Chapter 4. Sediment Characteristics

INTRODUCTION

Ocean sediment samples are collected and analyzed as part of the Point Loma Ocean Outfall (PLOO) monitoring program to characterize the surrounding physical environment and assess general sediment conditions. These conditions define the primary microhabitats for benthic invertebrates that live within or on the surface of sediments, and can therefore influence the distribution and presence of various species. The distributions of many demersal fishes are also often associated with specific sediment types that reflect the habitats of their preferred invertebrate prey (Cross and Allen 1993). Consequently, an understanding of differences in sediment conditions over time and space is crucial to assessing coincident changes in benthic invertebrate and demersal fish populations (see Chapters 5 and 6, respectively).

Both natural and anthropogenic factors affect the composition, distribution, and stability of seafloor sediments. Natural factors that affect sediment conditions on the continental shelf include the strength and direction of bottom currents, exposure to wave action, seafloor topography, inputs associated with outflows from rivers and bays, beach erosion, runoff from other terrestrial sources, bioturbation by benthic macrofauna, and decomposition of calcareous organisms (e.g., Emery 1960). The analysis of parameters such as sediment grain size and the relative percentages of different sediment fractions (e.g., sand, silt, and clay) can provide useful information about current velocity, amount of wave action and overall habitat stability in an area. Further, understanding sediment particle size distributions facilitates interpretation of the interactions between benthic organisms and the environment. For example, differences in sediment composition (e.g., fine vs. coarse particles) and associated levels of organic loading at specific sites can affect the burrowing, tube building, and feeding abilities of infaunal invertebrates, thus affecting benthic community structure (Gray 1981, Snelgrove and Butman 1994). Geological history can also affect the chemical composition of local sediments. For example, erosion from coastal cliffs and shores, and flushing of terrestrial sediments and debris from bays, rivers, and streams can contribute to the deposition and accumulation of metals or other contaminants and also affect the overall organic content of sediments. Additionally, primary productivity by phytoplankton is a major source of organics to these sediments (Mann 1982, Parsons et al. 1990). Finally, particle size composition can affect concentrations of chemical constituents within sediments. For example, levels of organic compounds and trace metals within ocean sediments generally rise with increasing amounts of fine particles (Emery 1960, Eganhouse and Venkatesan 1993).

Municipal wastewater outfalls are one of many anthropogenic factors that can directly influence the composition and distribution of sediments through the discharge of treated effluent and the subsequent deposition of a wide variety of organic and inorganic compounds. Some of the most commonly detected compounds discharged via ocean outfalls are trace metals, pesticides, and various organic compounds such as organic carbon, nitrogen, and sulfides (Anderson et al. 1993). Moreover, the presence of large outfall pipes and associated ballast materials (e.g., rock, sand) may alter the hydrodynamic regime in surrounding areas.

This chapter presents summaries and analyses of sediment grain size and chemistry data collected during 2008 at monitoring sites surrounding the PLOO. The primary goals are to: (1) assess possible effects of wastewater discharge on benthic habitats by analyzing spatial and temporal variability of various sediment parameters, (2) determine the presence or absence of sedimentary and chemical footprints near the discharge site, and (3) evaluate overall sediment quality in the region.

Materials and Methods

Field Sampling

Sediment samples were collected at 22 benthic stations in the PLOO region during 2008 (Figure 4.1). Stations in the PLOO region are located along the 88, 98, and 116-m depth contours, and include "E" stations located within 8 km of the outfall, and "B" stations located greater than 11 km north of the outfall. All 22 stations were sampled during the January survey while the July sampling was limited to 12 primary core stations to accommodate additional sampling for the Bight'08 regional project (see Chapter 1). The four stations considered to represent "nearfield" conditions herein (i.e., E11, E14, E15, E17) are located between about 100 and 750 m of the outfall wye or diffuser legs. Each sediment sample was collected from one side of a chain-rigged double Van Veen grab with a 0.1-m^2 surface area; the other grab sample from the cast was used for macrofaunal community analysis and visual observations of sediment composition (see Chapter 5). Sub-samples for various analyses were taken from the top 2 cm of the sediment surface and handled according to EPA guidelines (U.S. EPA 1987).

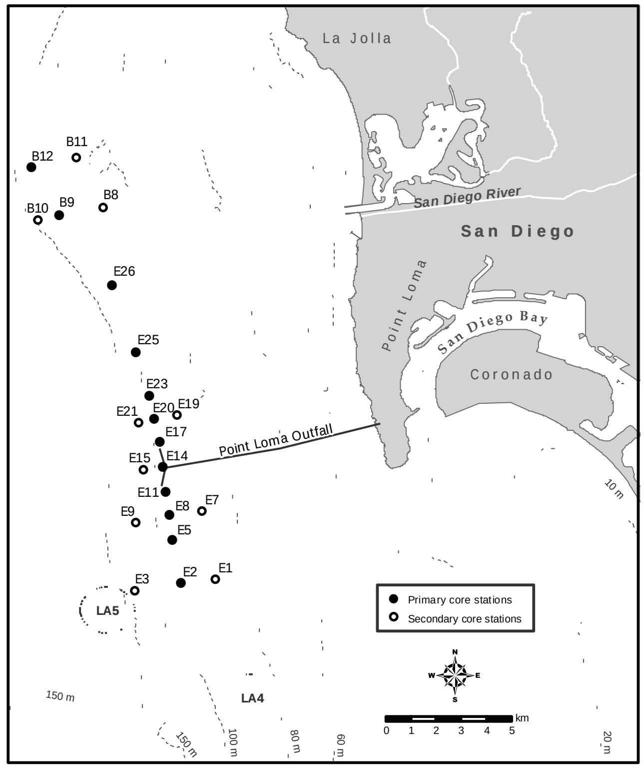

Figure 4.1
Benthic station locations sampled for the Point Loma Ocean Outfall Monitoring Program.

