Chapter 2

Environmental Setting

The Environmental Setting establishes the baseline physical conditions present in the environment so that impacts of the project can be assessed. The structure of this chapter and the remaining chapters addressing project impacts is based on the 16 general resource categories identified in the Environmental Checklist. This chapter is organized into the following 16 general resource categories:

- 2.1 Hydrology and Water Quality
- 2.2 Biological Resources
- 2.3 Agricultural Resources
- 2.4 Utilities and Service Systems
- 2.5 Hazards and Hazardous Materials
- 2.6 Transportation and Traffic
- 2.7 Recreation
- 2.8 Air Quality
- 2.9 Mineral Resources
- 2.10 Noise
- 2.11 Geology and Soils
- 2.12 Land Use and Planning
- 2.13 Public Services
- 2.14 Population and Housing
- 2.15 Cultural Resources
- 2.16 Aesthetics

2.1 Hydrology and Water Quality

This section is organized into surface water hydrology, surface water quality, groundwater hydrology, groundwater quality and report operations.

Surface Water Hydrology

The Delta evolved within a network of slow moving river channels that drained into San Francisco Bay. Cyclic flooding of these rivers deposited material along streams and around islands, forming natural levees. The centers of these leveed islands became periodically inundated tule marshes.

The Sacramento and San Joaquin Rivers unite at the western end of the Delta at Suisun Bay. The Sacramento River contributes roughly 85 percent of the Delta inflow in most years, while the San Joaquin River contributes 10 to 15 percent. The Mokelumne, Consumnes, and Calaveras rivers, which flow through the Delta from the east, also contribute a minor amount of the inflow. From Suisun Bay, water flows through Carquinez Strait into San Pablo Bay (the northern half of San Francisco Bay) and then through the Golden Gate to the Pacific Ocean.

Tidal influence is important throughout the Delta. Historically, when mountain runoff dwindled the during summer, ocean water intruded upstream as far as Sacramento. During winter and spring, fresh water from heavy rains pushed the salt water back, sometimes past the mouth of San Francisco Bay.

With the addition of Shasta, Folsom, and Oroville dams, salt water intrusion during summer has been controlled by reservoir releases. Typically, peaks in winter and spring flows have been dampened, and summer and fall flows have been increased. In very wet years such as 1969, 1982, 1983, and 1986, reservoirs were unable to control runoff, so during the winter and spring the upper bays became fresh and even the upper several feet of water at the Golden Gate was fresh.

On average, about 21 million acre-feet of water reaches the Delta annually, but actual inflow varies widely from year-to-year and within the year (Source: Bureau of Reclamation and Department of Water Resources, 1985). In 1977, a year of extraordinary drought, Delta inflow totaled only 5.9 million acre-feet. Inflow for 1983, an exceptionally wet year, was about 70 million acre-feet. On a seasonal basis, average natural flow to the Delta varies by a factor of more than 10 between the highest month in winter or spring and the lowest month in fall.

During normal water years, the fate of water reaching the Delta is:

10 percent	Local use
30 percent	Export by the Central Valley Project and State Water Project
20 percent	Salinity control
40 percent	Delta outflow in excess of minimum requirements.

The excess outflow would occur almost entirely during the season of high inflow.

Delta hydraulics are complex. The influence of tide is combined with freshwater outflow, resulting in flow patterns that vary daily. Inflow varies seasonally and is affected by upstream diversions. Hydraulics are further complicated by a multitude of agricultural, industrial, and municipal diversions for use in the Delta itself and by exports by the federal Central Valley Project and the State Water Project. Delta outflow is affected by tides, inflow, internal use, and export pumping. Because of the large tidal flows compared to inflows, outflow must be calculated rather than measured. Calculated outflows are reasonably accurate on time scales longer than a few weeks but not at all accurate for shorter periods.

Surface Water Quality

Delta tributaries generally have relatively good water quality. However, in the north bay area, local surface water has deteriorated since the 1960s (Source: Army Corps of Engineers and Department of Water Resources, 1981). Both chlorides and total dissolved solids have increased, possibly due to changing agricultural practices. Chloride and Total Dissolved Solid (TDS) concentrations are generally higher during the spring and decrease during the summer, when better quality Sacramento River water is imported. Seepage of both poor quality groundwater, and irrigation return flows, contribute to the poor water quality.

In most respects, Delta water quality is generally adequate to support beneficial uses. While evidence of gross pollution has been largely eliminated, the recent rapid growth in population and industrial activity in tributary areas has left some problems unsolved and has created new ones. Existing water quality problems may be categorized as 1) eutrophication and associated dissolved oxygen fluctuations, 2) suspended sediments and turbidity, 3) salinity, 4) toxic material, and 5) bacteria.

Industrial wastes have killed large numbers of fish in localized areas, and agricultural pesticides have been responsible for fish kills in the Delta and other areas of the Central Valley. Most kills were the result of accidental spills or discharges. For many years, there has been some mortality among striped bass and other fish during late spring and early summer. The causes are unknown, but seasonal water quality changes and toxic pollutants are suspected.

Pesticides are found in the water and bottom sediments throughout the Delta. The more persistent chlorinated hydrocarbon pesticides are consistently found at higher levels than the less persistent organophosphate compounds. Sediments in the western Delta have the highest pesticide content. Pesticides have concentrated in aquatic life, but long-term effects and the effects of intermittent exposure are not known.

Bacteriological quality, as measured by the presence of coliform bacteria, varies depending on the proximity to waste discharges and significant runoff. The highest concentration of coliform organisms is generally in the western Delta and near major municipal waste discharges.

The most serious enrichment is a high influx of nutrients. Problems in the Delta are along the lower San Joaquin River and in certain areas receiving waste discharges but having little or no net freshwater flow. These problems occur mainly in the late summer and coincide with low streamflow, high temperature, and the harvest season when fruit and vegetable canneries are in full operation. Deepening channels for navigation has further depressed dissolved oxygen levels to the point that at times levels are insufficient to support aquatic life. In the fall, these circumstances, combined with reverse flows due to export pumping, have created conditions unsuitable for salmon passage through the Delta to spawning areas in the San Joaquin Valley.

Warm, shallow, dead-end sloughs of the eastern Delta support populations of planktonic blue-green algae during the summer. Floating, semi-attached and attached aquatic plants such as water primrose (*Ludwigia peploides*), water hyacinth (*Eichhornia crassipes*), hornwort or coontail (*Ceratophyllum demersum*), eurasian milfoil (*Myriophyllum spicatum*), and *Egeria* frequently clog Delta waterways during summer. Extensive growth of these plants interferes with small boat traffic and contributes to the total organic load as these plants break loose and move downstream in the fall and winter.

Most Delta waters are turbid as a result of suspended silt, clay, and organic matter. Most of these sediments enter the Delta system with flow from major tributaries. Some enriched areas are turbid as a result of planktonic algal populations, but inorganic turbidity tends to suppress nuisance algal populations in much of the Delta. Continuous dredging to maintain deep channels for shipping also has contributed to turbidity and has been a significant factor in the temporary destruction of bottom organisms through displacement and suffocation.

Salinity control is necessary in the Delta because it is contiguous with the ocean and its channels are at, or below, sea level. Unless repelled by continuous seaward flow of fresh water, ocean water will advance up the estuary and degrade water quality. During winter and early spring, flows through the Delta are usually above the minimum required to control salinity (described as “excess water conditions”). At least for a few months in summer and during the fall of most years, however, salinity must be carefully monitored and controlled for “balanced water conditions”. Salinity monitoring and control is provided by the Central Valley Project and State Water Project, and is regulated by the State Water Resources Control Board under its water right authority.

Salinity intrusion is a problem mainly during years of below-normal runoff. In the eastern Delta salinity is largely associated with the high concentration of salts carried by the San Joaquin River. The Banks and Tracy pumping plant operations draw high quality Sacramento River water across the Delta and restrict the low quality area to the southeastern corner. In areas such as dead-end sloughs, irrigation returns cause localized problems. In the western Delta, incursion of saline water from San Francisco Bay is the main water quality problem.

Another concern is that Delta water contains trihalomethane (THM) precursors. THMs are suspected carcinogens produced when chlorine used for disinfection reacts with natural substances during the water treatment process. Dissolved organic compounds that originate from decayed vegetation act as precursors by providing a source of carbon in THM formation reactions. During periods of reverse flow, bromides from the ocean mix with Delta water at the western edge of Sherman Island. When bromides occur in water along with organic THM precursors, THMs are formed that contain bromine as well as chlorine. Drinking water supplies taken from the Delta are treated to meet THM standards. However, more restrictive standards are being considered, which if adopted will increase the cost and difficulty of treatment.

Groundwater Hydrology

The groundwater hydrology of the Sacramento-San Joaquin Delta, as with the geology, is contiguous with that of the Sacramento River Basin. Large amounts of water are stored in thick sedimentary deposits in the Sacramento Valley groundwater basin. Groundwater is used intensively in some areas but only slightly in areas where surface water supplies are abundant.

Groundwater occurs in various degrees of confinement in the Sacramento Valley basin. Groundwater is generally unconfined in the relatively shallow alluvial fan, flood plain, and stream channel deposits and partially confined in and under the flood basin deposits. In the older Pleistocene and Pliocene formations, especially at deeper levels, water is confined beneath impervious thick clay and mudflow strata.

Groundwater levels fluctuate according to supply and demand on daily, seasonal, annual, and even longer bases. Short-term and long-term water level changes have been recorded for wells since the first documented measurements in 1929. In the low-lying central portion of the Sacramento Valley Basin, from the Delta north to Glenn and Butte counties, depth to water in wells is 10 feet or less.

Groundwater is replenished through deep percolation of streamflow, precipitation, and applied irrigation water. Recharge by subsurface inflow is negligible compared to other sources.

Groundwater Quality

The groundwater hydrology of the Sacramento-San Joaquin Delta is contiguous with that of the Sacramento River Basin. Groundwater quality is generally excellent throughout the area and is suitable for most uses, although at shallow depths within the Delta the water is often saline.

Export Operations

To minimize water level fluctuation caused by the State Water Project intake along Old River, Clifton Court Forebay is operated so water is drawn through the gates at high tides and the gates are closed at low tides. This operation provides a more constant head for the pumps and allows the Department of Water Resources to maintain optimum velocities in the channel and across the fish screens.

The Central Valley Project draws water directly from the channels over the entire tidal cycle, resulting in a continuous flow toward the Tracy Pumping Plant whenever it is operating.

Operational changes of the State Water Project and Central Valley Project can affect flow in the lower San Joaquin River along Sherman Island. When outflow is low, increases in export and internal use results in a net reverse flow in this portion of the river, so that net movement of water is upstream toward the pumps. Although they are small in relation to tidal flows, there is concern that net reverse flows may harm fish, including salmon, steelhead, delta smelt, and the planktonic eggs and larvae of striped bass.

The Central Valley Project can pump a maximum of 4,600 cubic feet per (cfs) second into the Delta-Mendota Canal. Adding the Contra Costa Canal brings the Central Valley Project export capacity to 4,900 cfs. The State Water Project can pump 10,300 cfs at Banks Pumping Plant, but an agreement with the U.S. Army Corps of Engineers limits pumping to 6,680 cfs (or a 3-day average of 13,250 acre-feet per day) to protect navigable capacity, except from mid-December to mid-March when San Joaquin River flows are greater than 1,000 cfs. With its greater export capacity, the State Water Project is in a better position to take advantage of surplus flows when available.

2.2 Biological Resources

This section describes the amount environmental setting associated with biological resources. This section is divided into four subsections: plants, invertebrates, fish, and wildlife. Threatened, endangered and other special status species that may be affected by project activities are detailed in each of the four subsections.

