Chapter 5

Marine Environment

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INTRODUCTION

This chapter discusses existing regulations, oceanography, water quality, biology, and beneficial uses of the marine environment that could be influenced by the Districts' wastewater discharges to the marine environment and identifies potential impacts of the 2010 Plan. Data and information were compiled using several sources, including the Districts, unpublished reports, and published literature. Hydrology, water quality conditions, and biological resources in the San Gabriel River tidal prism are discussed in Chapter 3, "Hydrology and Water Quality".

SETTING

Regulatory Setting

Under Section 403 of the CWA, all NPDES-permitted discharges to the marine environment must comply with the guidelines for determining degradation of marine waters. This includes a determination that water quality criteria established under Section 403 be met at the edge of a designated mixing zone (zone of initial dilution) around an outfall. Initial dilution is defined in the California Ocean Plan as the mixing process that ends where a plume of diluting wastewater ceases to rise in the water column and first begins to spread horizontally. For computational purposes, an initial dilution of 166:1 (166 parts seawater to 1 part effluent) is specified in the Districts' NPDES permit for the JWPCP. Based on this dilution and the numerical objectives in the California Ocean Plan, the RWQCB established effluent limitations for the JWPCP discharge.

The 1991 NPDES permit for the JWPCP establishes discharge limitations for 86 constituents. These include all the major wastewater constituents, aquatic life toxicants, noncarcinogens, and carcinogens included in the 1990 California Ocean Plan. Many of the limits are more stringent than those in the California Ocean Plan and are based either on previous performance or practical quantification limits. Limits for major constituents and aquatic life toxicants are provided for both concentration and mass emissions, and are expressed for various time periods (30-day, 7-day, daily, instantaneous, or in various combinations).

The NPDES permit also requires the continuation of the Districts' pretreatment program for industrial discharges to the system, an effluent monitoring program, and a receiving water monitoring program. Unless otherwise noted, all data presented below on JWPCP effluent and the receiving environment off the Palos Verdes Peninsula are from the Districts' monitoring programs.

Regional Setting

The Districts currently operate two wastewater outfalls that terminate approximately 2 miles (3 kilometers [km]) offshore from the Palos Verdes Peninsula on the shelf (Palos Verdes Shelf) at a water depth of about 200 feet (60 meters [m]) (Figure 5-1). The Palos Verdes Peninsula is a coastal promontory with bays to the north (Santa Monica Bay) and south (San Pedro Bay). The peninsula's shoreline is generally characterized by cliffs, with a rocky intertidal zone and a few cobble and sandy pocket beaches. Active southern slope landslides supply sediment to the shelf; the largest, at Portuguese Bend, has been active since 1956 (Sediment Dynamics Group 1987).

The bathymetry of the ocean bottom off Palos Verdes Peninsula is unique for Southern California. The continental shelf is exceptionally narrow; it extends seaward 1-3 miles (2-5 km). At a depth of 250 feet (75 m), the slope of the bottom steepens from approximately 1° on the shelf to 2-10°. The shelf is bordered to the north and south by the Redondo Submarine Canyon and the San Pedro Sea Valley, respectively. A series of deep basins separated by sills are located further offshore.

Physical Oceanography

The California Current (Figure 5-2) is the dominant oceanic feature controlling water circulation along the southern California coast (Hickey 1979, 1993). The California Current is a surface current that originates in colder, more nutrient-rich northern waters and flows southward along the west coast of North America. At Point Conception, where the coastline verges to the east, the California Current continues southward and offshore, following the continental slope. In the vicinity of the Districts' outfalls, the California Current lies approximately 100-125 miles (160-200 km) offshore. The current speed varies annually and seasonally, with a maximum speed of about 4-6 inches per second (10-15 cm/sec). The California Current forms the western boundary of what is referred to as the Southern California Bight. The northern and southern boundaries of the bight are Point Conception, California, and Cabo Colnett in Baja California, respectively.

Surface currents in the bight form a counterclockwise gyre around the Channel Islands, resulting in predominantly northerly surface water currents (the Southern California Counter Current) on the eastern side of the islands. Closer to the mainland, surface currents are generally southerly.

The California Undercurrent is a subsurface current that underlies the Southern California Coastal Current. In contrast to the surface currents, the California Undercurrent flows predominantly northward. This northerly flowing subsurface current receives most of the discharge waters from the Districts' outfalls. Averaged over the year, the net northerly flow of the undercurrent is 1-2 inches per second (3-6 cm/sec), although the undercurrent can achieve velocities as high as 18 inches per second (45 cm/sec) in winter.

In addition to the primary currents discussed above, several other factors also influence the dispersion of effluent and sediments in the vicinity of the Districts' outfalls. These include tidal and longshore currents, localized upwelling of bottom waters to the surface, and large-scale oceanographic phenomena such as El Niño events. Combined, these currents create an extremely variable mixing environment at the Districts' outfalls; however, accumulation of sediments near the outfalls indicates that subsurface flow is predominantly to the northwest.

Historical Wastewater Discharges

Whites Point Outfalls. The Districts have four outfalls at White Point on the Palos Verdes Peninsula. Two outfalls (measuring 120 inches and 90 inches in diameter) are in regular service. A third outfall (72 inches in diameter) is used occasionally, during heavy rains. The fourth outfall (60 inches in diameter) serves as a standby for use in an extreme emergency. The total discharge from the two active JWPCP outfalls averaged 328 million gallons (12.4 x 10^8 liters) of treated wastewater per day in 1993. The JWPCP provides advanced primary treatment for all of the flow and partial secondary treatment (in 1993, 60% of the daily flow, 195 million gallons or 7.4 x 10^8 liters, received secondary treatment). The effluent is chlorinated before discharge to the Pacific Ocean through the Districts' outfalls extending off the Palos Verdes Peninsula.

The Districts have discharged treated wastewater (effluent) off Palos Verdes Peninsula for 55 years (Figure 5-3). Between 1937 and 1970, flow and suspended solids emissions increased as the county grew. Since construction of upstream WRPs began in the 1960s and 1970s, the volume of effluent discharged to the ocean has remained relatively constant. As a result of advanced primary treatment, secondary treatment, and improved solids handling (e.g. using centrifuges), the amount of suspended solids in the discharge has been reduced to one-fifth of that discharged in 1971 (Figure 5-3). Most of the solids (about 75%) are removed during advanced primary treatment. In 1993, the efficiency of final effluent solids removal for wastewater receiving advanced primary treatment comingled with a portion of flow receiving secondary treatment was 86%.

Aggressive source-control measures and improved treatment and operation of facilities have resulted in a dramatic decline in trace contaminants in the effluent since the early 1970s (County Sanitation Districts of Los Angeles County 1993, Moshiri et al. 1982, Stull and Haydock 1988). As a consequence, mass emissions of trace contaminants from the Districts' outfalls has also declined (Figure 5-4). For example, metals such as cadmium, chromium, copper, lead, and zinc are present at a few percent of 1971 values. Many of the trace constituents are near the detection limit, contributing to the apparent variability in contaminant emission data.

Montrose Chemical, the world's largest manufacturer of DDT discharged its process wastes into Districts' sewers from approximately 1950 to 1971 (Chartrand et al. 1985). Following disconnection of Montrose Chemical from the sewer system in 1971, DDT emissions discharged to the ocean through the Districts' outfalls dropped dramatically (Figure 5-5). Effluent concentration of total DDT (a sum of six isomers) was generally near the detection limit in 1993, with some detections at a level of about 0.02 micrograms per liter (μg/l). Thus, the mass emission of DDT is currently less than 8.6 kg per year. PCBs have also exhibited a substantial decline and have not been detected in JWPCP effluent for a decade.

Year-to-year fluctuations in flow (Figure 5-3) are sometimes notable. Flows at the JWPCP declined markedly in the early 1990s compared with flows of the previous decade because of water conservation measures implemented in response to prolonged drought conditions and because of the economic slowdown. Flows can also be influenced by diversions among the six treatment plants in the JOS.

Other Regional Inputs. Three other major publicly owned treatment works (POTWs) discharge to the Southern California Bight: the City of Los Angeles' Hyperion treatment plant, which discharges 14 miles to the north of Whites Point in central Santa Monica Bay; the Orange County Sanitation Districts' treatment plant, which discharges 18 miles to the south into San Pedro Bay; and the City of San Diego's treatment plant, which discharges 75 miles to the south at Point Loma. Combined mass emissions of effluent constituents from the large POTWs to the Southern California Bight have decreased substantially over the past two decades (Table 5-1). The three largest industrial dischargers in the region are Scattergood Generating Station, Redondo Generating Station, and El Segundo Refinery; all three facilities discharge into Santa Monica Bay and also operate under NPDES permits issued by the RWQCB.

