4.2 BIOLOGICAL RESOURCES

Section 4.2 presents the existing environment and impacts analysis of biological resource issues associated with the granting of a new lease to the Amorco Marine Oil Terminal (Amorco Terminal) to continue to operate in the southeastern Carquinez Strait. The existing biological resources in the San Francisco Bay Estuary and in the Amorco Marine Oil Terminal Lease Consideration Project (Project) study area (lower Suisun Bay and upper Carquinez Strait) are described, as well as in the immediate vicinity of the Amorco Terminal. Also included is a summary of laws and regulations that may affect biological resources. This is followed by an analysis of the potential Project impacts. Routine operations at the Amorco Terminal, or an accidental release of oil, present the potential to impact nearby biological resources. An oil spill could have wide-ranging effects on biological resources in the San Francisco Bay Estuary.

4.2.1 ENVIRONMENTAL SETTING

4.2.1.1 San Francisco Bay Estuary

Geographic and Hydrologic Characteristics of the San Francisco Bay Estuary

The San Francisco Bay Estuary is typically divided into five segments: The Sacramento-San Joaquin River Delta (Delta), Suisun Bay, San Pablo Bay, Central Bay, and South Bay (see Figure 4.2-1).

The Delta is the easternmost, or most upstream, segment. The Delta is a 1,150-square-mile triangle-shaped region roughly bounded on the north by the city of Sacramento, on the south by the city of Tracy, and on the west by Chipps Island. The Sacramento and San Joaquin Rivers and their tributaries flowing into the Delta drain about half of the surface area of California and establish the extent of brackish water habitat in Suisun Bay.

Suisun Bay is a shallow estuarine bay bounded by Chipps Island on the east and the Benicia-Martinez Bridge on the west. Suisun Marsh, the largest brackish water marsh in the United States and the largest wetland in California, forms its northern boundary. Suisun Bay has the lowest salinity levels in the San Francisco Bay system, with values ranging from oligohaline (0.5 to 5.0 parts per thousand [ppt]) to mesohaline (5.0 to 18.0 ppt) depending on seasonal variations in tides, evaporation, and freshwater inflows from the Delta. The southern shore of Suisun Bay is home to the Concord Naval Weapons Station and the cities of Pittsburg, West Pittsburg, Avon, and Martinez. Suisun Bay is connected to San Pablo Bay via the Carquinez Strait, a narrow, 12-mile-long band of water that extends from between the Benicia-Martinez Bridge to Mare Island.

San Pablo Bay is the second largest bay in the estuary; it extends from the Carquinez Strait to the San Pablo Strait near the Richmond-San Rafael Bridge, where it forms the upstream boundary of the Central Bay. San Pablo Bay is moderately saline, or polyhaline, with salinity levels ranging from 18.0 – 30.0 ppt. Much of the north shore of San Pablo Bay is protected as part of the San Pablo Bay National Wildlife Refuge.

The Central Bay is defined as an area bounded by three bridges: The Richmond-San Rafael Bridge, Golden Gate Bridge, and San Francisco-Oakland Bay Bridge. Central Bay is the coldest, deepest, and most saline of the bays; it is considered euhaline, with salinity levels between 30.0 – 35.0 ppt. Because of its proximity to the Pacific Ocean, its water quality parameters are more stable than its neighboring bays. Ecological conditions in the Central Bay are also more stable than in neighboring bays (SFEP 2011).

The waters south of the San Francisco-Oakland Bay Bridge form the largest embayment, known as the South Bay. The waters here are shallow and polyhaline. Freshwater flows to the South Bay are limited to seasonal flows from Guadalupe River and other streams. Throughout the year, the largest flows into South Bay are treated waters from the San Jose/Santa Clara County Water Pollution Control Plant (Okamoto and Wong 2011). Water circulation and fresh inflows are so limited that this bay is considered a lagoon-like, estuarine backwater.

The estuary's tidal cycle is mixed semidiurnal, resulting in two cycles each day. The average height of the higher tide is called extreme high tide, or local mean higher high water (MHHW), while the average of the high tides is called high tide, or local mean high water (MHW). Extreme low tide or mean lower low water (MLLW) and low tide or mean low water (MLW) refer to the average height of the lowest tide and the average of all low tides, respectively. Mean tide level (MTL) lies midway between MHW and MLW. Tidal highs and lows in the bay vary with time of day, the position of the moon, season, and distance from the Pacific Ocean. The relative height covered by these tidal datums have important implications for shoreline habitat.

Habitats of the San Francisco Bay Estuary

The habitats in the estuary are dynamic and can be influenced by seasonal flooding, extreme tides, drought, and human activity. Characteristics of the biotic communities at each habitat are found in Table 4.2-1. Figure 4.2-2 depicts habitat distribution in the estuary.

