appendix A

DETAILED METHODS

Appendix A
DETAILED METHODS

INTRODUCTION

This appendix contains a summary of the field sampling, laboratory testing, and data analysis methods used in the District's Ocean Monitoring Program (OMP). The methods also include calculations of water quality compliance with California Ocean Plan (COP) criteria. More detailed methods can be found in the program Quality Assurance Project Plan (QAPP) (OCSD 2013a), Environmental Assessment Division Standard Operating Procedures (OCSD 2008), and the Environmental Sciences Laboratory Operating Procedures Manual (LOPM) (OCSD 2013b).

For 2013-14, the OMP was conducted under conditions stipulated in the District's 2012 NPDES discharge permit (Order No. R8-2012-0035, NPDES No. CA0110604).

WATER QUALITY MONITORING

Field Methods

Offshore Zone

Permit-specified water quality studies were conducted monthly at 28 stations comprising a 2 × 2 km fixed-grid pattern with seven nearshore-offshore transects of four stations each (Figure A-1, Tables A-1 and A-2). Each survey included measurements of pressure (from which depth is calculated), water temperature, conductivity (from which salinity is calculated), dissolved oxygen (DO), pH, water clarity (light transmissivity, beam attenuation coefficient [beam-c], and photosynthetically active radiation [PAR]), chlorophyll-*a* fluorescence, and colored dissolved organic matter (CDOM). Measurements were conducted using a Sea-Bird Electronics SBE9/SBE 11 Deck Unit (SBE9/11) CTD (conductivity-temperature-depth) profiling system deployed from the M/V *Nerissa*. Profiling was conducted from 1 m below the surface to 2 m above the bottom or to a maximum depth of 75 m, when station water depths exceeded 75 m. SEASOFT (2014a) software was used for data acquisition, data display, and sensor calibration. PAR was measured in conjunction with chlorophyll-*a* because of the positive linkage between light intensity and photosynthesis per unit chlorophyll (Hardy 1993). A summary of the sampling methods are presented in Table A-3.

Visual observations of floatable materials or grease that might be of sewage origin were also conducted. Daily rainfall, sea state, and wind condition data were summarized from Newport Beach Fire and Marine Department and the District's Treatment Plant No. 2 records.

Ammonium (NH3-N) samples were also collected three times per quarter at a subset of 14 stations; NH3-N and fecal indicator bacteria (FIB; total coliform, fecal coliform (using *Escherichia coli*), and enterococci) samples were collected at a subset of eight stations

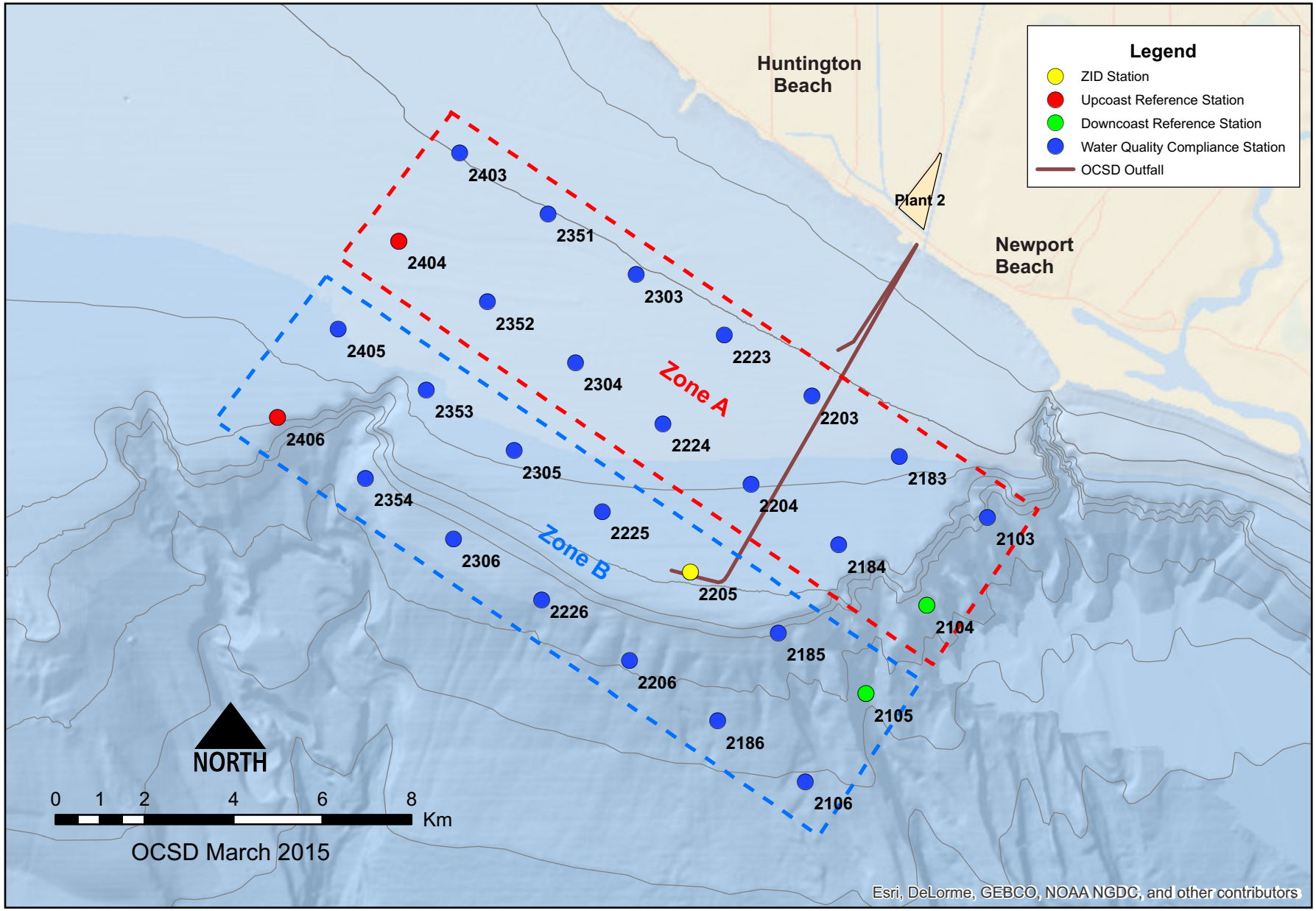

Figure A-1. **Water quality monitoring stations and zones used for compliance determinations.**

Orange County Sanitation District, California.

Table A-1. OCSD ocean monitoring program station positions and nominal depths.

Orange County Sanitation District, California.