Nonpoint sources are important contributors of contaminants to the marine environment. These include urban runoff, marine vessels (commercial, public, naval, and recreational), ocean dumpsites, oil and hazardous material spills, advection and aerial fallout (Santa Monica Bay Restoration Project 1993). All point- and nonpoint-source emissions contribute to the overall condition of the Southern California Bight.

Receiving Water Quality

As part of the JWPCP NPDES permit requirements, the Districts monitor ocean water conditions at 34 sites on the shelf and slope around the Palos Verdes Peninsula using monthly hydrographic surveys of temperature, salinity, pH, and dissolved oxygen. Light transmission is measured monthly at seven nearshore stations. Ammonia nitrogen is measured quarterly

Table 5-1. Flow and Combined Mass Emissions from the JWPCP and the Hyperion, Orange County, and San Diego Wastewater Treatment Plants

	1971	1981	1991
Flow (10^9 liters)	1,284	1,492	1,455
Flow (million gallons per day)	930	1,080	1,053
Suspended solids[a] (mt)	294,000	224,900	79,400
BOD (mt)	283,100	260,900	139,300
Oil and grease (mt)	62,312	36,700	19,300
NH_3-N (mt)	54,500	40,500	43,600
Total P[b] (mt)	33,500	9,500	6,700
MBAS[c] (mt)	6,500	5,600	3,500
Cyanide (mt)	188	98	16
Silver (mt)	15	28	8
Arsenic (mt)	3[d]	12	5.4
Cadmium (mt)	52	32	0.4
Chromium (mt)	667	187	10
Copper (mt)	535	337	47
Mercury (mt)	2.9	1.8	0.2
Nickel (mt)	326	167	33
Lead (mt)	226	130	1.4
Selenium (mt)	12	15	6.8
Zinc (mt)	1,834	538	125
DDT (kg)	21,527	480	ND
PCB (kg)	8,730	1,252	ND

Notes: BOD = biochemical oxygen demand.
mt = metric ton.
Kg = kilograms.
ND = below detection limit.

[a] Solids for Hyperion 7-mile outfall are total solids.

[b] San Diego measures only PO_4P.

[c] Hyperion 7-mile outfall not included.

[d] Only Hyperion data were available.

Source: Southern California Coastal Water Research Project 1992.

at 21 stations. Coliform and enterococcus bacteria are surveyed daily at seven beach sites and weekly at six inshore stations. Detailed results and analyses are submitted to the RWQCB monthly and annually.

The measurement of physical and chemical properties of the water column is important in the determination of the vertical dispersion of the effluent. Both temperature and salinity affect the density of seawater. When surface waters are significantly less dense than bottom waters and there is a steep gradient in density between the two layers, the water column is said to be stratified. The zone of the greatest difference in density between the two layers is commonly referred to as the pycnocline. The pycnocline acts as a barrier to exchange of water between the two layers. In a stratified condition, the denser bottom layer, which usually contains the effluent, is isolated from mixing with the less dense surface layer by the density gradient. Figures 5-6 and 5-7 show 5-year depth-weighted average profiles for temperature, salinity, density, light transmission, dissolved oxygen, and pH for January, April, July, and October, representing typical annual cycles in the water quality profiles.

Water Temperature. Surface temperatures in the Southern California Bight range from about 52°F to 73°F (11-23°C) and are warmest (61-73°F, 16-23°C) from July to December and coolest (52-63°F, 11-17°C) from January to June. Typically, a pycnocline forms during late spring (April), deepens and strengthens during summer, and remains in place until late fall (Winant and Bratkovich 1981). Only weak temperature stratification is present in the water column in winter. Upwelling events usually occur in the spring or early summer, on the southeast side of the Palos Verdes headland, bringing colder water and nutrients to the surface (Grove and Sonu 1983).

Salinity. Salinity in the California Current ranges from 33.5 parts per thousand (ppt) to 34.1 ppt, and in the California Undercurrent it ranges from 33.4 ppt to 34.6 ppt (Jackson 1986). The coastal waters are normally more saline during summer because of evaporation; they can be less saline in winter because of freshwater runoff. Vertical stratification is present in spring, but in winter there is little vertical variability in salinity. During upwelling events in spring or early summer, bottom waters increase in salinity as deep offshore water is brought onto the shelf. The minimum salinity below the pycnocline is typically observed through summer and fall.

Dissolved Oxygen. Over the Palos Verdes Shelf, dissolved oxygen (DO) concentrations tend to be stratified. DO is generally greatest in the surface layers because of inputs from the atmosphere and photosynthesis. Because the pycnocline (or thermocline) acts to isolate bottom waters from oxygen-rich surface waters, biological activity can decrease oxygen concentrations in deeper waters when waters are strongly stratified. The NPDES permit states that the DO concentration outside the zone of initial dilution should not at any time be depressed more than 10% below the natural DO concentration. Monitoring data indicate that the effluent field appears to have only limited effect on ambient dissolved oxygen levels and that the discharge complies with the DO criteria (County Sanitation Districts of Los Angeles County 1992c).

Turbidity. Turbidity resulting from suspended material in water can affect the transmittance of light through the water column. The NPDES permit states that transmittance of natural light in water should not be significantly reduced at any point outside the zone of initial dilution. Photosynthetically active radiation (the light spectra used by algae) and depth of light penetration in the water are measured monthly. Transmissivity at different water depths can be used to track the effluent plume. These surveys, combined with other data, enable identification of the plume, as well as natural features such as turbidity from the Portuguese Bend landslide and algal blooms.

Conversi (1992) examined the variability of water clarity (Secchi depth) and transmissivity (at 15 m) off Santa Monica Bay (City of Los Angeles Hyperion outfall), Palos Verdes Peninsula, and Point Loma (City of San Diego outfall). Monthly data from 1976 to 1987 were compared with effluent flow and mass emissions of suspended solids. The study concluded that most of the variability in these measures of waterborne particulates is driven by Bight-wide, natural phenomena, rather than mass emissions of suspended solids. The 15-m water depth was, however, usually above the thermocline, which can prevent the upward transport of suspended solids.

Ammonia Nitrogen. Ammonia nitrogen is generally below detection levels in surface waters. At mid-depth, ammonia is often elevated over the outfalls, and localized ammonia nitrogen is occasionally recorded to the edge of the survey area (Figure 5-1). The mid-depth distributions vary greatly from survey to survey. Most bottom-depth samples are also below detection, although occasionally elevated concentrations coincide with midwater elevations, suggesting that both samples represent the effluent field. California Ocean Plan receiving water limits are 6,000 μg/l ammonia for acute toxicity and 600 μg/l ammonia for the 6-month median (chronic) toxicity. The highest ammonia nitrogen measured in 1990-1992 was 290 μg/l, less than half the 6-month median limit.

Metals and Other Aquatic Life Toxicants. Most trace metals are naturally present in the bight. The most abundant metals include cadmium, cobalt, copper, iron, manganese, nickel, and silver (Williams, P. 1986). Metals detected in the water column are primarily associated with suspended particles (bound), but dissolved metals are also detected. Dissolved metals are bioavailable (available for assimilation by biological organisms). Many organisms require trace metals for physiological functions; however, high concentrations of bioavailable metals can have significant adverse biological effects. Metals and other aquatic life toxicants (e.g., pesticides and phenols) are currently discharged at levels far below the standards set by the California Ocean Plan for protection of marine life (Appendix B).

Bacteria and Viruses. Sewage treatment plant effluent may contain pathogenic organisms with the potential to infect humans who contact receiving waters or consume shellfish. Pathogens, such as viruses, are present in sewage at low numbers and are technically difficult and expensive to monitor in receiving waters. Coliform bacteria, a group of bacteria that are typically harmless and thrive in the intestines of mammals, are also associated with sewage. Because these organisms are common and easy to sample, total and fecal coliform levels have been used as a regulatory indicator of the potential for presence of pathogens for the past 35 years. More recently, the Districts have also begun to monitor enterococcus, another group of enteric bacteria, which may be a better indicator of the presence of viral pathogens.

The Districts disinfect JWPCP effluent to prevent contamination of receiving waters with pathogenic organisms. Consequently, the Districts' discharge has been in compliance with regulatory standards set to protect contact recreation and harvestable shellfish.

Sediment Quality

Surface Sediments. Surface sediments from the sea floor are sampled by the Districts to determine contaminant and organic matter distributions in relation to the Districts' outfalls and to aid in comparing sediment quality to populations of sediment-dwelling animals (benthos) and bottom (demersal) fish.