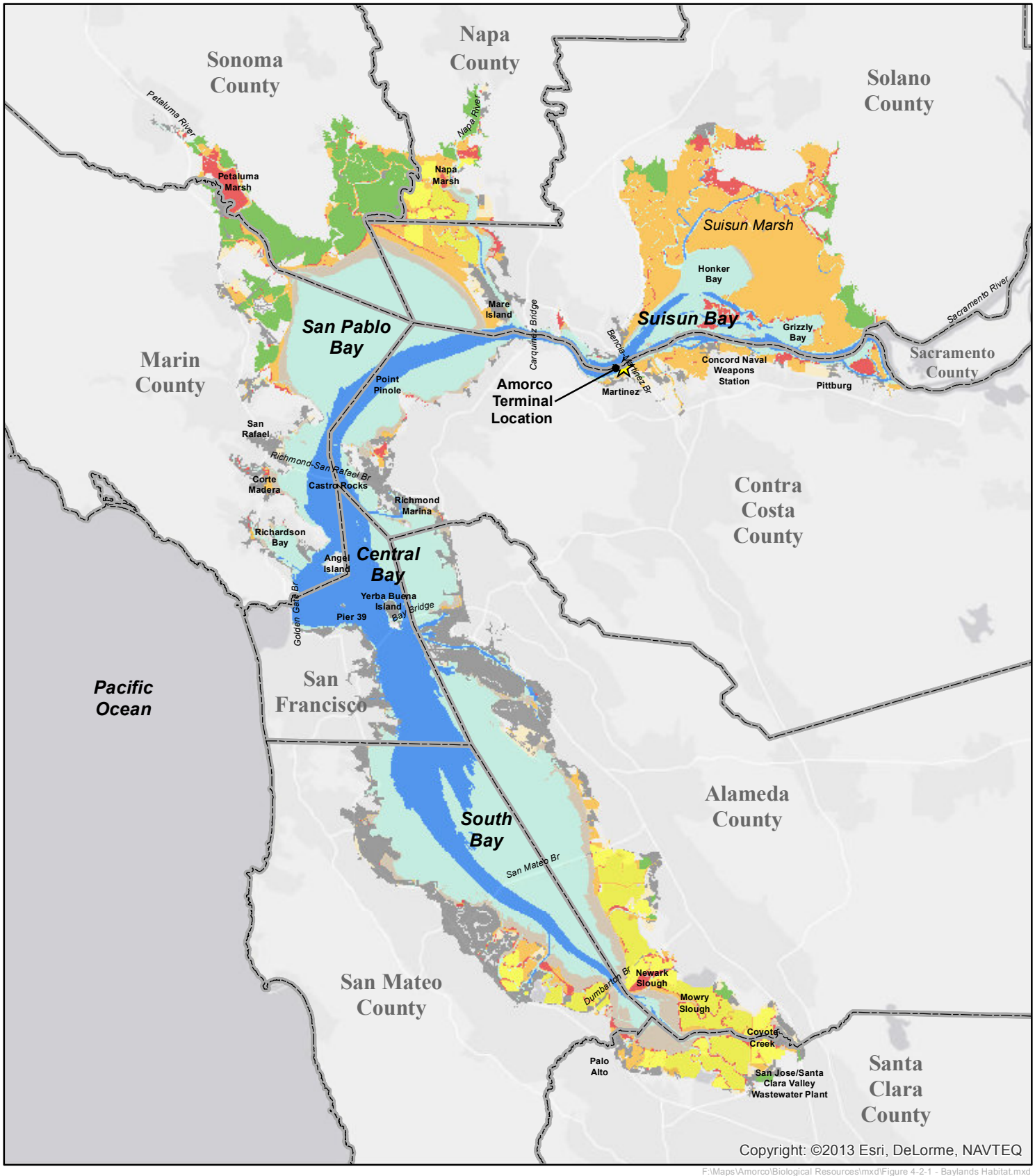

Figure 4.2-1 Bayland Habitat
California State Lands Commission
Amorco Marine Oil Terminal
Lease Consideration Project

TRC

8/21/2013

Habitat Type

- Shallow Bay
- Deep Bay
- Tidal Flat
- Old Tidal Marsh
- Tidal Marsh
- Diked Marsh
- Agricultural Bayland
- Salt Pond
- Filled Baylands

DATA: SFEI

N

1:500,000

1 inch = 8 miles

0 19,000 38,000 ft

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1 **Table 4.2-1: Biotic Communities of the San Francisco Bay Estuary[1]**

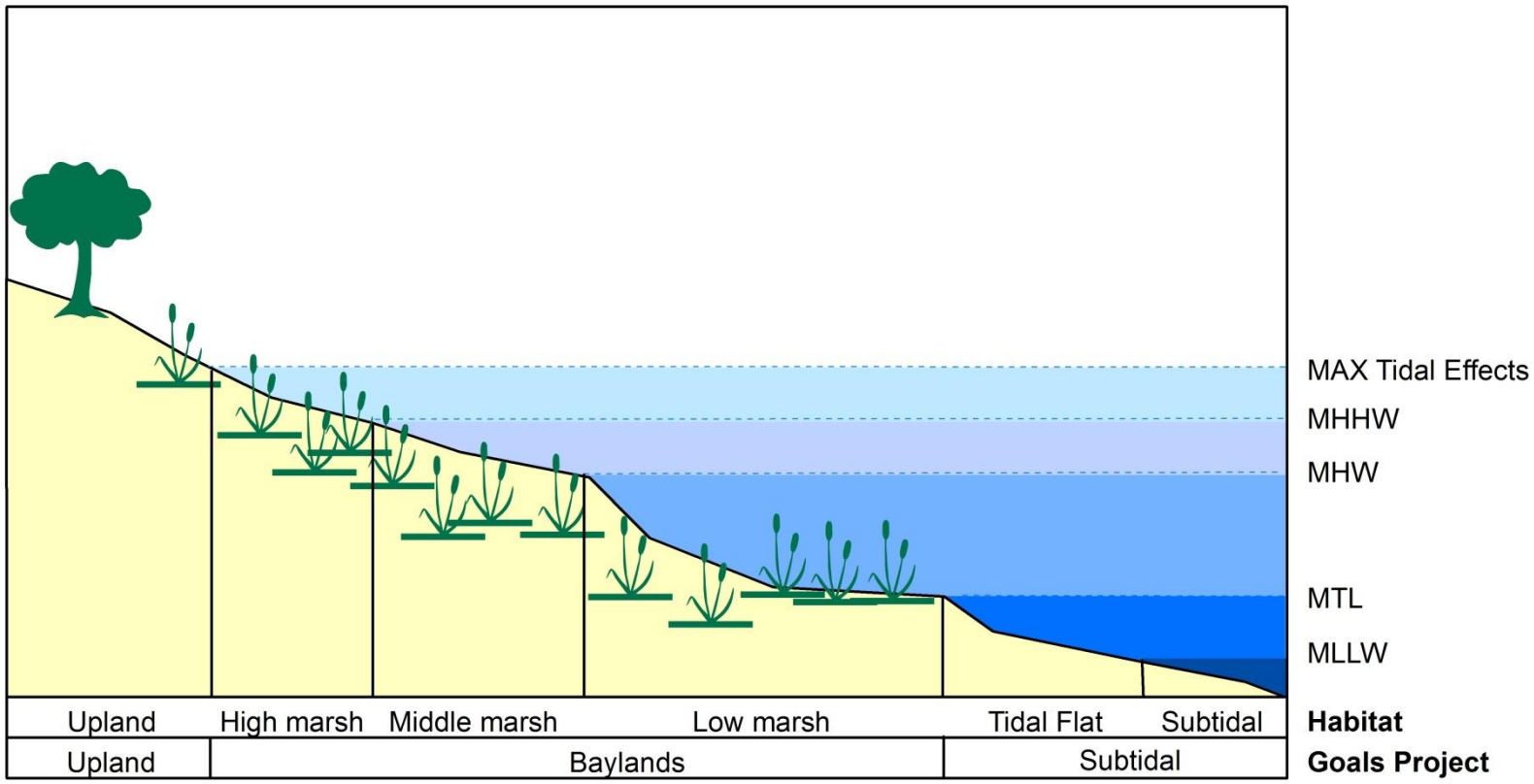
Community	Locations & Examples	Characteristic Plants	Characteristic Animals
Diadromous	Open waters of the San Francisco Bay Estuary, Sacramento and San Joaquin Rivers, Napa River	N/A	Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*Oncorhynchus mykiss*), delta smelt (*Hypomesus transpacificus*), longfin smelt (*Spirinchus thaleichthys*), striped bass (*Morone saxatilis*)
Limnetic	0 – 0.5 ppt[2] salinity. Sacramento River, San Joaquin River	Sago pondweed (*Potomogeton pectinatus*)	Asian clam (*Corbicula fluminea*)
Oligohaline	0.5 – 5.0 ppt salinity. Suisun Bay	Widgeon grass (*Ruppia maritime*)	California bay shrimp (*Crangon franciscorum*)
Mesohaline	5.0 – 18.0 ppt salinity. Suisun Bay, Carquinez Strait	Widgeon grass (*Ruppia maritime*)	Overbite clam (*Corbula amurensis*), Oriental shrimp (*Palaemon macrodactylus,* starry flounder (*Platichthys stellatus*)
Polyhaline	18.0 – 30.0 ppt salinity. Carquinez Strait, San Pablo Bay, South Bay	*Ulva, Gracilaria pacifica, Fucus, Sargassum muticum,* eelgrass (*Zostera marina*)	Blacktail bay shrimp (*Crangon nigricauda*), Dungeness crab (*Metacarcinus magister*), Pacific herring (*Clupea pallasii*), Pacific staghorn sculpin (*Leptocottus armatus*), English sole (*Parophyrys vetulus*)
Euhaline	30.0 – 35.0 ppt salinity. Central Bay	*Ulva, Gracilaria pacifica, Fucus, Sargassum muticum,* eelgrass (*Zostera marina*)	Blackspotted bay shrimp (*Crangon nigromaculata*), leopard shark (*Triakis semifasciatai*), bat ray (*Myliobatis californica*), Pacific sardine (*Sardinops sagax*), northern anchovy (*Engraulis mordax*), California halibut (*Paralichthys californicus*)

