ORANGE COUNTY SANITATION DISTRICT

Marine Monitoring Annual Report

Year 2016-2017

Orange County, California

ORANGE COUNTY SANITATION DISTRICT
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March 1, 2018

Hope Smythe
Executive Officer
California Regional Water Quality Control Board
Santa Ana Region 8
3737 Main Street, Suite 500
Riverside, CA 92501-3348

SUBJECT: Board Order No. R8-2012-0035, NPDES No. CA0110604 2016-17 Marine Monitoring Annual Report

Dear Ms. Smythe,

Enclosed is the Orange County Sanitation District's 2016-17 Marine Monitoring Annual Report. This report focuses on the findings and conclusions for the monitoring period July 1, 2016 to June 30, 2017. The results of the monitoring program document that the combined discharge of our secondary-treated wastewater (effluent) and water reclamation flows (brine) into the coastal waters off Huntington Beach and Newport Beach, California, continues to protect the environment and human health.

The results of the 2016-17 monitoring effort showed minimal changes in the coastal receiving water. Plume-related changes in dissolved oxygen, pH, and transmissivity beyond the zone of initial dilution (ZID) were well within the range of natural variability, and compliance with numeric receiving water criteria was achieved over 97% of the time. This demonstrated that the receiving water outside the ZID has not been degraded by the District's wastewater discharge. The low concentrations of fecal indicator bacteria in water contact zones, coupled with the low concentrations of ammonium at depth, also suggest that the wastewater discharge posed no human health risk and did not compromise recreational use.

There were no impacts to the benthic animal communities within and adjacent to the ZID. Infauna and fish communities in the monitoring area were healthy, with all sites classifying as reference condition based on several biological indices. In addition, sediment contaminants remained at background levels and no measurable toxicity was observed in whole sediment toxicity tests. The low levels of contaminants in fish tissues and the low incidence of external abnormalities and diseases in fish populations demonstrated that the outfall was not an epicenter of disease.

Should you have questions regarding the information provided in this report, or wish to meet with the District's staff to discuss any aspect of our ocean monitoring program, please feel free to contact me at (714) 593-7450 or at jcolston@ocsd.com.

However, you may also contact Dr. Jeff Armstrong, the supervisor of our Ocean Monitoring section, who may be reached at (714) 593-7455 or at jarmstrong@ocsd.com.

James E. Colston
Director of Environmental Services

JA:ja:bg
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Enclosure

c: Alexis Strauss, U.S. EPA, Region IX

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March 1, 2018

Certification Statement

The following certification satisfies Attachment E of the Orange County Sanitation District's Monitoring and Reporting Program, Order No. R8-2012-0035, NPDES No. CA0110604, for the submittal of the attached OCSD Annual Report 2018 – Marine Monitoring.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for known violations.

James E. Colston
Director of Environmental Services

March 1, 2018
Date

Our Mission: To protect public health and the environment by providing effective wastewater collection, treatment, and recycling.

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ACKNOWLEDGMENTS

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EXECUTIVE SUMMARY

The Orange County Sanitation District (District) conducts extensive water quality, sediment quality, and fish and invertebrate community monitoring to evaluate potential environmental and public health risks from its combined discharge of secondary-treated wastewater (effluent) and water reclamation flows (brine) into the coastal waters off Huntington Beach and Newport Beach, California. The discharge is released 7 km offshore, in 60 m of water. The data collected are used to determine compliance with receiving water conditions as specified in the District's National Pollution Discharge Elimination System (NPDES) permit (R8-2012-0035, CA0110604), jointly issued in 2012 by the U.S. Environmental Protection Agency (EPA), Region IX and the Regional Water Quality Control Board (RWQCB), Region 8. This report focuses on monitoring results and conclusions from July 2016 through June 2017.

WATER QUALITY

The public health risks and measured environmental effects to the receiving water continue to be small. Consistent with previous years, minor changes in measured water quality parameters related to the discharge of effluent to the coastal ocean were detected. Plume-related changes in temperature, salinity, dissolved oxygen, pH, and light transmissivity were measurable beyond the initial mixing zone (<2 km) during some surveys. None of these changes were determined to be environmentally significant; all values were within the ranges of natural variability for the study area, and reflected seasonal and yearly changes of large-scale regional influences. The limited observable plume effects occurred primarily at depth, even during the winter when stratification was weakest. All state and federal offshore bacterial standards were met during all surveys. In summary, the 2016-17 discharge of effluent did not greatly affect the receiving water environment; therefore, beneficial uses were protected and maintained.

SEDIMENT QUALITY

As in previous years, mean concentrations of organic contaminants and metals tended to increase with increasing depth, with the highest in depositional areas. Sediment parameter values were comparable between within-ZID (zone of initial dilution) and non-ZID station groups and were below levels of biological concern (ERM values) at all stations. Whole sediment toxicity tests showed no measurable toxicity. These results, coupled with the presence of healthy fish and invertebrate communities adjacent to and farther afield from the outfall (see below), indicate good sediment quality in the monitoring area.

BIOLOGICAL COMMUNITIES

Infaunal Invertebrate Communities

As with previous years, the abundance and number of species of infauna were markedly lower at stations deeper than 120 m. Infaunal communities were similar at within-ZID and non-ZID stations based on multivariate analyses. Furthermore, the infaunal communities within the monitoring area can be classified as reference condition based on their low Benthic Response Index values and high Infaunal Trophic Index values. These results indicate that the outfall discharge had an overall negligible effect on the benthic community structure within the monitoring area.

Demersal Fishes and Macroinvertebrates

Community measure values of the epibenthic macroinvertebrates (EMIs) and fishes collected at outfall and non-outfall stations were generally comparable. Furthermore, fish communities at all stations were classified as reference condition based on their low Fish Response Index values. These results indicate that the outfall area supports normal fish and EMI populations.

Contaminants in Fish Tissue

Concentrations of mercury and other chlorinated pesticides were similar in the muscle tissue of Hornyhead Turbot and English Sole captured by otter trawl at outfall and non-outfall stations. No spatial comparison of liver chemistry data could be made for trawl-caught Hornyhead Turbot and English Sole due to instrument failure during analysis of non-outfall samples. Concentrations of mercury, arsenic, selenium, DDT, PCB, and other chlorinated pesticides in muscle tissue of rockfishes caught by hook-and-line at outfall and non-outfall locations were below federal and state human consumption guidelines. These results demonstrate that demersal fishes residing near the outfall are not more prone to bioaccumulation and also suggest there is little risk from consuming fish from the monitored areas.

Fish Health

The color and odor of fishes appeared normal. The lack of tumors, fin erosion, and skin lesions showed that fishes in the monitoring area were healthy. External parasites and other external abnormalities occurred in less than 1% of the fishes collected, which is comparable to southern California Bight background levels. These results are consistent with previous years and indicate that the outfall is not an epicenter of disease.

CONCLUSION

In summary, California Ocean Plan criteria for water quality were met within the monitoring area. State and federal bacterial standards were also met at offshore stations. Sediment quality was not degraded by chemical contaminants or by physical changes from the discharge of effluent. This was supported by (1) the absence of sediment toxicity in controlled laboratory tests, (2) the presence of normal infaunal, fish, and EMI communities throughout the monitoring area, and (3) no exceedances in federal and state fish consumption guidelines in rockfish tissue samples. Altogether, these results indicate that the marine environment and human health were protected.

CHAPTER 1
The Ocean Monitoring Program

INTRODUCTION

The Orange County Sanitation District (District) operates 2 wastewater treatment facilities located in Fountain Valley (Plant 1) and Huntington Beach (Plant 2), California. The District discharges treated wastewater to the Pacific Ocean through a submarine outfall located offshore of the Santa Ana River (Figure 1-1). This discharge is regulated by the US Environmental Protection Agency (EPA), Region IX and the Regional Water Quality Control Board (RWQCB), Region 8 under the Federal Clean Water Act (CWA), the California Ocean Plan (COP), and the RWQCB Basin Plan. Specific discharge and monitoring requirements are contained in a National Pollutant Discharge Elimination System (NPDES) permit issued jointly by the EPA and the RWQCB (Order No. R8-2012-0035, NPDES Permit No. CA0110604) on June 15, 2012.

Southern California's Mediterranean climate and convenient beach access results in high, year-round public use of beaches. For example, although the highest visitation occurs during the summer, beach usage during the typically cooler and rainier months can exceed 2 million visitors per month (Figure 1-2A; City of Huntington Beach 2017, City of Newport Beach 2017, CDPR 2017). As a result, a large percentage of the local economies rely on beach use and its associated recreational activities, which are highly dependent upon water quality conditions (Turbow and Jiang 2004, Leeworthy and Wiley 2007). In 2012, Orange County's coastal economy accounted for $3.8 billion (2%) of the county's Gross Domestic Product (NOAA 2015). It has been estimated that a single day of beach closure at Bolsa Chica State Beach would result in an economic loss of $7.3 million (WHOI 2003).

For 2016-17, annual beach attendance for Bolsa Chica State Beach, Huntington Beach City Beach, Huntington Beach State Beach, Newport Beach City Beach, and Crystal Cove State Beach was over 27 million (Figure 1-2B; City of Huntington Beach 2017, City of Newport Beach 2017, CDPR 2017). Monthly visitations ranged from 985,975 in December 2016 to 5,745,894 in July 2016 (Figure 1-2A) with monthly visitation patterns above historical averages for most of the year.

DESCRIPTION OF THE DISTRICT'S OPERATIONS

The District's mission is to safely collect, process, recycle, and dispose of treated wastewater while protecting human health and the environment in accordance with federal, state, and local laws and regulations. These objectives are achieved through extensive industrial pre-treatment (source control), secondary treatment processes, biosolids management, and water reuse programs.

Together, the District's 2 wastewater treatment plants receive domestic sewage from approximately 80% of the county's 3.2 million residents and industrial wastewater from 688 permitted businesses within its service area. Under normal operations, the treated wastewater (effluent) is discharged through a 120-in (305-cm) diameter ocean outfall, which extends 4.4 miles (7.1 km) from the Huntington

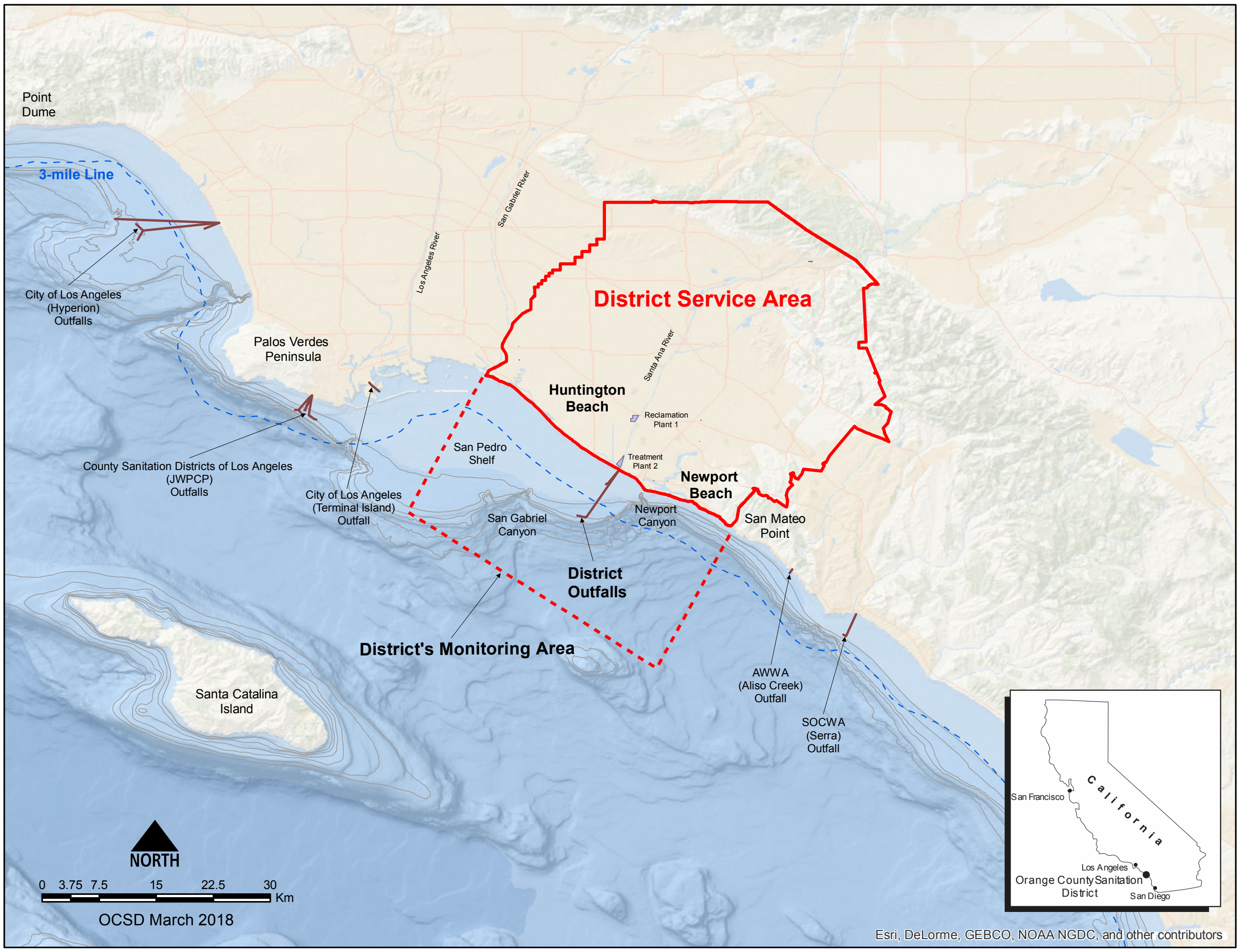

Figure 1–1 Regional setting and sampling area for the District's Ocean Monitoring Program.

Beach shoreline (Figure 1-1). The last 1.1 miles (1.8 km) of the outfall consists of a diffuser with 503 ports that discharge the treated effluent at an approximate depth of 197 ft (60 m).

Since 1999, OCSD has accepted a total of 9 billion gallons of dry-weather urban runoff from various locations in North and Central Orange County that would otherwise have entered the ocean without treatment (OCSD 2017). The collection and treatment of dry-weather runoff, which began as a regional effort to reduce beach bacterial pollution associated with chronic dry-weather flows, has grown to include accepting diversions of high selenium flows to protect Orange County's waterways. There are currently 21 active diversions including stormwater pump stations, the Santa Ana River, several creeks, and 3 flood control channels. The diversions are owned and operated by the City of Huntington Beach (11), the Public Works Department of Orange County (3), the Irvine Ranch Water District (3), the City of Newport Beach (3), and PH Finance, LLC (1). For 2016-17, the diverted monthly average daily discharge flows ranged from 0.18–1.58 million gallons per day (MGD) (0.7–6.0×10^6 L/day) with an average daily discharge of 1.25 MGD (4.7×10^6 L/day).

The District has a long history of providing treated effluent to the Orange County Water District for water reclamation starting with Water Factory 21 in the late 1970s. Since July of 1986, 3–10 MGD (1.1–3.8×10^7 L/day) of the final effluent has been provided to the Orange County Water District (OCWD) where it received further (tertiary) treatment to remove residual solids in support of the Green Acres Project (GAP). OCWD provides this water for a variety of uses including public landscape irrigation (e.g., freeways, golf courses) and for use as a saltwater intrusion barrier in the local aquifer OCWD

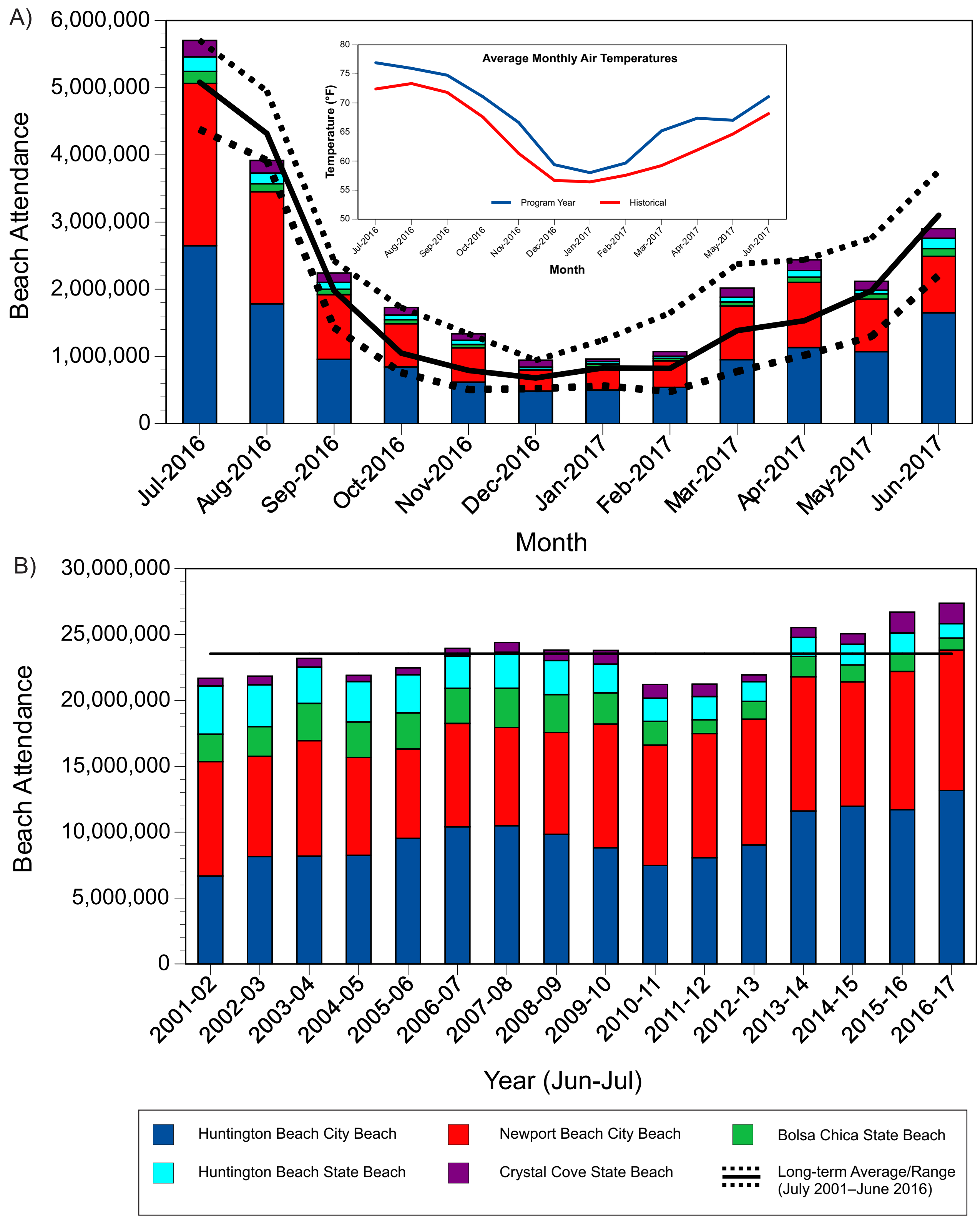

Figure 1–2 2016-17 monthly beach attendance and air temperature (A) and annual beach attendance (B) for selected Orange County beaches.

manages. In 2007-08, the District began diverting additional flows to OCWD for the Groundwater Replenishment System (GWRS) totaling 35 MGD (1.3×10^8 L/day). Over time, the average GAP and GWRS diversions increased to 68 MGD (2.6×10^8 L/day) in 2008-09, 84 MGD (3.2×10^8 L/day) in 2013-14, and 120 MGD (4.6×10^8 L/day) in 2016-17 (Figure 1-3).

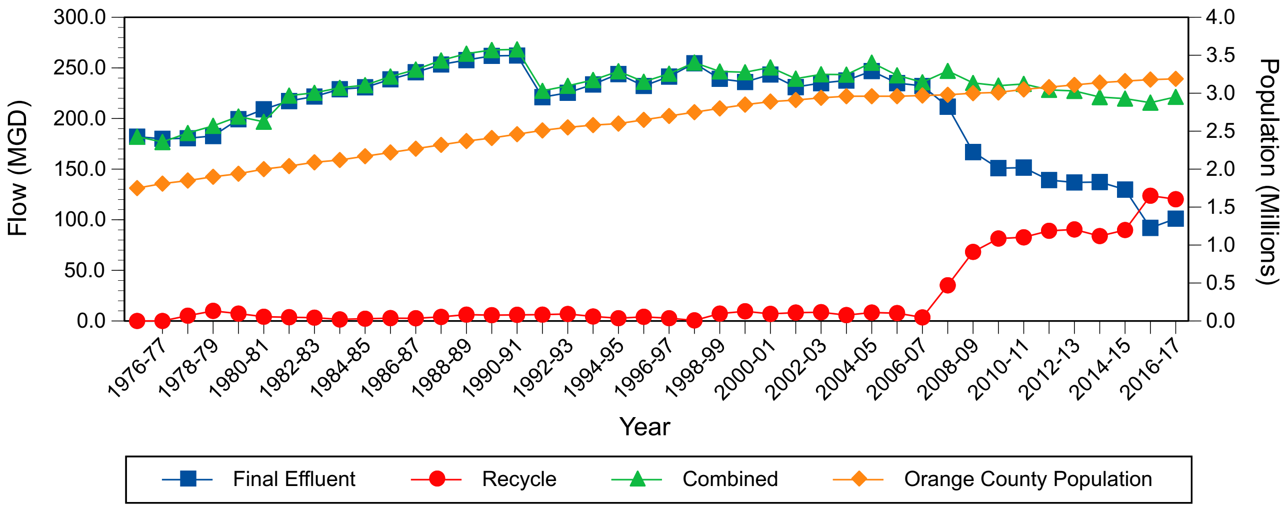

Figure 1–3 The District's annual average final effluent, recycle, and combined (final effluent plus recycle) flows and annual population for Orange County, California, 1975-2017 (CDF 2017).

During 2016-17, the 2 wastewater treatment plants received and processed influent volumes averaging 188 MGD (7.1×10^8 L/day). Treatment plant processes achieved a 98% reduction in suspended solids concentration. After diversions to the GAP and GWRS and the return of OCWD's reject flows (e.g., brines), the District discharged an average of 101.1 MGD (3.7×10^8 L/day) of treated wastewater to the ocean (Figure 1-3). Peak flow [134.9 MGD (5.1×10^8 L/day)] occurred in February of 2017, which was well below the historical peak flow of 550 MGD (2.1×10^9 L/day) that occurred during an extreme rainfall event in the winter of 1996. Seasonal and interannual differences in flow volumes are due to the variability in the amount of local water conservation efforts, rainfall, infiltration of the treatment system by runoff, and reclamation.

Prior to 1990, the annual wastewater discharge volumes gradually increased with population growth within the District's service area (Figure 1-3; CDF 2017). However, wastewater flows decreased in 1991-92 due to drought conditions and water conservation measures. Since then combined effluent and water reclamation flows have remained relatively stable despite continued population growth. Since 2007, average discharge flows have declined dramatically due to the implementation of the GWRS.

REGULATORY SETTING FOR THE OCEAN MONITORING PROGRAM

The District's permit includes requirements to monitor influent, effluent, and the receiving water. Effluent flows, constituent concentrations, and toxicity are monitored to determine compliance with permit limits and to provide data for interpreting changes to receiving water conditions. Wastewater impacts to coastal receiving waters are evaluated by the District's Ocean Monitoring Program (OMP) based on 3 inter-related components: Core monitoring, Strategic Process Studies (SPS), and Regional monitoring. In addition, the District conducts special studies not required under the existing NPDES permit. Information obtained from each of these program components is used to further the understanding of the coastal ocean environment and improve interpretations of the monitoring data. These program elements are summarized below.

The Core monitoring program was designed to measure compliance with permit conditions and for temporal trend analysis. Four major components comprise the program: (1) coastal oceanography and water quality, (2) sediment quality, (3) benthic infaunal community health, and (4) demersal fish and epibenthic macroinvertebrate community health, which include fish tissue contaminant concentrations.

The District conducts SPS to provide information about relevant coastal and ecotoxicological processes that are not addressed by Core monitoring. These studies have included evaluating the physical and chemical processes that affect the fate and transport of the discharged wastewater, tracking wastewater particles, contributing to the development of ocean circulation models, and studying the effects of endocrine disrupting compounds (EDCs) on fish.

Since 1994, the District has participated in 5 regional monitoring studies of environmental conditions within the Southern California Bight (SCB): 1994 Southern California Bight Pilot Project (SCBPP), Bight'98, Bight'03, Bight'08, and Bight'13. The District has played an integral role in these regional projects by carrying out program design, sampling, quality assurance, sample analysis, data analysis, and report writing. Results from these efforts provide information that is used by individual dischargers, local, state, and federal resource managers, researchers, and the public to improve understanding of regional environmental conditions. This provides a larger-scale perspective for comparisons with data collected from local, individual point sources. Program documents, data, and reports can be found at the Southern California Coastal Water Research Project's (SCCWRP) website (http://sccwrp.org). In 1997, the District began participation in the Southern California Bight Regional Water Quality Program (previously known as Central Bight Water Quality Program), a collaborative regional water quality sampling effort along with the City of Oxnard, the City of Los Angeles, the County Sanitation Districts of Los Angeles, and the City of San Diego.

Other collaborative projects organized by SCCWRP include "Characteristics of Effluents from Large Municipal Wastewater Treatment Facilities" and "Comparison of Mass Emissions among Sources in the Southern California Bight." Both of these projects involved analyses of historical data from large publicly owned treatment works (POTWs), including the District. Finally, the District has been working with the Southern California Coastal Ocean Observing System (SCCOOS; http://www.sccoos.org) to provide the public with historical and ongoing water quality data and have upgraded sensors on SCCOOS's Newport Pier Automated Shore Station (http://www.sccoos.org/data/autoss/). The District also partnered with SCCWRP, other local POTWs, and the OC Health Care Agency in conducting studies not mandated by the NPDES permit. Recent examples include continuing research on source tracking of bacterial contamination and evaluating rapid tests for fecal indicator bacteria.

The District's OMP has contributed substantially to the understanding of water quality and environmental conditions along the beaches and in the area adjacent to the submarine outfall. This monitoring program has generated a vast amount of data that provides a broad understanding of both natural and anthropogenic processes that affect coastal oceanography and marine biology.

ENVIRONMENTAL SETTING

The District's ocean monitoring area is adjacent to one of the most highly urbanized areas in the United States, covering most of the San Pedro Shelf and extending off the shelf (Figure 1-1). The shelf is composed primarily of soft sediments (sands with silts and clays) and inhabited by biological communities typical of these environments. The seafloor increases in depth gradually from the shoreline to a depth of approximately 262 ft (80 m), after which the depth increases rapidly as it slopes down to the open basin. The outfall diffuser lies at about 60 m depth on the shelf between the Newport and San Gabriel submarine canyons, located southeast and northwest, respectively. The area southeast of the shelf is characterized by a much narrower shelf and deeper water offshore (Figure 1-1).

The 120-inch outfall represents one of the largest artificial reefs in this coastal region and supports communities typical of hard substrates that would not otherwise be found in the monitoring area (Lewis and McKee 1989, OCSD 2000). Together with the District's 78-inch outfall, approximately 1.1×10^6 ft^2 (102,193 m^2) of seafloor was converted from a flat, sandy habitat into a raised, hard-bottom substrate.

Conditions within the District's monitoring area are affected by large regional-scale current patterns that influence the water characteristics and the direction of water flow along the Orange County coastline. Locally, the predominant low-frequency current flows in the monitoring area are alongshore (i.e., either upcoast or downcoast) with minor across-shelf (i.e., toward the beach) transport (OCSD 1997, 1998, 2004, 2011; SAIC 2001, 2009, 2011). The specific direction of the flows varies with depth and is subject to reversals over time periods of days to weeks (SAIC 2011).

Other natural oceanographic processes, such as upwelling and eddies, also influence the characteristics of receiving waters on the San Pedro Shelf. Tidal flows, currents, and internal waves mix and transport the District's wastewater discharge with coastal waters and resuspended sediments. Tidal currents in the study region are relatively weak compared to lower frequency currents, which are responsible for transporting material over long distances (OCSD 2001, 2004). Combined, these processes contribute to the variability of seawater movement observed within the monitoring area.

Episodic storms, drought, and climatic cycles influence environmental conditions and biological communities within the monitoring area. For example, stormwater runoff has a large influence on sediment movement in the region (Brownlie and Taylor 1981, Warrick and Millikan 2003). Major storms contribute large amounts of contaminants to the ocean and can generate waves capable of extensive shoreline erosion, sediment resuspension, and movement of sediments along the coast as well as offshore. Some of the greatest effects are produced by wet weather cycles, periods of drought, and periodic oceanographic events, such as El Niño and La Niña conditions. An understanding of the effects of the inputs from rivers and watersheds, particularly non-point source runoff, is important for evaluating spatial and temporal trends in the environmental quality of coastal areas. River flows, together with urban stormwater runoff, represent significant, episodic sources of freshwater, sediments, suspended particles, nutrients, bacteria and other contaminants to the coastal area (Hood 1993, Grant et al. 2001, Warwick et al. 2007), although recent studies indicate that the spatial impact of these effects may be limited (Ahn et al. 2005, Reifel et al. 2009). While many of the materials supplied to coastal waters by rivers are essential to natural biogeochemical cycles, an excess or a deficit may have important environmental consequences. In 2016-17, total rainfall for Newport Harbor was 15.8 inches (401 mm) (Orange County, CA Department of Public Works 2016), well above the long-term historical mean of 10.9 inches (277 mm) (Figure 1-4). Annual Santa Ana River flows were more than 1.5 times greater than the historical Santa Ana River (Figure 1-5), which had significant negative impacts on local beach bacteria levels (Heal the Bay 2017).

Nearshore coastal waters of the SCB receive wastes from a variety of human-related sources, such as wastewater discharges, dredged material disposal, oil and gas activities, boat/vessel discharges, urban and agricultural runoff, and atmospheric fallout. The majority of municipal and industrial sources are located between Point Dume and San Mateo Point (Figure 1-1) while discharges from the Los Angeles, San Gabriel, and Santa Ana Rivers are responsible for substantial surface water contaminant inputs to the SCB (Schafer and Gossett 1988, SCCWRP 1992, Schiff and Tiefenthaler 2001).

A goal of the District's OMP is to provide an understanding of the effects of its wastewater discharge on beneficial uses of the ocean. However, distinguishing the effects of the District's discharge from

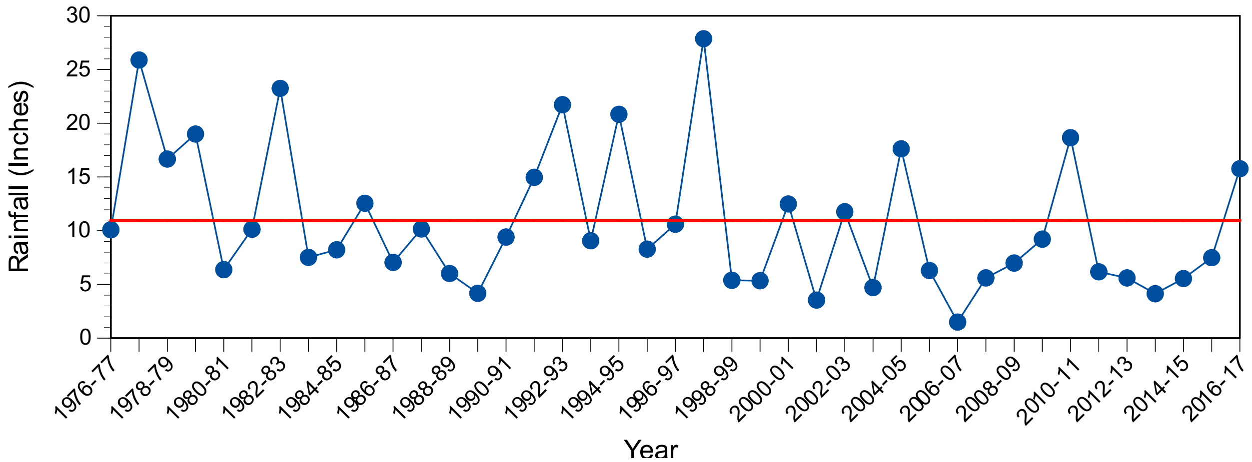

Figure 1–4 Newport Harbor annual rainfall, 1976-2017. Red line represents the historical annual mean value from 1976–2017 (OCPW 2017).

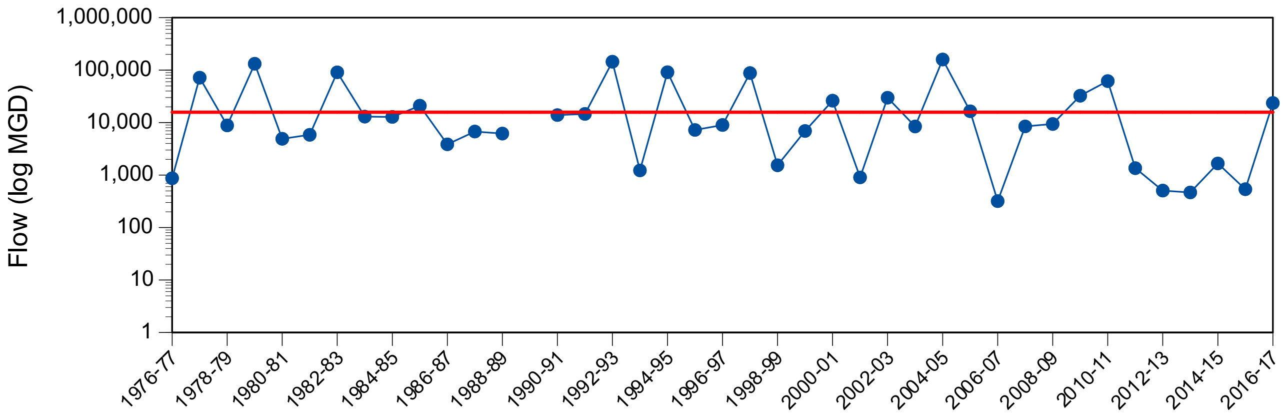

Figure 1–5 Santa Ana River annual flow, 1976-2017. Red line represents the historical annual mean value from 1976–2017 (USGS 2017).

those of natural and other human influences is difficult, especially as the "signal" (impact) from the outfall has been greatly reduced since the 1970s (Figure 1-3). The complexities of the environmental setting and related difficulties in assigning a cause or source to a pollution event are the rationale for the District's extensive monitoring program.

This report[1] presents OMP compliance determinations for data collected from July 2016 through June 2017. Compliance determinations were made by comparing OMP findings to the criteria specified in the District's NPDES permit. Any related special studies or regional monitoring efforts are also documented.

[1] This and earlier annual reports are available digitally at the District's website: https://www.ocsd.com/about-us/transparency/document-central/-folder-385

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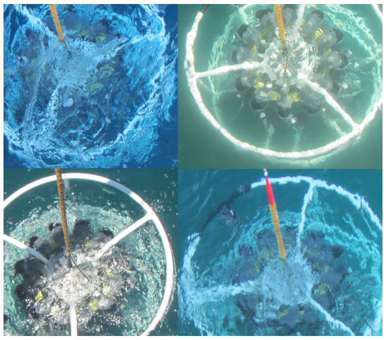

CHAPTER 2
Compliance Determinations

INTRODUCTION

This chapter provides compliance results for the 2016-17 monitoring year for the Orange County Sanitation District's (District) Ocean Monitoring Program (OMP). The program includes sample collection, analysis, and data interpretation to evaluate potential impacts of wastewater discharge on the following receiving water characteristics:

- Bacterial
- Physical
- Chemical
- Biological
- Radioactivity

Each of these characteristics have specific criteria (Table 2-1) for which permit compliance must be determined each monitoring year based on the Federal Clean Water Act, the California Ocean Plan (COP), and the Regional Water Quality Control Board Basin Plan.

The Core OMP sampling locations include 28 offshore water quality stations, 68 benthic stations to assess sediment chemistry and bottom-dwelling communities, 14 trawl stations to evaluate demersal fish and macroinvertebrate communities, and 2 rig-fishing zones for assessing human health risk from the consumption of sport fishes (Figures 2-1, 2-2, and 2-3). Monitoring frequencies varied by component, and ranged from 2–5 days per week for surfzone water quality to annual assessments of fish health and tissue analyses.

WATER QUALITY

Offshore bacteria

The majority (83–93%; n=700) of fecal indicator bacteria (FIB) counts collected at the 8 REC-1 stations were below the method detection limit (MDL) of 10 MPN/100 mL leading to most depth-averaged values being below detection (Tables B-1, B-2, and B-3). The highest density observed for any single sample at a single depth for total coliforms, fecal coliforms, and enterococci was 2143, 603, and 109 MPN/100 mL, respectively. Compliance for all 3 FIB were achieved 100% for both state and federal criteria, indicating no impact of bacteria to offshore receiving waters.

Floating Particulates and Oil and Grease

There were no observations of oils and grease or floating particles of sewage origin at any offshore or nearshore station in 2016-17 (Tables B-4 and B-5). Therefore, compliance was achieved.

Table 2–1 Listing of compliance criteria from NPDES ocean discharge permit (Order No. R8-2012-0035, Permit # CA0110604) and compliance status for each criterion in 2016-17. N/A = Not Applicable.