2.2.1 Plants

Vegetation Community Types

Species of plants growing in the same area under similar environmental conditions are often grouped into vegetation communities. These communities are regional vegetation elements characterized by certain dominant species. Delta vegetation community types include valley and foothill riparian, valley grassland, freshwater emergent wetland, and agricultural/urban.

Valley and Foothill Riparian

Valley and foothill riparian habitat occurs in the Sacramento and San Joaquin valleys and the surrounding lower foothills. This habitat is typically composed of cottonwoods, sycamores, oaks, blackberries, willows, sedges, and rushes. It is usually found in conjunction with low-velocity channels, flood plains, and gentle topography. Much of this plant community has been removed or destroyed by agriculture and urbanization. Riparian trees and shrubs along the Sacramento River range a few yards wide where the levee is near the riverbank to a flood plain of riparian forest several hundred yards wide.

Sensitive valley and foothill riparian community types in the Delta include: great valley-valley oak riparian forest, great valley cottonwood riparian forest, great valley mixed riparian forest, great valley willow scrub, buttonbush scrub, elderberry savanna, and central coast riparian scrub.

Valley Grassland

Valley grassland is a broadly defined habitat. It often contains mosaics of other habitats, including valley foothill riparian, freshwater emergent wetland, and cropland. Although valley grassland historically consisted of perennial bunch grasses, grazing and the introduction of non-native species have changed the composition to mostly annual grass species.

One type of sensitive community found in association with grasslands is the vernal pool - low herbaceous communities dominated by annual herbs and grasses. Vernal pools form over hardpan, claypan, basalt, and volcanic mudflow soils. Winter precipitation fills the pools, stimulating vegetative growth in the pool and around the margins. Some of this vegetation is endemic to the vernal pool habitat, having evolved to survive in the extreme and rapidly changing hydrologic conditions. By late spring, most pools evaporate.

Other sensitive communities of the Delta that can be generally categorized as valley grassland include: valley needlegrass grassland, serpentine bunchgrass, wildflower fields, freshwater seeps, alkali playas, coastal terrace prairie, and pine bluegrass grassland.

Freshwater Emergent Wetland

Between 30 and 50 percent of the original wetlands of the United States have been lost, mostly to urban development, water diversions, conversion of land to agriculture, or contamination. In 1990, rates of wetland loss were estimated at 300,000 acres annually. In California, 90 percent of the original 5 million acres of wetlands has been lost in the last century. The Fish and Wildlife Service is committed to protecting these wetlands in accordance with the emergency Wetlands Resources Act of 1986.

Historically, freshwater marshes were widespread throughout the Delta and backwaters of the upper Sacramento River. Many types of wetlands and their inhabitants have disappeared. The U.S. Fish and Wildlife Service defines primary wetland types along the Sacramento River as palustrine forested, scrub-shrub, or emergent wetlands (freshwater wetlands dominated by trees, shrubs, or emergent vegetation) and riverine wetlands (freshwater wetlands contained within a channel).

Freshwater emergent wetlands occur throughout California, but most of them are in the Klamath Basin, the Sacramento and San Joaquin valleys, the Delta, and the Imperial Valley/Salton Sea area. They occur in a variety of topographies, so long as a basin is saturated or periodically flooded. Freshwater emergent wetlands are usually dominated by perennial hydrophytic monocots. Three sensitive freshwater emergent wetland communities occur in the Delta: cismontane alkali marsh, coastal and valley freshwater marsh, and vernal marsh.

Agricultural / Urban

Agricultural and urban habitats are found throughout California. Agricultural habitats vary from irrigated pastureland to orchards to row crops. Vegetation in urban areas often consists of non-native species. The downtown urban areas have little vegetation, while landscaping in residential zones and the suburbs provides increasing amounts of vegetation.

Special Status Plant Species

There are a number of special status plant species present in the Delta region proposed for *Egeria* treatment. These species are listed in Exhibit R-1 in Appendix R. A subset of these species will potentially be affected by the project. These species are identified in **Exhibit 2-1**, on the following pages, and are described below:

Delta Mudwort

Delta mudwort (*Limosella subulata Ives.*) has no federal or state status. It is included on CNPS List 2: Plants Rare, Threatened, or Endangered in California, but more Common Elsewhere. No critical habitat has been designated for this species.

Delta mudwort is found in the Sacramento/San Joaquin Delta, along the Sacramento River near Antioch and in Montezuma Slough on Grizzly Island. The plant also has been located in Marin County at Drakes Bay, and in Oregon, Washington, and on the Atlantic coast (Source: Munz and Keck 1968, CNPS 1994, NDDB 1992)

Delta mudwort occurs in intertidal fresh- and brackish-water marshes. It grows on exposed mud often associated with Mason's lilaeopsis, aquatic pigmy-weed, or dwarf spike-rush (NDDB 1992).

The intertidal habitats available to Delta mudwort are limited. Levee construction and maintenance, recreational boating, and trampling from fishing access are possible threats to Delta mudwort populations (NDDB 1992).

Delta Tule Pea

Delta tule pea (*Lathyrus jepsonii Greene ssp. Jepsonii*) is on CNPS List 1B: Plants Rare, Threatened, or Endangered in California and Elsewhere. It has no state or federal status. No critical habitat has been designated for this species.

Delta tule pea occurs on the Delta islands of the lower Sacramento and San Joaquin rivers and westward through Suisun Bay to the lower Napa River. The plant also has been reported in western Alameda and Santa Clara counties, as well as from the mountains of San Benito and Fresno counties (Source: CNPS 1994, NDDB 1992).

Delta tule pea is a sprawling perennial vine found in coastal and Valley freshwater marshes. It has been observed in association with a broad spectrum of other plants ranging from common tule to Valley oak to arrowgrass. It prefers sites above tidal influence, which are still within the area of soil saturation (NDDB 1992).

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Special Statust Species in the Sacramento-San Joaquin Delta

Common Name	Scientific Name	Status
Plants		
Delta mudwort	*Limosella subulata*	CNPS List 2
Delta tule-pea	*Lathyrus jepsonii var. jepsonii*	FSC, CNPS List 1B
Mason's lilaeopsis	*Lilaopsis masonii* Math and Const.	FSC, SR, CNPS List 1B
Northern California black walnut	*Juglans californica* Wats. var. *hindsii* Jeps.	FSC, CNPS List 1B
Rose-mallow	*Hibiscus castanea*	CNPS List 2
Suisun Marsh aster	*Aster lentus* Greene	FSC, CNPS List 1B
Invertebrates		
Valley elderberry longhorn beetle	*Desmocersus californicus dimorphus*	FT
Fish		
Winter-run chinook salmon	*Oncorhynchus tshawytscha*	SE, FE
Winter-run chinook salmon crit. hab	*Oncorhynchus tshawytscha critical habitat*	FE
Cen Val fall/late fall-run chinook crit. hab.	*Oncorhynchus tshawytscha critical habitat*	FT
Cen. Val. fall/late fall-run chinook salmon	*Oncorhynchus tshawytscha*	FPT
Cen. Val. spring-run chinook crit. hab.	*Oncorhynchus tshawytscha critical habitat*	FE
Cent. Val. spring-run chinook salmon	*Oncorhynchus tshawytscha*	ST, FPE
Cent. Val. steelhead	*Oncorhynchus mykiss*	FT
Delta smelt	*Hypomesus transpacificus*	ST, FT
Delta smelt critical habitat	*Hypomesus transpacificus critical habitat*	FT
Green sturgeon	*Acipenser medirostris*	FSC
Longfin smelt	*Spirinchus thaleichthys*	FSC
Pacific lamprey	*Lampetra tridentata*	FSC
River lamprey	*Lampetra ayresi*	FSC
Sacramento splittail	*Pogonichthys macrolepidotus*	FT

**** Status***

FE: Federally listed, endangered
FPE: Federally proposed, endangered
FT: Federally listed, threatened
FPT: Federally proposed, threatened
FC1: Federal candidate, category 1
FC2: Federal candidate, category 2
FSS: Federally sensitive species
SE: State listed, endangered
ST: State listed, threatened
SR: State listed, rare
SP: State protected
SSC: State Species of Special Concern
2: Federal Category 2 candidate for listing**
CEQA: Status of species must be fully considered
CFP: California Fully Protected
CNPS List 1B: Plants Rare, Threatened, or Endangered in California and Elsewhere
CNPS List 2: Plants Rare, Threatened, or Endangered in California, but more Common Elsewhere

EXHIBIT 2-1
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Special Statust Species in the Sacramento-San Joaquin Delta

Common Name	Scientific Name	Status
Wildlife		
Amphibians		
California red-legged frog	*Rana aurora draytonii*	FT, SSC
Reptiles		
Giant garter snake	*Thamnophis couchi gigas*	ST, FT
Northwestern pond turtle	*Clemmys marmorata marmorata*	FSC, SSSC, 2
Southwestern pond turtle	*Clemmys marmorata pallida*	FSC, SSC, 2
Birds		
California black rail	*Laterallus jamaicensis coturniculus*	CFP, ST/FC2
Great blue heron	*Ardea herodias*	SSC
Great sandhill crane	*Grus canadensis tabida*	CFP, ST
Short-eared owl	*Asio flammeus*	SSC
Tricolored blackbird	*Agelaius tricolor*	FSC
White-faced ibis	*Plegadis chihi*	FSC, SSC
Mammals		
Small-footed myotis bat	*Myotis ciliolabrum*	FSC
Yuma myotis bat	*Myotis yumanensis*	FSC

**** Status***

FE: Federally listed, endangered
FPE: Federally proposed, endangered
FT: Federally listed, threatened
FPT: Federally proposed, threatened
FC1: Federal candidate, category 1
FC2: Federal candidate, category 2
FSS: Federally sensitive species
SE: State listed, endangered
ST: State listed, threatened
SR: State listed, rare
SP: State protected
SSC: State Species of Special Concern
2: Federal Category 2 candidate for listing**
CEQA: Status of species must be fully considered
CFP: California Fully Protected
CNPS List 1B: Plants Rare, Threatened, or Endangered in California and Elsewhere
CNPS List 2: Plants Rare, Threatened, or Endangered in California, but more Common Elsewhere

Agricultural conversion, water diversions, vegetation burning, dredge spoil disposal, recreation, changes in salinity, and levee construction and maintenance all are cited as reasons for the species decline (CNPS 1994, Niehaus 1977b).

Mason's lilaeopsis

Mason's lilaeopsis (*Lilaeopsis masonii*) is State listed rare and a Federal candidate, category 2. It is a perennial herb found in the intertidal zone of brackish and freshwater marshes and riparian scrub. It is found in the Delta from Mare Island to Barker Slough in Sacramento County and near Stockton in San Joaquin County. This species is threatened by development, flood control projects, recreation, levee maintenance, erosion, and agriculture.

Northern California Black Walnut

Northern California black walnut (*Juglans californica Wats. var. hindsii Jeps.*) is on CNPS List 1B: Plants Rare, Threatened, or Endangered in California and Elsewhere. It has no state or federal status. No critical habitat has been designated for this species.

The original distribution of northern California black walnut is unknown. Stands along Walnut and Lafayette creeks in Contra Costa County, near Walnut Grove in Sacramento County, and near Wooden Valley in Napa County are cited as the "native" stands of this species and are considered endangered (CNPS 1994, NDDB 1992). The species was planted as a street tree in central California and used as root stock for the early California walnut industry. It freely hybridizes with commercial varieties (Munz and Keck 1968). California black walnut and various crosses have since become widely naturalized in riparian forests of the Great Valley and surrounding foothills (CNPS 1994, Griffin and Critchfield 1972, NDDB 1992). Many of these trees are located near Indian settlements, and were undoubtedly established by the residents of these settlements (Munz and Keck 1968).

