Marine Monitoring Annual Report

Program Year 2021 - 2022

ORANGE COUNTY SANITATION DISTRICT

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Certification Statement

The following certification satisfies Attachment E of the Orange County Sanitation District (OC San) Monitoring and Reporting Program, Order No. R8-2021-0010, NPDES No. CA0110604, for the submittal of the attached OC San 2021-22 Marine Monitoring Annual Report.

I certify under penalty of law that this document was prepared under my 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 data, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fines and imprisonment for known violations.

Lan C. Wiborg
Director of Environmental Services

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

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March 14, 2023

Tomás Torres
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, CA 94105

SUBJECT: 2021 NPDES Permit Requirement (Order No. R8-2021-0010, NPDES Permit No. CA0110604) Marine Monitoring Annual Report

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In accordance with the requirements of the 2021 NPDES Permit (Order No. R8-2021-0010, NPDES permit No. CA0110604), Attachment E. Monitoring and Reporting Program, Section XII. Reporting Requirements, Subsection D(3) Receiving Water Monitoring Report (pg. E-72), enclosed is the Orange County Sanitation District (OC San) 2021-22 Marine Monitoring Annual Report.

This report focuses on the final effluent and receiving water findings and conclusions for the monitoring period of July 1, 2021 to June 30, 2022. The results from this reporting period document that no permit exceedances occurred in OC San's secondary-treated effluent. Furthermore, OC San's ocean discharge, which consisted of water reclamation reject flows and secondary-treated wastewater, did not adversely affect the receiving environment or pose a risk to human health.

Compliance with bacteria standards in zones used for water contact sports was achieved in 100% of the water samples. Numeric receiving water criteria for water clarity, dissolved oxygen, and pH were met in at least 93% of the samples. Concentrations of ammonia nitrogen in water samples were 17 and 25 times lower than the chronic and acute toxicity standards of the California Ocean Plan, respectively. Additionally, there were no positive relationships between the measured concentrations of ammonia nitrogen and chlorophyll-*a* in the receiving environment.

There were no discernible impacts to the sediment-dwelling animal communities within and adjacent to the zone of initial dilution (ZID). Infauna and demersal fish communities in the monitoring area were considered healthy (i.e., comparable to reference condition) based on the low Benthic Response Index (<25) and Fish Response Index (<45) scores, respectively. In addition, the contaminant concentrations in all sediment samples were comparable to background levels (i.e., below threshold levels), and no measurable toxicity was recorded in whole sediment toxicity tests. The low levels of contaminants in fish tissue samples, as well as the negligible

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disease symptoms and minimal liver pathologies in fish samples, demonstrated that OC San's ocean discharge was not associated with any incidence or prevalence of fish disease.

If you have any questions or comments, please contact me at (714) 593-7450 or Dr. Violet Renick, Ocean Monitoring Supervisor, at (714) 593-7465.

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Enclosure

cc: J. Joy, RWQCB (via email)

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cc: T. Torres, EPA (via email)

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Acknowledgements

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Executive Summary

The Orange County Sanitation District (OC San) operates Reclamation Plant No. 1 in Fountain Valley and Treatment Plant No. 2 in Huntington Beach, California, with the mission to safely collect, process, recycle, and dispose of treated wastewater while protecting human health and the environment. To evaluate potential environmental and human health impacts from its discharge of final effluent into the Pacific Ocean, OC San conducts extensive testing of final effluent samples and long-term monitoring of coastal water quality, sediment quality, invertebrate and fish communities, fish bioaccumulation, and fish health within 185 square miles (479 square km) of ocean. The final effluent, consisting of secondary-treated wastewater mixed with water reclamation flows, is released through a 120-in (305-cm) outfall extending 4.4 miles (7.1 km) offshore in 197 ft (60 m) of water. The data collected are used to determine compliance with final effluent and receiving water conditions as specified in OC San's National Pollution Discharge Elimination System permit (Order No. R8-2021-0010, NPDES Permit No. CA0110604). The permit was jointly issued on June 23, 2021, by the U.S. Environmental Protection Agency, Region IX and the Regional Water Quality Control Board, Region 8 and came into effect on August 1, 2021. This report focuses on monitoring results and conclusions from July 2021 through June 2022.

EFFLUENT QUALITY

No permit exceedances were recorded among the final effluent parameters measured for compliance, and all mass emission benchmarks were met. In terms of performance goals, only 2 of the 80 final effluent constituents monitored were detected above their respective performance goal value for 2 or more consecutive months.

WATER QUALITY

Compliance for all 3 fecal indicator bacteria was achieved in 100% of the samples collected in coastal areas used for water contact sports. Analysis of ammonia nitrogen samples and water column profiles of chlorophyll-*a* concentrations indicated no correlation between nutrients discharged from the outfall and primary production. Compliance criteria for dissolved oxygen and pH were met in 100% of the measurements. By contrast, minimal plume-related changes in water clarity were occasionally detected; however, none of the changes were determined to be environmentally significant since they fell within natural ranges to which marine organisms are exposed.

SEDIMENT QUALITY

Measured sediment parameters were comparable among benthic stations located within and beyond the zone of initial dilution[1] (ZID). Furthermore, measured values were comparable to OC San historical values and Southern California Bight Regional Monitoring results and were below applicable Effects-Range-Median guidelines of biological concern. In addition, whole sediment toxicity tests showed no measurable toxicity.

[1] The zone of initial dilution represents a 60 m boundary around the OC San outfall diffuser.

BIOLOGICAL COMMUNITIES

Infaunal Communities

Infaunal communities were generally similar among within-ZID and non-ZID benthic stations based on comparable community measure values and community structure. In addition, the infaunal communities within the monitoring area can be classified as reference condition based on their low Benthic Response Index scores (<25) and high Infaunal Trophic Index scores (>60).

Demersal Fish and Epibenthic Macroinvertebrate Communities

The community measure values and community structure of the epibenthic macroinvertebrates and demersal fishes at outfall and non-outfall trawl stations were comparable. In addition, the community measure values were within regional and OC San historical ranges. Fish communities at all stations were classified as reference condition based on their low Fish Response Index scores (<45).

FISH BIOACCUMULATION AND HEALTH

Contaminants in Fish Tissue

The concentration of chlorinated pesticides and trace metals in composite liver tissues of flatfish samples and in composite muscle tissues of sport fish samples were similar between outfall and non-outfall locations. Furthermore, the concentration of all contaminants measured in sport fish samples did not exceed California's "Do not consume" Advisory Tissue Level.

Fish Health

No anomalies were detected in the odor and color of demersal fish samples. Additionally, disease symptoms such as skeletal deformities, tumors, fin erosion, and skin lesions were absent in fish samples, and large external parasites were observed in <1% of the fish samples examined. Minimal liver tissue damage was observed in most of the Hornyhead Turbot and English Sole samples collected at outfall and non-outfall sites; however, no significant differences were observed for either species between sites.

CONCLUSION

The 2021-22 effluent monitoring results indicate that OC San's treatment systems are robust, and OC San employs sound operation practices at its 2 plants. The results of the bacterial, physical, and chemical parameters measured in the water column during the 2021-22 program year indicate good water quality in OC San's monitoring area. Additionally, the sediment quality appeared to be minimally impacted based on the relatively low concentrations of chemical contaminants measured in samples collected at select depth strata, as well as from the absence of sediment toxicity in controlled laboratory tests of sediment collected at outfall-depth stations. The animal communities and contaminant concentrations in fish tissue samples were comparable between outfall and non-outfall areas, and negligible disease symptoms and minimal liver pathologies were observed in fish samples. Overall, these results suggest that the receiving environment was not degraded by OC San's discharge of treated wastewater, and as such, beneficial uses were protected and maintained.

Chapter 1. The Ocean Monitoring Program

INTRODUCTION

The Orange County Sanitation District (OC San) operates 2 facilities, one located in Fountain Valley (Reclamation Plant No. 1) and the other in Huntington Beach (Treatment Plant No. 2), California. OC San discharges treated wastewater to the Pacific Ocean through a 120-in (305-cm) diameter, submarine outfall located offshore of the Santa Ana River (Figure 1-1). This discharge is regulated by the U.S. Environmental Protection Agency (EPA), Region IX and the California Regional Water Quality Control Board (RWQCB), Region 8 under the Federal Clean Water Act, the California Ocean Plan, and the RWQCB Basin Plan. Specific discharge and monitoring requirements for the 2021-22 program year are contained in a National Pollutant Discharge Elimination System (NPDES) permit (Order No. R8-2021-0010, NPDES Permit No. CA0110604) that was issued jointly by the EPA and the RWQCB on June 23, 2021 and came into effect on August 1, 2021.

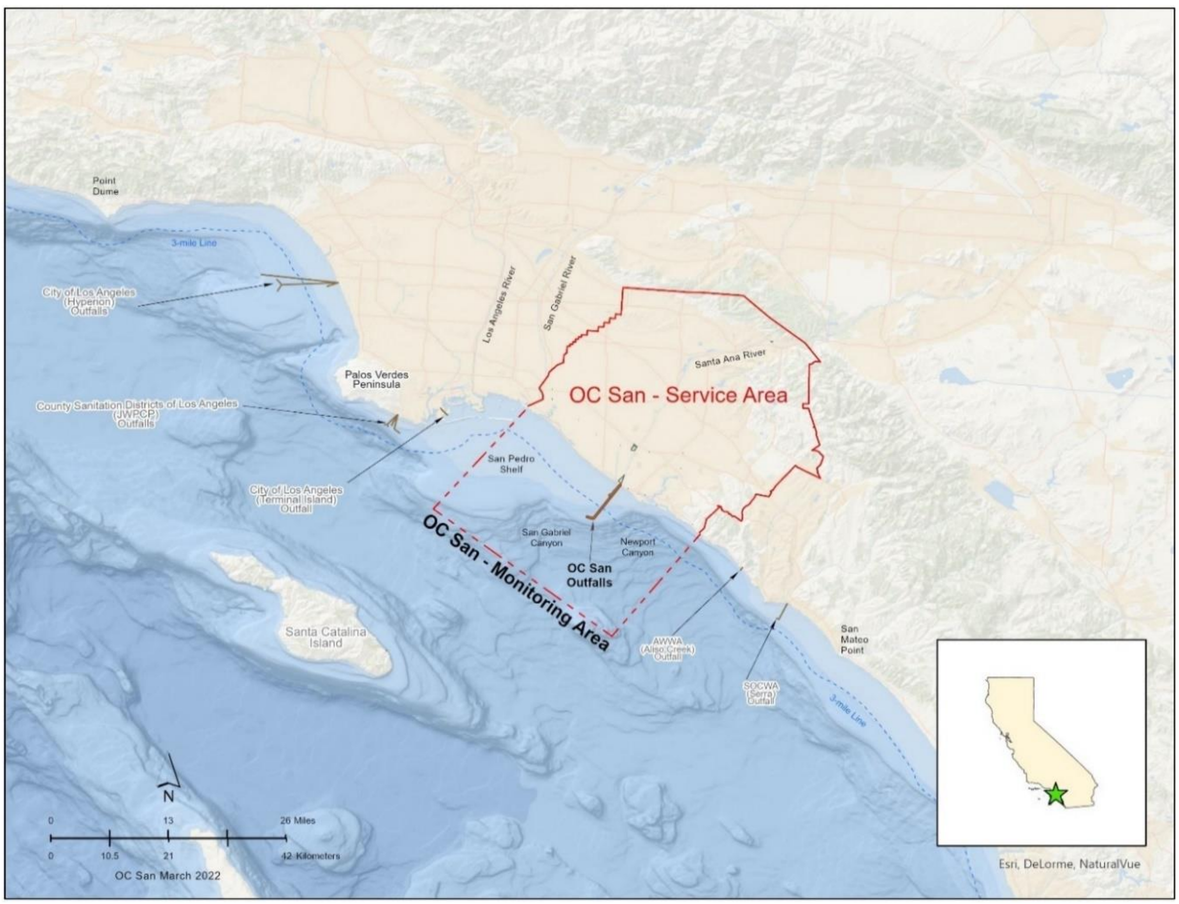

Figure 1-1 Regional setting and sampling area for OC San's Ocean Monitoring Program. Inset shows the general location of OC San's sampling area relative to the State.

OC San Environmental Laboratory and Ocean Monitoring Division

REGULATORY SETTING FOR THE OCEAN MONITORING PROGRAM

OC San's NPDES permit includes requirements to monitor influent, final 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. Additionally, constituent concentrations and average mass emissions of the effluent are evaluated as indicators of treatment efficiency of the plants. Impacts of wastewater discharge to coastal receiving waters are evaluated by OC San's Ocean Monitoring Program (OMP) based on 3 inter-related components: (1) Core monitoring; (2) Strategic Process Studies (SPS); and (3) Regional monitoring. 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 and further described throughout this report.

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 includes fish tissue contaminant and liver histopathology analyses.

OC San conducts SPS, as well as other smaller special studies, to provide information about relevant coastal and ecotoxicological processes, emerging contaminants, and modern monitoring tools to provide further insight into the traditional Core monitoring program. Recent studies have included contributions to the development of ocean circulation and biogeochemical models and demersal fish tracking to inform species selection for continued monitoring. Ongoing and recently completed SPS are further described in Chapter 4 of this report.

Since 1994, OC San has participated in 6 regional monitoring studies of environmental conditions within the Southern California Bight (SCB): 1994 Southern California Bight Pilot Project, Bight '98, Bight '03, Bight '08, Bight '13, and Bight '18. OC San plays an integral role in these regional projects by contributing to many of the program design decisions and by participating in field sampling, sample and data analyses, and reporting. 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 and reports can be found at the Southern California Coastal Water Research Project's website.

Other collaborative regional monitoring efforts include:

- Participation in the Southern California Bight Regional Water Quality Program (previously known as the Central Bight Water Quality Program), a water quality sampling effort with the City of Los Angeles, the County Sanitation Districts of Los Angeles, and the City of San Diego.
- Supporting and working with the Southern California Coastal Ocean Observing System (SCCOOS) to upgrade and maintain water quality sensors on the Newport Pier Automated Shore Station.
- Supporting the SCCOOS Newport Pier Imaging FlowCytobot (IFCB), an in-situ autonomous imaging flow cytometer which captures high resolution images of phytoplankton.
- Partnering with the Orange County Health Care Agency and other local Publicly Owned Treatment Works to conduct regional shoreline (aka surfzone) bacterial monitoring used to determine the need for beach postings and/or closure.
- Collaborating on a regional aerial kelp monitoring program.

ENVIRONMENTAL SETTING

OC San's ocean monitoring area is adjacent to California's most highly urbanized area (OCSD 2021, 2022). Beaches are a primary reason for people to visit coastal Southern California (Kildow and Colgan 2005, NOAA 2015). Although highest visitations occur during the warmer, summer months, Southern California's Mediterranean climate and convenient beach access results in significant year-round use by the public. A large percentage of the local economies rely on beach use and its associated recreational activities, which are highly dependent upon local water quality conditions (Turbow and Jiang 2004, Leeworthy and Wiley 2007, Leggett et al. 2014). In 2016, Orange County's coastal economy, comprising tourism, recreation, construction and fishing industries, was valued at $4.3 billion (E2 2019). 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).

The Core monitoring area covers most of the San Pedro Shelf and extends southeast off the shelf (Figure 1-1). These nearshore coastal waters receive inputs from a variety of anthropogenic sources, such as wastewater discharges, dredged material disposals, 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). Untreated discharges from the Los Angeles, San Gabriel, and Santa Ana Rivers—representing nearly 30% of the surface flow to the SCB (SCCWRP, personal communication, November 30, 2020)—are responsible for a substantial amount of contaminant inputs (Schafer and Gossett 1988, SCCWRP 1992, Schiff et al. 2000, Schiff and Tiefenthaler 2001, Tiefenthaler et al. 2005).

The San Pedro Shelf is primarily composed of soft sediments (sands with silts and clays) with scattered hard substrate reefs and manmade structures and is inhabited by biological communities typical of these environments (OCSD 2004). Seafloor depth on the shelf increases gradually from the shoreline to approximately 262 ft (80 m), after which it increases rapidly down to the open basin. The outfall diffuser lies at a nominal depth of 197 ft (60 m) on the southern portion of the shelf between the Newport and San Gabriel submarine canyons. The monitoring area southeast of the outfall is characterized by a much narrower shelf and deeper water offshore (Figure 1-1).

The 120-in outfall, and its associated ballast rock, rests on soft-bottom habitat and is one of the largest artificial reefs in the SCB. As a reef, it supports communities typical of hard substrates that would not otherwise be found in the monitoring area (Lewis and McKee 1989, OCSD 2000). Together with OC San's 78-in (198-cm) outfall, nearly 25 acres (approximately 102,193 m^2 or 1.1×10^6 ft^2) of seafloor was converted from a flat, sandy habitat into a raised, hard-bottom substrate.

As part of the California Current Ecosystem, conditions within OC San's Core monitoring area are affected by global, regional, and local oceanographic influences. Global climatic (e.g., El Niño) and large-scale regional current conditions (e.g., California Current) influence the water characteristics and the direction of water flow along the Orange County coastline (Hood 1993). The California Multivariate Ocean Climate Index (MOCI; Farallon Institute 2022) is a unitless measure that synthesizes multiple local and regional ocean and atmospheric conditions to represent the environmental state of California's coastal ocean (Figure 1-2). It displays both temporal and spatial ocean state variability and intensity along the coast and has been shown to have good predictive skill relative to biology across multiple trophic levels (García-Reyes and Sydeman 2017). Consistent with MOCI, temperature anomalies recorded at stations along the California Cooperative Oceanic Fisheries Investigations (CalCOFI) Transect Line 90 (SIO 2022) illustrate that the basin-wide, cross-shelf temperature signal reaches out to 311 miles (500 km) from shore and spans the water column from near the surface to the OC San outfall depth of 60 m (Rudnick et al. 2017; Figure 1-3).