Criteria	Criteria Met
Bacterial Characteristics	
V.A.1.a. For the Ocean Plan Water-Contact Standards, total coliform density shall not exceed a 30-day Geometric Mean of 1,000 per 100 mL nor a single sample maximum of 10,000 per 100 mL. The total coliform density shall not exceed 1,000 per 100 mL when the single sample maximum fecal coliform/total coliform ratio exceeds 0.1.	Yes
V.A.1.a. For the Ocean Plan Water-Contact Standards, fecal coliform density shall not exceed a 30-day Geometric Mean of 200 per 100 mL nor a single sample maximum of 400 per 100 mL.	Yes
V.A.1.a. For the Ocean Plan Water-Contact Standards, *Enterococcus* density shall not exceed a 30-day Geometric Mean of 35 per 100 mL nor a single sample maximum of 104 per 100 mL.	Yes
V.A.1.b. For the USEPA Primary Recreation Criteria in Federal Waters, *Enterococcus* density shall not exceed a 30 day Geometric Mean (per 100 mL) of 35 nor a single sample maximum (per 100 mL) of 104 for designated bathing beach, 158 for moderate use, 276 for light use, and 501 for infrequent use.	Yes
V.A.1.c. For the Ocean Plan Shellfish Harvesting Standards, the median total coliform density shall not exceed 70 per 100 mL, and not more than 10 percent of the samples shall exceed 230 per 100 mL.	N/A
Physical Characteristics	
V.A.2.a. Floating particulates and grease and oil shall not be visible.	Yes
V.A.2.b. The discharge of waste shall not cause aesthetically undesirable discoloration of the ocean surface.	Yes
V.A.2.c. Natural light shall not be significantly reduced at any point outside the initial dilution zone as a result of the discharge of waste.	Yes
V.A.2.d. The rate of deposition of inert solids and the characteristics of inert solids in ocean sediments shall not be changed such that benthic communities are degraded.	Yes
Chemical Characteristics	
V.A.3.a. The dissolved oxygen concentration shall not at any time be depressed more than 10 percent from that which occurs naturally, as the result of the discharge of oxygen demanding waste materials.	Yes
V.A.3.b. The pH shall not be changed at any time more than 0.2 units from that which occurs naturally.	Yes
V.A.3.c. The dissolved sulfide concentration of waters in and near sediments shall not be significantly increased above that present under natural conditions.	Yes
V.A.3.d. The concentration of substances, set forth in Chapter II, Table B of the Ocean Plan, in marine sediments shall not be increased to levels which would degrade indigenous biota.	Yes
V.A.3.e. The concentration of organic materials in marine sediments shall not be increased to levels which would degrade marine life.	Yes
V.A.3.f. Nutrient materials shall not cause objectionable aquatic growths or degrade indigenous biota.	Yes
V.A.3.g. The concentrations of substances, set forth in Chapter II, Table B of the Ocean Plan, shall not be exceeded in the area within the waste field where initial dilution is completed.	Yes
Biological Characteristics	
V.A.4.a. Marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded.	Yes
V.A.4.b. The natural taste, odor, and color of fish, shellfish, or other marine resources used for human consumption shall not be altered.	Yes
V.A.4.c. The concentration of organic materials in fish, shellfish, or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.	Yes
V.A.5. Discharge of radioactive waste shall not degrade marine life.	Yes

Ocean Discoloration and Transparency

The water clarity standards were met, on average, 100% and 95.6% of the time for Zone A and B station groups, respectively (Table 2-2). Overall compliance was met 97.7% of the time for all stations combined. Compliance was slightly lower than the previous year's value of 99.9% but was well within the annual ranges since 1985 (Figure 2-4). All transmissivity values (Table B-6) were within natural ranges of variability to which marine organisms are exposed (OCSD 1996a). Hence, there were no impacts from the wastewater discharge relative to ocean discoloration at any offshore station.

Dissolved Oxygen (DO)

In 2016-17, compliance was met, on average, 99.0% and 95.5% of the time for Zone A and B station groups, respectively (Table 2-2). Overall compliance was met 97.2% of the time for all stations combined. This represents a decrease in compliance of 1.7% from the 2015-16 monitoring year

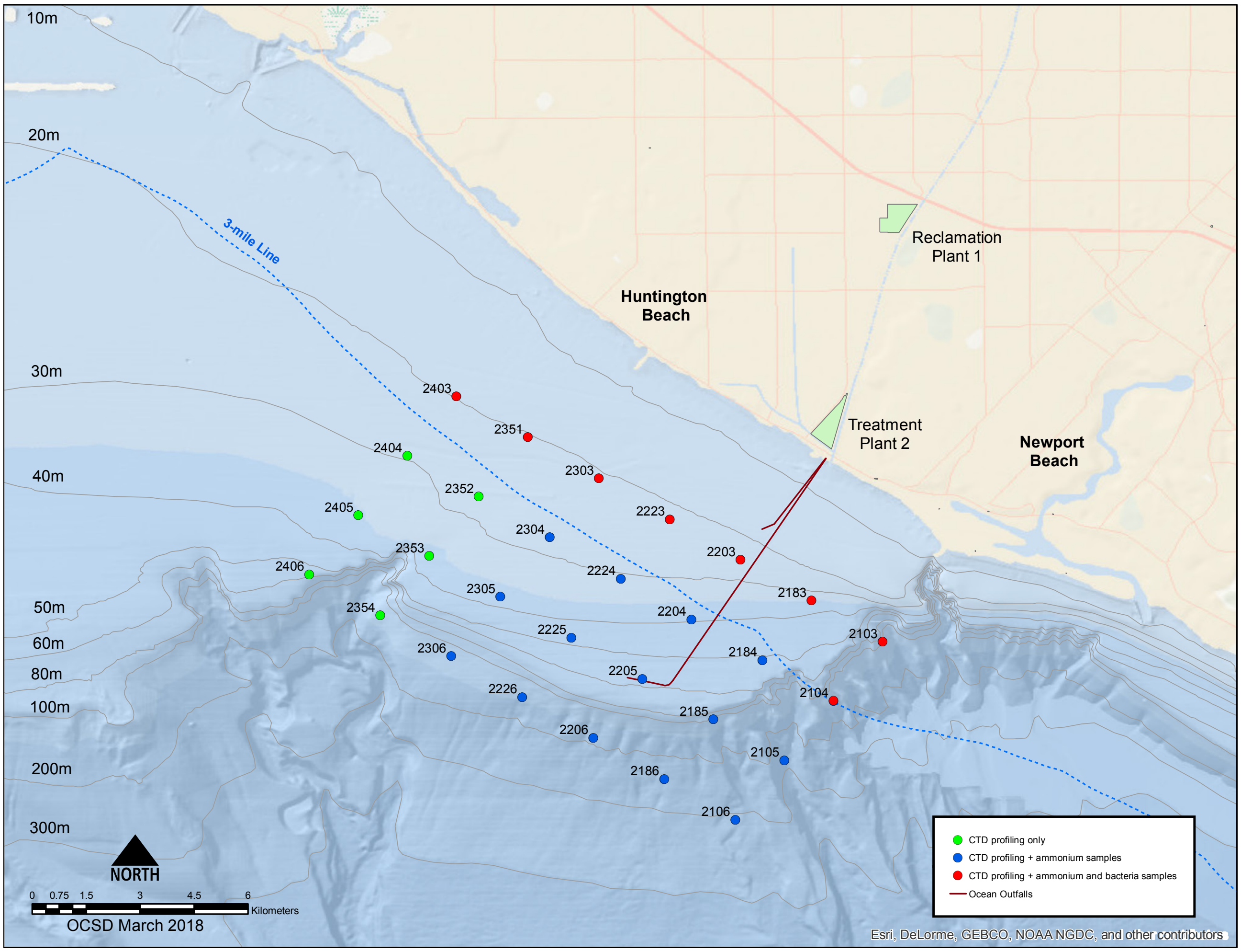

Figure 2–1 Offshore water quality monitoring stations for 2016-17.

(Figure 2-4). The DO values (Table B-6) were well within the range of long-term monitoring results (OCSD 1996b, 2004). Thus, it was determined that there were no environmentally significant effects to DO from the wastewater discharge.

Acidity (pH)

Compliance was met on average 99.6% and 97.4% of the time for Zone A and B station groups, respectively (Table 2-2). Overall compliance was met 98.5% of the time for all stations combined, which was a 2.2% decrease from the previous year's value, but within the ranges since 1985 (Figure 2-4). There were no environmentally significant effects to pH from the wastewater discharge as the measured values (Table B-6) were within the range to which marine organisms are naturally exposed.

Nutrients (Ammonium)

During 2016-17, 90% of the samples (n=1654) were below the Reporting Limit (0.02 mg/L). Detectable ammonium concentrations, including estimated values, ranged from 0.016 to 0.257mg/L, with over 96% of the detected values found below 10 m (Table B-6). Plume-related changes in ammonium were not considered environmentally significant as maximum values were over 15 times less than the chronic (4 mg/L) and more than 20 times less than the acute (6 mg/L) toxicity standards of the COP (SWRCB 2012). In addition, there were no detectable plankton-associated impacts (i.e., excessive plankton blooms caused by the discharge).

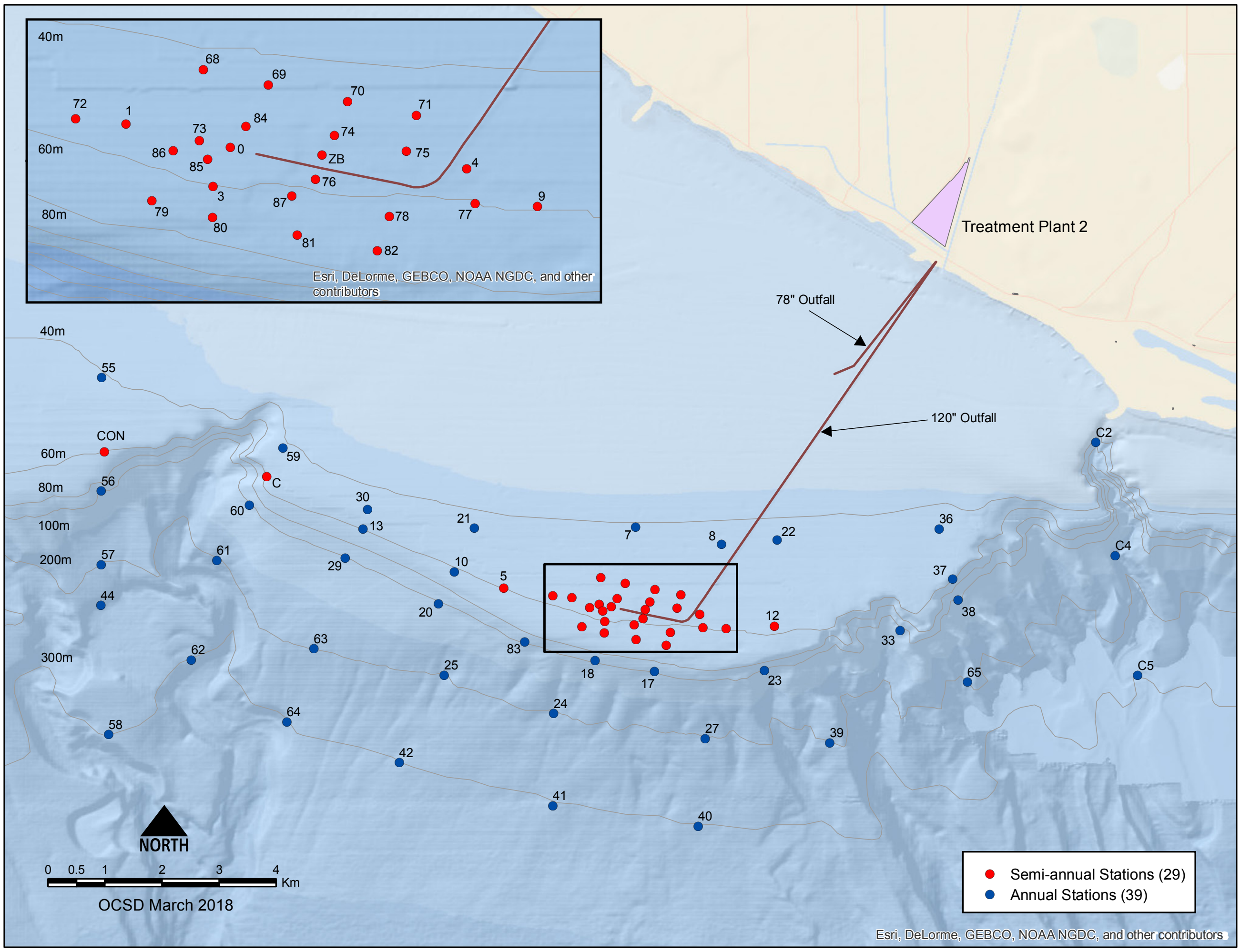

Figure 2–2 Benthic (sediment geochemistry and infauna) monitoring stations for 2016-17.

Organics in the Water Column

Only 8 constituents from Table B of the COP have effluent limitations established in the District's NPDES permit. During the period from July 2016 through June 2017, none of these constituents exceeded the effluent limitations established in the permit.

Radioactivity

Pursuant to the District's NPDES Permit, the District measures the influent and the effluent for radioactivity but not the receiving waters. The results of the influent and the effluent analyses during 2016-17 indicated that both state and federal standards were consistently met, and are published in the District's Discharge Monitoring Reports. As fish and invertebrate communities are diverse and healthy, compliance is considered to be met.

Overall Results

Overall, results from the District's 2016-17 water quality monitoring program detected minor changes in measured water quality parameters related to the discharge of wastewater to the coastal ocean. This is consistent with previously reported results (e.g., OCSD 2016). Plume-related changes in temperature, salinity, DO, pH, and transmissivity were measurable beyond the initial mixing zone during some surveys. This usually extended only into the nearfield stations, typically <2 km away from the outfall, similar to what has been seen in the past. None of these changes were determined

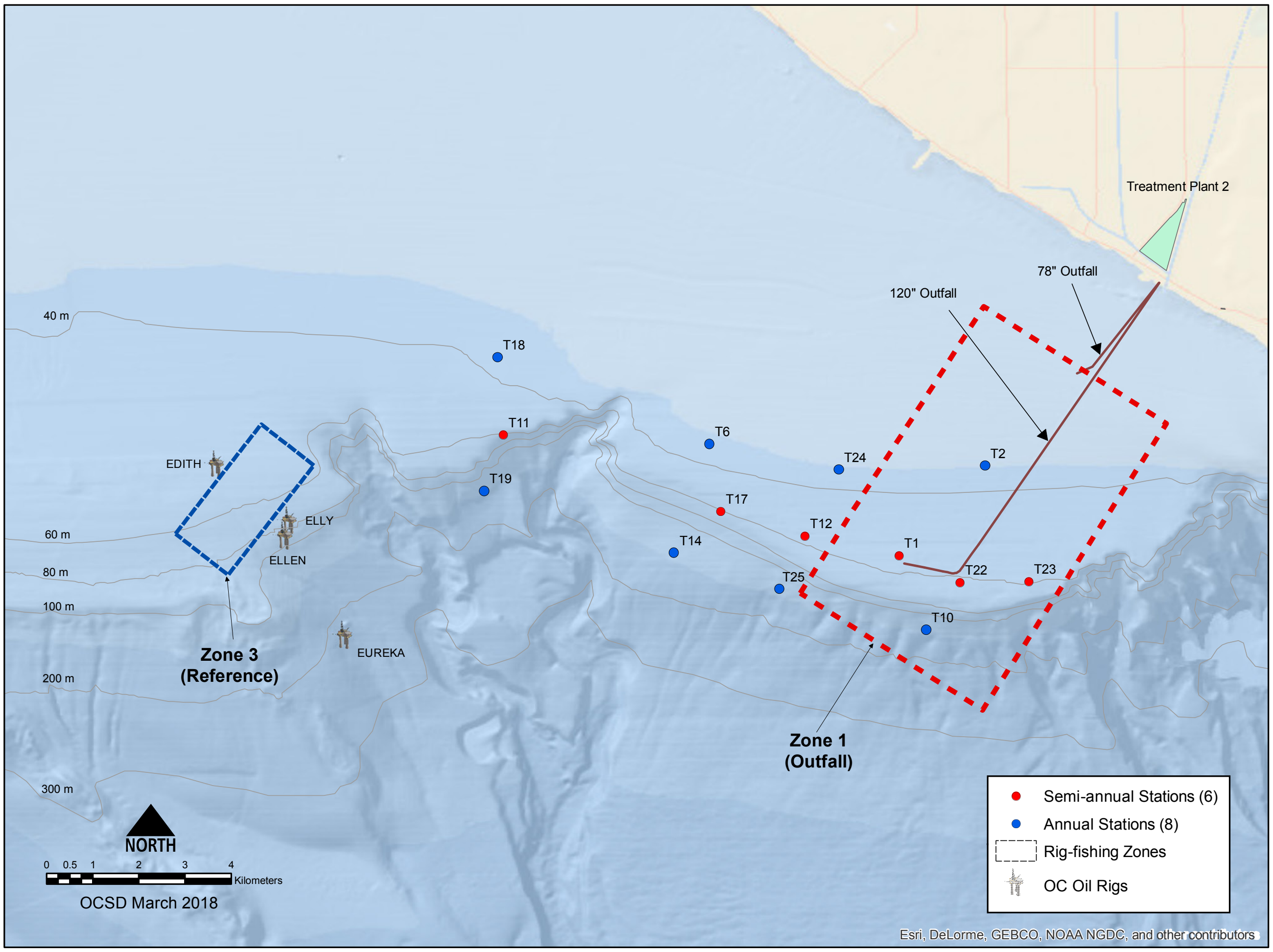

Figure 2–3 Trawl monitoring stations, as well as rig-fishing locations, for 2016-17.

to be environmentally significant since they fell within natural ranges to which marine organisms are exposed (OCSD 1996a, 2004; Wilber and Clarke 2001, Chavez et al. 2002, Jarvis et al. 2004, Allen et al. 2005, Hsieh et al. 2005). Overall, the public health risks and measured environmental effects to the receiving water continue to be small. All values were within the ranges of natural variability for the study area, and reflected seasonal and yearly changes of large-scale regional influences. The limited observable plume effects occurred primarily at depth, even during the winter when stratification was weakest. In summary, OMP staff concluded that the discharge, in 2016-17, did not greatly affect the receiving water environment, and that beneficial uses were protected and maintained.

SEDIMENT GEOCHEMISTRY

Consistent with previous years (OCSD 2014, 2016, 2017), mean concentrations of organic contaminants and metals in 2016-17 tended to increase with increasing depth, with the highest in depositional areas (Tables 2-3 and 2-4). The mean concentrations of most sediment geochemistry parameters at the within-ZID stratum were comparable with those of the non-ZID stratum and the Bight'13 regional study (Tables 2-3, 2-4, 2-5, and 2-6). The elevated mean ΣPAH value of 208.7 μg/kg for the within-ZID station group in Winter 2017 was skewed by the 751.3 μg/kg value at Station 0. This is not cause for concern as the ΣPAH concentration at Station 0 was below levels of biological concern (Effects Range-Median (ERM) values) (Long et al. 1995) and was within historical ranges (OCSD 2013, 2014, 2015, 2016). These results, coupled with the absence of sediment toxicity

Table 2–2 Summary of offshore water quality compliance testing results for dissolved oxygen, pH, and transmissivity for 2016-17.

Parameter	Number of Observations	Current Direction	Number of Out-of-Range Occurrences	Percent Out-of-Range Occurrences	Number Out-of-Compliance	Percent Out-of-Compliance
		Zone A Stations (Inshore Station Group)				
Dissolved Oxygen	453	Predominant Direction	17	3.8	3	0.7
		Opposite Direction	36	7.9	6	1.3
		Mean	**26.5**	**5.9**	**4.5**	**1.0**
pH	453	Predominant Direction	64	14.1	2	0.4
		Opposite Direction	55	12.1	2	0.4
		Mean	**59.5**	**13.1**	**2**	**0.4**
%Transmissivity	453	Predominant Direction	217	47.9	0	0.0
		Opposite Direction	160	35.3	0	0.0
		Mean	**188.5**	**41.6**	**0**	**0.0**
		Zone B Stations (Offshore Station Group)				
Dissolved Oxygen	468	Predominant Direction	68	14.5	27	5.8
		Opposite Direction	31	6.6	15	3.2
		Mean	**49.5**	**10.6**	**21**	**4.5**
pH	468	Predominant Direction	24	5.1	12	2.6
		Opposite Direction	24	5.1	12	2.6
		Mean	**24**	**5.1**	**12**	**2.6**
%Transmissivity	468	Predominant Direction	126	26.9	21	4.5
		Opposite Direction	138	29.5	20	4.3
		Mean	**132**	**28.2**	**20.5**	**4.4**
		Zone A and Zone B Stations Combined				
Dissolved Oxygen	921	Predominant Direction	85	9.2	30	3.3
		Opposite Direction	67	7.3	21	2.3
		Mean	**76**	**8.3**	**25.5**	**2.8**
pH	921	Predominant Direction	88	9.6	14	1.5
		Opposite Direction	79	8.6	14	1.5
		Mean	**83.5**	**9.1**	**14**	**1.5**
%Transmissivity	921	Predominant Direction	343	37.2	21	2.3
		Opposite Direction	298	32.4	20	2.2
		Mean	**320.5**	**34.8**	**20.5**	**2.3**

Predominant Direction values indicate results using Stations 2104/2404 (Zone A) or 2105/2406 (Zone B) as the reference stations. Opposite Direction values represent results using the opposite reference stations when a predominant current direction (based on ammonium, bacteria, CDOM, salinity, and current meter data) was not evident. Overall compliance determination used the mean of Predominant and Opposite Directions.

in amphipod survival tests (Table 2-7) and the presence of healthy fish and invertebrate communities both near and away from the outfall (see below), suggest good sediment quality in the monitoring area. Therefore, we conclude that compliance was met.

BIOLOGICAL COMMUNITIES

Infaunal Communities

A total of 621 invertebrate taxa comprising 27,858 individuals were collected in the 2016-17 monitoring year. As with previous years (OCSD 2013, 2014), there were noticeable declines in the mean species number (richness) and mean abundance of infauna at stations deeper than 120 m (Table 2-8) and the Annelida (segmented worms) was the dominant taxonomic group at all depth strata (Table B-7). Mean community measure values were comparable between within- and non-ZID stations, and most station values were within regional and District historical ranges in both surveys (Tables 2-8 and 2-9). The infaunal community at all within-ZID and non-ZID stations in both surveys can be classified as reference condition based on their low (<25) Benthic Response Index (BRI) values and/or high (>60) Infaunal Trophic Index (ITI) values. The community composition at all within-ZID stations was similar to that of non-ZID stations based on multivariate analyses of the infaunal species and abundances (Figure 2-5). These multiple lines of evidence suggest that the outfall discharge had an overall negligible effect on the benthic community structure within the monitoring area. We conclude that the biota was not degraded by the outfall discharge, and as such, compliance was met.

Epibenthic Macroinvertebrate Communities

A total of 44 epibenthic macroinvertebrate (EMI) species, comprising 7,181 individuals and a total weight of 38.8 kg, were collected from 20 trawls conducted in the 2016-17 monitoring period (Tables B-8 and

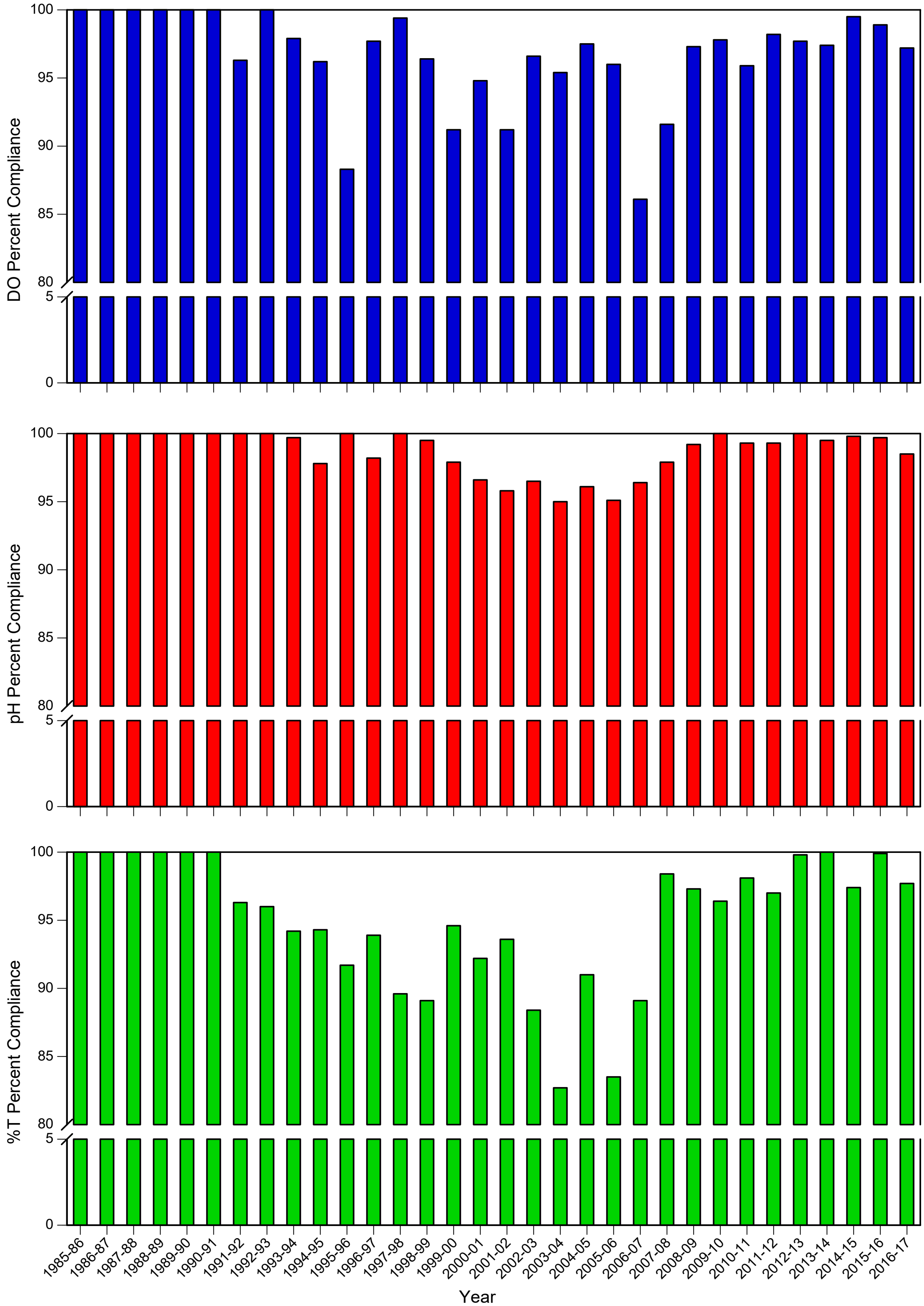

Figure 2–4 Summary of mean percent compliance for dissolved oxygen (DO), pH, and light transmissivity (%T) for all compliance stations compared to reference stations, 1985-2017.

Table 2–3 Physical properties and organic contaminant concentrations of sediment samples collected at each semi-annual and annual (*) station in Summer 2016 compared to Effects Range-Median (ERM) values and regional measurements. ZID = Zone of Initial Dilution, ND = Not Detected, N/A = Not Applicable.

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (mg/kg)	ΣDDT (mg/kg)	ΣPest (mg/kg)	ΣPCB (mg/kg)
Middle Shelf Zone 1 (31-50 meters)											
7 *	41	3.83	36.3	0.41	3.26	1100	640	46.4	3.30	ND	0.17
8 *	44	3.82	34.0	0.42	3.63	1000	550	34.6	2.71	ND	0.43
21 *	44	3.77	33.2	0.38	1.19	1000	470	37.5	2.46	ND	0.33
22 *	45	3.91	43.4	0.41	3.94	920	240	66.5	3.50	ND	0.64
30 *	46	3.54	25.2	0.37	1.36	930	450	33.1	2.02	ND	ND
36 *	45	3.88	41.5	0.39	1.72	880	420	56.6	2.99	ND	0.65
55 *	40	2.83	4.3	0.19	ND	600	180	9.8	ND	ND	ND
59 *	40	3.39	18.8	0.27	1.23	950	280	19.4	ND	ND	ND
	Mean	**3.62**	**29.6**	**0.36**	**2.33**	**922**	**404**	**38.0**	**2.12**	**0**	**0.28**
Middle Shelf Zone 2, Within-ZID (51-90 meters)											
0	56	3.32	9.9	0.46	2.10	1300	550	103.6	ND	ND	8.25
4	56	3.37	12.1	0.36	3.44	810	380	54.3	ND	ND	0.59
76	58	3.44	19.5	0.33	4.05	690	500	23.4	ND	ND	1.09
ZB	56	3.45	16.7	0.40	13.30	1000	540	38.5	2.17	ND	0.94
	Mean	**3.40**	**14.5**	**0.39**	**5.72**	**950**	**492**	**55.0**	**0.54**	**0**	**2.72**
Middle Shelf Zone 2, Non-ZID (51-90 meters)											
1	56	3.60	23.3	0.37	1.49	970	410	258.4	1.78	ND	13.61
3	60	3.53	18.6	0.38	2.63	970	370	43.7	ND	ND	1.12
5	59	3.74	30.3	0.36	1.70	1000	410	77.1	ND	ND	1.47
9	59	3.37	17.3	0.34	2.96	840	350	23.5	ND	ND	0.15
10 *	62	3.86	38.3	0.38	ND	950	370	37.3	2.53	ND	0.46
12	58	3.36	15.7	0.34	4.72	860	360	39.0	ND	ND	0.15
13 *	59	3.73	31.9	0.41	ND	950	450	24.8	3.15	ND	0.37
37 *	56	2.82	15.4	0.35	7.78	590	350	27.7	ND	ND	ND
68	52	3.72	29.2	0.35	2.50	1000	440	45.1	ND	ND	0.40
69	52	3.64	25.3	0.39	3.30	1000	500	48.7	1.96	ND	0.65
70	52	3.61	25.0	0.44	2.27	740	420	50.1	ND	ND	1.05
71	52	3.41	15.9	0.35	4.68	950	370	63.0	ND	ND	1.19
72	55	3.62	24.4	0.39	2.59	1000	440	61.3	ND	ND	1.24
73	55	3.48	17.6	0.49	6.13	1100	500	116.5	ND	ND	4.61
74	57	3.44	15.3	0.36	4.16	1000	440	53.8	ND	ND	0.67
75	60	3.40	14.9	0.32	5.67	960	330	65.2	ND	ND	0.63
77	60	3.32	14.2	0.33	6.51	940	390	15.9	ND	ND	0.18
78	63	3.41	16.3	0.32	4.35	1000	380	29.9	ND	ND	0.58
79	65	3.54	17.0	0.36	6.57	1100	370	17.5	2.41	ND	1.03
80	65	3.58	25.6	0.38	7.26	1200	550	67.5	1.80	ND	0.41
81	65	3.48	18.9	0.36	7.16	870	360	34.7	2.09	ND	0.35
82	65	3.47	19.9	0.34	10.80	850	390	29.9	1.76	ND	0.17
84	54	3.42	15.2	0.37	6.15	870	370	39.4	1.91	ND	3.10
85	57	3.41	13.8	0.42	9.13	1100	460	72.8	2.65	ND	10.22
86	57	3.41	10.9	0.41	5.58	1100	440	34.1	2.27	ND	10.30
87	60	3.44	18.9	0.48	9.52	1000	370	20.9	ND	ND	1.26
C	56	3.43	21.3	0.38	2.78	1000	550	21.7	11.65	ND	ND
C2 *	56	5.37	84.4	1.31	29.10	1000	820	233.1	6.85	ND	6.77
CON	59	3.57	23.3	0.40	4.21	1000	490	33.7	3.67	ND	0.33
	Mean	**3.56**	**22.7**	**0.41**	**5.99**	**962**	**429**	**58.1**	**1.60**	**0**	**2.15**
Middle Shelf Zone 3 (91-120 meters)											
17 *	91	3.56	22.1	0.39	7.32	840	470	33.7	2.43	ND	0.15
18 *	91	3.65	23.2	0.34	4.21	790	330	104.2	2.20	ND	0.15
20 *	100	3.97	48.1	0.47	1.88	910	470	61.1	3.95	ND	2.62
23 *	100	3.37	18.5	0.37	6.29	800	400	45.8	2.46	ND	ND
29 *	100	4.24	61.6	0.53	3.92	910	540	68.2	4.05	ND	2.44
33 *	100	3.40	26.2	0.47	11.30	910	440	44.2	2.49	ND	ND
38 *	100	3.99	49.2	0.56	7.43	920	480	67.4	2.94	ND	0.34
56 *	100	3.76	33.5	0.47	2.61	950	420	15.3	2.76	ND	0.36
60 *	100	4.15	56.4	0.66	3.27	930	570	68.1	3.20	ND	2.42
83 *	100	3.90	43.0	0.46	5.17	810	420	34.3	ND	ND	0.57
	Mean	**3.80**	**38.2**	**0.47**	**5.34**	**877**	**454**	**54.2**	**2.65**	**0**	**0.9**
Outer Shelf (121-200 meters)											
24 *	200	4.62	78.4	0.94	3.72	920	980	104.2	9.84	ND	3.18
25 *	200	4.90	82.0	1.23	7.55	800	1100	122.1	9.05	ND	4.73
27 *	200	4.29	61.7	0.69	4.45	880	610	92.1	5.50	ND	1.14
39 *	200	3.61	30.4	0.53	3.36	790	560	28.0	2.04	ND	ND
57 *	200	5.52	89.1	2.02	35.20	800	1500	79.0	7.69	ND	6.73
61 *	200	4.76	79.9	1.34	18.20	920	1100	124.9	1.94	ND	0.28
63 *	200	4.58	76.5	1.11	5.32	970	940	85.0	3.57	ND	1.74
65 *	200	4.61	68.8	0.97	8.59	1000	810	60.0	7.72	ND	0.56
C4 *	187	4.61	77.4	1.46	25.70	930	1100	304.9	2.85	ND	1.11
	Mean	**4.61**	**71.6**	**1.14**	**12.45**	**890**	**967**	**111.1**	**5.58**	**0**	**2.16**

Table 2-3 continues.

Table 2-3 continued.

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (mg/kg)	ΣDDT (mg/kg)	ΣPest (mg/kg)	ΣPCB (mg/kg)
					Upper Slope/Canyon (201-500 meters)						
40 *	303	4.78	77.4	1.37	8.06	780	1100	46.0	4.15	ND	1.19
41 *	303	4.72	72.4	1.37	12.20	870	1200	64.2	2.80	3.10	ND
42 *	303	5.11	83.2	1.75	7.21	790	1400	44.0	2.72	ND	ND
44 *	241	5.64	90.4	2.15	24.50	850	1700	184.5	6.03	ND	6.27
58 *	300	5.91	92.8	2.55	16.70	760	2000	96.1	34.33	ND	5.25
62 *	300	5.92	91.5	2.40	27.80	990	2000	87.7	10.68	ND	5.72
64 *	300	5.40	83.1	1.35	9.54	930	1200	81.2	2.71	ND	0.14
C5 *	296	5.01	62.2	1.55	21.30	700	1100	138.1	3.78	ND	0.56
	Mean	**5.31**	**81.6**	**1.81**	**15.91**	**834**	**1462**	**92.7**	**8.40**	**0.39**	**2.39**
					Sediment quality guidelines						
ERM		N/A	N/A	N/A	N/A	N/A	N/A	44,792.0	46.10	N/A	180.00
					Regional summer values (area weighted mean)						
Bight'13 Middle Shelf		N/A	48.0	0.70	N/A	N/A	N/A	55.0	18.00	N/A	2.70
Bight'13 Outer Shelf		N/A	49.0	0.93	N/A	N/A	N/A	92.0	79.00	N/A	4.50
Bight'13 Upper Slope		N/A	75.0	1.90	N/A	N/A	N/A	160.0	490.00	N/A	15.00

Table 2–4 Metal concentrations (mg/kg) in sediment samples collected at each semi-annual and annual (*) station in Summer 2016 compared to Effects Range-Median (ERM) values and regional measurements. ZID = Zone of Initial Dilution, ND = Not Detected, N/A = Not Applicable.