Community	Locations & Examples	Characteristic Plants	Characteristic Animals
Tidal flat	Along bay shore in San Mateo, Santa Clara, Alameda, Marin, Napa, Contra Costa, Solano counties	*Ulva spp., Gracilaria pacifica, Fucus spp., Sargassum muticum,* eelgrass (*Zostera marina*)	California bay shrimp (*Crangon franciscorum*), least sandpiper (*Calidris minutilla*), western sandpiper (*Calidris mauri*), willet (*Tringa semipalmata*)
Tidal marsh	Along bay shore in San Mateo, Santa Clara, Alameda, Marin, Napa, Contra Costa, Solano counties (e.g., Martinez marshes, Peyton Slough)	Pickleweed (*Salicornia virginica*), sea blite (*Suaeda californica*), marsh rosemary (*Limonium commune*), marsh grindelia (*Grindelia hirsutula*), California cord grass (*Spartina foliosa*)	Clapper rail (*Rallus longirostris*), marsh hawk (*Circus cyaneus*), short-eared owl, (*Asio flammeus*), salt-marsh harvest mouse (*Reithrodontomys raviventris*), vagrant shrew (*Sorex vagrans*), salt marsh fly (*Ephydra riparia*), salt marsh mosquitoes (*Aedes sqamiger, A. dorsalis*).
Coastal scrub	Dry rocky or gravelly slopes below 3,000 feet (e.g., steep slopes at the Amorco Terminal)	California sage brush (*Artemesia californica*), black sage (*Salvia mellifera*), coyote brush (*Baccharis pilularis*), bush monkey-flower (*Mimulus aurantiacus*).	Rufous-crowned sparrow (*Aimophila rucifeps*), rock wren (*Salpinctes obsoletus*), wrentit (*Chamaea fasciata*), brush rabbit (*Sylvilagus bachmani*), western fence lizard (*Sceloporus occidentalis*).
Urban shoreline	Manmade shorelines in all San Francisco Bay Area counties, San Francisco shoreline, Oakland shoreline	Himalayan blackberry (*Rubus armeniacus*), pampas grass (*Cortaderia spp.*), Bermuda grass (*Cynodon dactylon*)	House sparrow (*Passer domesticus*), rock dove (*Columba livia*), western scrub jay (*Aphelocoma californica*), domestic cat (*Felis catus*), domestic dog (*Canis lupus familiaris*), raccoon (*Procyon lotor*)

Note: [1] Many aquatic plant and animal species may be found in more than one biotic community and inclusion as a characteristic species does not mean a species can only be found in a single habitat.

[2] Parts by weight of salt per thousand parts of water (ppt)

Sources: Smith 1959, NOAA 2007



Source: Josselyn 1983

Figure 4.2-2: Marsh Zonation
California State Lands Commission
Amorco Marine Oil Terminal Lease Consideration Project

Subtidal

Open-water habitats are divided into two categories: Shallow bay and deep bay. Shallow bays are subtidal areas less than 18 feet deep below extreme low tide; deep bay habitats are deeper. The bay contains approximately 164,000 acres of shallow bay habitat and 81,000 acres of deep bay habitat (Monroe et al. 1999). Deep bay areas are found in the Central Bay and South Bay, and along the main deep-water channel in the San Pablo and Suisun Bays. All bays contain extensive areas of shallow bay habitat.

The open waters of the bay are primarily underlain by soft-bottom bay sediments, although there are small and important areas where the substrate is either vegetated or supports shellfish beds. Areas of eelgrass habitat are found along the urban coastlines west of Richmond and Oakland. The southern shoreline of San Pablo Bay contains the most extensive areas of eelgrass beds in the San Francisco Bay Estuary. Native oyster beds are found in the same general areas as eelgrass habitats. Crushed shell substrate is found in the South Bay (SFEP 2011).

Soft-bottom substrate consists of sedimentary particles such as clay, silt, and sand that can be readily mobilized by tidal currents. This widespread substrate covers 90 percent of the San Francisco Bay Estuary (SFEP 2011). The primary sources of sediment into the San Francisco Estuary are the watersheds of the Sacramento and San Joaquin Rivers. River currents carry sediment into the estuary and deposit it onto the channel bottom, while tidal currents resuspend the fine sediment into the water column. The cyclical deposition and resuspension of fine sediments leads to sorting by grain size, where larger grain sediments are found in the channels and mud/silt/clay accretes into consolidated mudflats near shore. Soft-bottom substrates are characterized by a lack of large, stable surfaces for plant and animal attachment (National Oceanic and Atmospheric Administration [NOAA] 2007). Because of the lack of hard surfaces for rooting, few plants are associated with soft-bottom habitats. However, though mobile, the fine-grained sediment is both stable and compact enough to support a diverse benthic assemblage.