In the early 1970s, prior to improvement of source control and treatment practices, wastewater discharges significantly altered the Palos Verdes Shelf environment. Sulfide-rich blackened sediments were reported in surface and buried sediments (to depths of 20 cm) near the outfalls, as well as sediments with elevated metals, DDT, and PCB concentrations (Galloway 1972; Southern California Coastal Water Research Project 1973). Concentrations decreased with distance from the outfall system.

In the 1990s, surface sediment surveys reveal a broad elliptical band of more organically enriched, finer grained, porous silt across the central Palos Verdes Shelf and slope. Highest contaminant concentrations are found northwest and offshore of the outfalls on the shelf and slope (200- to 500-foot depth, 60-150 m) (Figure 5-8). The elliptical distribution is related to present and past wastewater discharge; its northwesterly skew reflects the dominant direction of bottom currents.

As an example of sediment quality trends, the spatial extent and peak concentrations of surface sediment organic nitrogen and copper have declined dramatically since the early 1970s (Figure 5-8). Similar reductions have been observed for other trace contaminants, including other metals and chlorinated hydrocarbons. These improvements resulted primarily from the decline in mass emissions of contaminants from the Districts' outfalls. Other physical, chemical, and biological factors have also influenced sediment quality, including sediment resuspension (small- and large-scale events), burial, and bioturbation (mixing by sediment dwellers).

Historical Deposits of Contaminants. A partly buried reservoir of historically discharged contaminants exists on the Palos Verdes Shelf and slope. This sediment contamination has been a major focus of the Districts, as well as federal and state regulatory agencies. The vertical distribution of contaminants is studied in sediment cores (Bascom et al. 1982; Stull, Baird, and Heesen 1986). Figure 5-9 illustrates the distribution of the persistent DDT isomer p,p'-DDE along the shelf at the 200-foot (60-m) water depth. The deposit of historically contaminated sediments near the outfall has been partially buried by deposition of natural sediments and effluent-derived organic deposits from ongoing discharge from the JWPCP outfall. This buried deposit contains elevated concentrations of DDT, PCBs, metals, polynuclear aromatic hydrocarbons (PAHs), and organic matter (including effluent-derived materials). The deposit forms a roughly 8-square-mile (20-square-km) sediment mound with a maximum depth of 2 feet (60 cm) near the outfall (Figure 5-9). Up to 300 parts per million of DDT (dry weight) has been found within this deposit.

The Districts conduct a biennial monitoring program to evaluate the distribution of the buried contaminants by collecting core samples of sediments and observing the change in the vertical (depth) and horizontal (geographic) concentrations of DDT over time. DDT is used as a marker because of its persistence; its discharge declined abruptly in 1971 when the primary contributor of DDT halted discharges to the Districts' system.

The monitoring has shown that persistent contaminants, such as DDT, are gradually being transported to the sediment surface and being redistributed (Figure 5-10). The mass of contaminants on the shelf has declined. Modeling studies (discussed below) indicate that physical, chemical, and biological processes could be responsible for upward migration and redistribution of these contaminated sediments.

The concentration of contaminants has decreased in sediments at the nearshore sampling stations near the outfall (water depth less than 100 feet). Farther offshore or downcurrent from the outfall (to the northwest) surface concentrations are still elevated, and the subsurface reservoir continues to decrease.

Forces Affecting Release of Contaminants. Environmental forces affect the release of buried contaminants at the discharge depth (water depth of 200 feet). Contaminants, such as DDT, that are bound to particles appear to be released largely through two combined actions, biodiffusion (movement or mixing of sediment associated with activities of animals in the sediments) and resuspension (wave or current actions that flush and disperse the upper sediments).

Biodiffusion moves contaminants upward from the subsurface reservoir to the less contaminated surface sediments. Sediments are continuously being mixed and reworked by infaunal organisms that burrow, feed, and build structures in these sediments. The most active excavators are thalassinid shrimp. Fish, such as bat rays, hagfish, eelpouts, and cusk eels, and invertebrates, such as sea urchins and octopi, also can disturb sediments.

Storm currents can resuspend the upper several centimeters of sediment and transport it a few kilometers down the shelf or slope. As a storm wanes, the eroded surface sediments are replaced by relatively clean sediment transported from other uncontaminated areas. Through time, continued bioturbation moves contaminated sediments from the buried deposit to the cleaner surface sediments. The rate of contaminant release varies with biological and storm activities and with the mass and depth of the contaminant. The quantity of buried p,p'-DDE in Palos Verdes shelf sediments has generally decreased over time (Figure 5-10).

Models to Analyze the Transport and Fate of Contaminants. Two sedimentary process models have been applied to the Palos Verdes Shelf to study the transport and fate of contaminated particles: a resuspension model and a contaminant release model (Niedoroda et al. submitted). The resuspension model, which examines erosion and redeposition, indicated that both severe and common storm events (waves and currents) can erode and redeposit bottom sediments on the shelf and upper slope, but the model did not sufficiently explain observed contaminant releases. Most of the contaminated sediment mass is deeper than can be explained by storm erosion in the model, assuming that a positive natural sedimentation rate is maintained.

The contaminant release model examines ongoing sedimentation, sediment properties, vertical contaminant distribution, biological mixing and episodic resuspension. Results of this model indicate that all these factors appear to be important to the fate of particle-associated contaminants. This model more accurately depicts the present distribution of contaminated sediments and can be used to predict observed rates of contaminant losses from sediments.

Marine Biota

The diversity of physical habitats and climatic environments on the Palos Verdes Shelf contribute greatly to the observed biological variability. Continuous large- and small-scale perturbations strongly influence biological recruitment, abundance, distribution, and succession. Consequently, it can be difficult to separate the effects of wastewater discharges from natural perturbations.

Marine Habitat. The Palos Verdes area provides a range of interdependent habitats for fish and wildlife, including rocky shores and beaches, hard- and soft-bottom seafloor, and pelagic environments. These support a diverse flora and fauna, which also has economic, aesthetic, and educational values. The Districts are working to ensure that the marine habitat is improved. One mechanism is cooperation with the Santa Monica Bay Restoration Project. The project's goals include monitoring, managing, restoring, and protecting the living resources and biodiversity of the Santa Monica Bay and Palos Verdes Peninsula areas, coordinating water quality concerns with resource management goals.

Plankton. Plankton are organisms that drift passively in oceanic currents. They include three primary groups: phytoplankton (plants), zooplankton (small invertebrate animals), and meroplankton (larvae of fish and invertebrates that eventually become pelagic or benthic).

Phytoplankton (floating algae) are the primary producers of the marine food web. Over 280 species have been recorded in coastal California waters (Riznyk 1977); diatoms and dinoflagellates are the most abundant groups. Phytoplankton are primary synthesizers of food from nutrients (e.g., nitrogen, phosphorus, silicon, and other inorganic compounds). In marine environments, nitrogen is generally a very important nutrient for production.

Phytoplankton also need light, and therefore they are found primarily in the photic zone (the zone of light penetration in water).

Upwelling events or surfacing plumes of diluted wastewaters can transport nutrients into the photic zone, causing a temporary enhancement in phytoplankton if natural supplies of nutrients are limiting production. There is no recent evidence of enhanced phytoplankton production off Palos Verdes Peninsula as a result of wastewater discharge practices. Phytoplankton are not routinely monitored because such data have questionable value.

Zooplankton include both herbivores (grazers eating algae) and carnivores (which eat other animals). They are the primary energy link between phytoplankton and higher trophic levels in the food chain, including fish, birds, and marine mammals. There have been at least 2,500 species of zooplankton and meroplankton (fish and invertebrate larvae) reported in the California Current system (Kramer and Smith 1972).

Zooplankton are found throughout the water column, with many species exhibiting daily vertical migrations. Peak seasonal abundance of zooplankton generally occurs slightly later than phytoplankton blooms in the spring and early summer. There have been few studies of zooplankton abundances offshore from Palos Verdes Peninsula.

Kelp Beds. The kelp beds off the Palos Verdes Peninsula rocky subtidal zone provide important habitats for fish, invertebrates, and some marine mammals. Giant kelp (*Macrocystis pyrifera*) is also harvested commercially. Districts divers monitor the kelp beds quarterly, and the California Department of Fish and Game (DFG) performs quarterly aerial photographic surveys.