Station	Depth (m)	Sb	As	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
						Middle Shelf Zone 1 (31-50 meters)								
7 *	41	0.1	3.39	42.6	0.25	0.23	20.80	10.10	6.54	0.02	10.2	0.28	0.14	40.2
8 *	44	0.1	3.12	51.6	0.25	0.26	21.50	9.86	6.41	0.02	10.3	0.35	0.13	39.3
21 *	44	ND	2.88	40.0	0.21	0.17	18.90	8.52	6.53	0.02	8.6	0.38	0.10	34.1
22 *	45	0.1	3.68	48.8	0.31	0.26	21.80	10.40	6.69	0.01	11.1	0.37	0.12	44.7
30 *	46	0.1	3.25	36.1	0.22	0.18	18.20	7.34	5.35	0.01	8.2	0.22	0.09	32.3
36 *	45	0.1	3.42	50.2	0.25	0.24	19.00	8.65	6.37	0.02	10.0	0.31	0.07	38.4
55 *	40	0.1	1.67	25.2	0.15	0.09	12.80	3.88	3.47	0.04	5.8	0.18	0.03	21.9
59 *	40	0.1	2.96	35.9	0.21	0.14	16.70	5.85	4.75	0.01	7.5	0.31	0.06	27.9
	Mean	**0.1**	**3.05**	**41.3**	**0.23**	**0.20**	**18.71**	**8.08**	**5.76**	**0.02**	**9.0**	**0.30**	**0.09**	**34.85**
						Middle Shelf Zone 2, Within-ZID (51-90 meters)								
0	56	ND	3.48	117.0	0.45	0.60	36.30	22.90	9.79	0.03	19.9	ND	0.31	65.6
4	56	ND	2.61	40.1	0.31	0.25	21.70	9.49	5.34	0.02	10.2	ND	0.15	41.6
76	58	ND	2.10	36.6	0.29	0.19	18.70	9.27	4.32	0.02	9.4	ND	0.11	41.7
ZB	56	ND	2.59	39.6	0.27	0.35	19.70	10.60	4.51	0.02	10.4	ND	0.14	41.6
	Mean	**0.0**	**2.70**	**58.3**	**0.33**	**0.35**	**24.10**	**13.06**	**5.99**	**0.02**	**12.5**	**0.00**	**0.18**	**47.6**
						Middle Shelf Zone 2, Non-ZID (51-90 meters)								
1	56	ND	2.78	43.7	0.27	0.30	22.20	12.00	5.93	0.02	10.4	ND	0.20	43.1
3	60	ND	1.84	40.3	0.27	0.23	19.90	11.30	4.79	0.03	9.4	ND	0.16	41.9
5	59	ND	2.41	48.5	0.27	0.25	22.60	11.00	5.54	0.02	11.0	ND	0.17	42.9
9	59	ND	2.13	37.6	0.28	0.21	20.20	8.70	4.80	0.01	9.5	ND	0.12	36.7
10 *	62	0.1	2.96	43.8	0.28	0.26	21.60	11.10	5.86	0.02	10.7	0.25	0.16	43.4
12	58	ND	2.09	36.0	0.27	0.22	18.90	8.09	4.96	0.01	9.4	ND	0.11	36.6
13 *	59	ND	3.05	44.0	0.26	0.22	23.30	9.50	6.35	0.02	10.1	0.34	0.12	40.4
37 *	56	ND	2.64	33.1	0.24	0.24	17.00	6.53	5.14	0.01	8.3	0.27	0.06	35.8
68	52	ND	2.96	42.4	0.27	0.24	20.80	10.50	5.80	0.02	10.2	ND	0.14	40.7
69	52	ND	2.89	42.2	0.25	0.25	20.40	10.30	5.66	0.02	10.1	ND	0.15	40.5
70	52	ND	3.19	45.3	0.26	0.28	22.00	10.90	6.02	0.01	10.9	ND	0.16	42.2
71	52	ND	2.61	38.0	0.25	0.31	19.60	8.97	4.86	0.03	9.8	ND	0.12	39.1
72	55	ND	2.87	41.5	0.26	0.28	21.60	11.20	5.42	0.03	10.2	ND	0.17	40.3
73	55	ND	2.42	36.5	0.27	0.48	21.10	12.60	5.70	0.02	9.7	ND	0.24	43.2
74	57	ND	2.87	41.6	0.28	0.31	21.20	9.55	5.02	0.02	9.8	ND	0.12	41.8
75	60	ND	2.70	41.3	0.27	0.29	19.70	8.94	4.77	0.02	10.0	ND	0.10	40.5
77	60	ND	2.21	34.1	0.26	0.22	20.10	8.43	4.86	0.01	9.7	ND	0.10	37.2
78	63	ND	2.04	37.1	0.30	0.21	20.60	9.81	4.46	0.01	9.9	ND	0.11	40.5
79	65	0.1	2.09	44.2	0.33	0.23	21.50	10.90	5.17	0.02	11.0	ND	0.14	45.8
80	65	ND	2.23	43.5	0.34	0.21	20.70	11.00	4.87	0.01	10.8	ND	0.11	43.5
81	65	ND	1.56	40.4	0.29	0.22	20.30	9.58	4.72	0.01	10.5	ND	0.12	39.5
82	65	0.2	1.65	41.6	0.30	0.22	21.50	9.47	5.00	0.01	11.1	ND	0.11	41.7
84	54	ND	2.79	36.6	0.26	0.37	20.60	10.50	5.03	0.02	9.2	ND	0.15	40.6
85	57	ND	1.86	35.5	0.26	0.39	21.00	11.90	5.05	0.02	8.9	ND	0.21	41.2
86	57	ND	2.48	36.5	0.27	0.37	21.50	11.90	5.45	0.03	9.5	ND	0.29	42.2
87	60	ND	2.15	38.0	0.32	0.22	19.40	9.40	4.46	0.01	9.4	ND	0.12	39.9
C	56	ND	2.68	41.1	0.24	0.21	20.20	8.00	5.64	0.01	9.1	ND	0.10	36.4
C2 *	56	0.2	5.06	117.0	0.47	0.41	32.00	21.10	13.2	0.03	19.8	0.52	0.12	85.0
CON	59	ND	2.58	55.2	0.26	0.22	22.10	10.00	5.60	0.01	10.9	ND	0.10	41.3
	Mean	**0.2**	**2.54**	**43.3**	**0.28**	**0.27**	**21.16**	**10.45**	**5.52**	**0.02**	**10.3**	**0.34**	**0.14**	**42.2**

Table 2-4 continues.

Table 2-4 continued.

Station	Depth (m)	Sb	As	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
Middle Shelf Zone 3 (91-120 meters)														
17 *	91	ND	2.28	38.6	0.26	0.19	18.00	8.53	5.51	0.01	9.9	0.33	0.08	39.9
18 *	91	ND	2.75	40.0	0.29	0.19	21.40	9.11	5.16	0.01	10.9	0.22	0.09	43.2
20 *	100	0.1	2.93	52.4	0.30	0.25	23.30	12.40	6.34	0.01	12.0	0.31	0.15	46.5
23 *	100	ND	2.70	36.2	0.28	0.20	18.20	8.16	4.83	0.01	10.0	0.22	0.06	37.3
29 *	100	0.1	2.92	66.7	0.32	0.34	26.80	14.00	7.09	0.02	12.9	0.37	0.20	50.3
33 *	100	ND	2.90	42.5	0.24	0.28	18.70	8.25	5.42	0.01	10.4	0.38	0.07	41.0
38 *	100	ND	3.02	57.4	0.27	0.35	20.30	9.91	6.51	0.01	11.3	0.56	0.08	42.4
56 *	100	0.1	2.89	57.3	0.31	0.24	22.00	10.70	5.61	0.01	11.7	0.31	0.12	44.7
60 *	100	0.1	2.91	65.3	0.30	0.33	27.10	13.70	7.31	0.03	13.1	0.42	0.18	48.7
83 *	100	ND	3.01	47.0	0.31	0.21	21.90	10.00	5.60	0.01	11.6	0.28	0.10	46.0
	Mean	**0.1**	**2.83**	**50.3**	**0.29**	**0.26**	**21.77**	**10.48**	**5.94**	**0.01**	**11.4**	**0.34**	**0.11**	**44.0**
Outer Shelf (121-200 meters)														
24 *	200	0.1	3.00	84.2	0.39	0.47	30.30	17.00	7.72	0.02	16.4	0.49	0.18	58.0
25 *	200	ND	3.48	33.1	0.24	0.44	21.40	14.20	7.73	0.06	8.7	0.43	0.17	43.3
27 *	200	ND	2.70	68.8	0.31	0.38	24.50	13.00	7.10	0.02	13.8	0.57	0.12	48.6
39 *	200	0.1	3.01	48.6	0.34	0.30	25.00	10.80	5.97	0.01	13.5	0.32	0.08	47.7
57 *	200	0.2	5.10	150.0	0.52	0.77	53.10	36.00	15.5	0.05	23.8	0.96	0.62	84.7
61 *	200	0.2	3.63	118.0	0.45	0.65	38.20	25.80	10.4	0.04	19.9	0.68	0.41	70.4
63 *	200	0.2	3.24	155.0	0.41	0.48	34.70	19.50	9.16	0.02	17.1	0.59	0.24	60.0
65 *	200	0.1	4.10	78.8	0.37	0.57	29.80	16.30	8.70	0.02	16.3	0.57	0.17	58.6
C4 *	187	0.2	6.79	114.0	0.52	0.52	37.10	23.70	12.90	0.03	22.3	0.69	0.16	88.2
	Mean	**0.2**	**3.89**	**94.5**	**0.39**	**0.51**	**32.68**	**19.59**	**9.46**	**0.03**	**16.9**	**0.59**	**0.24**	**62.2**
Upper Slope/Canyon (201-500 meters)														
40 *	303	0.2	3.77	92.9	0.47	0.53	36.00	20.70	8.39	0.02	20.0	0.69	0.18	66.0
41 *	303	ND	3.53	89.6	0.37	0.44	33.10	18.70	8.75	0.01	18.0	0.95	0.15	60.6
42 *	303	0.2	4.12	115.0	0.46	0.55	41.80	24.50	10.90	0.02	21.3	0.95	0.23	70.4
44 *	241	0.3	6.51	202.0	0.62	1.18	60.10	51.90	18.90	0.06	28.1	0.67	1.06	97.4
58 *	300	0.1	4.45	163.0	0.51	0.64	46.40	30.80	25.80	0.03	24.2	ND	0.40	76.7
62 *	300	ND	5.90	165.0	0.53	0.95	54.90	38.60	17.60	0.04	25.3	1.55	0.56	85.5
64 *	300	0.2	5.10	119.0	0.56	0.52	38.80	25.30	10.50	0.02	22.2	0.84	0.23	68.6
C5 *	296	0.2	4.48	90.3	0.44	0.63	33.90	21.80	12.60	0.02	19.8	0.70	0.21	67.1
	Mean	**0.2**	**4.73**	**129.6**	**0.50**	**0.68**	**43.12**	**29.04**	**14.18**	**0.03**	**22.4**	**0.91**	**0.38**	**74.0**
Sediment quality guidelines														
ERM		N/A	70.00	N/A	N/A	9.60	370.00	270.00	218.00	0.70	51.6	N/A	3.70	410.0
Regional summer values (area weighted mean)														
Bight'13 Middle Shelf		0.9	2.70	130.0	0.21	0.68	30.00	7.90	7.00	0.05	15.0	0.10	0.29	48.0
Bight'13 Outer Shelf		1.1	5.30	130.0	0.36	0.82	37.00	11.00	10.00	0.07	18.0	0.21	0.39	57.0
Bight'13 Upper Slope		1.4	5.40	160.0	0.27	1.50	57.00	21.00	12.00	0.08	30.0	0.89	0.24	88.0

B-9). As with the previous monitoring period, *Ophiura luetkenii* (brittlestar) and *Strongylocentrotus fragilis* (sea urchin) were the most dominant species in terms of abundance (n=4,198; 59% of total) and biomass (16.4 kg; 42% of total), respectively. Among the strata sampled in summer, the average abundance of EMIs was highest at Middle Shelf Zone 1 due to large catches (>1,600) of *O. luetkenii* at Stations T6 and T24 (Tables 2-10 and B-8). By contrast, the average biomass of EMIs was highest at the Outer Shelf due to large catches of *S. fragilis* at Stations T10 and T25, as well as *Sicyonia ingentis* (shrimp) at Station T19 (Tables 2-10, B-8, and B-9). Within the Middle Shelf Zone 2 stratum, the average abundance and biomass values were higher at non-outfall than outfall stations in both summer and winter because of the greater numbers of *O. luetkenii*, *Sicyonia penicillata* (shrimp), and *Hamatoscalpellum californicum* (barnacle) at Station T11. Despite these disparities, the overall EMI community composition at the outfall stations were similar to those at other non-outfall stations in both surveys based on the results of the Multivariate analyses (cluster and non-metric multidimensional scaling (nMDS) analyses) (Figure 2-6). Furthermore, the community measure values at the outfall stations are within regional and District historical ranges (Table 2-10). These results suggest that the outfall discharge had an overall negligible effect on the EMI community structure within the monitoring area, and as such, we conclude that the EMI communities within the monitoring area were not degraded by the outfall discharge, and consequently, compliance was met.

Fish Communities

A total of 43 fish taxa, comprising 5,844 individuals and a total weight of 176.4 kg, were collected from the monitoring area during the 2016-17 trawling effort (Tables B-10 and B-11). The mean species richness, abundance, biomass, Shannon-Wiener Diversity (H′), and Swartz's 75% Dominance

Table 2–5 Physical properties and organic contaminant concentrations of sediment samples collected at each semi-annual station in Winter 2017 compared to Effects Range-Median (ERM) values and regional measurements. ZID = Zone of Initial Dilution, ND = Not Detected, N/A = Not Applicable.

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (mg/kg)	ΣDDT (mg/kg)	ΣPest (mg/kg)	ΣPCB (mg/kg)
Middle Shelf Zone 2, Within-ZID (51-90 meters)											
0	56	3.36	12.1	0.43	2.31	1300	510	751.3	ND	ND	7.76
4	56	3.39	15.1	0.35	3.15	870	380	23.9	ND	ND	0.19
76	58	3.43	16.9	0.34	3.73	900	360	24.3	ND	ND	1.85
ZB	56	3.41	15.7	0.33	5.91	820	340	35.3	ND	ND	0.62
	Mean	**3.40**	**15.0**	**0.36**	**3.78**	**972**	**398**	**208.7**	**0.00**	**0**	**2.6**
Middle Shelf Zone 2, Non-ZID (51-90 meters)											
1	56	3.60	23.5	0.34	1.85	960	420	38.4	2.04	ND	4.45
3	60	3.53	17.7	0.35	1.58	950	420	33.1	1.89	ND	3.48
5	59	3.73	28.5	0.33	3.02	1000	360	39.3	ND	ND	56.99
9	59	3.37	16.1	0.33	2.20	760	380	23.6	ND	ND	ND
12	58	3.32	17.2	0.32	2.61	760	380	22.2	ND	ND	ND
68	52	3.71	29.4	0.37	1.76	1000	460	38.9	2.19	ND	1.95
69	52	3.61	25.8	0.40	2.87	790	390	36.9	ND	ND	1.13
70	52	3.62	26.3	0.38	5.30	830	380	36.0	1.89	ND	0.60
71	52	3.44	16.8	0.32	3.38	870	330	19.9	4.11	ND	0.17
72	55	3.60	21.2	0.32	3.53	1100	430	81.2	1.86	ND	7.83
73	55	3.39	13.1	0.42	7.80	1000	390	42.2	2.37	ND	11.26
74	57	3.43	16.9	0.34	3.81	780	340	45.6	ND	ND	0.20
75	60	3.40	14.6	0.33	2.68	1000	380	36.6	ND	ND	0.21
77	60	3.40	15.9	0.31	4.08	890	360	25.0	ND	ND	1.37
78	63	3.42	16.0	0.31	3.70	930	370	23.0	ND	ND	0.73
79	65	3.55	15.6	0.35	4.36	810	350	210.8	ND	ND	0.42
80	65	3.68	29.3	0.32	3.41	860	270	32.6	ND	ND	0.37
81	65	3.49	18.5	0.31	3.41	880	440	27.8	ND	ND	10.04
82	65	3.41	15.6	0.33	3.53	840	410	27.6	ND	ND	ND
84	54	3.43	16.0	0.38	9.44	940	450	88.1	2.11	ND	7.00
85	57	3.42	13.8	0.35	7.03	940	390	99.4	ND	ND	9.66
86	57	3.47	17.0	0.41	8.32	900	610	61.4	1.78	1.60	5.77
87	60	3.45	17.3	0.31	3.60	840	350	35.3	ND	ND	2.41
C	56	3.42	20.0	0.29	3.97	920	430	51.8	ND	ND	ND
CON	59	3.54	22.4	0.36	6.51	900	280	43.6	2.32	ND	ND
	Mean	**3.50**	**19.4**	**0.34**	**4.15**	**898**	**391**	**48.8**	**0.90**	**0.06**	**5.04**
Sediment quality guidelines											
ERM		N/A	N/A	N/A	N/A	N/A	N/A	44792.0	46.10	N/A	180.00
Regional summer values (area weighted mean)											
Bight'13 Middle Shelf		N/A	48.0	0.70	N/A	N/A	N/A	55.0	18.00	N/A	2.70

Index (SDI) values of demersal fishes were comparable between outfall and non-outfall stations in both surveys, with values falling within regional and/or District historical ranges (Table 2-11). More importantly, the fish communities at outfall and non-outfall stations were classified as reference condition based on their low (<45) mean Fish Response Index (FRI) values in both surveys. Multivariate analyses (cluster and nMDS) of the demersal fish species and abundance data further demonstrated that the fish communities were similar between the outfall and non-outfall stations (Figure 2-7). These results indicate that the outfall discharge had no adverse effect on the demersal fish community structure within the monitoring area. We conclude that the demersal fish communities within the monitoring area were not degraded by the outfall discharge, and thus, compliance was met.

FISH BIOACCUMULATION AND HEALTH

Demersal Fish Tissue Chemistry

Muscle tissue contaminant concentrations in Hornyhead Turbot and English Sole were generally similar between outfall and non-outfall stations (Table 2-12). No spatial comparison of liver chemistry data could be made for this survey due to instrument failure during non-outfall sample analysis (see Appendix C). All mean contaminant concentration values for muscle and liver tissue were within historical ranges within the monitoring area (Table 2-12).

Table 2–6 Metal concentrations (mg/kg) in sediment samples collected at each semi-annual station in Winter 2017 compared to Effects Range-Median (ERM) values and regional measurements. ZID = Zone of Initial Dilution, ND = Not Detected, N/A = Not Applicable.

Station	Depth (m)	Sb	As	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
Middle Shelf Zone 2, Within-ZID (51-90 meters)														
0	56	ND	2.78	26.7	0.24	0.32	16.40	11.20	4.80	0.08	7.4	0.29	0.17	35.3
4	56	ND	2.90	35.9	0.29	0.20	19.40	7.74	4.77	0.01	8.6	0.38	0.09	38.5
76	58	ND	2.78	33.7	0.32	0.24	20.30	8.99	4.74	0.37	9.2	0.41	0.11	42.3
ZB	56	ND	3.20	37.1	0.32	0.30	19.80	9.00	4.73	0.02	9.4	0.43	0.12	43.8
	Mean	**0.0**	**2.92**	**33.4**	**0.29**	**0.26**	**18.98**	**9.23**	**4.76**	**0.12**	**8.7**	**0.38**	**0.12**	**39.98**
Middle Shelf Zone 2, Non-ZID (51-90 meters)														
1	56	ND	2.48	36.5	0.29	0.26	21.80	10.70	5.64	0.03	9.2	0.40	0.22	43.1
3	60	ND	2.11	34.3	0.30	0.41	19.00	9.23	4.58	0.02	8.2	0.35	0.15	38.8
5	59	ND	2.96	41.8	0.30	0.23	22.00	9.70	5.61	0.02	9.9	0.45	0.16	42.4
9	59	ND	2.87	30.8	0.30	0.19	19.10	7.42	4.59	0.01	8.4	0.37	0.09	37.0
12	58	ND	2.88	30.3	0.27	0.14	17.30	6.84	4.34	0.01	8.0	0.36	0.08	34.2
68	52	ND	3.70	38.8	0.26	0.26	20.30	9.50	5.39	0.01	9.4	0.43	0.13	42.2
69	52	ND	3.25	42.2	0.30	0.23	20.50	9.20	5.45	0.02	9.5	0.38	0.13	41.4
70	52	ND	3.43	44.6	0.31	0.25	21.90	9.74	5.67	0.02	10.1	0.46	0.13	43.3
71	52	ND	2.35	32.7	0.28	0.30	19.60	8.34	4.86	0.02	8.7	0.38	0.12	40.4
72	55	ND	2.93	36.8	0.26	0.23	20.20	9.40	5.09	0.02	8.8	0.41	0.15	39.4
73	55	ND	3.10	37.3	0.29	0.49	24.60	15.50	6.42	0.03	9.1	0.43	0.21	45.7
74	57	ND	2.50	33.0	0.27	0.27	18.80	7.73	4.50	0.43	8.3	0.38	0.11	39.5
75	60	ND	1.87	34.5	0.28	0.29	18.30	7.56	4.01	0.02	8.2	0.37	0.10	38.8
77	60	ND	3.02	29.7	0.31	0.17	20.20	7.70	4.63	0.01	8.8	0.36	0.09	38.6
78	63	ND	2.22	33.3	0.29	0.17	18.10	7.38	4.20	0.02	8.0	0.34	0.10	36.4
79	65	ND	2.68	36.1	0.31	0.18	20.30	9.25	4.78	0.01	9.3	0.41	0.12	41.7
80	65	ND	2.91	37.4	0.26	0.17	19.30	7.14	5.44	0.01	7.9	0.45	0.09	34.9
81	65	ND	1.90	34.8	0.32	0.17	18.60	7.51	4.35	0.01	8.5	0.37	0.10	37.3
82	65	ND	1.95	30.1	0.29	0.14	17.30	6.69	3.76	0.01	7.8	0.36	0.07	35.0
84	54	ND	3.45	37.0	0.29	0.41	22.50	18.40	6.13	0.02	9.5	0.44	0.51	45.9
85	57	0.1	2.53	36.4	0.31	0.37	21.30	10.70	5.11	0.01	8.8	0.42	0.20	42.6
86	57	ND	2.42	33.2	0.25	0.38	20.20	11.00	5.56	0.06	8.5	0.41	0.21	41.2
87	60	ND	2.33	30.9	0.31	0.16	18.10	7.59	4.39	0.01	8.1	0.36	0.11	37.9
C	56	ND	2.86	34.8	0.26	0.17	19.30	7.03	5.50	0.01	8.0	0.37	0.11	34.2
CON	59	ND	2.83	49.7	0.29	0.17	20.20	8.18	5.62	0.01	9.6	0.41	0.09	40.1
	Mean	**0.1**	**2.70**	**35.9**	**0.29**	**0.25**	**19.95**	**9.18**	**5.02**	**0.03**	**8.7**	**0.39**	**0.14**	**39.68**
Sediment quality guidelines														
ERM		N/A	70.00	N/A	N/A	9.60	370.00	270.00	218.00	0.70	51.6	N/A	3.70	410.0
Regional summer values (area weighted mean)														
Bight'13 Middle Shelf		0.9	2.70	130.0	0.21	0.68	30.00	7.90	7.00	0.05	15.0	0.10	0.29	48.0

Table 2–7 Whole-sediment *Eohaustorius estuarius* (amphipod) toxicity test results for 2016-17. The home sediment represents the control; N/A = Not Applicable.

Station	% Survival	% of home	p-value	Assessment
home	100	N/A	N/A	N/A
0	100	100	0.91	Nontoxic
1	99	99	0.75	Nontoxic
4	100	100	0.91	Nontoxic
72	100	100	0.91	Nontoxic
73	99	99	0.75	Nontoxic
76	97	97	0.52	Nontoxic
77	98	98	0.52	Nontoxic
CON	100	100	0.91	Nontoxic
ZB	98	98	0.52	Nontoxic
ZB Dup	100	100	0.91	Nontoxic

Sport Fish Muscle Chemistry

Muscle tissue contaminant concentrations were generally similar in sport fishes collected at the outfall and non-outfall zones (Table 2-13). More importantly, all muscle tissue contaminant levels at both zones were well below federal and/or state human consumption guidelines. These results indicate there is little risk from consuming fish from the monitored areas and compliance was achieved.

Table 2–8 Community measure values for each semi-annual and annual (*) station sampled during the Summer 2016 infauna survey, including regional and Districal historical values. ZID = Zone of Initial Dilution, N/A = Not Applicable, NC = Not Calculated.

Station	Depth (m)	Total No. of Species	Total Abundance	H'	SDI	ITI	BRI
			Middle Shelf Zone 1 (31-50 m)				
7 *	41	79	339	3.56	23	93	12
8 *	44	94	416	3.60	24	89	17
21 *	44	115	609	3.91	33	89	13
22 *	45	66	243	3.27	18	98	14
30 *	46	102	399	4.04	36	88	10
36 *	45	82	294	3.85	26	95	15
55 *	40	67	188	3.57	23	94	16
59 *	40	91	308	3.78	30	91	12
	Mean	**87**	**350**	**3.70**	**27**	**92**	**14**
			Middle Shelf Zone 2, Within-ZID (51-90 m)				
0	56	87	355	3.70	24	83	17
4	56	103	518	3.68	22	78	15
76	58	94	353	3.82	32	88	14
ZB	56	78	263	3.70	26	91	13
	Mean	**91**	**372**	**3.73**	**26**	**85**	**15**
			Middle Shelf Zone 2, Non-ZID (51-90 m)				
1	56	96	397	3.66	27	78	14
3	60	89	370	3.64	25	83	15
5	59	83	297	3.75	27	86	14
9	59	82	379	3.60	23	84	10
10 *	62	81	257	3.82	32	94	11
12	58	70	305	3.48	21	90	10
13 *	59	62	182	3.78	27	91	11
37 *	56	62	193	3.66	24	89	14
68	52	98	516	3.67	27	86	15
69	52	99	479	3.92	28	89	11
70	52	94	353	3.68	29	83	12
71	52	85	297	3.68	27	81	12
72	55	93	399	3.84	30	88	11
73	55	103	704	3.71	23	80	17
74	57	99	367	3.97	33	86	12
75	60	58	233	3.29	15	80	15
77	60	80	281	3.46	20	84	13
78	63	90	384	3.57	24	71	16
79	65	74	337	3.30	21	79	13
80	65	83	418	3.48	21	83	12
81	65	90	447	3.58	22	83	13
82	65	81	319	3.57	23	70	13
84	54	103	459	3.91	31	84	15
85	57	102	432	3.80	28	82	16
86	57	94	429	3.71	26	84	15
87	60	78	303	3.63	25	86	16
C	56	89	288	3.90	31	93	14
C2 *	56	45	189	2.86	13	86	36
CON	59	64	177	3.67	26	89	11
	Mean	**84**	**351**	**3.64**	**25**	**84**	**14**
			Middle Shelf Zone 3 (91-120 m)				
17 *	91	76	277	3.67	25	90	15
18 *	91	51	179	3.41	18	88	9
20 *	100	77	285	3.73	27	90	13
23 *	100	58	218	3.31	17	72	14
29 *	100	54	266	3.32	17	90	17
33 *	100	69	209	3.81	28	78	19
38 *	100	52	249	3.39	17	83	23
56 *	100	64	235	3.66	23	90	12
60 *	100	45	198	3.36	17	87	17
83 *	100	59	240	3.51	20	94	14
	Mean	**61**	**236**	**3.52**	**21**	**86**	**15**
			Outer Shelf (121-200 m)				
24 *	200	30	69	2.99	14	69	26
25 *	200	35	59	3.36	21	62	29
27 *	200	24	58	2.83	12	72	27
39 *	200	39	129	2.86	11	50	25
57 *	200	26	44	3.04	16	43	30
61 *	200	27	52	3.01	16	63	23
63 *	200	30	60	3.16	17	70	23
65 *	200	23	38	2.86	14	67	27
C4 *	187	19	57	2.33	9	72	37
	Mean	**28**	**63**	**2.94**	**14**	**63**	**27**

Table 2-8 continues.

Table 2-8 continued.

Station	Depth (m)	Total No. of Species	Total Abundance	H'	SDI	ITI	BRI
Upper Slope/Canyon (201-500 m)							
40 *	303	21	47	2.69	10	N/A	N/A
41 *	303	23	50	2.96	12	N/A	N/A
42 *	303	25	50	2.96	13	N/A	N/A
44 *	241	15	23	2.61	10	N/A	N/A
58 *	300	20	27	2.92	14	N/A	N/A
62 *	300	19	30	2.77	12	N/A	N/A
64 *	300	23	43	2.81	13	N/A	N/A
C5 *	296	13	33	2.29	6	N/A	N/A
	Mean	**20**	**38**	**2.75**	**11**	**N/A**	**N/A**
Regional summer values [mean (range)]							
Bight'13 Middle Shelf		90 (45-171)	491 (142-2718)	3.60 (2.10-4.10)	NC	NC	18 (7-30)
Bight'13 Outer Shelf		66 (24-129)	289 (51-1492)	3.40 (2.30-4.10)	NC	NC	18 (8-28)
Bight'13 Upper Slope		30 (6-107)	96 (12-470)	2.70 (0.60-3.90)	NC	N/A	N/A
District historical summer values (2006-2016 Fiscal Years) [mean (range)]							
Middle Shelf Zone 1		109 (7-157)	427 (12-820)	3.98 (1.59-4.46)	35 (4-51)	84 (67-98)	16 (8-23)
Middle Shelf Zone 2, Within-ZID		88 (33-138)	506 (212-1491)	3.36 (0.36-4)	22 (1-35)	50 (1-83)	29 (13-52)
Middle Shelf Zone 2, Non-ZID		96 (29-142)	417 (90-785)	3.73 (2.29-4.43)	28 (5-52)	76 (1-96)	19 (10-57)
Middle Shelf Zone 3		97 (66-146)	474 (177-807)	3.77 (3.06-4.23)	27 (15-43)	82 (65-93)	18 (10-26)
Outer Shelf		46 (23-80)	137 (40-367)	3.29 (2.50-3.95)	19 (8-32)	71 (42-100)	24 (14-39)
Upper Slope/Canyon		27 (13-49)	64 (22-165)	2.89 (2.31-3.34)	13 (7-19)	N/A	N/A

Table 2–9 Community measure values for each semi-annual station sampled during the Winter 2017 infauna survey, including regional and Districal historical values. ZID = Zone of Initial Dilution, NC = Not Calculated.

Station	Depth (m)	Total No. of Species	Total Abundance	H'	SDI	ITI	BRI
Middle Shelf Zone 2, Within-ZID (51-90 m)							
0	56	90	317	3.98	35	70	19
4	56	81	267	3.97	35	76	14
76	58	82	261	3.89	30	74	16
ZB	56	97	356	3.98	32	77	16
	Mean	**97**	**356**	**3.98**	**32**	**77**	**16**
Middle Shelf Zone 2, Non-ZID (51-90 m)							
1	56	78	285	3.77	26	81	10
3	60	82	224	3.99	33	77	16
5	59	75	244	3.66	28	75	13
9	59	95	428	3.59	27	82	15
12	58	98	299	4.20	44	79	12
68	52	99	488	3.76	23	70	14
69	52	104	399	3.99	34	74	13
70	52	101	387	3.87	34	74	16
71	52	87	398	3.62	27	73	18
72	55	83	268	3.80	30	82	14
73	55	109	426	4.09	33	65	21
74	57	83	259	3.94	31	85	15
75	60	75	256	3.76	27	78	16
77	60	82	212	4.06	35	72	15
78	63	84	313	3.78	31	76	16
79	65	95	359	3.98	31	78	15
80	65	90	338	3.93	30	87	9
81	65	87	359	3.78	29	79	12
82	65	95	376	3.79	30	78	13
84	54	99	426	3.97	31	76	15
85	57	83	380	3.82	28	73	19
86	57	104	427	4.04	35	80	19
87	60	98	369	3.97	32	77	12
C	56	90	252	4.07	39	78	20
CON	59	68	215	3.80	27	83	13
	Mean	**90**	**335**	**3.88**	**31**	**77**	**15**
Regional summer values [mean (range)]							
Bight'13 Middle Shelf		90 (45-171)	491 (142-2718)	3.60 (2.10-4.10)	NC	NC	18 (7-30)
District historical summer values (2006-2016 Fiscal Years) [mean (range)]							
Middle Shelf Zone 2, Within-ZID		88 (33-138)	506 (212-1491)	3.36 (0.36-4)	22 (1-35)	50 (1-83)	29 (13-52)
Middle Shelf Zone 2, Non-ZID		96 (29-142)	417 (90-785)	3.73 (2.29-4.43)	28 (5-52)	76 (1-96)	19 (10-57)

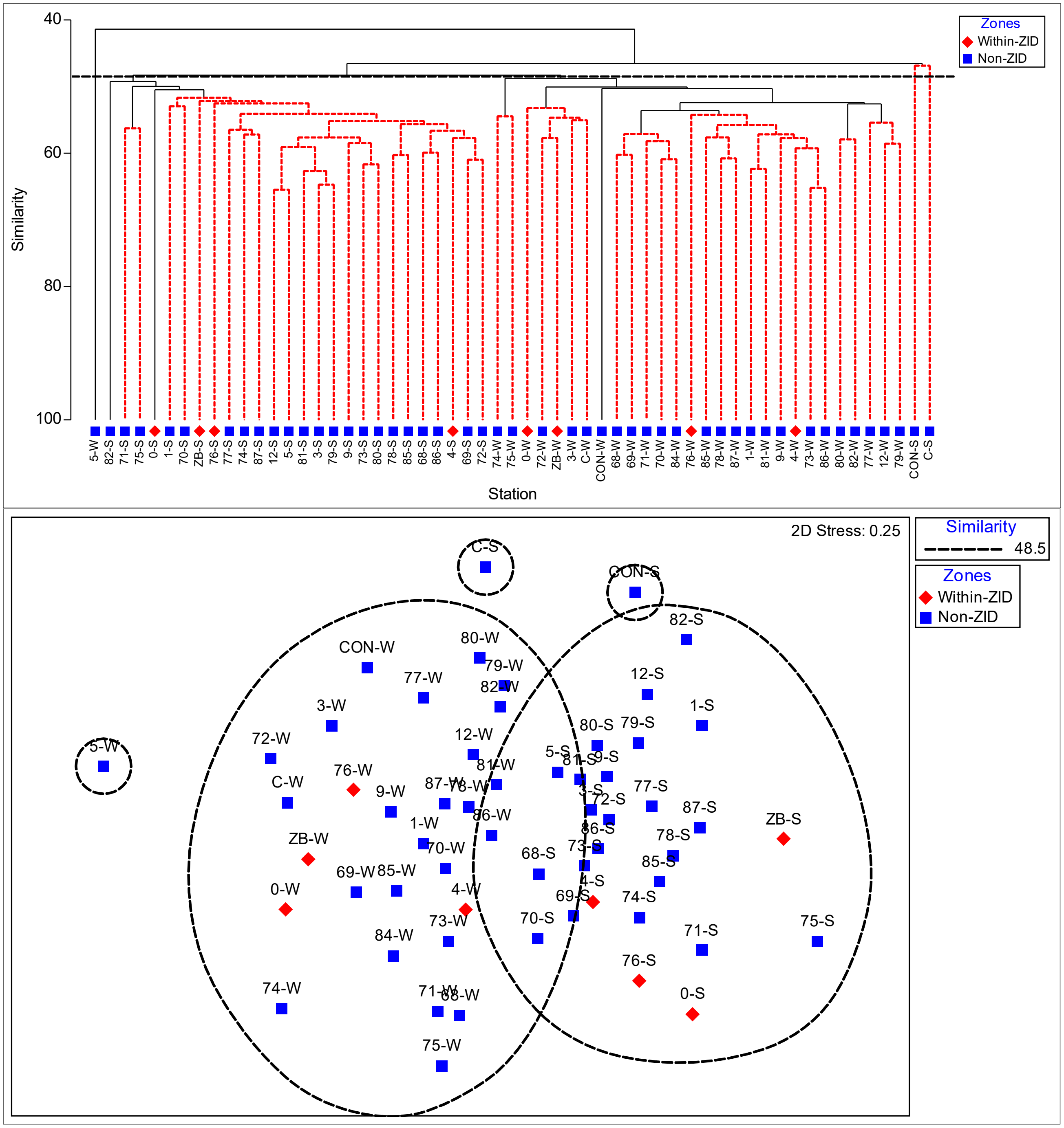

Figure 2–5 Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the infauna collected at within- and non-ZID stations along the Middle Shelf Zone 2 stratum for the Summer 2016 (S) and Winter 2017 (W) benthic surveys. Stations connected by red lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 5 main clusters formed at a 48.5% similarity on the dendrogram are superimposed on the nMDS plot.

Table 2–10 Summary of epibenthic macroinvertebrate community measures for each semi-annual and annual (*) station sampled during the Summer 2016 and Winter 2017 trawl surveys, including regional and District historical values. MPA = Marine Protected Area; NC = Not Calculated.