Station	Latitude	Longitude	Depth	Station	Latitude	Longitude	Depth
Offshore Water Quality							
1901 *	33° 33.682' N	117° 49.654' W	10	2204 ***	33° 35.423' N	117° 59.546' W	39
1902 *	33° 33.165' N	117° 49.944' W	60	2205 ***	33° 34.534' N	118° 00.282' W	57
1903 *	33° 32.762' N	117° 50.182' W	100	2206 ***	33° 33.644' N	118° 01.018' W	185
1904 *	33° 31.787' N	117° 50.734' W	405	2221 *	33° 38.099' N	117° 58.908' W	10
1905 *	33° 30.810' N	117° 51.285' W	510	2222 *	33° 37.522' N	117° 59.374' W	15
1906 *	33° 29.829' N	117° 51.842' W	550	2223 ****	33° 36.924' N	117° 59.871' W	22
2001 *	33° 35.335' N	117° 51.564' W	10	2224 ***	33° 36.035' N	118° 00.608' W	31
2002 *	33° 34.755' N	117° 51.844' W	60	2225 ***	33° 35.146' N	118° 01.346' W	47
2003 *	33° 34.565' N	117° 52.123' W	100	2226 ***	33° 34.257' N	118° 02.083' W	135
2004 *	33° 33.589' N	117° 52.657' W	345	2301 *	33° 38.572' N	118° 00.064' W	10
2005 *	33° 32.613' N	117° 53.225' W	410	2302 *	33° 38.053' N	118° 00.495' W	15
2006 *	33° 31.647' N	117° 53.793' W	470	2303 ****	33° 37.537' N	118° 00.936' W	21
2021 *	33° 35.771' N	117° 52.099' W	10	2304 ***	33° 36.649' N	118° 01.674' W	29
2022 *	33° 35.283' N	117° 52.379' W	53	2305 ***	33° 35.760' N	118° 02.412' W	38
2023 *	33° 34.796' N	117° 52.658' W	165	2306 ***	33° 34.871' N	118° 03.149' W	114
2024 *	33° 33.811' N	117° 53.179' W	300	2349 *	33° 39.190' N	118° 01.135' W	10
2025 *	33° 32.851' N	117° 53.741' W	390	2350 *	33° 38.667' N	118° 01.566' W	14
2026 *	33° 31.900' N	117° 54.301' W	432	2351 ****	33° 38.151' N	118° 02.001' W	21
2101 *	33° 36.183' N	117° 55.749' W	10	2352 **	33° 37.262' N	118° 02.739' W	29
2102 *	33° 35.631' N	117° 56.206' W	26	2353 **	33° 36.373' N	118° 03.477' W	37
2103 ****	33° 35.089' N	117° 56.678' W	110	2354 **	33° 35.484' N	118° 04.214' W	123
2104 ****	33° 34.199' N	117° 57.414' W	143	2401 *	33° 39.920' N	118° 02.103' W	10
2105 ***	33° 33.309' N	117° 58.150' W	280	2402 *	33° 39.342' N	118° 02.593' W	16
2106 ***	33° 32.420' N	117° 58.885' W	309	2403 ****	33° 38.765' N	118° 03.072' W	21
2181 *	33° 36.877' N	117° 56.752' W	10	**2404** **	33° 37.875' N	118° 03.808' W	29
2182 *	33° 36.272' N	117° 57.264' W	15	2405 **	33° 36.986' N	118° 04.544' W	37
2183 ****	33° 35.701' N	117° 57.744' W	36	**2406** **	33° 36.096' N	118° 05.280' W	60
2184 ***	33° 34.811' N	117° 58.480' W	51	2451 *	33° 41.475' N	118° 03.944' W	10
2185 ***	33° 33.922' N	117° 59.215' W	114	2452 *	33° 40.739' N	118° 04.584' W	17
2186 ***	33° 33.032' N	117° 59.951' W	247	2453 *	33° 39.987' N	118° 05.204' W	22
2201 *	33° 37.493' N	117° 57.831' W	10	2454 *	33° 39.098' N	118° 05.946' W	30
2202 *	33° 36.901' N	117° 58.314' W	16	2455 *	33° 38.210' N	118° 06.675' W	36
2203 ****	33° 36.313' N	117° 58.810' W	25	2456 *	33° 37.318' N	118° 07.411' W	42

* Central Bight Water Quality Regional Grid station only - CTD profiling only.
** Core Water Quality Station - CTD profiling only.
*** Core Water Quality Station - CTD profiling and ammonium samples.
**** Core Water Quality Station - CTD profiling plus ammonium and bacteria (REC-1) samples.
Stations denoted in bold represent the potential California Ocean Plan water quality compliance reference stations.

Table A-1 Continues.

Table A-1 Continued.

Station	Latitude	Longitude	Depth	Station	Latitude	Longitude	Depth
Core Nearshore (Surfzone) Water Quality							
39N	33° 42.114' N	118° 03.321' W	Surf	0 *	33° 37.764' N	117° 57.598' W	Surf
33N	33° 41.281' N	118° 02.495' W	Surf	3S	33° 37.619' N	117° 57.264' W	Surf
27N	33° 40.587' N	118° 01.712' W	Surf	6S	33° 37.337' N	117° 56.704' W	Surf
21N	33° 39.843' N	118° 00.785' W	Surf	9S	33° 37.033' N	117° 56.283' W	Surf
15N	33° 39.114' N	117° 59.846' W	Surf	15S	33° 36.342' N	117° 55.459' W	Surf
12N	33° 38.854' N	117° 59.413' W	Surf	21S	33° 36.059' N	117° 54.213' W	Surf
9N *	33° 38.565' N	117° 58.924' W	Surf	27S	33° 35.646' N	117° 52.910' W	Surf
6N *	33° 38.331' N	117° 58.573' W	Surf	29S	33° 35.559' N	117° 52.508' W	Surf
3N *	33° 38.018' N	117° 58.032' W	Surf	39S	33° 34.700' N	117° 51.946' W	Surf
* Bacteria sample collected at least twice per week. Bacteria sample collected at least once per week at all other stations.							
Regional Nearshore (Surfzone) Water Quality							
OSB02 *	33° 44.420' N	118° 06.937' W	Surf	HB4 **	33° 39.680' N	118° 00.613' W	Surf
OSB03	33° 44.355' N	118° 06.449' W	Surf	HB5 **	33° 39.414' N	118° 00.310' W	Surf
OSB05	33° 44.296' N	118° 06.378' W	Surf	TM	33° 37.994' N	117° 57.645' W	Surf
OSB04	33° 44.209' N	118° 06.121' W	Surf	SAR-N	33° 37.870' N	117° 57.434' W	Surf
OSB01	33° 43.603' N	118° 05.041' W	Surf	BGC **	33° 35.389' N	117° 52.121' W	Surf
OSUB1	33° 42.986' N	118° 04.341' W	Surf	PPC **	33° 34.933' N	117° 51.416' W	Surf
BCO-1	33° 40.994' N	118° 02.138' W	Surf	WFC **	33° 34.900' N	117° 51.334' W	Surf
HB1 **	33° 40.065' N	118° 01.937' W	Surf	ONB39 **	33° 34.444' N	117° 50.410' W	Surf
HB2 **	33° 40.022' N	118° 01.937' W	Surf	MDC **	33° 33.838' N	117° 49.702' W	Surf
HB3 **	33° 39.952' N	118° 00.933' W	Surf	El Moro **	33° 33.593' N	117° 49.292' W	Surf
* Bacteria sample collected at least twice per week. ** When flowing, 2 additional bacteria samples are collected: 1) 25 yards upcoast and 2) 25 yards downcoast of freshwater-ocean interface. When flow is not observed at the interface, a single sample is collected 25 yards downcoast. Bacteria sample collected at least once per week at all other stations.							
Trawl							
T0 *	33° 34.641' N	118° 00.567' W	55	T17 **	33° 36.960' N	118° 05.273' W	36
T1 **	33° 35.688' N	117° 59.561' W	35	T18	33° 35.394' N	118° 05.424' W	137
T2	33° 35.946' N	118° 02.785' W	36	T19	33° 34.326' N	117° 59.856' W	60
T6	33° 33.771' N	118° 00.250' W	137	T22 **	33° 34.336' N	117° 59.051' W	58
T10	33° 36.055' N	118° 05.199' W	60	T23 **	33° 35.648' N	118° 01.274' W	36
T11 **	33° 34.868' N	118° 01.670' W	57	T24	33° 34.245' N	118° 01.967' W	137
T12 **	33° 34.672' N	118° 03.200' W	137	T25	33° 34.641' N	118° 00.567' W	55
T14	33° 35.160' N	118° 02.658' W	60	T17 **	33° 36.960' N	118° 05.273' W	36
***** Sampled for historical purposes. ****** Semi-annual station. All other stations are sampled annually.							
Rig-fishing							
RF1	**Zone 1 (outfall):** Inshore of the 60 m depth contour bounded by the coordinates 33° 36.272' N / 117° 57.264' W and 33° 37.522' N / 117° 59.374' W along the 15 m contour and 33° 34.698' N / 118° 01.713' W along the 80 m contour, and 33° 33.475' N / 117° 59.583' W along the 180 m contour.						
RF2	**Zone 2 (farfield reference):** Inshore of the 60 m depth contour bounded by the coordinates 33° 34.535' N / 117° 52.078' W and 33° 32.381' N / 117° 49.218' W along the 15 m contour inshore and coordinates 33° 31.860' N / 117° 49.894' W and 33° 33.983' N / 117° 52.699' W along the 60 m contour off shore, and bordering the Laguna Beach State Marine Reserve.						