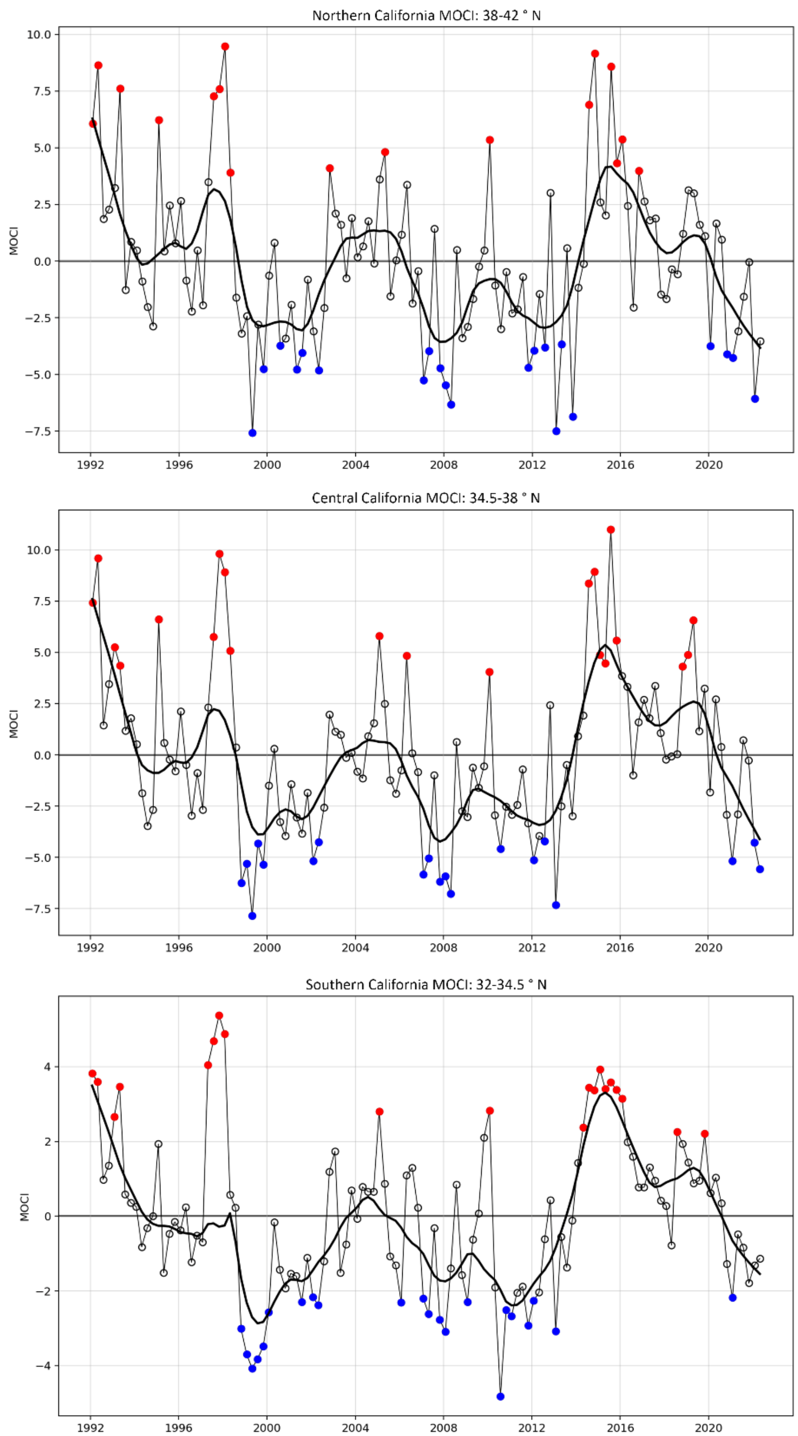

Figure 1-2 California Multivariate Ocean Climate Index for Northern (top figure), Central (middle figure) and Southern (bottom figure) California ([MOCI - Farallon Institute]). Red circles represent values 1 standard deviation above the mean (i.e., they indicate warm conditions and weak upwelling); blue circles represent values 1 standard deviation below the mean (i.e., they indicate cold conditions and strong upwelling).

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Other oceanographic processes (e.g., upwelling, coastal eddies) and algal blooms also influence the characteristics of receiving waters on the San Pedro Shelf. Tidal flows, currents, and internal waves mix and transport OC San's wastewater discharge with coastal waters and resuspended sediments. Locally, the predominant low-frequency current flows in the monitoring area are alongshore (upcoast or downcoast) with minor across-shelf (toward the beach) transport (CSDOC 1997, 1998; SAIC 2001, 2009, 2011; OCSD, 2004, 2011). The specific direction of the flow varies with depth and season and is subject to reversals over time periods of days to weeks (SAIC 2011). Tidal currents in the monitoring area 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. Algal blooms, while variable, have both regional and local distributions that can impact human and marine organism health (Nezlin et al. 2018, Smith et al. 2018, UCSC 2018, CeNCOOS 2019).

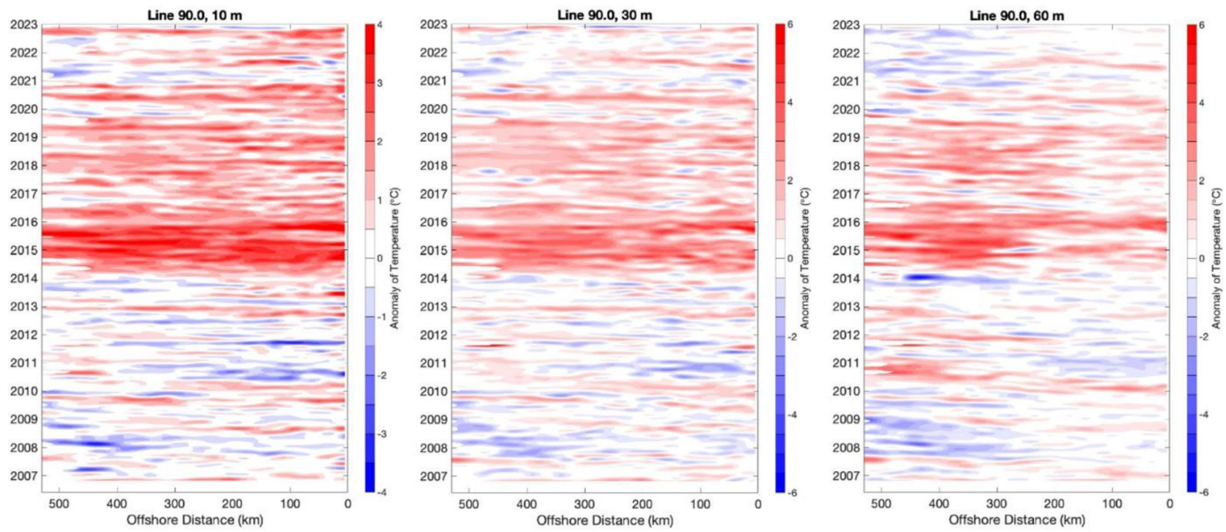

Figure 1-3 Temperature anomalies measured from the shoreline to 311 miles (500 km) offshore along CalCOFI Line 90 at 32 ft (10 m) below the surface (left figure), at OC San's typical plume trapping depth of 98 ft (30 m) (middle figure), and at OC San's nominal outfall depth of 197 ft (60 m) (right figure). Source: Climatology of the California Underwater Glider Network, Scripps Institution of Oceanography (1/3/2023).

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Atmospheric weather events (e.g., episodic storms, drought, and climatic cycles) influence surface flows and hence, environmental conditions and biological communities. River flows, together with urban stormwater runoff, represent significant, if episodic, sources of fresh water, sediments, suspended particles, nutrients, bacteria, and other contaminants to the coastal area (Hood 1993, Grant et al. 2001, Warrick et al. 2007), although some studies indicate that the spatial impact of these effects may be limited (Ahn et al. 2005, Reifel et al. 2009). While materials supplied to coastal waters by rivers and stormwater flows are essential to natural biogeochemical cycles, an excess or a deficit may have important environmental and human health consequences.

Stormwater runoff has a large influence on sediment movement in the region (Brownlie and Taylor 1981, Warrick and Millikan 2003). Major storm events can generate waves capable of extensive coastal erosion and inundation and can resuspend and move sediments along the coast. Understanding the interplay of weather cycles and watershed inputs is an important factor in evaluating spatial and temporal trends in local coastal environmental quality, especially as it relates to beach bacterial contamination. For example, in the 2021-22 program year, during non-rainfall periods, 99% of monitored Orange County Beaches received grades of either "A" or "B", while after storm events, this dropped down to 66% (Heal the Bay 2022).

Other anthropogenic influences that are present in the region likely also contribute to the complexity of contaminant signatures in the monitoring region. For example, in October 2021, a damaged and leaking pipeline approximately 3 miles (4.8 km) offshore of Huntington Beach released approximately 25,000 gallons (nearly 95,000 L) of crude oil into the monitoring region (Pipeline P00547 Incident). The spill created a 13-square mile (34-square km) oil slick that extended over most of OC San's offshore monitoring stations. The Orange County oil spill and its impacts to the OMP are further detailed in Chapter 4.

PROGRAM RATIONALE

The complexities of the environmental setting and related difficulties in assigning a cause or source to a pollution event are the rationale for OC San's extensive OMP. The program has contributed substantially to the understanding of water quality and environmental conditions along Orange County beaches and coastal ocean reach. The large amount of information collected provides a broad understanding of both natural and anthropogenic processes that affect coastal oceanography and marine biology, the near-coastal ocean ecosystem, and its related beneficial uses.

This report presents OMP compliance determinations for data collected from July 2021 through June 2022. Results of effluent monitoring for permit-specified limits, performance goals, and mass emission benchmarks are reported in Chapter 2. Compliance determinations for receiving water monitoring results were made by comparing OMP findings to the criteria specified in OC San's NPDES permit and are addressed in Chapter 3. Progress and outcomes for SPS, special studies, and regional monitoring efforts can be found in Chapter 4. Supporting information including methods, detailed results, and QA/QC findings are provided in appendices.

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Chapter 2. Final Effluent Characteristics and Mass Emissions

INTRODUCTION

OC San'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 requirements. This is achieved through extensive industrial pretreatment (source control), primary, secondary and solids treatment processes, biosolids management, and water reuse programs. This chapter presents OC San's compliance determinations, performance goals, and mass emission benchmarks for its final effluent to demonstrate the effectiveness of the suite of treatment processes used during the 2021-22 program year. The performance goals and mass emission benchmarks are not considered enforceable effluent limitations or standards for the regulation of discharge from OC San.

OC San's Reclamation Plant No. 1 and Treatment Plant No. 2 receive domestic sewage from approximately 80% of the County's 3.2 million residents, industrial wastewater from 547 permitted businesses within its service area and, for the past 23 years, dry weather urban runoff from over 20 diversions. Once the influent undergoes secondary treatment processes at Plant No. 1, including nitrification and partial denitrification at 2 activated sludge facilities, this flow is provided to the Orange County Water District (OCWD) for the Groundwater Replenishment System (GWRS). OCWD further treats this water for industrial and landscaping uses and to recharge local groundwater supplies (primarily for indirect potable use and secondarily as a saltwater intrusion barrier). The influent at Plant No. 2 undergoes secondary treatment by either a high purity oxygen activated sludge or a trickling filter solids-contact process. The final effluent, which consists of Plant No. 2 secondary effluent mixed with reverse osmosis (RO) concentrate from OCWD, is discharged under normal operations through the 120-in ocean outfall (Discharge Point 001). The 120-in outfall extends 4.4 miles (7.1 km) from the Huntington Beach shoreline and has a discharge capacity of 480 million gallons per day (MGD) (1.8×10^9 L/day) (Figure 3-1). The last 1.1 miles (1.8 km) of the 120-in outfall consists of a diffuser with 503 ports that discharge the treated effluent at a nominal depth of 197 ft (60 m). OC San also operates a 78-in outfall (Discharge Point 002) that is 1.3 miles (0.8 km) long (Figure 3-1) and is used as an emergency ocean outfall. The 0.2-mile (0.3-km) long diffuser section of the 78-in outfall resides at a nominal depth of 66 ft (20 m) and has 130 effluent ports, with a discharge capacity of 230 MGD (8.7×10^8 L/day).

During the 2021-22 program year, OC San received and processed influent volumes averaging 179 MGD (6.8×10^8 L/day). After diversions to OCWD and the return of their reject flows (e.g., RO concentrate), OC San discharged an average of 94 MGD (3.6×10^8 L/day) of treated wastewater through the 120-in outfall. The 78-in outfall was not used during the 2021-22 program year.

RESULTS

No permit exceedances were recorded among the 42 final effluent parameters measured for compliance during the 2021-22 program year (Table 2-1). The annual average of most parameters was considerably lower than their respective permit limit. For example, the annual average for the monthly total suspended solids (TSS) was 4,579 lbs/day compared to the 51,541 lbs/day permit limit. Likewise, the annual average for the instantaneous maximum of total chlorine residual was 129 lbs/day compared to the 18,658 lbs/day permit limit. Among the 3 radioactivity parameters measured in the final effluent, only 1 result was recorded above the stipulated criterion of 15 pCi/L for monthly gross alpha radioactivity and 5 results were recorded above the stipulated criterion of 50 pCi/L for monthly gross beta radioactivity (Table 2-1). Nonetheless, the monthly combined radium-226 & 228[2] values were all below the stipulated criterion of 5 pCi/L. No anomalies were detected among the 50 miscellaneous parameters measured in the final effluent (Table 2-1). Furthermore, the results of the nitrogen-based nutrient parameters were within expected ranges.

In terms of performance goals, only 2 of the 80 constituents monitored were detected above their respective performance goal value for 2 or more consecutive months in the 2021-22 program year (see Table 2.10 in OC San's 2021-22 Pretreatment Program Annual Report). Upon investigation, the total chromium performance goal exceedances in the final effluent were determined to consist entirely of trivalent chromium (Cr(III)) rather than hexavalent chromium (Cr(VI)), and all measured total chromium concentrations, ranging from 0.97–4.29 µg/L, were well below the water quality objectives of 190,000 µg/L for Cr(III) (OCSD 2022). The performance goal exceedances for total cyanide were determined to be most likely attributable to cyanide signals created from the chloramine in the GWRS' RO concentrate stream reacting with sodium hydroxide used to preserve samples for cyanide analysis (OCSD 2022).

Among the 80 constituents analyzed for mass emission benchmarks, all had a 12-month average value below their respective benchmark (Table 2-2). Indeed, results for 75% (60/80) of the measured constituents were below their respective detection limit.

CONCLUSION

Overall, these results indicate OC San's treatment systems are robust, and OC San employs sound operation practices at its 2 plants.

SUMMARY OF NON-COMPLIANCE

There were no excursions of effluent limitations in the 2021-22 program year.

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[2] Analysis for combined radium-226 & 228 is triggered when the gross alpha or gross beta result for the same sample is above the stipulated criterion of 15 pCi/L and 50 pCi/L, respectively.

Table 2-1 Monthly and annual averages of parameters measured in the final effluent during the 2021-22 program year. ND = Not Detected; NA = Not Applicable. OC San Environmental Laboratory and Ocean Monitoring Division

		Month/Year													
Parameter	**Units**	**7/21**	**8/21**	**9/21**	**10/21**	**11/21**	**12/21**	**1/22**	**2/22**	**3/22**	**4/22**	**5/22**	**6/22**	**Annual Average**	**Permit Limit or Criterion**
Parameters with Effluent Limitations															
Turbidity Monthly Avg	NTU	2.2	2.1	2.6	3.0	2.6	2.5	2.6	2.7	2.2	3.4	2.3	3.4	2.6	75
Turbidity Weekly Avg [a]	NTU	2.2	2.1	2.6	3.0	2.6	2.5	2.6	2.7	2.2	3.4	2.3	3.4	2.6	100
Turbidity Instantaneous Max [a]	NTU	2.2	2.1	2.6	3.0	2.6	2.5	2.6	2.7	2.2	3.4	2.3	3.4	2.6	225
pH Instantaneous Min	Standard Units	7.35	7.25	7.23	6.88	7.06	7.07	7.08	7.04	7.03	6.94	7.28	7.25	7.12	6
pH Instantaneous Max	Standard Units	8.21	7.86	7.90	7.87	8.19	7.65	7.56	7.67	7.65	7.60	7.86	7.74	7.81	9
TSS Monthly Avg	mg/L	4.8	5.7	5.5	5.2	6.2	6.6	6.7	6.2	5.6	5.6	4.9	6.2	5.8	30
TSS Weekly Avg	mg/L	5.5	6.3	6	5.6	6.9	7.4	7.4	6.9	5.9	6.3	5.1	6.2	6.3	45
TSS Monthly Avg	lbs/day	3,100	7,035	4,429	3,809	4,319	5,225	5,116	4,568	4,092	5,131	3,421	4,698	4,579	51,541
TSS Weekly Avg	lbs/day	4,179	9,454	7,836	4,292	4,773	5,840	5,411	5,264	4,271	8,750	3,591	4,785	5,704	77,312
TSS Monthly Avg Removal	%	99.4	98.5	99.0	99.2	99.1	98.9	98.9	99.0	99.1	98.9	99.3	99.0	99.0	≥85
Settleable Solids Monthly Avg	ml/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Settleable Solids Weekly Avg	ml/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.5
Settleable Instantaneous Max	ml/L	ND	ND	ND	0.2	ND	ND	ND	ND	ND	ND	ND	ND	0.02	3
Oil & Grease Monthly Avg	mg/L	0.303	0.543	0.532	0.526	0.521	2.68	0.421	0.417	0.816	0.435	ND	ND	0.600	25
Oil & Grease Weekly Avg [b]	mg/L	0.303	0.543	0.532	0.526	0.521	2.68	0.421	0.417	0.816	0.435	ND	ND	0.600	40
Oil & Grease Instantaneous Max [b]	mg/L	0.303	0.543	0.532	0.526	0.521	2.68	0.421	0.417	0.816	0.435	ND	ND	0.600	75
Oil & Grease Monthly Avg	lbs/day	232	415	664	458	361	1,866	286	300	563	319	0	0	455	42,951
Oil & Grease Weekly Avg [c]	lbs/day	232	415	664	458	361	1,866	286	300	563	319	0	0	455	68,722
Oil & Grease Instantaneous Max [c]	lbs/day	232	415	664	458	361	1,866	286	300	563	319	0	0	455	128,853
Total Chlorine Residual Daily Max	mg/L	0.10	0.07	0.10	0.10	0.08	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	1.45
Total Chlorine Residual Instantaneous Max	mg/L	0.14	0.10	0.16	0.17	0.13	0.16	0.22	0.14	0.13	0.16	0.15	0.18	0.15	10.86
Total Chlorine Residual 6-Month Median	mg/L	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.07	0.36
Total Chlorine Residual Daily Max	lbs/day	75	78	78	80	58	68	101	68	74	142	73	98	83	2,491
Total Chlorine Residual Instantaneous Max	lbs/day	104	125	115	112	98	144	178	120	97	193	98	160	129	18,658
Total Chlorine Residual 6-Month Median	lbs/day	51	50	47	48	48	47	50	53	53	52	52	52	50	618

Table 2-1 Monthly and annual averages of parameters measured in the final effluent during the 2021-22 program year. ND = Not Detected; NA = Not Applicable. OC San Environmental Laboratory and Ocean Monitoring Division