Northern California black walnut is associated with deep alluvial soil near creeks, streams, or springs that provide summer water. It is a riparian canopy tree, often associated with Valley oak, Oregon ash, and poison oak (CNPS 1994).

Only two of the original "native" stands of northern California black walnut still survive as pure genetic stock (CNPS 1994). The species is threatened by hybridization with English walnut and the black walnut of the eastern United States, both of which were widely used in the early walnut industry.

Rose Mallow

Rose-mallow (*Hibiscus lasiocarpus Cav.*) was previously classified as *Hibiscus californicus*, which was considered to be restricted to California. CNPS includes rose-mallow on List 2: Plants Rare, Threatened, or Endangered in California, but more Common Elsewhere (CNPS 1994). The plant has no state or federal status. No critical habitat has been designated for this species.

Rose-mallow occurs along the Sacramento River and adjoining sloughs from Butte County to the Delta. Outside of California, the species is widespread, but threatened, in western North America and occurs as far east as Missouri (NDDB 1992, CNPS 1994).

In California, rose-mallow is restricted to freshwater marshes in riverine backwaters, irrigation canal banks, and Delta islands. It is associated with tules, willows, buttonwillow, and other marsh and riparian species on heavy silt, clay, or peat soils (NDDB 1992).

Within California, the loss of riverine wetlands, sloughs, and other freshwater marsh habitats through channelization of the Sacramento River and its tributaries is the leading cause of the plant's decline (CNPS 1994). In the south Delta, levee maintenance, bank erosion, and island submergence have resulted in the loss of some populations of rose-mallow (NDDB 1992).

Suisun Marsh Aster

Suisun Marsh aster (*Aster lentus Greene*) is on CNPS List 1B: Plants Rare, Threatened, or Endangered in California and Elsewhere. The plant has no state or federal status. No critical habitat has been designated for Suisun Marsh aster.

Suisun Marsh aster is known from several locations in the western Sacramento/San Joaquin River Delta and Suisun Bay (CNPS 1994, NDDB 1992).

Suisun Marsh aster grows in brackish and freshwater marshes. It occurs along brackish sloughs, riverbanks, and levees affected by tidal fluctuations. Associated species include marsh plants such as bulrush, cattail, common reed, willow, and rose-mallow. The plants are often found at, or near, the water's edge.

Factors leading to the decline of this species include the filling or draining of wetland habitats within the plant's range, pollution (oil spills, sewage discharges), and changes in water chemistry from water projects affecting Delta or Bay salinities (Niehaus 1977a). Levee maintenance, erosion, and fishing access in high traffic areas are also cited as threats (NDDB 1992).

2.2.2 Invertebrates

Only one special status invertebrate, the Valley elderberry longhorn beetle, could be affected by EDCP operations or the Two-Year Komeen Field Trials. It is described below.

Valley Elderberry Longhorn Beetle

The Valley elderberry longhorn beetle (Federal threatened) is a dimorphic species strictly tied to its host plant, the elderberry (*Sambucus sp.*). It historically occurred throughout the Sacramento and San Joaquin valleys and into the foothills of the Coast Ranges and the Sierra Nevada to 2,200-foot in elevation. The Valley elderberry longhorn beetle is found in the eastern portion of the Delta. Over the last 150 years, agricultural and urban development has destroyed 90 percent of Central Valley riparian vegetation, which included the elderberry host plant, resulting in extreme fragmentation of the beetle's habitat.

2.2.3 Fish

Fish dependent on the Delta as a migration corridor, nursery, or permanent residence include striped bass, American shad, sturgeon, Chinook salmon, steelhead, catfish, largemouth bass, and numerous less known marine and freshwater species. Aquatic habitat ranges from fresh water in the upper reaches of the Delta to brackish in the lower reaches. Transition from one zone to the next is gradual, and the zones move up or downstream depending on the amount of fresh water entering the estuary.

Delta fish habitat types include estuary, fresh water, and marine water. The amount of habitat in each component partly depends on outflow regimes and water year hydrology. Habitat varies from dead-end sloughs to deep, open-water areas of the lower Sacramento and San Joaquin rivers and Suisun Bay. A scattering of flooded islands also offer submerged vegetative shelter. Channel banks are varied and include riprap, tules, emergent marshes, and native riparian habitat. Water temperatures generally reflect ambient air temperatures, but riverine shading may moderate summer temperatures in some areas.

Food supplies for Delta fish communities consist of phytoplankton, zooplankton, benthic invertebrates, insects, and fish. General productivity is in constant flux, and an evaluation of the interrelationships of the food web is now underway by the Interagency Ecological Program for the Sacramento-San Joaquin Estuary. There are indications that overall productivity at the lower food chain levels has decreased during the past 15 years or so.

The entrapment zone concentrates sediments, nutrients, phytoplankton, some fish larvae, and fish food organisms. Biological standing crop (biomass) of phytoplankton and zooplankton in the estuary was historically highest in this zone; however, phytoplankton levels no longer show a peak in the entrapment zone since introduced clams began cropping production in 1987. Keeping the entrapment zone in the upper reaches of Suisun Bay may create more desirable habitat for some species than could be maintained in the narrower channels upstream in the Delta.

Flows caused, provided, or controlled by the Central Valley Project and State Water Project affect fish in numerous ways. Flows toward the project pumps draw both fish and fish food organisms into the export facilities. Most larger fish are screened out, and many do not survive screening and subsequent handling. Most fish less than about an inch long and fish food pass through. In addition, the draw of the pumps may cause water in some channels to flow too fast for optimal fish food production, and reverse flows in some channels may confuse migrating fish. Delta flows may act as cues for anadromous fish outmigrating to the ocean.

Factors beside Central Valley Project and State Water Project operations that affect fish include water diversions within the Delta; upstream spawning conditions and diversions; municipal, industrial, and agricultural water pollution; habitat reduction by landfills; legal and illegal harvesting; competition from introduced species; natural predator/prey interactions; and drought. Cumulative effects of these and other factors have contributed to declining populations of many Delta fish.

Of the more than 100 fish species in the Delta, important game fish include American shad, Chinook salmon, steelhead, and striped bass. Although all these anadromous fish spend most of their adult lives in the lower bays or in the ocean, the Delta is a major nursery area for most of them. Other fish in the estuary include catfish, black bass, crappie, bluegill, and several threatened, endangered, or candidate species.

Special Status Fish Species

Special status fish species that occur in the Delta and could be impacted by EDCP operations or the Two-Year Komeen Field Trials are listed in Exhibit 2-1 and described below.

Chinook Salmon

There are four distinct runs of chinook salmon, distinguished by their timing of upstream migration and spawning season. The runs are named for the season during which the adults enter fresh water. Three of these runs are special concern and will be discussed below: winter-run, spring-run and fall-run. In 1989, the Sacramento River winter-run chinook salmon was listed as threatened under the federal ESA by National Marine Fisheries Service (NMFS) (54 FR 32085). NMFS reclassified the winter-run as endangered in 1994 (59 FR 440). In 1993, NMFS designated critical habitat for the winter-run chinook from Keswick Dam (Sacramento river mile 302) to the Golden Gate Bridge (58 FR 33212). Central Valley spring-run salmon was listed as threatened in August 1998. Fall-run salmon and fall-run critical habitat are proposed threatened.

Chinook salmon are found in the Delta only during migration to and from the Pacific Ocean. They do not spawn or rear in the Delta.

Chinook salmon has the broadest geographic range of any of the Pacific salmon species and is an important recreational and commercial species throughout most of its range. Runs of Chinook salmon are found along the northern Pacific Ocean and tributary drainages and around the Pacific Rim from northern Japan to southern California. In spite of its wide distribution, Chinook salmon is the least abundant of Pacific salmon species. As a species, Chinook salmon is distinguished by its highly variable life history, and many rivers have more than one distinct stock identifiable by life history patterns.

The life span of Chinook salmon ranges from 2 to 7 years. Although Chinook salmon can spend 1½ to 5 years in the ocean before returning to natal streams to spawn, most return to fresh water 2½ years after entering the ocean.

Chinook salmon eggs are laid in nests (called "redds") excavated by the female in loose gravel. Juvenile salmon may migrate downstream to the estuary immediately after emerging from the redd, or they may spend a year or more in fresh water. The length of juvenile residence time in fresh water and estuaries varies between salmon runs and depends on a variety of factors, including season of emergence, streamflow, turbidity, water temperature, and interaction with other species.

There are two general types of Chinook salmon life history strategies, stream type and ocean type. Stream-type juveniles remain in the river for a year or more before migrating to the ocean. Ocean-type juveniles typically move to the ocean during their first few months. Although California races typically follow the ocean pattern, some juveniles of the fall, late-fall, and spring runs may emigrate as age-one smolts. Apparently all winter-run salmon migrate during the first few months after emergence.

Adult (3- to 4-year-old) fall-run Chinook salmon migrate up the Sacramento River system from July to December. Most juveniles migrate to the ocean within a few months following emergence. A few remain in fresh water and migrate as yearlings. The fall run is by far the dominant run in the Central Valley.

Late-fall-run adults immigrate from October to April. Rearing and emigration occurs from April to October. The populations of concern are those spawning in the Sacramento and San Joaquin Rivers and their tributaries.

Adult winter-run salmon immigrants enter the Sacramento River from December through July. Juveniles begin to move out of the upper river as early as August, but the main emigration is in January through April.

Spring-run Chinook salmon traditionally spawned in the upper reaches of Central Valley rivers and their tributaries, which are now blocked by dams. The spring run in the Sacramento River system generally enters fresh water between March and June. The distinguishing feature of this run is that adults hold over during the summer in colder pools in the upper river areas and do not spawn until fall, sometime between late August and October.

Delta operations of the Central Valley Project and State Water Project affect adult and juvenile Chinook salmon as they pass through the Delta on their way to and from spawning and nursery areas in the Sacramento and San Joaquin river systems. Flow direction and velocity in Delta channels, operation of the Delta Cross Channel, and exposure of fish to the export pumps are the major project-related factors affecting salmon survival.

Adult salmon require the presence of homestream water to guide them to their spawning grounds. Salmon from the Sacramento River system outmigrating through the Delta as juveniles in the spring and early summer may be affected by altered flow patterns in the lower San Joaquin River. Some are also diverted to the interior Delta through Georgiana Slough and the Delta Cross Channel, where survival is lower than if they continued downstream in the Sacramento River. Exposure to the water project fish screens results in losses due to predation by larger fish in front of the screens, screen inefficiency, and attrition in the process of handling and hauling salvaged fish.

Steelhead

Central Valley steelhead (*Oncorhynchus mykiss*), which are the anadromous form of rainbow trout, are Federally listed threatened. They migrate to the ocean as juveniles and return to fresh water to spawn when they are 2 to 4 years old. Spawning migration can be anytime from August through March.

Steelhead usually do not die after spawning. Survivors return to the ocean between April and June, and some make several more spawning migrations. Juvenile steelhead usually remain in fresh water for the first year, then migrate to the ocean between November and May. Steelhead are found in the Delta predominantly during migration.

Delta Smelt

The delta smelt (*Hypomesus transpacificus*) is State and Federally listed as threatened. Critical habitat for this species includes Suisun Bay (including the contiguous Grizzly and Honker bays); the length of Goodyear, Suisun, Cutoff, First Mallard, and Montezuma sloughs; and the existing continuous waters within the Sacramento-San Joaquin Delta. Delta smelt is native to the Sacramento-San Joaquin estuary. It is found primarily in the lower Sacramento and San Joaquin rivers, in the Delta above their confluence, in Suisun Marsh water channels and in Suisun Bay.