Table A-1 Continues.

Table A-1 Continued.

Station	Latitude	Longitude	Depth	Station	Latitude	Longitude	Depth
Sediment Geochemistry and Benthic Infauna							
0 *	33° 34.573' N	118° 00.598' W	56	58	33° 33.365' N	118° 05.347' W	300
1 *	33° 34.657' N	118° 00.968' W	56	59	33° 36.070' N	118° 03.701' W	40
3 *	33° 34.434' N	118° 00.660' W	60	60	33° 35.532' N	118° 04.017' W	100
4 *	33° 34.498' N	117° 59.761' W	56	61	33° 35.011' N	118° 04.326' W	200
5 *	33° 34.749' N	118° 01.612' W	59	62	33° 34.069' N	118° 04.568' W	300
7	33° 35.325' N	118° 00.367' W	41	63	33° 34.173' N	118° 03.407' W	200
8	33° 35.164' N	117° 59.555' W	44	64	33° 33.484' N	118° 03.663' W	300
9 *	33° 34.363' N	117° 59.510' W	59	65	33° 33.859' N	117° 57.230' W	200
10	33° 34.902' N	118° 02.081' W	62	68 *	33° 34.848' N	118° 00.694' W	52
12 *	33° 34.385' N	117° 59.054' W	58	69 *	33° 34.794' N	118° 00.465' W	52
13	33° 35.307' N	118° 02.944' W	59	70 *	33° 34.736' N	118° 00.183' W	52
17	33° 33.961' N	118° 00.187' W	91	71 *	33° 34.687' N	117° 59.939' W	52
18	33° 34.064' N	118° 00.750' W	91	72 *	33° 34.674' N	118° 01.146' W	55
20	33° 34.599' N	118° 02.229' W	100	73 *	33° 34.596' N	118° 00.709' W	55
21	33° 35.313' N	118° 01.891' W	44	74 *	33° 34.616' N	118° 00.230' W	57
22	33° 35.204' N	117° 59.028' W	45	75 *	33° 34.559' N	117° 59.974' W	60
23	33° 33.968' N	117° 59.147' W	100	76 *	33° 34.459' N	118° 00.297' W	58
24	33° 33.563' N	118° 01.140' W	200	77 *	33° 34.373' N	117° 59.730' W	60
25	33° 33.924' N	118° 02.176' W	200	78 *	33° 34.329' N	118° 00.036' W	63
27	33° 33.326' N	117° 59.708' W	200	79 *	33° 34.383' N	118° 00.876' W	65
29	33° 35.033' N	118° 03.113' W	100	80 *	33° 34.324' N	118° 00.662' W	65
30	33° 35.493' N	118° 02.899' W	46	81 *	33° 34.263' N	118° 00.362' W	65
33	33° 34.349' N	117° 57.866' W	100	82 *	33° 34.207' N	118° 00.077' W	65
36	33° 35.308' N	117° 57.495' W	45	83	33° 34.239' N	118° 01.414' W	100
37	33° 34.832' N	117° 57.369' W	56	84 *	33° 34.648' N	118° 00.543' W	54
38	33° 34.634' N	117° 57.317' W	100	85 *	33° 34.532' N	118° 00.679' W	57
39	33° 33.283' N	117° 58.531' W	200	86 *	33° 34.560' N	118° 00.802' W	57
40	33° 32.496' N	117° 59.775' W	303	87 *	33° 34.401' N	118° 00.380' W	60
41	33° 32.690' N	118° 01.149' W	303	C *	33° 35.799' N	118° 03.855' W	56
42	33° 33.098' N	118° 02.598' W	303	C2	33° 36.125' N	117° 56.014' W	56
44	33° 34.586' N	118° 05.422' W	241	C4	33° 35.056' N	117° 55.833' W	187
55	33° 36.739' N	118° 05.413' W	40	C5	33° 33.920' N	117° 55.620' W	296
56	33° 35.665' N	118° 05.417' W	100	Control 1 *	33° 36.037' N	118° 05.387' W	59
57	33° 34.970' N	118° 05.418' W	200	ZB *	33° 34.545' N	118° 00.274' W	56

* Semi-annual station.
All other stations are sampled annually.

Table A-2. Sampling, equipment deployment, and training dates during 2013-14.

Orange County Sanitation District, California.

Quarter	Date	Cruise #	# of days	Purpose
Water Quality				
Summer	07/23/2013	OC-2013-024	1	Water Quality – REC-1 (Day 1)
	07/24-07/25/2013	OC-2013-025	2	Water Quality – Full Grid (Day 1)
	07/29/2013	OC-2013-026	1	Water Quality – REC-1 (Day2)
	08/06/2013	OC-2013-027	1	Water Quality – Full Grid (Day 2)
	08/07/2013	OC-2013-028	1	Water Quality – Central Bight
	08/08/2013	OC-2013-029	1	Water Quality – REC-1 (Day 3)
	09/11/2013	OC-2013-031	1	Water Quality – Full Grid (Day 3) – Ammonia only
Fall	10/23/2013	OC-2013-033	1	Water Quality – Full Grid (Day 1)
	10/30/2013	OC-2013-035	1	Water Quality – REC-1 (Day 1)
	10/31/2013	OC-2013-036	1	Water Quality – REC-1 (Day2)
	11/05/2013	OC-2013-037	1	Water Quality – Full Grid (Day 2)
	11/06/2013	OC-2013-040	1	Water Quality – Central Bight
	11/07/2013	OC-2013-038	1	Water Quality – REC-1 (Day 3)
	12/11/2013	OC-2013-039	1	Water Quality – Full Grid (Day 3) – Ammonia only
Winter	01/22/2014	OC-2014-003	1	Water Quality – Full Grid (Day 1)
	02/04/2014	OC-2014-006	1	Water Quality – Full Grid (Day 2)
	02/05/2014	OC-2014-007	1	Water Quality – Central Bight
	02/06/2014	OC-2014-008	1	Water Quality – REC-1 (Day 1)
	02/10/2014	OC-2014-009	1	Water Quality – REC-1 (Day 2)
	02/13/2014	OC-2014-010	1	Water Quality – REC-1 (Day 3)
	03/12/2014	OC-2014-012	1	Water Quality – Full Grid (Day 3) – Ammonia only
	03/31/2014	OC-2014-013	1	USC Wirewalker Deployment
Spring	04/01/2014	OC-2014-014	1	MBARI Mooring Deployment
	04/10/2014	OC-2014-015	1	MBARI Waveglider Deployment
	04/16/2014	OC-2014-016	1	USC Wirewalker Service/Deployment
	04/22/2014	OC-2014-018	1	MBARI Waveglider Recovery
	04/23/2014	OC-2014-017	1	Water Quality – Full Grid (Day 1)
	05/13/2014	OC-2014-022	1	Water Quality – Full Grid (Day 2) & Bight'13 pH
	05/12/2014	OC-2014-023	1	Water Quality – Central Bight & Bight'13 pH
	05/07/2014	OC-2014-024	1	Water Quality – REC-1 (Day 1)
	05/08/2014	OC-2014-025	1	Water Quality – REC-1 (Day 2)
	05/21/2014	OC-2014-026	1	Water Quality – REC-1 (Day 3)
	06/11/2014	OC-2014-030	1	Water Quality – Full Grid (Day 3) – Ammonia only

Table A-2 Continues.

Table A-2 Continued.