Laboratory Analyses

All sediment chemistry and particle size analyses were performed at the City of San Diego's Wastewater Chemistry Services Laboratory. Particle size analysis was performed using a Horiba LA-920 laser scattering particle analyzer, which measures particles ranging in size from 0.00049 to 2.0 mm (i.e., 11 to -1 phi). Coarser particles (e.g., gravel, shell hash) were removed prior to laser analysis by screening the samples through a 2.0-mm mesh sieve; these data are expressed herein as the "coarse" fraction of the total sample sieved.

Output from the Horiba particle size analyzer was categorized into sand, silt, and clay fractions as follows: sand was defined as particles ranging between 2.0 and >0.0625 mm in diameter, silt as particles between 0.0625 and 0.0039 mm, and clay as particles <0.0039 mm. These data were standardized and combined with any sieved coarse fraction as described above (i.e., particles >2.0 mm) to obtain a complete distribution of the coarse, sand, silt, and clay fractions totaling 100%. The coarse fraction was included with the sand-silt-clay fractions in the calculation of various particle size parameters, which were determined using a normal probability scale (see Folk 1968). These parameters were then summarized and expressed as overall mean particle size (mm), phi size (mean, median, skewness, kurtosis), and the proportion of coarse materials, sand, silt, and clay. Additionally, the proportion of all fine particles (percent fines) was calculated as the sum of all silt and clay fractions for each sample.

Each sediment sample was analyzed for total organic carbon (TOC), total nitrogen (TN), total sulfides, biochemical oxygen demand (BOD), total volatile solids (TVS), trace metals, chlorinated pesticides (e.g., DDT), polychlorinated biphenyl compounds

(PCBs), and polycyclic aromatic hydrocarbons (PAHs) on a dry weight basis (see Appendix C.1). TOC, TN, and TVS were measured as percent weight (% wt) of the sediment sample; BOD, sulfides, and metals were measured in units of mg/kg and are expressed in this report as parts per million (ppm); pesticides and PCBs were measured in units of ng/kg and expressed as parts per trillion (ppt); PAHs were measured in units of µg/kg and expressed as parts per billion (ppb). The data for each parameter reported herein were generally limited to values above method detection limits (MDL). However, concentrations below MDLs were included as estimated values if the presence of the specific constituent was verified by mass-spectrometry (i.e., spectral peaks confirmed). A detailed description of the analytical protocols is available in City of San Diego (2009).

Data Analyses

Total DDT, total PCB, and total PAH were calculated for each sample as the sum of all constituents with reported values. Values for the individual constituents are listed in Appendix C.2. A value of zero was substituted for each non-detect (i.e., null value) data record when calculating means or other statistical descriptors. Summaries for each parameter included the detection rate (i.e., number of reported values/number of samples), annual mean by station, annual mean for all stations combined (areal mean), and maximum value during the year. Contaminant concentrations were further evaluated by comparing data from this study for 2008 to the Effects Range Low (ERL) and Effects Range Median (ERM) sediment quality guidelines of Long et al. (1995) when available. The National Status and Trends Program of the National Oceanic and Atmospheric Administration (NOAA) originally calculated these thresholds to provide a mechanism for interpreting monitoring data. The ERLs are considered to represent chemical concentrations below which adverse biological effects are rarely observed. Values above the ERL but below the ERM represent values at which effects occasionally occur. Although concentrations above the ERM are considered to indicate likely biological effects, it is not always possible to validate such effects by subsequent toxicity testing (Schiff and Gossett 1998).

Results and Discussion

Particle Size Distribution

During 2008, ocean sediments collected off Point Loma were composed predominantly of coarse silt and very fine sands, with mean particle sizes ranging from about 0.04 to 0.09 mm (Table 4.1). There was little difference in intra-station particle size composition between the January and July surveys. The greatest difference occurred at station E2, where fines decreased from about 55% in January to 45% in July (Appendix C.3). Overall, fines averaged about 38% across the region during the year, ranging from a low of about 28% to a high of 56%. Several stations along the 98-m and 116-m depth contours from E21 south to E5 were composed of sediments that had lower percent fines than most stations to the north and to the south (Figure 4.2). Field observations of sediment samples from these stations (i.e., E5, E8, E11, E14, E15, E17, E21) indicated the presence of shell hash and/or coarse black sand (see Appendix C.3), which likely originated from the offshore deposition of dredged anoxic sediments from San Diego Bay and/or stabilizing materials used for the outfall pipe. Although no major changes in the percent fines composition of sediments have occurred since wastewater discharge began at the present discharge site at the end of 1993 (Figure 4.3), there has been a slight increase in mean particle size at station E14 located nearest the discharge site (see City of San Diego 2007). This increase is likely due to the presence of ballast material used during construction of the outfall extension.