The biotic assemblages in the subtidal habitats of the San Francisco Bay Estuary vary with salinity. Species tolerant of high levels of salinity but less adaptable to variable changes in salinity are found in Central and South Bays. San Pablo Bay and Suisun Bay support brackish water and freshwater species that are more tolerant of the shifting salinity levels.

Suisun Bay is also the site of the entrapment zone, an area where suspended materials concentrate as a result of mixing by the outgoing freshwater flow from the Delta above the heavier saltwater flow from San Francisco Bay. The entrapment zone contains concentrations of suspended materials such as nutrients, plankton, and fine sediments that are often many times higher than in areas upstream or downstream of the entrapment zone (Levine-Fricke 2004). This trophically rich habitat is thought to be important for the

rearing of many fish species. Its precise location between the lower Delta and Suisun Bay varies according to the strength and phase of the tides, and the level of freshwater inflow from the Sacramento and San Joaquin Rivers. High freshwater flows from the Delta push the entrapment zone west toward Carquinez Strait; low flows put it closer to the mouth of the Delta.

Tidal Flats

Tidal flat habitat is the strip of intertidal habitat located between MLLW and MTL. It is exposed twice a day during low tide. During high tide, inundated tidal flats provide foraging habitat for fish such as longfin smelt , starry flounder (*Platichthys stellatus*), and several species of sculpin. During low tide, shorebirds feed on clams, shrimp, and worms found in the exposed tidal flats. Extreme high and low tides occur between May and June and in November and December, the latter period coinciding with the time that high numbers of waterbirds migrate through the San Francisco Bay Area (Bay Area).

The most extensive areas of tidal flat are found in the South Bay and along the north shore of San Pablo Bay. About half of the bay's tidal flats are found in the South Bay, making it the region's most important area for shorebirds (Monroe et al. 1999). Tidal flats in the Central Bay are limited by shoreline development. Suisun Bay has a more narrow tidal range than the other bays and has correspondingly less tidal flat.

Tidal Marsh

Tidal marshes are defined as the vegetated habitat between MLW and extreme high water (Josselyn 1983). Though not all tidal marshes are saline, they are sometimes also called salt marshes or saline wetlands. These marshes intergrade on their bay side with tidal flats and on their inland side with freshwater marshes. Tidal marshes are highly productive biological systems. Though only a small number of vascular plant species are capable of living in these areas, they support unique and diverse communities of plants and animals. Vegetation in tidal marshes are nurseries for commercially important species and endangered species; the tidal marshes are feeding and nesting areas for birds. In recognition of the importance of the San Francisco Bay Estuary, the United States named it as its 35th Wetland of International Importance (Ramsar Convention on Wetlands 2013).

Birds that feed or roost in tidal marshes include herons, egrets, ducks, coots, rails, swallows, wrens, and hawks. The majority of birds that use the tidal marshes of San Francisco Bay are migratory. Shorebirds that breed in the marshes include American avocet (*Recurvirostra Americana*), black-necked stilt (*Himantopus mexicanus*), and snowy plover (*Charadrius alexandrines*). Mammals found in these areas include mice, shrews, bats, and raccoons. Lizards and snakes are commonly found here, as are frogs and toads. Tidal marshes provide nursery habitat for fish, offering protection, food, and reduced osmoregulatory stress (Josselyn 1983).

Tidal marshes can be qualitatively divided into low, middle, and high marsh based on tidal inundation (see Figure 4.2-2). Low marsh consists of the area between MTL and MHW (Monroe et al. 1999). In salt marshes, these areas are characterized by saline-tolerant plants, usually grasses, which are adapted to regular inundation. In brackish and freshwater tidal marshes, cattails (*Typha* sp.), California bulrush (*Scirpus* sp.), and alkali bulrush (*Bolboschoenus maritimus*) dominate the low marsh. Waterfowl and rails make extensive use of low marshes. Middle marsh consists of the area between MHW and MHHW. Plant species typically found in the middle marsh include bulrushes (*Scirpus* sp.), spike rush (*Eleocharis* sp.), silverweed (*Potentilla anserine*), and salt grass (*Atriplex* sp.). High marsh consists of the area between MHHW and the highest margin of the marsh. Plants found in the high marsh include pickleweed (*Salicornia* sp.), saltgrass, gumplant (*Grindelia* sp.), and alkali heath (*Frankenia salina*).

Extensive areas of tidal marsh are found in all bays except the Central Bay. Suisun Marsh, found north of Suisun Bay, is the State's largest brackish-water marsh. Most of northern San Pablo Bay is marshland, and the extent of marshland in the South Bay is rising with ongoing restoration of the area's salt ponds.

Urban Shoreline

Much of the historical shoreline of Central Bay has been replaced with artificial fill or structures armored with revetments, seawalls, or rip-rap. Urban land uses tend to encroach on the shoreline in urbanized areas. These areas of shoreline may be fringed with narrow bands of recently formed tidal marshes dominated by common, widespread marsh species, including a high proportion of non-native species. The shorelines of the Central Bay and the northeast and northwest shorelines of the South Bay are heavily urbanized; the south shorelines of San Pablo Bay and Suisun Bay are less intensely urbanized.

Coastal Scrub

California's coastal scrub communities are dominated by low-growing shrubs such as coyote brush (*Baccharis pilularis*), California blackberry (*Rubus ursinus*), and poison oak (*Toxicodendron diversilobum*). Coastal scrub provides habitat for a variety of small-mammal species such as Botta's pocket gopher (*Thomomys bottae*), California mouse (*Peromyscus californicus*), and western harvest mouse *(Reithrodontomys megalotis).* Larger mammals such as bobcat (*Lynx rufus*), coyote (*Canis latrans*), and mule deer (*Odocoileus hemionus*) may occur in or near frequent larger areas of coastal scrub communities. Bird species that frequent coastal scrub habitat include California towhee (*Melozone crissalis*), spotted towhee (*Pipilo maculatus*), white-crowned sparrow (*Zonotrichia leucophrys*), wrentit (*Chamaea fasciata*), California thrasher (*Toxostoma redivivum*), and western scrub jay (*Aphelocoma californica*). Lizards such as western fence lizard (*Sceloporus occidentalis*) and northern alligator lizard (*Elgaria coerulea*) may also occur within coastal scrub and adjacent grassland habitats.