Quarter	Date	Cruise #	# of days	Purpose
Sediment and Infauna				
Summer	07/01-07/03/2013	OC-2013-021	5	Semi-annual Benthic Infauna and Sediment Geochemistry
Summer	07/15-08/01/2013	OC-2013-023	1	Bight'13 Benthic Infauna and Sediment Geochemistry
Winter	01/07-01/13/2014	OC-2014-001	2	Semi-annual Benthic Infauna, Sediment Geochemistry, and Sediment Toxicity
Trawls & Rig Fishing				
Summer	07/09-07/10/2013	OC-2013-022	2	Trawl – Semi-annual
	08/13-08/29/2013	OC-2013-030	10	Bight '13 Trawls
Winter	01/15-01/21/2014	OC-2014-002	3	Trawl – Semi-annual
	01/29-01/30/2014	OC-2014-005	2	Rig Fishing
Spring	04/14/2014	OC-2014-021	1	Rig Fishing Pilot Study
	05/19/2014	OC-2014-027	1	Rig Fishing Pilot Study
Current Meters and Moorings				
Fall	10/16-24/2013	OC-2013-034	3	TRBM/ADCP Deployment
Winter	01/23-28/2012	OC-2014-004	2	TRBM/ADCP Deployment/Recovery
Spring	05/20/2014	OC-2014-028	1	TRBM/ADCP Deployment/Recovery
	05/22/2014	OC-2014-029	1	TRBM/ADCP Deployment/Recovery
	06/16/2014	OC-2014-031	1	TRBM/ADCP Deployment/Recovery

Note:
Full grid water quality Days 1 and 2 include CTD sampling at six stations, CTD and ammonium sampling at 14 stations, and CTD, ammonium, and bacteria sampling at eight REC-1 stations.
Full grid water quality Day 3 includes CTD sampling at six stations and CTD and ammonium sampling at 22 stations.

Table A-3. Water quality sample collection and analysis methods by parameter.

Orange County Sanitation District, California.

Parameter	Sampling Method	Method Reference	Preservation	Container	Holding Time	Sampling Interval	Field Replicates
Nearshore (Surfzone)							
Total Coliforms, Fecal Coliforms, and Enterococci	grab	Standard Methods 9222 B ** Standard Methods 9222 D ** EPA Method 1600 ***	Ice (<6°C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Ankle deep water	at least 10% of samples
Offshore							
Temperature [1]	*in-situ* probe	SOP 1500.1 - CTD Operations	none	none	not applicable	every 1 m *	at least 10% of stations
Salinity [2] (conductivity)	*in-situ* probe	SOP 1500.1 - CTD Operations	none	none	not applicable	every 1 m *	at least 10% of stations
pH [3]	*in-situ* probe	SOP 1500.1 - CTD Operations	none	none	not applicable	every 1 m *	at least 10% of stations
Dissolved Oxygen [4]	*in-situ* probe	SOP 1500.1 - CTD Operations	none	none	not applicable	every 1 m *	at least 10% of stations
Transmissivity [5]	*in-situ* probe	SOP 1500.1 - CTD Operations	none	none	not applicable	every 1 m *	at least 10% of stations
Photosynthetically Active Radiation (PAR) [6]	*in-situ* probe	SOP 1500.1 - CTD Operations	none	none	not applicable	every 1 m *	at least 10% of stations
Chlorophyll-*a* fluorescence [6]	*in-situ* probe	SOP 1500.1 - CTD Operations	none	none	not applicable	every 1 m *	at least 10% of stations
Color Dissolved Organic Matter (CDOM) [6]	*in-situ* probe	SOP 1500.1 - CTD Operations	none	none	not applicable	every 1 m *	at least 10% of stations
Ammonium (NH3-N)	Niskin	SOP 4500-NH_3.G, Rev. J ** (Standard Method 4500-NH_3.G)	Ice (<6°C)	125 mL HDPE	28 days	Surface, 10m, 20m, 30m, 40m, 50m, 60m, Bottom	at least 10% of samples
Total Coliforms, *Escherichia coli*, Fecal Coliforms [9], and Enterococci	Niskin	Standard Methods 9223 B **	Ice (<6°C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Surface, 10m, 20m, 30m, 40m, 50m, 60m, Bottom	at least 10% of samples
Surface Observations	visual observations	Permit specs.	none	none	not applicable	surface	none

1 Calibrated to reference cells (0.0005°C accuracy) annually.
2 Calibrated to IAPSO Standard and Guildline 8400B Autosal annually.
3 Referenced and calibrated to NIST buffers of pH 7, 8, and 9 prior to every survey.
4 Referenced and calibrated each survey by comparison with the lab DO probe, which is calibrated daily.
5 Referenced and calibrated to known transmittance in air.
6 Factory calibrated annually.
7 Calculated result (*Escherichia coli* MPN/100mL x 1.1)
* Sampled continuously at 24 scans/second but data processed to 1 m intervals.
** APHA (2012).
*** Available online at www.epa.gov.

concurrently with two of the three quarterly surveys (Tables A-1 and A-2). The eight stations are located within waters designated by the RWQCB for water contact sports (i.e., waters designated as REC-1). Samples were collected at 10 m depth intervals from the surface (1 m below) to 2 m above the ocean floor or a maximum depth of 60 m (Table A-3). Three additional surveys were conducted to collect FIB and NH3-N samples at the eight REC-1 water quality stations within 30 days of two of the three quarterly water quality sampling days in order to calculate a 30-day geometric mean. During most surveys, additional bacteriological samples were collected at the outfall (Station 2205) and two nearfield stations (1 and 9).

Discrete sampling was conducted using a Sea-Bird Electronics Carousel Water Sampler (SBE32/SBE33) equipped with Niskin bottles. Sample depths are provided in Table A-3. All samples were kept on wet ice in coolers and transported to the District's laboratory within 6-hours of collection for analysis.

Central Bight Regional Water Quality

An expanded grid of water quality stations was sampled quarterly as part of the District's Central Bight Regional Water Quality monitoring. These additional stations were sampled concurrently with the permit specified stations and in conjunction with the Los Angeles County Sanitation District (LACSD), the City of Los Angeles, and the City of Oxnard. The total sampling area extends from the Ventura River in the north to Crystal Cove State Beach in the south. Samples were collected using CTDs during a targeted 3- or 4-day period, over which sampling occurred at 216 stations comprising a fixed-grid pattern (see Figure 2-1). Parameters measured included pressure, water temperature, conductivity, DO, pH, chlorophyll-*a*, CDOM, and water clarity. Profiling was conducted from the surface depth to 2 m from the bottom or to a maximum depth of 75–100 m. Sampling and analytical methods were the same as those presented in Table A-3.

Nearshore Zone

Nearshore (surfzone) FIB samples were collected 1–2 days per week at 38 stations (Figure 2-1, Table A-1). Samples were collected in ankle-deep waters, on an incoming wave, with the sampler downstream and away from the bottle, and the mouth of the bottle facing into the current. Sterile sample bottles were used and the sampler used aseptic techniques, making certain that the bottle did not touch the ocean bottom. After the sample was taken, the bottle was tightly capped and promptly stored on ice in the dark. Laboratory analysis began within 6 hours of sample collection. The occurrence and size of any grease particles at the high tide line was recorded 2 days per week at the same sampling locations.

When creek/storm drain stations (denoted by ** in Table A-1) flowed to the ocean, three bacteriological samples were collected: 1) at the source, 2) 25 yards downcoast, and 3) 25 yards upcoast. When flow was absent, a single sample was collected 25 yards downcoast.

Laboratory Methods

Laboratory analyses of NH3-N and bacteriology samples followed standard EPA guidelines as listed in Table A-3. Quality assurance/quality control (QA/QC) procedures included analysis of laboratory blanks and duplicates. All data underwent at least three separate reviews prior to being included in the final database used for statistical analysis, comparison to standards, and data summaries.