The kelp beds off Palos Verdes Peninsula had virtually disappeared by 1958, partly as a result of particulates discharged from the Districts' outfall system (California State Water Quality Control Board 1964). These particulates altered substrates needed for kelp attachment, and decreased light intensity in the water column. Other factors such as sea urchin grazing and warm water from El Niño conditions were also related to the decline of kelp. Significant efforts were made to reestablish the kelp beds (Wilson, Haaker, and Hanan 1978). As a result of several factors including transplantation, competitor and grazer control programs, and improvements in effluent quality from the Districts' outfalls (an 80% reduction in effluent suspended solids since 1970), the kelp beds off the peninsula have recovered (Figure 5-11) (Wilson, Haaker, and Hanan 1978; Wilson, Mearns, and Grant 1980; Meistrell and Montagne 1983).

Although reductions in emissions of suspended solids contributed to this recovery, it is apparent that many other biological, geological, and meteorological factors control kelp populations. Winter storms periodically destroy kelp beds all along the coast (Wilson and Togstad 1983; Dayton and Tegner 1984). However, compared with kelp beds in other areas, the Palos Verdes beds have recovered very quickly after storms (Wilson and Togstad 1983). Turbidity and sedimentation from the Portuguese Bend landslide also has had a major impact on the Palos Verdes kelp beds. Fluctuations in grazing pressure from sea urchins also affect kelp; this is thought to be the dominant factor causing the decline in acreage of kelp beds in the 1990s.

Benthic Invertebrates. Benthic organisms dwell in or on sediments on the sea floor. This group includes benthic infauna and epibenthic macroinvertebrates, described separately below.

Benthic Infauna. Benthic infauna include a wide variety of organisms that burrow in soft, unconsolidated sediments on the sea floor. The most abundant groups are polychaete worms, mollusks (clams) and crustaceans (e.g., shrimps and crabs). These organisms can bioaccumulate toxins and are important in the diet of many fish and crustaceans.

The types of species present and their distribution and abundance are dependent on several natural factors, including depth, distance from shore, currents, sediment type, biogeographic location, and oxygen concentration in the bottom waters. Because these organisms are sedentary (not capable of extended movement), they are commonly used as indicator organisms to evaluate environmental stress near outfalls. Important community variables include species numbers and types, abundance, biomass, and diversity. Benthic communities that have been disturbed can recover once environmental stresses are reduced.

The Districts monitor infaunal communities semiannually at up to 44 Palos Verdes sites using benthic grab samples. The objective is to observe distribution patterns of the benthos in relation to the outfalls, monitor changes in the communities over time as sediment quality improves, and relate infaunal changes to fish populations.

In the early 1970s, benthic infaunal communities near the outfalls were dominated by polychaete worms, such as *Schistomeringos longicornis* and *Capitella* spp.; *Chaetopterus variopedatus* beds covered some nearshore sediments in the 1960s (Allan Hancock Foundation 1965; Jones 1969). Species diversity was low, crustaceans and echinoderms were rare, and many infaunal species were conspicuously absent near the outfalls.

Infauna recovered substantially between 1972 and 1992 (Figures 5-8 and 5-12). Communities became more balanced: diversity and numbers of arthropods, echinoderms, and burrowing organisms increased, while total biomass, and the abundance of polychaetes and mollusks decreased. Many organisms previously absent from the midshelf progressively recolonized areas near the outfall.

In 1992, infaunal abundance and biomass were highest at a depth of 500 feet (150 m) (Figures 5-8 and 5-12). The small clam *Parvilucina tenuisculpta* was very abundant in this zone. The number of species was highest nearshore and decreased offshore. The zone northwest and offshore of the outfalls continued to harbor fewer species; however, the number of species had increased markedly and the area affected by the outfall has decreased substantially over the past two decades. Important factors in benthic recovery probably included improvements in sediment quality resulting from reductions in effluent emissions, stimulated by natural events such as El Niño, storms, and biological invasions (Stull, Haydock, and Montagne 1986; Stull, Haydock, Smith, and Montagne 1986).

Epibenthic Macroinvertebrates. Epibenthic macroinvertebrates are a group of relatively mobile organisms that reside and feed on the ocean floor. Most common are crustaceans (e.g., shrimps and crabs) and echinoderms (starfish and sea urchins). These species can potentially bioaccumulate toxins and can be consumed by other marine organisms.

The Districts monitor Palos Verdes epibenthic populations through quarterly trawl surveys. The three dominant species collected from 1978 to 1992 were the ridgeback rock shrimp (*Sicyonia ingentis*), 40% of the 15-year invertebrate catch; the white sea urchin (*Lytechinus pictus*), 30%; and the pelagic red crab (*Pleuroncodes planipes*), 25%.

Invertebrate community composition varies with depth and distance from the outfalls, but has also varied over time. Some species have expanded their ranges, colonizing areas closer to the outfalls. Climatic events such as El Niño and storms strongly influence the sizes of populations (County Sanitation Districts of Los Angeles County 1992a).

The health of the epibenthic communities has improved since the late 1970s. Thompson et al. (1993) performed a multivariate analysis of southern California monitoring data (1,168 trawls, 224 sites, 30-3,000 feet [10-915 m], 1971-1984). Pre-1980 Palos Verdes samples were classified as a unique low-diversity assemblage. In the 1980s, this group declined, and Palos Verdes epibenthic fauna were classified with the normal shelf assemblage for southern California.

Demersal Fish. The Districts have trawled Palos Verdes bottom fish for 20 years to assess populations in relation to effluent discharge and environmental conditions. Flatfish (*Pleuronectiformes*) and rockfish (*Scorpaenidae*) dominated the soft-bottom demersal fish fauna between 1973 and 1992. Other fish were most abundant in 1983 (an El Niño and storm year), 1977 (El Niño), and 1988 (storm). Assemblages varied greatly over time and by depth, distance from the outfalls, and site. The seven most numerous species were Dover sole (*Microstomus pacificus*) 18% of 20-year catch; stripetail rockfish (*Sebastes saxicola*), 9%; slender sole (*Eopsetta exilis*), 8%; Pacific sanddab (*Citharichthys sordidus*), 8%; plainfin midshipman (*Porichthys notatus*), 7%; yellowchin sculpin (*Icelinus quadriseriatus*), 7%; and speckled sanddab (*Citharichthys stigmaeus*), 6%.

In the early 1970s, demersal fish catches near the outfalls were smaller, biomass was lower, and there were fewer species and less diversity than at sites distant from the discharge (Mearns et al. 1976, Allen 1977 and 1982). Hornyhead turbot (*Pleuronichthys verticalis*), California tonguefish (*Symphurus atricauda*), and plainfin midshipman (*Porichthys notatus*) were among the rare or absent fish species near the outfalls, whereas white croaker (*Genyonemus lineatus*), shiner perch (*Cymatogaster aggregata*), and curlfin sole (*Pleuronichthys decurrens*) were unusually abundant.

Many species that were rare on the shelf and slope in the 1970s became more abundant and widespread in the 1980s and 1990s. Also, previously abundant species that had been associated with the discharge declined. Figure 5-13 show a few representative species from each of the three water depths sampled.

Fish catches fluctuated greatly over the two decades. Most population changes occurred over the entire Palos Verdes study area in response to large-scale climatic conditions. Because of a multiplicity of varying environmental perturbations of different intensity, frequency, and duration, the causes of changes in fish populations cannot be easily quantified. However, Allen (1982) developed a model of the functional structure of the demersal fish assemblages of the Southern California shelf, to aid in studying wastewater effects. The study indicated that, for the most part, the functional structure of present Palos Verdes assemblages was similar to elsewhere in the bight.

Bioaccumulation of Toxicants. Marine organisms may be exposed to contaminants in a variety of ways, including contacting water and sediments and feeding on contaminated prey. Contaminants of greatest concern with regard to the marine biota and their human consumers are those that biomagnify, or increase in concentration up the food chain. In the environment off Palos Verdes, DDT and PCBs are the persistent synthetic chlorinated hydrocarbons. DDT inputs to the Districts' sewer system were terminated in 1971, and other sources of this chlorinated hydrocarbon have been minimized (Chartrand et al. 1985). PCBs have been virtually undetected in JWPCP effluent since 1985. However, DDT and other contaminants contained in sediments deposited historically can be a source of those contaminants to the marine environment

DDT and PCBs are measured in tissues of fish and invertebrates from the Palos Verdes Shelf and slope to assess risks to the health of humans and marine organisms. Bioaccumulation data have been gathered since the early 1970s. A comprehensive historical summary and assessment of contaminant trends in the Southern California Bight was recently published by the National Oceanic and Atmospheric Administration (Mearns et al. 1991).