		Month/Year													
Parameter	**Units**	**7/21**	**8/21**	**9/21**	**10/21**	**11/21**	**12/21**	**1/22**	**2/22**	**3/22**	**4/22**	**5/22**	**6/22**	**Annual Average**	**Permit Limit or Criterion**
$CBOD_5$ Monthly Avg	mg/L	7.5	7.6	8.3	7.1	8.2	7.1	10.3	12.3	11.2	10.7	6.1	7.2	8.6	25
$CBOD_5$ Weekly Avg	mg/L	9.4	10.9	8.3	8.4	9.6	7.6	13.4	13.3	11.9	14.7	7.7	9.1	10.4	40
$CBOD_5$ Monthly Avg	lbs/day	4,728	8,509	6,761	5,108	5,618	5,616	7,824	9,066	8,071	9,052	4,321	5,439	6,676	42,951
$CBOD_5$ Weekly Avg	lbs/day	6,843	9,725	11,033	6,053	6,837	6,356	9,775	10,147	8,623	10,698	5,532	7,013	8,219	68,722
$CBOD_5$ Monthly Avg Removal	%	98.6	97.4	97.9	98.4	98.3	98.4	97.6	97.2	97.5	97.2	98.6	98.4	98.0	≥85
Benzidine Monthly Avg	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0125
Benzidine Monthly Avg	lbs/day	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0215
Hexachlorobenzene Monthly Avg	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0380
Hexachlorobenzene Monthly Avg	lbs/day	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0653
Toxaphene Monthly Avg	µg/L	ND	—	—	—	—	—	ND	—	—	—	—	—	ND	0.0380
Toxaphene Monthly Avg	lbs/day	0	—	—	—	—	—	0	—	—	—	—	—	0	0.0653
PCBs Monthly Avg	µg/L	ND	—	—	—	—	—	ND	—	—	—	—	—	ND	0.0034
PCBs Monthly Avg	lbs/day	0	—	—	—	—	—	0	—	—	—	—	—	0	0.0058
TCDD Equivalents Monthly Avg	pg/L	ND	—	—	ND	—	—	ND	—	—	ND	—	—	ND	0.7059
TCDD Equivalents Monthly Avg	lbs/day	0	—	—	0	—	—	0	—	—	0	—	—	0	0.0000012
Acute Toxicity Quarterly	Pass or Fail	Pass	—	—	—	Pass	—	–	—	Pass	Pass	—	—	N/A	Pass
Chronic Toxicity Monthly	Pass or Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	N/A	Pass
Parameters with Stipulated Criteria															
Gross Alpha Radioactivity Monthly	pCi/L	28.8	7.1	5.1	6.3	8.4	10.1	4.9	4.0	1.4	3.5	3.4	6.0	7.4	15
Gross Beta Radioactivity Monthly [d]	pCi/L	71.7	64.9	60.6	62.9	47.2	79.10	49.9	-5.8	-0.3	10.0	10.0	-0.9	37.4	50
Radium-226 & 228 Monthly	pCi/L	0.2	0.7	1.0	1.1	—	1.5	—	—	—	—	—	—	0.9	5
Miscellaneous Parameters															
Fecal Coliform Density Monthly Avg	MPN/100 mL	440,000	430,000	530,000	330,000	340,000	420,000	290,000	230,000	240,000	310,000	260,000	660,000	373,333	N/A
Fecal Coliform Density Daily Max	MPN/100 mL	1,700,000	3,500,000	3,500,000	790,000	1,300,000	1,300,000	2,400,000	490,000	1,100,000	1,300,000	1,100,000	3,500,000	1,831,667	N/A
Enterococcus Density Monthly Avg	MPN/100 mL	9,434	9,113	9,032	7,205	7,355	14,135	11,314	8,556	8,182	9,030	6,936	6,416	8,892	N/A
Enterococcus Density Daily Max	MPN/100 mL	17,329	24,196	19,863	17,329	15,531	24,196	24,196	19,863	14,136	24,196	14,136	24,196	19,931	N/A
Nitrite Nitrogen Monthly	mg/L	4.7	6.7	4.9	4.1	4.4	4.4	4.3	3.9	3.6	5.2	5.3	3.5	4.6	N/A
Nitrate Nitrogen Monthly	mg/L	21.0	14.0	10.0	19.0	9.4	10.0	9.1	12.0	13.0	17.0	14.0	12.0	13.4	N/A
Organic Nitrogen Monthly	mg/L	2.5	6.8	8.2	5.6	4.7	4.3	0	4.5	2.3	5.2	9.0	5.2	4.9	N/A
Total Nitrogen Annually	lbs/year	—	—	—	—	—	—	—	—	—	—	—	—	15,927,759 [e]	N/A

Table 2-1 Monthly and annual averages of parameters measured in the final effluent during the 2021-22 program year. ND = Not Detected; NA = Not Applicable. OC San Environmental Laboratory and Ocean Monitoring Division

		Month/Year													
Parameter	**Units**	**7/21**	**8/21**	**9/21**	**10/21**	**11/21**	**12/21**	**1/22**	**2/22**	**3/22**	**4/22**	**5/22**	**6/22**	**Annual Average**	**Permit Limit or Criterion**
Total Phosphorus (as P) Monthly	mg/L	3.5	3.4	2.83	3.44	3.38	2.3	1.96	2.37	2.36	2.82	2.47	1.95	2.73	N/A
BOD_5 Monthly Avg	mg/L	12.9	12.0	13.2	11.0	12.8	11.1	15.6	19.3	17.8	16.0	13.3	15.1	14.2	N/A
Ammonia (as N) Monthly Avg	mg/L	30.7	23.2	27.0	30.3	34.2	35.2	33.3	35.0	32.3	28.3	32.8	30.8	31.1	N/A
PCB-18 Annually	µg/L	32.0	—	—	—	—	—	—	—	—	—	—	—	32.0	N/A
PCB-28 Annually	µg/L	23.0	—	—	—	—	—	—	—	—	—	—	—	23.0	N/A
PCB-37 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-44 Annually	µg/L	54.0	—	—	—	—	—	—	—	—	—	—	—	54.0	N/A
PCB-49 Annually	µg/L	8.1	—	—	—	—	—	—	—	—	—	—	—	8.1	N/A
PCB-52 Annually	µg/L	24.0	—	—	—	—	—	—	—	—	—	—	—	24.0	N/A
PCB-66 Annually	µg/L	7.6	—	—	—	—	—	—	—	—	—	—	—	7.6	N/A
PCB-70 Annually	µg/L	18.0	—	—	—	—	—	—	—	—	—	—	—	18.0	N/A
PCB-74 Annually	µg/L	18.0	—	—	—	—	—	—	—	—	—	—	—	18.0	N/A
PCB-77 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-81 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-87 Annually	µg/L	12.0	—	—	—	—	—	—	—	—	—	—	—	12.0	N/A
PCB-99 Annually	µg/L	6.4	—	—	—	—	—	—	—	—	—	—	—	6.4	N/A
PCB-101 Annually	µg/L	18.0	—	—	—	—	—	—	—	—	—	—	—	18.0	N/A
PCB-105 Annually	µg/L	4.9	—	—	—	—	—	—	—	—	—	—	—	4.9	N/A
PCB-110 Annually	µg/L	15.0	—	—	—	—	—	—	—	—	—	—	—	15.0	N/A
PCB-114 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-118 Annually	µg/L	13.0	—	—	—	—	—	—	—	—	—	—	—	13.0	N/A
PCB-119 Annually	µg/L	12.0	—	—	—	—	—	—	—	—	—	—	—	12.0	N/A
PCB-123 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-126 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-128 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-138 Annually	µg/L	11.0	—	—	—	—	—	—	—	—	—	—	—	11.0	N/A
PCB-149 Annually	µg/L	6.1	—	—	—	—	—	—	—	—	—	—	—	6.1	N/A
PCB-151 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-153/168 Annually	µg/L	9.4	—	—	—	—	—	—	—	—	—	—	—	9.4	N/A
PCB-156 Annually	µg/L	2.8	—	—	—	—	—	—	—	—	—	—	—	2.8	N/A

Table 2-1 Monthly and annual averages of parameters measured in the final effluent during the 2021-22 program year. ND = Not Detected; NA = Not Applicable. OC San Environmental Laboratory and Ocean Monitoring Division

		Month/Year													
Parameter	**Units**	**7/21**	**8/21**	**9/21**	**10/21**	**11/21**	**12/21**	**1/22**	**2/22**	**3/22**	**4/22**	**5/22**	**6/22**	**Annual Average**	**Permit Limit or Criterion**
PCB-157 Annually	µg/L	2.8	—	—	—	—	—	—	—	—	—	—	—	2.8	N/A
PCB-158 Annually [f]	µg/L	—	—	—	—	—	—	—	—	—	—	—	—	—	N/A
PCB-167 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-169 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-170 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-177 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-180 Annually	µg/L	4.4	—	—	—	—	—	—	—	—	—	—	—	4.4	N/A
PCB-183 Annually	µg/L	3.2	—	—	—	—	—	—	—	—	—	—	—	3.2	N/A
PCB-187 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-189 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-194 Annually	µg/L	1.5	—	—	—	—	—	—	—	—	—	—	—	1.5	N/A
PCB-201 Annually	µg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-206 Annually	µg/L	1.8	—	—	—	—	—	—	—	—	—	—	—	1.8	N/A

[a] The values reported for this parameter are the same as those for the Turbidity Monthly Avg, because turbidity is measured only once in each calendar month.
[b] The values reported for this parameter are the same as those for the Oil & Grease Monthly Avg (mg/L), because oil & grease are measured only once in each calendar month.
[c] The values reported for this parameter are the same as those for the Oil & Grease Monthly Avg (lbs/day), because oil & grease are measured only once in each calendar month.
[d] The gross beta value is calculated by subtracting naturally occurring potassium-40 from the gross beta particle, which may result in a negative value.
[e] This value represents the annual total, not the annual average.
[f] Although this parameter was added to OC San's new 2021 NPDES permit, it was not analyzed in the July 2021 sample because the new permit went into effect in August 2021.

Table 2-2 Mass emissions for all benchmark constituents for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Constituent	12-Month Avg Benchmark (MT/yr)	12-Month Avg Actual (MT/yr)	Percent of Benchmark	Min. Mass (MT/yr) [a]	Max. Mass (MT/yr)	Sampling Frequency	Frequency Detected	Avg. Flow (MGD) [b]	Avg. Conc. (µg/L)
Marine Aquatic Life Toxicants									
Arsenic, total recoverable	1.88	0.39	21	0.31	0.45	12	12	87.59	3.22
Cadmium, total recoverable	0.07	0	0	0	0	12	0	87.59	0
Chromium (VI) [c]	0.44	0.22	49	0.11	0.49	12	12	87.59	1.79
Copper, total recoverable	5.21	0.81	16	0.44	2.42	12	12	87.59	6.76
Lead, total recoverable	0.18	0.04	19	0	0.17	12	7	87.59	0.30
Mercury, total recoverable	0.002	0.001	50	0	0.003	12	12	87.59	0.01
Nickel, total recoverable	6.69	1.19	18	0.96	1.45	12	12	87.59	9.82
Selenium, total recoverable	6.23	1.40	22	1.15	1.73	12	12	87.59	11.55
Silver, total recoverable	0.05	0	0	0	0	12	0	87.59	0
Zinc, total recoverable	13.09	3.38	26	2.94	4.05	12	12	87.59	27.83
Cyanide, total recoverable	1.67	0.52	31	0	0.85	17	16	95.10	4.29
Ammonia as nitrogen	10,457	3,802	36	3,397	4,293	20	20	91.69	31,065
Total chlorine residual	38.09	8.02	21	3.03	10.11	1,097	912	94.25	66.17
Non-chlorinated phenols	0.44	0.002	0	0	0.024	12	1	87.35	0.02
Chlorinated phenols	0.15	0	0	0	0	12	0	87.35	0
Endosulfan	0.003	0	0	0	0	2	0	96.51	0
Endrin	0.006	0	0	0	0	2	0	96.51	0
Hexachlorocyclohexane	0.003	0	0	0	0	2	0	96.51	0
Human Health Toxicants – Non-Carcinogen									
Acrolein	3.03	0	0	0	0	4	0	88.46	0
Antimony	0.72	0.15	21	0.14	0.19	12	12	87.59	1.25
Bis(2-chloroethoxy) methane	3.03	0	0	0	0	12	0	87.35	0
Bis(2-chloroiso-propyl) ether	1.21	0	0	0	0	12	0	87.35	0
Chlorobenzene	1.21	0	0	0	0	4	0	88.46	0
Chromium (III) [c]	0.44	0.22	49	0.11	0.49	12	12	87.59	1.79
Di-n-butyl-phthalate	0.51	0	0	0	0	12	0	87.35	0
Dichlorobenzenes	0.61	0	0	0	0	12	0	87.35	0
Diethyl phthalate	0.22	0.03	12	0	0.33	12	1	87.35	0.21
Dimethyl phthalate	1.21	0	0	0	0	12	0	87.35	0

Table 2-2 **Mass emissions for all benchmark constituents for the 2021-22 program year.**
OC San Environmental Laboratory and Ocean Monitoring Division

Constituent	12-Month Avg Benchmark (MT/yr)	12-Month Avg Actual (MT/yr)	Percent of Benchmark	Min. Mass (MT/yr) [a]	Max. Mass (MT/yr)	Sampling Frequency	Frequency Detected	Avg. Flow (MGD) [b]	Avg. Conc. (µg/L)
4,6-dinitro-2-methylphenol	3.03	0	0	0	0	12	0	87.35	0
2,4-dinitrophenol	3.03	0	0	0	0	12	0	87.35	0
Ethylbenzene	1.21	0	0	0	0	4	0	88.46	0
Fluoranthene	0.61	0	0	0	0	12	0	87.35	0
Hexachlorocyclopentadiene	3.03	0	0	0	0	12	0	87.35	0
Nitrobenzene	0.11	0	0	0	0	12	0	87.35	0
Thallium	0.06	0	0	0	0	12	0	87.59	0
Toluene	0.05	0	0	0	0	4	0	88.46	0
Tributyltin [d]	0.07	0	0	0	0	3	0	93.17	0
1,1,1-trichloroethane	1.21	0	0	0	0	4	0	88.46	0
Human Health Toxicants – Carcinogens									
Acrylonitrile	1.21	0	0	0	0	4	0	88.46	0
Aldrin	0.001	0	0	0	0	2	0	96.51	0
Benzene	1.21	0	0	0	0	4	0	88.46	0
Benzidine	0.004	0	0	0	0	12	0	87.35	0
Beryllium	0.3	0	0	0	0	12	0	87.59	0
Bis(2-chloroethyl) ether	0.61	0	0	0	0	12	0	87.35	0
Bis(2-ethylhexyl) phthalate	1.11	0	0	0	0	12	0	87.35	0
Carbon tetrachloride	1.21	0	0	0	0	4	0	88.46	0
Chlordane	0.001	0	0	0	0	2	0	96.51	0
Chlorodibromomethane	1.21	0.04	3	0	0.15	4	1	88.46	0.32
Chloroform	4.72	0.90	19	0.67	1.18	4	4	88.46	7.28
DDT	0.003	0	0	0	0	2	0	96.51	0
1,4-dichlorobenzene	0.12	0	0	0	0	12	0	87.35	0
3,3′-dichlorobenzidine	0.42	0	0	0	0	12	0	87.35	0
1,2-dichloroethane	1.21	0	0	0	0	4	0	88.46	0
1,1-dichloroethylene	1.21	0	0	0	0	4	0	88.46	0
Dichlorobromomethane	2.56	0.36	14	0.19	0.43	4	4	88.46	2.91
Dichloromethane	1.21	0.19	15	0	0.74	4	1	88.46	1.59
1,3-dichloropropene	1.21	0	0	0	0	4	0	88.46	0

Table 2-2 Mass emissions for all benchmark constituents for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Constituent	12-Month Avg Benchmark (MT/yr)	12-Month Avg Actual (MT/yr)	Percent of Benchmark	Min. Mass (MT/yr) [a]	Max. Mass (MT/yr)	Sampling Frequency	Frequency Detected	Avg. Flow (MGD) [b]	Avg. Conc. (µg/L)
Dieldrin	0.002	0	0	0	0	2	0	96.51	0
2,4-dinitrotoluene	3.03	0	0	0	0	12	0	87.35	0
1,2-diphenylhydrazine	0.61	0	0	0	0	12	0	87.35	0
Halomethanes	0.12	0.02	20	0	0.08	4	2	88.46	0.19
Heptachlor	0.003	0	0	0	0	2	0	96.51	0
Heptachlor epoxide	0.001	0	0	0	0	2	0	96.51	0
Hexachlorobenzene	0.01	0	0	0	0	12	0	87.35	0
Hexachlorobutadiene	0.61	0	0	0	0	12	0	87.35	0
Hexachloroethane	0.61	0	0	0	0	12	0	87.35	0
Isophorone	0.61	0	0	0	0	12	0	87.35	0
N-nitrosodimethylamine	3.03	0	0	0	0	12	0	87.35	0
N-nitrosodi-n-propylamine	3.03	0	0	0	0	12	0	87.35	0
N-nitrosodiphenylamine	0.61	0	0	0	0	12	0	87.35	0
PAHs	0.45	0	0	0	0	12	0	87.35	0
PCBs	0.001	0	0	0	0	2	0	96.51	0
TCDD equivalents	0.000000201	0	0	0	0	4	0	89.28	0
1,1,2,2-tetrachloroethane	1.21	0	0	0	0	4	0	88.46	0
Tetrachloroethylene	0.45	0	0	0	0	4	0	88.46	0
Toxaphene	0.01	0	0	0	0	2	0	96.51	0
Trichloroethylene	1.21	0	0	0	0	4	0	88.46	0
1,1,2-trichloroethane	1.21	0	0	0	0	4	0	88.46	0
2,4,6-trichlorophenol	0.15	0	0	0	0	12	0	87.35	0
Vinyl chloride	1.21	0	0	0	0	4	0	88.46	0

[a] A zero value indicates a result below the method detection limit.
[b] This is calculated for each parameter by dividing the sum of the effluent flow recorded on each sampling date by the total number of sampling days.
[c] The MT/yr values for this parameter represent total recoverable chromium.
[d] When OC San's new 2021 NPDES permit went into effect in August 2021, the summer quarter samples had already been collected in July 2021. As such, this parameter was not analyzed in the summer quarter.

Chapter 3. Receiving Water Compliance Monitoring

INTRODUCTION

This chapter provides receiving water compliance results for the 2021-22 program year for the Orange County Sanitation District's (OC San) Ocean Monitoring Program (OMP). The program includes sample collection, analysis, and data interpretation to evaluate potential impacts of treated wastewater discharge on the following receiving water characteristics:

- Bacterial
- Physical
- Chemical
- Biological
- Radioactivity

Specific criteria for each of those characteristics are listed in OC San's National Pollutant Discharge Elimination System (NPDES) permit (Table 3-1). 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, 57 benthic stations to assess sediment quality and infaunal 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 (Figure 3-1, Figure 3-2, and Figure 3-3). Sampling frequencies varied by component and ranged from monthly for offshore water quality sampling to annual assessments of fish tissue analyses (see Appendix A).

WATER QUALITY

Offshore Bacteria

The majority (77–94%) of samples for 3 fecal indicator bacteria (FIB) were below the method detection limit (10 MPN/100mL), with over 99% of the fecal coliform counts being below the State Water Board (SWB) REC-1 30-day geometric mean objective, over 95% of total coliform measured below the SWB shellfish harvesting median density objective, and over 99% of enterococci recorded below the SWB REC-1 6-week rolling geometric mean objective (Table B-1). The highest density observed for any single sample at any single depth for total coliforms, fecal coliforms, and enterococci was 1,785, 592, and 31 MPN/100 mL, respectively. Compliance for all 3 FIB in the 2021-22 program year was achieved in 100% of the samples (Table B-2, Table B-3, and Table B-4), indicating no adverse effect of FIB 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 water quality station in the 2021-22 program year (Table B-5 and Table B-6). Therefore, compliance was achieved.

Ocean Discoloration and Transparency

Overall, transmissivity (water clarity) standards were met 93% of the time (Table 3-2). All transmissivity values were within natural ranges of variability to which marine organisms are exposed (Table B-7;

CSDOC 1996a, b; OCSD 2004). Hence, there were no adverse effects from the treated wastewater discharge relative to ocean discoloration at any offshore station.

Table 3-1 List of compliance criteria from OC San's ocean discharge permit (Order No. R8-2021-0010, NPDES No. CA0110604) including compliance status of each criterion for the 2021-22 program year.