Delta smelt spawn in fresh water from February to June, with peak spawning in April and May. Spawning has been reported to occur at about 45 to 59° F in tidally influenced rivers and sloughs, including dead-end sloughs and shallow edgewaters of the upper Delta. The demersal, adhesive eggs sink and attach to hard substrates, such as submerged tree branches and roots, gravel or rocks, and submerged vegetation.

Newly hatched larvae are planktonic and drift downstream near the surface in nearshore and channel areas to the freshwater/saltwater interface. Mager (1993) found that larvae hatched in 10 to 14 days under laboratory conditions and started feeding on phytoplankton at day 4 and on zooplankton at day 6. Growth is rapid through summer, and juveniles reach 40 to 50 millimeters (fork length) by early August. Growth slows in fall and winter, presumably to allow for gonadal development. Adults range from 55 to 120 millimeters, but most do not grow larger than 80 millimeters.

The midwater trawl index, the best index of delta smelt abundance, declined in the mid-1980s, then generally increased through the late 1980s and early 1990s. In 1993, the midwater trawl index was the sixth highest of the 25 years of record. In 1990, the Department of Fish and Game reviewed the status of delta smelt but could not determine factors causing the decline. In 1994, the index dropped to a 28-year low, but it rebounded again in 1995. Delta smelt larvae, juveniles, and adults are entrained in diversions of the Central Valley Project and State Water Project.

Splittail

Sacramento splittail (*Pogonichthys macrolepidotus*) was proposed threatened by the USFWS in January 1994 and officially listed as threatened in February 1999. No critical habitat is currently designated for this species.

The Sacramento splittail is a large minnow endemic to the Bay-Delta Estuary. Once found throughout low elevation lakes and rivers of the Central Valley from Redding to Fresno, this native species is now confined to the lower reaches of the Sacramento and San Joaquin rivers, the Delta, Suisun and Napa marshes, and tributaries of north San Pablo Bay (DFG 1994b). Although the Sacramento splittail is considered a freshwater species, the adults and sub-adults have an unusually high tolerance for saline waters, up to 10-18 ppt (Meng 1993), for a member of the minnow family (DFG 1994b). Therefore, the Sacramento splittail is often considered an estuarine species. When splittail were more abundant, they were commonly found in Suisun Bay and Suisun Marsh. The salt tolerance of splittail larvae is unknown (DFG 1992b).

Juveniles and adults use shallow edgewater areas lined by emergent aquatic vegetation. Submerged vegetation provides food sources and escape cover. Shallow, seasonally flooded vegetation is also apparently a preferred splittail spawning habitat. Year class strength appears to be primarily controlled by inundation of floodplain areas, which provides spawning, rearing and foraging habitat.

The splittail is a relatively long-lived minnow, reaching ages of 5 and possibly up to 7 years. Both males and females usually reach sexual maturity in their second year. Like most cyprinids, splittail has high fecundity, ranging from 5,000 to 100,800 eggs per female.

Timing and location of splittail reproduction have varied during separate investigations. From 1978 to 1983, samples of larvae indicate that splittail spawned in tidal freshwater and oligohaline habitats such as Montezuma and Suisun sloughs and San Pablo Bay from late January or early February through July. However, most spawning activity appears to occur in the Sacramento and San Joaquin rivers and their tributaries.

Splittail eggs are adhesive or become adhesive soon after contacting water. Eggs appear to be demersal, are believed to be laid in clumps, and attach to vegetation or other submerged substrates. Larvae become free swimming 5 to 7 days after hatching; feeding begins after 5 days post-hatch.

Young splittail appear to seek out shallow, vegetated areas protected from strong currents near spawning grounds and move downstream as they grow. They apparently move or are carried with higher spring flows downstream into the estuary and bays, where they are captured regularly by midwater trawl sampling in Suisun Bay near Montezuma Slough, in the vicinity of Pittsburgh Power Plant near New York Slough, near Antioch, and sometimes as far downstream as Carquinez Strait and San Pablo Bay.

Splittail recruitment decreased during 1987 to 1990 and apparently improved in 1991 and 1993. Juvenile splittail abundance is often highest in wet years such as 1982, 1983, 1986, and 1993. In 1994, the midwater trawl index once again showed a decline in young-of-the-year abundance, but the 1995 year class was exceptionally strong. In most surveys, the number of adult splittail has been variable since 1979, without a discernible trend, but the Suisun Marsh survey showed a major decline after 1981, with little or no resurgence since then. Again, the 1995 abundance indices were the highest on record for the state water project and central valley project salvages, the Bay study otter trawel, and the Bay study midwater trawel (Sommer et. al., 1997).

The recent drought appears to be the primary cause of lower splittail abundance, based on a strong correlation with Delta outflow. Abundance is also well correlated with the duration of flood plain inundation, which may provide a large amount of additional spawning, rearing, and foraging habitat in wet years. Except for 1993 and 1995, there has been little flooding in the range of splittail since 1986, perhaps contributing to a series of weaker year classes. A number of other factors may also influence splittail abundance, including water diversions, urban and agricultural pollution, exotic species, food abundance, and recreational fishing. Water project entrainment does not appear to have an important population level effect.

Longfin Smelt

Longfin smelt (*Spirinchus thaleichthys*) is designated as a Species of Concern. No critical habitat or special protection has been granted to this species.

The longfin smelt (*Spirinchus thaleichthys*) is a small, planktivorous fish that is found in several Pacific coast estuaries from San Francisco Bay to Prince William Sound, Alaska. Until 1963, the population in San Francisco Bay was thought to be a distinct species. Within California, longfin smelt have been reported from Humboldt Bay and the mouth of the Eel River. However, data are infrequently collected from Humboldt Bay, and there are no recent records from the Eel River (SFEP 1992a). In California, the largest longfin smelt reproductive population inhabits the Bay-Delta Estuary (DFG 1992c). This 4-5 inch long (adult), pelagic anadromous species spawns in the fresh waters of the Delta and lower rivers, rears throughout the Estuary and matures in brackish and marine waters (SFEP 1997).

Longfin smelt can tolerate salinities ranging from fresh water to sea water. Spawning occurs in fresh to brackish water over sandy-gravel substrates, rocks, or aquatic vegetation (Meng 1993). Optimal salinity for spawning is 0 - 0.5 (CUWA 1994).

In the Bay-Delta Estuary, the longfin smelt life cycle begins with spawning in the lower Sacramento and San Joaquin rivers, the Delta, and freshwater portions of Suisun Bay (SFEP 1992a). Spawning may take place as early as November and extend into June, with the peak spawning period occurring from February to April (Meng 1993). The eggs are adhesive and, after hatching, the larvae are carried downstream by freshwater outflow to nursery areas in the lower Delta and Suisun and San Pablo bays (SFEP 1992a). The principal nursery habitat for larvae is the productive waters of Suisun and San Pablo bays. Adult longfin smelt are found mainly in Suisun, San Pablo, and San Francisco bays, although their distribution is shifted upstream in years of low outflow (Meng 1993).

With the exceptions that both longfin smelt and Delta smelt spawn adhesive eggs in river channels of the eastern Estuary and have larvae that are carried to nursery areas by freshwater outflow, the two species differ substantially. Consistently, a measurable portion of the longfin smelt population survives into a second year (SFEP 1992a). During the second year of life, they inhabit San Francisco Bay and, occasionally, the Gulf of the Farallones; thus, longfin smelt are often considered anadromous. Longfin smelt are also more broadly distributed throughout the Estuary, and are found at higher salinities, than Delta smelt (Sommer et al, In press). Because longfin smelt seldom occur in fresh water except to spawn, but are widely dispersed in brackish waters of the Bay, it seems likely that their range formerly extended as far up into the Delta as salt water intruded. The easternmost catch of longfin smelt in the fall mid-water trawl was at Medford Island in the Central Delta. They have been caught at all stations of the Bay Study. A pronounced difference between the two species in their region of overlap in Suisun Bay is by depth; longfin smelt are caught more abundantly at deep stations (10 m), whereas Delta smelt are more abundant at shallow stations (<3 m) (SFEP 1992a).

A strong relationship exists between freshwater outflow during the spawning and larval periods and the subsequent abundance of longfin smelt (SFEP 1997). Outflow disperses buoyant larvae--increasing the likelihood that some will find food. By reducing salinities in Suisun and San Pablo bays, outflow may also provide habitat with few marine or freshwater competitors and predators (marine species often do not tolerate lower salinities, and freshwater species have mechanisms to avoid being washed downstream SFEP 1997.

The factor most strongly associated with the recent decline in the abundance of longfin smelt has been the increase in water diverted by the SWP and the CVP during the winter and spring months when the smelt are spawning (NHI 1992a, DWR 1992a). The pumping changes the hydrology of the Delta and increases the exposure of larval, juvenile, and adult longfin smelt to predation and entrainment (NHI 1992b). Salvage data indicate that longfin smelt have been more vulnerable to pumping operations since 1984. This increase in vulnerability may be due to the concentration of longfin smelt populations in the upper Estuary, within the zone of influence of the pumps, as a result of reduced Delta outflow. Also, decreases in outflow fail to disperse the larvae downstream to Suisun Bay nursery areas, away from the effects of Delta pumping (Meng 1993).

Green Sturgeon

Green sturgeon (*Acipenser medirostris*) is designated as a Federal Special Concern species by the USFWS and as a California Special Concern species by DFG. No critical habitat has been designated for this species.

The following is quoted from Moyle et al (1995):

> "In California, green sturgeon have been collected in small numbers in marine waters from the Mexican border to the Oregon border. They have been noted in a number of rivers, but spawning populations are known only in the Sacramento and Klamath Rivers….The San Francisco Bay system, consisting of San Francisco Bay, San Pablo Bay, Suisun Bay and the Delta, is home to the southernmost reproducing population of green sturgeon...
>
> "The habitat requirements of green sturgeon are poorly known, but spawning and larval ecology probably are similar to that of white sturgeon. However, the comparatively large egg size, thin chorionic layer on the egg, and other characteristics indicate that green sturgeon probably require colder, cleaner water for spawning than white sturgeon (*S. Doroshov, pers. comm.*). In the Sacramento River, adult sturgeon are in the river, presumably spawning, when temperatures range between 8-14°C. Preferred spawning substrate likely is large cobble, but can range from clean sand to bedrock. Eggs are broadcast-spawned and externally fertilized in relatively high water velocities and probably at depths >3 in (Emmett et al. 1991). The importance of water quality is uncertain, but silt is known to prevent the eggs from adhering to each other (C. Tracy, minutes to USFWS meeting)…
>
> "The ecology and life history of green sturgeon have received comparatively little study evidently because of their generally low abundance in most estuaries and their low commercial and sport

> fishing value in the past. Adults are more marine than white sturgeon, spending limited time in estuaries or fresh water…
>
> "Juveniles and adults are benthic feeders, and may also take small fish. Juveniles in the Sacramento-San Joaquin Delta feed on opossum shrimp *Neomysis mercedis*) and amphipods (*Corophium sp.*) (Radtke 1966). Adult sturgeon caught in Washington had been feeding mainly on sand lances (*A mmodyies hexapterus*) and callianassid shrimp (P. Foley, unpublished). In the Columbia River estuary, green sturgeon are known to feed on anchovies, and they perhaps also feed on clams (C. Tracy, minutes to USFWS meeting). Adults can reach sizes of 2.3 in FL and 159 kg, but in San Francisco Bay most are probably less than 45 kg (Skinner 1962)."

Pacific Lamprey

Pacific lamprey (*Lampetra tridentata*) is designated by USFWS as a Federal Special Concern species. No critical habitat has been designated for this species.