Figure 5-14 shows historical contaminant trends for muscle tissue from two fish species collected near the outfalls: Dover sole, a flatfish that is not harvested for human consumption, and kelp bass (*Paralabrax clathratus*), a popular sport fish, whose populations off Palos Verdes Peninsula increased in the 1980s with the expansion of kelp beds (Stull et al. 1987). In the 1970s, Dover sole and kelp bass muscle tissue concentrations of DDT and PCBs were the highest in fish caught near outfalls in the 1970s.

Although tissue concentrations of DDT and PCBs have decreased markedly since the 1970s, the Palos Verdes biota still continue to carry these contaminants (Smokler et al. 1979, Young et al. 1988, and Mearns et al. 1991). Because these contaminants are no longer discharged in significant quantities, the only known source is the historical discharges preserved in shelf and slope sediments.

The California (Cal-EPA's) Office of Environmental Health Hazards Assessment (OEHHA) (California Environmental Protection Agency 1991) analyzed edible muscle tissue from 16 marine fish species at 24 southern California locations for chemical contaminants and made site-specific consumption recommendations that have been incorporated into the California sport fishing regulations (California Department of Fish and Game 1992). For areas off the Palos Verdes Peninsula, OEHHA recommends that white croaker not be consumed, and that outfall-area sculpin, rockfishes, and kelp bass (together) not be consumed at more than one meal every 2 weeks. Other recommendations apply to other areas of the Southern California Bight.

DDT and PCBs are lipophilic compounds (compounds that have a strong affinity for lipids), and highest tissue concentrations have been measured in the lipid-rich tissues of white croaker (Gossett et al. 1982). The Palos Verdes commercial white croaker fishery was closed in 1991 because of health risk evaluations of the California Department of Health Services (predecessor agency of the Cal-EPA OEHHA).

Fin Erosion. Fin erosion, the degeneration of fins, is thought to result from a complex set of causes, possibly including contact with contaminated sediments, low dissolved oxygen environments, and secondary bacterial infections (Sindermann et al. 1980, Sherwood 1982). Trawled fish are individually examined for evidence of external physical anomalies, of which the most common has been fin erosion. Thirty-one of 69 species collected off the Palos Verdes Peninsula during 1969-1972 trawl surveys exhibited fin erosion (Southern California Coastal Water Research Project 1973). Dover sole had the highest incidence. This species is a deepwater flatfish that prefers muddy bottoms, where it feeds on benthos. Juvenile Dover sole settle on the shelf and gradually move downslope as they mature (Hunter et al. 1990).

Fin erosion was very common among Palos Verdes Dover sole at the 450-foot (137-m) depth in the 1970s (Figure 5-15). The highest incidence of fin erosion was found at the near-outfall (T4 and T5) stations; the syndrome was rare at the most distant site (T0). Fin erosion had virtually disappeared by 1986. Severity of the syndrome also declined over time: typically in the 1980s only a very small section of the mid-dorsal fin was afflicted, whereas there were near total losses of most fins in the early 1970s.

The specific cause of fin erosion has never been determined; however, the syndrome is thought to be associated with contaminated sediments (Sherwood and Mearns 1977). With improving environmental conditions, this syndrome has disappeared, first from fish caught at sites distant from the discharge outfall and later from fish caught nearer the outfall.

Pelagic Fish. Pelagic fish are generally highly mobile schooling fishes that reside and feed in the water column. Common commercially caught pelagic fish in the region are Pacific mackerel (*Scomber japonicus*), jack mackerel (*Trachurus symmetricus*), Northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax*), and Pacific bonita (*Sarda chiliensis*). The migratory yellowtail (*Seriola lalandi*) and Pacific barracuda (*Sphyraena argentea*) are also in the area during summer and are common during El Niño events.

Because of their high mobility and pelagic feeding habits, these species are more subject to regional rather than localized environmental conditions.

Coastal and Pelagic Birds. The bird fauna of the Southern California Bight is diverse and highly transitory. Over 15 families and 80 species of marine-related birds inhabit the Southern California Bight (Bonnell et al. 1981). Birds use the shoreline, open waters, and the Pacific Flyway (during migration). Many of these species feed on epipelagic fishes and invertebrates. The only California breeding populations of storm petrels (*Oceanodroma* spp.), Xantus murrelets (*Endomychura hypoleuca*), and brown pelicans (*Pelecanus occidentalis*) are located in the Southern California Bight. Breeding of these species would not be influenced by future actions associated with the Districts' discharge.

Marine Mammals. Thirty-six species of marine mammals have been recorded in the Southern California Bight; these include whales, dolphins, seals, sea lions, and sea otters (Dohl et al. 1981). All marine mammals are protected under the Marine Mammal Protection Act of 1972. Most of the species are seasonal migrants that are widely dispersed and not dependent on the habitat near the Districts' outfalls. Some species are found in the Bight year round.

Six species of pinnipeds (seals and sea lions) inhabit the waters of the Bight year round: California sea lions (*Zalophus californianus*), Northern sea lions (*Eumetopias jubata*), Northern fur seals (*Callorhinus ursinus*), Guadalupe fur seals (*Archtocephalus townsendi*), harbor seals (*Phoca vitulina*), and Northern elephant seals (*Mirounga angustirostris*) (Antonelis and Fiscus 1980). Concentrations of these species are common around the northern Channel Islands where they haul out (rest), breed, nurse, and forage. Some foraging also occurs in nearshore waters. Of the bight's pinnipeds, only the California sea lion is resident off the Palos Verdes Peninsula. The elephant seal is a seasonal migrant.

Whales and dolphins are also transient or migratory throughout the bight. The two species that are most common in nearshore waters are the migratory California gray whale (*Eschrichtius robustus*) and the resident Pacific bottlenose dolphin (*Tursiops truncatus*).

Southerly migrating gray whales pass the Palos Verdes Peninsula from December to February en route to calving lagoons in Baja California; northerly migrating whales pass by from February to May en route to feeding grounds in the Bering Sea (Dohl et al. 1981). Because the whales seldom feed during their migration, contaminant bioaccumulation from the Palos Verdes area is not likely.

Rare, Threatened, and Endangered Species. There are 21 species of marine mammals, turtles, or birds that may occur in the Southern California Bight that are state or federally listed as rare, threatened, or endangered. However, only one of these species, the California brown pelican, is likely to be present in the vicinity of the Districts' outfalls. The California gray whale was removed from the federal endangered species list in 1994.

The California brown pelican population was nearly decimated in the 1960s as a result of reproductive failures associated with bioaccumulation of DDT. The species was consequently listed as endangered under the federal Endangered Species Act and was listed under the California Endangered Species Act as endangered and protected. The brown pelican populations have increased markedly since the banning of DDT in the early 1970s. The pelican nests on the Channel Islands (West Anacapa, Scorpion Rock, Santa Barbara) and Los Coronado Islands off Baja, Mexico. Pelicans feed near the rookeries during nesting periods, dispersing and feeding all along the southern California coast the remainder of the year. The abundance of anchovy, the pelican's primary food, now strongly influences the species' population size.

It has been suggested that the brown pelican may soon be downlisted to threatened status because its populations are recovering (Leet et al. 1992). However, in 1992, pelicans experienced one of the worst seasons in the last decade, with high nest abandonment on West Anacapa Island (over 75% of 2,175 pairs) and the lowest productivity (0.30) since 1978. On Santa Barbara Island, 225 pairs produced three fledged young.

Areas of Special Biological Significance. In 1976, the SWRCB designated 34 "Areas of Special Biological Significance" to afford special protection for marine life by prohibiting waste discharges in those areas (California State Water Resources Control Board 1976). There are no Areas of Special Biological Significance near the Palos Verdes Peninsula. The closest sites are Mugu Lagoon to Latigo Point (north of Santa Monica Bay), four Catalina Island sites, and Newport Beach (Orange County).

Several coastal portions of the Palos Verdes Peninsula, all within 4 miles of the outfall system, have been named reserves or refuges. Point Fermin is a state marine life refuge. The cities of Rancho Palos Verdes and Palos Verdes Estates have declared all their seashores as reserves. Abalone Cove was designated a reserve by Los Angeles County; it is managed by Rancho Palos Verdes. No special designation has been assigned to Whites Point. The proposed discharges would not affect these coastal sites.

Uses of the Marine Environment. Beneficial uses of the Palos Verdes receiving environment include industrial service supply, navigation, water contact recreation, non-contact water recreation, ocean commercial and sport fishing, shellfish harvesting, preservation of rare and endangered species, and marine habitat (California Regional Water Quality Control Board 1989).