OC San, Environmental Laboratory and Ocean Monitoring Division

	Criteria	Criteria Met
	Bacterial Characteristics	
VI.A.1.a.	For the State Water Board Water-Contact Objectives, a 30-day geometric mean of fecal coliform density shall not exceed 200/100 mL and a single sample maximum shall not exceed 400/100 mL.	Yes
VI.A.1.a.	For the State Water Board Water-Contact Objectives, a 6-week rolling geometric mean of enterococci, calculated weekly, shall not exceed 30 CFU or MPN per 100 mL and a statistical threshold value of 110 CFU or MPN per 100 mL shall not be exceeded by more than 10 percent of all enterococci samples collected in a calendar month.	Yes
VI.A.1.c.	For the State Water Board 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.	Yes
VI.A.1.d.	For the USEPA Recreational Water Quality Criteria, a 30-day geometric mean of enterococci shall not exceed 30 CFU or MPN per 100 mL and a statistical threshold value corresponding to the 90th percentile of the same water quality distribution shall not exceed 110 CFU or MPN per 100 mL in the same 30-day interval.	Yes
	Physical Characteristics	
VI.A.2.a.	Floating particulates and grease and oil shall not be visible.	Yes
VI.A.2.b.	The discharge of waste shall not cause aesthetically undesirable discoloration of the ocean surface.	Yes
VI.A.2.c.	Natural light shall not be significantly reduced at any point outside the initial dilution zone as the result of the discharge of waste.	Yes
VI.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
VI.A.2.e.	Trash from the discharge shall not be present in ocean waters, along shorelines or adjacent areas in amounts that adversely affect beneficial uses or cause nuisance.	Yes
	Chemical Characteristics	
VI.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
VI.A.3.b.	The pH shall not be changed at any time more than 0.2 units from that which occurs naturally.	Yes
VI.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
VI.A.3.d.	The concentration of substances, set forth in Chapter II, Table 3 of the California Ocean Plan, in marine sediments shall not be increased to levels which would degrade indigenous biota.	Yes
VI.A.3.e.	The concentration of organic materials in marine sediments shall not be increased to levels which would degrade marine life.	Yes
VI.A.3.f.	Nutrient materials shall not cause objectionable aquatic growths or degrade indigenous biota.	Yes
VI.A.3.g.	Numerical water quality objectives established in Table 3 of the California Ocean Plan shall not be exceeded as a result of discharges from the facility through Discharge Points 001 and 002 (as computed using an applicable dilution factor).	Yes
	Biological Characteristics	
VI.A.4.a.	Marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded.	Yes
VI.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
VI.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
VI.A.5.	Discharge of radioactive waste, which meets the definition of "pollutant" at 40 CFR § 122.2, shall not degrade marine life.	Yes

Dissolved Oxygen

Oxygen compliance was 100% (Table 3-2), with measured values well within the range of long-term monitoring results (Table B-7; CSDOC 1996a, b; OCSD 2004).

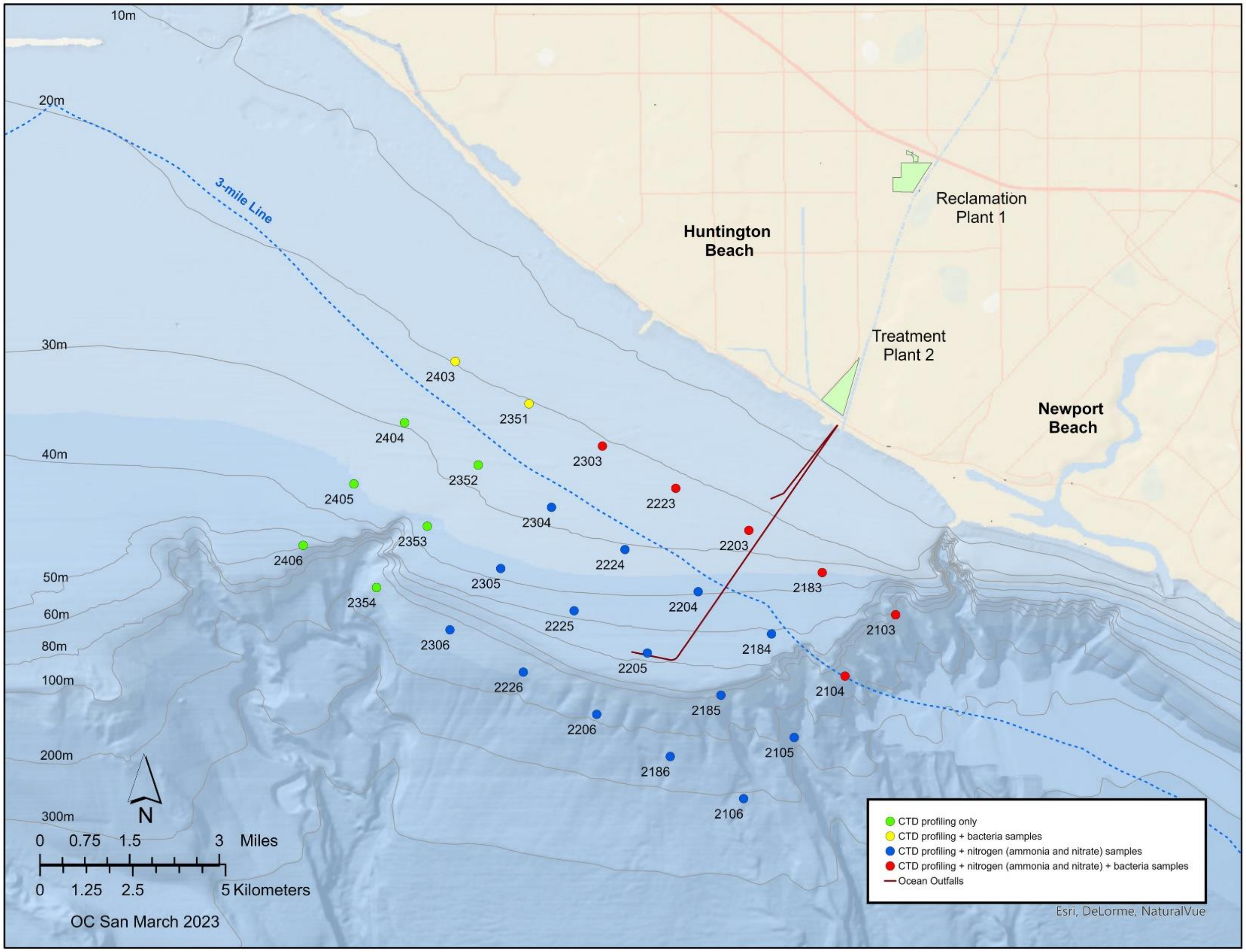

Figure 3-1 Offshore water quality monitoring stations for the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

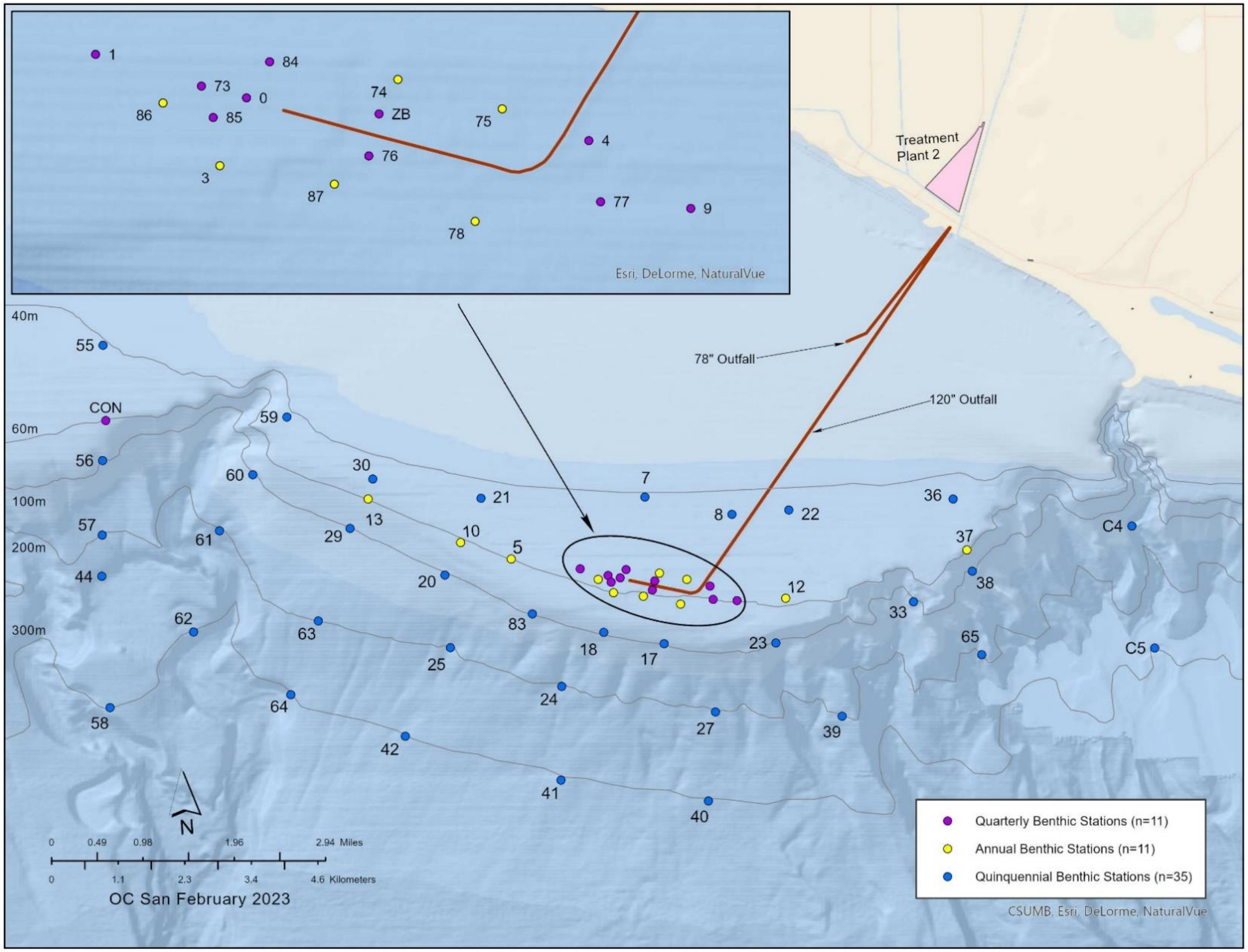

Figure 3-2 Benthic (sediment geochemistry and infauna) monitoring stations for the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

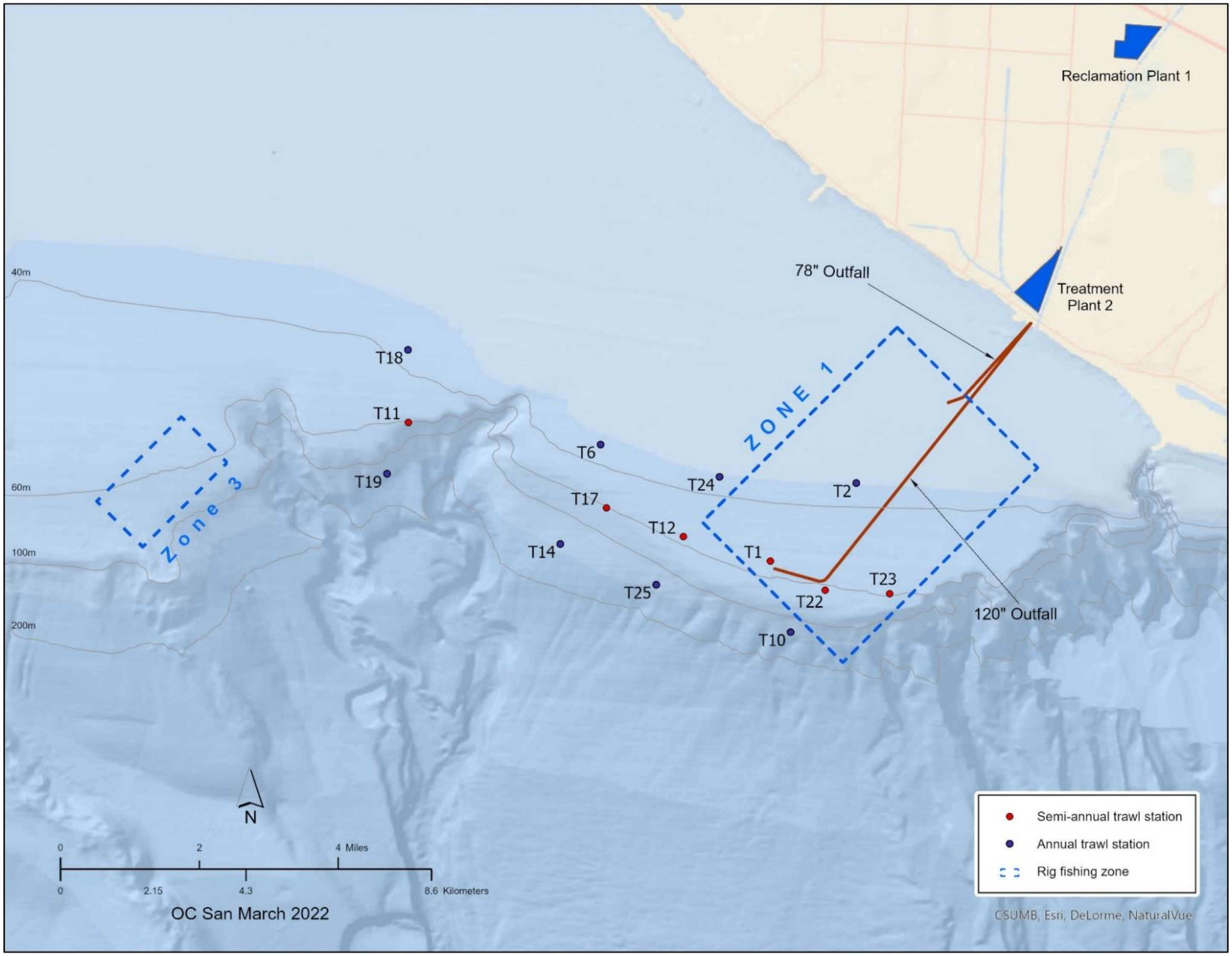

Figure 3-3 Trawl monitoring stations, as well as rig fishing locations, for the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Acidity (pH)

Compliance with COP pH standards was 100% (Table 3-2), with measured values within the range to which marine organisms are naturally exposed (Table B-7; CSDOC 1996a, b; OCSD 2004).

Nutrients

Ammonia Nitrogen

For the 2021-22 program year, over 95% of the monthly Core water samples for ammonia nitrogen (NH_3-N) analysis—which included within-ZID Station 2205—were below the method detection limit of 0.04 mg/L (Table B-8). The small fraction of detectable NH_3-N concentrations ranged from 0.04 to 0.24 mg/L. Plume-related changes in NH_3-N were not considered environmentally significant as maximum values were nearly 17 times less than the chronic (4 mg/L) and 25 times less than the acute (6 mg/L) toxicity standards of the COP (SWRCB 2012). In addition, and in contrast to colored dissolved organic matter, there were no positive relationships between NH_3-N values and chlorophyll-*a* concentrations (a proxy for the amount of phytoplankton present in the ocean) (Figure 3-4), indicating no direct impact to aquatic life (e.g., phytoplankton blooms caused by the discharge).

Nitrate Nitrogen

For the 2021-22 program year, over 62% of the monthly Core water quality samples for nitrate nitrogen (NO_3-N) analysis were below the reporting limits of 0.2 and 0.015 mg/L for the contract and OC San laboratories, respectively (Table B-9).

Radioactivity

Pursuant to OC San's NPDES Permit, OC San measures the influent and the effluent for radioactivity but not the receiving waters. The results of radioactive measurements of influent (published in OC San's monthly Discharge Monitoring Reports) and effluent (see Chapter 2) samples during the 2021-22 program year indicated that federal standards were consistently met. As fish and invertebrate communities are diverse and healthy, compliance was met.

Table 3-2 Summary of OC San's monthly offshore water quality compliance testing results for dissolved oxygen, pH, and transmissivity for the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Survey Date	Number of Stations [a]	Dissolved Oxygen		pH		Transmissivity	
		ORO [b]	OOC [c]	ORO	OOC	ORO	OOC
7/28/2021	27	0%	0%	0%	0%	15%	15%
8/3/2021	27	0%	0%	0%	0%	7%	0%
9/14/2021	27	0%	0%	0%	0%	7%	4%
10/1/2021 [d]	0	No Data	No Data	No Data	No Data	No Data	No Data
11/9/2021	27	0%	0%	0%	0%	7%	7%
12/8/2021	27	0%	0%	0%	0%	7%	7%
1/19/2022	27	0%	0%	0%	0%	11%	11%
2/9/2022	27	0%	0%	0%	0%	7%	7%
3/8/2022	27	0%	0%	0%	0%	11%	11%
5/4/2022	27	0%	0%	0%	0%	4%	4%
6/2/2022	27	0%	0%	0%	0%	7%	7%
6/7/2022 [e]	27	0%	0%	0%	0%	7%	7%
Annual	**297**	**0%**	**0%**	**0%**	**0%**	**8%**	**7%**

[a] Does not include within-ZID Station 2205.
[b] Out-of-Range-Occurrence (ORO) - see Appendix A for calculation method.
[c] Out-of-Compliance (OOC) - see Appendix A for calculation method.
[d] Sampling was cancelled due to the Orange County oil spill.
[e] Since poor weather precluded sampling in April 2022, this survey was conducted in its stead as agreed upon by the Regional Water Quality Control Board on 4/28/2022.