The following is quoted from Wang (1986):

> "In the Bay-Delta Estuary, the longfin smelt life cycle begins with spawning in the lower Sacramento and San Joaquin rivers, the Delta, and freshwater portions of Suisun Bay (SFEP 1992a). Spawning may take place as early as November and extend into June, with the peak spawning period occurring from February to April (Meng 1993). The eggs are adhesive and, after hatching, the larvae are carried downstream by freshwater outflow to nursery areas in the lower Delta and Suisun and San Pablo bays (SFEP 1992a). The principal nursery habitat for larvae is the productive waters of Suisun and San Pablo bays. Adult longfin smelt are found mainly in Suisun, San Pablo, and San Francisco bays, although their distribution is shifted upstream in years of low outflow (Meng 1993)."

Pacific lamprey spawn in freshwater environments where there are riffles, usually over gravel and rocks, and occasionally over sand (Wang 1986). Ammocoetes live in freshwater or estuarine environments with sandy or soft mud substrates. They burrow tail first into substrates or sometimes lie on top of the substrates and move from one place to another. Ammocoetes are filter feeders, subsisting on algae and organic matter (Moyle 1976). After 5-6 years, physiological changes occur, transforming the ammocoete into predatory adults. The adult lamprey migrates to the ocean. After one or two years, the lamprey returns to freshwater to spawn.

River Lamprey

The River lamprey (*Lampetra ayresi*) is a Federal Species of Special Concern. No critical habitat has been designated for this species.

The following is quoted from Moyle and others (1995):

> "The habitat requirements of spawning adults and ammocoetes have not been studies in California. Presumably, the adults need clean, gravelly riffles in permanent streams for spawning, while the ammocoetes require sandy backwaters or stream edges in which to bury themselves, where water quality is continuously high and temperatures do not exceed 25°C.
>
> "River lampreys have been collected from large coastal streams from fifteen miles north of Juneau, Alaska, down to San Francisco Bay. In California, they have been recorded only from the lower Sacramento and San Joaquin rivers and from the Russian River (Lee and others 1980), but they have not really been looked for elsewhere. Wang (1980) indicates that a landlocked population may exist in upper Sonoma Creek (Sonoma County), a tributary to San Francisco Bay…
>
> "Trends in the populations of river lamprey are unknown in California, but it is likely that they have declined, along with the degradation of suitable spawning and rearing habitat in rivers and tributaries. River lamprey are abundant in British Columbia, the center their range, but there are relatively few records from California, the southern end of their range.
>
> "The river lamprey has become uncommon in California, and it is likely that the population are declining because the Sacramento, San Joaquin, and Russian rivers and their tributaries have been severely altered by dams, diversions, pollution, and other factors. Two tributary streams where spawning has been recorded in the past (Sonoma and Cache creeks) are both severely altered by channelization, urbanization, and other problems."

2.2.4 Wildlife

The complex interface between land and water in the Delta provides rich and varied habitat for wildlife, especially birds. Wildlife habitats include agricultural land, riparian forest, riparian scrub-shrub, emergent freshwater marsh, heavily shaded riverine aquatic, and grassland/rangeland.

Although much of the Delta is used for agriculture, the land also provides habitat for wildlife. Many agricultural fields are flooded in the winter, providing foraging and roosting sites for migratory waterfowl. Aside from these seasonally used areas, thousands of acres are managed specifically for wildlife. Major State and Federal Wildlife areas in Delta areas are shown in **Table 2-1** below.

Table 2-1

Major State and Federal Wildlife Areas in the Sacramento-San Joaquin Delta

Name	County	Owner/Manager	Acreage
Lower Sherman Island Wildlife Area	Sacramento	DFG	3,114.85
White Slough Wildlife Area	San Joaquin	DWR/DFG	880.00
Woodbridge Ecological Reserve	San Joaquin	DFG	358.88
Antioch Dunes National Wildlife Refuge	Contra Costa	USFWS	67.00
Palm Tract Conservation Easement	Contra Costa	DFG	1,076.00
Total			5,496.73

The Delta is particularly important to waterfowl migrating via the Pacific Flyway. The principal attraction for waterfowl is winter-flooded fields, mainly cereal crops, which provide food and extensive seasonal wetlands. The Delta and other Central Valley wetlands provide winter habitat for 60 percent of waterfowl on the Pacific Flyway and 91 percent of waterfowl that winter in California. More than a million waterfowl are frequently in the Delta at one time.

Small mammals find suitable habitat in the Delta and upland areas. Vegetated levees, remnants of riparian forest, and undeveloped islands provide some of the best mammalian habitat in the region. Species include muskrat, mink, river otter, beaver, raccoon, gray fox, and skunks.

Special Status Wildlife

Special status wildlife species that occur in the Delta and could be impacted by EDCP operations or the Two-Year Komeen Field Trials are listed in Exhibit 2-1 and described below.

Amphibians

California Red-Legged Frog

The California red-legged frog (Federal threatened and State special concern) is the largest frog native to California. Habitat of the California red-legged frog is characterized by dense, shrubby vegetation associated with deep, still, or slow-moving water. They are infrequent inhabitants where introduced aquatic predators (e.g., bullfrogs) are present. Red-legged frogs rely on dense cover to protect them while breeding and foraging. They were found historically throughout the Central Valley, along the Pacific Coast, and in the San Francisco Bay area. Today the frog occupies only about 30 percent of its original range and is found primarily along the coast between Santa Cruz and Ventura species. California red-legged frogs breed from late November to April. At breeding sites, males typically call in small mobile groups (3 to 7 individuals) to attract females. Females attach eggs to emergent vegetation where embryos hatch 6 to 14 days after fertilization. Larvae require 4 to 5 months to attain metamorphosis. Juvenile frogs seem to favor open, shallow aquatic habitats with dense submergent vegetation. They frequently are active during the day, spending daylight hours basking in the warm surface water layer associated with floating and submergent vegetation. Adult frogs are wary and highly nocturnal. Introduced predators, habitat modification and destruction, and drought have all contributed to the decline of the species.

Reptiles

Giant Garter Snake

The Giant garter snake (State and Federal threatened) is the largest garter snake in North America and is endemic to the valley floor wetlands in the Sacramento and San Joaquin valleys. It inhabits sloughs, ponds, small lakes, and other low-gradient waterways, including irrigation canals were water is present throughout the summer. It typically avoids larger waterways with predatory fish and woodland streams with excessive cover.

Although recent studies have found no Giant garter snakes in the Delta proper, the snakes have been seen at scattered Delta locations over the last 20 years. The Natural Diversity Data Base contains 80 records of Giant garter snake sightings between 1977 and 1997, primarily in the northern and eastern Delta. In more recent surveys on New Hope, Brack, and Terminous tracts, Giant garter snakes were seen at three new locations (Source: George Hansen, Letter to Jim Martin, California Department of Water Resources, August 15, 1994).

Western pond turtle

The western pond turtle (*Clemmys marmorata*) includes two subspecies, the northwestern pond turtle (*Clemmys marmorata marmorata*) and the southwestern pond turtle (*Clemmys marmorata pallida*). Both subspecies are designated as Category 2 candidates for federal listing and as Species of Special Concern by DFG. No critical habitat has been designated for this species.

The western pond turtle occurs in suitable aquatic habitats throughout California west of the Sierra-Cascade crest and in parts of Oregon and Washington (Stebbins 1985, DFG 1988). The northwestern subspecies is found generally north of San Francisco Bay, while the southwestern subspecies is found south of San Francisco Bay. The two subspecies may intergrade throughout the Delta and San Joaquin Valley (Stebbins 1985), or intergrades may be restricted to the Delta region with San Joaquin Valley populations represented by the southwestern pond turtle (USFWS 1992).

The western pond turtle is a moderately large turtle. Adults may grow carapaces as large as 9 inches in length, although they are only about 1 inch in length at hatching. The carapace is low and broad, and usually wider anteriorly. The shell is smooth and lacks a keel or serrations. The hind feet are webbed to the base of the claws. Typically, the dorsal coloration ranges from dark brown to olive and with or without darker streaks. Ventral coloration ranges from cream colored to light yellowish with scattered darker markings.

Western pond turtles are sexually dimorphic. Males have a concave plastron while a female's plaston is flat. The cloaca is usually at or posterior to the carapace in males but usually anterior in females. Males typically have shorter and thicker tails and display a bright yellow maxilla. These sexual dimorphic characters may not be apparent until the animals reach approximately 4.5 inches in length.

The western pond turtle is omnivorous. In addition to aquatic vegetation, turtles feed on larval dragonflies, mayflies, stoneflies, caddisflies, beetles, and other aquatic invertebrates (Bury 1986; Holland 1985a, 1985b). Carrion is reported to be a common food item. Manning (1990) notes that western pond turtles are a common prey item for river otters, raccoons, minks, coyotes, and bears.

Western pond turtles are found in association with a wide variety of wetlands, including ponds, marshes, lakes, streams, and irrigation ditches (Stebbins 1985, DFG 1988). Suitable habitat is typically well-vegetated and contains exposed logs, rocks, or other basking sites from which turtles can easily escape into the water when disturbed (Stebbins 1985). Egg-laying may occur along sandy wetland margins or at upland locations as far as 1,300 feet from water (Holland and Bury 1992). Hatchlings and juveniles apparently require a more specialized aquatic habitat than do adults (USFWS 1992). Western pond turtles may move overland for short distances: females to lay eggs; entire local populations to reach new water and escape drying bodies of water (Zeiner 1988).

Historic populations of western pond turtles in California have declined extensively (possibly as much as 90 to 99 percent in the Central Valley since 1850) as riparian corridors have been stripped of vegetation, flood plains diminished, and natural waterways channelized, leveed, and riprapped. Young turtles are vulnerable to a wide variety of predators including many of the introduced species such as bullfrogs and game fish (Morey 1985). Pond turtles may be victims of the bioaccumulation of heavy metals and other toxins, which have increased dramatically in California's waterways since the industrialization of the state (Holland 1991).

In the San Joaquin Valley, western pond turtles have declined from an estimated 10 million or more in the 1880s to less than 5000 at present (Holland 1991).

Commercial collecting, wetland and upland habitat loss, and introduced predators have all been implicated in the decline of the western pond turtle (Brode pers. comm., Holland and Bury 1992, USFWS 1992). Less than 10 percent of wetlands historically found throughout the species' range in California persist today (Jennings pers. comm., USFWS 1992).

Birds

California Black Rail

The California black rail (State threatened and Federal special concern) is the most secretive of rails, moving through and hiding under dense marsh vegetation. The population of California black rail subspecies has been reduced to just a few thousand, the bulk of which is now limited to the northern San Francisco Bay area. Suitable California black rail habitat is limited in the Delta. The few areas of marsh vegetation that form suitable habitat are either growing from inundated substrates or are dominated by willows.

Greater Sandhill Crane

The greater sandhill crane (State threatened) is the largest of six subspecies of sandhill cranes in North America. The cranes forage primarily in harvested grain fields and roost in shallow wetlands, harvested fields, and winter wheat fields. Greater sandhill cranes overwinter throughout the Central Valley from October through March, but 95 percent of California's winter population is from the Delta northward. Important wintering grounds in the Delta include Staten Island, Tyler Island, and Brack Tract.

Tricolored Blackbird

The Tricolored blackbird (*Agelaius Tricolor*) is identified as a California Species of Special Concern by DFG. No critical habitat has been designated for this species.

Tricolored blackbirds are highly colonial birds. They are most numerous in the Central Valley and vicinity, and are largely endemic to California (NDDB 1997). Their habitat requirements include open water, protected nesting substrate, and foraging area with nearby insect prey. These birds breed near fresh water, preferably in emergent wetlands with tall, dense cattails and tules, but also in thickets of willow, blackberry, wild rose, and tall herbs (Zeiner et al. 1990). The usual breeding season is mid-April into late July, however active breeding may occur in October and November in the Sacramento Valley.