The sorting coefficient reflects the range of grain sizes comprising sediments and is calculated as the standard deviation (SD) in phi size units (see Table 4.1). In general, areas composed of particles of similar size are considered to have well-sorted sediments (i.e., SD≤0.5 phi) and are indicative of areas subject to fast moving currents

Table 4.1

Summary of particle size parameters and organic loading indicators at PLOO benthic stations during 2008. Data are annual means per station (n=2) except where noted; SD=standard deviation; BOD=biochemical oxygen demand; TN=total nitrogen; TOC=total organic carbon; TVS=total volatile solids.

		Particle size						Organic indicators				
	Depth (m)	Mean (mm)	Mean (phi)	SD (phi)	Coarse (%)	Sand (%)	Fines (%)	BOD (ppm)	Sulfides (ppm)	TN (%wt)	TOC (%wt)	TVS (%wt)
North reference stations												
B8*	88	0.043	4.5	1.5	0.0	44.0	56.0	287	3.40	0.077	0.85	2.92
B11*	88	0.053	4.2	2.0	3.8	49.9	46.3	376	1.63	0.078	3.51	4.14
B9	98	0.052	4.3	1.6	0.0	57.2	42.8	253	0.09	0.060	0.93	2.87
B12	98	0.069	3.9	1.8	0.9	66.5	32.7	268	0.17	0.054	3.99	3.23
B10*	116	0.071	3.8	1.6	0.0	71.6	28.4	314	2.52	0.056	2.32	2.77
Stations north of the outfall												
E19*	88	0.051	4.3	1.5	0.0	54.4	45.6	214	2.97	0.063	0.71	2.33
E20	98	0.060	4.1	1.4	0.0	63.1	36.9	193	3.95	0.053	0.62	2.08
E23	98	0.058	4.1	1.4	0.0	60.4	39.6	205	3.42	0.060	0.68	2.30
E25	98	0.060	4.1	1.5	0.0	62.6	37.3	180	0.31	0.056	0.72	2.24
E26	98	0.051	4.3	1.5	0.0	56.3	43.7	201	2.94	0.065	0.74	2.52
E21*	116	0.064	4.0	1.4	0.0	66.2	33.8	227	0.68	0.053	0.61	2.10
Nearfield stations												
E11	98	0.069	3.9	1.3	0.0	68.1	31.9	255	16.52	0.047	0.69	2.37
E14	98	0.070	3.8	1.4	1.0	69.1	29.8	322	8.24	0.043	0.66	1.91
E17	98	0.068	3.9	1.3	0.0	67.6	32.4	252	5.55	0.049	0.55	1.81
E15*	116	0.062	4.0	1.5	0.0	67.4	32.6	467	0.72	0.056	0.79	2.32
Stations south of the outfall												
E1*	88	0.055	4.2	1.7	1.4	55.0	43.6	254	1.91	0.039	0.45	2.34
E7*	88	0.056	4.2	1.5	0.0	58.2	41.8	249	0.31	0.054	0.59	2.08
E2	98	0.088	3.6	1.8	6.5	43.8	49.7	231	0.82	0.040	0.69	2.66
E5	98	0.064	4.0	1.4	0.0	65.2	34.8	148	0.53	0.043	0.64	1.80
E8	98	0.069	3.9	1.3	0.0	67.1	32.9	188	1.13	0.043	0.61	1.97
E3*	116	0.066	3.9	1.9	2.2	60.2	37.6	169	7.37	0.028	0.48	2.19
E9*	116	0.054	4.2	1.7	0.0	60.2	39.8	239	1.64	0.062	1.81	2.59
Detection rate (%)								100	88	100	100	100
2008 area mean		0.063	4.0	1.5	0.7	61.2	38.1	241	3.25	0.053	1.03	2.39
2008 area max		0.123	4.5	2.0	10.8	71.6	56.0	469	29.60	0.078	4.11	4.14

*Station sampled in January survey only (n=1) (see text).

or large disturbances (e.g., storm surge, rapid suspension/deposition of materials) (Folk 1968). In contrast, samples with particles of varied sizes are characteristic of poorly sorted sediments (i.e., SD≥1.0 phi). Sediments in the Point Loma region were poorly sorted in 2008 with sorting coefficients ranging from 1.3 to 2.0 phi (Table 4.1). These results are typical of the mid-shelf and reflect the multiple origins of sediments in the region (see Emery 1960). This also suggests that these sites are not subject to fast moving currents or large physical disturbances.

Indicators of Organic Loading

Sulfides, biochemical oxygen demand (BOD), total volatile solids (TVS), total organic carbon (TOC), and total nitrogen (TN) are quantified in sediments as measures of potential organic loading in the region from the PLOO discharge. Organic materials may