Season	Station	Nominal Depth (m)	Total No. of Species	Total Abundance	Biomass (kg)	H'	SDI
Summer	*Middle Shelf Zone 1 (31-50 m)*						
	T2 *	35	10	55	0.02	1.76	4
	T24 *	36	11	1748	1.22	0.35	1
	T6 *	36	9	1886	1.70	0.21	1
	T18 *	36	2	2	0.03	0.69	2
		Mean	**8**	**923**	**0.74**	**0.75**	**2**
	Middle Shelf Zone 2, Outfall (51-90 m)						
	T22	60	9	114	0.36	1.80	4
	T1	55	11	138	0.82	1.80	4
		Mean	**10**	**126**	**0.59**	**1.80**	**4**
	Middle Shelf Zone 2, Non-outfall (51-90 m)						
	T23	58	8	118	0.94	1.52	3
	T12	57	10	51	0.04	1.87	4
	T17	60	8	46	0.14	1.64	4
	T11	60	11	601	3.40	1.31	3
		Mean	**9**	**204**	**1.13**	**1.59**	**4**
	Outer Shelf (121-200 m)						
	T10 *	137	4	385	7.36	0.70	2
	T25 *	137	7	307	11.62	0.74	1
	T14 *	137	3	146	1.36	0.17	1
	T19 *	137	9	526	5.57	0.22	1
		Mean	**6**	**341**	**6.48**	**0.46**	**1**
Winter	*Middle Shelf Zone 2, Outfall (51-90 m)*						
	T22	60	10	64	0.14	1.95	5
	T1	55	12	90	0.08	1.94	4
		Mean	**11**	**77**	**0.11**	**1.95**	**5**
	Middle Shelf Zone 2, Non-outfall (51-90 m)						
	T23	58	8	91	0.09	1.45	3
	T12	57	10	116	1.12	1.81	4
	T17	60	9	65	0.66	1.64	3
	T11	60	19	632	2.17	1.38	3
		Mean	**12**	**226**	**1.01**	**1.57**	**3**
Regional (non-MPA) summer values [area-weighted mean (range)]							
Bight'13 Middle Shelf			12 (3-23)	1093 (19-17973)	5 (0.31-36)	1.11 (0.09-2.49)	NC
Bight'13 Outer Shelf			15 (3-29)	728 (4-5160)	27 (0.39-83)	1.26 (0.10-2.39)	NC
District historical values (2006-2016 Fiscal Years) [mean (range)]							
Middle Shelf Zone 1			12 (3-18)	350 (33-2592)	0.74 (0.00-3.44)	1.40 (0.01-2.22)	3 (1-5)
Middle Shelf Zone 2, Outfall			12 (7-18)	320 (49-1436)	1.64 (0.08-5.67)	1.31 (0.22-2.15)	2 (1-5)
Middle Shelf Zone 2, Non-outfall			11 (5-18)	339 (12-2498)	1.65 (0.02-11.16)	1.32 (0.06-2.43)	3 (1-9)
Outer Shelf			10 (3-15)	147 (19-548)	3.50 (0.03-19.31)	1.08 (0.15-2.12)	2 (1-8)

Fish Health

Fishes appeared normal in both color and odor in 2016-17, thus compliance was met. Furthermore, less than 1% of all fishes collected showed evidence of irregularities. The most common irregularity was the presence of the eye parasite *Phrixocephalus cincinnatus* on the Pacific Sanddab (*Citharichthys sordidus*), which occurred in ~1% of the examined fish. These results are comparable to background levels found within the Southern California Bight (Perkins and Gartman 1997) and do not indicate a degraded biota.

Liver Histopathology

No histopathology analysis was conducted for the 2016-17 monitoring period (see Appendix A).

CONCLUSIONS

In summary, COP criteria for water quality were met and state and federal bacterial standards were also met at offshore stations. Sediment quality was not degraded by loading of measured chemical contaminants or by physical changes from the discharge of treated wastewater. This was supported by the absence of sediment toxicity in controlled laboratory tests and the presence of normal infaunal

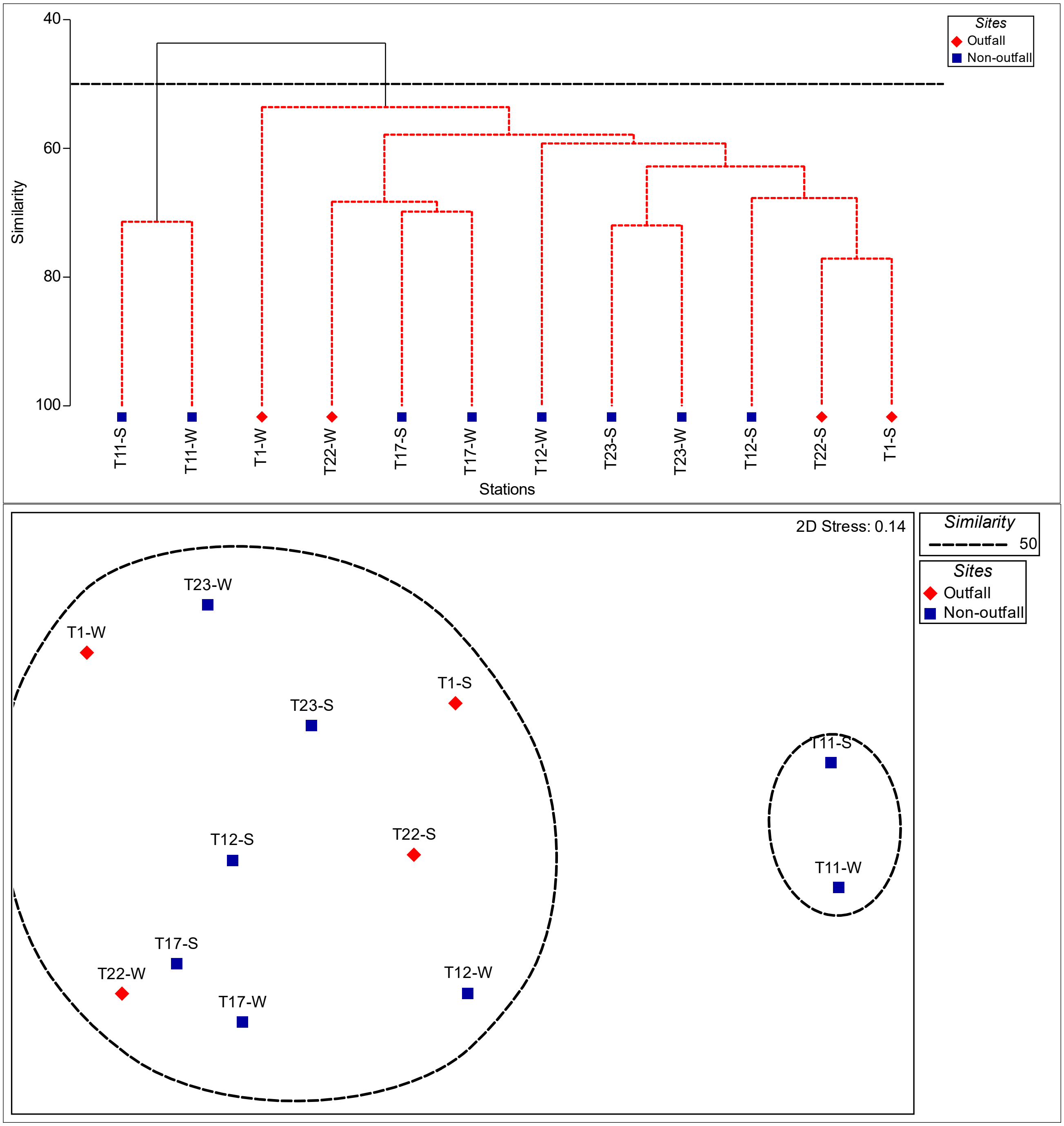

Figure 2–6 Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the epibenthic macroinvertebrates collected at outfall and non-outfall stations along the Middle Shelf Zone 2 stratum for the Summer 2016 (S) and Winter 2017 (W) trawl surveys. Stations connected by red lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 2 main clusters formed at a 50% similarity on the dendrogram is superimposed on the nMDS plot.

Table 2–11 Summary of demersal fish community measures for each semi-annual and annual (*) station sampled during the Summer 2016 and Winter 2017 trawl surveys, including regional and District historical values. MPA = Marine Protected Area; NC = Not Calculated.

Season	Station	Nominal Depth (m)	Total No. of Species	Total Abundance	Biomass (kg)	H'	SDI	FRI
				Middle Shelf Zone 1 (31-50 m)				
Summer	T2 *	35	9	219	7.95	0.96	2	22
	T24 *	36	11	128	3.46	1.39	2	22
	T6 *	36	9	153	2.44	1.55	3	17
	T18 *	36	9	331	4.05	1.66	4	19
		Mean	**10**	**208**	**4.47**	**1.39**	**3**	**20**
				Middle Shelf Zone 2, Outfall (51-90 m)				
	T22	60	16	214	9.71	1.89	4	22
	T1	55	11	246	11.01	1.75	3	28
		Mean	**14**	**230**	**10.36**	**1.82**	**4**	**25**
				Middle Shelf Zone 2, Non-outfall (51-90 m)				
	T23	58	15	290	16.97	1.84	4	28
	T12	57	14	248	12.77	2.04	5	34
	T17	60	16	177	6.87	2.11	5	31
	T11	60	17	448	15.39	1.80	3	27
		Mean	**16**	**291**	**13.00**	**1.95**	**4**	**30**
				Outer Shelf (121-200 m)				
	T10 *	137	20	594	16.88	1.73	3	26
	T25 *	137	14	396	7.21	1.63	3	26
	T14 *	137	18	345	7.88	1.60	3	21
	T19 *	137	19	751	11.34	1.46	3	41
		Mean	**18**	**522**	**10.82**	**1.61**	**3**	**29**
				Middle Shelf Zone 2, Outfall (51-90 m)				
Winter	T22	60	10	147	5.50	1.71	3	27
	T1	55	15	255	6.93	1.98	5	25
		Mean	**13**	**201**	**6.21**	**1.85**	**4**	**26**
				Middle Shelf Zone 2, Non-outfall (51-90 m)				
	T23	58	13	143	6.57	1.94	4	25
	T12	57	11	204	8.62	1.75	3	18
	T17	60	10	92	3.91	1.85	4	23
	T11	60	15	463	10.99	1.93	4	22
		Mean	**12**	**226**	**7.53**	**1.87**	**4**	**22**
				Regional (non-MPA) summer values [area-weighted mean (range)]				
Bight'13 Middle Shelf			15 (5-24)	506 (12-2446)	12 (0.70-64.20)	1.65 (0.67-2.35)	NC	28 (17-61)
Bight'13 Outer Shelf			14 (2-21)	790 (2-3088)	16 (0.20-54.50)	1.35 (0.59-2.01)	NC	20 (-1-51)
				District historical values (all trawl surveys from 2006-2016 Fiscal Years) [mean (range)]				
Middle Shelf Zone 1			11 (2-16)	246 (83-470)	5.27 (1.16-11.86)	1.65 (0.69-2.22)	3 (2-6)	22 (18-26)
Middle Shelf Zone 2, Outfall			13 (2-18)	500 (149-3227)	21.34 (4.34-78.72)	1.62 (0.39-2.14)	3 (1-6)	23 (18-33)
Middle Shelf Zone 2, Non-outfall			15 (3-25)	637 (41-12274)	14.25 (1.01-135.64)	1.70 (0.14-2.22)	3 (1-6)	23 (13-32)
Outer Shelf			15 (2-23)	678 (260-2644)	18.22 (2.60-86.41)	1.35 (0.65-1.91)	3 (1-5)	13 (2-33)

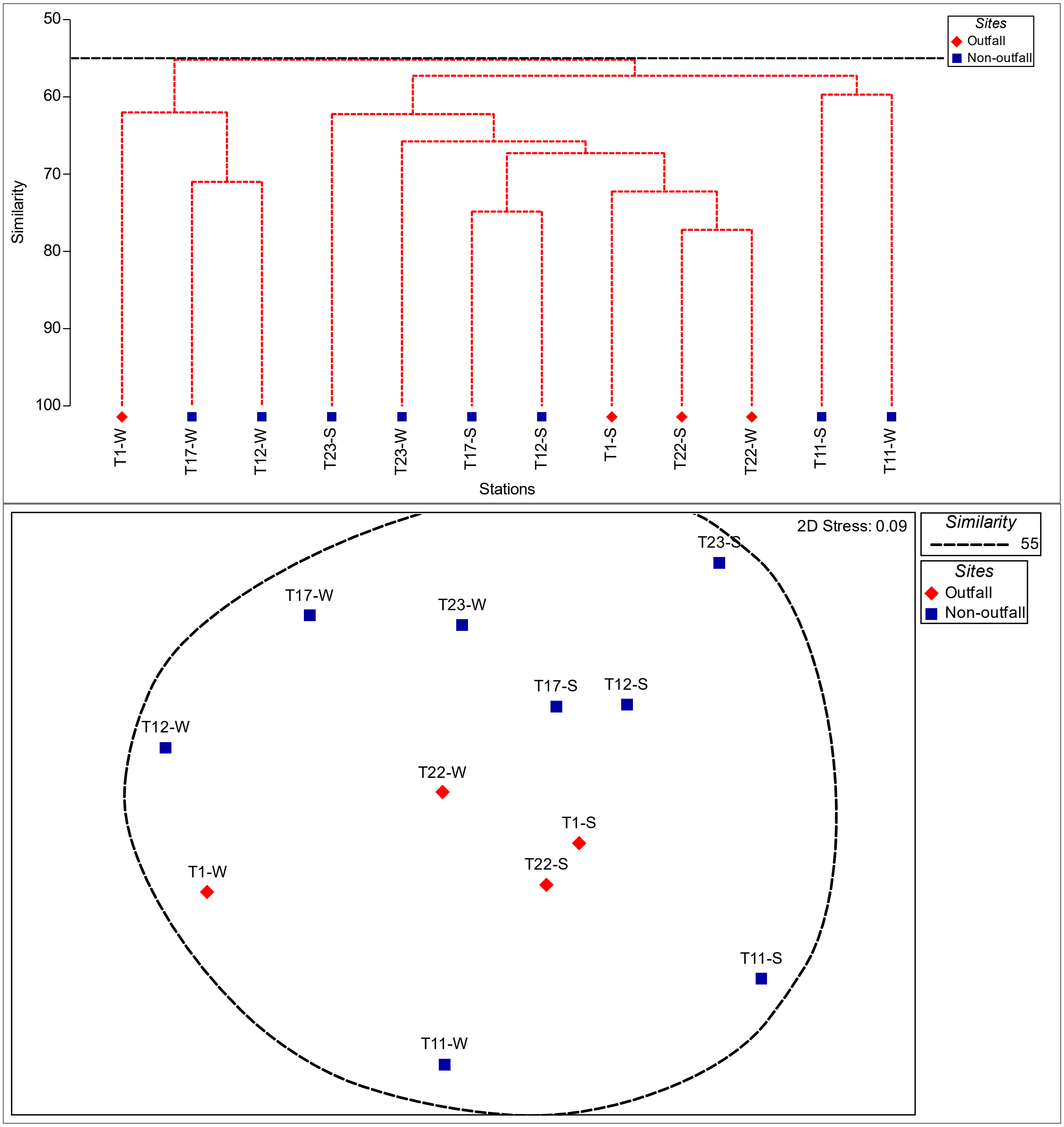

Figure 2–7 Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the demersal fishes collected at outfall and non-outfall stations along the Middle Shelf Zone 2 stratum for the Summer 2016 (S) and Winter 2017 (W) trawl surveys. Stations connected by red lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The main cluster formed at a 55% similarity on the dendrogram is superimposed on the nMDS plot.

Table 2–12 Means and ranges of tissue contaminant concentrations in selected flatfishes collected by trawling in July 2016 at Stations T1 (outfall) and T11 (non-outfall), as well as District historical values. ND = Not Detected; NR = Not Reportable.

Species	Tissue	Station	n	Standard Length (mm)	Percent Lipid	Mercury (mg/kg)	ΣDDT (µg/kg)	ΣPCB (µg/kg)	ΣChlordane (µg/kg)	Dieldrin (µg/kg)
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	Non-outfall	8	110	ND (All ND)	0.02 (0.01-0.06)	7.16 (1.86-27.19)	ND (All ND)	ND (All ND)	ND (All ND)
		Outfall	10	142	ND (All ND)	0.05 (0.02-0.13)	2.13 (1.19-3.32)	ND (All ND)	ND (All ND)	ND (All ND)
	Liver	Non-outfall	8	110	4.14 (2.01-12.70)	0.20 (0.13-0.34)	NR	NR	NR	NR
		Outfall	10	142	2.73 (0-5.74)	0.16 (0.05-0.26)	99.81 (0-190)	4.27 (0-21.40)	ND (All ND)	ND (All ND)
Parophrys vetulus (English Sole)	Muscle	Non-outfall	10	177	0.71 (0-1.88)	0.06 (0.02-0.10)	32.24 (7.86-97.34)	3.03 (0-7.03)	ND (All ND)	ND (All ND)
		Outfall	10	196	0.70 (0-1.76)	0.06 (0.04-0.08)	39.43 (3.97-160.60)	5.29 (0-13.51)	ND (All ND)	ND (All ND)
	Liver	Non-outfall	10	177	12.19 (1.93-26.80)	0.08 (0.02-0.19)	NR	NR	NR	NR
		Outfall	10	196	10.04 (4.58-16)	0.09 (0.04-0.14)	747.92 (102-2471.40)	134.92 (0-545)	ND (All ND)	ND (All ND)
District historical values (from 2006-2016 FY)										
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	Non-outfall	64	156 (115-217)	0.18 (0-0.68)	0.06 (0.01-0.30)	12.61 (0-38.75)	3.35 (0-18.36)	0.09 (0-1.45)	ND (All ND)
		Outfall	91	162 (120-204)	0.18 (0-0.77)	0.07 (0.01-0.42)	8.85 (0-54.50)	2.04 (0-12.57)	0.01 (0-0.71)	0.20 (0-12.70)
	Liver	Non-outfall	64	156 (115-217)	6.79 (0.42-30.40)	0.19 (0.04-0.79)	608.42 (0-2100)	51.14 (0-432.59)	ND (All ND)	ND (All ND)
		Outfall	91	160 (120-204)	9.81 (1.34-24.60)	0.16 (0.02-0.59)	653.61 (103-1822.70)	146.09 (10.42-457.80)	5.15 (0-81.70)	ND (All ND)
Parophrys vetulus (English Sole)	Muscle	Non-outfall	83	183 (124-247)	0.81 (0-6.22)	0.05 (0.01-0.12)	84.63 (0-524.30)	9.26 (0-61.20)	ND (All ND)	0.05 (0-4.45)
		Outfall	87	184 (136-306)	1.16 (0-8.23)	0.05 (0.01-0.11)	122.42 (4.73-633.46)	16.50 (0-130.90)	ND (All ND)	ND (All ND)
	Liver	Non-outfall	83	182 (124-247)	9.87 (1.93-26.50)	0.06 (0.02-0.19)	1384.92 (71.10-14300)	171.08 (0-1694.70)	0.09 (0-5.27)	ND (All ND)
		Outfall	87	184 (136-306)	11.54 (0-27.10)	0.06 (0.02-0.16)	1667.16 (95.70-20967)	216.80 (0-1627.29)	1.44 (0-30.80)	ND (All ND)

Table 2–13 Means and ranges of muscle tissue contaminant concentrations in selected scorpaenid fishes collected by rig-fishing in September 2016 at Zones 1 (outfall) and 3 (non-outfall), as well as District historical data plus state and federal tissue thresholds. ND = Not Detected; N/A = Not Applicable.

Zone	Species	n	Standard Length (mm)	Percent Lipid	Mercury (mg/kg)	Arsenic (mg/kg)	Selenium (mg/kg)	ΣDDT (µg/kg)	ΣPCB (µg/kg)	ΣChlordane (µg/kg)	Dieldrin (µg/kg)
Non-outfall	*Sebastes caurinus* (Copper Rockfish)	2	228	0.71 (0.59-0.83)	0.11 (0.10-0.13)	1.85 (1.49-2.21)	1.03 (0.42-1.64)	23.05 (19.70-26.40)	ND (All ND)	ND (All ND)	ND (All ND)
	Sebastes flavidus (Yellowtail Rockfish)	1	278	0.64	0.09	1.27	0.97	7.57	ND	ND	ND
	Sebastes miniatus (Vermilion Rockfish)	6	235	0.52 (0.35-0.86)	0.08 (0.05-0.20)	4.14 (1.96-10.30)	1.34 (1.17-1.54)	33.90 (13.60-99.20)	ND (All ND)	ND (All ND)	ND (All ND)
	Sebastes rosenblatti (Greenblotched Rockfish)	1	188	0.83	0.1	2.87	0.57	18.9	ND	ND	ND
Outfall	*Sebastes caurinus* (Copper Rockfish)	1	272	ND	0.07	3.13	0.51	6.4	ND	ND	ND
	Sebastes miniatus (Vermilion Rockfish)	8	259	1.14 (0.58-2.26)	0.05 (0.04-0.06)	4.42 (1.85-5.89)	0.61 (0.54-0.70)	17.05 (8.27-34.80)	ND (All ND)	ND (All ND)	ND (All ND)
	Sebastes rosenblatti (Greenblotched Rockfish)	1	238	ND	0.63	7.83	0.67	12.4	ND	ND	ND
District historical values (from 2006-2016 FY)											
Non-outfall	*Sebastes caurinus* (Copper Rockfish)	5	369	0.51 (0-0.97)	0.12 (0.07-0.19)	1.86 (1.62-2.04)	0.78 (0.66-0.90)	20.64 (6.05-43)	3.20 (0.26-7.60)	ND (All ND)	ND (All ND)
	Sebastes miniatus (Vermilion Rockfish)	5	260	0.73 (0.34-1.26)	0.08 (0.05-0.12)	2.53 (1.84-3.29)	0.69 (0.68-0.71)	15.13 (6.91-22.47)	1.40 (0-2.46)	ND (All ND)	ND (All ND)
Outfall	*Sebastes caurinus* (Copper Rockfish)	14	277	0.65 (0-2)	0.11 (0.05-0.16)	1.54 (0.93-2.08)	0.86 (0.71-1.01)	10.20 (5.21-20.77)	3.80 (1.04-6.14)	ND (All ND)	ND (All ND)
	Sebastes miniatus (Vermilion Rockfish)	27	262	1.18 (0-3.67)	0.05 (0.02-0.08)	2.06 (0.68-3.68)	0.58 (0.23-0.88)	12.49 (0-58.30)	3.01 (0-17.24)	0.38 (0-8.80)	ND (All ND)
Tissue thresholds											
CA Advisory Tissue Level			N/A	N/A	0.44	N/A	15	2100	120	560	46
Federal Action Level for Edible Tissue			N/A	N/A	1	N/A	N/A	5000	2000	300	300

communities throughout the monitoring area. Fish and trawl invertebrate communities in the monitoring area were also healthy and diverse, and federal and state fish consumption guidelines were met. These results indicate that the receiving environment was not degraded by the discharge of treated wastewater, all permit compliance criteria were met, and environmental and human health were protected.

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CHAPTER 3
Strategic Process Studies and Regional Monitoring

INTRODUCTION

The Orange County Sanitation District (District) operates under the auspices of a National Pollutant Discharge Elimination System (NPDES) permit issued jointly by the United States Environmental Protection Agency (EPA) and the State of California Regional Water Quality Control Board (RWQCB) (Order No. R8-2012-0035, NPDES Permit No. CA0110604) in June 2012. The permit requires the District to conduct an ocean monitoring program (OMP) that documents the effectiveness of the District's source control and wastewater treatment operations in protecting coastal ocean resources and beneficial uses. A requirement of the OMP is to conduct Strategic Process Studies (SPS) and to participate in regional monitoring programs. In addition, the District performs special studies, which are generally less involved than SPS and have no regulatory requirement for prior approval or level of effort.

SPS are designed to address unanswered questions raised by the Core monitoring program results or they may focus on issues of interest to the District and/or its regulators, such as the effect of contaminants of emerging concern (CECs) on local fish populations. SPS are proposed and must be approved by state and/or federal regulators to ensure proper focus and level of effort. For the 2016-17 program year, no SPS were conducted.

Regional monitoring studies do not focus on the District's monitoring area, but instead sample larger areas of the Southern California Bight. These may include the "Bight" studies coordinated by the Southern California Coastal Water Research Project (SCCWRP) or studies conducted in coordination with other public agencies and/or non-governmental organizations in the region. Examples include the Central Region Kelp Survey Consortium and the Southern California Bight Regional Water Quality Program.

This chapter provides overviews of recently completed and ongoing studies and regional monitoring efforts. Unlike other chapters in this report, these summaries are not restricted to the most recent program year (i.e., 2016-17) and include the most recent information available to date. When appropriate, this information is also incorporated into other report chapters to supplement Core monitoring results. Links to final study reports, if available, are listed under each section below.

REGIONAL MONITORING

Regional Nearshore (Surfzone) Bacterial Sampling

The District partners with the Orange County Health Care Agency (OCHCA), the South Orange County Wastewater Authority (SOCWA), and the Orange County Public Works (OCPW) in the Ocean Water Protection Program, a regional bacterial sampling program that samples 126 stations along 42 miles (67.5 km) of coastline (from Seal Beach to San Clemente State Beach) and 70 miles (112.6 km) of harbor and bay frontage. In 2016, over 8,100 samples were collected and

24,586 analyses were performed for 3 fecal indicator bacteria (FIB; total coliform, fecal coliform, and enterococci).

OCHCA reviews bacteriological data to determine whether a station meets Ocean Water-Contact Sports Standards (i.e., Assembly Bill 411 [AB411]), and uses these results as the basis for health advisories, postings, or beach closures. The 2016 Annual Ocean, Harbor, and Bay Water Quality Report (OCHCA 2017) provides a countywide summary of beach bacteriological water quality. Included in the report are year-to-year variability and trends since 1987.

A few of the county-wide report findings for 2016 include:

- The number of reported sewage spills (129) for 2016 represented a continued annual decline since 2002.
- The number of beach closures due to sewage spills (9) was 53% below the 30-year average (19).
- The total number of Beach Mile Days closures (14.0) due to sewage spills was 33% below the 18-year average from 1999–2016.
- Total Beach Mile Days posted due to bacteriological standards violations during the AB411 period (April 1 to October 31) were 29.1, which was 92% less than the record high of 366 in 2002.
- Thirteen rain advisories were posted for a total of 51 days, a 25% increase over the previous 3-year's drought-impacted average of 38 days.

The District samples 38 of the 126 regional surfzone stations, of which 18 are legacy stations sampled since the 1970s (Figure 3-1). These legacy stations were analyzed separately for 2016-17 for comparison with the District's historical surfzone results (Table B-12). Table B-13 presents summary statistics for the remaining stations. Results for the 18 District stations were similar to those of previous years (OCSD 2014, 2015, 2016, 2017). FIB counts at these stations varied by season, location, and bacteria type. A general spatial pattern was associated with the mouth of the Santa Ana River. Seasonal geomeans and the percent of samples exceeding geomean and single sample standards all peaked near the river mouth and tapered off upcoast and downcoast. Collectively, exceedance of the state single sample standard (AB411) was low, with <1% for total coliforms, <2% for fecal coliforms, and <5% for enterococci.

Southern California Bight Regional Water Quality Program

The District is a member of a regional cooperative sampling effort known as the Southern California Bight Regional Water Quality Program (SCBRWQP; previously known as the Central Bight Regional Water Quality Monitoring Program) with the City of Oxnard, City of Los Angeles, the County Sanitation Districts of Los Angeles, and the City of San Diego. Each quarter, the participating agencies sample 301 stations that covers the coastal waters from Ventura County to Crystal Cove State Beach and from Point Loma to the United States–Mexico Border (Figure 3-2). The participants use comparable conductivity-temperature-depth (CTD) profiling systems and field sampling methods. The District samples 66 stations, which includes the 28 Core water quality program stations, as part of this program (Figure 3-1). The SCBRWQP monitoring provides regional data that enhances the evaluation of water quality changes due to natural (e.g., upwelling) or anthropogenic discharges (e.g., outfalls and stormwater flows) and provides a regional context for comparisons with the District's monitoring results. The SCBRWQP data also provides a way to link to other larger-scale regional programs, such as the California Cooperative Oceanic Fisheries Investigations (CalCOFI) and serves as the basis for SCCWRP's Bight water quality sampling (see section below). Additionally, the group has been evaluating the establishment of data quality assurance guidelines and data quality flags for submitting Central Bight data to the Southern California Coastal Ocean Observing System in order to comply with national Integrated Ocean Observing System guidelines.

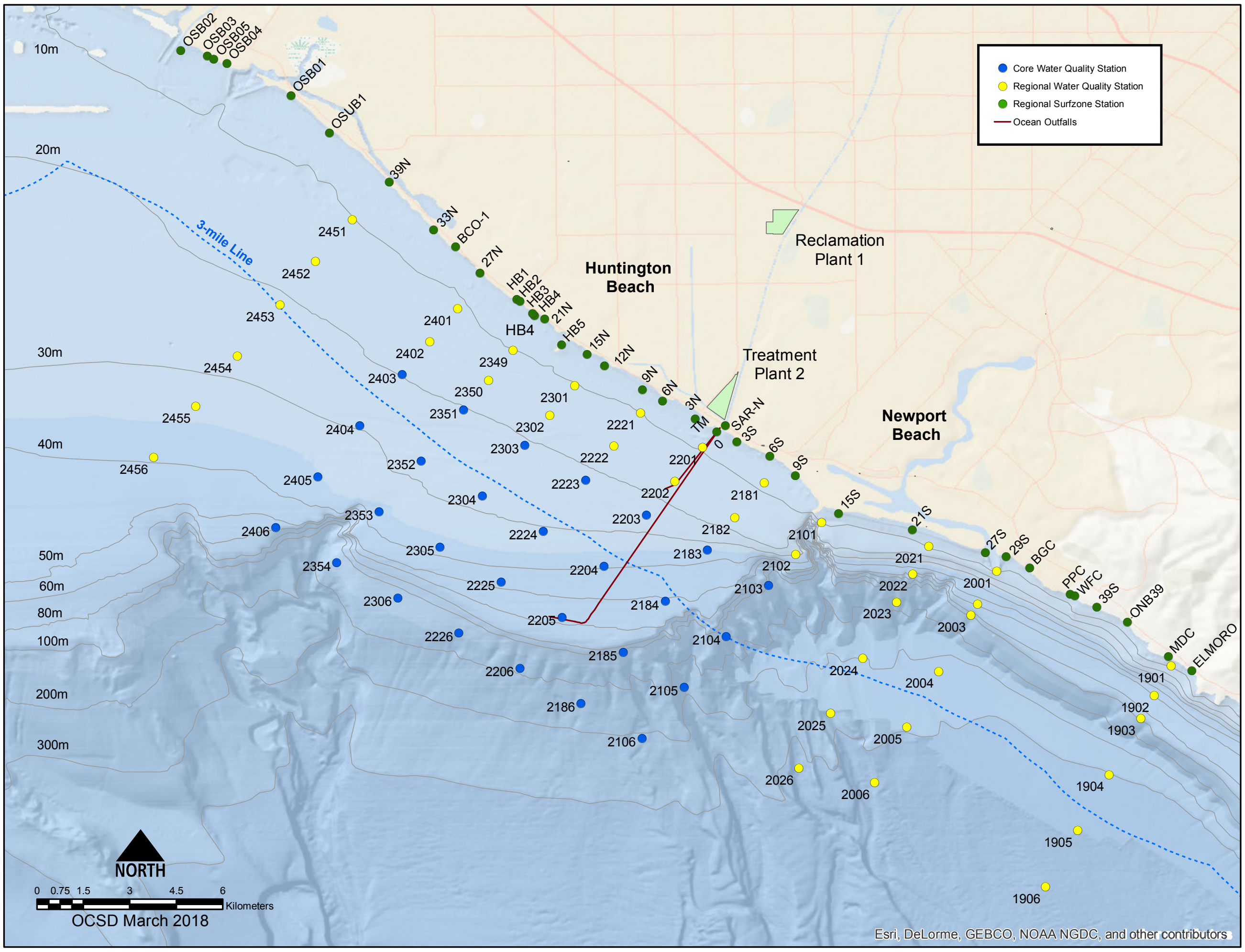

Figure 3–1 Offshore and nearshore (surfzone) water quality monitoring stations for 2016-17.

Bight'13 Regional Monitoring

Since 1994, the District has participated in 5 regional monitoring studies of environmental conditions within the Southern California Bight (SCB): 1994 Southern California Bight Pilot Project (SCBPP), Bight'98, Bight'03, Bight'08, and Bight'13. The District has played a considerable role in all aspects of these regional projects, including program design, sampling, quality assurance, data analysis, and report writing. Results from these efforts provide information that is used by individual dischargers, resource managers, and the public to improve region-wide understanding of environmental conditions and to provide a regional perspective for comparisons with data collected from individual point sources. During the summer of 2013, District staff conducted field operations, ranging from Orange County south to Camp Pendleton in northern San Diego County and west to the southern end of Santa Catalina Island, as part of the Bight'13 sampling effort. District staff is currently involved in final report production for the Bight'13 project, while working on preparations for the sixth regional program — Bight'18. Information for the Bight programs, along with planning documents, data, and reports on the previous studies are available on SCCWRP's website (http://www.sccwrp.org/ResearchAreas/RegionalMonitoring.aspx).

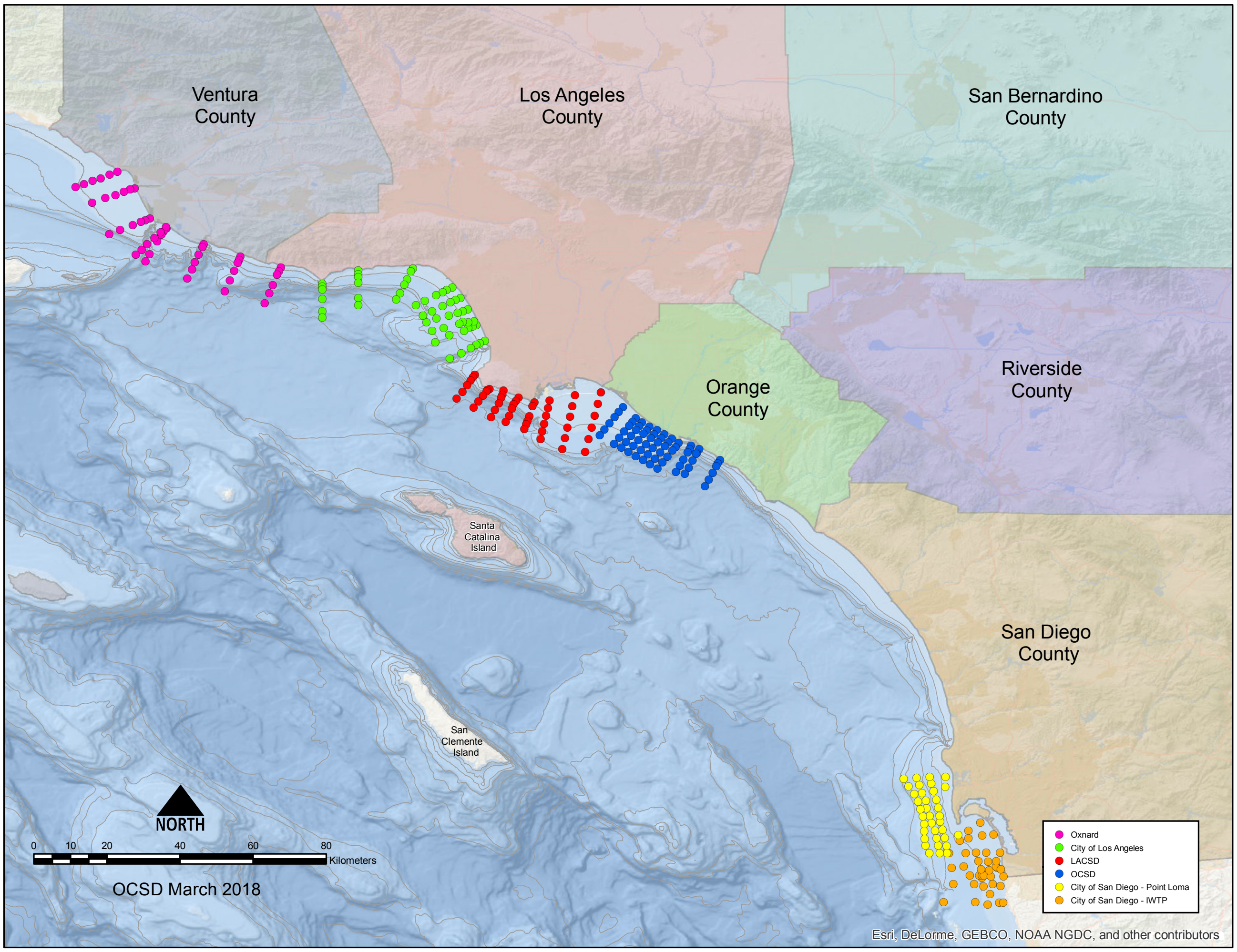

Figure 3–2 Southern California Bight Regional Water Quality Program monitoring stations for 2016-17.

Central Region Kelp Survey Consortium

The District is a member of the Central Region Kelp Survey Consortium (CRKSC), which was formed in 2003 to map Giant Kelp (*Macrocystis pyrifera*) beds off Ventura, Los Angeles, and Orange Counties via aerial photography. The program is modeled after the San Diego Regional Water Quality Control Board, Region Nine Kelp Survey Consortium, which began in 1983. Both consortiums sample quarterly to count the number of observable kelp beds and calculate maximum kelp canopy coverage. Combined, the CRKSC and San Diego aerial surveys provide synoptic coverage of kelp beds along approximately 81% of the 270 miles (435 km) of the southern California mainland coast from northern Ventura County to the United States–Mexico Border. Survey results are published and presented annually by MBC Applied Environmental Sciences to both consortium groups, regulators, and the public. Reports are available on SCCWRP's website (http://kelp.sccwrp.org/reports.html).