Biological Characteristics of the San Francisco Estuary

Plankton

Phytoplankton (e.g., diatoms, cyanobacteria, dinoflagellates) are photosynthesizing microorganisms that inhabit water. Phytoplankton provide a source of organic carbon and energy at the base of the food chain (Cloern 1979). Compared to other estuaries, phytoplankton primary productivity in the San Francisco Bay Estuary is relatively low. The population density of phytoplankton in the bay cycles throughout the year, with levels higher during spring in San Pablo, Central, and South Bays, and during the summer in Suisun Bay (Cloern 1979). In the northern bays, phytoplankton growth can be separated into three seasons: A spring bloom period during which water-born nitrates are available to phytoplankton; a low-productivity period in the summer when turbidity limits light penetration into the water; and a second, smaller fall bloom based on ammonium uptake (Wilkerson et al. 2006). High levels of phytoplankton (algal blooms) can cause environmental stress, affecting concentrations of dissolved oxygen and carbon dioxide, dissolved organic and inorganic substances, and pH.

Zooplankton are a diverse group that can range in size from microscopic (microplankton) to those that can be seen by the naked eye (macroplankton). This heterogeneous group includes mysid shrimp, clams, jellyfish, copepods, and crustaceans. They feed upon phytoplankton, bacteria, organic detritus, and each other.

Nonnative jellyfish are found throughout the estuary, including three hydrozoan species thought to be native to the Black Sea and one scyphozoan species thought to be introduced from Tokyo Bay. The hydrozoan species are present among the plankton from May through November, with peak abundances coinciding with warmer summer and fall temperatures. It has been suggested that jellyfish are passively spread through all low-salinity areas of San Francisco Bay via attachment to boat bottoms (NOAA 2007).

Icthyoplankton consists of fish eggs and larvae found in near-surface waters, where they float passively on water currents. Ichtyoplankton feed on microplankton and are in turn fed on by larger animals.

Invertebrates

California bay shrimp (*Crangon franciscorum*) is the most common shrimp in San Francisco Bay most years and supports a small commercial fishery. The blackspotted shrimp (*Crangon nigromaculata*) is the second most common shrimp in the San Francisco Bay overall and the most common shrimp in some years.

The San Francisco Bay Estuary is a nursery area for shrimp and crabs, and fish. The highest densities of bay shrimp are found in Suisun Bay, where juveniles rear in shallow, low saline waters (NOAA 2007). Dungeness crab (*Metacarcinus magister*) reproduce in the ocean, and the small juvenile stages settle to the bottom of the ocean where they are

carried into the bay on tidal currents and spend the first year or two of their lives rearing in San Pablo and South Bays (NOAA 2007).

Different species of shrimp tend to inhabit different regions of the bay, though species do overlap in distribution. Shrimp species that live in the more saline environment of the bay have grown in abundance over the past 15 years and expanded in range into the upstream regions of the bay, particularly in dry years when saline levels increase upstream. Low-salinity species such as the bay shrimp show no increase in abundance over the past 15 years. Regionally, shrimp abundance increased in all parts of the bay except in Suisun Bay (SFEP 2011).

The abundance of shrimp and crab in the South Bay during the last 15 years is largely in response to increased nutrient availability in coastal waters. Because shrimp and crab prey on large benthic invertebrates, particularly clams, the increased numbers have led to a decline in the abundance of clams in the South Bay (Cloern 2011).

Fish

The health of the San Francisco Bay Estuary's fish communities varies geographically. The Central Bay fish population has been stable for 30 years, but the populations in the other bays have seen declines in health over the same period. This decline has been most dramatic for Suisun Bay, but is also apparent in San Pablo Bay and, increasingly, in the South Bay. Fish abundance, diversity, and percentage of native species have declined in all bays except the Central Bay (SFEP 2011).

Beginning in 2002, abundance indices of four pelagic fishes in the upper San Francisco Estuary declined rapidly to record low levels from which they have not recovered. Since 2004, a consortium of federal and State agencies formed the Pelagic Organisms Decline Management Team to focus attention on the causes of the decline for delta smelt, longfin smelt, threadfin shad (*Dorosoma petenense*), and juvenile striped bass (*Morone saxatilis*). The emerging conclusion from nearly a decade of research is that the decline has its roots in multiple, interacting causes, including low original population abundance, a decrease in suitable habitat, mortality from predation and entrainment into water diversions, and a fundamental shift in the food web in the upper Delta from a phytoplankton-based food web to a detritus-based food web (IEP 2010).

Birds

San Francisco Bay Estuary is a major stopover for birds migrating along the Pacific Flyway, and many birds also nest along the San Francisco Bay. Nearly half of Pacific Coast waterfowl and shorebirds depend upon the San Francisco Bay and its mudflats for foraging during migration, with peak abundance occurring November through mid-March (SFEP 2011). In recognition of its critical conservation importance for shorebirds, San Francisco Bay Estuary is listed as an important shorebird migratory stopover in the Western Hemisphere Shorebird Reserve Network (USFWS 2002). Migratory stopovers

are wetlands and associated habitats that have high densities of food available at critical times during waterfowl and shorebird migration. These migrations are energy intensive and may include long-distance, non-stop flights of over 1,000 miles between stopover areas. Migrating flocks are large and migrations may occur in a very tight window, resulting in a large proportion of a species' entire population visiting a single site over a few weeks and requiring a vast quantity of available forage.

Waterbirds are typically classified based on habitat and foraging preference. Waterfowl are those species that depend primarily on open-water habitat for foraging and roosting, but breed in wetland and/or adjacent upland habitats. Ducks, geese, and grebes are all waterfowl. Waterfowl are further divided into dabblers and divers. Dabbling ducks, which feed at or below the surface of shallow water, have increased in Suisun and San Pablo Bays, while populations have held steady in the Central and South Bays (Pitkin and Wood 2011). Diving ducks, which feed in deeper waters, have decreased in San Pablo Bay but increased in Suisun Bay as populations of their primary prey, large invertebrates such as clams, have changed. Overall, populations of dabbling ducks have increased and winter populations of diving ducks have decreased. Seabirds such as gulls, terns, and cormorants forage and nest in many of the habitats found around the San Francisco Bay. Many species make use of human-created habitats such as piers, bridges, and the structures found at Alcatraz Island (Pitkin and Wood 2011).