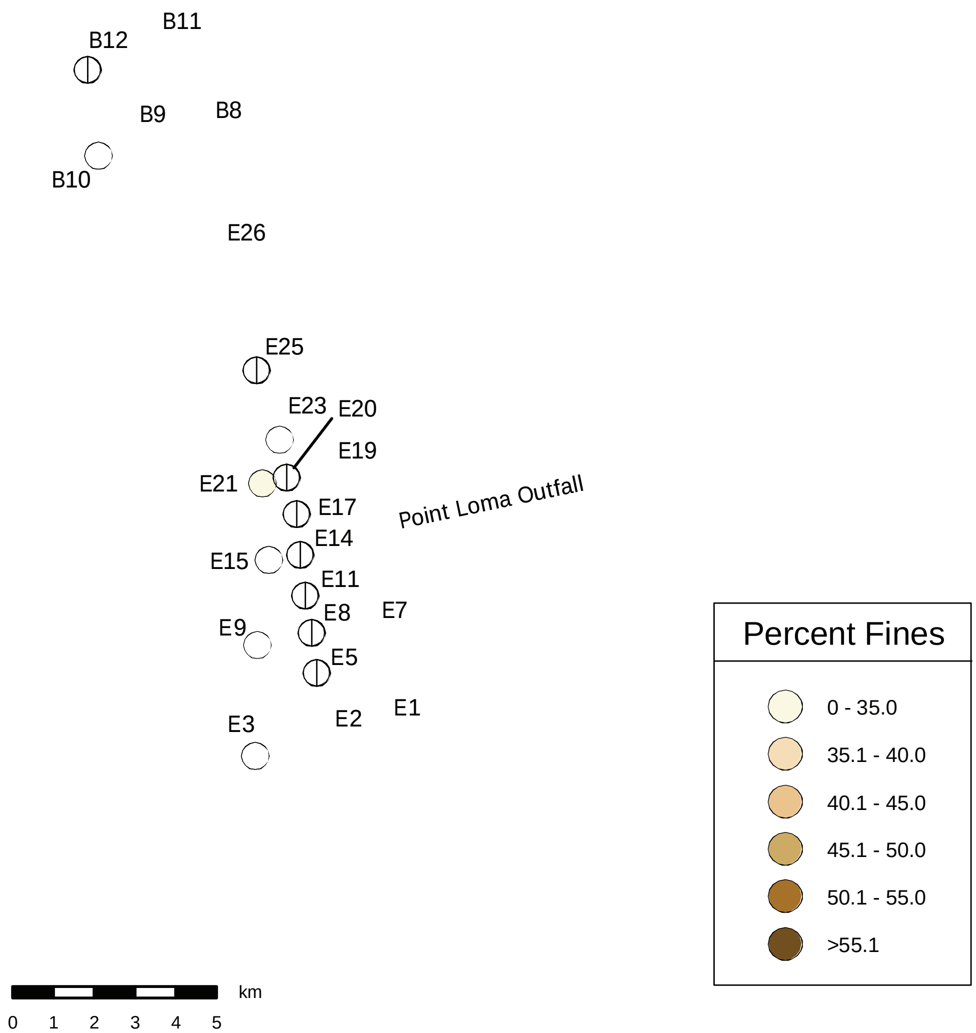

Figure 4.2
Distribution of fine material at PLOO benthic stations sampled during 2008. All stations were sampled in January; only primary core stations were sampled in July (see text); split circles show results of January (left) and July (right) surveys.

also become deposited in marine sediments via natural sources, including the result of primary productivity, breakdown of detrital materials, and outflows from rivers (Eganhouse and Venkatesan 1993). Such organic enrichment is of concern because it may disrupt ecological processes and impair habitat quality for macrobenthic marine organisms. For example, sulfides, which are the by-products of anaerobic bacterial breakdown of organic matter, may be toxic to benthic marine organisms if the sediments become excessively enriched (Gray 1981). Additionally, nitrogen is typically limiting in marine systems, and when enriched can lead to sudden phytoplankton "blooms" in coastal waters. After such blooms occur, a flux of organic material is again deposited in the sediment as the phytoplankton die and settle to the seafloor.

Generally, the distribution of organic indicators in PLOO sediments during 2008 was similar to that seen prior to discharge (see City of San Diego 1995). Biochemical oxygen demand, TOC, TN, and TVS