<u>2016 Central Region Kelp Bed Results</u>

The number of kelp beds displaying canopy (14 of 26) decreased in the Central Region and the overall canopy cover decreased by 9.5% from 2.03 mi² (5.26 km²) in 2015 to 1.84 mi² (4.76 km²) in 2016. Six beds had increased surface coverage (1–434%) and 2 beds had no change. While less than 2015, the total coverage in 2016 was still above the long-term (1965-2016) regional average of

1.68 mi² (4.34 km²) (MBC 2016). Consistent with previous results, most of the Central Region kelp beds reached their maximum extent in early summer.

The 4 beds off Orange County showed either no change (3 beds) or decreased canopy (1 bed) compared to 2015. The 3 beds that did not change, Horseshoe Kelp, Huntington Flats and Huntington Flats to Newport Harbor, have had no observable kelp since the monitoring began in 2003. Newport/Irvine Coast beds showed a decrease of 20% from 2015 (0.02 mi² [0.045 km²] to 0.01 mi² [0.036 km²]), the lowest total coverage since 2007.

There was no evidence of any adverse effects on Giant Kelp resources from any of the region's dischargers. Rather, the Giant Kelp surveys of 2016 continued to demonstrate that most kelp bed dynamics in the Central region are influenced by the large-scale oceanographic environment and micro-variations in local topography and currents that can cause anomalies in kelp bed performances.

Ocean Acidification Mooring

The District's Ocean Acidification (OA) Mooring was deployed for a 3-month period (October 2016 to January 2017) during the program year. Technical issues with the pH sensors and telemetry modem prevented deployments prior to October or subsequent to January until the mooring was redeployed in June 2017.

SPECIAL STUDIES

California Ocean Plan Compliance Determination Method Comparison

Background

Southern California ocean dischargers maintain extensive monitoring programs to assess their effects on ambient receiving water quality and to determine compliance with California Ocean Plan (COP) standards. However, historically each agency used a different approach for analyzing these data and determining COP compliance. In 2009, at the behest of the State Water Resources Control Board (SWRCB), SCCWRP, in collaboration with dischargers, began developing a new method to establish an Out-of-Range occurrence (ORO_{SCCWRP}) for dissolved oxygen (DO) and then for pH and light transmissivity. Presented below is a comparison, for the 2016-17 program year, between the District's standard approach used over the past 30-plus years and the newly developed SCCWRP method for DO, pH, and light transmissivity.

Compliance Determinations

District Approach

Compliance evaluations are based on statistical comparisons between 2 (inner and outer) reference stations located upcurrent of the outfall. For each survey, the presence and depth range of the pycnocline is calculated for each station with data binned into above, within, or below the pycnocline strata; when a pycnocline is absent, data are binned into the top, middle, or bottom third of the water column. Mean values for each parameter are calculated by stratum and station. Out-of-range occurrences (ORO_{OCSD}) are calculated by station for each depth strata and sampling date. District OROs are based on comparing each station and depth strata with the corresponding reference station data to determine whether COP compliance criteria (e.g., a 10% decrease in oxygen concentration values) were exceeded.

To determine whether an ORO_{OCSD} was Out-of-Compliance (OOC_{OCSD}), distributional maps are created that identify the reference stations for each monthly survey and location of each ORO_{OCSD}. These maps are evaluated to determine if a logical OOC_{OCSD} event is represented based on: (A) presence of the plume using a combination of temperature, density, salinity, Colored Dissolved Organic Matter (CDOM), ammonium (NH_4+), FIB, and current direction; (B) water column features relative to naturally occurring events (e.g., high chlorophyll-*a* due to phytoplankton); and (C) unique station characteristics that may make them inappropriate for comparison with reference stations (e.g., excessive differences in depth strata).

A detailed summary of the District's water quality compliance methodology is presented in Appendix A.

SCCWRP Approach

The methodology involves 3 steps: (A) identification of the stations affected by effluent wastewater, (B) selection of reference sampling sites representing "natural" conditions, (C) a per meter comparison between water quality profiles in the reference and plume-affected zones, and (D) calculation of maximum delta and comparison to COP standards to determine ORO_{SCCWRP}. Plume-affected areas are identified using CDOM as a wastewater indicator. Reference sites were selected from the areas around the outfalls, excluding the sites affected by the effluent. Reference density profiles are calculated and the profiles in the plume zone are compared to the reference profiles and a maximum difference value is used to establish the number of ORO_{SCCWRP}. Detailed methodology, as applied to DO, can be found in Nezlin et al. (2016).

Comparison Method

The 2 methods differ in their approach to establishing OROs and the SCCWRP methodology does not calculate OOCs, therefore the following steps were taken to make the output of both approaches more comparable.

- The SCCWRP approach identifies varying number of "plume impacted" and reference stations per survey while the OCSD method does not explicitly identify stations impacted by the plume and uses only 2 predetermined reference stations. For this analysis, only the number of reference stations can be directly compared.
- SCCWRP methodology compares only those values located below the mixed layer while the OCSD method includes surface values. For this comparison, all ORO_{OCSD} found in the upper part of the water column (i.e., Strata 1) were not considered.
- Under the District approach, a station may have multiple ORO and/or OOC values on a given survey, while the SCCWRP approach identifies a single maximum difference value per station. Therefore, monthly station ORO_{OCSD} were recalculated as presence/absence when multiple ORO_{OCSD} occurred at a station.
- Unlike the District method, the SCCWRP method does not provide a path to evaluate whether an ORO did or did not constitute an OOC. For this comparison, it was assumed that an ORO_{SCCWRP} was equivalent to the OOC_{OCSD} if it was located downcurrent from the outfall.
- SCCWRP methodology does not exclude the outfall station (2205) which is located within the ZID. For this analysis, any ORO_{SCCWRP} associated with Station 2205 was not included.
- SCCWRP methodology currently does not distinguish between positive and negative significant differences. For those instances when an ORO_{SCCWRP} was positive when the applicable COP criteria is relative to a negative impact, these OROs were not included.

<u>Results and Discussion</u>

In general, the SCCWRP approach identified greater numbers of reference stations per survey and fewer OROs and OOCs (Table 3-1). A possible source of these differences is the different approaches used in identifying OROs, determining statistical significance, and subsequently OOCs. The District uses multiple parameters and contextual information (e.g., Is the station upcurrent of the outfall? Was there a large phytoplankton bloom?) while ORO_{SCCWRP} events are established using stations where CDOM values that exceed the ±95th percentile of all CDOM samples per survey. The SCCWRP approach also does not take into account values that are due to natural variability and sources of

Table 3–1 Comparison of District and SCCWRP California Ocean Plan Compliance Determinations for Oxygen, pH, and Transmissivity for Program Year 2016-2017.

Month	Year	Current Flow	# Plume Impacted Stations		# Reference Stations		# Out-of-Range Stations		# Out-of-Compliance Stations	
			OCSD	SCCWRP	OCSD	SCCWRP	OCSD	SCCWRP	OCSD	SCCWRP
					Oxygen					
Jul	2016	Upcoast	N/A	3	2	17	0	0	0	0
Aug	2016	Upcoast	N/A	6	2	14	1	0	1	0
Sep	2016	Downcoast	N/A	4	2	9	1	0	0	0
Oct	2016	Upcoast	N/A	4	2	12	2	0	0	0
Nov	2016	Downcoast	N/A	5	2	10	3	0	2	0
Dec	2016	Downcoast	N/A	2	2	17	7	0	2	0
Dec	2016	Upcoast	N/A	2	2	17	6	0	6	0
Jan	2017	Downcoast	N/A	3	2	16	5	0	1	0
Jan	2017	Upcoast	N/A	3	2	16	0	0	0	0
Feb	2017	Downcoast	N/A	4	2	16	8	0	5	0
Mar	2017	Downcoast	N/A	3	2	12	3	0	3	0
Mar	2017	Upcoast	N/A	3	2	12	9	0	4	0
Apr	2017	Downcoast	N/A	7	2	9	4	2	1	0
May	2017	Upcoast	N/A	6	2	8	1	0	0	0
Jun	2017	Downcoast	N/A	2	2	8	0	0	0	0
					pH					
Jul	2016	Upcoast	N/A	3	2	17	0	0	0	0
Aug	2016	Upcoast	N/A	6	2	14	5	0	5	0
Sep	2016	Downcoast	N/A	4	2	9	13	0	0	0
Oct	2016	Upcoast	N/A	4	2	12	0	0	0	0
Nov	2016	Downcoast	N/A	5	2	10	0	0	0	0
Dec	2016	Downcoast	N/A	2	2	17	0	0	0	0
Dec	2016	Upcoast	N/A	2	2	17	0	0	0	0
Jan	2017	Downcoast	N/A	3	2	16	1	0	0	0
Jan	2017	Upcoast	N/A	3	2	16	10	0	0	0
Feb	2017	Downcoast	N/A	4	2	16	7	0	6	0
Mar	2017	Downcoast	N/A	3	2	12	0	0	0	0
Mar	2017	Upcoast	N/A	3	2	12	0	0	0	0
Apr	2017	Downcoast	N/A	7	2	9	0	0	0	0
May	2017	Upcoast	N/A	6	2	8	16	0	5	0
Jun	2017	Downcoast	N/A	2	2	8	11	0	1	0
					Transmissivity					
Jul	2016	Upcoast	N/A	3	2	17	12	0	0	1
Aug	2016	Upcoast	N/A	6	2	14	13	5	1	4
Sep	2016	Downcoast	N/A	4	2	9	2	1	0	0
Oct	2016	Upcoast	N/A	4	2	12	7	2	3	2
Nov	2016	Downcoast	N/A	5	2	10	10	0	2	0
Dec	2016	Downcoast	N/A	2	2	17	2	0	2	0
Dec	2016	Upcoast	N/A	2	2	17	10	0	0	0
Jan	2017	Downcoast	N/A	3	2	16	2	0	0	0
Jan	2017	Upcoast	N/A	3	2	16	18	0	3	0
Feb	2017	Downcoast	N/A	4	2	16	6	0	5	0
Mar	2017	Downcoast	N/A	3	2	12	2	0	1	0
Mar	2017	Upcoast	N/A	3	2	12	17	0	0	0
Apr	2017	Downcoast	N/A	7	2	9	0	3	0	3
May	2017	Upcoast	N/A	6	2	8	18	5	5	5
Jun	2017	Downcoast	N/A	2	2	8	0	0	0	0

N/A = Not Applicable.

CDOM not originating from the effluent. For example, the 2 oxygen OROSCCWRP values identified in April 2017 were upcurrent and inshore of the outfall.

The benefit of using the SCCWRP approach is its ability to be standardized so that all agencies are using the same methodology. A disadvantage is disregarding plume transport by currents and changes due to natural variability. The District's approach identified a greater number of OROs/OOCs but it involved significant staff effort to interpret OROs, which would be harder to replicate across agencies.

Fish Tracking Study

Background

The District's OMP assesses discharge effects on marine communities, including bioaccumulation analyses of contamination levels in tissue samples of flatfishes (predominantly Hornyhead Turbot and English Sole; occasionally Pacific Sanddab) and rockfishes relative to background levels and human health consumption guidelines. In making these comparisons it is assumed that the location of capture is also the location of exposure. However, little is known about the movement patterns of sentinel fish species within the District's monitoring area. As such, the District contracted Professor Chris Lowe from California State University, Long Beach to conduct a fish tracking study using passive acoustic telemetry from 2017-2018 to understand the site fidelity and potential risk exposure of sentinel fishes at the outfall and a reference area.

Methods

Study area and instrumentation

Vemco Ltd. VR2W automated, omnidirectional acoustic receivers and 69 kHz Vemco Ltd. sync transmitters were deployed together in a grid at depths ranging from 50-75 m in January 2017 at the outfall and an upcoast reference area (Figure 3-3). The receivers and transmitters were moored together using 2 biodegradable sand bags and cotton rope fitted with a Sub Sea Sonics AR-50 underwater acoustic release.

Fish collection and tagging

A total of 149 fishes were internally (i.e., California Scorpionfish and Vermilion Rockfish) or externally (i.e., English Sole, Hornyhead Turbot, and Pacific Sanddab) fitted with a Vemco Ltd. V9 coded tag (Table 3-2). Fish samples were caught either by trawls or rig fishing from the District's M/V *Nerissa* at the outfall and reference area between February to June 2017. Twenty Pacific Sanddab were tagged at the outfall but were subsequently released at the reference area; all other fish samples were released at the site of capture.

Data collection and analyses

Acoustic receivers were recovered in May and October 2017 at the outfall and in April and October 2017 at the reference area. Receivers were redeployed immediately after data from the receivers were downloaded to a laptop on the boat. Receiver data, tag information, and water temperature data were sent to Vemco Ltd. for position rendering after each download. Rendered fish positions were layered over detailed habitat maps (i.e., bathymetry and sediment parameters) in a geographic information system (GIS) for movement analysis. Preliminary calculations of the first data download included Euclidean distance measurements and a selectivity index to examine site selectivity of tagged fish.

Preliminary Results

Preliminary results indicate that Hornyhead Turbot and English Sole have little to no association with the outfall pipe, whereas Pacific Sanddab, California Scorpionfish, and Vermilion Rockfish exhibit

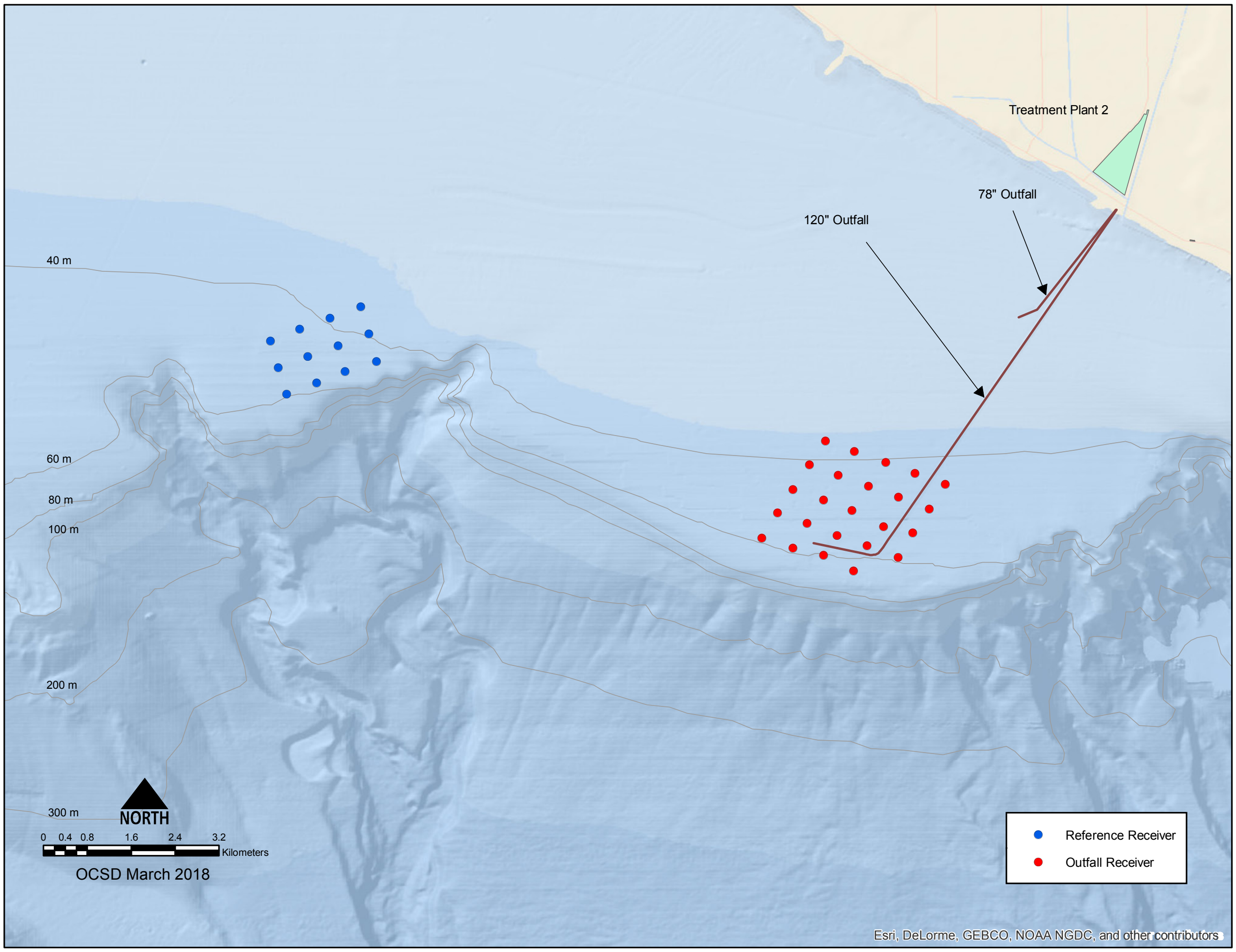

Figure 3–3 Acoustic receiver locations for the District's fish tracking study.

Table 3–2 Number of fishes tagged at the outfall and reference area for the District's fish tracking study.

Study area	Fish Family	Fish Species	Common Name	Number Tagged
Outfall	Paralichthyidae	*Citharichthys sordidus*	Pacific Sanddab	54*
	Pleuronectidae	*Parophrys vetulus*	English Sole	6
		Pleuronichthys verticalis	Hornyhead Turbot	15
	Scorpaenidae	*Scorpaena guttata*	California Scorpionfish	2
		Sebastes miniatus	Vermilion Rockfish	55
			Total	**132**
Reference	Paralichthyidae	*Citharichthys sordidus*	Pacific Sanddab	5
	Pleuronectidae	*Parophrys vetulus*	English Sole	7
		Pleuronichthys verticalis	Hornyhead Turbot	2
	Scorpaenidae	*Scorpaena guttata*	California Scorpionfish	0
		Sebastes miniatus	Vermilion Rockfish	3
			Total	**17**

* Twenty of the 54 Pacific Sanddab tagged at the outfall were released at the reference area.

high site fidelity at the outfall. Final results will be available after March 2018 when the last data download is scheduled to occur.

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APPENDIX A
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.

WATER QUALITY MONITORING

Field Methods

Offshore Zone

Permit-specified water quality monitoring was conducted 3 times per quarter at 28 stations (Figure 2-1). Eight stations located inshore of the 3-mile line of the coast are designated as areas used for water contact sports by the Regional Water Quality Control Board (RWQCB) (i.e., waters designated as REC-1), and were sampled an additional 3 days per quarter for fecal indicator bacteria (FIB). The additional surveys were conducted in order to calculate a 30-day geometric mean.

Each survey included measurements of pressure (from which depth is calculated), temperature, conductivity (from which salinity is calculated), dissolved oxygen (DO), acidity/alkalinity (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 SBE911 plus conductivity-temperature-depth (CTD) profiling system deployed from the M/V *Nerissa*. Profiling was conducted at each station from 1 m below the surface to 2 m above the bottom or to a maximum depth of 75 m, when water depths exceeded 75 m. SEASOFT V2 (2017a) 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). Wind condition, sea state, and visual observations of floatable materials or grease that might be of sewage origin were also noted. Discrete water samples were collected using a Sea-Bird Electronics Carousel Water Sampler (SBE32) equipped with Niskin bottles for ammonium (NH3-N) and FIB at specified stations and depths. All discrete samples were kept on wet ice in coolers and transported to the District's laboratory within 6 hours. A summary of the sampling and analysis methods is presented in Table A-1.

Southern California Bight Regional Water Quality

An expanded grid of water quality stations was sampled quarterly as part of the Southern California Bight Regional Water Quality monitoring program. These 38 stations were sampled by the District in conjunction with the 28 Core water quality stations (see Figure 3-1) and those of the County Sanitation Districts of Los Angeles, the City of Los Angeles, the City of Oxnard, and the City of San Diego.

Table A–1 Water quality sample collection and analysis methods by parameter during 2016-17.

Parameter	Sampling Method	Method Reference	Preservation	Container	Holding Time	Sampling Depth	Field Replicates
			Nearshore (Surfzone)				
Total Coliforms	grab	Standard Methods 9222 B **	Ice (<6°C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Ankle-deep water	at least 10% of samples
Fecal Coliforms		Standard Methods 9222 D **					
Enterococci		EPA Method 1600 ***					
			Offshore				
Temperature [1]	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Salinity (conductivity) [2]	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
pH [3]	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Dissolved Oxygen [4]	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Transmissivity [5]	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Photosynthetically Active Radiation (PAR) [6]	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Chlorophyll-*a* fluorescence [6]	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Color Dissolved Organic Matter (CDOM) [6]	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Ammonium (NH3-N)	Niskin	LMC SOP 4500-NH_3.G, Rev. J **	Ice (<6°C)	125 mL HDPE	28 days	Surface, 10m, 20m, 30m, 40m, 50m, 60m, Bottom	at least 10% of samples
Total Coliforms and *Escherichia coli* [7]	Niskin	Standard Methods 9223 C **	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
Enterococci	Niskin	Standard Methods 9230 D	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.	not applicable	not applicable	not applicable	surface	not applicable

[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] Fecal coliform count calculation: (*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.

The total sampling area extends from the Ventura River in the north to the U.S./Mexico Border in the south, with a significant spatial gap between Crystal Cove State Beach and Mission Bay (Figure 3-2). Data were collected using CTDs within a fixed-grid pattern comprising 304 stations during a targeted 3–4 day period. Parameters measured included pressure, water temperature, conductivity, DO, pH, chlorophyll-*a*, CDOM, and water clarity. Profiling was conducted from the surface to 2 m from the bottom or to a maximum depth of 100 m. The District's sampling and analytical methods were the same as those presented in Table A-1.

<u>Nearshore Zone</u>

Regional nearshore (surfzone) FIB samples were collected 1–2 days per week at a total of 38 stations (Figure 3-1). When water at creek/storm drain stations flowed to the ocean, a sample was collected at the source, 25 yards downcoast, and 25 yards upcoast. When flow was absent, a sample was collected 25 yards downcoast.

Samples were collected in ankle-deep water, with the mouth of the sterile bottle facing an incoming wave but away from both the sampler and ocean bottom. After the sample was taken, the bottle was tightly capped and promptly stored on ice in the dark. The occurrence and size of any grease particles at the high tide line were also recorded. Laboratory analysis of FIB samples began within 6 hours of collection.

Laboratory Methods

Laboratory analyses of NH3-N and bacteriology samples followed methods listed in Table A-1. Quality assurance/quality control (QA/QC) procedures included analysis of laboratory blanks and duplicates. All data underwent at least 3 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 (2017b) and third party (IGODS 2012) software. The steps included retaining downcast data and removing potential outliers, i.e. data that 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 data; if there were any missing 1 m depth values, then the upcast data were 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

COP compliance was assessed based on: (1) specific numeric criteria for DO, pH, and 3 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.

<u>Dissolved Oxygen, pH, and Transmissivity</u>

Station locations were defined as either Zone A or Zone B 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). 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, DO, 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

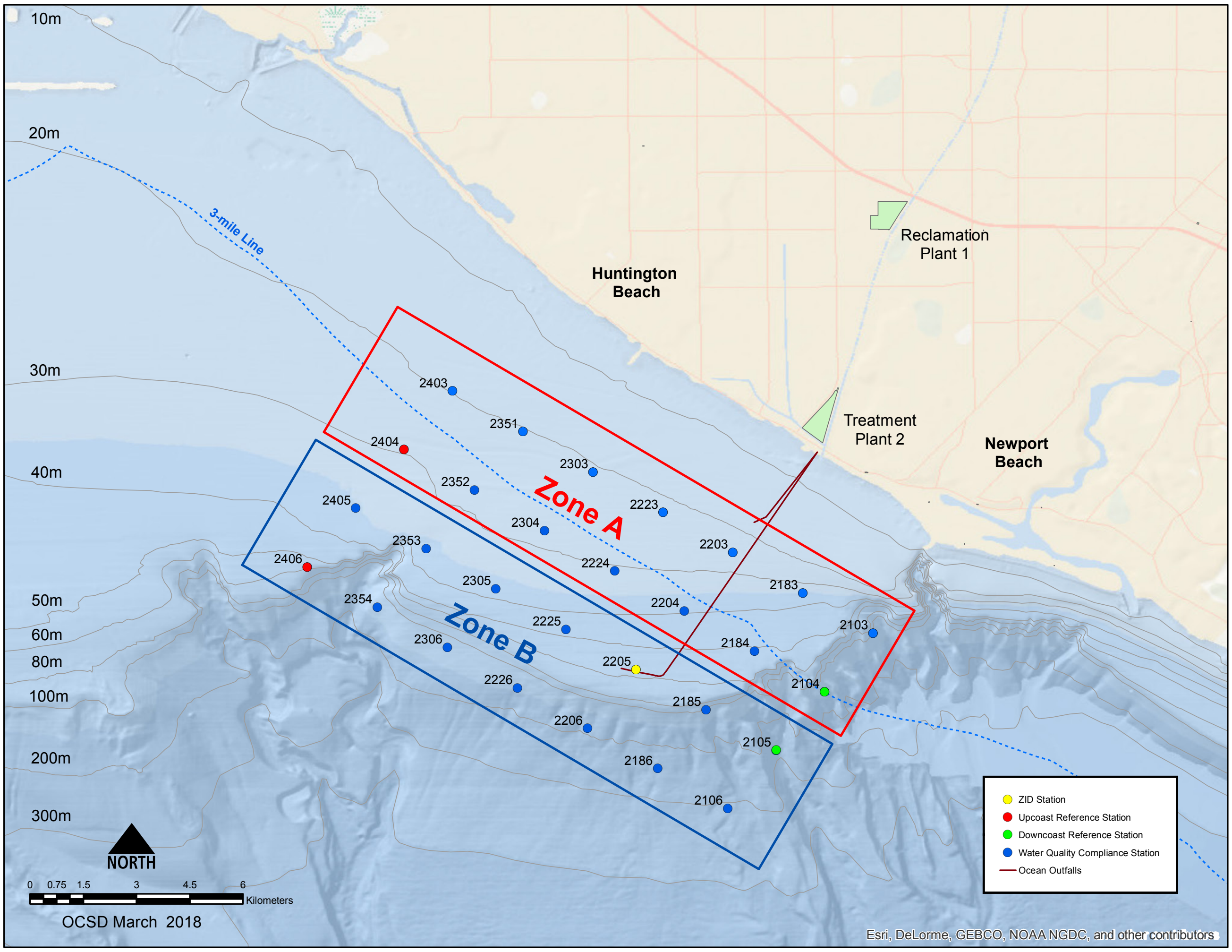

Figure A–1 Offshore water quality monitoring stations and zones used for compliance determinations.

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 was determined based on available current measurements and the presence or absence of typical plume "signals" (e.g., ammonium, FIB, and CDOM). If the choice of a reference station was indeterminate, then the data were 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 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 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, some Zone A stations (e.g., 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 468 possible comparisons if 13 stations (not including the reference station) and 3 strata over 12 survey dates per year are used. For Zone B, 432 comparisons are possible from 12 stations (not including the reference and outfall stations), 3 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. When all of the strata are not present (e.g. below thermocline at shallow stations) 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 (900).

<u>Fecal Indicator Bacteria (FIB)</u>

FIB compliance used corresponding bacterial standards at each REC-1 station and for stations outside the 3-mile state limit. 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 (which 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

These compliance determinations were done based on presence/absence and level of potential effect at each station. Station groupings are shown in Table B-4 and are based on relative distance and direction from the outfall. 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 from 29 semi-annual stations in July 2016 (summer) and in January 2017 (winter), as well as from 39 annual stations in July 2016 (Figure 2-2). In addition, 2–3 L of sediment was collected from Stations 0, 1, 4, 72, 73, 76, 77, CON, and ZB in January 2017 for sediment toxicity testing. Each station was assigned to 1 of 6 station groups: (1) Middle Shelf Zone 1 (31–50 m); (2) Middle Shelf Zone 2, within-ZID (51–90 m); (3) Middle Shelf Zone 2, non-ZID (51–90 m); (4) Middle Shelf Zone 3 (91–120 m); (5) Outer Shelf (121–200 m); and (6) Upper Slope/Canyon (201–500 m). In Chapter 2, the Middle Shelf Zone 2, within- and non-ZID station groups are simply referred to as within-ZID and non-ZID stations, respectively.

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*. All sediment samples were qualitatively and quantitatively assessed for acceptability prior to processing. Samples were deemed acceptable if they had a minimum depth of 5 cm. However, if 3 consecutive sediment grabs each yielded a depth of <5 cm at a station, then the depth threshold was lowered to ≤4 cm. The top 2 cm of the sample was transferred into containers using a stainless steel scoop (Table A-2). The sampler and scoop were rinsed thoroughly with filtered seawater prior to sample collection. All sediment samples were transported on wet ice to the laboratory. Sample storage and holding times followed specifications in the District's Laboratory, Monitoring, and Compliance Standard Operating Procedures (LMC SOP) (OCSD 2016; Table A-2).

Table A–2 Sediment collection and analysis summary during 2016-17. * = Available online at: www.epa.gov.

Parameter	Container	Preservation	Holding Time	Method
Dissolved Sulfides	HDPE container	Freeze	6 months	LMC SOP 4500-S G Rev. B
Grain Size	Plastic bag	4° C	6 months	Plumb (1981)
Mercury	Amber glass jar	Freeze	6 months	LMC SOP 245.1B Rev. G
Metals	Amber glass jar	Freeze	6 months	LMC SOP 200.8B_SED Rev. F
Sediment Toxicity	HDPE container	4° C	2 months	LMC SOP 8810
Total Chlorinated Pesticides (ΣPest)	Glass jar	Freeze	6 months	LMC SOP 8000-SPP
Total DDT (ΣDDT)	Glass jar	Freeze	6 months	LMC SOP 8000-SPP
Total Nitrogen (TN)	Glass jar	Freeze	6 months	EPA 351.2M and 353.2M*
Total Organic Carbon (TOC)	Glass jar	Freeze	6 months	ASTM D4129-05*
Total Phosphorus (TP)	Glass jar	Freeze	6 months	EPA 6010B*
Total Polychlorinated Biphenyls (ΣPCB)	Glass jar	Freeze	6 months	LMC SOP 8000-SPP
Total Polycyclic Aromatic Hydrocarbons (ΣPAH)	Glass jar	Freeze	6 months	LMC SOP 8000-PAH

Laboratory Methods

Sediment grain size, total organic carbon, total nitrogen, and total phosphorus samples were subsequently transferred to local and interstate laboratories for analysis (see Appendix C). Sample transfers were conducted and documented using required chain of custody protocols through the Laboratory Information Management Systems (LIMS) software. All other analyses were conducted by District lab staff.

Sediment chemistry and grain size samples were processed and analyzed using the methods listed in Table A-2. The measured sediment chemistry parameters are listed in Table A-3. Method blanks, analytical quality control samples (duplicates, matrix spikes, and blank spikes), and standard reference materials were prepared and analyzed with each sample batch. Total polychlorinated biphenyls (ΣPCB) and total polycyclic aromatic hydrocarbons (ΣPAH) were calculated by summing the measured value of each respective constituent listed in Table A-3. Total dichlorodipheynltrichloroethane (ΣDDT) represents the summed values of 4,4'-DDMU and the 2,4- and 4,4'-isomers of DDD, DDE, and DDT,

Table A–3 Parameters measured in sediment samples during 2016-17.

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

and total chlorinated pesticides (ΣPest) represents the summed values of 13 chlordane derivative compounds plus dieldrin.

Sediment toxicity was conducted using the 10-day *Eohaustorius estuarius* amphipod survival test (EPA 1994b). Amphipods were exposed to test and home (control) sediments, and the percent survival in each was determined.

Data Analyses

All analytes that were undetected (i.e., value below the method detection limit) are reported as ND (not detected). Further, an ND value was treated as zero for calculating a mean analyte concentration; however, if a station group contained all ND for a particular analyte, then the mean analyte concentration is reported as ND. Sediment contaminant concentrations were evaluated against sediment quality guidelines known as Effects Range-Median (ERM) (Long et al. 1998). The ERM guidelines were developed for the National Oceanic and Atmospheric Administration (NOAA) National Status and Trends Program (NOAA 1993) as non-regulatory benchmarks to aid in the interpretation of sediment chemistry data and to complement toxicity, bioaccumulation, and benthic community assessments (Long and MacDonald 1998). The ERM is the 50th percentile sediment concentration above which a toxic effect frequently occurs (Long et al. 1995), and as such, an ERM exceedance is considered a significant potential for adverse biological effects. Bight'13 sediment geochemistry data (Dodder et al. 2016) were also used as benchmarks. Data analysis consisted of summary statistics and qualitative comparisons only.

Toxicity threshold criteria applied in this report were consistent with those of the Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality (Bay et al. 2009, SWRCB 2009). Stations with statistically different ($p<0.05$) survival rates when compared to the control, determined by a two-sample t-test, were categorized as nontoxic 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 with no statistically different ($p>0.05$) survival rates when compared to the control were categorized as nontoxic when survival was 82–100% of the control and lowly toxic when survival was 59–81% of the control. Any station exhibiting survival less than 59% of the control was categorized as highly toxic.

BENTHIC INFAUNA MONITORING

Field Methods

A paired, 0.1 m^2 Van Veen grab sampler deployed from the M/V *Nerissa* was used to collect a sediment sample from 29 semi-annual stations in July 2016 (summer) and in January 2017 (winter), as well as from 39 annual stations in July 2017 (Figure 2-2). As the January 2017 sample from within-ZID Station 0 yielded only 9 individuals and no polychaete taxa (historically, >300 individuals, mostly comprised of polychaetes, are collected at this station), 2 additional infauna samples were collected in March 2017 from Station 0. The purpose of the semi-annual surveys was to determine long-term trends and potential effects along the 60-m depth contour, while the annual survey was conducted primarily to assess the spatial extent of the influence of the effluent discharge. Each station was assigned to 1 of 6 depth categories as described above in the sediment geochemistry field methods section.

All sediment samples were qualitatively and quantitatively assessed for acceptability prior to processing as described above in the sediment geochemistry field methods section. At each station, acceptable sediment in the sampler was emptied into a 63.5 cm × 45.7 cm × 20.3 cm (25 in × 18 in × 8 in) plastic tray and then decanted onto a sieving table whereupon a hose with a fan spray nozzle was used to gently wash the sediment with filtered seawater through a 40.6 cm × 40.6 cm (16 in × 16 in), 1.0 mm sieve. Organisms retained on the sieve were rinsed with 7% magnesium sulfate anesthetic into one or more 1 L plastic containers and then placed in a cooler containing ice packs. After approximately 30 minutes in the anesthetic, animals were fixed by adding full strength buffered formaldehyde to the container to achieve a 10%, by volume, solution. Samples were transported to the District's laboratory for further processing.

Laboratory Methods

After 3–10 days in formalin, samples were rinsed with tap water and then transferred to 70% ethanol for long-term preservation. Samples were sent to Marine Taxonomic Services, Inc. (San Marcos, CA) to be sorted to 5 major taxonomic groups (aliquots), Annelida, (worms), Mollusca (snails, clams, etc.), Arthropoda (shrimps, crabs, etc.), Echinodermata (sea stars, sea urchins, etc.), and miscellaneous phyla (Cnidaria, Nemertea, etc.). Removal of organisms 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 (Table A-4). Taxonomic differences were resolved and the database was edited accordingly (see Appendix C). Species names used in this report follow those given in Cadien and Lovell (2016).

Table A–4 Benthic infauna taxonomic aliquot distribution for 2016-17.

Quarter	Survey (No. of samples)	Taxonomic Aliquots	Contractor	OCSD
Summer 2016	Annual (39)	Annelida	0	39
		Arthropoda	0	39
		Echinodermata	0	39
		Mollusca	20	19
		Miscellaneous Phyla	0	39
	Semi-annual (29)	Annelida	0	29
		Arthropoda	29	0
		Echinodermata	29	0
		Mollusca	29	0
		Miscellaneous Phyla	29	0
Winter 2017	March (2)	Annelida	1	1
		Arthropoda	0	2
		Echinodermata	0	2
		Mollusca	0	2
		Miscellaneous Phyla	0	2
	Semi-annual (29)	Annelida	5	24
		Arthropoda	29	0
		Echinodermata	29	0
		Mollusca	0	29
		Miscellaneous Phyla	0	29
		Totals	**200**	**295**

Data Analyses

Since the January 2017 sample from Station 0 was determined to be an anomaly based on the low infauna abundance (n=9) as well as the absence of polychaete taxa, sediment toxicity (see Chapter 2), and threshold exceedances in sediment chemistry parameters (see Chapter 2), the first sample (of two) taken from Station 0 in March 2017 was analyzed along with that from the other stations as described below.

Infaunal community data were analyzed to determine if populations outside the ZID were affected by the outfall discharge. Six community 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 $\log_e$ (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 ITI and BRI were not calculated for stations >200 m in depth following recommendations provided by Word (1978) and Ranasinghe et al. (2012), respectively. 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 District's historical infauna data from the past 10 monitoring periods, as well as Bight'13 infauna data (Gillett et al. 2017), were also used as benchmarks.