Data Analyses

Raw CTD data were processed using both SEASOFT (2014b) and third party (IGODS 2012) software. The steps included retaining downcast data and identifying outliers by flagging the data if it exceeded specific criteria limits. Flagged data were removed if they were considered to be due to instrument failures, electrical noise (e.g., large data spikes), or physical interruptions of sensors (e.g., by bubbles) rather than by actual oceanographic events. After outlier removal, averaged 1 m depth values were prepared from the downcast scan data; if there were any missing 1 m depths, then the upcast data was used as a replacement. CTD and discrete data were then combined to create a single data file that contained all sampled stations for each survey day.

Compliance Determinations

Water quality compliance was assessed based on: (1) specific numeric criteria for DO, pH, and three FIB (total and fecal coliform and enterococci); and (2) narrative (non-numeric) criteria for transmissivity, floating particulates, oil and grease, water discoloration, beach grease, and excess nutrients. Station locations were defined as either Zone A (stations inshore of the 3-mile limit for state waters) or Zone B (offshore of the 3-mile limit) as shown in Figure A-1. Compliance evaluations for DO, pH, and transmissivity were based on statistical comparisons to the corresponding Zone A or Zone B reference station located upcurrent of the outfall (OCSD 1999). FIB compliance used corresponding COP bacterial standards at each REC-1 station. The remaining compliance determinations were done based on presence/absence and level of potential effect at each station.

Dissolved Oxygen, pH, and Transmissivity

For each survey, the depth of the pycnocline layer, if present, was calculated for each station using temperature and salinity data. The pycnocline is defined as the depth layer where stability is greater than 0.05 kg/m^3 (Officer 1976). Data for each station and numeric compliance parameter (transmissivity, dissolved oxygen, and pH) were binned by water column stratum: above, within, or below the pycnocline. When a pycnocline was absent, data were binned into the top, middle, or bottom third of the water column for each station. Mean values for each parameter were calculated by stratum and station. The number of observations usually differed from station to station and survey to survey due to different water and pycnocline depths. The selection of appropriate reference stations (i.e., upcoast or downcoast) for each survey day were determined based on available current measurements and the presence or absence of typical plume "signals" (e.g., elevated ammonium, FIB, and colored dissolved organic matter [CDOM]). If the choice of a reference station is indeterminate, then the data is analyzed twice using both upcoast and downcoast reference stations. Once reference stations were determined, the data were analyzed using in-house MATLAB (2007) routines to calculate out-of-range occurrences (OROs) for each sampling date and parameter. These OROs were based on comparing the mean data by stratum and station with the corresponding reference station data to determine whether the following COP criteria were exceeded:

- Dissolved oxygen: cannot be depressed >10% below the mean;
- pH: cannot be greater than ± 0.2 pH units of the mean; and

- Natural light (defined as transmissivity): shall not be significantly reduced, where statistically different from the mean is defined as the lower 95% confidence limit.

In accordance with permit specifications, the outfall station (2205) was not included in the comparisons because it is within the zone of initial dilution (ZID).

To determine whether an ORO was out-of-compliance (OOC), distributional maps were created that identified the reference stations for each sampling date and location of each ORO, including which stratum was out of range. Each ORO was then evaluated to determine if it represented a logical OOC event. These evaluations were based on: (A) evaluation of the wastewater plume location relative to depth using a combination of temperature, density, salinity, CDOM, and when available, FIB and ammonium (NH3-N); (B) evaluation of features in the water column relative to naturally occurring events (i.e., high chlorophyll-*a* due to phytoplankton); and (C) unique characteristics of some stations that may not be comparable with permit-specified reference stations (2104/2105 or 2404/2406) due to differences in water depth and/or variable oceanographic conditions. For example, Zone A stations (2103, 2203, 2303, and 2403) are located at shallower depths than reference Station 2104. Waves and currents can cause greater mixing and resuspension of bottom sediments at shallower stations under certain conditions (e.g., winter storm surges). This can result in naturally decreased water clarity (transmissivity) that is unrelated to the wastewater discharge. An ORO can be in-compliance if, for example, a downcurrent station is different from the reference, but no intermediate (e.g., nearfield) stations exhibited OROs.

Once the total number of OOC events was summed by parameter, the percentage of OROs and OOCs were calculated according to the total number of observations. In a typical year, Zone A has a total of 504 possible comparisons if 14 stations (not including the reference station) and three strata over 12 survey dates per year are used. For Zone B, 432 comparisons are possible from 12 stations (not including the reference station), three strata, and 12 sampling dates. The total combined number of ORO and OOC events was then determined by summing the Zone A and Zone B results. If not all of the strata are present or additional surveys are conducted, the total number of comparisons in the analysis may be more or less than the target number of comparisons possible (936).

<u>Fecal Indicator Bacteria (FIB)</u>
FIB counts at individual REC-1 stations were averaged per survey and compliance for each FIB was determined using the following COP criteria (SWRCB 2010):

30-day Geometric Mean
- Total coliform density shall not exceed 1,000 per 100 mL.
- Fecal coliform density shall not exceed 200 per 100 mL.
- Enterococci density shall not exceed 35 per 100 mL.

Single Sample Maximum
- Total coliform density shall not exceed 10,000 per 100 mL.
- Fecal coliform density shall not exceed 400 per 100 mL.
- Enterococci density shall not exceed 104 per 100 mL.

- Total coliform density shall not exceed 1,000 per 100 mL when the fecal coliform/total coliform ratio exceeds 0.1.

Additionally, the District's permit includes the following USEPA Primary Recreation Criteria for *Enterococcus* (EPA 1994a).

- 30-day geometric mean: Density less than 35 per 100 mL.
- Single sample: Density less than 104 per 100 mL for designated bathing beaches.
- Single sample: Density less than 158 per 100 mL for moderate use.
- Single sample: Density less than 276 per 100 mL for light use.
- Single sample: Density less than 501 per 100 mL for infrequent use.

For purposes of this report, compliance with the EPA criteria was based on infrequent use.

Determinations of fecal coliform compliance were accomplished by multiplying *E. coli* data by 1.1 to obtain a calculated fecal coliform value.

There are no compliance criteria for FIB at the nearshore stations. Nevertheless, FIB data were given to the Orange County Health Agency (who follows State Department of Health Service AB411 standards) for the Ocean Water Protection Program (http://ocbeachinfo.com/); and are briefly discussed in Chapter 2.

Nutrients and Aesthetics

Compliance for the floating particulates, oil and grease, and water discoloration were determined based on presence/absence at the ocean surface for each station. Compliance with the excess nutrient criterion was based on evaluation of NH3-N compared to COP objectives for chronic (4 mg/L) and acute (6 mg/L) toxicity to marine organisms. Compliance was also evaluated by looking at potential spatial relationships between NH3-N distribution and phytoplankton (using chlorophyll-*a* fluorescence).

SEDIMENT GEOCHEMISTRY MONITORING

Field Methods

Sediment samples were collected for geochemistry analyses during July 2013 and January 2014 at 29 semi-annual stations that ranged in depth from 52 to 65 m along the San Pedro Shelf (Figure 2-2, Tables A-1 and A-2). In addition, 3 L of sediment was collected from nine stations in January 2014 for sediment toxicity testing.

A single sample was collected at each station using a paired 0.1 m^2 Van Veen grab sampler deployed from the M/V *Nerissa*. The top 2 cm of the sample was transferred into containers and re-sealable plastic bags using a stainless steel scoop. The sampler and scoop were rinsed thoroughly with filtered seawater prior to sample collection. All sediment samples were transported to the laboratory. Sample storage and holding times followed specifications in the District's QAPP (Table A-4). Sediment grain size, total organic carbon (TOC), total nitrogen, and total phosphorus samples were subsequently transferred to local and interstate laboratories for analysis (see Appendix C). All sample transfers were

Table A-4. Sediment handling and analysis summary during 2013-14.

Orange County Sanitation District, California.