Also, the Palos Verdes Peninsula region is included in the Santa Monica Bay Restoration Project area, which was recognized by the U.S. Congress and the State of California as a natural resource to be preserved and protected under the National Estuary Program. The Districts are active in the management and technical committees of the restoration project, and contribute to various environmental studies of the area.

Industrial Service Supply. Industrial service supply is a beneficial use listed for the entire Los Angeles County nearshore coastal zone. Industrial activities are not apparent on the Palos Verdes Peninsula. Local waters are not generally used for mining, cooling water supply, hydraulic conveyance, gravel washing, or fire protection.

Ocean Dumping. The only permitted dumpsite in the area, LA-2, is 1½ miles south of the Palos Verdes Peninsula. It is a site 1.1 miles in diameter at a water depth of 600 feet (200 m), which receives maintenance and construction dredging material from the Los Angeles and Long Beach Harbors. From 1931 to 1978, there were four designated ocean dumping sites between the Palos Verdes Peninsula and Santa Catalina Island (Chartrand et al. 1985).

Navigation. Vessel traffic is active off the Palos Verdes Peninsula, especially to and from neighboring harbors and bays. The coastal shipping lane extends west of Point Fermin for 8.9 miles before turning northwest and parallel to the 500-m isobath. The Los Angeles and Long Beach Harbors are 2.5 miles east of Point Fermin. In 1990, 7,013 vessels arrived at these harbors, of which 1,000 were tankers; over 10,000 vessels are expected to arrive annually by 2000 (U.S. Army Corps of Engineers 1992). The harbors host a variety of commercial and pleasure boat docks, dry docks, and fuel docks.

Water Contact Recreation. Sport diving is popular off the Palos Verdes Peninsula, at Bluff Cove, Point Vicente, Abalone Cove, and Whites Point and off Cabrillo Beach. Swimmers enter from Cabrillo Beach. The Cabrillo Beach area is also used for jet-skiing and wind surfing. Surfing is prevalent at many beaches on the northwest side of the peninsula.

Noncontact Water Recreation. Shore activities on the Palos Verdes Peninsula, such as picnicking, sunbathing, hiking, and tidepooling, are limited by a general shortage of public facilities; limited access; and the rugged, rocky terrain of the shoreline. Palos Verdes Peninsula beaches that were formerly sandy, such as Abalone Cove and Portuguese Bend, are now mostly cobble with patches of sand; this change resulted from the El Niño-related storms of 1982-1983. However, Cabrillo Beach on the south and Rat Beach on Santa Monica Bay are still sandy. Recreational boating is common; the closest marinas are in the Los Angeles and Long Beach Harbors and Santa Monica Bay. Kayakers paddle near Cabrillo Beach. Bird and whale watching is common, particularly from the Palos Verdes Peninsula cliffs.

Ocean Commercial and Sport Fishing. Fishing includes commercial passenger boat fishing ("party boats"), pier fishing, private boat fishing, diving, scientific collecting, and limited commercial fishing. Sport fishing is allowed throughout the area off the Palos Verdes Peninsula, although Cal-EPA has recommended in the California sportfishing regulations limited consumption of certain species based on tissue levels of DDT and PCBs. Commercial fishing for white croaker has been banned since 1991 because of contamination of the species with DDT and PCBs. Purse seines, gill nets, and traps are prohibited west of Palos Verdes Point, where commercial fishing is restricted to hook-and-line fishing. Fishing for halibut and white seabass using gill nets was recently prohibited in the area. On January 1, 1994, as a result of Proposition 132 and the Marine Resources Protection Act, a constitutional amendment was enacted banning nearshore use of gill nets.

The Palos Verdes Peninsula area is an important fisheries resource. Stull et al. (1987) documents DFG data on 50 years (1936 to 1985) of catches from party boats, and 15 years (1969 to 1983) of commercial landings. Between 1978 and 1984, 2.65 million fish were taken by party boats. Important species included Pacific bonito, Pacific mackerel, kelp bass, sand bass (*Paralabrax* spp.), and Pacific barracuda. California halibut (*Paralichthys californicus*) catches were not dominant but were increasing. Between 1989 and 1992, the annual commercial catch was 770,000 pounds, dominated by Pacific mackerel, Pacific sardine, Pacific barracuda, and white croaker.

A myriad of environmental factors might influence fisheries, including natural phenomena (e.g., temperature, storms, upwelling) and anthropogenic perturbations (e.g., DDT and other trace contaminants, fishing practice, economics). Therefore, it is difficult to relate fish catch to specific environmental parameters.

Shellfish Harvesting. DFG's Nearshore Sportfish Habitat Enhancement Project (in Long Beach) monitors sea urchin population dynamics and commercial landings in southern California (Stull et al. 1987). The red urchin (*Strongylocentrotus franciscanus*) is the only urchin presently harvested off the Palos Verdes Peninsula (for its roe). It is found at a water depth of 10-100 feet (3-30 m), in crevices, among kelp holdfasts or coralline algae, or even on bare rocks.

Large masses of red urchins were taken in the late 1970s, following the return of kelp beds; overharvesting diminished stocks, however, and smaller masses were taken in the 1980s and 1990s (Stull et al. 1987). In 1993, 223,000 pounds of red urchins were taken off the Palos Verdes Peninsula, of a total of 11.4 million pounds taken in southern California. Long-term heavy harvest pressure has forced divers to go further afield (mostly to the Channel Islands) and to take both small and large urchins. Minimum size limits were recently imposed.

Market squid (*Teuthoidea*), rock crab (*Cancer* spp.), and California spiny lobster (*Panulirus interruptus*) are also harvested commercially in the Palos Verdes Peninsula area. An annual average of 280,000 pounds of invertebrates was taken commercially between 1989 and 1992.

Clams, oysters, and mussels are collected recreationally in small numbers. The abalone (*Haliotis* spp.) population off the Palos Verdes Peninsula and throughout California coastal waters has declined substantially in the past several decades. There are complex reasons for this decline, including overfishing, loss of habitat, and competition with sea urchins.

IMPACTS AND MITIGATION MEASURES OF THE 2010 PLAN ALTERNATIVES

The following impact analysis discusses potential impacts associated with the discharge of treated effluent from the Districts' outfalls to the marine environment. Construction in the marine environment is not being considered under any of the project alternatives.

The Districts are considering five operational alternatives; however, three of the alternatives result in identical discharge flows and effluent quality. The three identical alternatives, Alternatives 1, 2, and 3 provide secondary treatment of all wastewater entering the JWPCP and result in discharge flows of 400 mgd. Alternative 4 also consists of full secondary treatment but includes a larger fraction of reclaimed wastewater, and therefore results in a smaller discharge to the marine environment (350 mgd). Under the No-Project Alternative, the existing operations (partial secondary treatment) continue and wastewater volumes increase linearly through 2010 to the Districts' current treatment capacity of 385 mgd at the JWPCP.

Methodology and Assumptions for Impact Analysis

The impact analyses are based on projected effluent flow and quality. The projection is based on the assumption that secondary treatment for all JWPCP flow will be achieved by 2002. Projections for contaminant concentrations in the effluent and contaminant emissions are based on the efficiency of secondary treatment in removal of solids, metals, and other contaminants from the effluent and are based on the assumption that effluent flow volumes will increase linearly to 2010.

Present and projected values for effluent quality for all alternatives are presented in Table 5-2. Projected mass emissions for the alternatives resulting in effluent discharges of 400 mgd (Alternatives 1, 2, and 3), 350 mgd (Alternative 4), and 385 mgd (No-Project Alternative) are presented in Table 5-3. Concentration limits for pesticides, PCBs, noncarcinogenic toxics, and carcinogenic toxics are presented in Tables B-7 to B-10 in Appendix B.

The following assumptions were made to evaluate potential impacts resulting from discharges to the marine environment associated with the implementation of the 2010 Plan:

- The existing regulatory framework applicable to discharges in the marine environment will be the basis for the protection of water quality, marine biota, and beneficial uses.
- Increases in flow will be linear.
- The concentration of metals in the influent will remain relatively constant through 2010.
- The treatment level at the JWPCP will remain at its current level through 2002.
- Secondary treatment of all JWPCP effluent will be achieved by December 31, 2002.