Shorebirds primarily use beach, tidal flats, salt ponds, and shallow open-water habitats for foraging and roosting, and nest on beaches or adjacent upland areas. Sandpipers, plovers, and dowitchers are all examples of shorebirds. The overall status of shorebirds in tidal flats is stable. Population declines in the South Bay have been offset by population increases in San Pablo Bay. The western sandpiper (*Calidris mauri*), one of the most common species, has declined across the San Francisco Estuary, but populations of two other common species, least sandpiper (*Calidris minutilla*) and willet (*Tringa semipalmata*), have increased greatly (Pitkin and Wood 2011).

Marsh birds include species that depend on emergent marshes for foraging, nesting, and roosting. California black rail (*Laterallus jamaicensis coturniculus*) and song sparrows are examples of marsh birds. Tidal marsh bird abundance has increased in San Pablo Bay and Suisun Bay, mainly driven by increases in common yellowthroat (*Geothlypis trichas*) and California black rail populations, but has decreased in the Central and South Bays (SFEP 2011). Reproductive success of tidal marsh birds has increased in Suisun Bay but is decreasing in San Pablo Bay. In particular, San Pablo song sparrow and Suisun song sparrow populations are below the level required to sustain their populations, and are expected to exhibit long-term declines. The decrease in tidal marsh bird abundance is attributed to predators and nest flooding (Pitkin and Wood 2011).

Wading birds use emergent marsh, marsh edge, and shallow open-water habitats to forage and roost in upland areas. Locally, examples include the great blue heron, cattle

egret, and great egret. Heron and many egret populations are increasing in San Pablo Bay, but there has been a decline in the nesting success for great egrets (SFEP 2011).

Mammals

San Francisco Bay Estuary's mammals are found on the shore and in the water. The most common terrestrial species found in coastal marshes include generalists such as Norway rat (*Rattus norvegicus*), house mouse (*Mus musculus*), California vole (*Microtus californicus*), and raccoon (*Procyon lotor*), which are adaptable to a wide range of habitats. Terrestrial mammals that are obligate users of marsh habitat, such as saltmarsh harvest mouse (*Reithrodontomys raviventris*), have seen drastic population declines as a result of habitat loss, and many are now listed as Threatened or Endangered by the federal and State governments.

Populations of beaver (*Castor canadensis*), river otter (*Lontra canadensis*), and sea otter (*Enhydra lutris*) were extirpated from the San Francisco Estuary by over harvesting in the 19th century. Both river otter and beaver have recently recolonized the San Francisco Estuary; river otter have been reported throughout the San Francisco Bay, including Coyote Creek in the South Bay, the Richmond Marina in the Central Bay, Martinez Marina on Carquinez Strait, and from wetlands in Suisun Bay (ROEP 2013). Beaver are now found in the marshes in north San Pablo Bay and on the lower Alhambra Creek in downtown Martinez.

The most common aquatic mammals in the San Francisco Estuary are California sea lion (*Zalophus californianus*) and harbor seal (*Phoca vitullina*) (NOAA 2007). The California sea lions are mainly males that migrate to the San Francisco Estuary to forage and establish a dominance hierarchy; female California sea lions stay south of Santa Barbara. California sea lion haul outs are found throughout the San Francisco Bay, most prominently on San Francisco's Pier 39. Harbor seals are resident breeders. Harbor seals will haul out throughout the San Francisco Bay; major haul out and pupping sites are located in the Central and South Bays at the Castro Rocks near the Richmond-San Rafael Bridge, Yerba Buena Island by the San Francisco-Oakland Bay Bridge, Corte Madera, and Mowry Slough in the South Bay.

Nonindigenous Aquatic Species

San Francisco Bay Estuary has been described as one of the most invaded ecosystems in North America (Cohen and Carlton 1995). Nonindigenous aquatic species dominate many parts of the San Francisco Bay, to the extent that in some locations only introduced species can be found. In 2010, the California Department of Fish and Wildlife (CDFW) collected 497 species from San Francisco Bay Estuary, of which 98 species were classified as introduced, including three newly detected species to San Francisco Bay Estuary that had likely been spread from other locations in California (OSPR 2011). The

results indicate high numbers of introduced species are found in the South Bay, San Pablo Bay, and Central Bay. Suisun Bay had the lowest number of introduced species.

Nonindigenous aquatic species have been introduced to the San Francisco Bay via a number of vectors, including the deliberate introduction of species for recreational or commercial purposes. The shipping industry has been identified as one of the major vectors of nonindigenous aquatic species, and vessel biofouling and ballast water are considered the largest contributors of nonindigenous species to the San Francisco Bay (California State Lands Commission [CSLC] 2013e). Eighteen percent of established nonindigenous aquatic species are tied to vessel biofouling as the primary likely vector and 9 percent for ballast water; however, when considering established species with multiple possible vectors, 60 percent could have been introduced via vessel biofouling as one of several possible vectors, and 53 percent could have been introduced via ballast water as one of several possible vectors (OSPR 2011).

Invasive species may compete directly with native species for food or space, or prey upon native species. They can also change the food chain or physical environment to the detriment of native species. Approximately 42 percent of the species on the federal Threatened or Endangered species list are at risk primarily because of predation, parasitism, and competition from nonindigenous invasive species (OSPR 2011). One such currently pernicious invasive species is the overbite clam (*Corbula amurensis*), first found in the San Francisco Bay Estuary in 1986. Thought to have been introduced into the San Francisco Bay Estuary by ballast water discharge from a vessel, this planktivore is now so abundant that the current population is capable of filtering the estuary's water column several times a day. In some portions of the Suisun Bay floor, the clam accounts for the vast majority of biomass, and it has been implicated in the pelagic organism decline by severely reducing the availability of phytoplankton in Suisun Bay (SFEP 2004, Greene 2011).

Rare, Threatened, and Endangered Species

Owing to the diversity of habitat between embayments, the distribution and abundance of rare and sensitive species that depend on the estuarine habitat for some or all of their life cycle vary throughout the region. Each habitat supports a distinct community of sensitive species. To aid in the assessment of impacts, each category of sensitive species is summarized by embayment. Appendix D includes Tables D-1 through D-5, which provide further detailed information about each species that was considered under this assessment and their potential to be present near the Project site and impacted by the Project.

Sensitive Plants

Tidal habitats in the San Francisco Estuary support 12 plant species that are identified by federal and/or State agencies as endangered, threatened, or rare, or are listed by the

California Native Plant Society as status 1B or higher. The distribution of sensitive plant species varies geographically within the estuary. In general, the less urbanized the bay, the more likely it is to retain a proportion of its historical marshland and to support rare or sensitive plants (see Appendix D, Table D-1).