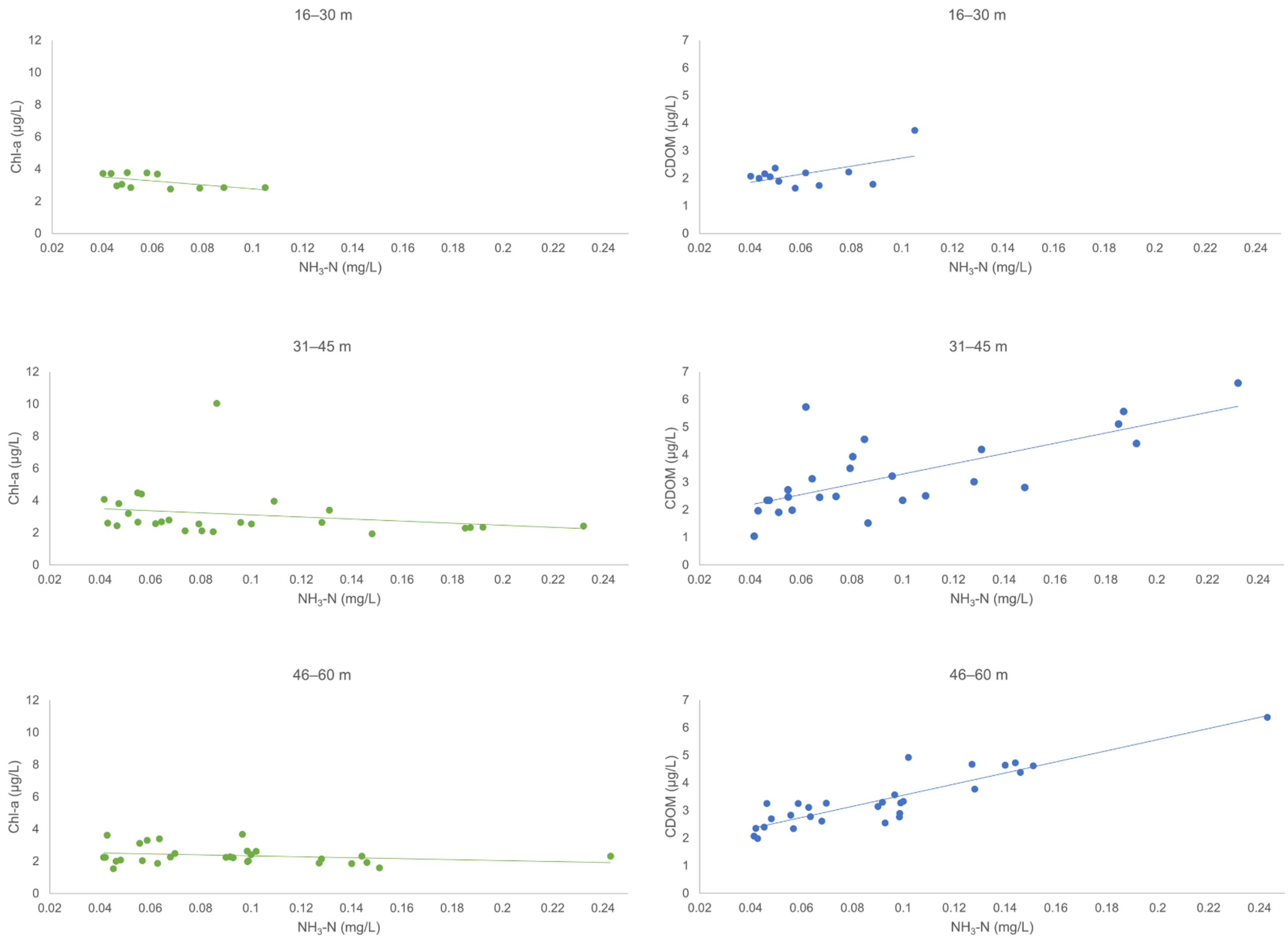

Figure 3-4 Linear regression plots of detectable ammonia nitrogen (NH_3-N) versus chlorophyll-*a* (left column) and colored dissolved organic matter (CDOM) (right column) by 15-m depth bins for the 2021-22 Core monthly water quality cruises. Note: plots from 0–15 m were not included because NH_3-N measurements at that depth bin were all below the method detection limit of 0.04 mg/L.

OC San Environmental Laboratory and Ocean Monitoring Division

SEDIMENT GEOCHEMISTRY

For most sediment parameters measured in the quarterly and annual surveys, the results were comparable to historical values (Table 3-3 and Table 3-4). Additionally, most station values were lower than those of the 2013 Southern California Bight Regional Monitoring Program (Bight ‘13), and all station values were below applicable sediment quality guidelines. From a temporal standpoint, the quarterly data remained consistent throughout the year and were comparable between within-ZID and non-ZID stations. There was no measurable sediment toxicity at any of the 11 quarterly stations monitored in the summer benthic survey (Table 3-5). For the quinquennial survey, all sediment chemistry data were comparable to historical averages and Bight ‘13 data, and they were also below applicable sediment quality guidelines (Table 3-6 and Table 3-7). The average concentration of some sediment parameters, such as total nitrogen, polycyclic aromatic hydrocarbons, aluminum and iron, increased with station depth. This pattern is consistent with these depositional, deep-water environments (OCSD 2014). Overall, measured sediment geochemistry data remained consistent between quarterly and annual surveys, as well as with historical trends.

Table 3-3 Physical properties, as well as biogeochemical and contaminant concentrations, of sediment samples collected at each quarterly and annual station sampled during the 2021-22 program year compared to Effects Range-Median (ERM), regional, and historical values. ND = Not Detected.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (µg/kg)	ΣDDT (µg/kg)	ΣPest (µg/kg)	ΣPCB (µg/kg)
Quarter 1 (July–September)											
Middle Shelf Zone 2, Non-ZID (51–90 m)											
1	56	3.33	15.0	0.44	ND	730	500	41.5	ND	ND	ND
9	59	3.01	8.1	0.99	ND	650	460	13.8	ND	ND	ND
73	55	3.15	9.8	0.47	ND	1,100	600	69.4	ND	ND	ND
77	60	3.07	8.2	0.36	ND	780	470	23.9	ND	ND	ND
84	54	3.19	8.2	0.56	ND	880	450	49.6	ND	ND	ND
85	57	3.15	8.6	0.53	ND	770	550	153.4	ND	ND	ND
CON	59	3.22	7.4	0.38	ND	820	460	28.1	ND	ND	ND
	Mean	**3.16**	**9.3**	**0.53**	**0**	**819**	**499**	**54.2**	**0**	**0**	**0**
Middle Shelf Zone 2, Within-ZID (51–90 m)											
0	56	3.13	7.7	0.50	ND	1,000	460	243.8	ND	ND	ND
4	56	3.18	13.5	0.39	ND	830	510	44.6	ND	ND	ND
76	58	3.10	8.4	0.35	ND	830	390	25.4	ND	ND	ND
ZB	56	3.12	9.5	0.43	ND	830	570	31.9	ND	ND	ND
	Mean	**3.13**	**9.8**	**0.42**	**0**	**872**	**482**	**86.4**	**0**	**0**	**0**
Quarter 2 (October–December)											
Middle Shelf Zone 2, Non-ZID (51–90 m)											
1	56	3.22	9.3	0.45	ND	970	430	69.9	—	—	0.21
9	59	2.92	5.7	0.35	ND	760	350	19.2	—	—	ND
73	55	3.03	5.1	0.44	1.71	1,000	400	335.2	—	—	3.85
77	60	3.02	8.6	0.39	ND	740	390	57.8	—	—	ND
84	54	3.17	10.8	0.41	1.27	860	490	101.9	—	—	0.24
85	57	3.10	9.4	0.49	1.14	1,100	170	166.1	—	—	2.57
CON	59	3.13	7.8	0.37	1.13	870	380	19.1	—	—	ND
	Mean	**3.08**	**8.1**	**0.41**	**0.75**	**900**	**373**	**109.9**	**—**	**—**	**0.98**

Table 3-3 Physical properties, as well as biogeochemical and contaminant concentrations, of sediment samples collected at each quarterly and annual station sampled during the 2021-22 program year compared to Effects Range-Median (ERM), regional, and historical values. ND = Not Detected.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (µg/kg)	ΣDDT (µg/kg)	ΣPest (µg/kg)	ΣPCB (µg/kg)
Middle Shelf Zone 2, Within-ZID (51–90 m)											
0	56	3.04	7.5	0.49	1.73	1,100	430	420.5	—	—	3.84
4	56	3.07	9.7	0.39	1.40	780	230	42.3	—	—	ND
76	58	3.11	7.2	0.38	ND	840	390	203.7	—	—	ND
ZB	56	3.19	11.1	0.44	1.23	900	450	80.1	—	—	ND
	Mean	**3.10**	**8.9**	**0.42**	**1.09**	**905**	**375**	**186.6**	**—**	**—**	**0.96**
Quarter 3 (January–March)											
Middle Shelf Zone 2, Non-ZID (51–90 m)											
1	56	3.34	13.1	0.47	ND	1,100	490	126.5	—	—	ND
9	59	3.02	8.9	0.35	1.42	860	420	68.8	—	—	ND
73	55	3.09	6.5	0.49	1.68	1,400	520	276.5	—	—	16.95
77	60	3.02	6.2	0.37	ND	900	290	26.7	—	—	0.20
84	54	3.69	29.6	0.50	ND	1,000	510	75.6	—	—	0.54
85	57	3.10	8.3	0.46	1.88	1,100	440	112.7	—	—	1.37
CON	59	3.26	10.5	0.46	ND	940	400	51.4	—	—	0.21
	Mean	**3.22**	**11.9**	**0.44**	**0.71**	**1,043**	**439**	**105.5**	**—**	**—**	**2.75**
Middle Shelf Zone 2, Within-ZID (51–90 m)											
0	56	3.08	8.4	0.55	ND	1,300	450	172.6	—	—	1.51
4	56	3.03	6.9	0.39	ND	960	430	33.0	—	—	ND
76	58	3.20	11.8	0.47	5.28	970	440	67.5	—	—	ND
ZB	56	3.23	12.5	0.43	ND	830	420	61.0	—	—	0.23
	Mean	**3.14**	**9.9**	**0.46**	**1.32**	**1,015**	**435**	**83.5**	**—**	**—**	**0.44**

Table 3-3 Physical properties, as well as biogeochemical and contaminant concentrations, of sediment samples collected at each quarterly and annual station sampled during the 2021-22 program year compared to Effects Range-Median (ERM), regional, and historical values. ND = Not Detected.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (µg/kg)	ΣDDT (µg/kg)	ΣPest (µg/kg)	ΣPCB (µg/kg)
Quarter 4 (April–June)											
Middle Shelf Zone 2, Non-ZID (51–90 m)											
1	56	3.66	26.5	0.40	1.17	1,000	480	51.9	—	—	1.22
9	59	2.91	6.5	0.33	ND	730	480	10.1	—	—	ND
73	55	3.24	15.9	0.57	1.35	1,400	610	192.5	—	—	15.77
77	60	3.06	7.5	0.37	ND	820	390	39.8	—	—	ND
84	54	3.20	7.9	0.43	ND	960	490	48.1	—	—	0.24
85	57	3.01	4.4	0.40	1.54	1,100	420	818.8	—	—	149.01
CON	59	3.27	11.5	0.43	1.20	900	410	46.1	—	—	ND
	Mean	**3.19**	**11.5**	**0.42**	**0.75**	**987**	**469**	**172.5**	**—**	**—**	**23.75**
Middle Shelf Zone 2, Within-ZID (51–90 m)											
0	56	3.21	18.5	0.51	ND	1,100	470	208.0	—	—	8.74
4	56	3.13	13.0	0.36	ND	880	410	34.1	—	—	ND
76	58	3.19	11.9	0.36	ND	890	390	24.4	—	—	ND
ZB	56	3.04	5.0	0.35	1.27	1,000	370	135.4	—	—	ND
	Mean	**3.14**	**12.1**	**0.40**	**0.32**	**968**	**410**	**100.5**	**—**	**—**	**2.18**

Table 3-3 Physical properties, as well as biogeochemical and contaminant concentrations, of sediment samples collected at each quarterly and annual station sampled during the 2021-22 program year compared to Effects Range-Median (ERM), regional, and historical values. ND = Not Detected.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (µg/kg)	ΣDDT (µg/kg)	ΣPest (µg/kg)	ΣPCB (µg/kg)
Annual (July–September)											
Middle Shelf Zone 2, Non-ZID (51–90 m)											
3	60	3.17	7.7	0.42	ND	910	580	46.1	ND	ND	ND
5	59	3.47	13.7	0.39	ND	920	510	31.6	ND	ND	ND
10	62	3.54	9.8	0.41	ND	830	500	33.4	ND	ND	ND
12	58	3.08	13.4	0.34	ND	770	420	21.0	ND	ND	ND
13	59	3.50	12.6	0.41	ND	720	470	23.4	ND	ND	ND
37	56	2.38	7.9	0.32	ND	420	380	166.1	ND	ND	ND
74	57	3.11	8.2	0.37	ND	770	490	28.7	ND	ND	ND
75	60	3.15	11.4	0.40	ND	720	430	23.7	ND	ND	ND
78	63	3.09	6.8	0.37	ND	770	410	29.1	ND	ND	ND
86	57	3.17	9.5	0.43	ND	790	590	42.9	ND	ND	ND
87	60	3.20	12.7	0.40	ND	880	530	39.5	ND	ND	ND
	Mean	**3.17**	**10.3**	**0.39**	**0**	**773**	**483**	**44.1**	**0**	**0**	**0**
Sediment Quality Guidelines											
ERM		—	—	—	—	—	—	44,792.0	46.10	—	180.00
Regional Bight ’13 Summer Values (area weighted mean)											
Middle Shelf		—	48.0	0.70	—	—	690	55.0	18.00	—	2.70
OC San Historical Values (July 2012–June 2021) [mean (range)]											
Middle Shelf Zone 2, Non-ZID		3.37 (2.47–5.41)	18.6 (4.0–87.0)	0.38 (0.14–2.70)	4.57 (ND–198.00)	908 (360–2,000)	389 (ND–2,100)	76.5 (2.7–1,713.9)	1.83 (ND–52.90)	0.19 (ND–36.26)	3.56 (ND–244.30)
Middle Shelf Zone 2, Within-ZID		3.26 (2.92–3.47)	13.9 (4.3–33.1)	0.38 (0.23–0.65)	3.77 (ND–19.00)	976 (490–2,200)	389 (90–610)	114.7 (6.5–758.3)	1.98 (ND–58.25)	0.45 (ND–21.40)	4.28 (ND–34.20)

Table 3-4 Metal concentrations (mg/kg) in sediment samples collected at each quarterly and annual station sampled during the 2021-22 program year compared to Effects Range-Median (ERM), regional, and historical values.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Sb	Al	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Se	Ag	Zn
Quarter 1 (July–September) Middle Shelf Zone 2, Non-ZID (51–90 m)																
1	56	0.09	8,364	3.13	39.3	0.27	0.18	19.20	8.61	15,168	6.82	0.02	8.4	2.69	0.15	41.8
9	59	0.07	7,887	3.12	34.0	0.27	0.09	17.40	6.04	14,802	5.71	0.03	7.6	2.55	0.07	37.5
73	55	0.08	7,820	3.88	37.5	0.27	0.25	20.50	17.60	15,002	7.40	0.03	8.3	2.45	0.19	41.1
77	60	0.06	8,048	3.24	31.8	0.27	0.09	17.80	6.43	15,352	5.66	0.01	7.7	2.41	0.07	37.2
84	54	0.08	8,448	3.78	38.5	0.27	0.20	19.00	8.63	15,376	6.92	0.04	8.6	2.58	0.13	41.2
85	57	0.07	8,045	3.76	35.9	0.28	0.22	20.20	9.45	15,391	7.22	0.03	8.4	2.52	0.15	41.6
CON	59	0.08	8,345	3.10	48.9	0.27	0.10	18.50	6.86	15,369	6.54	0.02	8.7	2.44	0.08	39.7
	Mean	**0.08**	**8,137**	**3.43**	**38.0**	**0.27**	**0.2**	**18.94**	**9.09**	**15,208**	**6.61**	**0.03**	**8.3**	**2.52**	**0.12**	**40.0**
Middle Shelf Zone 2, Within-ZID (51–90 m)																
0	56	0.07	7,868	3.69	36.3	0.28	0.34	20.70	13.90	14,941	7.37	0.04	8.5	2.16	0.17	44.5
4	56	0.07	8,099	3.69	34.7	0.28	0.12	18.40	6.75	15,566	6.21	0.01	8.0	2.30	0.09	44.5
76	58	0.06	8,606	4.06	35.6	0.29	0.08	18.00	6.81	17,073	5.72	0.36	8.2	2.47	0.08	40.1
ZB	56	0.07	8,363	3.27	36.6	0.28	0.22	18.20	7.55	15,485	5.76	0.02	8.4	2.33	0.10	42.1
	Mean	**0.07**	**8,234**	**3.68**	**35.8**	**0.28**	**0.19**	**18.83**	**8.75**	**15,766**	**6.27**	**0.11**	**8.2**	**2.32**	**0.11**	**42.8**
Quarter 2 (October–December) Middle Shelf Zone 2, Non-ZID (51–90 m)																
1	56	0.09	7,859	3.70	40.1	0.29	0.18	19.40	9.31	15,474	7.25	0.08	8.6	1.79	0.15	40.4
9	59	0.07	7,135	3.25	31.4	0.25	0.09	16.30	6.25	14,314	5.11	0.01	7.5	2.26	0.07	35.8
73	55	0.08	7,149	3.71	36.6	0.26	0.39	20.30	27.10	14,410	7.19	0.03	8.2	1.60	0.22	44.8
77	60	0.07	7,629	3.02	35.0	0.27	0.11	17.50	6.76	15,315	5.40	0.01	8.1	2.11	0.09	37.7
84	54	0.09	8,077	4.06	41.9	0.27	0.22	19.40	9.54	16,051	6.74	0.05	9.1	2.22	0.16	42.7
85	57	0.10	7,304	4.16	35.0	0.26	0.28	20.10	11.20	14,929	6.32	0.02	8.8	1.97	0.17	41.8
CON	59	0.09	7,851	3.27	51.4	0.26	0.10	18.70	7.07	15,462	5.92	0.02	9.0	1.75	0.07	38.9
	Mean	**0.08**	**7,572**	**3.60**	**38.8**	**0.27**	**0.20**	**18.81**	**11.03**	**15,136**	**6.28**	**0.03**	**8.5**	**1.96**	**0.13**	**40.3**

Table 3-4 Metal concentrations (mg/kg) in sediment samples collected at each quarterly and annual station sampled during the 2021-22 program year compared to Effects Range-Median (ERM), regional, and historical values.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Sb	Al	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Se	Ag	Zn
Middle Shelf Zone 2, Within-ZID (51–90 m)																
0	56	0.09	7,564	3.98	37.5	0.27	0.32	20.10	10.50	15,135	6.54	0.02	8.6	2.13	0.16	44.1
4	56	0.08	7,648	3.83	35.9	0.26	0.14	18.20	7.28	15,042	5.56	0.01	8.2	1.90	0.12	39.4
76	58	0.07	7,900	2.82	38.0	0.29	0.14	17.90	7.42	15,792	5.17	0.03	8.5	1.94	0.10	41.6
ZB	56	0.08	7,694	3.53	39.5	0.27	0.22	17.40	7.72	15,377	5.36	0.02	8.6	2.16	0.11	41.1
	Mean	**0.08**	**7,701**	**3.54**	**37.7**	**0.27**	**0.21**	**18.40**	**8.23**	**15,336**	**5.66**	**0.02**	**8.5**	**2.03**	**0.12**	**41.6**
Quarter 3 (January–March)																
Middle Shelf Zone 2, Non-ZID (51–90 m)																
1	56	0.09	7,272	3.50	38.8	0.25	0.13	18.70	7.99	14,108	6.93	0.02	7.9	1.26	0.12	39.4
9	59	0.07	7,241	2.67	35.9	0.25	0.10	16.70	5.93	13,810	5.11	0.01	7.5	1.29	0.07	36.5
73	55	0.09	7,158	3.55	36.3	0.25	0.26	21.20	11.70	14,446	7.76	0.02	7.6	1.43	0.16	40.0
77	60	0.07	7,145	3.75	36.3	0.26	0.09	17.10	6.38	14,492	5.35	0.01	7.5	1.56	0.08	37.1
84	54	0.08	7,130	3.09	38.8	0.24	0.22	17.90	8.20	13,748	6.46	0.01	8.0	1.39	0.14	39.5
85	57	0.09	7,233	3.14	36.8	0.26	0.24	19.20	9.00	14,257	7.35	0.03	8.0	1.48	0.16	42.5
CON	59	0.10	8,285	3.01	56.6	0.26	0.09	18.10	7.07	15,738	6.55	0.02	8.9	1.49	0.08	39.5
	Mean	**0.08**	**7,352**	**3.24**	**39.9**	**0.25**	**0.16**	**18.41**	**8.04**	**14,371**	**6.50**	**0.02**	**7.9**	**1.41**	**0.12**	**39.2**
Middle Shelf Zone 2, Within-ZID (51–90 m)																
0	56	0.10	7,669	4.63	40.2	0.28	0.25	20.10	10.00	15,268	7.37	0.03	8.3	1.37	0.16	44.4
4	56	0.08	7,174	3.08	35.3	0.26	0.13	16.50	6.16	13,836	5.42	0.01	7.3	1.29	0.10	37.7
76	58	0.08	7,541	2.96	37.5	0.28	0.10	17.00	6.71	15,147	5.23	0.02	7.9	1.35	0.07	39.5
ZB	56	0.08	7,565	4.16	38.5	0.27	0.17	17.90	7.45	15,127	5.75	0.02	8.3	1.30	0.18	41.8
	Mean	**0.09**	**7,487**	**3.71**	**37.9**	**0.27**	**0.16**	**17.88**	**7.58**	**14,844**	**5.94**	**0.02**	**8.0**	**1.33**	**0.13**	**40.9**