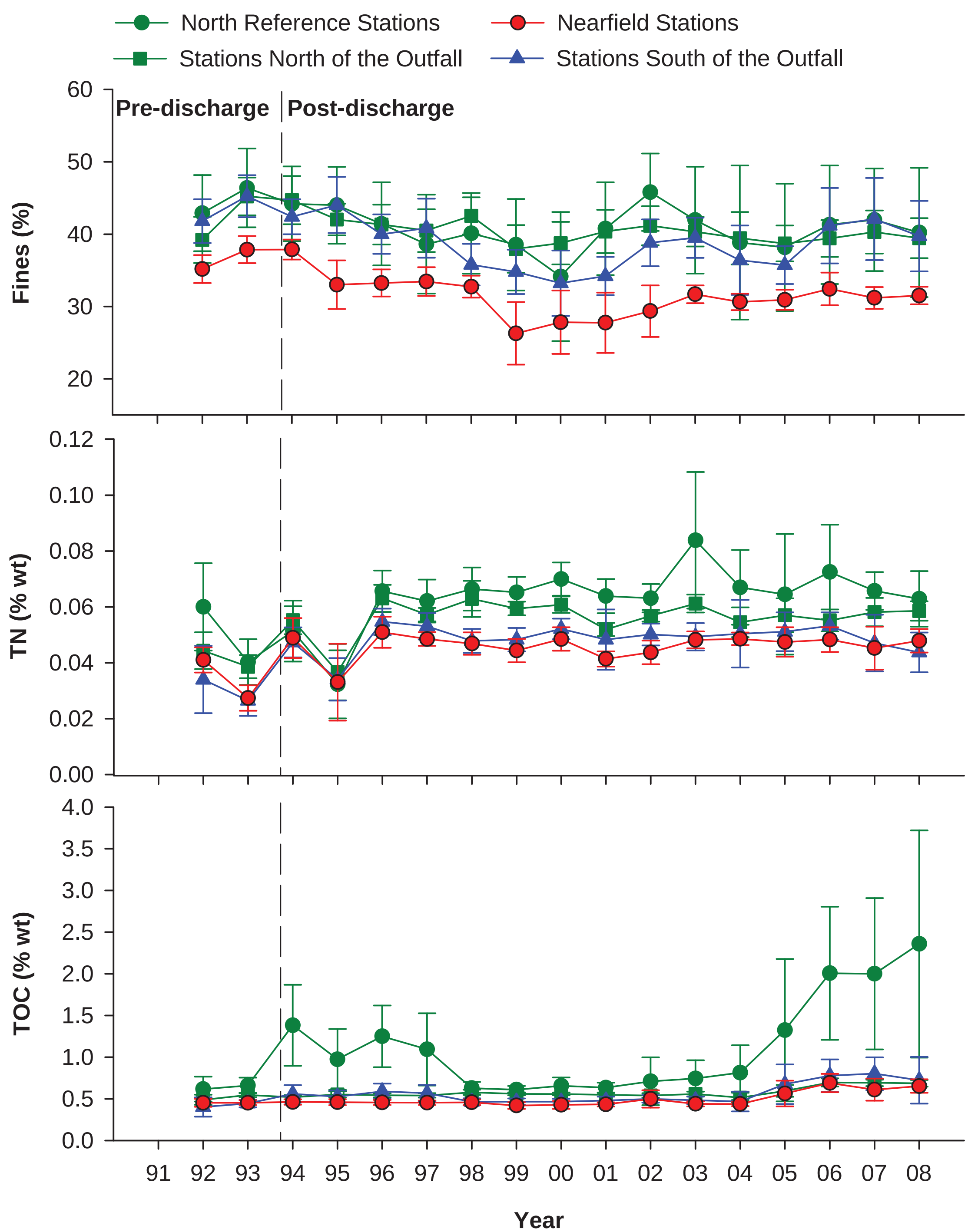

Figure 4.3

Summary of particle size and organic indicator data surrounding the PLOO from 1991–2008: Percent Fines (Fines); Total Nitrogen (TN); Total Organic Carbon (TOC); Sulfides; Biochemical Oxygen Demand (BOD); Total Volatile Solids (TVS). Data are expressed as means pooled over all stations in each station group (see Table 4.2; n≤14); % wt=percent weight. Error bars represent 95% confidence limits; reference line represents onset of discharge from PLOO.

were detected in 100% of samples, while sulfides were detected in 88% of samples (Table 4.1). With the exceptions of sulfides and BOD, the highest indicator concentrations did not occur at any of the four nearfield stations. For example, the highest concentrations of TOC, TN, and TVS occurred in sediments from stations B11 and B12, two of the northern reference stations (Appendix C.4). Only sulfides, and to a lesser extent BOD, have demonstrated noticeable changes near the outfall that