The Central Bay has not retained any historical tidal marsh remnants, which limits the potential for rare plants with few exceptions. Naturally occurring populations of Point Reye's bird's-beak (*Cordylanthus maritimus* ssp*. palustris*) are found along the shores of Richardson Bay, and a population was reintroduced to the Crissy Field wetlands in the Presidio. This species inhabits the high marsh or upper middle marsh zone. It is a hemiparasitic plant, meaning that although it possesses chlorophyll and is capable of limited photosynthesis, it must attach its root system to a host plant to extract water and nutrients and to reproduce. Point Reye's bird's-beak is dependent upon plants that are active in summer such as pickleweed (*Salicornia* sp.), saltgrass (*Distichlis* sp.), and fleshy jaumea (*Jaumea carnosa*), all of which are abundant in Richardson Bay. One other sensitive species is found in the Central Bay: California sea blite (*Suaeda californica*). This species is restricted to the intertidal zone of salt marshes, and was extirpated from the San Francisco Bay region in the 1960s. Since 2000, it has been successfully reintroduced at four sites in the Central Bay: Heron's Head Park at Pier 98, Pier 94, Eastshore State Park north of Oakland, and Roberts Landing near San Leandro in South Bay.

The South Bay retains fragments of historical tidal marshes at upper Newark Slough, Dumbarton Marsh, and along the Palo Alto shoreline. However, no sensitive tidal marsh or estuarine beach plants are known to remain in the South Bay. As mentioned above, one population of California sea blite was re-introduced at Roberts Landing.

San Pablo Bay has retained more of its historic tidal marshes than any other bay, and as a result supports naturally occurring populations of six rare species. Historical tidal marshes are found along the north edge of San Pablo Bay, including China Camp in San Rafael, Heerdt Marsh by Corte Madera, most of Petaluma Marsh, Whittell Marsh by Point Pinole, and areas of Napa marsh, including Fagan's Slough. The richest diversity of sensitive plants is found in the marshes at the mouths of the Petaluma and Napa Rivers.

San Joaquin spearscale (*Atriplex joaquinana*) is a tall annual herb known mainly from alkali grasslands and is only rarely known from tidal marsh edges where it may opportunistically colonize the high-tide shorelines. Recent populations are reported from along the lower Napa River. Saline marsh clover (*Trifolium hydrophilum*) is known to occur in marshes as well as alkaline grasslands. One population is known from the Viansa wetlands in northwest San Pablo Bay. The upper marsh zone of San Pablo Bay's brackish and freshwater marshes supports populations of endemic species known only to San Francisco Bay Estuary: Suisun marsh aster (*Symphyotrichum lentum*), delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), and Mason's lilaeopsis (*Lilaeopsis masonii*). Suisun

marsh aster was once widely distributed in San Pablo Bay, but is reported now only from the vicinity of Fagan Slough. The delta tule pea is a climbing species; individuals are present in marshes along the Napa River. Mason's lilaeopsis (*Lilaeopsis masonii*) is also known from the Napa River corridor; it is a shade-sensitive, early successional colonizer of newly deposited or exposed sediments. Two species of bird's-beak are found in the upper marsh zone in San Pablo Bay: Point Reye's bird's beak and the federally endangered soft-bird's beak (*Cordylanthus mollis* ssp*. mollis*). One population of Point Reye's bird's-beak is known from the Petaluma River. Extant populations of soft bird's-beak are found in the marshes along the mouth of the Napa River.

Most of the sensitive plants found in San Pablo Bay are also found in Suisun Bay, where they are more widely distributed and abundant, particularly in the extensive brackish waters of Suisun Marsh. In addition to the plants described above, Suisun Bay contains populations of the federally endangered Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*) in the northern reaches of Suisun Marsh in the vicinity of Rush Ranch. Bolander's water-hemlock (*Cicuta maculata* var. *bolanderi*) was once common in Suisun Marsh.

Sensitive Fishes

The San Francisco Estuary provides habitat to seven species of sensitive fish. Most of the sensitive fish species in the estuary either rely on brackish water habitat for their adult habitat and/or travel upstream to spawn in freshwaters and have thus been affected by degradation or removal of spawning habitats, entrainment by the State water projects, drought, pollution, predation, disruption of the food web and direct competition for space with and predation by non-indigenous aquatic species. The discussion below summarizes the distribution of sensitive species in the estuary; Table D-2 in Appendix D provides more detailed information for each species. Sensitive fish species are found mainly in the north bays. All sensitive fish species of the San Francisco Estuary have the potential to be impacted by a crude oil spill. Suisun Bay is home to two native species of "true" estuarine fish, i.e. fish that spend all their lives in estuaries: delta smelt and Sacramento splittail (*Pogonichthys macrolepidotus*). Both species are endemic to the Delta, and both travel into fresh water to spawn. Delta smelt are found in greatest abundance in shallow, turbid waters at the freshwater edge of the entrapment zone where they feed on plankton; Sacramento splittail are found mainly along the benthos of small, shallow, turbid sloughs lined with emergent vegetation, where they feed on macroinvertebrates and detritus. The delta smelt population is listed as threatened at the federal level and endangered by the State. As of 2010, populations of the splittail were considered stable by the United States Fish and Wildlife Service (USFWS), which found its listing was not warranted, but the species remains a CDFW species of special concern, and it is a targeted species of the Delta Stewardship Council (USFWS 2010).

Four anadromous species are found in the San Francisco Bay: longfin smelt, chinook salmon (*Oncorhynchus tshawytscha*), steelhead trout (*Oncorhynchus mykiss*), and the Southern Distinct Population of green sturgeon (*Acipenser medirostris*). Longfin smelt are primarily estuarine, though they are found in small numbers in the coastal waters beyond the Golden Gate Bridge. In summer, adults congregate in the cooler waters and deep-water habitats of the Central Bay, where they feed on zooplankton such as the opossum shrimp, *Acanthomysis* sp., and *Neomysis mercedis* when available and on copepods otherwise (Hobbs 2006). They migrate upstream in fall to spawn in the limnetic and oligohaline waters of the Delta. Populations have declined steadily over the past two decades (Rosenfeld and Baxter 2007).

