified by BDCP as a Core Element of the Draft Conservation Strategy.

Suisun Marsh: http://iep.water.ca.gov/suisun/

Tidal Marsh Restoration: http://resources.ca.gov/bdcp/docs/Overview_of_Conservation_Strategy_1-12-2009.pdf

Recent Accomplishments

CALFED Program

CALFED Performance Assessment: http://calwater.ca.gov/content/Documents/meetings/2007/06-21-07Item_9A_Prog_Perf_BDPACProgramAssessment.pdf

Program Performance: http://www.calwater.ca.gov/Program_Performance/Program_Performance_Home.html

The CALFED agencies have worked together to invest approximately $2.5 billion, and stakeholders have invested many billions more in a wide variety of actions within the Delta, in the upstream watersheds, and in the water service areas, primarily in the Bay Area and Southern California. A hallmark of the CALFED Program has been the development and integration of sound scientific information into all CALFED activities and decisions. The report, titled Program Performance Assessment (2007, prepared by the Bay-Delta Public Advisory Committee's Program Performance and Financing Subcommittee), contains an overview of program progress during Stage 1. More recently, CALFED has established a project performance information system to assist state and federal CALFED implementing agencies with tracking and reporting of performance measures associated with the Sacramento-San Joaquin Delta.

Suisun Marsh Plan

Blacklock Restoration site: http://www.iep.ca.gov/suisun/restoration/blacklock/images/breach/aerial010.jpg.

Blacklock: http://www.iep.ca.gov/suisun/restoration/index.html

The first tidal restoration project was implemented in 2006. Seventy acres of tidal wetlands were created at the Blacklock Restoration Site. Current activities include implementation of a 10-year monitoring program developed for the Blacklock site.

The Habitat Management, Preservation, and Restoration Plan for the Suisun Marsh (Suisun Marsh Plan) and its accompanying Programmatic Environmental Impact Statement/Report (PEIS/EIR) will develop, analyze, and evaluate potential environmental benefits and impacts resulting from various actions necessary in the Suisun Marsh to preserve and enhance managed seasonal wetlands, implement a comprehensive levee protection/improvement program, and protect ecosystem and drinking water quality, while restoring habitat for tidal marsh-dependent sensitive species, consistent with the CALFED Bay-Delta Program's strategic goals and objectives.

Table DB-4 Public Agencies and their core interests in the Delta region

Agency Name	Level Of Gov't	Ecosystems/ Environment	Land Use	Transportation	Utilities	Water Supply/ Quality	Recreation / Tourism	Flood Control	Emergency Response	Economic Impacts
Federal										
Federal Emergency Management Agency	Federal								X	
Federal Energy Regulatory Commission	Federal				X					
National Marine Fisheries Service	Federal	X								X
Army Corps of Engineers	Federal	X	X	X	X	X	X	X	X	
Bureau of Land Management	Federal	X			X	X	X			X
Bureau of Reclamation	Federal				X			X		
Coast Guard	Federal								X	
Department of Agriculture	Federal	X				X				X
Department of Homeland Security	Federal								X	
Department of the Interior	Federal	X				X	X	X		
Department of Transportation	Federal			X						
Environmental Protection Agency	Federal	X				X				
Fish and Wildlife Service	Federal	X				X	X			
Forest Service	Federal	X	X				X		X	
Natural Resources Conservation Service	Federal	X								
Western Area Power Service	Federal				X					
Local										
Alameda County	Local	X	X	X	X	X	X	X	X	X
Alameda County Resource Conservation District	Local	X								
Ambrose Recreation and Park District (Contra Costa County)	Local						X			
American River Flood Control District (Sacramento County)	Local							X		
Bethel Island Municipal Improvement District (Contra Costa County)	Local	X					X	X		
Brannan-Andrus Levee Maintenance District (Sacramento County)	Local							X		
California Irrigation District (San Joaquin County)	Local					X				
Central Delta Water Agency (San Joaquin County)	Local					X				
City of Antioch (Contra Costa County)	Local	X	X	X	X	X	X	X	X	X
City of Benicia (Solano County)	Local	X	X	X	X	X	X	X	X	X
City of Brentwood (San Joaquin County)	Local	X	X	X	X	X	X	X	X	X
City of Isleton (Sacramento County)	Local	X	X	X	X	X	X	X	X	X
City of Lathrop (San Joaquin County)	Local	X	X	X	X	X	X	X	X	X
City of Lodi (San Joaquin County)	Local	X	X	X	X	X	X	X	X	X