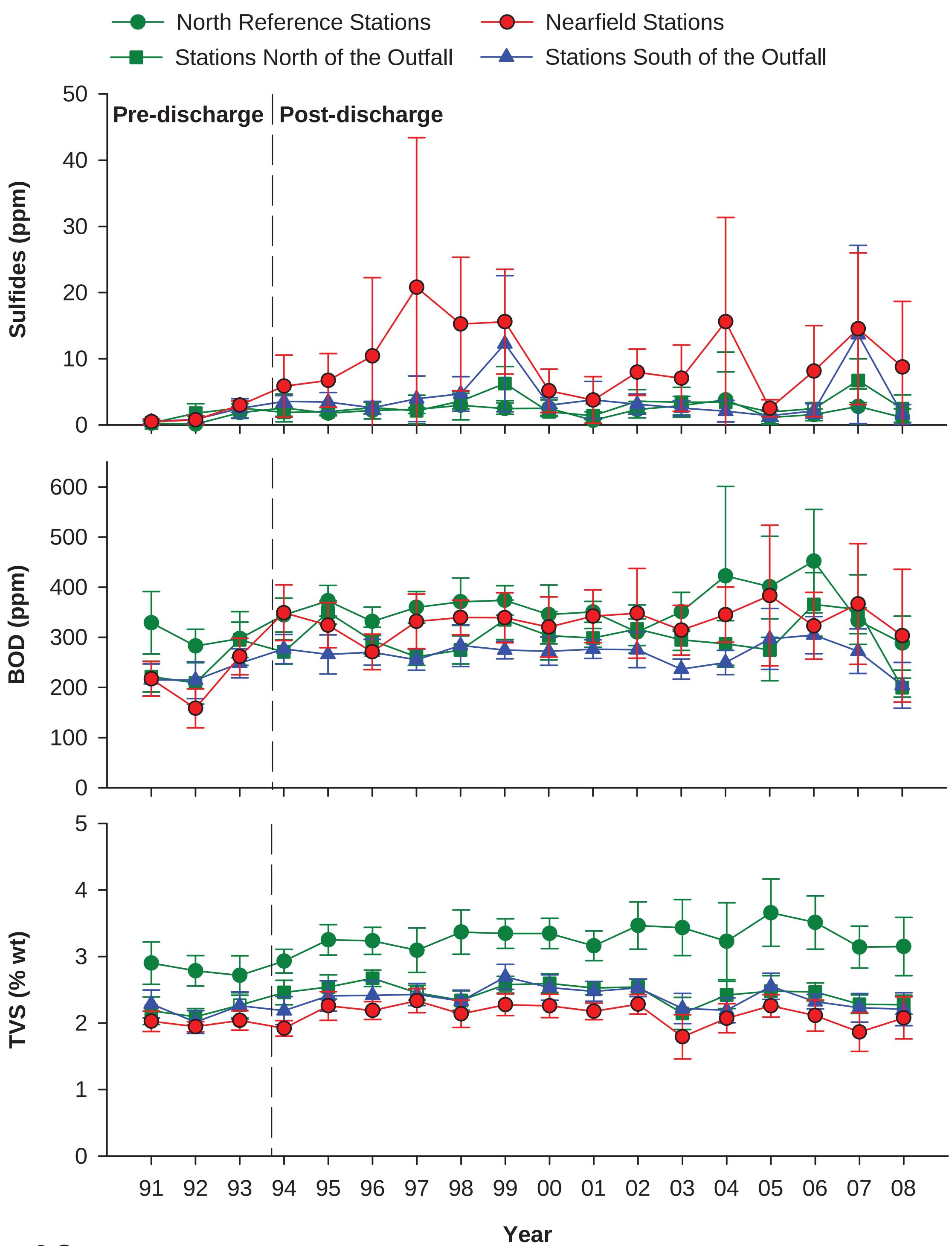

Figure 4.3 *continued*

appear to be associated with wastewater discharge (see Figure 4.3 and City of San Diego 2007).

Trace Metals

Aluminum, arsenic, barium, chromium, copper, iron, lead, manganese, mercury, nickel, tin, and zinc were detected in 100% of the sediment samples collected in the Point Loma region during 2008 (Table 4.2). Another five metals (i.e., antimony, cadmium, selenium, silver, thallium) were also detected, but less frequently, at rates between 24–94%. Beryllium was not detected at all. Concentrations of each metal were highly variable, with no discernable patterns relative to the outfall. With the one exception of tin measured in sediments

Table 4.2

Concentrations of trace metals (ppm) detected at each PLOO benthic station during 2008. Data are annual means per station (n=2) except where noted; Values that exceed ERL or ERM threshold values are in bold; ERL=effects range low threshold value; ERM=effects range median threshold value; na=not available; nd=not detected. See Appendix C.1 for MDLs and the names of each metal represented by periodic table symbol.

	Al	Sb	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Se	Ag	Tl	Sn	Zn
North reference stations																		
B8*	11000	1.2	3.94	52.9	nd	0.13	23.4	7.3	17100	4.7	150.0	0.035	11.3	nd	**3.38**	1.1	2.3	36.4
B11*	11400	1.6	4.64	46.0	nd	0.20	26.4	5.1	21500	4.6	163.0	0.033	10.9	0.35	**1.27**	nd	1.6	41.4
B9	9060	0.7	4.03	80.1	nd	0.12	24.5	5.0	18400	3.6	113.1	0.031	8.9	nd	**1.48**	nd	1.6	38.0
B12	7775	0.7	5.21	25.8	nd	0.18	26.8	2.8	23000	4.4	76.3	0.017	7.1	nd	0.04	nd	1.4	38.6
B10*	6740	0.9	3.31	25.1	nd	0.14	20.2	3.1	15500	3.1	80.4	0.016	6.6	0.28	nd	nd	1.9	29.2
Stations north of the outfall																		
E19*	13100	0.9	3.27	52.1	nd	0.17	22.4	6.7	15500	4.1	151.0	0.034	10.9	nd	**2.17**	1.1	2.5	35.9
E20	9095	0.4	3.05	37.5	nd	0.14	16.7	6.0	11450	2.7	100.8	0.029	7.9	nd	**1.77**	0.3	1.6	28.0
E23	10050	0.6	3.10	41.1	nd	0.16	18.2	6.6	12650	3.3	111.0	0.032	8.8	nd	**2.36**	0.4	1.6	30.6
E25	9025	0.5	3.30	35.8	nd	0.14	16.7	5.5	11600	3.2	100.1	0.030	7.8	0.15	**1.82**	nd	1.5	27.6
E26	9640	0.5	3.19	41.2	nd	0.15	18.6	6.5	12950	3.7	113.6	0.037	8.9	nd	**2.41**	0.3	1.6	31.3
E21*	8050	0.9	2.68	30.3	nd	0.16	16.3	4.5	11000	2.9	98.7	0.026	7.8	0.12	**2.05**	nd	2.2	24.0
Nearfield stations																		
E11	7965	0.4	3.38	28.2	nd	0.13	14.4	4.5	10200	2.1	88.3	0.016	6.7	nd	**1.78**	0.3	1.9	25.4
E14	7290	0.4	2.86	29.0	nd	0.17	14.0	5.1	9545	2.1	83.2	0.022	6.6	0.12	0.77	0.6	1.5	24.3
E17	8575	0.3	3.48	32.1	nd	0.18	15.7	6.2	11000	2.6	92.4	0.027	7.3	nd	**1.15**	0.3	1.5	27.1
E15*	9330	0.7	2.87	32.1	nd	0.14	18.0	5.0	12300	3.1	106.0	0.027	8.2	0.25	**1.83**	nd	2.4	28.4
Stations south of the outfall																		
E1*	9750	0.4	3.15	41.5	nd	nd	15.6	5.9	12000	3.4	85.0	0.038	6.1	nd	**2.73**	nd	2.0	27.2
E7*	10700	1.0	2.85	39.7	nd	0.21	17.4	5.2	12500	3.2	118.0	0.031	8.3	0.30	**1.15**	0.7	2.2	29.2
E2	11050	0.5	2.85	52.3	nd	0.06	17.1	12.0	14850	3.9	102.5	0.045	7.1	0.15	**2.44**	nd	1.6	36.6
E5	10550	0.5	2.41	43.5	nd	0.09	17.1	7.8	12900	3.6	106.0	0.021	7.4	nd	**2.34**	0.2	1.4	32.9
E8	7975	0.5	2.82	32.4	nd	0.12	15.1	5.3	10550	2.7	90.5	0.022	6.6	nd	**1.78**	0.3	1.5	26.9
E3*	10600	0.7	2.45	54.5	nd	nd	14.8	12.7	13600	3.8	97.0	0.045	5.6	nd	**2.95**	nd	1.9	37.9
E9*	9240	0.8	2.66	31.3	nd	0.13	20.6	7.2	14200	4.3	101.0	0.059	7.7	nd	**1.32**	nd	2.2	38.4
Detection rate (%)	100	65	100	100	0	91	100	100	100	100	100	100	100	24	94	32	100	100
2008 area mean	9294	0.6	3.27	40.1	–	0.13	18.4	6.2	13629	3.3	103.1	0.030	7.8	0.06	**1.74**	0.2	1.7	31.3
2008 area max	13100	1.6	5.28	101.0	–	0.21	27.8	14.3	23500	5.4	163.0	0.059	11.3	0.35	**3.38**	1.1	3.0	41.4
ERL	na	na	8.2	na	na	1.20	81	34	na	46.7	na	0.15	20.9	na	1	na	na	150
ERM	na	na	70	na	na	9.6	370	270	na	218	na	0.71	51.6	na	3.7	na	na	410