Parameter	OCSD Method	Method Reference	Preservation	Container	Holding Time
Dissolved Sulfides	LOPM 4500-S G Rev. B	Green and Schnitker (1974); Standard Methods 4500-S G*	Freeze	Plastic container	6 months
Chlorinated Pesticides	Sediment Fish PCB/Pesticides by GCMS	NS&T (NOAA 1993); EPA 8270**	Freeze	Glass jar	6 months (analyze within 40 days of extraction)
Grain Size	EMSL Analytical, Inc. (Plumb 1981)	Plumb (1981)	4° C	Plastic bag	6 months
Linear Alkyl Benzenes	Ocean Sediment Extraction and GCMS Analysis For PAH_LAB	NS&T (NOAA 1993); Eganhouse *et al*. (1983)	Freeze	Glass jar	12 months
Metals	EPA 200.8	NS&T (NOAA 1993); EPA 200.8**	Freeze	Amber glass jar	6 months
Polychlorinated Biphenyls	Sediment Fish PCB/Pesticides by GCMS	NS&T (NOAA 1993); EPA 8270**	Freeze	Glass jar	6 months (analyze within 40 days of extraction)
Polycyclic Aromatic Hydrocarbons	Ocean Sediment Extraction and GCMS Analysis FOR PAH_LAB	NS&T (NOAA 1993); EPA 8270**	Freeze	Glass jar	6 months (analyze within 40 days of extraction)
Total Organic Carbon	ALS Environmental (EPA 9060)	EPA 9060**	Freeze	Glass jar	6 months

* APHA (2012)
** Available online at www.epa.gov.

Table A-5. Sediment composition, geochemistry, and benthic infaunal sampling summary during 2013-14.

Orange County Sanitation District, California.

Stations	Sampling Frequency	Sampling Interval	Field Replicates	Parameters
Infauna				
0, 1, 3, 4, 5, 9 12, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 84, 85, 86, 87, C,CON, ZB	Semi-annual (summer and winter)	≥4 cm	1 replicate per station	Infauna
Sediment Geochemistry				
0, 1, 3, 4, 5, 9 12, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 84, 85, 86, 87, C,CON, ZB	Semi-annual (summer and winter)	0-2 cm; from undisturbed grab sample	1 replicate per station	Metals Total Organic Carbon Dissolved Sulfides Grain size Chlorinated Pesticides Polychlorinated Biphenyls (PCBs) Polycyclic Aromatic Hydrocarbons (PAHs) Linear Alkyl Benzenes (LABs) *

* Summer only

conducted and documented using required chain-of custody protocols through Laboratory Information Management Systems (LIMS) software.

Laboratory Methods

Sediment chemistry and grain size samples were processed and analyzed using the methods listed in Table A-4. The measured sediment chemistry parameters are listed in Tables A-5 and A-6.

Sediment toxicity, following EPA-recommended methods (EPA 1994b), was conducted using the 10-day *Eohaustorius estuarius* amphipod survival test. Amphipods were exposed to test and control sediments and the percent survival in each were determined. Toxicity threshold criteria were selected to be consistent with the Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality (Bay *et al*. 2009, SWRCB 2009). Stations which were significantly different when compared to the control, determined by a two sample t-test, were categorized as non-toxic when survival was 90–100% of the control, lowly toxic when survival was 82–89% of the control, and moderately toxic when survival was 59-81% of the control. Stations which were not significantly different when compared to the control were categorized as non-toxic when survival was 82–100% of the control and lowly toxic when survival was 59–81% of the control. All stations exhibiting survival less than 59% of the control were categorized as highly toxic.

Data Analyses

Total dichlorodipheynltrichloroethane (tDDT), total polychlorinated biphenyls (tPCB), total chlorinated pesticides (tPest), and total polycyclic aromatic hydrocarbons (tPAH) represent the summed concentrations of the respective components listed in Table A-6. All analytes (individual or summed) that were undetected (i.e., concentrations below the method detection limit) were assumed to be zero for calculating means, but are reported as not detected (ND) in Tables 2-4 to 2-6. If a mean value was below the method detection limit, the mean was likewise reported as ND in Tables 2-4 to 2-6. Data analysis consisted of summary statistics and qualitative comparisons only.

BENTHIC INFAUNA MONITORING

Field Methods

The infaunal community was monitored by collecting marine sediments concurrently with sediment geochemistry samples at 29 semi-annual stations in July 2013 (summer) and in January 2014 (winter) (Figure 2-2, Tables A-1 and A-2). Each station was assigned to either the middle shelf Zone 2, within-ZID (51–90 m) or middle shelf Zone 2, non-ZID (51–90 m) depth categories. In the Compliance Chapter, the middle shelf Zone 2, within- and non-ZID stations are simply referred to as within-ZID and non-ZID stations, respectively.

All infauna sediment samples were qualitatively and quantitatively assessed for acceptability prior to processing. Samples were deemed as acceptable if they had a minimum depth of 5 cm. However, if three consecutive sediment grabs each yielded a depth of < 5 cm at a station, then the depth threshold was lowered to ≤ 4 cm. Each

Table A-6. Parameters measured in sediment samples.

Orange County Sanitation District, California.

Metals		
Aluminum	Cadmium	Mercury
Antimony	Chromium	Nickel
Arsenic	Copper	Selenium
Barium	Iron	Silver
Beryllium	Lead	Zinc
Other Metrics		
Total Organic Carbon	Total Phosphorus	Total Nitrogen
Dissolved Sulfides	Grain Size	
Chlorinated Pesticides (Chlordane derivatives and Dieldrin)		
Aldrin	*trans*-Chlordane	Hexachlorobenzene
Dieldrin	*gamma*-BHC	Mirex
Endrin	Heptachlor	*trans*-Nonachlor
cis-Chlordane	Heptachlor epoxide	
DDTs		
2,4'-DDD (o,p'-DDD)	4,4'-DDD (p,p'-DDD)	4,4'-DDMU
2,4'-DDE (o,p'-DDE)	4,4'-DDE (p,p'-DDE)	
2,4'-DDT (o,p'-DDT)	4,4'-DDT (p,p'-DDT)	
PCB Congeners		
PCB 8	PCB 105	PCB 167
PCB 18	PCB 110	PCB 169
PCB 28	PCB 114	PCB 170
PCB 37	PCB 118	PCB 177
PCB 44	PCB 119	PCB 180
PCB 49	PCB 123	PCB 183
PCB 52	PCB 126	PCB 187
PCB 66	PCB 128	PCB 189
PCB 70	PCB 138	PCB 194
PCB 74	PCB 149	PCB 195
PCB 77	PCB 151	PCB 200
PCB 81	PCB 153/168	PCB 201
PCB 87	PCB 156	PCB 206
PCB 99	PCB 157	PCB 209
PCB 101	PCB 158	
PAH Compounds		
1,6,7-Trimethylnaphthalene	Benz[a]anthracene	Dibenzothiophene
1-Methylnaphthalene	Benzo[a]pyrene	Fluoranthene
1-Methylphenanthrene	Benzo[b]fluoranthene	Fluorene
2,3,6-Trimethylnaphthalene	Benzo[e]pyrene	Indeno[1,2,3-c,d]pyrene
2,6-Dimethylnaphthalene	Benzo[g,h,I]perylene	Naphthalene
2-Methylnaphthalene	Benzo[k]fluoranthene	Perylene
Acenaphthene	Biphenyl	Phenanthrene
Acenaphthylene	Chrysene	Pyrene
Anthracene	Dibenz[a,h]anthracene	

Table A-6 Continues.

Table A-6 Continued.