Table DB-4 Public Agencies and their core interests in the Delta region (Continued)

Agency Name	Level Of Gov't	Ecosystems/ Environment	Land Use	Transportation	Utilities	Water Supply/ Quality	Recreation / Tourism	Flood Control	Emergency Response	Economic Impacts
City of Manteca (San Joaquin County)	Local	X	X	X	X	X	X	X	X	X
City of Martinez (Contra Costa County)	Local	X	X	X	X	X	X	X	X	X
City of Oakley (Contra Costa County)	Local	X	X	X	X	X	X	X	X	X
City of Pittsburg (Contra Costa County)	Local	X	X	X	X	X	X	X	X	X
City of Rio Vista (Solano County)	Local	X	X	X	X	X	X	X	X	X
City of Sacramento (Sacramento County)	Local	X	X	X	X	X	X	X	X	X
City of Stockton (San Joaquin County)	Local	X	X	X	X	X	X	X	X	X
City of Tracy (San Joaquin County)	Local	X	X	X	X	X	X	X	X	X
City of Vallejo (Solano County)	Local	X	X	X	X	X	X	X	X	X
City of West Sacramento (Yolo County)	Local	X	X	X	X	X	X	X	X	X
Collinsville Levee District (Solano County)	Local							X		
Contra Costa County	Local	X	X	X	X	X	X	X	X	X
Contra Costa County Mosquito and Vector Control District	Local	X								
Contra Costa County Reclamation Districts (14)	Local							X		
Contra Costa County Resource Conservation District	Local	X								
Contra Costa Water Agency	Local					X		X		
Contra Costa Water District	Local				X	X	X			
Cordelia Fire Protection District (Solano County)	Local								X	
Courtland Fire Protection District (Sacramento County)	Local								X	
Crockett Community Services District (Contra Costa County)	Local						X			
Delta Diablo Sanitary District (Contra Costa County)	Local	X				X				
Delta Fire Protection District (Sacramento County)	Local								X	
Diablo Water District (Contra Costa County)	Local					X		X		
Dos Reis Storm Drain Maintenance District (San Joaquin County)	Local							X		
East Contra Costa Irrigation District	Local					X				
Fairfield-Suisun Sewer District (Solano County)	Local	X				X				
French Camp-McKinley Fire District (San Joaquin County)	Local								X	
Ironhouse Sanitary District (Contra Costa County)	Local	X				X				
Lathrop Irrigation District (San Joaquin County)	Local					X				
Lathrop-Manteca Fire Protection District (San Joaquin County)	Local								X	
Lower Consumnes Resource Conservation District (Sacramento County)	Local	X								
Montezuma Fire Protection District (Solano County)	Local								X	
Mountain House Community Services District (San Joaquin County)	Local	X	X	X	X	X	X	X	X	X

Table DB-4 Public Agencies and their core interests in the Delta region (Continued)