Table 3-4 Metal concentrations (mg/kg) in sediment samples collected at each quarterly and annual station sampled during the 2021-22 program year compared to Effects Range-Median (ERM), regional, and historical values.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Sb	Al	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Se	Ag	Zn
Quarter 4 (April–June) Middle Shelf Zone 2, Non-ZID (51–90 m)																
1	56	0.09	6,791	3.15	37.9	0.24	0.15	17.40	9.21	13,706	10.40	0.02	7.7	1.59	0.13	38.6
9	59	0.08	6,675	2.69	31.7	0.24	0.10	16.20	5.98	13,577	5.49	0.01	7.2	1.66	0.07	36.3
73	55	0.09	6,917	3.21	37.7	0.25	0.31	20.10	13.60	13,928	8.21	0.03	7.9	1.75	0.20	43.0
77	60	0.08	6,824	3.13	33.9	0.26	0.12	16.60	6.56	14,145	5.57	0.01	7.5	1.72	0.08	37.7
84	54	0.09	7,089	3.29	37.4	0.25	0.18	17.70	8.29	14,146	6.57	0.08	8.3	1.76	0.13	40.6
85	57	0.09	6,656	3.11	34.6	0.24	0.23	18.60	9.38	14,031	6.25	0.03	7.7	1.55	0.14	39.8
CON	59	0.11	7,447	3.07	52.1	0.25	0.09	17.80	7.06	14,763	6.49	0.02	8.5	1.90	0.07	39.5
	Mean	**0.09**	**6,914**	**3.09**	**37.9**	**0.25**	**0.17**	**17.77**	**8.58**	**14,042**	**7.00**	**0.03**	**7.8**	**1.70**	**0.12**	**39.4**
Middle Shelf Zone 2, Within-ZID (51–90 m)																
0	56	0.10	6,836	4.11	46.1	0.25	0.37	20.40	21.30	14,564	8.91	0.03	8.1	1.71	0.17	44.0
4	56	0.08	6,632	3.41	32.5	0.24	0.12	17.00	8.89	13,955	7.47	0.01	7.3	1.83	0.08	37.0
76	58	0.09	7,007	3.46	35.4	0.25	0.09	16.20	6.87	14,985	5.41	0.06	7.4	1.73	0.10	38.5
ZB	56	0.08	6,734	3.36	33.9	0.24	0.25	15.90	7.38	14,039	5.25	0.02	7.4	1.57	0.12	40.3
	Mean	**0.09**	**6,802**	**3.59**	**37.0**	**0.25**	**0.21**	**17.38**	**11.11**	**14,386**	**6.76**	**0.03**	**7.5**	**1.71**	**0.12**	**40.0**
Annual (July–September) Middle Shelf Zone 2, Non-ZID (51–90 m)																
3	60	0.07	8,720	3.01	39.3	0.29	0.13	18.80	7.62	16,277	6.25	0.01	8.3	2.36	0.11	42.3
5	59	0.08	9,409	3.87	48.2	0.30	0.14	21.10	8.60	17,280	7.18	0.02	9.6	2.63	0.13	44.7
10	62	0.08	9,570	3.08	51.9	0.30	0.16	20.60	8.68	16,623	7.62	0.02	9.6	2.62	0.20	44.2
12	58	0.06	7,600	3.67	34.1	0.26	0.10	16.40	5.94	14,393	5.59	0.03	7.6	2.04	0.07	35.9
13	59	0.09	8,778	3.84	49.8	0.28	0.14	20.80	7.93	15,763	7.00	0.02	9.8	2.28	0.12	40.7
37	56	0.05	7,424	2.38	33.4	0.24	0.10	13.20	4.79	12,633	4.66	0.01	6.8	1.82	0.04	33.4
74	57	0.07	8,134	4.05	43.4	0.27	0.18	18.40	7.66	15,029	6.12	0.01	8.4	2.58	0.11	40.9
75	60	0.07	8,029	4.31	38.3	0.28	0.14	17.90	7.11	15,396	5.88	0.01	8.2	2.27	0.09	39.5
78	63	0.07	8,436	3.37	35.9	0.29	0.08	17.90	6.23	16,582	5.60	0.01	7.8	2.66	0.07	39.2
86	57	0.07	7,808	3.14	35.7	0.27	0.26	19.40	9.93	14,885	6.65	0.06	8.3	2.42	0.16	42.1
87	60	0.07	8,090	3.47	36.8	0.28	0.12	18.70	7.72	15,719	7.24	0.02	8.3	2.38	0.10	40.6
	Mean	**0.07**	**8,363**	**3.47**	**40.6**	**0.28**	**0.14**	**18.47**	**7.47**	**15,507**	**6.34**	**0.02**	**8.4**	**2.37**	**0.11**	**40.3**

Table 3-4 Metal concentrations (mg/kg) in sediment samples collected at each quarterly and annual station sampled during the 2021-22 program year compared to Effects Range-Median (ERM), regional, and historical values.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Sb	Al	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Se	Ag	Zn
Sediment Quality Guidelines																
ERM		—	—	70.00	—	—	9.60	370.00	270.00	—	218.00	0.71	51.6	—	3.70	410.0
Regional Bight '13 Summer Values (area weighted mean)																
Middle Shelf		0.92	13,000	2.70	130.0	0.21	0.68	30.00	7.90	18,000	7.00	0.05	15.0	0.10	0.29	48.0
OC San Historical Values (July 2012–June 2021) [mean (range)]																
Middle Shelf Zone 2, Non-ZID		0.05 (ND–5.12)	7,606 (2,120–22,504)	3.01 (1.56–9.60)	38.3 (22.9–202.0)	0.48 (0.12–95.20)	0.25 (0.06–8.78)	20.52 (5.65–95.00)	9.75 (4.13–45.50)	14,833 (4,310–35,278)	5.74 (2.79–21.80)	0.02 (0.01–1.23)	9.6 (3.5–26.8)	0.86 (ND–8.88)	0.18 (0.03–5.46)	42.0 (20.0–132.0)

Table 3-5 Whole-sediment *Eohaustorius estuarius* (amphipod) toxicity test results at select outfall-depth stations for the 2021-22 program year. The home sediment represents the control; within-ZID stations are indicated by an asterisk. N/A = Not Applicable.

OC San Environmental Laboratory and Ocean Monitoring Division

Station	Percent Survival	Percent of Home	p-value	Assessment
home	100	—	—	N/A
0 *	96	96	0.55	Nontoxic
1	100	100	0.92	Nontoxic
4 *	100	100	0.92	Nontoxic
9	97	97	0.30	Nontoxic
73	99	99	0.78	Nontoxic
76 *	95	95	0.30	Nontoxic
77	99	99	0.78	Nontoxic
84	99	99	0.78	Nontoxic
85	99	99	0.78	Nontoxic
CON	98	98	0.55	Nontoxic
ZB *	93	93	0.13	Nontoxic
ZB Dup *	95	95	0.55	Nontoxic

Table 3-6 Physical properties, as well as biogeochemical and contaminant concentrations, of sediment samples collected at each quinquennial station in summer 2021 compared to Effects Range-Median (ERM), regional, and historical values. ND = Not Detected.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (µg/kg)	ΣDDT (µg/kg)	ΣPest (µg/kg)	ΣPCB (µg/kg)
Middle Shelf Zone 1 (31–50 m)											
7	41	3.45	13.6	0.36	ND	1,000	480	46.3	3.40	0.84	2.62
8	44	3.67	20.9	0.38	2.13	1,000	510	43.5	3.20	0.29	2.83
21	44	3.36	8.3	0.35	ND	1,100	510	31.4	2.50	ND	1.93
22	45	3.54	11.4	0.37	ND	910	500	41.2	2.70	ND	2.29
30	46	2.56	6.8	0.33	ND	1,000	490	21.8	2.60	0.31	1.96
36	45	3.55	12.3	0.37	1.20	1,000	390	51.2	4.70	0.41	3.16
55	40	2.50	2.8	0.19	ND	530	190	ND	1.80	0.46	1.14
59	40	2.89	6.7	0.30	ND	870	450	42.3	ND	ND	ND
	Mean	**3.19**	**10.4**	**0.33**	**0.42**	**926**	**440**	**34.7**	**2.61**	**0.29**	**1.99**
Middle Shelf Zone 3 (91–120 m)											
17	91	3.02	8.1	0.36	1.67	660	420	66.2	2.40	0.36	1.81
18	91	3.23	7.5	0.28	ND	820	420	35.5	2.80	0.56	1.84
20	100	3.67	14.9	0.47	35.60	1,000	700	75.4	5.00	0.32	6.06
23	100	3.02	8.5	0.34	2.13	750	490	21.9	2.60	0.36	1.80
29	100	3.70	12.3	0.55	ND	1,000	820	72.0	7.30	0.49	6.56
33	100	3.55	8.3	0.41	3.16	590	550	32.4	4.10	0.52	2.73
38	100	3.49	18.9	0.58	2.18	800	660	59.8	4.80	1.14	3.90
56	100	3.58	14.3	0.56	1.56	870	600	61.6	ND	ND	ND
60	100	3.75	18.1	0.55	3.07	850	710	62.7	ND	ND	ND
83	100	3.38	10.3	0.42	1.96	860	460	44.3	ND	ND	ND
	Mean	**3.44**	**12.1**	**0.45**	**5.13**	**820**	**583**	**53.2**	**2.90**	**0.38**	**2.47**

Table 3-6 Physical properties, as well as biogeochemical and contaminant concentrations, of sediment samples collected at each quinquennial station in summer 2021 compared to Effects Range-Median (ERM), regional, and historical values. ND = Not Detected.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (µg/kg)	ΣDDT (µg/kg)	ΣPest (µg/kg)	ΣPCB (µg/kg)
Outer Shelf (121–200 m)											
24	200	4.14	28.7	0.83	2.89	910	970	76.5	9.70	0.60	5.43
25	200	4.50	38.8	1.03	155.00	800	1,200	105.7	11.50	0.58	7.95
27	200	3.61	14.1	0.62	1.80	1,000	890	58.6	6.40	0.66	3.42
39	200	3.21	12.3	0.45	ND	680	610	27.0	4.50	0.66	2.81
57	200	5.07	53.5	1.50	17.00	860	1,700	154.6	6.85	ND	ND
61	200	4.39	37.5	1.11	2.44	910	1,100	125.6	ND	ND	ND
63	200	4.09	27.9	0.80	2.58	840	910	79.9	ND	ND	ND
65	200	3.93	30.6	0.68	4.36	950	770	67.8	ND	ND	ND
C4	187	4.76	46.1	1.27	9.72	840	1,200	182.9	ND	ND	ND
	Mean	**4.19**	**32.1**	**0.92**	**21.75**	**866**	**1,039**	**97.6**	**4.33**	**0.28**	**2.18**
Upper Slope/Canyon (201–500 m)											
40	303	4.28	35.8	1.07	2.93	800	1,300	85.8	9.80	0.82	4.22
41	303	4.39	38.7	1.14	1.50	880	1,200	67.2	9.30	0.65	3.66
42	303	5.07	53.3	1.51	3.90	720	1,700	122.0	11.20	0.69	4.52
44	241	4.86	48.5	1.70	6.46	720	1,600	198.6	14.90	0.69	11.75
58	300	5.19	56.0	1.93	10.90	790	1,600	189.1	7.91	ND	ND
62	300	5.35	60.6	1.86	5.71	640	1,900	163.9	ND	ND	ND
64	300	4.86	48.7	1.07	1.27	880	1,000	116.5	ND	ND	ND
C5	296	5.41	62.4	1.75	2.64	750	1,600	110.3	ND	ND	ND
	Mean	**4.93**	**50.5**	**1.50**	**4.41**	**772**	**1,488**	**131.7**	**6.64**	**0.36**	**3.02**
Sediment Quality Guidelines											
ERM		—	—	—	—	—	—	44,792.0	46.10	—	180.00
Regional Bight ’13 Summer Values (area weighted mean)											
Middle Shelf		—	48.0	0.70	—	—	690	55.0	18.00	—	2.70
Outer Shelf		—	49.0	0.93	—	—	1,000	92.0	79.00	—	4.50
Upper Slope/Canyon		—	75.0	1.90	—	—	2,500	160.0	490.00	—	15.00

Table 3-6 Physical properties, as well as biogeochemical and contaminant concentrations, of sediment samples collected at each quinquennial station in summer 2021 compared to Effects Range-Median (ERM), regional, and historical values. ND = Not Detected.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (µg/kg)	ΣDDT (µg/kg)	ΣPest (µg/kg)	ΣPCB (µg/kg)
OC San Historical Values (July 2012–June 2021) [mean (range)]											
Middle Shelf Zone 1		3.47 (2.45–3.95)	20.1 (2.0–45.8)	0.34 (0.17–0.45)	2.58 (ND–14.10)	945 (550–1,300)	364 (170–640)	46.3 (1.5–388.5)	3.54 (ND–43.65)	0.08 (ND–3.99)	0.39 (ND–3.85)
Middle Shelf Zone 3		3.58 (2.57–4.29)	25.7 (4.3–64.0)	0.46 (0.27–0.76)	4.61 (ND–13.00)	887 (560–1,200)	469 (230–800)	51.7 (7.7–131.7)	2.53 (ND–19.17)	ND (All ND)	0.88 (ND–7.14)
Outer Shelf		4.58 (3.30–5.78)	56.5 (12.1–90.2)	1.09 (0.41–2.02)	10.95 (ND–82.00)	940 (780–1,200)	966 (490–1,600)	111.4 (22.2–304.9)	6.16 (ND–23.82)	ND (All ND)	2.22 (ND–11.59)
Upper Slope/Canyon		5.21 (2.19–6.33)	70.8 (34.0–97.1)	1.71 (ND–2.55)	15.95 (ND–88.20)	894 (700–1,100)	1,508 (460–2,400)	141.8 (20.6–336.3)	8.03 (1.22–34.33)	0.40 (ND–13.30)	2.55 (ND–10.33)

Table 3-7 Metal concentrations (mg/kg) in sediment samples collected at each quinquennial station in summer 2021 compared to Effects Range-Median (ERM), regional, and historical values.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Sb	Al	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Se	Ag	Zn
Middle Shelf Zone 1 (31–50 m)																
7	41	0.08	8,112	4.43	45.3	0.26	0.12	17.90	7.64	14,079	7.87	0.01	8.6	2.31	0.11	38.4
8	44	0.09	7,936	3.98	48.7	0.25	0.14	17.30	7.01	13,737	6.67	0.02	8.5	2.23	0.10	37.6
21	44	0.07	7,405	3.99	37.7	0.24	0.12	17.30	6.60	13,424	6.38	0.02	8.1	2.11	0.09	37.6
22	45	0.09	7,976	4.09	48.7	0.25	0.12	16.20	6.59	14,135	7.44	0.02	8.4	2.49	0.06	38.5
30	46	0.10	6,671	3.56	36.8	0.23	0.09	17.10	6.23	12,823	6.55	0.01	7.3	2.35	0.08	34.8
36	45	0.08	8,316	4.06	47.8	0.26	0.15	17.20	6.89	14,489	6.68	0.02	8.6	2.61	0.08	39.6
55	40	0.08	5,246	2.72	25.7	0.17	0.04	12.20	3.49	10,622	3.80	0.01	6.0	1.40	0.02	25.0
59	40	0.09	6,044	3.17	31.6	0.20	0.07	14.60	4.88	11,444	5.25	0.01	6.8	1.96	0.05	29.7
	Mean	**0.09**	**7,213**	**3.75**	**40.3**	**0.23**	**0.11**	**16.23**	**6.17**	**13,094**	**6.33**	**0.02**	**7.8**	**2.18**	**0.07**	**35.2**
Middle Shelf Zone 3 (91–120 m)																
17	91	0.06	9,531	2.78	40.6	0.31	0.11	18.50	6.79	18,174	6.09	0.01	9.3	2.23	0.07	43.0
18	91	0.06	9,284	3.03	44.1	0.30	0.10	18.20	6.71	17,069	5.90	0.01	9.1	2.62	0.07	41.3
20	100	0.08	10,149	3.43	59.1	0.31	0.17	21.30	9.49	17,525	7.71	0.02	10.3	2.48	0.15	46.3
23	100	0.06	8,568	3.13	37.5	0.29	0.12	17.20	6.09	16,560	5.97	0.01	8.7	2.41	0.06	38.5
29	100	0.11	10,513	3.40	68.5	0.32	0.21	22.60	10.7	18,121	8.76	0.02	11.0	2.73	0.19	49.6
33	100	0.06	8,608	3.73	45.6	0.28	0.21	16.50	6.36	16,203	5.69	0.01	9.1	2.07	0.08	41.6
38	100	0.09	8,116	4.70	49.8	0.27	0.22	15.40	7.41	20,900	6.28	0.02	8.9	2.09	0.07	37.8
56	100	0.09	10,819	3.26	71.4	0.33	0.18	22.70	9.83	18,940	8.24	0.02	11.0	2.93	0.15	48.1
60	100	0.10	10,177	3.48	66.8	0.31	0.24	22.80	10.9	17,595	8.58	0.02	10.9	2.43	0.21	49.5
83	100	0.08	9,310	3.31	47.1	0.30	0.12	19.00	7.34	17,203	6.54	0.01	9.4	2.36	0.09	44.0
	Mean	**0.08**	**9,508**	**3.43**	**53.1**	**0.30**	**0.17**	**19.42**	**8.16**	**17,829**	**6.98**	**0.02**	**9.8**	**2.44**	**0.11**	**44.0**