Chinook salmon are born in fresh water and migrate into the Pacific Ocean to mature, reaching maturity between 2 and 5 years of age. They migrate into freshwater streams to spawn, after which they die. Their eggs incubate for several months. Upon hatching, fry undergo physiological changes in preparation for migration and enter the smolt stage. Most chinook smolt migrate to the ocean within a few months of hatching, though some may remain in fresh water for a year. Peak out-migrations are between April and June.

The Sacramento-San Joaquin River basin runs of chinook salmon are differentiated into four runs by their time-of-spawning migrations: Fall-run, late fall-run, winter-run, and spring-run. Fall-run chinook migrate upstream from July to November, late fall-run migrate October to February, winter-run migrate December to April, and spring-run migrate April to July. The Delta is a nursery area for all runs of chinook salmon. Winter-run chinook, the young of which out-migrate during the driest times of the year, are listed as critically endangered at both the federal level and by the State. Spring-run salmon are listed as threatened at both federal and state levels.

A close ally to salmon, the steelhead is an anadromous kind of rainbow trout. They migrate into the estuarine river basins from October to April and spawn from December to May. Populations that spawn eastward to the Napa River are listed as threatened at the federal level. This includes runs in San Pablo Bay's Napa River, Petaluma River, and Sonoma Creek, and the South Bay's Guadalupe River.

Green sturgeon may be found throughout the Central, San Pablo, and Suisun Bays. Adults are primarily marine, but enter the estuary to feed or migrate to spawning grounds. Juveniles rear in the northern bays for 1 to 4 years before joining the more marine adults. Sturgeon are benthic feeders, feeding mainly on shrimp and crabs.

Sensitive Birds

San Francisco Bay Estuary's sensitive birds are generally obligate inhabitants of tidal marshes, and have experienced population declines as a result of the removal and degradation of marsh habitat. Thus, the Central Bay, which possesses few tidal marshes, has few populations of sensitive birds (see Appendix D, Table D-3).

Many sensitive species such as California clapper rail (*Rallus longirostris obsoletus*) and California black rail are widely distributed throughout the bays. Others are subspecies known from single embayments: The Suisun song sparrow (*Melospiza melodia maxillaris*) is found in Suisun Bay, the San Pablo song sparrow (*Melospiza melodia samuelis*) in San Pablo Bay, and the Alameda song sparrow (*Melospiza melodia pusillula*) in the South Bay. California least tern (*Sterna antillarum browni*) is known to nest in the South Bay and along the southern shore of Suisun Bay. Western snowy plover (*Charadrius nivosus* ssp. *nivosus*) also nests in the South Bay, as well as in the San Pablo Bay marshes.

Colonial nesters found in the estuary include double-crested cormorant (*Phalacrocorax auritus*), great blue heron (*Ardea herodias*), great egret (*Ardea alba*), black-crowned night-heron (*Nycticorax nycticorax*), and snowy egret (*Egretta thula*). Double-crested cormorant colony nest sites are found under the bridges that divide the bays and on large electric transmission structures in the South Bay. Heron rookeries, which may consist of several heron and egret species, are found throughout the Bay Area.

Sensitive Mammals

Tidal marshes in the San Francisco Estuary support four sensitive mammalian species, while seven mammalian species use the aquatic habitats of the estuary. Additionally, three species of bats forage over tidal marsh and estuarine waters (see Appendix D, Table D-4).

Many of the sensitive mammals of the tidal marsh habitats are small rodents: Suisun ornate shrew (*Sorex ornatus sinuosus*), saltmarsh wandering shrew (*Sorex vagrans halicoetes*), the federally endangered saltmarsh harvest mouse, and the San Pablo vole (*Microtus californicus sanpabloensis*) all weigh less than an ounce at adult size. Where present, they are prey species for higher order predators. Both shrews are insectivorous, while the mouse and vole are vegetarian. The endemic saltmarsh harvest mouse is generally restricted to tidal marsh habitats. It is found throughout the estuary, albeit in low numbers due to habitat destruction and degradation. The saltmarsh wandering shrew is found in the South Bay, while the Suisun ornate shrew is found in Suisun Bay. The San Pablo vole is known only from a small region in the vicinity of Wildcat Creek, on the southeast shore of San Pablo Bay.

Seven marine mammal species are known to migrate, forage, and rest in the San Francisco Bay. Gray whale (*Eschrichtius robustus*) and humpback whale (*Megaptera novaeangliae*) occasionally enter the Central Bay to feed during seasonal migrations. The harbor porpoise (*Phocoena phocoena*) is another visitor to the Central Bay. Harbor seal and California sea lion both venture as far upstream as Suisun Bay, but in general marine mammals prefer the deep, cold waters of the Central Bay.

The big free-tailed bat (*Nyctinomops macrotis*) has been collected in Martinez. Hoary bat (*Lasiurus cinereus*) has been observed in Suisun Marsh, but is more widely distributed in

the South Bay. The pallid bat (*Antrozous pallidus*) has been collected in the Central, South, and San Pablo Bays. The distribution of these species and their use of estuarine habitats has not been well described.

Sensitive Amphibians and Reptiles

The San Francisco Bay Estuary supports only a handful of sensitive amphibians and reptiles (see Appendix D, Table D-5). Both California red-legged frog (*Rana draytonii*) and western pond turtle (*Actinemys marmorata*) are distributed in low numbers throughout the San Francisco Bay (CDFW 2013c). These species prefer freshwater ponds and streams, but are tolerant of limited saltwater intrusion and are documented from brackish marshes in San Pablo and Suisun Bays. California red-legged frogs appear to be eliminated from the western lowland portions of Contra Costa and Alameda counties (west of Highway 80 and 880, particularly in urban areas). California tiger salamanders, which are found in grasslands and vernal pools, are known only from the Don Edwards National Wildlife Refuge in the South Bay (CDFW 2013c).

4.2.1.2 Project Study Area

The Project study area includes lower Suisun Bay and upper Carquinez Strait, including vegetation at the Amorco Terminal lease area and along the shoreline within a 0.5-mile radius of the Amorco Terminal, as well as known habitats of rare, threatened, or endangered plant or animal species within a 1-mile radius of the Amorco Terminal (see Figure 4.2-3). Table D-6 in Appendix D includes a matrix depicting habitat use by wildlife found in the Project study area.

Characteristics of the Project Study Area

The Project is located on the eastern end of the Carquinez Strait in northern Contra Costa County on 16.6 acres of public land leased from the CSLC (proposed to be 14.9 acres as part of a new lease), approximately 300 feet west of the Benicia-Martinez Bridge. The lease extends approximately 1,300 feet into the Strait.