Agency Name	Level Of Gov't	Ecosystems/ Environment	Land Use	Transportation	Utilities	Water Supply/ Quality	Recreation / Tourism	Flood Control	Emergency Response	Economic Impacts
Naglee Burk Irrigation District (San Joaquin County)	Local					X				
Oakwood Lake Water District (San Joaquin County)	Local					X		X		
Port of Stockton (San Joaquin County)	Local			X						X
Sacramento County	Local	X	X	X	X	X	X	X	X	X
Sacramento Metropolitan Fire District	Local								X	
Sacramento Reclamation Districts (17)	Local							X		
San Joaquin County	Local	X	X	X	X	X	X	X	X	X
San Joaquin County Mosquito and Vector Control District	Local	X								
San Joaquin County Reclamation Districts (52)	Local							X		
San Joaquin County Resource Conservation District	Local	X								
Solano County	Local	X	X	X	X	X	X	X	X	X
Solano County Mosquito Abatement District	Local	X								
Solano County Reclamation Districts (12)	Local							X		
Solano County Water Agency	Local	X				X		X		
South Delta Water Agency (San Joaquin County)	Local					X		X		
Stockton East Water District (San Joaquin County)	Local					X				
Suisun Fire Protection District (Solano County)	Local								X	
Thornton Fire Protection District (San Joaquin County)	Local								X	
Tracy Rural Fire District (San Joaquin County)	Local								X	
Walnut Grove Fire Protection District (Sacramento County)	Local								X	
Woodbridge Fire District (San Joaquin County)	Local								X	
Woodbridge Irrigation District (San Joaquin County)	Local					X				
Yolo County	Local	X	X	X	X	X	X	X	X	X
Yolo County Reclamation Districts (6)	Local							X		
Yolo County Resource Conservation District	Local	X								
Bethel Island Fire Protection District	Local								X	
Isleton Fire Protection District (Sacramento County)	Local								X	
Regional										
Association of Bay Area Governments	Regional	X	X	X	X	X	X	X	X	X
Byron-Bethany Irrigation District (Contra Costa County)	Regional					X				
Central Contra Costa Sanitary District	Regional	X				X				
Central Valley Regional Water Quality Control Board	Regional					X				
Contra Costa County Fire Protection District	Regional								X	

Table DB-4 Public Agencies and their core interests in the Delta region (Continued)

Agency Name	Level Of Gov't	Ecosystems/ Environment	Land Use	Transportation	Utilities	Water Supply/ Quality	Recreation / Tourism	Flood Control	Emergency Response	Economic Impacts
East Bay Municipal Utility District (Alameda County)	Regional				X	X	X			
East Bay Regional Park District (Alameda County)	Regional						X			
Metropolitan Transportation Commission (Alameda County)	Regional			X						
North Delta Water Agency	Regional					X				
Sacramento Area Council of Governments	Regional		X	X						
Sacramento Area Flood Control Agency	Regional							X		
Sacramento Municipal Utility District	Regional				X					
Sacramento Regional County Sanitation District	Regional					X				
Sacramento-Yolo Mosquito and Vector Control District	Regional	X								
Sacramento-Yolo Port District	Regional			X						X
San Francisco Bay Area Water Transit Authority	Regional			X						
San Joaquin Council of Governments	Regional		X	X						
Suisun Resource Conservation District	Regional	X								
State										
San Francisco Bay Conservation and Development Commission	State	X	X			X	X			
CALFED Bay-Delta Authority	State	X	X			X				
California Department of Boating and Waterways	State			X		X	X	X		X
California Department of Conservation	State	X	X			X	X			
California Department of Fish and Game	State	X	X			X	X			
California Department of Food and Agriculture	State	X	X			X				X
California Department of Health Services	State								X	
California Department of Parks and Recreation	State	X	X			X	X			X
California Department of Transportation	State			X						
California Department of Water Resources	State		X			X	X	X		
California Energy Commission	State				X					
California Environmental Protection Agency	State	X				X				
Delta Protection Commission	State	X	X	X	X	X	X	X	X	X
Governor's Office of Emergency Services	State								X	
State Lands Commission	State		X	X			X			X
State Reclamation Board	State						X			
State Water Resources Control Board	State					X				
California Natural Resources Agency	State	X	X		X	X	X	X		

Note: From Delta Vision's Governance Context memo

Appendix C. Selected References

Editor's Note: The author used some bibliographic references for several topics listed here, but in the interest of space, those references are listed only once in this appendix.

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