*Station sampled in January survey only (n=1) (see text).

from station E11 in January, none of the highest metal concentrations occurred in sediments closest to the PLOO. Instead, most of the relatively high metal values were found in sediments from the north reference stations and/or stations south of the outfall. For example, maximum values for lead, nickel, silver, and thallium were detected in sediments collected from station B8 (Appendix C.5). In addition, arsenic, iron, and nickel were detected in concentrations that exceeded their pre-discharge maxima (i.e., 4.0, 20300, and 10.0 ppm respectively; see City of San Diego 2007) at stations located north of the outfall, including the "B" reference sites. Further, stations E2 and E3, located south of the outfall relatively close to the LA-5 dumpsite, had sediments with the highest concentrations of copper. The highest concentrations of mercury that were detected occurred in sediments from station E9, located about halfway between LA-5 and the outfall. Of all the metals detected, only silver exceeded any of the environmental threshold values during the year. For example, the ERL for this metal was exceeded in about 76% of the sediment samples collected throughout the region, although less frequently at the nearfield stations (i.e., ~43% of samples).

Pesticides

Chlorinated pesticides were detected in up to 97% of the samples collected from PLOO stations in 2008 (Table 4.3). Total DDT (primarily p,p-DDE) was the most prevalent pesticide, occurring in sediments from all but one station with an overall mean concentration of 97 ppt. All total DDT values were lower than the ERL of 1580 ppt for this pesticide and well below the pre-discharge maximum concentration of 7300 ppt (see City of San Diego 2007). Another pesticide detected during 2008 was hexachlorobenzene (HCB), which was found in 44% of samples at concentrations ranging from 86 to 1900 ppt. HCB occurred at a total of 13 different sites throughout the region, including two of the four nearfield stations (i.e., E14 and E17). While the maximum HCB value of 1900 ppt during the year was detected at station E17 in July, average concentrations for this pesticide at the nearfield sites were within the range of values reported elsewhere in the region. In addition, HCB was not detected at any of the nearfield stations during the earlier January survey (see Appendix C.6). A third pesticide, Dieldrin, was detected in a single sediment sample from station E5 during 2008 (i.e., 270 ppt in January), which represents the

Table 4.3

Concentrations of dieldrin, total DDT (tDDT), hexachlorobenzene (HCB), total PCB (tPCB), and total PAH (tPAH) at PLOO benthic stations in 2008. Data are annual means per station (n=2) except where noted; ERL=effects range low threshold value; ERM=effects range median threshold value; na=not available; nd=not detected.

	Dieldrin (ppt)	tDDT (ppt)	HCB (ppt)	tPCB (ppt)	tPAH (ppb)
North reference stations					
B8*	nd	600	910	45	17
B11*	nd	390	nd	nd	7
B9	nd	435	70	nd	4
B12	nd	328	nd	nd	7
B10*	nd	300	nd	nd	20
Stations north of the outfall					
E19*	nd	370	nd	311	11
E20	nd	300	115	nd	10
E23	nd	415	nd	nd	16
E25	nd	370	275	nd	4
E26	nd	313	535	nd	nd
E21*	nd	405	280	nd	nd
Nearfield stations					
E11	nd	200	nd	nd	nd
E14	nd	324	475	nd	nd
E17	nd	405	950	nd	3
E15*	nd	310	nd	110	89
Stations south of the outfall					
E1*	nd	nd	nd	nd	147
E7*	nd	290	86	nd	246
E2	nd	855	65	674	24
E5	135	220	60	nd	77
E8	nd	220	270	nd	4
E3*	nd	310	nd	9159	689
E9*	nd	310	670	9956	84
Detection rate (%)	3	97	44	21	56
2008 area mean	8	354	223	616	47
2008 area max	270	1340	1900	9956	689
ERL	na	1580	na	na	4022
ERM	na	46100	na	na	44792