Great Blue Heron

The great blue heron is a California Species of Special Concern. The protection afforded them is directed at the birds' nest sites. No critical habitat has been designated for the species.

Great blue herons occur throughout most of North America as far north as Alaska. In California, they are year-round residents throughout the State with the exception of the desert habitats and the highest mountain elevations. It is a fairly common bird in California, often observed along shorelines of ponds, lakes and streams, as well as in crop- and grasslands (Small 1994).

The great blue heron is large grayish shorebird almost four feet in length. The bird is an opportunistic feeder, although 75 percent of its diet is fish (Zeiner 1990). Other prey includes various amphibians and reptiles common around aquatic habitats, but also hunts small mammals in grasslands and irrigated fields, earning its layman's name of mouse stork; on occasion it will eat small birds as well (Zeiner 1990).

Great blue herons nest mainly in colonies, usually in tall stands of oaks, cottonwoods and eucalyptus. These stands are typically associated with riparian habitat adjacent to swamps, rivers, sloughs, lagoons, estuaries, and lakes. They are often found nesting in mixed flocks with other herons and egrets. They arrive at their nesting grounds in February and eggs are laid shortly thereafter and into March (Zeiner 1990). The eggs, usually numbering 3-4, hatch in 28 days, and the young typically fledge by July.

It is unclear to what extent the great blue heron population has declined. Foraging area may have increased with the development of irrigated cropland

and reservoirs. It is likely, though, that nesting habitat has decreased dramatically from its historical levels, as the vast majority of California's riparian vegetation was lost throughout this century. Surveys indicate that the population actually increased between 1970 and 1978 (Zeiner 1990).

White-faced Ibis

The white-faced ibis (*Plegadis chihi*) is currently a California Species of Special Concern. No critical habitat is designated for this species.

White-faced ibis mostly breed in the western United State, Mexico and southern South America, but also in Florida and Louisiana (Ryder 1967). Their range has been reduced this century because of habitat loss, direct human activities, and heavy pesticide use (especially in Texas). The population and breeding range of white-faced ibis, in California especially, have undergone substantial reduction due mostly to wetland habitat loss and human disturbance (Ryder 1967). There is however, indication that white-faced ibis may be re-occurring in portion of California where irrigated agricultural fields have replaced former habitat. Small numbers of white-faced ibis breed in the Sacramento-San Joaquin Delta and Sacramento and northern San Joaquin valleys. Small numbers also winter in portion of southern and northern California including the Sacramento-San Joaquin Delta area.

White-faced ibis typically breed in mixed colonies of conspecifics, herons, and egrets, but may also share colony sites with ducks and gulls (Palmer 1962). Nest densities can be relatively high, averaging as little as one meter from the nearest neighbor. Nesting primarily occurs in dense bulrush and cattail marshes where nests are floated over water. Breeding may also occur in dry land habitats where nests area typically placed on the ground (Burger and Miller 1977). Reproductive success in dry land colonies may, however, approach zero in some colonies due to nesting predation. Foraging habitat in both the breeding and nonbreeding seasons occurs in marshes and irrigated fields, including rice fields, where the birds probe the soil for aquatic invertebrates and earthworms. Winter roosts are often also in dense deep-water marshes (Ehrlich and others 1988).

White-faced ibis may use the same nesting sites repeatedly for years, especially in marshes (Ehrlich and others 1988). Other sites may only be used intermittently. In dry years breeding may be postponed until the following year. Novel breeding sites will also be used should conditions become favorable. For example, approximately 700 white-faced ibis nested in a sugar plant's wastewater pond in Yolo County in 1990 adjacent to extensive rice fields that the birds used for foraging.

Post breeding dispersal is common at many colonies, probably due to substantial reduction of the food base during the nesting season (Ryder 1967). White-faced ibis wander in fall and winter throughout the west, sometimes through several states, stopping in marshes and irrigated areas to forage.

Short-eared Owl

The short-eared owl (*Asio flammeus*) is a California Species of Special Concern. No critical habitat has been designated for this species.

The short-eared owl is a widespread winter migrant, found primarily in the Central Valley, in the western Sierra Nevada foothills, and in the southern desert region. It is usually found in open areas with few trees, such as annual and perennial grasslands, prairies, dunes, meadows, irrigated lands, and saline and fresh emergent wetlands. It occasionally still breeds in northern California (McCaskie and others 1988). Numbers have declined over most of the range in recent decades because of destruction and fragmentation of grassland and wetland habitats and grazing (Remsen 1978).

The short-eared owl feeds primarily on voles and other small mammals (Earhart and Johnson 1970). Birds are an important food source in coastal wintering areas, and in nesting season. The owl also eats reptiles, amphibians, and arthropods. The short-eared owl requires dense vegetation for cover. Tall grasses, brush, ditches, and wetlands are used for resting and roosting cover (Grinnell and Miller 1944). It nests on the ground in depressions concealed in vegetation, and lined with grasses forbs, sticks, feathers, and occasionally burrows.

Migrants usually arrive in California in September or October, and leave in April. The owl concentrates in winter areas where prey is abundant, and snow cover is scant or absent (Bent 1938).

Mammals

Small-footed Myotis Bat

The small-footed myotis bat (*Myotis ciliolabrum*) is listed by the USFWS as a Species of Special Concern. No critical habitat has been designated for this species.

Four subspecies of *M. ciliolabrum* occur in the United States, while only one species, *M.c. melanorhinus*, occurs in California (Hall 1981). The small-footed myotis bat is found throughout California, except from San Francisco north through Oregon, and from the coast east to mid California.

The small-footed myotis bat is a common bat of arid uplands in the upper Sonoran and transition life zones of California. It occurs along the southern half of the California coast and the west and east sides of the Sierra Nevada to about 2700 m. The small-footed myotis bat occurs in deserts, chaparral, riparian zones, and western coniferous forests; it is most common above pinion-juniper forest. It may occur in the Delta area for brief periods during migration.

The small-footed myotis bat forages early in the evening while flying over water and among trees. It feeds on a variety of small flying insects, including moths, flies and beetles. It can be found drinking shortly after night emergence. The small-footed myotis bat can be found roosting singly or in small groups, in caves, mines, buildings, cliff and rock crevices, and sometimes under bark and bridges, preferring more humid areas. Copulation takes place in the fall. Females form small maternity colonies and bear a single young from May through June. Young are usually able to fly by mid-August. This bat has a very high tolerance for cold, hibernates from November to March (Zeiner 1990), and may make small movements in hibernating sites.

Yuma Myotis Bat

The Yuma myotis bat (*Myotis yumanensis*) is listed by the USFWS as a Species of Special Concern, and is identified by DFG as a California Species of Special Concern. No critical habitat has been designated for this species.

This bat is common in California and found throughout the State, except in the Mojave and Colorado deserts of southeastern California. It occupies a variety of habitats below 3.300 m, but is rare above 2,560 m (Zeiner 1990). This species is comprised of six subspecies, four of which occur in California (*M.y. saturatus, M.y. oxalis, M.y. sociabilis, M.y. yumanensis*).

The Yuma myotis bat occurs in a variety of habitats including riparian, arid scrublands and deserts, and open forests and woodlands. It emerges soon after sunset. It feeds primarily on aquatic emergent insects (WBWG 1998). Roosts may be found in buildings, mines, caves, or crevices (Zeiner 1990).

The Yuma myotis bat hibernates in some areas and may make short seasonal migrations from higher elevations to preferred hibernacula. It can form large maternity colonies of several thousands in buildings, caves and bridge structures. This bat mates in the fall and bears one young between late May to mid-June. The Yuma myotis bat has been found roosting with other bats including pallid and mexican free-tailed bats. Individuals are known to have lived up to 8.8 years (Zeiner 1990).

2.3 Agricultural Resources

The Delta is an important agricultural area. Historically, the area was noted for its truck crops, such as asparagus, potatoes, and celery, but since the 1920s, there has been a shift toward lower valued field crops. Corn, grain, hay, and pasture currently account for more than 75 percent of the region's total production. The change has been attributed mainly to market conditions, although changes in technology and growing conditions also have played a role. Delta farming produces an average gross income of about $375 million (Source: Draft Environmental Impact Report/Environmental Impact Statement, North Delta Program, DWR, Sacramento, 1990).

Agriculture is a major industry in the Delta, as demonstrated by the San Joaquin County General Plan. The State of California Farmland Conversion Report (1988 to 1990) indicates that 265,902 (51 percent) of Alameda County's 524,452 acres; 291,060 (57 percent) of Contra Costa County's 514,466 acres; and 788,896 (86 percent) of San Joaquin County's 912,329 acres were in agricultural production in 1990.

As an example of the breakout of agricultural production by crop type, the highest percentage of acreage in the southern Delta is used for alfalfa (26 percent), followed by grains (16 percent), tomatoes (14 percent), and sugar beets (10 percent) (DWR 1993). San Joaquin County usually ranks among the top ten counties in California for agricultural production (County of San Joaquin 1992). Much of the agricultural success of the region can be attributed to the area's rich, productive soils and active preservation of prime agricultural lands.

2.4 Utilities and Service Systems

Water-Related Infrastructure

Most water conveyance facilities in the Delta have been developed under the authority of the federal government's Central Valley Project (CVP) and California's State Water Project (SWP). As part of CVP development, exportation of water from the Delta began in 1940 with the completion of the Contra Costa Canal. Other major federal units were completed during the early 1950s, including the Delta-Mendota Canal and the Delta Cross Channel (DCC). The DCC transfers water across the Delta from the Sacramento River to the Tracy Pumping Plant, which serves the Delta-Mendota Canal. Numerous SWP facilities have been developed in the Delta, including the Harvey O. Banks Delta Pumping Plant, the California Aqueduct, and the North Bay Aqueduct (NBA).

Water conveyance infrastructure consists of many agricultural, industrial, and municipal diversions for supplying water to the Delta itself and for export by the SWP and CVP. Diversions and conveyance require canals, waterways, levees, siphons, pumps, radial gates, and other miscellaneous infrastructure. Municipal and industrial demands in the Delta are met by conveying water through the Contra Costa Canal to the cities of Martinez, Antioch, and Pittsburgh and to numerous industrial complexes in the vicinity.

Natural Gas Infrastructure

Natural gas was discovered in the Delta region in 1935 and has since been developed into a significant source supply and depot for underground storage. Gas fields, pipelines, underground storage areas, and related infrastructure are located in the Delta. Infrastructure consists mainly of pipelines and storage facilities owned by oil and gas companies, public utilities, and various independent leaseholders.

Public Services

Police protection is provided by various departments within the cities and counties of the Delta Region. For example, the San Joaquin Sheriff's Department marine patrol division provides water patrol services to approximately 600 square miles of waterways in the Delta area. The Contra Costa County Sheriff's Department provides law enforcement services in the area . Fire protection service is provided by various departments in the Delta area, including the San Joaquin County Delta Fire Protection District and the Contra Costa Fire Protection District. Volunteer firefighters are also to respond to fire emergencies as needed. Fire suppression in areas not under the jurisdiction of a fire protection district is the responsibility of the landowners. Emergency services are provided by cities and counties in the region.

Electric Utilities and Communication Infrastructure

Power transmission facilities have developed with the population growth of various communities surrounding the Delta. Pacific Gas and Electric and the Western Area Power Administration have developed power transmission lines across the Delta islands and waterways. Many of the corridors are within the periphery of the Delta upland areas, including several natural gas-fired plants. Power-generating facilities are absent from the central Delta. Communication infrastructure in the region includes underground cable and fiber optic lines, and communication/transmission towers.