Table 3-7 Metal concentrations (mg/kg) in sediment samples collected at each quinquennial station in summer 2021 compared to Effects Range-Median (ERM), regional, and historical values.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Sb	Al	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Se	Ag	Zn
Outer Shelf (121–200 m)																
24	200	0.11	13,386	4.26	89.8	0.39	0.37	25.60	13.00	20,370	10.30	0.03	13.0	3.18	0.23	56.4
25	200	0.13	14,450	4.24	113.0	0.41	0.39	28.20	14.70	21,488	11.50	0.03	14.2	3.22	0.25	61.1
27	200	0.10	11,116	3.43	68.1	0.35	0.22	22.10	9.16	19,006	7.62	0.02	11.4	3.15	0.11	48.5
39	200	0.09	9,783	3.50	46.6	0.32	0.16	19.60	7.26	18,021	6.63	0.01	10.0	2.25	0.07	44.4
57	200	0.16	17,554	5.95	149.0	0.50	0.57	36.80	23.20	24,798	17.30	0.04	16.7	4.17	0.61	78.0
61	200	0.13	14,209	4.44	114.0	0.42	0.46	29.10	15.70	21,586	11.60	0.03	14.3	3.57	0.39	64.4
63	200	0.11	12,617	4.06	158.0	0.37	0.32	25.50	12.60	19,673	9.77	0.02	12.8	3.06	0.22	54.8
65	200	0.11	12,218	4.85	71.3	0.37	0.36	22.40	10.60	19,435	8.81	0.03	12.2	3.13	0.14	53.7
C4	187	0.15	16,136	8.03	108.0	0.48	0.43	26.80	14.90	26,112	14.00	0.03	15.3	3.75	0.17	76.4
	Mean	**0.12**	**13,497**	**4.75**	**102.0**	**0.40**	**0.36**	**26.23**	**13.46**	**21,165**	**10.84**	**0.03**	**13.3**	**3.28**	**0.24**	**59.7**
Upper Slope/Canyon (201–500 m)																
40	303	0.13	14,196	4.33	95.1	0.42	0.31	28.70	13.30	21,401	10.40	0.02	16.8	3.39	0.15	60.1
41	303	0.13	14,882	4.82	93.5	0.45	0.30	27.90	13.40	22,657	9.43	0.02	14.7	3.60	0.15	61.0
42	303	0.16	17,095	5.85	125.0	0.49	0.45	33.50	17.50	24,182	13.90	0.02	16.3	3.88	0.29	69.9
44	241	0.19	18,834	8.86	201.0	0.55	0.87	41.80	29.70	26,317	21.30	0.06	18.3	4.02	0.91	84.9
58	300	0.19	20,316	7.84	185.0	0.57	0.54	39.60	21.50	26,785	17.90	0.03	18.8	4.24	0.42	81.2
62	300	0.18	19,665	6.88	164.0	0.54	0.61	38.50	22.30	26,681	16.80	0.03	18.4	4.58	0.50	81.7
64	300	0.14	16,191	6.89	117.0	0.53	0.33	28.00	15.90	24,285	14.50	0.02	17.6	3.81	0.17	63.9
C5	296	0.29	19,367	7.96	132.0	0.57	0.73	34.50	59.00	26,552	16.90	0.04	17.4	4.49	0.38	114.0
	Mean	**0.18**	**17,568**	**6.68**	**139.1**	**0.52**	**0.52**	**34.06**	**24.08**	**24,858**	**15.14**	**0.03**	**17.3**	**4.00**	**0.37**	**77.1**
Sediment Quality Guidelines																
ERM		—	—	70.00	—	—	9.60	370.00	270.00	—	218.00	0.71	51.6	—	3.70	410.0
Regional Bight '13 Summer Values (area weighted mean)																
Middle Shelf		0.92	13,000	2.70	130.0	0.21	0.68	30.00	7.90	18,000	7.00	0.05	15.0	0.10	0.29	48.0
Outer Shelf		1.10	13,000	5.30	130.0	0.36	0.82	37.00	11.00	28,000	10.00	0.07	18.0	0.21	0.39	57.0
Upper Slope/Canyon		1.40	20,000	5.40	160.0	0.27	1.50	57.00	21.00	29,000	12.00	0.08	30.0	0.89	0.24	88.0

Table 3-7 Metal concentrations (mg/kg) in sediment samples collected at each quinquennial station in summer 2021 compared to Effects Range-Median (ERM), regional, and historical values.

OC San Environmental Laboratory and Ocean Monitoring Program

Station	Depth (m)	Sb	Al	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Se	Ag	Zn
OC San Historical Values (July 2012–June 2021) [mean (range)]																
Middle Shelf Zone 1		0.05 (ND–0.29)	6,654 (3,620–8,890)	3.08 (1.43–4.41)	40.4 (24.0–54.5)	0.21 (0.13–0.31)	0.16 (0.04–0.27)	17.80 (11.00–26.10)	7.60 (3.38–11.00)	12,241 (7,550–15,400)	5.68 (2.47–7.53)	0.02 (0.01–0.04)	8.5 (5.4–11.1)	0.59 (ND–1.55)	0.10 (ND–0.52)	34.6 (21.5–44.7)
Middle Shelf Zone 3		0.05 (ND–0.18)	8,893 (4,150–12,000)	3.00 (1.55–7.48)	52. (27.3–132.0)	0.28 (0.20–0.56)	0.23 (0.10–0.69)	21.85 (14.90–34.60)	10.29 (5.59–21.10)	16,632 (7,990–19,549)	6.20 (3.20–15.30)	0.02 (0.01–0.04)	11.5 (8.1–33.1)	0.65 (ND–1.72)	0.13 (0.05–0.36)	45.8 (32.2–85.1)
Outer Shelf		0.10 (ND–0.48)	13,171 (6,180–19,400)	4.26 (1.88–8.75)	105.3 (33.1–195.0)	0.39 (0.23–0.55)	0.48 (0.17–0.94)	33.36 (19.90–83.10)	18.71 (8.43–40.00)	21,272 (10,908–28,800)	9.79 (4.90–16.00)	0.03 (0.01–0.18)	16.5 (8.7–24.9)	1.04 (0.20–2.35)	0.26 (0.07–0.82)	64.0 (43.3–90.6)
Upper Slope/Canyon		0.15 (ND–0.32)	17,003 (7,350–22,200)	5.38 (1.20–7.93)	132.1 (32.0–212.0)	0.49 (0.09–0.81)	0.59 (0.11–1.18)	43.08 (6.64–86.80)	25.64 (4.37–51.90)	25,400 (15,200–32,100)	12.78 (2.83–25.80)	0.03 (0.01–0.06)	20.9 (3.3–31.7)	1.50 (ND–3.23)	0.35 (0.08–1.06)	76.3 (13.5–101.0)

BIOLOGICAL COMMUNITIES

Infaunal Communities

A total of 618 invertebrate taxa comprising 28,930 individuals were collected in the 2021-22 program year. Annelida (segmented worms) was the dominant taxonomic group at all depth strata and among the 4 seasons (Table B-10). Mean community measure values were comparable between within- and non-ZID stations in the quarterly surveys, and most station values in the quarterly, annual, and quinquennial surveys were within regional and OC San historical ranges (Table 3-8 and Table 3-9). The infaunal community at all within-ZID and non-ZID stations 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 within-ZID stations was comparable to those at most non-ZID stations based on multivariate analyses of the infaunal species and abundances (Figure 3-5). These multiple lines of evidence suggest that the outfall discharge had no adverse effect on the benthic community structure within the monitoring area. We conclude, therefore, that the biota was not degraded by the outfall discharge, and as such, compliance was met.

Epibenthic Macroinvertebrate Communities

A total of 61 epibenthic macroinvertebrate (EMI) species, comprising 13,550 individuals and a total weight of 116.0 kg, was collected from 20 trawls conducted in the 2021-22 program year (Table B-11 and Table B-12). As with the previous monitoring period, *Lytechinus pictus* (sea urchin) was the most dominant species in terms of abundance (n=5,601; 41.3% of total), while *Strongylocentrotus fragilis* (sea urchin) was the leading species in respect to biomass (80.8 kg; 69.7% of total). Within the Middle Shelf Zone 2 stratum, the overall EMI community composition at the outfall stations were similar to those at other non-outfall stations in both Summer and Winter surveys based on the results of the Multivariate analyses (cluster and non-metric multidimensional scaling (nMDS) analyses) (Figure 3-6). Furthermore, the community measure values at the outfall stations were within regional and District historical ranges (Table 3-10). These results suggest that the outfall discharge had no adverse 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 42 fish taxa, comprising 15,369 individuals and a total weight of 242.8 kg, was collected from the monitoring area during the 2021-22 program year (Table B-13 and Table B-14). The mean species richness, abundance, biomass, Shannon-Wiener Diversity (H′), and Swartz's 75% Dominance Index (SDI) values of demersal fishes collected at all stations were comparable between outfall and non-outfall stations in both surveys, with values falling within regional and/or OC San historical ranges (Table 3-11). 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) scores 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 (Middle Shelf Zone 2 stratum) regardless of season (Figure 3-7). These results indicate that the outfall discharge had no adverse effect on the demersal fish community structure within the monitoring area. OC San concludes that the demersal fish communities within the monitoring area were not degraded by the outfall discharge, and thus, compliance was met.

Table 3-8 **Community measure values for each quarterly and annual station sampled during the 2021-22 infauna surveys, including regional and historical values.**

OC San Environmental Laboratory and Ocean Monitoring Division

Station	Depth (m)	Species Richness	Abundance	H′	SDI	ITI	BRI
Quarter 1 (July–September)							
Middle Shelf Zone 2, Non-ZID (51–90 m)							
1	56	88	525	3.51	23	70	15
9	59	68	190	3.81	29	70	15
73	55	86	299	3.9	32	80	12
77	60	74	243	3.84	28	89	14
84	54	73	313	3.71	23	80	13
85	57	99	452	3.95	31	76	17
CON	59	70	195	3.79	29	81	14
	Mean	**80**	**317**	**3.79**	**28**	**78**	**14**
Middle Shelf Zone 2, Within-ZID (51–90 m)							
0	56	91	405	3.93	29	75	13
4	56	64	195	3.64	24	81	12
76	58	91	369	3.94	30	75	16
ZB	56	62	269	3.57	21	83	15
	Mean	**77**	**310**	**3.77**	**26**	**79**	**14**
Quarter 2 (October–December)							
Middle Shelf Zone 2, Non-ZID (51–90 m)							
1	56	95	432	3.76	27	73	13
9	59	82	288	3.87	28	82	12
73	55	92	532	3.54	20	76	16
77	60	74	234	3.78	27	81	17
84	54	93	540	3.63	20	71	16
85	57	104	497	3.91	29	83	12
CON	59	48	143	3.52	21	87	15
	Mean	**84**	**381**	**3.72**	**25**	**79**	**14**
Middle Shelf Zone 2, Within-ZID (51–90 m)							
0	56	84	208	4.14	39	71	15
4	56	73	317	3.78	24	71	15
76	58	61	235	3.49	20	82	14
ZB	56	80	408	3.67	21	79	16
	Mean	**75**	**292**	**3.77**	**26**	**76**	**15**
Quarter 3 (January–March)							
Middle Shelf Zone 2, Non-ZID (51–90 m)							
1	56	96	492	3.74	27	74	14
9	59	89	335	3.97	29	83	11
73	55	101	571	3.96	31	72	16
77	60	85	336	3.9	31	74	16
84	54	97	626	3.75	24	78	14
85	57	88	406	3.78	25	75	12
CON	59	68	237	3.55	23	76	12
	Mean	**89**	**429**	**3.81**	**27**	**76**	**14**

Table 3-8 **Community measure values for each quarterly and annual station sampled during the 2021-22 infauna surveys, including regional and historical values.**

OC San Environmental Laboratory and Ocean Monitoring Division

Station	Depth (m)	Species Richness	Abundance	H′	SDI	ITI	BRI
Middle Shelf Zone 2, Within-ZID (51–90 m)							
0	56	88	416	3.74	28	76	19
4	56	97	377	3.81	27	75	12
76	58	97	362	3.97	32	78	15
ZB	56	83	533	3.6	22	73	18
	Mean	**91**	**422**	**3.78**	**27**	**76**	**16**
Quarter 4 (April–June)							
Middle Shelf Zone 2, Non-ZID (51–90 m)							
1	56	98	383	4.07	35	72	16
9	59	114	539	3.97	33	77	11
73	55	92	655	3.59	22	71	14
77	60	108	506	3.9	31	66	15
84	54	102	687	3.76	24	73	13
85	57	81	392	3.72	25	74	13
CON	59	76	280	3.68	24	73	15
	Mean	**96**	**492**	**3.81**	**28**	**72**	**14**
Middle Shelf Zone 2, Within-ZID (51–90 m)							
0	56	119	636	4.05	34	73	15
4	56	89	448	3.85	26	75	15
76	58	96	426	3.85	29	74	15
ZB	56	104	583	3.84	28	73	12
	Mean	**102**	**523**	**3.90**	**29**	**74**	**14**
Annual (July–September)							
Middle Shelf Zone 2, Non-ZID (51–90 m)							
3	60	61	115	3.92	36	72	13
5	59	73	232	3.82	29	83	11
10	62	67	189	3.51	24	85	13
12	58	68	139	3.9	36	60	8
13	59	64	158	3.72	28	88	10
37	56	118	408	4.31	44	66	13
74	57	102	419	3.94	29	75	11
75	60	78	307	3.75	23	82	13
78	63	83	284	3.9	32	79	12
86	57	98	380	3.87	27	80	11
87	60	90	292	3.97	32	81	13
	Mean	**82**	**266**	**3.87**	**31**	**77**	**12**
Regional Bight ’13 Summer Values [mean (range)]							
Middle Shelf		90 (45–171)	491 (142–2,718)	3.60 (2.10–4.10)	—	—	18 (7–30)
OC San Historical Values (July 2011–June 2021) [mean (range)]							
Middle Shelf Zone 2 Non-ZID		88 (20–142)	310 (90–634)	3.72 (2.24–4.45)	18 (1–53)	78 (40–94)	19 (10–43)
Middle Shelf Zone 2 Within-ZID		73 (44–110)	585 (222–1,230)	2.46 (0.72–4.07)	14 (1–38)	31 (1–73)	35 (18–48)

Table 3-9 Community measure values for each quinquennial station sampled during the summer 2021 infauna survey, including regional and historical values. N/A = Not Applicable.

OC San Environmental Laboratory and Ocean Monitoring Division

Station	Depth (m)	Species Richness	Abundance	H′	SDI	ITI	BRI
Middle Shelf Zone 1 (31–50 m)							
7	41	89	322	3.79	32	68	13
8	44	95	502	3.34	20	78	15
21	44	120	530	3.95	31	77	13
22	45	104	446	3.74	30	80	15
30	46	92	496	3.67	20	75	12
36	45	85	263	3.75	32	88	9
55	40	80	386	3.64	23	71	12
59	40	108	688	3.53	21	79	9
	Mean	**97**	**454**	**3.68**	**26**	**77**	**12**
Middle Shelf Zone 3 (91–120 m)							
17	91	76	222	3.76	30	73	19
18	91	57	164	3.60	24	76	13
20	100	50	142	3.46	21	66	21
23	100	61	200	3.66	23	71	20
29	100	53	214	3.29	15	73	15
33	100	59	142	3.69	27	84	16
38	100	73	454	3.69	24	75	20
56	100	71	188	3.84	32	76	16
60	100	51	192	3.53	19	74	19
83	100	65	189	3.75	26	78	15
	Mean	**62**	**211**	**3.63**	**24**	**75**	**17**
Outer Shelf (121–200 m)							
24	200	26	76	2.70	11	67	22
25	200	31	111	2.64	10	64	26
27	200	39	586	1.15	1	64	27
57	200	18	66	1.91	4	67	26
61	200	31	213	1.75	2	67	24
63	200	35	238	2.09	5	64	23
65	200	27	856	0.45	1	57	27
C4	187	27	162	2.16	4	67	31
	Mean	**29**	**289**	**1.86**	**5**	**65**	**26**
Upper Slope/Canyon (201–500 m)							
40	303	24	60	2.53	10	N/A	N/A
41	303	23	65	2.62	9	N/A	N/A
42	303	24	50	2.70	12	N/A	N/A
44	241	17	58	1.94	6	N/A	N/A
58	300	14	26	2.38	8	N/A	N/A
62	300	15	39	2.14	6	N/A	N/A
64	300	17	44	2.42	7	N/A	N/A
C5	296	13	41	1.55	3	N/A	N/A
	Mean	**18**	**48**	**2.29**	**8**	**N/A**	**N/A**

Table 3-9 Community measure values for each quinquennial station sampled during the summer 2021 infauna survey, including regional and historical values. N/A = Not Applicable.

OC San Environmental Laboratory and Ocean Monitoring Division

Station	Depth (m)	Species Richness	Abundance	H′	SDI	ITI	BRI
Regional Bight ’13 Summer Values [mean (range)]							
Middle Shelf		90 (45–171)	491 (142–2,718)	3.60 (2.10–4.10)	—	—	18 (7–30)
Outer Shelf		66 (24–129)	289 (51–1,492)	3.40 (2.30–4.10)	—	—	18 (8–28)
Upper Slope/Canyon		30 (6–107)	96 (12–470)	2.70 (0.60–3.90)	—	—	—
OC San Historical Values (July 2011–June 2021) [mean (range)]							
Middle Shelf Zone 1		93 (63–140)	399 (168–820)	3.73 (2.99–4.26)	31 (13–45)	84 (64–98)	14 (8–19)
Middle Shelf Zone 3		69 (45–102)	276 (120–488)	3.62 (3.10–4.06)	26 (14–43)	80 (64–94)	18 (9–28)
Outer Shelf		34 (18–64)	106 (38–292)	2.94 (1.80–3.59)	15 (3–28)	63 (43–81)	25 (16–39)
Upper Slope/Canyon		23 (13–38)	52 (22–128)	2.69 (1.57–3.41)	11 (3–21)	60 (33–100)	26 (15–37)

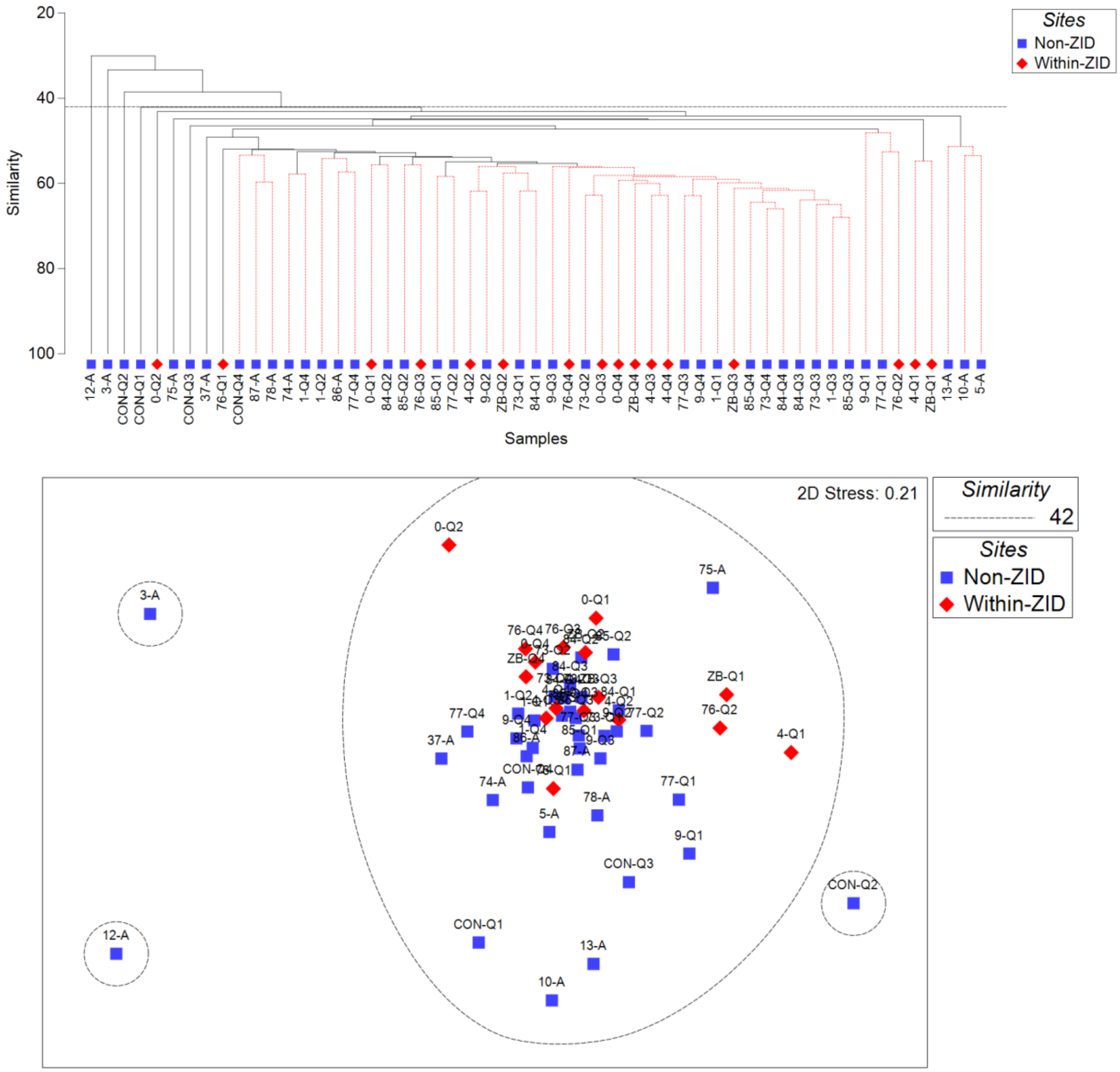

Figure 3-5 **Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the infauna collected at within- and non-ZID stations along the Middle Shelf Zone 2 stratum for the 2021-22 program year. Stations connected by red dashed lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 4 main clusters formed at a 42% similarity on the dendrogram are superimposed on the nMDS plot. A Q1, Q2, Q3, or Q4 suffix on a station label represents quarters 1 to 4, while an A suffix on a station label represents an annual (summer) station.**