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., *Amphiodia urtica* (brittlestar) and amphipod crustaceans 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* Cmplx (polychaete), 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 v7 (2015) multivariate statistical software was also used to examine the spatial patterns of infaunal invertebrate communities at the Middle Shelf Zone 2 stations. The other stations were excluded from the analyses, as Clarke and Warwick (2014) advocated that clustering is less useful and may be misleading where there is a strong environmental forcing, such as depth. Analyses included (1) hierarchical clustering with group-average linking based on Bray-Curtis similarity indices and similarity profile (SIMPROF) permutation tests of the clusters and (2) ordination of the same data using non-metric multidimensional scaling (nMDS) to confirm hierarchical clustering. 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 to incorporate the less common species (Clarke and Warwick 2014).

TRAWL COMMUNITIES MONITORING

Field Methods

Demersal fishes and epibenthic macroinvertebrates (EMIs) were collected by trawling in July and August, 2016 (summer) and in February 2017 (winter). Sampling was conducted at 15 stations: Inner Shelf (18 m) Station T0; Middle Shelf Zone 1 (36 m) Stations T2, T24, T6, and T18; Middle Shelf Zone 2 (60 m) Stations T23, T22, T1, T12, T17, and T11; and Outer Shelf (137 m) Stations T10, T25, T14, and T19 (Figure 2-3). Only Middle Shelf Zone 2 stations were sampled in both summer and winter; the remaining stations were sampled in summer only. Station T0 was sampled to maintain the long-term abundance records of fishes and EMIs at this site. Data for this historical station are not discussed in this report, however.

A minimum of 1 trawl was conducted from the M/V *Nerissa* at each station using a 7.6 m (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 trawl QA/QC methods for southern California were used (see Appendix C). Station locations and trawling speeds and paths were determined using Global Positioning System (GPS) navigation. Trawl depths were determined using a Sea-Bird Electronics SBE 39 pressure sensor attached to one of the trawl boards.

Upon retrieval of the trawl net, the contents (fishes and EMIs) were 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 Fish Tissue Contaminants Monitoring and Fish Health Monitoring sections below). The remaining fish specimens were processed as follows: (1) a minimum of 15 arbitrarily 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. For each invertebrate species with large abundances (n>100), 100 individuals were counted and batch weighed; the remaining individuals were batch weighed and enumerated later by back calculating using the weight of the first 100 individuals. EMI specimens that could not be identified in the field were preserved in 10% buffered formalin for subsequent laboratory analysis.

Laboratory Methods

After 3–10 days in formalin, the EMI specimens retained for further taxonomic scrutiny were rinsed with tap water and then transferred to 70% ethanol for long-term preservation. These EMIs were identified using relevant taxonomic keys and, in some cases, were compared to voucher specimens housed in the District's Taxonomy Lab. Species and common names used in this report follow those given in Page et al. (2013) and Cadien and Lovell (2016).

Data Analyses

Total number of species, total abundance, biomass, H′, and SDI 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). The District's historical trawl EMI and fish data from the past 10 monitoring periods, as well as Bight'13 trawl data (Walther et al. 2017), were also used as benchmarks.

PRIMER v.7 (2015) multivariate statistical software was used to examine the spatial patterns of the fish and EMI assemblages at the Middle Shelf Zone 2 stations. The other stations were excluded from the analyses, as Clarke and Warwick (2014) advised that clustering is less useful and may be misleading where there is a strong environmental forcing, such as depth. Analyses included (1) hierarchical clustering with group-average linking based on Bray-Curtis similarity indices and similarity profile (SIMPROF) permutation tests of the clusters and (2) ordination of the same data using non-metric multidimensional scaling (nMDS) to confirm hierarchical clustering. Prior to the calculation of the Bray-Curtis indices, the data were square root transformed in order to down-weight the highly abundant species and incorporate the importance of the less common species (Clarke and Warwick 2014).

Middle Shelf Zone 2 stations were grouped into the following categories to assess spatial, outfall-related patterns: "outfall" (Stations T22 and T1) and "non-outfall" (Stations T23, T12, T17, and T11).

FISH TISSUE CONTAMINANTS MONITORING

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).

Demersal fishes in the Scorpaenidae (e.g., California Scorpionfish and Vermilion Rockfish) and Serranidae (e.g., Kelp Bass and Sand Bass) were targeted, as they are frequently caught and consumed by recreational anglers. As such, contaminants in the muscle tissue of these 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 non-outfall (T11) stations during the July 2016 trawl survey. Likewise, 10 individuals in total of scorpaenid and serranid fishes were targeted at the outfall (Zone 1) and non-outfall (Zone 3) areas using hook-and-line fishing gear ("rig-fishing") in September 2016 (Figure 2-3).

Each fish collected for bioaccumulation analysis was weighed to the nearest gram and its standard length measured to the nearest millimeter; placed in pre-labelled, plastic, re-sealable bags; and stored on wet ice in an insulated cooler. Bioaccumulation samples were subsequently transported under chain of custody protocols to the District's laboratory. Sample storage and holding times for bioaccumulation analyses followed specifications in the District's LMC SOP (OCSD 2016; Table A-5).

Table A–5 Fish tissue handling and analysis summary during 2016-17. * = Available online at www.epa.gov; N/A = Not Applicable.

Parameter	Container	Preservation	Holding Time	Method
Arsenic and Selenium	Ziplock bag	Freeze	6 months	LMC SOP 200.8B SED Rev. F
Organochlorine Pesticides	Ziplock bag	Freeze	6 months	NS&T (NOAA 1993); EPA 8270*
DDTs	Ziplock bag	Freeze	6 months	NS&T (NOAA 1993); EPA 8270*
Lipids	Ziplock bag	Freeze	N/A	EPA 9071*
Mercury	Ziplock bag	Freeze	6 months	LMC SOP 245.1B Rev. G
Polychlorinated Biphenyls	Ziplock bag	Freeze	6 months	NS&T (NOAA 1993); EPA 8270*

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-6 using methods shown in Table A-5. Method blanks, analytical quality control samples (duplicates, matrix spikes, and blank spikes), and standard reference materials were prepared and analyzed with each sample batch. All reported concentrations are on a wet weight basis.

Total dichlorodipheynltrichloroethane (ΣDDT) represents the summed values of 2,4- and 4,4'-isomers of DDD, DDE, and DDT and 4,4'-DDMU, total polychlorinated biphenyls (ΣPCB) represents the summed values of 44 congeners, and total chlordane (ΣChlordane) represents the sum of 7 derivative

Table A–6 Parameters measured in fish tissue samples during 2016-17. * = Analyzed only in rig-fish specimens.

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

compounds (*cis*- and *trans*-chlordane, *cis*- and *trans*-nonachlor, heptachlor, heptachlor epoxide, and oxychlordane). Organic contaminant data were not lipid normalized.

Data Analyses

All analytes that were undetected (i.e., value below the method detection limit) are reported as not detected (ND). Further, an ND value was treated as zero for calculating a mean analyte concentration; however, if fish tissue samples had all ND for a particular analyte, then the mean analyte concentration is reported as ND. Data analysis consisted of summary statistics (i.e., means and ranges) and qualitative comparisons only.

The U.S. Food and Drug Administration (FDA) action levels and the State of California Office of Environmental Health Hazard Assessment (OEHHA) advisory tissue levels (ATLs) for ΣDDT, ΣPCB, methylmercury, dieldrin and ΣChlordane were used to assess human health risk in rig-caught fish (Klasing and Brodberg 2008, FDA 2011).

Analysis of bioaccumulation data consisted of summary statistics and qualitative comparisons only.

FISH HEALTH MONITORING

Assessment of the overall health of fish populations is also required by the NPDES permit. This entails documenting physical symptoms of disease in fish samples collected during each monitoring period, as well as conducting liver histopathology analysis once every 5 years (starting from June 15, 2012, the issue date of the current NPDES permit).

Field Methods

All trawl fish samples collected during the 2016-17 monitoring period were visually inspected for lesions, tumors, large, non-mobile external parasites, and other signs (e.g., skeletal deformities) of disease. Any atypical odor and coloration of fish samples were also noted. No fish samples were collected for liver histopathology analysis, as this analysis was conducted during the 2015-16 monitoring period (OCSD 2017).

Data Analyses

Analysis of fish disease data consisted of qualitative comparisons only.

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APPENDIX B
Supporting Data

Table B–1 Depth-averaged total coliform bacteria (MPN/100 mL) collected in offshore waters and used for comparison with California Ocean Plan Water-Contact (REC-1) compliance criteria, July 2016 through June 2017.

Station	Date					Meets 30-day Geometric Mean of ≤1000/100mL	Meets Single Sample Standard of ≤10,000/100mL	Meets Single Sample Standard of ≤1000/100mL *
	7/19/2016	**7/20/2016**	**7/21/2016**	**8/2/2016**	**8/3/2016**			
2103	<10	<10	<10	<10	<10	YES	YES	YES
2104	<10	<10	<10	<10	<10	YES	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	10/18/2016	**10/19/2016**	**10/20/2016**	**11/1/2016**	**11/2/2016**			
2103	21	16	11	<10	15	YES	YES	YES
2104	26	10	11	<10	44	YES	YES	YES
2183	16	14	16	<10	<10	YES	YES	YES
2203	26	11	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	60	<10	<10	YES	YES	YES
	2/8/2017	**2/14/2017**	**2/28/2017**	**3/1/2017**	**3/2/2017**			
2103	17	13	25	13	32	YES	YES	YES
2104	11	13	13	24	76	YES	YES	YES
2183	11	21	32	<10	19	YES	YES	YES
2203	10	16	28	<10	15	YES	YES	YES
2223	<10	10	21	<10	<10	YES	YES	YES
2303	<10	11	14	<10	10	YES	YES	YES
2351	<10	18	10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	4/18/2017	**4/19/2017**	**4/20/2017**	**5/8/2017**	**5/10/2017**			
2103	<10	12	10	<10	<10	YES	YES	YES
2104	19	43**	16	<10	<10	YES	YES	YES**
2183	12	11	11	<10	<10	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	12	YES	YES	YES

* Standard is based on when the single sample maximum fecal coliform/total coliform ratio >0.1.
** Depths combined, meet single sample standard (4/19/17).

Table B–2 Depth-averaged fecal coliform bacteria (MPN/100 mL) collected in offshore waters and used for comparison with California Ocean Plan Water-Contact (REC-1) compliance criteria, July 2016 through June 2017.

Station	Date					Meets 30-day Geometric Mean ≤200/100mL	Meets single sample standard of ≤400/100mL
	7/19/2016	**7/20/2016**	**7/21/2016**	**8/2/2016**	**8/3/2016**		
2103	<10	<10	<10	<10	<10	YES	YES
2104	<10	<10	<10	<10	<10	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES
	10/18/2016	**10/19/2016**	**10/20/2016**	**11/1/2016**	**11/2/2016**		
2103	12	11	<10	<10	<10	YES	YES
2104	14	<10	<10	<10	24	YES	YES
2183	<10	10	<10	<10	<10	YES	YES
2203	17	<10	<10	<10	<10	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES
2403	<10	<10	14	<10	<10	YES	YES
	2/8/2017	**2/14/2017**	**2/28/2017**	**3/1/2017**	**3/2/2017**		
2103	<10	<10	10	10	20	YES	YES
2104	<10	10	<10	13	27	YES	YES
2183	<10	13	16	<10	10	YES	YES
2203	<10	<10	10	<10	12	YES	YES
2223	<10	<10	11	<10	<10	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES
2351	<10	11	<10	<10	<10	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES
	4/18/2017	**4/19/2017**	**4/20/2017**	**5/8/2017**	**5/10/2017**		
2103	<10	10	<10	<10	<10	YES	YES
2104	11	21*	10	<10	<10	YES	YES*
2183	<10	<10	<10	<10	<10	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES

* Depths combined, meet single sample standard (4/19/17).

Table B–3 Depth-averaged enterococci bacteria (MPN/100mL) collected in offshore waters and used forcomparison with California Ocean Plan Water-Contact (REC-1) compliance criteria and EPA Primary Recreation Criteria in Federal Waters, July 2016 through June 2017.

Station	Date					Meets COP 30-day Geometric Mean of ≤35/100 mL	Meets COP single sample standard of ≤104/100 mL	Meets EPA single sample standard of ≤501/100 mL*
	7/19/2016	**7/20/2016**	**7/21/2016**	**8/2/2016**	**8/3/2016**			
2103	<10	<10	<10	<10	<10	YES	YES	YES
2104	<10	<10	<10	<10	<10	YES	YES	YES
2183	<10	<10	10	<10	12	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	10/18/2016	**10/19/2016**	**10/20/2016**	**11/1/2016**	**11/2/2016**			
2103	<10	<10	<10	<10	<10	YES	YES	YES
2104	<10	<10	<10	<10	10	YES	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	2/8/2017	**2/14/2017**	**2/28/2017**	**3/1/2017**	**3/2/2017**			
2103	<10	<10	<10	<10	10	YES	YES	YES
2104	<10	<10	<10	<10	<10	YES	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES	YES
2203	10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	4/18/2017	**4/19/2017**	**4/20/2017**	**5/8/2017**	**5/10/2017**			
2103	<10	<10	<10	<10	<10	YES	YES	YES
2104	<10	14**	<10	<10	<10	YES	YES**	YES
2183	<10	<10	<10	<10	<10	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	15	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES

* Standard is based on area of infrequent use.

** Depths combined, meet single sample standard (4/19/17).

Table B–4 Summary of floatable material by station group observed during the 28-station grid water quality surveys, July 2016 through June 2017. Total number of station visits = 336.

Surface Observation	Station Group							Totals
	Upcoast Offshore 2225, 2226 2305, 2306 2353, 2354 2405, 2406	Upcoast Nearshore 2223, 2224 2303, 2304 2351, 2352 2403, 2404	Nearfield Offshore 2206	Within ZID 2205	Nearfield Nearshore 2203, 2204	Downcoast Offshore 2105, 2106 2185, 2186	Downcoast Nearshore 2103, 2104 2183, 2184	
Oil and Grease	0	0	0	0	0	0	0	0
Trash/Debris	2	2	0	0	0	1	0	5
Biological Material (kelp)	0	0	0	0	0	1	0	1
Material of Sewage Origin	0	0	0	0	0	0	0	0
Totals	2	2	0	0	0	2	0	6

Table B–5 Summary of floatable material by station group observed during the REC-1 water quality surveys, July 2016 through June 2017. Total number of station visits = 108.

Surface Observation	Station Groups				Totals
	Upcoast Nearshore 2223, 2303 2351, 2403	Within ZID 2205	Nearfield Nearshore 2203	Downcoast Nearshore 2103, 2104, 2183	
Oil and Grease	0	0	0	0	0
Trash/Debris	0	0	0	1	1
Biological Material (kelp)	0	0	0	0	0
Material of Sewage Origin	0	0	0	0	0
Totals	0	0	0	1	1

Table B–6 Summary of monthly Core COP water quality compliance parameters by season and depth strata, July 2016 to June 2017.

Depth Strata (m)	Summer				Fall				Winter				Spring				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Dissolved Oxygen (mg/L)																				
1-15	7.02	7.88	8.78	0.24	6.23	7.63	8.36	0.29	6.39	7.77	8.32	0.23	4.18	8.34	10.53	1.05	4.18	7.91	10.53	0.63
16-30	5.63	7.68	8.95	0.63	5.63	6.75	7.94	0.56	4.52	7.43	8.07	0.61	3.57	5.82	9.41	1.47	3.57	6.92	9.41	1.15
31-45	4.81	6.21	8.40	0.65	4.97	5.98	7.31	0.44	4.28	6.50	7.83	0.90	3.39	4.25	6.27	0.41	3.39	5.73	8.40	1.08
45-60	4.50	5.33	6.55	0.39	4.85	5.54	6.45	0.32	4.18	5.31	7.18	0.68	3.16	3.78	4.46	0.30	3.16	4.99	7.18	0.84
61-75	4.19	4.85	5.72	0.28	4.66	5.20	5.83	0.25	3.97	4.73	5.60	0.42	2.97	3.57	4.09	0.28	2.97	4.59	5.83	0.69
All	4.19	6.83	8.95	1.26	4.66	6.53	8.36	0.97	3.97	6.77	8.32	1.24	2.97	5.76	10.53	2.11	2.97	6.47	10.53	1.52
pH																				
1-15	7.92	8.03	8.13	0.05	7.81	7.99	8.09	0.05	7.93	8.09	8.22	0.08	7.99	8.21	8.30	0.06	7.81	8.08	8.30	0.10
16-30	7.74	7.95	8.11	0.05	7.68	7.88	8.05	0.09	7.81	8.07	8.20	0.09	7.69	8.02	8.26	0.11	7.68	7.98	8.26	0.12
31-45	7.65	7.81	8.00	0.07	7.62	7.79	8.00	0.10	7.76	8.02	8.20	0.10	7.65	7.83	8.04	0.08	7.62	7.86	8.20	0.13
45-60	7.62	7.72	7.84	0.05	7.60	7.73	7.90	0.09	7.74	7.92	8.11	0.10	7.60	7.75	7.88	0.09	7.60	7.78	8.11	0.12
61-75	7.57	7.66	7.75	0.04	7.57	7.69	7.85	0.09	7.73	7.84	8.01	0.09	7.58	7.72	7.84	0.09	7.57	7.73	8.01	0.11
All	7.57	7.88	8.13	0.15	7.57	7.85	8.09	0.14	7.73	8.02	8.22	0.13	7.58	7.97	8.30	0.21	7.57	7.93	8.30	0.17
Light Transmissivity (%)																				
1-15	70.81	82.80	87.31	2.26	71.04	83.03	87.55	2.88	69.66	83.14	87.75	2.99	45.99	81.12	86.25	3.39	45.99	82.52	87.75	3.02
16-30	71.09	82.81	87.36	2.75	77.89	84.85	88.58	2.19	71.51	84.43	87.74	2.24	35.68	80.22	88.58	6.18	35.68	83.08	88.58	4.15
31-45	73.65	85.32	87.70	1.69	82.28	87.09	88.83	1.08	78.68	86.27	88.98	1.63	73.49	86.64	89.08	1.97	73.49	86.33	89.08	1.75
45-60	82.07	86.95	88.70	1.21	85.03	87.58	88.93	0.79	79.01	86.83	89.24	2.00	84.83	87.43	89.38	1.08	79.01	87.20	89.38	1.38
61-75	81.22	87.49	88.86	1.33	84.60	87.68	88.94	0.83	81.95	87.09	89.34	1.58	81.54	87.62	89.50	1.42	81.22	87.47	89.50	1.34
All	70.81	84.37	88.86	2.83	71.04	85.41	88.94	2.77	69.66	85.01	89.34	2.78	35.68	83.50	89.50	5.00	35.68	84.57	89.50	3.56
*Ammonium (mg/L)**																				
1-15	0.015	0.015	0.026	0.001	0.015	0.015	0.015	0.000	0.015	0.015	0.077	0.005	0.015	0.015	0.033	0.002	0.015	0.015	0.077	0.003
16-30	0.015	0.016	0.035	0.003	0.015	0.016	0.062	0.006	0.015	0.015	0.030	0.002	0.015	0.019	0.066	0.009	0.015	0.016	0.066	0.006
31-45	0.015	0.017	0.083	0.012	0.015	0.022	0.119	0.022	0.015	0.033	0.257	0.041	0.015	0.024	0.135	0.023	0.015	0.024	0.257	0.027
45-60	0.015	0.018	0.065	0.009	0.015	0.024	0.123	0.022	0.015	0.030	0.136	0.027	0.015	0.026	0.234	0.035	0.015	0.024	0.234	0.025
61-75	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
All	0.015	0.016	0.083	0.006	0.015	0.018	0.123	0.013	0.015	0.020	0.257	0.020	0.015	0.019	0.234	0.018	0.015	0.018	0.257	0.016

* Ammonium values below MDL (0.02 mg/L) were adjusted to 75% of MDL (0.015 mg/L).
ns = Not Sampled.

Table B–7 Species richness and abundance values of the major taxonomic groups collected at each depth stratum and season during the 2016-17 infauna survey. Values represent the mean and range (in parentheses).

Season	Parameter	Stratum	Annelida	Arthropoda	Echinodermata	Misc. Phyla	Mollusca
Summer	Number of Species	Middle Shelf Zone 1 (31-50)	49 (36-70)	15 (8-24)	4 (2-7)	7 (1-10)	12 (6-14)
		Middle Shelf Zone 2, Within-ZID (51-90)	56 (47-64)	15 (8-22)	4 (2-5)	5 (3-8)	11 (8-13)
		Middle Shelf Zone 2, Non-ZID (51-90)	51 (29-69)	13 (4-22)	3 (1-6)	5 (1-9)	11 (1-17)
		Middle Shelf Zone 3 (91-120)	39 (32-47)	8 (3-15)	2 (1-4)	3 (0-6)	9 (5-15)
		Outer Shelf (121-200)	16 (12-20)	2 (0-8)	2 (1-3)	1 (0-2)	8 (6-12)
		Upper Slope/Canyon (201-500)	10 (6-13)	2 (0-5)	1 (0-2)	0 (0-1)	6 (3-9)
	Abundance	Middle Shelf Zone 1 (31-50)	240 (136-430)	38 (18-53)	13 (2-30)	26 (1-68)	32 (7-53)
		Middle Shelf Zone 2, Within-ZID (51-90)	307 (205-450)	29 (14-37)	8 (5-11)	9 (4-15)	20 (9-38)
		Middle Shelf Zone 2, Non-ZID (51-90)	281 (117-615)	25 (10-50)	14 (2-36)	8 (1-15)	24 (1-52)
		Middle Shelf Zone 3 (91-120)	138 (93-172)	16 (8-30)	46 (6-90)	4 (0-10)	33 (22-51)
		Outer Shelf (121-200)	36 (20-59)	2 (0-8)	4 (1-7)	1 (0-2)	21 (15-54)
		Upper Slope/Canyon (201-500)	21 (10-30)	3 (0-8)	2 (0-3)	0 (0-1)	12 (7-17)
Winter	Number of Species	Middle Shelf Zone 2, Within-ZID (51-90)	59 (56-64)	16 (12-18)	5 (4-6)	5 (3-7)	11 (11-12)
		Middle Shelf Zone 2, Non-ZID (51-90)	55 (44-66)	13 (7-20)	4 (2-10)	6 (1-12)	11 (5-17)
	Abundance	Middle Shelf Zone 2, Within-ZID (51-90)	221 (197-267)	30 (21-34)	10 (8-11)	7 (5-10)	32 (23-46)
		Middle Shelf Zone 2, Non-ZID (51-90)	255 (155-387)	29 (9-107)	12 (2-52)	8 (2-18)	31 (18-48)

Table B–8 Abundance of epibenthic macroinvertebrates by species and station for the Summer 2016 and Winter 2017 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	**T2**	**T24**	**T6**	**T18**	**T23**		**T22**		**T1**		**T12**		**T17**		**T11**		**T10**	**T25**	**T14**	**T19**		
Nominal Depth	**35**	**36**	**36**	**36**	**58**		**60**		**55**		**57**		**60**		**60**		**137**	**137**	**137**	**137**		
Season	**S**	**S**	**S**	**S**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**S**	**S**	**S**	**Total**	**%**
Ophiura luetkenii	2	1630	1812		13	14	30	1	42	1	4	14	5	1	256	373					4198	58.5
Sicyonia ingentis						5		13		12		8	1	4		8		45	141	507	744	10.4
Strongylocentrotus fragilis																	234	239			473	6.6
Sicyonia penicillata			1	1	20		16	3	6		12	47	5	27	181	67					386	5.4
Hamatoscalpellum californicum	22	12			11	4	34	19	30	6	16	1	20	8	122	51					356	5.0
Lytechinus pictus	1		1		59	50	9	5	18	22	4	7		1	1	1	149	17	4		349	4.9
Thesea sp B	12	52	48		6	10	13	7	26	16	8	14	5	8	28	93					346	4.8
Astropecten californicus	1				6	5	6	6	10	23	3	9	8	14	8	21					120	1.7
Ophiothrix spiculata	1	37	7				2		1	1	1	14				2					66	0.9
Astropecten sp	6	3	10																		19	0.3
Heterogorgia tortuosa			2				3	8					1	1	1	2					18	0.3
Orthopagurus minimus		6				2		1	2	2						1					14	0.2
Octopus rubescens					2		1				1				1	3	1			1	10	0.1
Flabellina iodinea		3	4													1					8	0.1
Neocrangon zacae																		2	1	4	7	0.1
Coryrhynchus lobifrons										2			1		1	2					6	0.1
Flabellina pricei	6																				6	0.1
Apostichopus californicus					1				1							1		2			5	0.1
Ericerodes hemphillii	2	2	1																		5	0.1
Luidia foliolata														1						4	5	0.1
Solenocera mutator																				5	5	0.1
Acanthodoris brunnea		1								2	1										4	0.1
Acanthoptilum sp	2					1			1												4	0.1
Doriopsilla albopunctata										2											2	<0.1
Loxorhynchus crispatus																2					2	<0.1
Neocrangon resima																	1			1	2	<0.1
Platymera gaudichaudii									1							1					2	<0.1
Pleurobranchaea californica												1						1			2	<0.1
Rossia pacifica																				2	2	<0.1
Armina californica											1										1	<0.1
Astropecten armatus				1																	1	<0.1
Doryteuthis opalescens																				1	1	<0.1
Lamellaria diegoensis																1					1	<0.1
Luidia asthenosoma												1									1	<0.1
Moreiradromia sarraburei		1																			1	<0.1
Muricidae															1						1	<0.1
Octopus californicus																				1	1	<0.1
Paguristes bakeri																1					1	<0.1
Paguristes turgidus								1													1	<0.1
Phimochirus californiensis										1											1	<0.1
Pleuroncodes planipes																		1			1	<0.1
Pteropurpura festiva															1						1	<0.1
Pyromaia tuberculata		1																			1	<0.1
Tritonia festiva																1					1	<0.1
Total Abundance	**55**	**1748**	**1886**	**2**	**118**	**91**	**114**	**64**	**138**	**90**	**51**	**116**	**46**	**65**	**601**	**632**	**385**	**307**	**146**	**526**	**7181**	**100**
Total No. of Species	**10**	**11**	**9**	**2**	**8**	**8**	**9**	**10**	**11**	**12**	**10**	**10**	**8**	**9**	**11**	**19**	**4**	**7**	**3**	**9**	**44**	

Table B–9 Biomass (kg) of epibenthic macroinvertebrates by station and species for the Summer 2016 and Winter 2017 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	**T2**	**T24**	**T6**	**T18**	**T23**		**T22**		**T1**		**T12**		**T17**		**T11**		**T10**	**T25**	**T14**	**T19**		
Nominal Depth	**35**	**36**	**36**	**36**	**58**		**60**		**55**		**57**		**60**		**60**		**137**	**137**	**137**	**137**		
Season	**S**	**S**	**S**	**S**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**S**	**S**	**S**	**Total**	**%**
Strongylocentrotus fragilis																	6.810	9.620			16.430	42.3
Sicyonia ingentis						0.006		0.024		0.015		0.008	0.001	0.009		0.007		0.698	1.348	4.810	6.926	17.8
Sicyonia penicillata			0.013	0.019	0.400		0.280	0.093	0.103		0.013	1.068	0.110	0.618	2.948	0.848					6.513	16.8
Ophiura luetkenii	0.001	1.158	1.648		0.008	0.007	0.011	0.001	0.039	0.001	0.001	0.006	0.001	0.001	0.290	0.366					3.539	9.1
Apostichopus californicus					0.440				0.393							0.478		1.148			2.459	6.3
Lytechinus pictus	0.001		0.002		0.050	0.066	0.015	0.008	0.019	0.026	0.001	0.001		0.001	0.001	0.001	0.500	0.075	0.014		0.781	2.0
Platymera gaudichaudii									0.220							0.238					0.458	1.2
Octopus californicus																				0.445	0.445	1.1
Octopus rubescens					0.030		0.030				0.018				0.008	0.106	0.050			0.035	0.277	0.7
Astropecten californicus	0.004				0.010	0.008	0.011	0.005	0.018	0.021	0.003	0.023	0.014	0.021	0.014	0.061					0.213	0.5
Luidia foliolata														0.007						0.200	0.207	0.5
Thesea sp B	0.008	0.035	0.022		0.004	0.003	0.006	0.002	0.020	0.008	0.004	0.008	0.005	0.005	0.014	0.043					0.187	0.5
Hamatoscalpellum californicum	0.003	0.007			0.001	0.001	0.003	0.003	0.006	0.001	0.001	0.001	0.002	0.001	0.110	0.008					0.148	0.4
Pleurobranchaea californica												0.001						0.055			0.056	0.1
Doryteuthis opalescens																				0.055	0.055	0.1
Ophiothrix spiculata	0.001	0.009	0.002				0.002		0.001	0.001	0.001	0.005				0.001					0.023	0.1
Pleuroncodes planipes																		0.018			0.018	<0.1
Solenocera mutator																				0.013	0.013	<0.1
Heterogorgia tortuosa			0.003				0.001	0.003					0.001	0.001	0.001	0.001					0.011	<0.1
Orthopagurus minimus		0.001				0.001		0.001	0.001	0.006						0.001					0.011	<0.1
Rossia pacifica																				0.011	0.011	<0.1
Astropecten armatus				0.010																	0.010	<0.1
Pteropurpura festiva															0.010						0.010	<0.1
Astropecten sp	0.001	0.001	0.003																		0.005	<0.1
Acanthodoris brunnea		0.001								0.002	0.001										0.004	<0.1
Coryrhynchus lobifrons										0.001			0.001		0.001	0.001					0.004	<0.1
Acanthoptilum sp	0.001					0.001			0.001												0.003	<0.1
Ericerodes hemphillii	0.001	0.001	0.001																		0.003	<0.1
Flabellina iodinea		0.001	0.001													0.001					0.003	<0.1
Neocrangon zacae																		0.001	0.001	0.001	0.003	<0.1
Neocrangon resima																	0.001			0.001	0.002	<0.1
Paguristes bakeri																0.002					0.002	<0.1
Tritonia festiva																0.002					0.002	<0.1
Armina californica											0.001										0.001	<0.1
Doriopsilla albopunctata										0.001											0.001	<0.1
Flabellina pricei	0.001																				0.001	<0.1
Lamellaria diegoensis																0.001					0.001	<0.1
Loxorhynchus crispatus																0.001					0.001	<0.1
Luidia asthenosoma												0.001									0.001	<0.1
Moreiradromia sarraburei		0.001																			0.001	<0.1
Muricidae															0.001						0.001	<0.1
Paguristes turgidus								0.001													0.001	<0.1
Phimochirus californiensis										0.001											0.001	<0.1
Pyromaia tuberculata		0.001																			0.001	<0.1
Total Biomass	**0.022**	**1.216**	**1.695**	**0.029**	**0.943**	**0.093**	**0.359**	**0.141**	**0.821**	**0.084**	**0.044**	**1.122**	**0.135**	**0.664**	**3.398**	**2.167**	**7.361**	**11.615**	**1.363**	**5.571**	**38.843**	**100**

Table B–10 Abundance of demersal fishes by station and species for the Summer 2016 and Winter 2017 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer shelf					
Station	**T2**	**T24**	**T6**	**T18**	**T23**		**T22**		**T1**		**T12**		**T17**		**T11**		**T10**	**T25**	**T14**	**T19**		
Nominal Depth (m)	**35**	**36**	**36**	**36**	**58**		**60**		**55**		**57**		**60**		**60**		**137**	**137**	**137**	**137**		
Season	**S**	**S**	**S**	**S**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**S**	**S**	**S**	**Total**	**%**
Citharichthys sordidus	2			34	119	36	90	53	81	30	93	25	47	13	153	83	182	152	158	15	1366	23.4
Sebastes saxicola													1				218	125	91	405	840	14.4
Synodus lucioceps	158	75	71	147	12	10	19	37	25	42	25	59	27	32	9	46	4		1		799	13.7
Zaniolepis latipinnis					56	33	11	2	79	4	27	10	39	13	127	22	2		1		426	7.3
Symphurus atricaudus	8	9	9	11	21	31	19	23	18	22	21	46	18	15	8	127	1	2		1	410	7.0
Icelinus quadriseriatus		5	28	39	6	3	39	14	14	10			2		62	112	1				335	5.7
Microstomus pacificus					40	3	11	4	6		20		6	1	2		67	32	12	95	299	5.1
Lyopsetta exilis																	35	39	31	135	240	4.1
Citharichthys xanthostigma	38	25	23	13			1			21		50		6	1	1				1	180	3.1
Zalembius rosaceus					13		8	7		96	18	2	11		14	3	1				173	3.0
Lycodes pacificus					7						16		1				37	13	24	55	153	2.6
Pleuronichthys verticalis	1	3	1	2	6	13	6	5	11	5	6	4	1	7	1	23	2				97	1.7
Parophrys vetulus	1	1			2	1	2	1	7	1	7	2	9	3	38	13	3	3	1	1	96	1.6
Chitonotus pugetensis		1	5	48			2		2	1					22						81	1.4
Citharichthys stigmaeus	5		14	36																	55	0.9
Zaniolepis frenata						1											23	18	4	8	54	0.9
Hippoglossina stomata	3	3	1		1	8			1	10		3			2	1	6	3		1	43	0.7
Porichthys notatus					3	2					11	1	5	1	2		2	4		7	38	0.7
Xystreurys liolepis		3	1			1				5			1	1		25					37	0.6
Merluccius productus																	1	1	13	20	35	0.6
Sebastes miniatus		1								6	1		6		1						15	0.3
Sebastes semicinctus							1									1	5	1	1		9	0.2
Odontopyxis trispinosa					1		2						2		1	2					8	0.1
Scorpaena guttata									2	1					2	2					7	0.1
Pleuronichthys decurrens					2	1	1	1			1										6	0.1
Porichthys myriaster										1		2				2					5	0.1
Sebastes sp											1				3				1		5	0.1
Chilara taylori							1										1		1	1	4	0.1
Genyonemus lineatus																		2	2		4	0.1
Raja inornata				1	1		1												1		4	0.1
Caulolatilus princeps		2											1								3	0.1
Paralichthys californicus	3																				3	0.1
Glyptocephalus zachirus																	1			1	2	<0.1
Sebastes jordani																			1	1	2	<0.1
Sebastes levis																	2				2	<0.1
Eopsetta jordani																			1		1	<0.1
Lyconema barbatum																				1	1	<0.1
Plectobranchus evides																				1	1	<0.1
Sebastes auriculatus																				1	1	<0.1
Sebastes dallii											1										1	<0.1
Sebastes elongatus																		1			1	<0.1
Sebastes rosenblatti																			1		1	<0.1
Sebastes rufus																				1	1	<0.1
Total Abundance	**219**	**128**	**153**	**331**	**290**	**143**	**214**	**147**	**246**	**255**	**248**	**204**	**177**	**92**	**448**	**463**	**594**	**396**	**345**	**751**	**5844**	**100**
Total No. of Species	**9**	**11**	**9**	**9**	**15**	**13**	**16**	**10**	**11**	**15**	**14**	**11**	**16**	**10**	**17**	**15**	**20**	**14**	**18**	**19**	**43**	

Table B–11 Biomass (kg) of demersal fishes by station and species for the Summer 2016 and Winter 2017 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	Total	%
Citharichthys sordidus	0.108			0.103	10.463	3.111	6.143	3.699	5.553	1.028	7.240	2.402	2.944	1.188	8.603	2.847	5.255	1.331	1.664	0.542	64.224	36.4
Synodus lucioceps	2.027	1.010	1.124	1.735	0.384	0.229	0.771	0.810	1.095	0.809	0.750	1.401	0.769	0.703	0.215	1.416	0.144		0.022		15.414	8.7
Sebastes saxicola													0.007				4.359	2.237	1.413	4.450	12.466	7.1
Parophrys vetulus	0.210	0.310			0.408	0.050	0.246	0.078	1.022	0.175	1.005	0.131	0.742	0.250	2.890	1.110	0.615	0.780	0.096	0.420	10.538	6.0
Microstomus pacificus					2.328	0.157	0.521	0.141	0.409		1.122		0.419	0.042	0.090		2.841	0.668	0.511	0.878	10.127	5.7
Citharichthys xanthostigma	1.358	1.013	0.792	0.355			0.067			1.441		3.352		0.749	0.052	0.082				0.040	9.301	5.3
Zaniolepis latipinnis					0.967	0.552	0.220	0.037	1.416	0.073	0.428	0.173	0.565	0.203	2.126	0.404	0.033		0.025		7.222	4.1
Pleuronichthys verticalis	0.139	0.182	0.162	0.250	0.316	0.900	0.347	0.264	0.892	0.388	0.262	0.277	0.041	0.464	0.054	1.456	0.152				6.546	3.7
Symphurus atricaudus	0.076	0.142	0.117	0.166	0.236	0.224	0.264	0.285	0.284	0.296	0.234	0.463	0.171	0.172	0.101	1.461	0.032	0.040		0.020	4.784	2.7
Lyopsetta exilis																	1.204	0.861	1.011	1.691	4.767	2.7
Paralichthys californicus	3.800																				3.800	2.2
Lycodes pacificus					0.221						0.674		0.045				0.816	0.251	0.392	1.244	3.643	2.1
Xystreurys liolepis		0.548	0.023			0.750				0.270			0.570	0.053		1.310					3.524	2.0
Hippoglossina stomata	0.169	0.168	0.063		0.059	0.459			0.055	0.891		0.107			0.119	0.070	0.523	0.280		0.220	3.183	1.8
Raja inornata				0.750	1.000		0.700												0.520		2.970	1.7
Merluccius productus																	0.112	0.108	1.471	1.105	2.796	1.6
Zalembius rosaceus					0.369		0.192	0.090		1.126	0.529	0.029	0.213		0.125	0.030	0.021				2.724	1.5
Porichthys notatus					0.115	0.051					0.420	0.086	0.241	0.090	0.074		0.049	0.148		0.311	1.585	0.9
Icelinus quadriseriatus		0.017	0.070	0.127	0.021	0.014	0.133	0.051	0.049	0.027			0.007		0.237	0.423	0.002				1.178	0.7
Scorpaena guttata									0.218	0.070					0.474	0.215					0.977	0.6
Zaniolepis frenata						0.040											0.333	0.314	0.023	0.152	0.862	0.5
Chitonotus pugetensis		0.004	0.022	0.336			0.026		0.020	0.008					0.200						0.616	0.3
Eopsetta jordani																			0.490		0.490	0.3
Porichthys myriaster										0.090		0.200				0.151					0.441	0.2
Sebastes miniatus		0.015								0.233	0.022		0.111		0.024						0.405	0.2
Citharichthys stigmaeus	0.065		0.069	0.227															0.000		0.361	0.2
Genyonemus lineatus																		0.158	0.185		0.343	0.2
Glyptocephalus zachirus																	0.170			0.160	0.330	0.2
Pleuronichthys decurrens					0.080	0.037	0.058	0.042			0.055										0.272	0.2
Sebastes semicinctus							0.017									0.014	0.188	0.020	0.019		0.258	0.1
Sebastes jordani																			0.032	0.052	0.084	<0.1
Caulolatilus princeps		0.047											0.021								0.068	<0.1
Sebastes dallii											0.029										0.029	<0.1
Chilara taylori							0.004										0.008		0.003	0.008	0.023	<0.1
Sebastes levis																	0.019				0.019	<0.1
Sebastes auriculatus																				0.018	0.018	<0.1
Odontopyxis trispinosa					0.003		0.004						0.004		0.002	0.002					0.015	<0.1
Sebastes rufus																				0.012	0.012	<0.1
Sebastes elongatus																		0.010			0.010	<0.1
Lyconema barbatum																				0.010	0.010	<0.1
Sebastes sp											0.001				0.003				0.001		0.005	<0.1
Plectobranchus evides																				0.005	0.005	<0.1
Sebastes rosenblatti																			0.001		0.001	<0.1
Total Biomass	**7.952**	**3.456**	**2.442**	**4.049**	**16.970**	**6.574**	**9.713**	**5.497**	**11.013**	**6.925**	**12.771**	**8.621**	**6.870**	**3.914**	**15.389**	**10.991**	**16.876**	**7.206**	**7.879**	**11.338**	**176.446**	**100**

Table B–12 Summary statistics of legacy District Core nearshore stations for total coliforms, fecal coliforms, and enterococci bacteria (CFU/100 mL) by station and season during 2016-17.