Table 5-2. Comparison of Existing and Projected (Year 2010) Concentrations of Contaminants in JWPCP Discharge with Current NPDES Permit Limitations

Constituent	NPDES Limits 30-day Average (mg/l)	1993 Effluent (328 mgd) (mg/l)	Alternatives 1, 2, and 3 (400 mgd) (mg/l)	Alternative 4 (350 mgd) (mg/l)
Arsenic	0.014	0.0026	0.002	0.002
Cadmium	0.006	< 0.001	< 0.001	< 0.001
Total chromium	0.07	0.011	0.01	0.01
Copper	0.057	0.024	0.009	0.009
Lead	0.067	< 0.008	< 0.008	< 0.008
Mercury	0.0007	< 0.0005	< 0.0005	< 0.0005
Nickel	0.066	0.039	0.035	0.035
Selenium	0.017	0.013	0.010	0.010
Silver	0.011	0.006	0.005	0.005
Zinc	0.197	0.086	0.038	0.038
Phenols	3	0.41	0.01	0.01

Note: < indicates that concentrations are below analytical detection limits.

Source: County Sanitation Districts of Los Angeles County 1994d.

Table 5-3. Comparison of Existing and Projected (Year 2010) JWPCP Mass Emissions with Current NPDES Permit Limits

Constituent	NPDES Limits 30-day Average (kg/day)	1993 Effluent (328 mgd) (kg/day)	Alternatives 1, 2, and 3 (400 mgd) (kg/day)	Alternative 4 (350 mgd) (kg/day)
Arsenic	20.37	3.22	3.02	2.65
Cadmium	8.73	<1.24	<1.51	<1.32
Total chromium	101.8	13.63	15.09	13.23
Copper	82.93	29.75	13.58	11.90
Lead	97.48	<10.41	<12.07	<10.58
Mercury	1.02	<0.62	<0.75	<0.66
Nickel	96.02	48.34	52.83	46.29
Selenium	24.73	16.61	15.39	13.49
Silver	16.00	7.44	7.55	6.61
Zinc	286.6	106.59	57.35	50.26
Phenols	4,365	508	15.09	13.23

Note: Mass emissions were calculated using projected effluent flows and quality.

< = indicates that, where effluent concentrations were determined to be below the analytical detection limit, the detection limit was used to project mass emissions.

Source: County Sanitation Districts of Los Angeles County 1994d.

Criteria for Determining Significance

This section outlines the criteria used to determine the level of significance of environmental impacts on the marine environment associated with implementing the 2010 Plan. The significance criteria were developed from Appendices G and I of the State CEQA Guidelines, EPA marine water quality criteria, the California Ocean Plan, current NPDES permit limitations, and professional practice. An alternative would be considered to have a significant impact if it would result in discharges that:

- do not comply with state and federal marine water quality criteria,
- do not comply with current NPDES permit limitations for concentrations or mass emissions of contaminants,
- substantially degrade marine sediment quality,
- substantially diminish habitat for marine biota,
- adversely affect the health of marine biota,
- adversely affect threatened or endangered species or their habitats,
- substantially affect designated beneficial uses, or
- create a potential public health hazard.

Comparison of Alternatives

Table 5-4 at the end of this chapter shows that the impacts on the marine environment associated with Alternatives 2, 3, and 4 are similar to those associated with Alternative 1.

Alternative 1: Upgrade JWPCP/Expand Los Coyotes WRP/San Jose Creek WRP

Impact: Potential for Degradation of Marine Water Quality Resulting from Disposal of Treated Effluent at the JWPCP. Effluent quality currently meets the Districts' NPDES permit limitations. After full secondary treatment is achieved under Alternative 1, the concentrations of most contaminants are projected to decrease. Comparisons of projected effluent quality and mass emissions in 2010 with 30-day average limitations stipulated in the Districts' NPDES permit (California Regional Water Quality Control Board 1989) are shown in Table 5-2. Effluent quality projections indicate that cadmium, lead, and mercury concentrations would remain at 1993 levels; however, these metals are currently below their respective analytical detection limits, and the detection limits were used to project effluent concentration. In all cases, the projected concentrations of contaminants in 2010 are less than current NPDES permit limitations. This impact is considered less than significant.

Effluent projections were made assuming no improvements in source control, so that mass emission calculations are simply proportational to flow (using current secondary effluent quality). After full secondary treatment is achieved, the mass emissions of many contaminants are projected to decrease (arsenic, copper, selenium, zinc, and phenols), while some are projected to increase slightly (cadmium, total chromium, lead, mercury, nickel, and silver) by 2010. Effluent concentrations of cadmium, lead, and mercury are presently below their respective analytical detection limits. To project emissions of these metals, concentrations were assumed to be at their detection limit. Therefore, projections for cadmium, lead, and mercury are likely higher than the levels that would actually be present in the discharge. In all cases, mass emissions in 2010 are projected to be less than existing NPDES limitations (Table 5-3). This impact is considered less than significant.

Effluent solids and contaminant concentrations in the Districts' discharge have steadily decreased since 1970 as a result of improved source control and advanced primary and secondary treatment and especially from better solids processing. The reduced sedimentation and contaminant accumulation have resulted in significantly improved surface sediment quality on the Palos Verdes Shelf and slope (Figure 5-8). The issue of concern regarding sediment quality is the release of historically deposited contaminants. Many factors will affect the extent of release of these deposits, including the reduction of outfall discharges resulting from implementation of full secondary treatment at the JWPCP; however, actions to reduce sediment contamination will be determined as part of compliance with consent decrees entered into by the Districts, as discussed below.

When secondary treatment of all flows is initiated at the JWPCP, both solids and contaminant discharges to the ocean will be proportionately reduced. Secondary treatment will not reduce the concentration of contaminants contained in a unit mass of suspended solids. However, secondary treatment does remove more solids from the effluent and will result in less sedimentation near the outfall.

The sedimentation associated with the discharge is slowly covering much of the deposit of historically contaminated sediments. The reduced sedimentation rate associated with secondary treatment of all JWPCP effluent would result in a slower burial of the historic deposit and would result in a higher potential for contaminant releases from the deposit in the future (because the cap above the deposit would be thinner and more susceptible to physical or biological disturbance). Over time, burrowers have (and will continue to) become more common progressively nearer the outfall. There is no evidence that DDT is being appreciably biodegraded; therefore, sediment quality could be affected by the buried deposit for several decades. Sediment-bound contaminants released from this deposit would likely settle away from the outfall in lesser concentrations.

Benthic communities respond to wastewater discharges in several ways, including changes in biomass and species diversity and a shift in community dominance from above-surface suspension-feeders to below-surface deposit-feeders (Mearns and Green 1976, Word et al. 1977). Effects on benthic fauna were found to be related to the concentration of organic matter in sediments, which is proportional to the suspended solids mass emission rates of a discharge (Bascom et al. 1979; Word 1978a, 1978b; Mearns and Word 1982).

Mass emissions of suspended solids are projected to decrease as a result of providing secondary treatment for all JWPCP flows under Alternative 1. This would result in a decrease in organic loading to sediments in the vicinity of the outfall. Therefore, adverse impacts on benthic fauna associated with organic loading are not anticipated.

Two lawsuits to which the Districts have become a party are expected to resolve the fate of the Palos Verdes Shelf sediment contamination. Under *U.S. et al. v. Montrose et al.* (the NOAA lawsuit), the federal and state governments are seeking damages to restore the natural resources of the Palos Verdes Shelf, the definition of which includes the sediments. The Districts and local governments, as well as one private company, have settled this lawsuit, but other private companies have not. The Districts expect that the lawsuit will eventually provide funding for remediation of the Palos Verdes Shelf sediment contamination, which might involve solutions such as dredging or capping. Such a solution would drastically affect future sediment quality, and would be expected to occur in the timeframe most relevant to this planning process (i.e., 2002-2010).

The "Clean Water Act lawsuit", under which the Districts have agreed to a schedule to provide secondary treatment for all JWPCP flows, also contains provisions regarding the sediment contamination. In this case, the consent decree includes an allowance for the Districts to request a modification of the start-up date for secondary treatment if it can be shown that the harm of proceeding to secondary treatment exceeds the benefits.

Mitigation. No mitigation is required.

Impact: Potential for Improved Conditions for Marine Biota Resulting from Disposal of Treated Effluent at the JWPCP. Under Alternative 1, the effluent concentration and mass emissions of most contaminants are projected to decrease, resulting in slightly improved water and surface sediment quality on the shelf. The concentrations and mass emissions of contaminants are now and are projected to be less than NPDES permit limitations and state and federal marine water quality criteria. Criteria are established to protect all marine species; therefore, toxic effects are not expected in the water column. However, all contaminant concentrations in the discharge and contaminant mass emissions projected for 2010 under Alternative 1 are estimated to be well within the federal and state criteria to protect aquatic life.