PAH Alkylated Homologues		
C1-Chrysenes	C2-Fluorenes	C3-Naphthalenes
C1-Dibenzothiophenes	C3-Fluorenes	C4-Naphthalenes
C2-Dibenzothiophenes	C1-Fluoranthenes/Pyrenes	C1-Phenanthrenes/Anthracenes
C3-Dibenzothiophenes	C1-Naphthalenes	C2-Phenanthrenes/Anthracenes
C1-Fluorenes	C2-Naphthalenes	C3-Phenanthrenes/Anthracenes
LAB Compounds		
2-Phenyldecane	2-Phenyltetradecane	4-Phenylundecane
3-Phenyldecane	3-Phenyltetradecane	5-Phenylundecane
4-Phenyldecane	4-Phenyltetradecane	6-Phenylundecane
5-Phenyldecane	5-Phenyltetradecane	2-Phenyldodecane
2-Phenyltridecane	6-Phenyltetradecane	3-Phenyldodecane
3-Phenyltridecane	7-Phenyltetradecane	4-Phenyldodecane
4-Phenyltridecane	2-Phenylundecane	5-Phenyldodecane
5-Phenyltridecane	3-Phenylundecane	6-Phenyldodecane
7+6-Phenyltridecane		

acceptable sample was gently washed with filtered seawater through a 1.0 mm sieve. Retained organisms were rinsed into one liter plastic containers and anesthetized with 7% magnesium sulfate for approximately 30 minutes. To preserve the animals, full strength buffered formaldehyde was then added to achieve a 10%, by volume, solution and returned to the laboratory.

Laboratory Methods

After 3–10 days in formalin, samples were rinsed with water and transferred to 70% ethanol for long-term preservation. Samples were sent to Marine Taxonomic Services, Inc. (San Marcos, CA) to be sorted to five major taxonomic groups, Polychaeta, (worms), Mollusca (snails, clams, etc.), Crustacea (shrimps, crabs, etc.), Echinodermata (sea stars, sea urchins, etc.), and miscellaneous phyla (Cnidaria, Nemertea, etc.). Removal of organisms from the sediment samples was monitored to ensure that at least 95% of all organisms were successfully separated from the sediment matrix (see Appendix C). Upon completion of sample sorting, the major taxonomic groups were distributed for identification and enumeration according to the schedule in Table A-7. Taxonomic differences were resolved and the database was edited accordingly (see Appendix C). Species names used in this report follow those given in the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) List, Edition 8 (Cadien and Lovell 2013).

Table A-7. Benthic infauna sample identification schedule.

Orange County Sanitation District, California.

Date	Survey	Taxonomic Groups				
		Annelida	Arthropoda	Mollusca	Echinodermata	Misc. Phyla
Summer 2013	Semi-annual	OCSD	OCSD	OCSD	OCSD	OCSD
Winter 2014	Semi-annual	Contractor	Contractor	OCSD	OCSD	OCSD

OCSD refers to staff taxonomists.
Contractor refers to Marine Taxonomic Services, Inc.

Data Analyses

Infaunal community data were analyzed to determine if populations outside the ZID were affected by the outfall discharge. Six measures were used to assess infaunal community health and function: (1) total number of species (richness), (2) total number of individuals (abundance), (3) Shannon-Wiener Diversity (H'), (4) Swartz's 75% Dominance Index (SDI), (5) Infaunal Trophic Index (ITI), and (6) Benthic Response Index (BRI). H' was calculated using loge (Zar 1999). SDI was calculated as the minimum number of species with combined abundance equal to 75% of the individuals in the sample (Swartz 1978). SDI is inversely proportional to numerical dominance, thus a low index value indicates high dominance (i.e., a community dominated by a few species). The ITI was developed by Word (1978, 1990) to provide a measure of infaunal community "health" based on a species' mode of feeding (e.g., primarily suspension vs. deposit feeder). ITI values greater than 60 are considered indicative of a "normal" community, while 30–60 represent a

"changed" community, and values less than 30 indicate a "degraded" community. The BRI measures the pollution tolerance of species on an abundance-weighted average basis (Smith *et al*. 2001). This measure is scaled inversely to ITI with low values (<25) representing reference conditions and high values (>72) representing defaunation or the exclusion of most species. The intermediate value range of 25–34 indicates a marginal deviation from reference conditions, 35–44 indicates a loss of biodiversity, and 45–72 indicates a loss of community function. The BRI was used to determine compliance with NPDES permit conditions, as it is a commonly used southern California benchmark for infaunal community structure and was developed with the input of regulators (Ranasinghe *et al*. 2007, 2012).

The presence or absence of certain indicator species (pollution sensitive and pollution tolerant) was also determined for each station. The presence of pollution sensitive species, i.e., the red brittlestar (*Amphiodia urtica*) and amphipods in the genera *Ampelisca* and *Rhepoxynius*, typically indicates the existence of a healthy environment, while the occurrence of large numbers of pollution tolerant species, i.e., *Capitella capitata* Complex (polychaete) and *Euphilomedes carcharodonta* (ostracod crustacean), may indicate stressed or organically enriched environments. Patterns of these species were used to assess the spatial and temporal influence of the wastewater discharge in the receiving environment.

PRIMER v6 (2001) multivariate statistical software was used to examine the spatial patterns of infaunal invertebrate communities in the July 2013 survey. Analyses included (1) hierarchical clustering with group-average linking based on Bray-Curtis similarity indices, (2) similarity profile (SIMPROF) permutation test of the clusters, and (3) ordination clustering of the data using non-metric multidimensional scaling (nMDS). Prior to the calculation of the Bray-Curtis indices, the data were 4th-root transformed in order to down-weight the highly abundant species and to incorporate the less common species (Clarke and Warwick 2001).

TRAWL COMMUNITIES MONITORING

Field Methods

Demersal fishes and epibenthic macroinvertebrates (EMIs) were collected in the summer (July) of 2013 and the winter (January) of 2014. Sampling was conducted at seven stations, shallow (18 m) Station T0, and middle shelf (60 m) Stations T1, T11, T12, T17, T22, and T23 (Figure 2-2, Tables A-1 and A-2). Station T0 is a historical trawl station near the short 78" emergency outfall; it was sampled during the 2013-14 monitoring period to maintain the long-term abundance record of fishes and EMIs at this site. Data for this historical station are not discussed.

One trawl was conducted from the M/V *Nerissa* at each station using a 7.6 meter (25 ft) wide, Marinovich, semi-balloon otter trawl (2.54 cm mesh) with a 0.64 cm mesh cod-end liner, an 8.9 m chain-rigged foot rope, and 23 m long trawl bridles following regionally adopted methodology (Mearns and Allen 1978). The trawl wire scope varied from a ratio of approximately 5:1 at the shallowest stations to approximately 3:1 at the deepest station. To minimize catch variability due to weather and current conditions, which may affect the

bottom-time duration of the trawl, trawls generally were taken along a constant depth at each station, and usually in the same direction.

Established survey methods for southern California require that a portion of the trawl track must pass within a 100 m circle that originates from the nominal sample station position and be within 10% of the station's depth. The speed of the trawl should range from 0.77 to 1.00 m/s or from 1.5 to 2.0 knots. Since 1985, the District has trawled a set distance of 450 m, the distance that the net is actually on the bottom collecting fish and invertebrates. Station locations and trawling paths were determined using Global Positioning System (GPS) navigation. GPS was also used to control the speed of the trawl (1.5–2.0 knots over the bottom) and determine the distance sampled (450 m). Trawl depths and time on the bottom were determined using an attached SBE 39 pressure sensor on one of the trawl boards.

Upon retrieval of the trawl net, the contents (fishes and EMIs) were first emptied into a large flow-through water tank and then sorted by species into separate containers. Fish bioaccumulation specimens were counted, recorded, and removed for processing (see below). The remaining fish specimens were processed as follows: (1) a minimum of 15 randomly selected specimens of each species were weighed to the nearest gram and measured individually to the nearest millimeter (standard length); and (2) if a haul sample contained substantially more than 15 individuals of a species, then the excess specimens were enumerated in 1 cm size classes and a bulk weight was recorded. All fish specimens were examined for abnormalities such as external tumors, lesions, parasites, and skeletal deformities. EMIs were sorted to species, counted, and batch weighed. In the event of a large haul of a single invertebrate species (n > 100), 100 individuals were counted and batch weighed, and the remaining animals were batch weighed and enumerated later by back calculating using the weight of the first 100. Fish and EMI specimens that required further taxonomic scrutiny were retained for final identification at a later date.