Station	Summer				Fall				Winter				Spring				Annual			
	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev
Total Coliforms																				
39N	<17	15	67	1.58	<17	28	>11000	7.3	<17	29	1000	4.04	<17	20	700	3.22	<17	23	>11000	3.87
33N	<17	24	100	2.22	<17	36	3100	5.59	<17	39	600	3.95	<17	17	100	2.06	<17	27	3100	3.44
27N	<17	14	17	1.16	<17	27	900	3.53	<17	36	600	4.16	<17	13	<20	1.09	<17	21	900	2.78
21N	<17	14	33	1.31	<17	22	1000	3.33	<17	48	1300	4.6	<17	14	<20	1.14	<17	21	1300	2.94
15N	<17	18	67	1.67	<17	27	230	2.67	<17	61	>2200	4.66	<17	14	33	1.31	<17	26	>2200	2.95
12N	<17	22	120	2.14	<17	28	130	2.43	<17	58	>1700	6.63	<17	16	>100	1.88	<17	27	>1700	3.4
9N	<17	38	>20000	5.81	<17	21	1700	3.49	<17	34	>1000	3.87	<17	15	<100	1.44	<17	25	>20000	3.76
6N	<17	33	1500	3.45	<17	30	2600	3.87	<17	54	5700	5.14	<17	16	67	1.66	<17	30	5700	3.7
3N	<17	30	660	2.83	<17	67	1400	5.48	<17	70	1800	4.48	<17	23	460	2.57	<17	42	1800	4.07
0	<17	25	300	2.65	<17	37	>20000	5.7	<17	93	>8000	5.58	<17	22	250	1.97	<17	37	>20000	4.29
3S	<17	16	200	2.14	<17	63	>20000	7.97	<17	72	>6000	6.74	<17	14	>17	1.19	<17	32	>20000	5
6S	<17	13	17	1.08	<17	29	1300	3.54	<17	60	>2100	6.3	<17	13	>17	1.15	<17	23	>2100	3.53
9S	<17	13	<17	1	<17	27	800	4.64	<17	169	>20000	8.45	<17	16	>33	1.41	<17	32	>20000	5.34
15S	<17	19	100	1.92	<17	27	1700	3.92	<17	33	460	3.66	<17	15	33	1.43	<17	22	1700	2.8
21S	<17	18	130	2.03	<17	17	420	2.62	<17	31	600	3.33	<17	19	130	2.17	<17	21	600	2.55
27S	<17	15	50	1.46	<17	18	480	2.7	<17	29	1200	3.89	<17	15	>33	1.39	<17	18	1200	2.44
29S	<17	13	17	1.11	<17	33	380	3.26	<17	48	1200	4.48	<17	14	17	1.16	<17	23	1200	2.95
39S	<17	13	17	1.11	<17	13	17	1.08	<17	15	33	1.42	<17	14	33	1.31	<17	14	33	1.26
All	<17	20	>20000	1.16	<17	30	>20000	1.76	<17	54	>20000	1.57	<17	16	700	0.58	<17	26	>20000	0.96
Fecal Coliforms																				
39N	<17	16	67	1.66	<17	17	480	2.73	<17	17	50	1.73	<17	13	<17	1	<17	16	480	1.86
33N	<17	18	100	2	<17	28	660	3.82	<17	19	100	2	<17	14	33	1.31	<17	19	660	2.35
27N	<17	13	17	1.08	<17	17	67	1.63	<17	21	67	1.84	<17	13	<17	1	<17	16	67	1.55
21N	<17	13	17	1.11	<17	15	33	1.43	<17	22	220	2.71	<17	14	17	1.13	<17	16	220	1.75
15N	<17	14	33	1.31	<17	19	150	2.1	<17	24	170	2.47	<17	13	17	1.08	<17	17	170	1.88
12N	<17	21	100	2	<17	15	33	1.31	<17	28	270	2.95	<17	14	17	1.13	<17	19	270	2.01
9N	<17	33	>20000	5.58	<17	15	250	1.79	<17	20	400	2.44	<17	13	17	1.11	<17	19	>20000	2.88
6N	<17	28	300	2.59	<17	19	300	2.15	<17	24	700	2.7	<17	14	33	1.22	<17	21	700	2.29
3N	<17	28	660	2.85	<17	42	1100	4.55	<17	31	320	2.98	<17	19	350	2.49	<17	29	1100	3.28
0	<17	19	200	2.28	<17	21	6100	3.42	<17	27	1200	3.02	<17	17	200	1.92	<17	21	6100	2.66
3S	<17	17	150	2.03	<17	28	1900	4.18	<17	26	1500	3.91	<17	14	33	1.31	<17	20	1900	2.91
6S	<17	13	<17	1	<17	14	33	1.31	<17	18	100	1.9	<17	13	<17	1	<17	14	100	1.44
9S	<17	13	17	1.11	<17	17	100	1.82	<17	22	100	2.16	<17	13	17	1.08	<17	16	100	1.69
15S	<17	15	67	1.58	<17	16	33	1.42	<17	20	170	2.59	<17	15	67	1.58	<17	16	170	1.82
21S	<17	13	17	1.11	<17	13	17	1.11	<17	15	50	1.46	<17	18	130	1.99	<17	15	130	1.51
27S	<17	13	17	1.11	<17	15	33	1.31	<17	18	660	2.98	<17	13	<17	1	<17	14	660	1.75
29S	<17	14	33	1.31	<17	18	130	1.93	<17	28	1100	3.88	<17	16	<100	1.71	<17	18	1100	2.29
39S	<17	13	17	1.08	<17	13	17	1.08	<17	13	<17	1	<17	14	17	1.13	<17	13	17	1.09
All	<17	18	>20000	1.10	<17	19	6100	1.10	<17	22	1500	0.77	<17	14	350	0.43	<17	18	>20000	0.58

Table B-12 continues.

Table B-12 continued.

Station	Summer				Fall				Winter				Spring				Annual			
	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev
									Enterococci											
39N	<2	5	20	2.64	<2	3	90	3.27	<2	6	198	5.48	<2	2	4	1.32	<2	3	198	3.38
33N	<2	5	68	3.89	<2	7	190	5.25	<2	10	224	6.19	<2	2	12	1.98	<2	5	224	4.58
27N	<2	3	18	2.32	<2	6	242	4.48	<2	12	200	5.82	<2	3	8	2.02	<2	5	242	3.89
21N	<2	4	22	2.39	<2	4	14	2.38	<2	18	>400	5.09	<2	3	88	3.04	<2	6	>400	3.84
15N	<2	6	32	3.22	<2	5	30	2.93	<2	13	240	6.55	<2	2	2	1.16	<2	5	240	4.09
12N	<2	4	36	3.13	<2	4	56	3.39	<2	12	306	6.92	<2	2	2	1.13	<2	4	306	4.21
9N	<2	8	236	4.46	<2	3	42	2.89	<2	9	254	5.26	<2	2	8	1.65	<2	5	254	4.06
6N	<2	7	150	3.57	<2	5	60	3.27	<2	10	172	4.4	<2	3	12	2.11	<2	6	172	3.59
3N	<2	10	>400	5.04	<2	12	>400	4.76	<2	15	216	4.46	<2	3	26	2.48	<2	9	>400	4.59
0	<2	4	108	3.8	<2	6	>400	4.6	<2	18	>400	4.66	<2	4	62	2.38	<2	6	>400	4.31
3S	<2	2	8	1.71	<2	10	>400	5.78	2	12	>400	4.9	<2	3	14	2.24	<2	5	>400	4.28
6S	<2	2	2	1.15	<2	4	66	3.18	<2	11	>400	5.69	<2	2	12	2.1	<2	3	>400	3.68
9S	<2	2	4	1.32	<2	3	18	2.36	<2	41	600	5.95	<2	3	220	4.11	<2	6	600	6.31
15S	<2	2	4	1.32	<2	2	10	1.89	<2	6	68	4.94	<2	2	6	1.68	<2	3	68	2.68
21S	<2	2	12	1.93	<2	2	14	2.31	<2	5	44	3.41	<2	4	38	2.94	<2	3	44	2.77
27S	<2	2	6	1.56	<2	2	4	1.44	<2	3	56	3.59	<2	2	10	1.92	<2	2	56	2.2
29S	<2	2	10	2.05	<2	3	18	2.37	2	8	258	5.08	<2	4	18	2.45	<2	4	258	3.18
39S	<2	2	4	1.44	<2	2	6	1.56	<2	3	58	3.07	<2	2	4	1.32	<2	2	58	1.91
All	<2	4	>400	1.18	<2	5	>400	1.27	<2	12	600	1.05	<2	3	220	0.75	<2	5	600	1.01

Table B–13 Summary statistics of OCHCA nearshore stations for total coliforms, fecal coliforms, and enterococci bacteria (CFU/100 mL) by station and season during 2016-17.

Station	Summer				Fall				Winter				Spring				Annual			
	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev
									Total Coliforms											
OSB02	<17	47	200	2.19	<17	182	>20000	14.92	17	482	>20000	10.03	<17	113	>20000	8.94	<17	147	>20000	9.54
OSB03	17	110	560	2.6	<17	159	>20000	11	17	229	>5300	5.03	<17	66	>20000	7.22	<17	128	>20000	6.18
OSB05	<17	65	520	3.4	17	180	>20000	9.61	50	228	2300	4.24	17	68	480	2.63	<17	116	>20000	5
OSB04	<17	34	180	1.91	<17	89	>12000	10.02	<17	92	3100	9.03	<17	24	>20000	8.1	<17	51	>20000	7.16
OSB01	<17	15	33	1.31	<17	32	>20000	8.43	<17		1000	4.01	<17	18	1000	3.35	<17	22	>20000	4.08
OSUB1	<17	19	170	2.28	<17	33	>20000	8.39	<17	29	300	3.13	<17	17	500	2.76	<17	24	>20000	3.89
BCO-1	<17	15	33	1.31	<17	16	100	1.76	<17	37	800	4.04	<17	21	120	2.11	<17	21	800	2.47
HB1U		0				0			320	439	>660	1.73		0			320	439	>660	1.73
HB1		0				0			>4800	17380	>40000	2.89		0			>4800	17380	>40000	2.89
HB1D	<17	14	33	1.31	<17	22	720	3.18	<17	54	1300	5.75	<17	15	33	1.31	<17	22	1300	3.22
HB2U		0			<17		<17		300	756	1200	2.23		0			<17	272	1200	8.53
HB2		0			>40000		>40000		>3600	12882	>40000	3.43		0			>3600	18081	>40000	3.37
HB2D	<17	15	33	1.31	<17	28	1900	4.11	<17	46	800	4.22	<17	15	50	1.46	<17	23	1900	3.04
HB3U		0				0			400		400			0			400		400	
HB3		0				0			>40000		>40000			0			>40000		>40000	
HB3D	<17	15	33	1.31	<17	31	940	3.23	<17	53	2500	5.98	<17	15	33	1.31	<17	24	2500	3.27
HB4U		0				0			1000	1183	1400	1.27		0			1000	1183	1400	1.27
HB4		0				0			>6800	14577	>20000	2.14		0			>6800	14577	>20000	2.14
HB4D	<17	15	33	1.42	<17	23	660	3.17	<17	46	1300	5.25	<17	17	67	1.64	<17	23	1300	3.04
HB5U		0				0			17	186	2300	8.13	<17		<17		<17	109	2300	8.8
HB5		0				0			>600	12950	>40000	7.26	>14000		>14000		>600	13754	>40000	5.6
HB5D	<17	14	17	1.15	<17	20	100	1.84	<17	75	>2000	5.89	<17	21	3600	4.69	<17	26	3600	3.84
SAR-N	<17	18	67	1.82	<17	114	>20000	10.34	17	221	>20000	14.64	<17	22	520	2.96	<17	56	>20000	8.34
TM	<17	17	67	1.62	<17	75	2500	4.93	<17	101	500	2.87	<17	30	270	2.66	<17	44	2500	3.61
BGCU	<17	37	180	3.01	<17	60	560	3.36	<17	49	2200	4.42	<17	42	500	3.63	<17	46	2200	3.51
BGC	>1700	5555	>14000	1.86	600	3210	>8600	2.52	>940	2225	>3800	1.6	>1100	8015	>40000	2.92	600	4246	>40000	2.53
BGCD	<17	40	580	3.14	<17	61	800	4.02	<17	27	83	1.97	<17	24	100	2.14	<17	35	800	2.92
PPCU		0			<17	13	<17	1	<17	52	150	2.72	<17	15	17	1.23	<17	29	150	2.72
PPC		0			>3000	13693	>40000	6.24	>4300	18478	>40000	2.26	>870	5214	>20000	9.18	>870	13051	>40000	3.62
PPCD	<17	15	100	1.77	<17	16	50	1.55	<17	20	100	2.07	<17	15	33	1.31	<17	16	100	1.7
WFCU	<17	16	33	1.42	<17	16	67	1.58	<17	21	170	2.1	<17	14	>17	1.19	<17	17	170	1.62
WFC	>270	1414	>4700	2.1	<15	540	2900	4.33	>200	1267	>40000	3.96	>530	4998	>16000	2.32	<15	1483	>40000	3.95
WFCD	<17	15	33	1.31	<17	14	33	1.31	<17	20	100	2.16	<17	18	320	2.46	<17	17	320	1.86
ONB39	<17	13	17	1.11	<17	21	300	2.69	<17	21	200	2.36	<17	20	100	2.02	<17	19	300	2.12
MDCU	<17		<17		<17	31	460	4.18	<17	20	150	2.42	<17	14	>17	1.2	<17	19	460	2.44
MDC	>330		>330		930	5314	>40000	5.9	200	1469	>40000	4.44	>1400	14025	>40000	4.7	200	3695	>40000	6.26
MDCD	<17	17	420	2.63	<17	29	2900	4.43	<17	27	540	3.72	<17	18	50	1.56	<17	22	2900	3.05
ELMOROU		0				0			17	17	17	1	<17	13	<17	1	<17	14	17	1.17
ELMORO		0				0			>1400	5400	>32000	5.69	200	4122	>40000	10.38	200	4628	>40000	6.96
ELMOROD	<17	13	17	1.08	<17	20	120	2.15	<17	17	130	1.95	<17	13	<17	1	<17	16	130	1.7
All	<17	307	>14000	0.70	<15	2469	>40000	3.59	<17	3540	>40000	2.79	<17	1705	>40000	2.67	<15	3607	>40000	2.30

Table B-13 continues.

Table B-13 continued.

Station	Summer Min.	Summer Mean	Summer Max.	Summer Std Dev	Fall Min.	Fall Mean	Fall Max.	Fall Std Dev	Winter Min.	Winter Mean	Winter Max.	Winter Std Dev	Spring Min.	Spring Mean	Spring Max.	Spring Std Dev	Annual Min.	Annual Mean	Annual Max.	Annual Std Dev
									Fecal Coliforms											
OSB02	<17	27	150	2.09	<17	52	>20000	8.2	<17	66	>4000	5.94	<17	32	1200	3.39	<17	41	>20000	4.82
OSB03	17	75	320	2.42	<17	56	>20000	9.02	17	54	420	3.04	<17	28	420	2.58	<17	50	>20000	4.05
OSB05	<17	56	440	3.24	<17	70	1100	4.43	<17	69	620	3.85	<17	32	180	2.64	<17	54	1100	3.54
OSB04	<17	26	120	2.04	<17	30	1700	4.37	<17	26	300	2.81	<17	19	440	2.59	<17	25	1700	2.88
OSB01	<17	13	17	1.11	<17	18	440	2.69	<17	17	67	1.72	<17	13	17	1.11	<17	15	440	1.77
OSUB1	<17	15	33	1.43	<17	17	540	2.82	<17	18	100	1.96	<17	13	<17	1	<17	16	540	1.9
BCO-1	<17	13	<17	1	<17	15	100	1.77	<17	19	220	2.27	<17	13	17	1.11	<17	15	220	1.67
HB1U		0				0			83	149	400	2.36		0			83	149	400	2.36
HB1		0				0			1500	2779	5300	1.88		0			1500	2779	5300	1.88
HB1D	<17	13	17	1.11	<17	13	17	1.08	<17	27	620	3.19	<17	14	33	1.31	<17	16	620	1.92
HB2U		0			<17		<17		67	172	420	2.51		0			<17	90	420	4.49
HB2		0			14000		14000		540	2196	7000	3.66		0			540	3489	14000	4.09
HB2D	<17	15	33	1.31	<17	16	100	1.83	<17	20	220	2.32	<17	13	<17	1	<17	16	220	1.73
HB3U		0				0			50		50			0			50		50	
HB3		0				0			9200		9200			0			9200		9200	
HB3D	<17	13	17	1.11	<17	15	33	1.31	<17	27	800	3.68	<17	13	17	1.08	<17	16	800	2.05
HB4U		0				0			100	179	320	2.28		0			100	179	320	2.28
HB4		0				0			620	2227	8000	6.1		0			620	2227	8000	6.1
HB4D	<17	15	33	1.31	<17	17	50	1.53	<17	19	170	2.16	<17	13	<17	1	<17	16	170	1.61
HB5U		0				0			<17	27	150	3.14	<17		<17		<17	23	150	2.85
HB5		0				0			220	974	4300	4.88	400		400		220	815	4300	4.17
HB5D	<17	13	17	1.11	<17	14	17	1.16	<17	24	150	2.58	<17	13	<17	1	<17	15	150	1.7
SAR-N	<17	18	83	1.88	<17	45	16000	6.69	<17	57	>20000	11.38	<17	18	400	2.57	<17	30	>20000	5.38
TM	<17	18	50	1.58	<17	33	230	2.79	<17	29	280	2.42	<17	15	33	1.31	<17	22	280	2.18
BGCU	<17	19	83	1.85	<17	32	400	3.63	<17	14	17	1.13	<17	17	230	2.21	<17	19	400	2.35
BGC	<15	176	2200	5.34	15	235	3300	5.5	46	203	1000	2.67	31	123	2400	3.91	<15	178	3300	4.19
BGCD	<17	16	83	1.75	<17	28	440	2.92	<17	14	33	1.31	<17	13	17	1.08	<17	17	440	1.96
PPCU		0			<17	13	<17	1	<17	17	50	1.84	<17	13	<17	1	<17	15	50	1.58
PPC		0			500	548	600	1.14	200	1278	8800	5.27	<15	318	9000	112.93	<15	777	9000	8.46
PPCD	<17	15	80	1.66	<17	13	17	1.08	<17	14	33	1.3	<17	13	17	1.08	<17	14	80	1.34
WFCU	<17	20	83	1.98	<17	13	17	1.11	<17	15	100	1.77	<17	13	<17	1	<17	15	100	1.6
WFC	<15	86	1100	3.95	<15	29	180	2.85	<15	40	600	3.36	<15	78	440	3.73	<15	53	1100	3.63
WFCD	<17	14	33	1.31	<17	13	<17	1	<17	15	120	1.86	<17	16	330	2.47	<17	15	330	1.74
ONB39	<17	13	17	1.11	<17	14	50	1.46	<17	15	67	1.58	<17	13	<17	1	<17	14	67	1.35
MDCU	<17		<17		<17	14	17	1.16	<17	14	50	1.46	<17	13	17	1.1	<17	14	50	1.3
MDC	280		280		15	164	1900	6.9	<15	93	880	4.34	110	763	4100	3.75	<15	208	4100	5.57
MDCD	<17	13	<17	1	<17	18	120	1.98	<17	18	150	2.19	<17	13	17	1.08	<17	15	150	1.71
ELMOROU		0				0			<17	20	50	2.2	<17	14	17	1.15	<17	16	50	1.66
ELMORO		0				0			62	376	7800	14.03	<15	99	960	10.58	<15	176	7800	10.69
ELMOROD	<17	13	<17	1	<17	13	17	1.11	<17	14	17	1.13	<17	13	17	1.08	<17	13	17	1.1
All	<15	39	2200	1.02	<15	519	>20000	2.30	<15	515	>20000	2.58	<15	69	9000	19.70	<15	523	>20000	2.07

Table B-13 continues.

Table B-13 continued.

Station	Summer				Fall				Winter				Spring				Annual			
	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev	Min.	Mean	Max.	Std Dev
										Enterococci										
OSB02	<2	8	52	2.89	<2	19	>400	6.53	4	55	>400	4.83	<2	22	>400	6.26	<2	21	>400	5.68
OSB03	4	11	48	2.21	<2	13	>400	6.92	4	34	>400	4.49	<2	11	168	4.03	<2	15	>400	4.48
OSB05	2	8	42	2.72	<2	19	304	4.25	6	35	>400	4.07	<2	8	120	4	<2	14	>400	4.2
OSB04	<2	5	16	2.08	<2	10	342	4.66	<2	16	398	7.01	<2	5	240	4.08	<2	8	398	4.58
OSB01	<2	2	6	1.56	<2	4	116	4.66	<2	5	158	5.4	<2	2	4	1.32	<2	3	158	3.43
OSUB1	<2	4	14	2.1	<2	2	108	3.35	<2	5	96	4.09	<2	2	4	1.32	<2	3	108	2.87
BCO-1	<2	3	10	1.94	<2	3	24	2.27	<2	14	120	4.83	<2	3	8	2.09	<2	4	120	3.34
HB1U		0				0			144	282	>400	1.87		0			144	282	>400	1.87
HB1		0				0			>400	500	>400	1		0			>400	500	>400	1
HB1D	<2	3	14	2.29	<2	5	34	3.05	2	23	354	5.96	<2	4	98	3.4	<2	6	354	4.39
HB2U		0			4		4		222	328	>400	1.5		0			4	109	>400	9.28
HB2		0			>400		>400		>400	500	>400	1		0			>400	500	>400	1
HB2D	<2	4	24	2.5	<2	6	92	4.24	2	21	>400	6.01	<2	3	80	3.2	<2	6	>400	4.63
HB3U		0				0			164		164			0			164		164	
HB3		0				0			>400		>400			0			>400		>400	
HB3D	<2	3	26	2.25	<2	6	54	3.31	2	22	368	5	<2	4	86	3.53	<2	6	368	4.18
HB4U		0				0			244	349	>400	1.66		0			244	349	>400	1.66
HB4		0				0			>400	500	>400	1		0			>400	500	>400	1
HB4D	<2	4	20	2.5	<2	5	40	3.3	<2	15	302	5.81	<2	4	12	2.19	<2	6	302	3.77
HB5U		0				0			2	30	190	9.32	<2		<2		<2	17	190	10.54
HB5		0				0			70	306	>400	2.67	>400		>400		70	337	>400	2.41
HB5D	<2	4	12	2.29	<2	4	26	3.15	<2	15	304	6.19	<2	2	60	2.78	<2	5	304	4.04
SAR-N	<2	4	38	2.99	<2	17	>400	5.82	2	30	>400	6.7	<2	3	8	1.81	<2	9	>400	5.55
TM	<2	6	58	3.6	<2	6	54	3.68	<2	14	92	4.04	<2	5	86	3.5	<2	7	92	3.8
BGCU	<2	3	22	2.22	<2	11	102	3.75	<2	4	98	3.32	<2	3	36	2.43	<2	4	102	3.31
BGC	156	217	318	1.27	120	293	>400	1.71	98	172	>400	1.68	146	216	>400	1.45	98	219	>400	1.58
BGCD	<2	3	16	2.27	<2	14	224	4.53	<2	6	50	3.37	<2	4	62	3.72	<2	6	224	3.85
PPCU		0			<2	2	2	1.23	<2	4	14	2.75	2	2	2	1	<2	3	14	2.33
PPC		0			>400	500	>400	1	368	470	>400	1.15	172	293	>400	2.13	172	429	>400	1.43
PPCD	<2	2	2	1.13	<2	2	8	1.66	<2	2	38	2.45	<2	2	6	1.67	<2	2	38	1.77
WFCU	<2	3	20	2.18	<2	2	6	1.54	<2	3	70	3.35	<2	2	12	1.77	<2	2	70	2.22
WFC	110	270	>400	1.7	<2	96	>400	4.08	38	86	292	1.96	36	167	398	2.06	<2	139	>400	2.69
WFCD	<2	2	22	2.17	<2	2	20	2.29	<2	3	156	3.66	<2	3	80	3.14	<2	3	156	2.75
ONB39	<2	2	2	1.13	<2	5	200	4.32	<2	3	62	3.65	<2	3	38	3.08	<2	3	200	3.19
MDCU	<2		<2		<2	3	66	4.44	<2	3	112	3.56	<2	2	2	1.14	<2	2	112	2.97
MDC	112		112		42	135	>400	3.03	30	118	>400	2.45	106	355	>400	1.7	30	171	>400	2.58
MDCD	<2	2	2	1.16	<2	6	302	4.52	<2	4	112	4.99	<2	2	8	1.87	<2	3	302	3.44
ELMOROU		0				0			<2	5	44	7.03	<2	2	4	1.63	<2	3	44	3.56
ELMORO		0				0			310	426	>400	1.32	76	188	>400	2.18	76	267	>400	2.05
ELMOROD	<2	2	6	1.64	<2	3	22	2.7	<2	3	54	2.81	<2	2	12	1.77	<2	2	54	2.25
All	<2	26	>400	0.66	<2	57	>400	1.58	<2	127	>400	2.07	<2	57	>400	1.19	<2	116	>400	1.99

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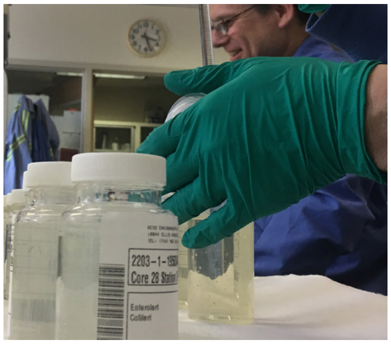

APPENDIX C
Quality Assurance/Quality Control

This appendix details quality assurance/quality control information for the collection and analyses of water quality, sediment geochemistry, fish tissue chemistry, benthic infauna, and trawl fish and invertebrate samples for the Orange County Sanitation District's (District) 2016-17 Core ocean monitoring program.

INTRODUCTION

The Core ocean monitoring program is designed to measure compliance with permit conditions and for temporal and spatial trend analysis. The program includes measurements of:

- Water quality;
- Sediment quality;
- Benthic infaunal community health;
- Fish and macroinvertebrate community health;
- Fish tissue contaminant concentrations (chemical body burden); and
- Fish health (including external parasites and diseases).

The Core ocean monitoring program complies with the District's Quality Assurance Project Plan (QAPP) (OCSD 2016a) requirements and applicable federal, state, local, and contract requirements. The objectives of the quality assurance program are as follows:

- Scientific data generated will be of sufficient quality to stand up to scientific and legal scrutiny.
- Data will be gathered or developed in accordance with procedures appropriate for the intended use of the data.
- Data will be of known and acceptable precision, accuracy, representativeness, completeness, and comparability as required by the program.

The various aspects of the program are conducted on a schedule that varies weekly, monthly, quarterly, semi-annually, and annually. Sampling and data analyses are designated by quarters 1 through 4, which are representative of the summer (July–September), fall (October–December), winter (January–March), and spring (April–June) seasons, respectively.

WATER QUALITY NARRATIVE

Introduction

The District's Laboratory, Monitoring, and Compliance (LMC) staff collected 654, 654, 653, and 653 discrete ammonium samples during the quarterly collections beginning July 1, 2016 and ending June 30, 2017. All samples were iced upon collection, preserved with 1:1 sulfuric acid upon receipt by the LMC laboratory staff, and stored at <6.0 °C until analysis according to the LMC's Standard Operating Procedures (SOPs) (OCSD 2016b).

Analytical Method - Ammonium

The samples were analyzed for ammonium on a segmented flow analyzer using Standard Methods 4500-NH_3 Rev G. Sodium phenolate and sodium hypochlorite were added to the samples to react with ammonium to form indophenol blue in a concentration proportional to the ammonium concentration in the sample. The blue color was intensified with sodium nitroprusside and was measured at 660 nm.

QA/QC - Ammonium

A typical sample batch included a blank and a spike in seawater collected from a control site at a maximum of every 20 samples; an external reference sample was also run once each month. One spike and spike replicate were added to the batch every 10 samples. The method detection limit (MDL) for low-level ammonium samples using the segmented flow instrument is shown in Table C-1. QA/QC summary data are presented in Table C-2. All samples were analyzed within the required holding time. All analyses conducted in each quarter met the QA/QC criteria.

Table C–1 Method Detection Limits (MDLs) and Reporting Limits (RLs), July 2016–June 2017.

Receiving Waters					
Parameter	**MDL (MPN/100mL)**	**RL (MPN/100mL)**	**Parameter**	**MDL (mg/L)**	**RL (mg/L)**
Total coliform	10	10	Ammonium	0.0162 *	0.020
E. coli	10	10	Ammonium (06/15/2017 only)	0.0130 *	0.020
Enterococci	10	10			
Sediments					
Parameter	**MDL (ng/g dry)**	**RL (ng/g dry)**	**Parameter**	**MDL (ng/g dry)**	**RL (ng/g dry)**
Organochlorine Pesticides					
2,4’-DDD	2.18	2.2	Endosulfan-alpha	1.54	2.0
2,4’-DDE	1.51	2.0	Endosulfan-beta	1.03	2.0
2,4’-DDT	1.56	2.0	Endosulfan-sulfate	0.94	2.0
4,4’-DDD	1.47	2.0	Endrin	3.52	5.0
4,4’-DDE	1.75	2.0	*gamma*-BHC	2.64	2.7
4,4’-DDT	0.56	0.6	Heptachlor	2.01	2.1
4,4’-DDMU	2.16	2.2	Heptachlor epoxide	1.02	1.1
Aldrin	0.42	0.5	Hexachlorobenzene	0.98	1.0
cis-Chlordane	1.29	2.0	Mirex	0.70	0.7
trans-Chlordane	1.58	2.0	*trans*-Nonachlor	1.48	2.0
Dieldrin	1.84	2.0			
PCB Congeners					
PCB 18	0.20	0.2	PCB 126	0.21	0.2
PCB 28	0.14	0.2	PCB 128	0.31	0.4
PCB 37	0.40	0.4	PCB 138	0.19	0.2
PCB 44	0.17	0.2	PCB 149	0.17	0.2
PCB 49	0.39	0.4	PCB 151	0.16	0.2
PCB 52	0.20	0.2	PCB 153/168	0.79	0.8
PCB 66	0.31	0.4	PCB 156	0.20	0.2
PCB 70	0.30	0.3	PCB 157	0.15	0.2
PCB 74	0.24	0.3	PCB 167	0.19	0.2
PCB 77	0.15	0.2	PCB 169	0.11	0.2
PCB 81	0.17	0.2	PCB 170	0.11	0.2
PCB 87	0.26	0.3	PCB 177	0.15	0.2
PCB 99	0.18	0.2	PCB 180	0.17	0.2
PCB 101	0.19	0.2	PCB 183	0.18	0.2
PCB 105	0.17	0.2	PCB 187	0.14	0.2
PCB 110	0.18	0.2	PCB 189	0.13	0.2
PCB 114	0.17	0.2	PCB 194	0.13	0.2
PCB 118	0.16	0.2	PCB 201	0.19	0.2
PCB 119	0.20	0.2	PCB 206	0.17	0.2
PCB 123	0.14	0.2			

Table C-1 continues.

Table C-1 continued.

Parameter	MDL	RL	Parameter	MDL	RL
		PAH Compounds			
1,6,7-Trimethylnaphthalene	0.4	1	Benzo[g,h,i]perylene	0.4	1
1-Methylnaphthalene	0.5	1	Benzo[k]fluoranthene	0.5	1
1-Methylphenanthrene	0.5	1	Biphenyl	0.8	1
2,3,6-Trimethylnaphthalene	0.5	1	Chrysene	0.3	1
2,6-Dimethylnaphthalene	0.4	1	Dibenz[a,h]anthracene	0.2	1
2-Methylnaphthalene	0.9	1	Dibenzothiophene	0.3	1
Acenaphthene	0.4	1	Fluoranthene	0.4	1
Acenaphthylene	0.4	1	Fluorene	0.4	1
Anthracene	0.3	1	Indeno[1,2,3-c,d]pyrene	0.3	1
Benz[a]anthracene	0.2	1	Naphthalene	1.1	1
Benzo[a]pyrene	0.2	1	Perylene	0.6	1
Benzo[b]fluoranthene	0.4	1	Phenanthrene	0.8	1
Benzo[e]pyrene	0.4	1	Pyrene	0.2	1
Parameter	**MDL (mg/kg dry)**	**RL (mg/kg dry)**	**Parameter**	**MDL (mg/kg dry)**	**RL (mg/kg dry)**
		Metals			
Antimony	0.008	0.10	Lead	0.008	0.10
Arsenic	0.003	0.02	Mercury	0.001	0.002
Barium	0.021	0.10	Nickel	0.019	0.10
Beryllium	0.010	0.01	Selenium	0.024	0.15
Cadmium	0.101	0.15	Silver	0.029	0.02
Chromium	0.101	0.15	Zinc	0.063	0.15
Copper	0.011	0.10			
Parameter	**MDL (mg/kg dry)**	**RL (mg/kg dry)**	**Parameter**	**MDL (%)**	**RL (%)**
		Miscellaneous Parameters			
Dissolved Sulfides	1.03	1.03	Grain Size	0.001	0.001
Total Nitrogen	0.49	1.5	Total Organic Carbon	0.10	0.1
Total Phosphorus	0.16	3.5			
		Fish Tissue			
Parameter	**MDL (ng/g wet)**	**RL (ng/g wet)**	**Parameter**	**MDL (ng/g wet)**	**RL (ng/g wet)**
		Organochlorine Pesticides			
2,4'-DDD	1.42	2.00	*cis*-Chlordane	0.989	1.00
2,4'-DDE	1.05	2.00	*trans*-Chlordane	1.87	2.00
2,4'-DDT	0.909	1.00	Oxychlordane	1.86	2.00
4,4'-DDD	0.893	2.00	Heptachlor	0.962	1.00
4,4'-DDE	0.813	1.00	Heptachlor epoxide	0.945	1.00
4,4'-DDT	1.04	2.00	*cis*-Nonachlor	1.02	2.00
4,4'-DDMU	0.99	1.00	*trans*-Nonachlor	1.41	2.00
Dieldrin	0.967	5.00			
		PCB Congeners			
PCB 18	1.12	2.00	PCB 126	1.18	2.00
PCB 28	0.938	1.00	PCB 128	1.63	2.00
PCB 37	1.31	2.00	PCB 138	0.71	1.00
PCB 44	1.43	2.00	PCB 149	0.651	1.00
PCB 49	1.57	2.00	PCB 151	0.869	1.00
PCB 52	1.42	2.00	PCB 153/168	1.43	2.00
PCB 66	1.12	2.00	PCB 156	1.45	2.00
PCB 70	0.762	1.00	PCB 157	1.66	2.00
PCB 74	0.779	1.00	PCB 167	1.02	2.00
PCB 77	0.778	1.00	PCB 169	1.69	2.00
PCB 81	0.813	1.00	PCB 170	0.935	1.00
PCB 87	0.976	1.00	PCB 177	1.36	2.00
PCB 99	1.12	2.00	PCB 180	0.712	1.00
PCB 101	0.711	1.00	PCB 183	1.31	2.00
PCB 105	0.744	1.00	PCB 187	0.708	1.00
PCB 110	0.956	1.00	PCB 189	1.00	1.00
PCB 114	0.824	1.00	PCB 194	1.24	2.00
PCB 118	0.765	1.00	PCB 201	1.41	2.00
PCB 119	0.925	1.00	PCB 206	0.961	2.00
PCB 123	0.686	1.00			
		Metals			
Arsenic	0.100	0.150	Mercury	0.000	0.000
Selenium	0.069	0.100			

* = Values reported between the MDL and the RL were estimated.