Effluent discharged to the marine environment could potentially affect local biota. The structure (species composition) and function (productivity) of marine communities and the flow of energy through ecosystems can be altered by changes in chemical pollutants, sewage-derived nutrients, and inorganic particulate loading. The extent of these effects depends on a number of environmental factors as well as the volume and constituents of the discharge. The following sections describe anticipated effects on individual populations. This impact is not likely to be measurable (less than significant) in most cases and potentially beneficial in a few cases for the reasons described below.

Plankton. Phytoplankton (drifting algae) are the lowest trophic level in the pelagic food web. Nutrients in the effluent could potentially affect pelagic communities if the effluent plume is entrained into the photic zone and phytoplankton productivity is enhanced. Phytoplankton abundance and diversity are controlled by a number of biotic and abiotic factors, the most prominent of these being light, temperature, salinity, nutrients, sinking loss, and loss through grazing. If entrainment of nutrients to the photic zone were to occur when nutrients were limiting, the discharge could result in a temporary enhancement of phytoplankton production. However, entrainment to the photic zone is more likely when the pycnocline is weakest and other factors such as light and temperature are limiting phytoplankton production. In view of the large natural spatial and temporal variations in phytoplankton production and standing stock, occasional stimulation by effluent-derived nutrients is not likely to have any significant long-term ecologically adverse impact on phytoplankton or associated pelagic communities.

Kelp Beds. Kelp beds off the Palos Verdes Peninsula are affected by a number of factors including water transparency, substrate modifications, grazing, competition, and storms. Historical emissions of suspended solids and contaminants from the Districts' discharge likely contributed to decreased water transparency and to increased sedimentation and contaminants on rocky substrates associated with kelp, thus reducing kelp bed size.

The acreage of kelp beds in the rocky subtidal zone has increased dramatically since its decline in the 1940 and early 1950s. Several factors, including transplantation programs, competitor and grazer control programs, and improvements in effluent quality from the Districts' discharge, have contributed to the apparent recovery of kelp on the peninsula (Wilson et al. 1978, 1980; Meistrell and Montagne 1983). Currently, the major factors threatening kelp beds are sea urchin grazing and the Portugese Bend landslide.

Continued improvements in effluent quality and further reductions in suspended solids emissions under Alternative 1 would further reduce any potential effect of the discharge on kelp standing crop and production.

Benthic Invertebrates. Reduction in discharges of suspended solids with implementation of full secondary treatment should result in improved benthic habitat conditions near the outfall. Suspended solids accumulate on the sea floor in the vicinity of the outfall, changing the physical and chemical characteristics of the substrate. Benthic communities respond to wastewater discharges in several ways, including changes in biomass, species diversity and composition, and community dominance. The effects of discharges generally appear as a gradient of effects, with the most severe impacts occurring downcurrent of the outfall, and decreasing with increasing distance.

Off the Palos Verdes Peninsula, notable improvements in benthic community structure have occurred over the past 20 years as discharges of suspended solids and trace contaminants have decreased and effluent and sediment quality have improved. Between 1972 and the present, benthic communities affected by the outfall have shown the return of previously absent species, increased species diversity, and decreased total biomass. Continued decreases in suspended solids and contaminant emissions are expected to allow the continuation of this trend. However, sediment quality could be strongly influenced by the deposit of historically contaminated sediments, as discussed earlier, and the fate of the contaminated sediments could affect the community structure of the benthos.

Demersal Fish. Future reductions of suspended solids and most contaminant emissions under Alternative 1 could add to the continuing fluctuations in the demersal fish community near the outfall. However, at this point, it is difficult to assess whether any further change that might occur would result from habitat improvements (e.g., sediment quality and food resources) or simply be a manifestation of natural variation. Incidence of externally evident diseases on fish and other organisms has been used as an indicator of stressed environments. The incidence of several types of disease and abnormalities is sometimes greater in human-altered environments. However, specific cause-and-effect relationships between abnormalities in fishes and pollutant discharges are often unknown. The incidence of fin erosion has been reduced to zero in recent years and would not be expected to recur under Alternative 1.

Pelagic Fish. Pelagic (open water) fishes are capable of long-range mobility. Any change in populations of these fish or in tissue concentrations of contaminants could not be ascribed to a single source of pollution but would instead be ascribed to the cumulative effect of a exposure of a fish to many sources of pollution throughout its habitat. Implementation of Alternative 1 would result in a slight overall decrease in the loading to the bight, but the change would probably not be measurable on a regional scale.

Coastal and Pelagic Birds. Potential impacts of wastewater discharges on coastal and pelagic birds are indirect, resulting from consumption of contaminated prey. Because the Districts' outfall is 2 miles offshore, there is minimal potential for discharges to affect prey species of coastal birds. Pelagic species feed over a larger area of the bight and in the general vicinity of the Districts' outfalls. Any bioaccumulation of toxicants that might result from these birds feeding on pelagic fishes would result from exposure of prey to multiple sources of contamination in the bight. Implementation of Alternative 1 would result in a slight overall decrease in the loading of most contaminants to the bight, but the change would probably not be measurable on a regional scale.

Marine Mammals. Marine mammals are highly transitory through the outfall area. Although individual marine mammals can occasionally be present or feed in the area, they do not concentrate to feed, breed, or rest near the outfall. Therefore, any bioaccumulation of contaminants in marine mammal tissue would result from exposure to contaminants and contaminated prey throughout the animals' range. Implementation of Alternative 1 would result in a slight overall decrease in the loading of most contaminants to the bight, but the change would probably not be measurable on a regional scale.

Rare, Threatened, and Endangered Species. Exposure of the California brown pelican to contaminants discharged under the proposed alternative is expected to be minimal. This species feeds over a wide area. Implementation of Alternative 1 would result in a slight overall decrease in the loading of most contaminants to the bight, but the change would probably not be measurable on a regional scale.

Beneficial Use. Noncontact recreation, industrial service supply, and navigation will not be affected by implementation of Alternative 1. Water contact recreation and fishing activities could be affected in the immediate vicinity of the discharge, but the impact is expected to be minor. The Districts disinfect their effluent prior to discharge to minimize the risk of viral and bacterial infection. Consequently, the Districts' discharge has been in compliance with regulatory standards set to protect contact recreation, harvestable fish and shellfish, and other marine biota. Additionally, secondary treatment is an effective means of removing bacteria and viruses from the effluent, with up to a 90% efficiency.

Mitigation. No mitigation is required.

Alternative 2: Upgrade JWPCP/Expand Los Coyotes WRP

Table 5-4 shows that the impacts under Alternative 2 would be the same as those under Alternative 1.

Alternative 3: Upgrade JWPCP/Expand Whittier Narrows WRP

Table 5-4 shows that the impacts under Alternative 3 would be the same as those under Alternative 1.

Alternative 4: Upgrade JWPCP/Expand Los Coyotes WRP/ San Jose Creek WRP/Whittier Narrows WRP

Table 5-4 shows that the impacts under Alternative 4 would be the same as those under Alternative 1.

No-Project Alternative

Impacts of Treated Effluent Disposal

Under the No-Project Alternative, the Districts would continue the present level of wastewater treatment (a combination of advanced primary treatment and secondary treatment), resulting in an increase in discharge flow and effluent contaminant and suspended solids emissions through 2010. The concentrations and mass emissions projected for 2010 meet marine water quality, current NPDES permit standards, and California Ocean Plan limitations; therefore, no significant impacts on the marine environment or beneficial uses are anticipated to result from implementation of the No-Project Alternative. However, the No-Project Alternative would not comply with the Consent Decree requiring that the Districts provide secondary treatment for all JWPCP flow. Additional sediment accumulations near the outfall under the No-Project Alternative may aid in the burial of the historical deposit of contaminated sediments near the outfall. However, other activities are expected to govern the sediment quality (i.e., the NOAA lawsuit), and the impacts would likely be less than significant.

Table 5-4. Comparison of Marine Environment Impacts by Alternative

	Alternative 1			Alternative 2			Alternative 3		Alternative 4				
Impacts and Mitigation Measures	JWPCP	LC	SJC	JWPCP	LC	Sewers	JWPCP	WN	JWPCP	LC	SJC	WN	Sewers
Impacts of Treatment Plant Operations													
Impact: Potential for degradation of marine water quality resulting from disposal of treated effluent at the JWPCP (LT) No mitigation is required	✓			✓			✓		✓				
Impact: Potential for improved conditions for marine biota resulting from disposal of treated effluent at the JWPCP (LT) No mitigation is required	✓			✓			✓		✓				

No significant impacts on the marine environment would occur.

LT = less than significant.