White Slough Bridge

2.5 Hazards and Hazardous Materials

Health Hazards

The Delta is a source of drinking water for approximately 20,000,000 Californians, and as such Project-induced changes in water quality may affect the quality of drinking water. Trihalomethanes (THMs) are a group of Water disinfection by-products which are potentially carcinogenic, and are regulated by the U.S. Environmental Protection Agency. Organics and bromides, derived from the Pacific Ocean and agricultural drainage, promote formation of THM's when water is treated by chlorination prior to distribution (Amy et al., 1990). Both the trihalomethane formation potential of exported Delta waters, and the method of disinfection determine the THM content of the drinking water.

Hazardous Materials and Waste

In the Delta Region, hazardous waste sites associated with agricultural production activities include storage facilities and agricultural ponds or pits contaminated with fertilizers, pesticides, herbicides, or insecticides. Petroleum products and other materials may be present in the soil and groundwater near leaking underground tanks used to store these materials. Leaking or abandoned pesticide storage containers also may be present on farmland. Water from agricultural fields on which fertilizers and pesticides are applied may drain into ponds, and rinse water from crop duster tanks and other application equipment routinely is dumped into pits. Evaporation can increase chemical concentrations in pond water and cause chemicals to be deposited in underlying soil. Surface water percolation can pollute groundwater and expand the area of soil contamination.

Spills and leaking tanks or pipelines from industrial and commercial sites also can be sources of contaminants, such as petroleum hydrocarbons and polychlorinated biphenyls from old electrical transformers.

2.6 Transportation and Traffic

The Delta region is serviced by several major freeways. I-5 and State Route 99 (SR 99) run north-south through the region while 1-80 and U.S. 50 run east-west through Sacramento. Other minor highways run from Sacramento and Stockton to small cities and towns in the region. New roadway networks have facilitated growth and urbanization along their corridors.

The immediate project area is rural in nature and is generally served by paved two-lane county-maintained roads, as well as paved and unpaved single-lane privately-owned and maintained roads. These rural roads provide local access to individual properties, and access to State and Interstate Highways in the project area. All of roadways will be important travel routes for personnel and equipment requiring access to and from proposed EDCP control sites. State and Interstate Highways support greater average daily traffic (ADT) than rural roadways. Although, seasonal use of rural roadways for agricultural and recreational purposes can increase ADT volumes above those observed during the "off season". Common travel routes leading to proposed treatment sites in the Delta would include unpaved, single-lane, agricultural access roads and unpaved, single-lane, levee maintenance roads atop public and privately-maintained levees.

Rail lines servicing the Delta region are the Southern Pacific; Western Pacific; Atchison; and Topeka and Santa Fe (ATSF) lines. These lines run from Sacramento to Stockton, with the Southern Pacific line extending from these major dries to other smaller cities in the Delta region.

Commercial shipping routes originating at the Golden Gate traverse the San Francisco Bay, San Pablo Bay, Suisun Bay, and Delta waterways, continuing to commercial and industrial ports. In the Delta region, commercial and industrial ports are situated along rivers. Two ports are located along the Sacramento River between Sacramento and Walnut Grove. Another commercial port is at Isleton, also along the Sacramento River. An additional commercial port is near Terminous, on the Little Potato Slough; and two ports are adjacent to one another the Old River and Middle River, northeast of Brentwood. Finally, a commercial port, the Port of Stockton, is located in Stockton on the San Joaquin River.

The waterways of the Delta serve both commercial and recreational vessels. Deep draft ocean-going vessels are restricted to the Stockton Deep Water Ship Channel and the Sacramento Deep Water Ship Channel, which serve the inland ports of Stockton and Sacramento. These dredged channels provide access to vessels drawing up to 35 feet. Approximately five million tons of cargo are handled annually by the two ports. While both of these deep water channels exist within the project area, they are not expected to receive any treatment for the control of *Egeria* due to the fact that the plant does not grow in depths greater than 15 feet. The majority of waterways in the project area are small to medium size sloughs and channels navigable by small craft. These smaller sloughs and channels are the waterways most affected by *Egeria* growth, and therefore will be targeted for weed control treatments to maintain their navigability.

Recreational vessels using these waterways range from rowboats and personal watercraft to large houseboats and cabin cruisers. Smaller commercial vessels found in the project area include towing and salvage vessels, clamshell dredges, dredges for repair and maintenance of levees and channels, and pile driving vessels. Navigation within the project area is facilitated mainly by the individual boater's knowledge and familiarity with the area, supplemented by published sources of information and occasional aids to navigation. Navigational charts are available commercially and timely local information is published by the U.S. Coast Guard (USCG) in the Notice to Mariners. Aids to navigation such as buoys and day markers, both USCG and privately maintained, are present in some heavily used areas.

Agricultural and agriculture-related activities occupy much of the Delta region. The coastal lowlands support considerable high-value fruit and vegetable farming, while the drier inland lowlands specialize in livestock and dry-farmed grains.

2.7 Recreation

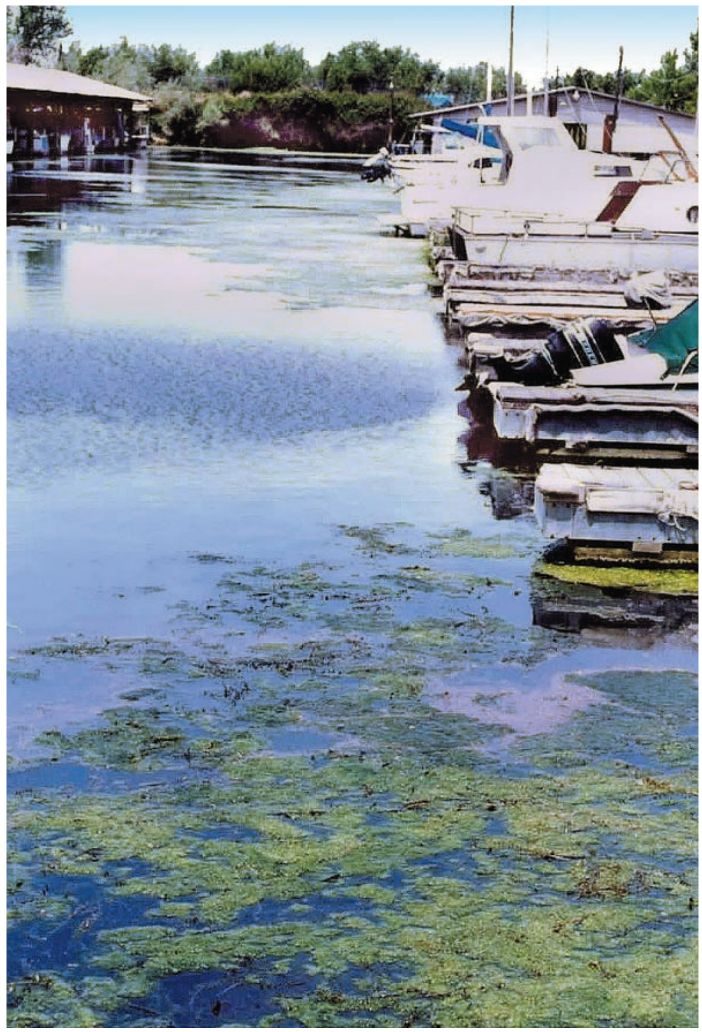
The Delta is a unique natural resource supporting a variety of recreational activities and attracting large numbers of recreationists because of its aesthetic beauty, wildlife, unique waterway systems and temperate climate. Recreational resources of the Delta serve the increasing populations of several areas: the Sacramento metropolitan area to the north, the San Francisco Bay Area to the west, and the Stockton/Tracy/Modesto region to the east and south. The Delta's proximity to these major population centers enhances its growing popularity. Recreation in the Delta, mostly water-oriented (including both water-dependent and water-enhanced activities), currently exceeds 12 million user-days annually and is expected to increase concurrent with the populations of surrounding areas (SLC, 1991).

Waterways are an obvious recreational resource in an area with long, hot, and dry summers, and the Sacramento-San Joaquin Delta's approximately 50,000 acres of water surface and nearly 1,100 miles of leveed shoreline present many recreational opportunities, of which boating and fishing are the most popular (Ebasco 1988). Although located predominantly in the northern Delta, recreational facilities are distributed throughout the region and can generally be grouped into: commercial and public. Recreational facilities, including marinas, boat launches, parks, picnic areas, and campgrounds, are commonly associated with commercial establishments, including boat and recreation equipment rentals, gas stations, restaurants, boating supply stores and repair shops.

Although the Delta environment has been extensively altered by reclamation and development over the last 125 years, natural and aesthetic values remain that make it a valuable and unique recreational asset. Waterfowl and wildlife are still abundant, sport fishing is still popular, and vegetation lining the channels and islands is still attractive. As a result, the miles of channels and sloughs that interlace the area attract a diverse and growing number of people seeking recreation. Recreational use of the estuary is probably higher than for any other area of similar size in California.

Delta recreationists enjoy an assortment of water-dependent and water-enhanced activities, such as boating, fishing, water skiing, swimming, camping, picnicking, hiking, bicycling, hunting, and scenic and wildlife observation. Boating is the single most popular pastime in the Delta, accounting for approximately 17 percent of all visits, followed by fishing (15 percent), relaxing (12 percent), sight-seeing (11 percent), and camping (8 percent) (USBR, 1994). Sport fishing in the Delta is a year-round activity, involving use of private watercraft and commercial passenger-carrying fishing vessels, as well as fishing along the shore. Important sport fish in the region include striped bass, white sturgeon, chinook salmon, and American shad (DWR 1993; USBR 1994).

About 20 public and more than 100 commercial recreational facilities in the Delta provide rentals, services, camping, guest docks, fuel, supplies, and food. Use of these facilities continues to grow.



Big Break Marina

2.8 Air Quality

The primary factors affecting air quality in the Sacramento-San Joaquin Delta are locations of air pollutant sources, amounts of pollutants emitted, and meteorological and topographical conditions affecting their dispersion. Atmospheric conditions including wind speed, wind direction, and air temperature gradients interact with the physical features of the landscape to determine the movement and dispersal of air pollutants. Effects of the local topography and the continuous interaction of maritime and continental air masses provide a varied Delta climate.

Prevailing winds in the Bay Area during summer are from the west and northwest, reinforced by an inland movement of air caused by the solar heating of the air masses in the Central Valley. This heating effect is greatest during the day and causes a marked diurnal, as well as a seasonal, pattern in wind speed. These prevailing winds are strongest at the Carquinez Strait. In the Delta, such winds often blow continuously day and night, and are generally from the west to southwest direction. Winds reach peak speeds of 10 to 15 miles per hour in the early evening. Summer airflow at Stockton is strongest in the afternoon, and throughout the day generally blows from the west to northwest direction.

Topography and climate have great effects on the area's air quality. Relatively light winds, surrounding higher terrain, and frequent warm temperatures can create ozone. In winter months, high atmospheric stability, calm winds, and cold temperatures combine to create ideal conditions for buildup of pollutants such as carbon monoxide (CO) and fine particulate matter (PM10).

The Delta climate is relatively mild and has a long growing season. In general, like most of California, the area has a Mediterranean climate. The Delta is influenced by both inland and coastal climates. Inland central California typically has hot, dry summers and cool, wet winters. Along the coast, the climate is dominated by the Pacific Ocean and has warmer winters and cool, foggy summers. Precipitation varies within the area from about 10 to 60 inches annually and also fluctuates seasonally.

High winds often blowing night and day are common throughout the project area. The high winds cause basinwide circulation patterns that superimpose on the tidal circulation patterns. Wind-generated waves resuspend sediment, oxygenate water, and disperse matter and organisms throughout the Delta.