Bacteria

<u>Introduction</u>

All bacteria samples were iced upon collection and stored at <10 °C until analysis following LMC SOPs.

Table C–2 Water quality QA/QC summary, July 2016-June 2017.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	Ammonium	654 (8)	Blank	38	1	38	100.0
			Blank Spike	38	1	38	100.0
			Matrix Spike	69	1	69	100.0
			Matrix Spike Dup	69	1	69	100.0
			Matrix Spike Precision	69	1	69	100.0
Fall	Ammonium	654 (8)	Blank	38	1	38	100.0
			Blank Spike	38	1	38	100.0
			Matrix Spike	69	1	69	100.0
			Matrix Spike Dup	69	1	69	100.0
			Matrix Spike Precision	69	1	69	100.0
Winter	Ammonium	653 (9)	Blank	39	1	39	100.0
			Blank Spike	39	1	39	100.0
			Matrix Spike	70	1	70	100.0
			Matrix Spike Dup	70	1	70	100.0
			Matrix Spike Precision	70	1	70	100.0
Spring	Ammonium	653 (9)	Blank	39	1	39	100.0
			Blank Spike	39	1	39	100.0
			Matrix Spike	69	1	69	100.0
			Matrix Spike Dup	69	1	69	100.0
			Matrix Spike Precision	69	1	69	100.0

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <2X MDL.
For blank spike - Target accuracy % recovery 90-110.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 80-120.
For matrix spike precision - Target precision % RPD <11%.
For duplicate - Target precision % RPD <10% at 3X MDL of sample mean.

Analytical Method

Samples collected offshore were analyzed for bacteria using Enterolert™ for enterococci and Colilert-18™ for total coliforms and *Escherichia coli*. Fecal coliforms were estimated by multiplying the *E. coli* result by a factor of 1.1. These methods utilize enzyme substrates that produce, upon hydrolyzation, a fluorescent signal when viewed under long-wavelength (365 nm) ultraviolet light. For samples collected along the surfzone, samples were analyzed by culture-based methods for direct count of bacteria. EPA Method 1600 was applied to enumerate enterococci bacteria. For enumeration of total and fecal coliforms, respectively, Standard Methods 9222B and 9222D were used. MDLs for bacteria are presented in Table C-1.

QA/QC

All samples were analyzed within the required holding time. Recreational (REC-1) samples were processed and incubated within 8 hours of sample collection. Duplicate analyses were performed on a minimum of 10% of samples with at least 1 sample per sample batch. All equipment, reagents, and dilution waters used for sample analyses were sterilized before use. Sterility of sample bottles was tested for each new lot/batch before use. Each lot of medium, whether prepared or purchased, was tested for sterility and performance with known positive and negative controls prior to use. For surfzone samples, a positive and a negative control were run simultaneously with each batch of sample for each type of media used to ensure performance. New lots of Quanti-Tray and petri dish were checked for sterility before use. Each Quanti-Tray sealer was checked monthly by addition of Gram stain dye to 100 mL of water, and the tray was sealed and subsequently checked for leakage. Each lot of dilution blanks commercially purchased was checked for appropriate volume and sterility. New lots of ≤10 mL volume pipettes were checked for accuracy by weighing volume delivery on a calibrated top loading scale.

SEDIMENT CHEMISTRY NARRATIVE

Introduction

The District's LMC laboratory received 68 sediment samples from LMC's ocean monitoring staff during July 2016, and 29 samples during January 2017. All samples were stored according to LMC SOPs. All samples were analyzed for organochlorine pesticides, polychlorinated biphenyl congeners (PCBs), polycyclic aromatic hydrocarbons (PAHs), trace metals, mercury, dissolved sulfides (DS), total organic carbon (TOC), total nitrogen (TN), total phosphorus (TP), and grain size. All samples were analyzed within the required holding times.

Analytical Methods – PAHs, PCBs, and Organochlorine Pesticides

The analytical methods used to detect PAHs, organochlorine pesticides, and PCBs in the samples are described in the LMC SOPs. All sediment samples were extracted using an accelerated solvent extractor (ASE). Approximately 10 g (dry weight) of sample were used for each analysis. A separatory funnel extraction was performed using 100 mL of sample when field and rinse blanks were included in the batch. All sediment extracts were analyzed by GC/MS.

A typical sample batch included 20 field samples with required quality control (QC) samples. Sample batches that were analyzed for PAHs, organochlorine pesticides, and PCBs included the following QC samples: 1 sand blank, 1 blank spike, 1 standard reference material (SRM), 1 matrix spike set, and 1 sample extraction duplicate.

MDLs and SRM acceptance criteria for each PAH, PCB, and pesticide constituent are presented in Tables C-1 and C-3, respectively. Sediment PAH, PCB, and pesticide QA/QC summary data are presented in Table C-4.

Table C–3 Acceptance criteria for standard reference materials for July 2016-June 2017. * = Parameter with non-certified value(s).

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
Sediments			
Organochlorine Pesticides, PCB Congeners, and Percent Dry Weight (SRM 1944; New York/New Jersey Waterway Sediment, National Institute of Standards and Technology)			
PCB 8	22.3	20	24.6
PCB 18	51	48.4	53.6
PCB 28	80.8	78.1	83.5
PCB 44	60.2	58.2	62.2
PCB 49	53	51.3	54.7
PCB 52	79.4	77.4	81.4
PCB 66	71.9	67.6	76.2
PCB 87	29.9	25.6	34.2
PCB 99	37.5	35.1	39.9
PCB 101	73.4	70.9	75.9
PCB 105	24.5	23.4	25.6
PCB 110	63.5	58.8	68.2
PCB 118	58	53.7	62.3
PCB 128	8.47	8.19	8.75
PCB 138	62.1	59.1	65.1
PCB 149	49.7	48.5	50.9
PCB 151	16.93	16.57	17.29
PCB 153/168	74	71.1	76.9
PCB 156	6.52	5.86	7.18
PCB 170	22.6	21.2	24
PCB 180	44.3	43.1	45.5
PCB 183	12.19	11.62	12.76
PCB 187	25.1	24.1	26.1
PCB 194	11.2	9.8	12.6
PCB 195	3.75	3.36	4.14
PCB 206	9.21	8.7	9.72

Table C-3 continues.

Table C-3 continued.

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
PCB 209	6.81	6.48	7.14
2,4'-DDD*	38	30	46
2,4'-DDE*	19	16	22
4,4'-DDD*	108	92	124
4,4'-DDE*	86	74	98
4,4'-DDT*	170	138	202
cis-Chlordane	16.51	15.68	17.34
trans-Chlordane*	19	17.3	20.7
gamma-BHC*	2	1.7	2.3
Hexachlorobenzene	6.03	5.68	6.38
cis-Nonachlor*	3.7	3	4.4
trans-Nonachlor	8.2	7.69	8.71
Percent Dry Weight	1.3	–	–
PAH Compounds and Percent Dry Weight (SRM 1944; New York/New Jersey Waterway Sediment, National Institute of Standards and Technology)			
1-Methylnaphthalene*	470	450	490
1-Methylphenanthrene*	1700	1600	1800
2-Methylnaphthalene*	740	680	800
Acenaphthene*	390	360	420
Anthracene*	1130	1060	1200
Benz[a]anthracene	4720	4610	4830
Benzo[a]pyrene	4300	4170	4430
Benzo[b]fluoranthene	3870	3450	4290
Benzo[e]pyrene	3280	3170	3390
Benzo[g,h,i]perylene	2840	2740	2940
Benzo[k]fluoranthene	2300	2100	2500
Biphenyl*	250	230	270
Chrysene	4860	4760	4960
Dibenz[a,h]anthracene	424	355	493
Dibenzothiophene*	500	470	530
Fluoranthene	8920	8600	9240
Fluorene*	480	440	520
Indeno[1,2,3-c,d]pyrene	2780	2680	2880
Naphthalene*	1280	1240	1320
Perylene	1170	930	1410
Phenanthrene	5270	5050	5490
Pyrene	9700	9280	10120
Percent Dry Weight	1.3	–	–
Metals (CRM-540 ERA Metals in Soil; Lot No. D074-540)			
Antimony	72.9	18.7	206
Arsenic	161	114	209
Barium	385	286	484
Beryllium	146	110	182
Cadmium	149	110	191
Chromium	180	127	233
Coipper	162	122	207
Lead	103	73	132
Mercury	3.73	1.9	5.55
Nickel	133	97.4	172
Selenium	153	103	202
Silver	71.1	47.8	94.5
Zinc	352	254	450
Fish Tissue *Organochlorine Pesticides, PCB Congeners, and Lipid (SRM1946, Lake Superior Fish Tissue; National Institute of Standards and Technology)*			
PCB 18*	0.84	0.73	0.95
PCB 28*	2	1.76	2.24
PCB 44	4.66	3.8	5.52
PCB 49	3.8	3.41	4.19
PCB 52	8.1	7.1	9.1
PCB 66	10.8	8.9	12.7
PCB 70	14.9	14.3	15.5
PCB 74	4.83	4.32	5.34
PCB 77	0.327	0.3	0.35
PCB 87	9.4	8	10.8
PCB 99	25.6	23.3	27.9
PCB 101	34.6	32	37.2
PCB 105	19.9	19	20.8
PCB 110	22.8	20.8	24.8
PCB 118	52.1	51.1	53.1
PCB 126	0.38	0.36	0.4
PCB 128	22.8	20.9	24.7
PCB 138	115	102	128
PCB 149	26.3	25	27.6

Table C-3 continues.

Table C-3 continued.

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
PCB 153/168	170	161	179
PCB 156	9.52	9.01	10
PCB 170	25.2	23	27.4
PCB 180	74.4	70.4	78.4
PCB 183	21.9	19.4	24.4
PCB 187	55.2	53.1	57.3
PCB 194	13	11.7	14.3
PCB 201*	2.83	2.7	2.96
PCB 206	5.4	4.97	5.83
2,4’-DDD	2.2	1.95	2.45
2,4’-DDE*	1.04	0.75	1.33
2,4’-DDT*	22.3	19.1	25.5
4,4’-DDD	17.7	14.9	20.5
4,4’-DDE	373	325	421
4,4’-DDT	37.2	33.7	40.7
cis-Chlordane	32.5	30.7	34.3
trans-Chlordane	8.36	7.45	9.27
Oxychlordane	18.9	17.4	20.4
Dieldrin	32.5	29	36
Heptachlor epoxide	5.5	5.27	5.73
cis-Nonachlor	59.1	55.5	62.7
trans-Nonachlor	99.6	92	107
Lipid*	10.17	–	–
Metals (SRM DORM-3; National Research Council Canada)			
Arsenic	6.88	6.58	7.18
Selenium*	3.3	–	–
Mercury	0.382	0.322	0.442

Table C–4 Sediment QA/QC summary, July 2016-June 2017. N/A = Not Applicable.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	PAHs	68 (4)	Blank	4	26	103	99.0
			Blank Spike	4	26	93	89.4
			Matrix Spike	4	26	104	100.0
			Matrix Spike Duplicate	4	26	104	100.0
			Matrix Spike Precision	4	26	104	100.0
			Duplicate	4	26	97	93.3
			CRM Analysis	4	22	73	83.0
Winter	PAHs	29 (2)	Blank	2	26	51	98.1
			Blank Spike	2	26	47	90.4
			Matrix Spike	2	26	49	94.2
			Matrix Spike Duplicate	2	26	51	98.1
			Matrix Spike Precision	2	26	51	98.1
			Duplicate	2	26	37	71.2
			CRM Analysis	2	22	38	86.4

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3X MDL.
For blank spike - Target accuracy % recovery 60-120.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 40-120.
For matrix spike precision - Target precision % RPD <25%.
For duplicate - Target precision % RPD <25% at 3X MDL of sample mean.
For SRM analysis - Target accuracy % recovery 60-140 or certified value, whichever is greater.

Table C-4 continues.

Table C-4 continued.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	PCBs and Pesticides	68 (4)	Blank	4	60	240	100.0
			Blank Spike	4	60	229	95.4
			Matrix Spike	4	60	230	95.8
			Matrix Spike Duplicate	4	60	235	97.9
			Matrix Spike Precision	4	60	227	94.6
			Duplicate	4	60	240	100.0
			CRM Analysis	4	33	116	87.9
Winter	PCBs and Pesticides	29 (2)	Blank	2	60	120	100.0
			Blank Spike	2	60	117	97.5
			Matrix Spike	2	60	119	99.2
			Matrix Spike Duplicate	2	60	117	97.5
			Matrix Spike Precision	2	60	60	50.0
			Duplicate	2	60	120	100.0
			CRM Analysis	2	33	62	93.9

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3X MDL.
For blank spike - Target accuracy % recovery 60-120.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 40-120.
For matrix spike precision - Target precision % RPD <25%.
For duplicate - Target precision % RPD <25% at 3X MDL of sample mean.
For SRM analysis - Target accuracy % recovery 60-140 or certified value, whichever is greater.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	68 (2)	Blank	8	12	92	95.8
			Blank Spike	8	12	96	100.0
			Matrix Spike	8	12	75	78.1
			Matrix Spike Dup	8	12	75	78.1
			Matrix Spike Precision	8	12	96	100.0
			Duplicate	8	12	83	86.5
			CRM Analysis	2	12	24	100.0
Summer	Mercury	68 (2)	Blank	8	1	8	100.0
			Blank Spike	8	1	8	100.0
			Matrix Spike	8	1	8	100.0
			Matrix Spike Dup	8	1	8	100.0
			Matrix Spike Precision	8	1	8	100.0
			Duplicate	8	1	8	100.0
			CRM Analysis	2	1	2	100.0
Winter	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	29 (1)	Blank	4	12	48	100.0
			Blank Spike	2	12	24	100.0
			Matrix Spike	3	12	33	91.7
			Matrix Spike Dup	3	12	33	91.7
			Matrix Spike Precision	3	12	35	97.2
			Duplicate	3	12	34	94.4
			CRM Analysis	1	12	12	100.0
Winter	Mercury	29 (1)	Blank	2	1	2	100.0
			Blank Spike	2	1	2	100.0
			Matrix Spike	3	1	3	100.0
			Matrix Spike Dup	3	1	3	100.0
			Matrix Spike Precision	3	1	3	100.0
			Duplicate	3	1	3	100.0
			CRM Analysis	1	1	1	100.0

* An analysis passed if the following criteria were met.
For blank – Target accuracy % recovery <3X MDL, Sample results for analyte >10 x blank result
For blank spike – Target accuracy % recovery 90-110
For matrix spike and matrix spike duplicate – Target accuracy % recovery 70-130
For matrix spike precision – Target precision % RPD <20
For duplicate – Target precision % RPD 30
For SRM analysis –Target accuracy % recovery 80-120% or certified value whichever is greater.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	Dissolved Sulfides	68 (7)	Blank	7	1	7	100.0
			Blank Spike	7	1	7	100.0
			Matrix Spike	7	1	7	100.0
			Matrix Spike Dup	7	1	7	100.0
			Matrix Spike Precision	7	1	7	100.0
			Duplicate	7	1	7	100.0
Winter	Dissolved Sulfides	31 (3)	Blank	3	1	3	100.0
			Blank Spike	3	1	3	100.0
			Matrix Spike	3	1	3	100.0
			Matrix Spike Dup	3	1	3	100.0
			Matrix Spike Precision	3	1	3	100.0
			Duplicate	3	1	3	100.0

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <2X MDL.
For blank spike - Target accuracy % recovery 80-120.
For matrix spike and matrix spike suplicate - Target accuracy % recovery 70-130.
For matrix spike precision - Target precision % RPD <11%.
For duplicate - Target precision % RPD <10% at 3X MDL of sample mean.

Table C-4 continues.

Table C-4 continued.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	TOC	68 (1)	Blank	4	1	4	100.0
			Blank Spike	N/A	N/A	N/A	N/A
			Matrix Spike	4	1	4	100.0
			Matrix Spike Dup	4	1	4	100.0
			Matrix Spike Precision	4	1	4	100.0
			Duplicate	8	1	8	100.0
Winter	TOC	29 (1)	Blank	2	1	2	100.0
			Blank Spike	N/A	N/A	N/A	N/A
			Matrix Spike	2	1	2	100.0
			Matrix Spike Dup	2	1	2	100.0
			Matrix Spike Precision	2	1	2	100.0
			Duplicate	3	1	3	100.0

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <10X MDL.
For matrix spike and matrix spike suplicate - Target accuracy % recovery 80-120.
For matrix spike precision - Target precision % RPD <10%.
For duplicate - Target precision % RPD <10% at 3X MDL of sample mean.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	Grain Size	68 (1)	Blank	N/A	N/A	N/A	N/A
			Blank Spike	N/A	N/A	N/A	N/A
			Matrix Spike	N/A	N/A	N/A	N/A
			Matrix Spike Dup	N/A	N/A	N/A	N/A
			Matrix Spike Precision	N/A	N/A	N/A	N/A
			Duplicate	7	1	7	100.0
Winter	Grain Size	29 (1)	Blank	N/A	N/A	N/A	N/A
			Blank Spike	N/A	N/A	N/A	N/A
			Matrix Spike	N/A	N/A	N/A	N/A
			Matrix Spike Dup	N/A	N/A	N/A	N/A
			Matrix Spike Precision	N/A	N/A	N/A	N/A
			Duplicate	3	1	3	100.0

* An analysis passed if the following criteria were met:
For duplicate - Target precision % RPD <10%.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	Total N	68 (1)	Blank	6	1	6	100.0
			Blank Spike	5	1	5	100.0
			Matrix Spike	7	1	3	42.9
			Matrix Spike Dup	7	1	4	57.1
			Matrix Spike Precision	7	1	7	100.0
			Duplicate	7	1	7	100.0
Winter	Total N	29 (1)	Blank	4	1	3	75.0
			Blank Spike	3	1	3	100.0
			Matrix Spike	4	1	2	50.0
			Matrix Spike Dup	4	1	2	50.0
			Matrix Spike Precision	4	1	4	100.0
			Duplicate	4	1	4	100.0

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3X MDL.
For blank spike, matrix spike, and matrix spike duplicate - Target accuracy % recovery 80-120.
For matrix spike precision - Target precision % RPD <20%.
For duplicate - Target precision % RPD <20% at 3X MDL of sample mean.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	Total P	68 (1)	Blank	5	1	5	100.0
			Blank Spike	5	1	5	100.0
			Matrix Spike	7	1	6	85.7
			Matrix Spike Dup	7	1	6	85.7
			Matrix Spike Precision	7	1	7	100.0
			Duplicate	7	1	7	100.0
Winter	Total P	29 (1)	Blank	2	1	2	100.0
			Blank Spike	2	1	2	100.0
			Matrix Spike	3	1	2	66.7
			Matrix Spike Dup	3	1	1	33.3
			Matrix Spike Precision	3	1	3	100.0
			Duplicate	3	1	3	100.0

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3X MDL.
For blank spike, matrix spike, and matrix spike duplicate - Target accuracy % recovery 80-120.
For matrix spike precision - Target precision % RPD <20%.
For duplicate - Target precision % RPD <20% at 3X MDL of sample mean.

All analyses were performed within holding times and with appropriate quality control measures, as stated in the District's QAPP, with the majority of the compounds tested during the 2 quarters meeting QA/QC criteria (Table C-4). When constituent concentrations exceeded the calibration range of the instrument, dilutions were performed and the samples reanalyzed. Any deviation from standard protocol that occurred during sample preparation or analyses are noted in the raw data packages.

Analytical Methods - Trace Metals

Dried sediment samples were analyzed for trace metals in accordance with methods in the LMC SOPs. A typical sample batch for antimony, arsenic, barium, beryllium, cadmium, chromium, copper, nickel, lead, silver, selenium, and zinc analyses included 3 blanks, a blank spike, and 1 SRM. Additionally, sample duplicates, sample spikes, and sample spike duplicates were analyzed a minimum of once every 10 sediment samples. The analysis of the blank spike and SRM provided a measure of the accuracy of the analysis. The analysis of the sample, its duplicate, and the 2 sample spikes were evaluated for precision.

All samples were analyzed using inductively coupled mass spectroscopy (ICPMS) within a 6-month holding time. If any analyte exceeded both the appropriate calibration curve and Linear Dynamic Range, the sample was diluted and reanalyzed. MDLs for metals are presented in Table C-1. Acceptance criteria for trace metal SRMs are presented in Table C-3. Most of the compounds tested for sediment trace metals during the 2 quarters met QA/QC criteria (Table C-4).

Analytical Methods - Mercury

Dried sediment samples were analyzed for mercury in accordance with methods described in the LMC SOPs. QC for a typical batch included a blank, blank spike, and SRM. Sediment sample duplicates, sample spike, and spike duplicates were run approximately once every 10 sediment samples. When sample mercury concentration exceeded the appropriate calibration curve, the sample was diluted with the reagent blank and reanalyzed. The samples were analyzed for mercury on a Perkin Elmer FIMS 400 system.

The MDL for sediment mercury is presented in Table C-1. Acceptance criteria for mercury SRM is presented in Table C-3. All QA/QC summary data are presented in Table C-4.

All samples met the QA/QC criteria guidelines for accuracy and precision.

Analytical Methods - Dissolved Sulfides

DS samples were analyzed in accordance with methods described in the LMC SOPs. The MDL for DS is presented in Table C-1. Sediment DS QA/QC summary data are presented in Table C-4. All analyses in both quarters met the QA/QC criteria.

Analytical Methods - Total Organic Carbon

TOC samples were analyzed by ALS Environmental Services, Kelso, WA. The MDL for TOC is presented in Table C-1. Sediment TOC QA/QC summary data are presented in Table C-4. All analyzed TOC samples passed the QA/QC criteria.

Analytical Methods - Grain Size

Grain size samples were analyzed by EMSL Analytical, Cinnaminson, NJ. The MDL for sediment grain size is presented in Table C-1. Sediment grain size QA/QC summary data are presented in Table C-4. All analyzed grain size samples passed the QA/QC criteria of RPD ≤10%.

Analytical Methods - Total Nitrogen

TN samples were analyzed by Weck Laboratories, Inc., City of Industry, CA. The MDL for TN is presented in Table C-1. Sediment TN QA/QC summary data are presented in Table C-4. The matrix spikes and their duplicate analyses had a RPD of less than 20%. The associated laboratory control sample (LCS) met acceptance criteria; however, for the year only 45% and 54% of matrix spikes and matrix spike duplicates, respectively, met the recovery criteria of 80-120% range due to matrix interferences in the analysis.

Analytical Methods - Total Phosphorus

TP samples were analyzed by Weck Laboratories. The MDL for TP is presented in Table C-1. Sediment TP QA/QC summary data are presented in Table C-4. The matrix spike precisions and their duplicate analyses had a RPD of less than 20%. The associated LCS met acceptance criteria; however, for the year only 80% and 70% of matrix spikes and matrix spike duplicates, respectively, met the recovery criteria of 80-120% range due to matrix interferences in the analysis.

FISH TISSUE CHEMISTRY NARRATIVE

Introduction

The District's LMC laboratory received 20 rig-fish samples and 38 trawl fish samples from LMC's ocean monitoring staff during the first quarter of the 2016-17 program year. The individual samples were stored, dissected, and homogenized according to methods described in the District's LMC SOPs. A 1:1 muscle to water ratio was used for muscle samples. No water was used for liver samples. After the individual samples were homogenized, equal aliquots of muscle from each rig-fish sample, and equal aliquots of muscle and liver from each trawl fish sample were frozen and distributed to the metals and organic chemistry sections of the analytical chemistry laboratory for analyses.

In addition to the percent lipid content determination, the organic chemistry section extracted 20 rig-fish muscle samples, 38 trawl fish muscle tissue samples, and 38 trawl fish liver tissue samples, and analyzed them for PCB congeners and organochlorine pesticides. Of the 38 trawl fish liver samples, results from 18 samples, all from the non-outfall area, were not reported due to a major instrument error resulting in the failure of all QC samples contained in the 2 batches. No additional samples were available for reanalysis. A laboratory QAQC corrective action notice was filed.

A typical organic tissue sample batch included 15 field samples with required QC samples. The QC samples included 1 hydromatrix blank, 2 sample duplicates, 1 matrix spike, 1 matrix spike duplicate, 1 SRM, and 1 reporting level spike (matrix of choice was tilapia).

For mercury analysis, 1 sample batch consisted of 15–20 fish tissue samples and the required QC samples, which included a blank, blank spike, SRM, sample duplicates, matrix spikes, and matrix spike duplicates.

Analytical Methods - Organochlorine Pesticides and PCB Congeners

The analytical methods used for organochlorine pesticides and PCB congeners were according to methods described in the LMC SOPs. All fish tissue was extracted using an ASE 350 and analyzed by GC/MS.

The MDLs for pesticides and PCBs in fish tissue are presented in Table C-1. Acceptance criteria for PCB and pesticides SRM in fish tissue are presented in Table C-3. Fish tissue pesticide and PCB QA/QC summary data are presented in Table C-5. All analyses were performed within the required holding times and with appropriate quality control measures. Most compounds tested in each parameter group met the QA/QC criteria (Table C-5). In cases where constituent concentrations exceeded the calibration range of the instrument, the samples were diluted and reanalyzed. Any variances that occurred during sample preparation or analyses are noted in the Comments/Notes section of each batch summary.

Analytical Methods – Lipid Content

Percent lipid content was determined for each sample of fish using methods described in the LMC SOPs. Lipids were extracted by dichloromethane from approximately 1 to 2 g of sample and concentrated to 2 mL. A 100 µL aliquot of the extract was placed in a tarred aluminum weighing boat and allowed to evaporate to dryness. The remaining residue was weighed, and the percent lipid content calculated. Lipid content QA/QC summary data are presented in Table C-5. All analyses passed and were performed within the required holding times and with appropriate quality control measures.

Table C–5 Fish tissue QA/QC summary, July 2016-June 2017.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	PCBs and Pesticides	96 (6)	Blank	12	54	648	100.0
			Blank Spike	6	54	316	97.5
			Matrix Spike	6	54	305	94.1
			Matrix Spike Dup	6	54	305	94.1
			Matrix Spike Precision	6	54	320	98.8
			Duplicate	9	54	484	99.6
			CRM Analysis	6	40	213	88.8
Summer	Percent Lipid - Liver	1	Duplicate Samples	1	1	1	100.0
	Percent Lipid - Muscle	3	Duplicate Samples	5	1	5	100.0
Summer	Mercury	96 (2)	Blank	6	1	6	100.0
			Blank Spike	6	1	5	83.3
			Matrix Spike	10	1	10	100.0
			Matrix Spike Dup	10	1	10	100.0
			Matrix Spike Precision	10	1	10	100.0
			Duplicate	10	1	10	100.0
			CRM Analysis	2	1	2	100.0
Summer	Arsenic & Selenium	20 (1)	Blank	3	2	6	100.0
			Blank Spike	1	2	2	100.0
			Matrix Spike	2	2	4	100.0
			Matrix Spike Dup	2	2	4	100.0
			Matrix Spike Precision	2	2	4	100.0
			Duplicate	2	2	4	100.0
			CRM Analysis	1	2	2	100.0

PCBs and Pesticides:
* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3X MDL.
For blank spike - Target accuracy % recovery 60-120.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 40-120.
For matrix spike precision - Target precision % RPD <20%.
For duplicate - Target precision % RPD <20% at 3X MDL of sample mean.
For SRM analysis - Target accuracy % recovery 60-140 or certified value, whichever is greater.

Percent Lipid:
* An analysis passed if the following criteria were met:
For duplicate - Target precision % RPD <25%.

Mercury, Arsenic & Selenium:
* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <2X MDL.
For blank spike - Target accuracy % recovery 90-110.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 70-130.
For matrix spike precision - Target precision % RPD <25%.
For duplicate - Target precision % RPD <30% at 10X MDL of sample mean.
For SRM analysis - Target accuracy % recovery 80-120 or certified value, whichever is greater.

Analytical Methods - Mercury

Fish tissue samples were analyzed for mercury in accordance with LMC SOPs. Typical QC analyses for a tissue sample batch included a blank, a blank spike, and SRMs (liver and muscle). In the same batch, additional QC samples included duplicate analyses of the sample, spiked samples, and duplicate spiked samples, which were run approximately once every 10 samples.

The MDL for fish mercury is presented in Table C-1. Acceptance criteria for the mercury SRMs are presented in Table C-3. Fish tissue mercury QA/QC summary data are presented in Table C-5. All samples were analyzed within their 6-month holding times and met the QA criteria guidelines. Nearly all samples met the QA criteria guidelines for accuracy and precision.

Analytical Methods - Arsenic and Selenium

Fish tissue samples were analyzed for arsenic and selenium in accordance with LMC SOPs. A typical QC analyses for a tissue sample batch included 3 blanks, a blank spike, and a SRM (muscle). In the same batch, additional QC samples included duplicate analyses of the sample, spiked samples, and duplicate spiked samples which were run approximately once every 10 samples.

The MDLs for fish arsenic and selenium are presented in Table C-1. Acceptance criteria for the arsenic and selenium SRMs are presented in Table C-3. Fish tissue arsenic and selenium QA/QC summary data are presented in Table C-5. All samples were analyzed within a 6-month holding time and met the QA criteria guidelines. All samples met the QA criteria guidelines for accuracy and precision.

BENTHIC INFAUNA NARRATIVE

Sorting and Taxonomy QA/QC

The sorting and taxonomy QA/QC follows the District's QAPP. These QA/QC procedures were conducted on sediment samples collected for infaunal community analysis in July 2016 (summer) from 29 semi-annual stations (52–65 m) and 39 annual stations (40–300 m), in January 2017 (winter) from the same 29 semi-annual stations, and in March 2017 (winter) from 2 additional samples taken at Station 0, for a total of 99 samples for the year (Table A-4).

Sorting QA/QC Procedures

The sorting procedure involved removal, by Marine Taxonomic Services, Inc. (MTS), of all organisms including their fragments from sediment samples into separate vials by major taxa (aliquots). The abundance of countable organisms (heads only) per station was recorded. After MTS' in-house sorting efficiency criteria were met, the organisms and remaining particulates (grunge) were returned to the District. Ten percent of these samples (10 of 99) were randomly selected for re-sorting by District staff. A tally was made of any countable organisms missed by MTS. A sample passed QC if the total number of countable animals found in the re-sort was ≤5% of the total number of individuals originally reported.

2016-17 Sorting QA/QC Results

Sorting results for all QA samples were well below the 5% QC limit.

Taxonomic Identification QA/QC Procedures

Selected benthic infauna samples underwent comparative taxonomic analysis by 2 independent taxonomists. Samples were randomly chosen for re-identification from each taxonomist's allotment of assigned samples. These were swapped between taxonomists with the same expertise in the major taxa. The resulting data sets were compared and a discrepancy report generated. The participating taxonomists reconciled the discrepancies. Necessary corrections to taxon names or abundances were made to the database. The results were scored and errors tallied by station. Percent errors were calculated using the equations below:

Equation 1. $\%Error_{\#\ Taxa} = (|\#\ Taxa_{Resolved} - \#\ Taxa_{Original}| \div \#\ Taxa_{Resolved}) \times 100$

Equation 2. $\%Error_{\#\ Individuals} = (|\#\ Individuals_{Resolved} - \#\ Individuals_{Original}| \div \#\ Individuals_{Resolved}) \times 100$

Equation 3. $\%Error_{\#\ ID\ Taxa} = (\#\ Taxa_{Misidentification} \div \#\ Taxa_{Resolved}) \times 100$

Equation 4. $\%Error_{\#\ ID\ Individuals} = (\#\ Individuals_{Misidentification} \div \#\ Individuals_{Resolved}) \times 100$

Please refer to the District's QAPP for detailed explanation of the variables. The first 3 equations are considered gauges of errors in accounting (e.g., recording on wrong line, miscounting, etc.), which, by their random nature, are difficult to predict. Equation 4 is the preferred measure of identification accuracy. It is weighted by abundance and has a more rigorous set of corrective actions (e.g., additional taxonomic training) when errors exceed 10%.

In addition to the re-identifications, a synoptic data review was conducted upon completion of all data entry and QA. This consisted of a review of the infauna data for the survey year, aggregated by taxonomist (including both in-house and contractor). From this, any possible anomalous species reports, such as species reported outside its known depth range and possible data entry errors, were flagged.

2016-17 Taxonomic QA/QC Results

QC objectives for identification accuracy (Equation 4) were met in 2016-17 (Table C-6). No significant changes to the 2016-17 infauna dataset were made following the synoptic data review.

Table C–6 Percent error rates calculated for July 2016 QA samples.

Error Type	Station			Mean
	4	68	22	
1. %Error # Taxa	2.8	12.2	1.4	5.5
2. %Error # Individuals	0.4	2.4	1.2	1.3
3. %Error # ID Taxa	1.8	18.4	2.8	7.7
4. %Error # ID Individuals	0.4	6.4	1.6	2.8

OTTER TRAWL NARRATIVE

The District’s trawl sampling protocols are based upon regionally developed sampling methods (Kelly et al. 2013). These methods require that a portion of the trawl track must pass within a 100-m radius of the nominal station position and be within 10% of the station’s nominal depth. In addition, the speed of the trawl should range from 0.77 to 1.0 m/s (1.5 to 2.0 kts). Since 1985, the District has trawled a set distance of 450 m ±10% (the distance that the net is on the bottom collecting fish and invertebrates). This contrasts with previous regional trawl surveys which factored in time on the bottom, not distance. Station locations and trawling speeds and paths were determined using Global Positioning System navigation. Trawl depths were determined using a Sea-Bird Electronics SBE 39 pressure sensor attached to one of the trawl boards.

For Summer 2016, trawl distances averaged 459 m and average trawl speed was 1.9 kts (Table C-7). All trawls were within the required distance of 450 m except at Stations T17 and T25. All trawls were conducted at speeds between 1.5–2.0 kts except at Station T19. All trawls passed through the designated 100-meter radius and all trawls were within ±10% of the nominal station depth except at Station T18.

For Winter 2017, trawl distances averaged 450 m and average trawl speed was 1.9 kts (Table C-7). All trawls were within the required distance of 450 m except at Station T1. All trawls were conducted at speeds between 1.5–2.0 kts, passed through the designated 100-meter radius, and were within ±10% of the nominal station depth.

Table C–7 Trawl track distance, vessel speed, bottom depth, and distance from nominal station position for sampling conducted in Summer 2016 and Winter 2017. Trawl QA variables that did not meet QA criteria are denoted by an asterisk (*).

Season	Station	Trawl Depth Range	Distance Trawled (m)	Vessel Speed (kts)	Average Trawl Track Depth	Distance from Nominal Center
Summer	T1	49.5 - 60.5	458.2	1.8	58	12
	T2	31.5 - 38.5	456.2	1.9	36	38
	T6	32.4 - 39.6	459.3	1.9	38	5
	T10	123.3 - 150.7	457.0	1.9	135	26
	T11	54 - 66	485.8	1.9	64	30
	T12	51.3 - 62.7	461.1	1.7	56	6
	T14	123.3 - 150.7	456.4	2.0	139	22
	T17	54 - 66	379.3 *	1.9	61	21
	T18	32.4 - 39.6	451.8	1.7	40 *	67
	T19	123.3 - 150.7	456.4	2.1 *	136	7
	T22	54 - 66	455.2	1.7	63	23
	T23	52.2 - 63.8	458.2	1.9	60	7
	T24	32.4 - 39.6	457.1	1.9	37	8
	T25	123.3 - 150.7	355.9 *	1.8	135	100
	Mean	**—**	**459.4**	**1.9**	**—**	**—**
Winter	T1	49.5 - 60.5	397.9 *	1.9	56	6
	T11	31.5 - 38.5	455.2	1.9	59	26
	T12	51.3 - 62.7	466.8	1.9	58	4
	T17	54 - 66	460.2	2.0	62	3
	T22	54 - 66	457.4	1.9	62	7
	T23	51.3 - 62.7	460.9	1.8	61	3
	Mean	**—**	**449.7**	**1.9**	**—**	**—**

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