*Station sampled in January survey only (n=1) (see text).

first time this pesticide has been detected at the PLOO stations since monitoring began in 1991. Analytical techniques that test for the presence of pesticides such as HCB and Dieldrin have improved significantly in recent years, which therefore may make pre- vs. post-discharge comparisons inappropriate for such compounds. Overall, the pesticide values detected in benthic sediments off Point Loma in 2008 continued to show no spatial patterns relative to the outfall discharge site.

PCBs and PAHs

Polychlorinated biphenyl compounds (PCBs) were detected in only 21% of all sediment samples during 2008, and these samples were collected from only six PLOO stations (i.e., stations B8, E2, E3, E9, E15, E19) (Table 4.3). The highest total PCB concentrations were found in sediments collected from two sites located nearest to the LA-5 dredge disposal site (i.e., stations E2 and E3), and from one station (E9) located between LA-5 and the PLOO discharge site. Sediments from each of these stations also had the greatest number of PCB congeners that were detected (e.g., up to 22/sample) (see Appendix C.2). PCBs have historically occurred at these and other stations located relatively near the LA-5 disposal site (City of San Diego 2007, Parnell et al. 2008).

In contrast to PCBs, low levels of various polycyclic aromatic hydrocarbons (PAHs) were detected at almost all of the stations during the year with a detection rate of 56% (Table 4.3). All concentrations of total PAH were below the ERL of 4022 ppt (Appendix C.6). The most prevalent PAHs detected were biphenyl, naphthalene, and pyrene (Appendix C.2). Each of these PAHs was detected in 18–29% of the samples. Overall, there was no apparent relationship between PAH concentrations and proximity to the outfall discharge site; instead, the highest concentrations occurred at stations south of the PLOO.

Summary and Conclusions

Ocean sediments at stations surrounding the PLOO in 2008 were comprised primarily of fine sands and coarse silt. Overall, these sediments were poorly sorted, consisting of particles of varied sizes, which suggest that sediments in the region were subject to low wave and current activity and/or physical disturbance. Several stations along the 98-m and 116-m depth contours from E21 south to E5 were composed of sediments that were coarser than most stations to the north and to the south. Field observations of these coarser sediment samples indicated the presence of shell hash and/or coarse black sand. Overall, differences in the particle size composition of sediments off Point Loma are likely affected by both anthropogenic and natural influences, including outfall construction materials, offshore disposal of dredged materials, multiple geological origins of specific sediment types, and recent deposits of detrital materials (e.g., Emery 1960, City of San Diego 2007, Parnell et al. 2008).

Concentrations of various contaminants, including most indicators of organic loading (e.g., BOD, TN, TVS), trace metals, pesticides (e.g., DDT), PCBs, and PAHs in sediments off Point Loma remained within the typical range of variability for San Diego and other areas of the southern California continental shelf (see Schiff and Gossett 1998, Noblet et al. 2003, Schiff et al. 2006). Most contaminants were detected rarely or in low concentrations during 2008. For example, PCBs, and the pesticides HCB and Dieldrin had detection rates ≤45% during the year. Although DDT and PAHs were detected in sediments at most stations, these compounds were present at concentrations below their ERLs. The only metal that exceeded ERL values for southern California was silver, which was present in relatively high concentrations throughout the PLOO region.

There were few clear spatial patterns in sediment contaminant concentrations relative to the PLOO discharge site in 2008, with the exception of slightly elevated sulfides and BOD near the outfall. Instead, the highest concentrations of several organic indicators, metals, DDT, PCBs, and PAHs were found in sediments from both the southern and/or northern-most stations. These included the highest values for copper, mercury, total PCBs, and total PAH in sediments near the LA-5 disposal site. In general, concentrations of sediment contaminants have been higher at these southern stations than elsewhere off San Diego, and are most likely due to misplaced deposits of dredged material that were originally destined for LA-5 (Parnell et al. 2008). Other previous studies have also attributed elevated levels of various contaminants such as PAHs, PCBs, trace metals, and DDT in this area to the deposits associated with LA-5 (see Anderson et al. 1993, City of San Diego 2003, Steinberger et al. 2003), many of which were also present in high concentrations in sediments originating from San Diego Bay (see City of San Diego 2003).

Overall, there is little evidence of organic and contaminant loading in sediments throughout the PLOO region after 15 years of wastewater discharge, with concentrations of most measured parameters occurring at levels within the typical range of variability seen throughout the Southern California Bight (e.g., see City of San Diego 2007). The only sustained effects have been restricted to a few sites located nearest the outfall discharge site, including station E14 near the center of the outfall wye, and stations E11 and E17 located near the ends of the southern and northern diffuser legs, respectively. These effects include a minor increase in sediment particle size through time, measurable increases in sulfide concentrations, and smaller increases in BOD (City of San Diego 2007). However, there is no evidence that the outfall discharge is affecting the quality of benthic sediments to the point that it will degrade the resident marine biota (e.g., see Chapter 5).

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