2.9 Mineral Resources

Sand and gravel are the primary mineral resources of the Delta. The Delta also serves as an important natural gas source. Natural gas was discovered in the Delta Region in 1935 and has since been developed into a significant source supply. Additionally, the Delta is utilized as an underground storage area for natural gas.

2.10 Noise

The proposed project would be located in the Sacramento-San Joaquin Delta, within the jurisdiction of Solano, Yolo, Sacramento, Contra Costa, and San Joaquin counties. Noise levels in these areas are primarily dependent upon the type of noise source, the distance to the noise source, and to a lesser extent wind direction, wind speeds, and atmospheric temperature profiles. Noise levels are expressed in decibels (dB), with 0 dB roughly corresponding to the hearing threshold. An evaluation of noise impacts considers all sound frequencies, with an adjustment to reflect that human hearing is less sensitive to low and high frequencies. The human adjusted noise levels are designated as A-weighted sound levels (dBA).

Agricultural machinery, boating and personal watercraft traffic, and vehicular traffic generate the principal sources of noise in the project area. Areas near high intensity agricultural operations, marinas, popular recreational locations, and high-volume roadways tend to have the highest levels of noise.

Noise-sensitive receptors generally are considered residences, hotels, hospitals, schools, libraries, churches, parks, nursing and convalescent homes. Commercial and industrial land uses, by contrast, tend to be less sensitive to noise due to relatively high ambient noise levels during daytime hours.

Residential uses are the only noise-sensitive uses found near sites of proposed project activity. The project area is generally rural agricultural land with very minor residential development. Most residences in the project area are isolated, single family dwellings, often associated with agricultural operations. Discovery Bay, Bethal Island, Hotchkiss Tract/Sandmound Slough, and Fourteenmile Slough represent the only localities in the project area with low to moderate residential development. Marinas in the area are commonly associated with boating-related businesses, including boat rentals, gas stations, restaurants, boating supply stores and repair shops. Also, certain marinas allow "live aboard" residents whose presence collectively would constitute a very low-density residential development.

2.11 Geology and Soils

The geology of the Sacramento-San Joaquin Delta is contiguous with that of the Sacramento River Basin. On the surface, the Delta is composed of a variety of soil types, ranging from mineral alluvial fan deposits around the edge to organic peat soil in the center. Soils are dominated by silts, clays, silty clays, and sandy soils. The organic peat soils reach depths of more than 20 feet, a result of thousands of years of deposition of tule marsh vegetative debris (California State Lands Commission, 1991).

Beneath these organic soils is a thick sequence of sedimentary materials deposited in both marine and nonmarine environments. The upper, nonmarine portion attains a maximum thickness of about 3,000 feet. Materials in this portion consist of volcanics transported as mudflows and fragmental rock eroded from the surrounding mountains and transported by stream action. As these were deposited, the structural trough of the Sacramento Valley gradually down-warped or subsided. As a result, a large volume of material accumulated without significant changes in surface elevation. Fresh groundwater occurs in the void spaces between these granular materials and saline water underlies the fresh water.

Alluvial fans and stream channel, flood plain, and flood basin deposits represent the most recently deposited materials and the important water sources. They are relatively thin, but most contain highly permeable materials. Stream channel and flood plain deposits consist of well-sorted sand, gravel, and silt adjacent to the major streams. Flood basin deposits are the finest-grained materials, consisting mostly of clay and silt. Five major flood basins occupy large areas adjacent to the Sacramento River. Their deposits are thin and poorly permeable and, therefore, unimportant for groundwater development, but the older alluvium underlying the basin sediments often contains highly productive aquifers, particularly in the north valley.

The Delta encompasses 1,153 square miles. It has about 1,100 miles of shoreline and 700 miles of waterway surrounding the 60 major leveed islands. Many Delta islands are small and unleveed. There are slightly less than 900 islands and islets Delta-wide which total about 450,000 acres. Originally, the elevation of the Delta was close to mean sea level, except for a few places that rose 10 or 15 feet above sea level. Sod removal, wind erosion, and agricultural practices and peat soil oxidation have contributed to land subsidence. Elevations now range from 5 feet above to 20 feet below sea level with an average of 10 to 15 feet below sea level.

2.12 Land Use and Planning

Before 1920, few records were kept of urban land development (urban acreage calculations) in California. Generally, urban development in the Delta Region began in the early 1900s, following construction of the railroads and as the San Francisco Bay and southern California geographic regions were developing into urban centers. Urban development includes residential, industrial, commercial, and other urban uses.

Land use in the Delta shifted dramatically in the 1850s, after the federal Swamp and Overflowed Lands Act was passed. This legislation allowed the Delta wetlands to be reclaimed, which they were, primarily for agricultural use. Between 1920 and 1950, another land use shift from agricultural to urban began. As in other parts of California, private water development projects by cities and utilities assisted in the urban expansion.

Urban expansion in the Delta Region continues. For example, between 1976 and 1993, urban land in the Delta increased by approximately 23,000 acres. In 1993, about 44,000 acres of land in the Delta were classified as urban land, and 83,000 acres were classified as native land. Since 1976, approximately 12,000 acres of native land were developed for urban uses.

The western Delta includes some important industrial areas in eastern Contra Costa County. Delta water also is supplied to a number of cities, including Antioch. Western Delta municipal and industrial water users obtain water either directly from channels or from Contra Costa Canal, a Central Valley Project facility that diverts from Rock Slough. The Contra Costa Water District is the water distribution authority for Contra Costa Canal. Direct diverters obtain supplies from the San Joaquin River and adjacent channels off the Contra Costa County shoreline in the Antioch-Pittsburg area, but they can also take water from Contra Costa Canal if offshore water is unsuitable.

The extensive industrial complex adjacent to the San Joaquin River in the Antioch-Pittsburg area depends on the availability of large quantities of water for processing and cooling. The industries have three possible Delta water sources:

- Water diverted directly from the San Joaquin River or New York Slough.
- Raw water purchased from the Contra Costa Water District conveyed via the Contra Costa Canal or, in the Pittsburg area, pumped from Mallard Slough.
- Treated water purchased from municipal purveyors, who obtain their raw water from the Contra Costa Canal or a San Joaquin River diversion.

Industry in Contra Costa County is diverse. With miles of waterfront linking ocean, river, and overland transportation facilities, the area offers many advantages to heavy industries that require large supplies of cooling and processing water, large land areas, and access to a deep-water ship channel. Major industries requiring the greatest amounts of water are petroleum and coal products, paper and allied products, chemicals and allied products, primary metal industries, and food and related products. The exceptionally high water needs of the petroleum refineries are now largely met with brackish supplies from the south shores of San Pablo and Suisun bays.

The Contra Costa Water District provides the municipal water needs of about 300,000 county residents. Of the nine Bay Area counties, Contra Costa Country is projected to experience the most rapid population growth. The growing trend toward municipal water use increases the need for both improved water quality to meet State and Federal standards and improved system reliability to meet peak water demands.

2.13 Public Services

The proposed project would not impact Public Services. Therefore, a discussion of Public Services in the Environmental Setting is not required to establish the baseline physical conditions.

2.14 Population and Housing

The proposed project would not impact Population and Housing. Therefore, a discussion of Population and Housing in the Environmental Setting is not required to establish the baseline physical conditions in the Delta.

2.15 Cultural Resources

The Sacramento-San Joaquin Delta area has been intensively studied for over a hundred years. Archaeological sites also include remains from prehistoric period activities. Chronological periods identified for Central California prehistory (Early, Middle, and Late) are defined primarily on distinctive funerary patterns and artifacts. Various regional cultures also have been identified (Heizer 1949; Gerow and Force 1968; Fredrickson 1974; Wallace 1978a; Elsasser 1978). These regional cultures are seen over time with increasing dietary dependence on fish and acorns.

Fossils may occur in various sedimentary deposits. Spencer (1989) reviewed known finds in the Sacramento-San Joaquin Delta. Numerous fossils have been found around the Delta, but only five vertebrate fossil finds were noted for the Delta proper (West 1994). West checked records at the Museum of Paleontology, University of California, Berkeley. No new vertebrate finds had been recorded since Spencer's study. Delta sediments contain Holocene micro- and macrofossils of paleoecological interest, but sediments at proposed construction sites are too badly disturbed to be useful (West 1977, 1994:34). The Delta is generally of low sensitivity for vertebrate paleontology. Significant finds are possible, but unlikely.

2.16 Aesthetics

The Sacramento-San Joaquin Delta spans a vast low-lying flat area at the confluence of the Sacramento-and San Joaquin rivers. Lands in the Delta region are frequently characterized as two distinct geographic and visual components: the lowlands, which consist of generally flat lands ranging in elevation from below sea level to about 10 feet above mean sea level (msl); and the uplands, a gently sloping alluvial plain rising from about 10 to 100 feet msl and forming a transition between the Delta lowlands and the inland hills of the Mount Hamilton, Altamont, and Mount Diablo ranges. Vistas throughout the Delta region incorporate an assortment of man-made features, but vary substantially between the Delta lowlands and uplands.

The Delta presents an image of managed landforms and water bodies extensively altered from its natural state. Man-made waterways, levees, and other evidence of human activity dominate the landscape, suppressing its original character, particularly within the context of foreground views near water development facilities and agricultural uses. Characteristic features set the man-made channels apart from the natural rivers. Unnatural attributes such as diversion structures, regular, evenly-sloped and riprapped banks, and uniform, often straight courses distinguish many of the dredged waterways. In some instances the contrasts between man-made and natural channels are less noticeable, caused by differences in line and scale rather than the intrusion of unnatural features. Due to the vegetation growing along their banks, many of the watercourses created during the reclamation process now blend visually with the natural channels of the original rivers. At close range, rural residential and agricultural uses form orderly rows and gridlike patterns on the landscape, clearly denoting human influences. However, due to the lack of buildings and extensive nature of most farms in the region, few artificial sources of light and glare are visible, adding to the rural character of the area. Consequently, man's imprint on the background is less obvious, as distance blends these features with the natural character of the Delta.

Overall, views in the Delta lowlands are fairly homogeneous. The region exhibits little topographic variation. Foreground views consist of immense areas of relatively flat agricultural land interspersed with levees, canals, rivers, occasional scattered clusters of trees, and occasional tracts of rural residential and commercial uses. With the exception of scattered trees, vegetation consists mostly of large agricultural expanses with almost indistinguishable differences in form, texture, and color. Numerous rivers and canals add complexity to the unvaried nature of the rural landscape. Wetlands and areas of riparian vegetation are evident along many waterways, and man-made levees furnish most vertical relief within the lowlands. Except the large community of

Discovery Bay, residential land uses are sparse and generally associated with farm operations. The uniform topography of the Delta lowlands renders few features visible in the middle-ground; however, on clear days, the Sierra Nevada and the Mount Hamilton, Altamont, and Mount Diablo ranges are noticeable in the eastern and western backgrounds, respectively.

Variations in vegetation, landforms, waterforms, and development patterns create a distinct contrast between the appearance of the upland plain and that of the lowlands. In the upland plain, natural vegetation has been largely replaced or altered by agricultural, residential, and commercial land uses. Typical vegetation apparent in undeveloped areas consists of grasslands, some scattered oaks, and a few riparian areas. Orchards and row crops increase the diversity of the upland landscape. Landforms evident in the Delta uplands and surrounding areas include broad slopes leading up to the rounded hills and ridges of eastern Alameda and Contra Costa counties. These ridgelines dominate background views from much of the region. Upland water forms include rivers and streams, agricultural ponds, and drainage/irrigation canals, but are less frequent than in the lowlands. Larger communities of rural to low-density residential development are associated with the uplands and divide their surroundings.

End of White Slough