Laboratory Methods

Specimens for the voucher collection and any animals that could not be identified in the field were preserved in 10% buffered formalin for subsequent laboratory analysis. A representative voucher collection of fishes and EMIs is maintained in the OCSD Taxonomy Lab for reference and verification.

Data Analyses

Number of species, number of individuals (abundance), biomass, Shannon-Wiener Diversity Index (H') and Swartz's 75% Dominance Index were calculated for both fishes and EMIs at each station. Fish biointegrity in the District's monitoring area was assessed using the fish response index (FRI). The FRI is a multivariate weighted-average index produced from an ordination analysis of calibrated species abundance data (Allen *et al*. 2001, 2006). FRI scores less than 45 are classified as reference (normal) and those greater than 45 are non-reference (abnormal or disturbed).

PRIMER (2001) multivariate statistical software was used to examine the spatial patterns of the fish and EMI assemblages in the District's monitoring area (Clarke 1993; Warwick 1993). Analyses included (1) hierarchical clustering with group-average linking based on Bray-Curtis similarity indices, (2) similarity profile (SIMPROF) permutation tests of the

clusters, and (3) ordination clustering of the data using non-metric multidimensional scaling (nMDS). Prior to the calculation of the Bray-Curtis indices, the data were fourth-root transformed in order to down-weight the highly abundant species and incorporate the importance of the less common species (Clarke and Warwick 2001).

Stations were grouped into the following categories to assess spatial, outfall-related patterns: “outfall” (Stations T1 and T22); and “non-outfall” (Stations T11, T12, T17, and T23).

FISH TISSUE CONTAMINANTS MONITORING

Demersal Fish Tissue Chemistry

Two demersal fish species, English Sole (*Parophrys vetulus*) and Hornyhead Turbot (*Pleuronichthys verticalis*), were targeted for analysis of muscle and liver tissue chemistry. Muscle tissue was analyzed because contaminants may bioaccumulate in this tissue and can be transferred to higher trophic levels. Liver tissue was analyzed because it typically has higher lipid content than muscle tissue and thus bioaccumulates relatively higher concentrations of lipid-soluble contaminants that have been linked to pathological conditions as well as immunological or reproductive impairment (Arkoosh *et al*. 1998).

Sport Fish Muscle Chemistry

Demersal fishes in the family Scorpaenidae (e.g., Vermilion Rockfish (*Sebastes miniatus*) and California Scorpionfish (*Scorpaena guttata*)) were targeted, as they are frequently caught and consumed by recreational anglers. As such, contaminants in the muscle tissue of scorpaenid fishes were analyzed to gauge human health risk.

Field Methods

The sampling objective for bioaccumulation analysis was to collect 10 individuals each of English Sole and Hornyhead Turbot at outfall (T1) and farfield (T11) stations during the January 2014 trawl survey. Likewise, 10 individuals of scorpaenid fishes were targeted at the outfall (Zone 1) and a reference area (Zone 2) using hook-and-line fishing gear (“rig fishing”) in January 2014 (Table A-1).

Individual fish were weighed to the nearest gram and measured to the nearest millimeter (standard length); placed in pre-labelled, plastic, re-sealable bags; and stored on wet ice in insulated coolers. All samples were subsequently transported under chain-of-custody protocols to OCSD’s laboratory.

Laboratory Methods

Individual fish were dissected in the laboratory under clean conditions. Muscle and liver tissues were analyzed for various parameters listed in Table A-8 using methods consistent with NOAA National Status and Trends (NS&T) protocols (NOAA 1993) (Table A-9). Method blanks, analytical quality control samples (duplicates, matrix spikes, and blank spikes), and standard reference materials were prepared and analyzed with each sample

Table A-8. Parameters measured in fish tissue.

Orange County Sanitation District, California.

Metals		
Mercury		
Chlorinated Pesticides (Chlordane derivatives and Dieldrin)		
cis-Chlordane	Dieldrin	*cis*-Nonachlor
trans-Chlordane	Heptachlor	*trans*-Nonachlor
Oxychlordane	Heptachlor epoxide	
DDT Derivatives		
2,4'-DDD (o,p'-DDD)	4,4'-DDD (p,p'-DDD)	4,4'-DDMU
2,4'-DDE (o,p'-DDE)	4,4'-DDE (p,p'-DDE)	
2,4'-DDT (o,p'-DDT)	4,4'-DDT (p,p'-DDT)	
PCB Congeners		
PCB 8	PCB 105	PCB 167
PCB 18	PCB 110	PCB 169
PCB 28	PCB 114	PCB 170
PCB 37	PCB 118	PCB 177
PCB 44	PCB 119	PCB 180
PCB 49	PCB 123	PCB 183
PCB 52	PCB 126	PCB 187
PCB 66	PCB 128	PCB 189
PCB 70	PCB 138	PCB 194
PCB 74	PCB 149	PCB 195
PCB 77	PCB 151	PCB 200
PCB 81	PCB 153/168	PCB 201
PCB 87	PCB 156	PCB 206
PCB 99	PCB 157	PCB 209
PCB 101	PCB 158	
Other Parameter		
Lipids		

Table A-9. Fish tissue handling and analysis summary.

Orange County Sanitation District, California.

Parameter	Method Reference	Preservation	Container	Holding Time
Arsenic and Selenium	NS&T (NOAA 1993); EPA 200.8*	Freeze	Ziplock bag	6 months
Mercury	EPA 245.6*	Freeze	Ziplock bag	6 months
Chlorinated Pesticides	NS&T (NOAA 1993); EPA 8270*	Freeze	Ziplock bag	6 months (analyze within 40 days of extraction)
DDTs	NS&T (NOAA 1993); EPA 8270*	Freeze	Ziplock bag	6 months (analyze within 40 days of extraction)
Polychlorinated Biphenyl Congeners (PCBs)	NS&T (NOAA 1993); EPA 8270*	Freeze	Ziplock bag	6 months (analyze within 40 days of extraction)
Lipids	EPA 9071*	Freeze	Ziplock bag	NA

NA = Not Applicable.
* Available online at www.epa.gov.

batch. Mercury was quantified by cold vapor atomic absorption spectrophotometry, polychlorinated biphenyls (PCBs) and organochlorines were measured using dual column gas chromatography with an electron capture detector, and lipids were determined gravimetrically. All reported concentrations are on a wet weight basis.

Total dichlorodipheynltrichloroethane (tDDT) represents the summed concentrations of 2,4- and 4,4'-isomers of DDD, DDE, and DDT and 4,4'-DDMU, total polychlorinated biphenyls (tPCB) represents the summed concentrations of 44 congeners, total chlordane represents the sum of seven derivative compounds (cis- and trans-chlordane, cis- and trans-nonachlor, heptachlor, heptachlor epoxide, and oxychlordane). All analytes (individual or summed) that were not detected (i.e., concentrations below the method detection limit) were assumed to be zero for calculating means. If a mean value was below the method detection limit, the mean was reported as not detected (ND) in Tables 2-12 and 2-13. Historically, organic contaminant data have been lipid normalized; however, this was not required for this survey period due to a lack of a significant correlation between percent lipids and organic contaminant concentrations.

The U.S. Food and Drug Administration (FDA) action levels for tDDT, tPCBs, methylmercury, dieldrin and total chlordane (FDA 2011), as well as the State of California Office of Environmental Health Hazard Assessment (OEHHA) advisory tissue levels (ATLs) for selected fish contaminants (Klasing and Brodberg 2008), were used to assess human health risk.

Data analysis consisted of summary statistics and qualitative comparisons only.

FISH HEALTH MONITORING

Field Methods

Assessment of the overall health of the fish population is also required by the NPDES permit. Consequently, all fish samples were visually inspected for large, non-mobile external parasites, lesions, tumors, and other signs of disease (e.g., skeletal deformities). In addition, any atypical odor and coloration of fish samples were noted.

Data analysis consisted of summary statistics and qualitative comparisons only.

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