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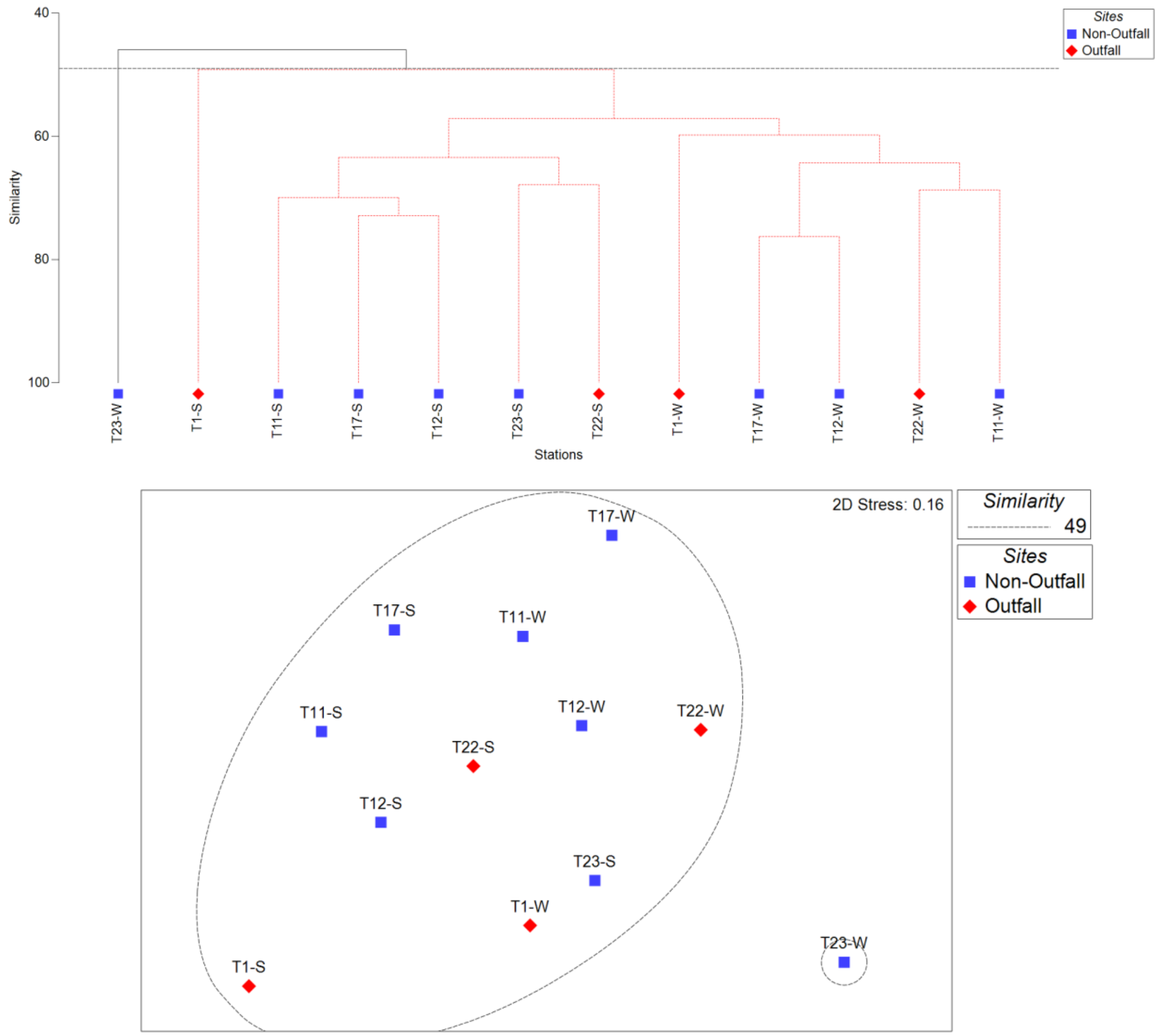

Figure 3-6 Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the epibenthic macroinvertebrates collected at outfall and non-outfall stations along the Middle Shelf Zone 2 stratum for the Summer 2021 (S) and Winter 2022 (W) trawl surveys. Stations connected by red dashed lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 2 clusters formed at a 49% similarity on the dendrogram are superimposed on the nMDS plot.

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Table 3-10 Summary of epibenthic macroinvertebrate community measures for each semi-annual and annual (*) station sampled during the Summer 2021 and Winter 2022 trawl surveys, including regional and historical values.

OC San Environmental Laboratory and Ocean Monitoring Division

Season	Station	Depth (m)	Species Richness	Total Abundance	Biomass (kg)	H′	SDI
Summer	**Middle Shelf Zone 1 (31–50 m)**						
	T2*	35	12	2,031	3.78	0.22	1
	T24*	36	17	1,051	1.40	0.87	1
	T6*	36	11	586	0.70	0.62	1
	T18*	36	15	276	0.63	1.35	2
		Mean	**14**	**986**	**1.63**	**0.77**	**1**
	Middle Shelf Zone 2, Non-outfall (51–90 m)						
	T23	58	14	1,928	4.98	0.34	1
	T12	57	13	288	1.88	1.89	4
	T17	60	11	136	1.45	1.78	4
	T11	60	14	273	1.53	1.66	3
		Mean	**13**	**656**	**2.46**	**1.42**	**3**
	Middle Shelf Zone 2, Outfall (51–90 m)						
	T22	60	13	1,099	2.94	0.51	1
	T1	55	22	589	1.33	1.70	4
		Mean	**18**	**844**	**2.14**	**1.11**	**3**
	Outer Shelf (121–200 m)						
	T10*	137	7	980	40.80	0.27	1
	T25*	137	8	728	24.62	0.83	2
	T14*	137	6	363	14.35	0.89	2
	T19*	137	8	388	8.13	0.86	2
		Mean	**7**	**615**	**21.98**	**0.71**	**2**
Winter	**Middle Shelf Zone 2, Non-outfall (51–90 m)**						
	T23	58	6	1,772	4.36	0.17	1
	T12	57	14	124	0.94	2.14	5
	T17	60	14	73	0.48	2.04	5
	T11	60	16	228	0.33	1.94	4
		Mean	**13**	**549**	**1.53**	**1.57**	**4**
	Middle Shelf Zone 2, Outfall (51–90 m)						
	T22	60	11	265	0.60	1.50	3
	T1	55	22	372	0.76	1.98	4
		Mean	**17**	**319**	**0.68**	**1.74**	**4**
Regional Bight ’13 Summer Values [area-weighted mean (range)]							
Middle Shelf			12 (3–23)	1,093 (19–17,973)	5.00 (0.31–36.00)	1.11 (0.09–2.49)	—
Outer Shelf			15 (3–29)	728 (4–5,160)	27.00 (0.39–83.00)	1.26 (0.10–2.39)	—
OC San Historical Values (July 2011–June 2021) [mean (range)]							
Middle Shelf Zone 1			12 (2–26)	679 (2–3,926)	0.92 (0.02–3.44)	1.09 (0.01–2.22)	2 (1–5)
Middle Shelf Zone 2, Non-outfall			11 (5–21)	515 (18–2,498)	1.67 (0.04–11.16)	1.26 (0.06–2.43)	3 (1–9)
Middle Shelf Zone 2, Outfall			12 (7–19)	380 (49–1,420)	1.36 (0.08–4.92)	1.38 (0.22–2.15)	3 (1–5)
Outer Shelf			10 (3–15)	216 (26–844)	5.41 (0.09–33.27)	1.01 (0.12–2.12)	2 (1–8)

Table 3-11 Summary of demersal fish community measures for each semi-annual and annual (*) station sample during the Summer 2021 and Winter 2022 trawl surveys, including regional and historical values.

OC San Environmental Laboratory and Ocean Monitoring Division

Season	Station	Depth (m)	Species Richness	Total Abundance	Biomass (kg)	H′	SDI	FRI
	Middle Shelf Zone 1 (31–50 m)							
Summer	T2*	35	10	265	3.84	0.83	1	19
	T24*	36	12	445	5.22	0.60	1	23
	T6*	36	6	159	0.66	0.56	1	26
	T18*	36	9	57	1.92	1.10	2	22
		Mean	**9**	**232**	**2.91**	**0.77**	**1**	**23**
	Middle Shelf Zone 2, Non-outfall (51–90 m)							
	T23	58	11	638	10.59	1.17	2	17
	T12	57	13	1,229	5.02	1.13	2	16
	T17	60	13	1,431	8.10	1.20	2	15
	T11	60	10	627	1.96	1.10	2	25
		Mean	**12**	**981**	**6.42**	**1.15**	**2**	**18**
	Middle Shelf Zone 2, Outfall (51–90 m)							
	T22	60	12	542	8.07	1.35	2	18
	T1	55	11	595	4.95	1.50	3	16
		Mean	**12**	**569**	**6.51**	**1.43**	**3**	**17**
	Outer Shelf (121–200 m)							
	T10*	137	25	1,141	25.95	1.95	4	15
	T25*	137	23	1,429	22.48	1.81	4	24
	T14*	137	23	1,068	19.93	1.79	4	23
	T19*	137	22	758	12.38	1.86	4	28
		Mean	**23**	**1,099**	**20.18**	**1.85**	**4**	**22**
	Middle Shelf Zone 2, Non-outfall (51–90 m)							
Winter	T23	58	14	991	30.01	1.44	3	25
	T12	57	16	707	11.11	1.58	3	19
	T17	60	15	1,007	17.22	1.79	4	23
	T11	60	17	895	12.26	1.65	3	21
		Mean	**16**	**900**	**17.65**	**1.62**	**3**	**22**
	Middle Shelf Zone 2, Outfall (51–90 m)							
	T22	60	14	802	15.42	1.80	4	17
	T1	55	13	583	23.72	1.88	5	16
		Mean	**14**	**693**	**19.57**	**1.84**	**5**	**16**
Regional Bight ’13 Summer Values [area-weighted mean (range)]								
Middle Shelf			15 (5–24)	506 (12–2,446)	12 (0.70–64.20)	1.65 (0.67–2–35)	—	28 (17–61)
Outer Shelf			14 (2–21)	790 (2–3,088)	16 (0.20–54.50)	1.35 (0.59–2.01)	—	20 (-1–51)
OC San Historical Values (July 2011–June 2021) [mean (range)]								
Middle Shelf Zone 1			10 (2–15)	208 (54–423)	4.71 (0.76–14.63)	1.54 (0.69–2.1)	3 (2–5)	21 (16–27)
Middle Shelf Zone 2, Non-outfall			14 (7–25)	594 (45–12,274)	12.7 (1.25–135.64)	1.71 (0.14–2.2)	3 (1–6)	22 (11–34)
Middle Shelf Zone 2, Outfall			13 (2–18)	407 (110–3,227)	13.83 (2.47–78.72)	1.7 (0.67–2.18)	3 (1–6)	22 (11–32)
Outer Shelf			17 (4–24)	699 (27–1,610)	14.58 (0.96–39.19)	1.49 (0.74–2.07)	3 (1–4)	19 (3–45)

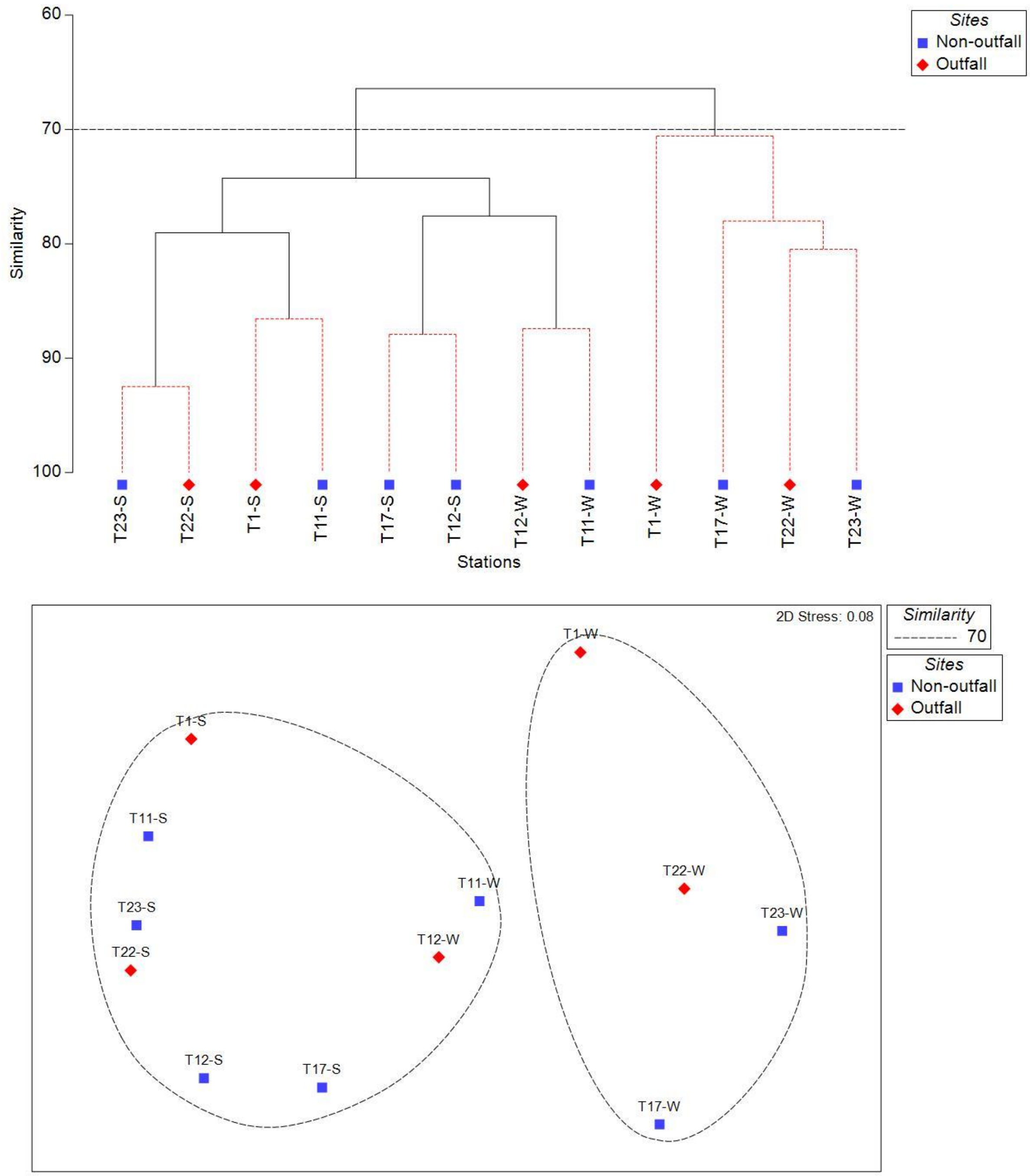

Figure 3-7 Dendrogram (top panel) and non-metric multidimensional scaling plot (bottom panel) of the demersal fishes collected at outfall and non-outfall stations along the Middle Shelf Zone 2 stratum for the Summer 2021 (S) and Winter 2022 (W) trawl surveys. Stations connected by red dashed lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 2 main clusters formed at a 70% similarity on the dendrogram are superimposed on the nMDS plot.

OC San Environmental Laboratory and Ocean Monitoring Division

FISH BIOACCUMULATION AND HEALTH

Demersal and Sport Fish Tissue Chemistry

Concentrations of trace metals and chlorinated pesticides measured in composited liver tissue of Hornyhead Turbot and English Sole were similar between outfall and non-outfall locations (Table 3-12). Additionally, the contaminant concentrations in the composite samples were comparable to the lower range of reported values for individual fish samples analyzed in previous surveys.

Contaminant concentrations in composited muscle tissue of rockfishes were similar between outfall and non-outfall zones (Table 3-13). Moreover, the contaminant concentrations in the composite samples were within historical ranges of individual fish samples analyzed in previous program years. Among the composited muscle tissue of sport fish samples, all contaminant concentrations, except 1 mercury result, were below the least restrictive seven 8-ounce servings per week advisory tissue level (ATL) (Table 3-13 and Table A-9). For the single slightly elevated mercury result (composite of 2 Bocaccio collected at reference Zone 3), the concentration fell within the two 8-ounce servings per week ATL for women aged 18–45 and children aged 1–17 and within the five 8-ounce servings per week ATL for women older than 45 and men. Of the contaminants measured in the Bight '18 survey, mercury concentrations in 1 or more target species exceeded the "consume not more than 2 servings per week" threshold in most fishing zones (McLaughlin et al. 2020). These results suggest that demersal fishes residing near the outfall are not more prone to bioaccumulation of contaminants than those fished regionally, and demonstrate there is negligible human health risk from consuming demersal fishes captured in the monitored area.

Fish Health

The color and odor of demersal fishes captured in the monitoring area appeared normal. Disease symptoms, such as tumors, fin erosion, and skin lesions, were absent in trawl-caught fishes. In addition, external parasites were recorded in less than 1% of the fishes collected, which is comparable to Southern California Bight background levels (Walther et al. 2017). These results indicate that the outfall discharge does not increase the prevalence of disease.

Liver Histopathology

Liver pathologies were observed in most of the Hornyhead Turbot and English Sole samples collected at Stations T1 and T11, however, no significant differences were observed for either species between sites. Among the 6 types of tissue damage that were screened for in the serial tissue sections (see Appendix A), fibrosis was the most prevalent, ranging from 40–60% in the Hornyhead Turbot samples and 73–80% in the English Sole samples. The mean histopathology (health) score for Hornyhead Turbot was 2.14 at Station T1 and 1.54 at Station T11, indicating relatively comparable yet minimal tissue damage in the fish samples at both sites (Figure 3-8). While the mean histopathology scores for English Sole (2.56 at T1 and 2.90 at T11) were slightly higher than those of Hornyhead Turbot (Figure 3-8), there was no significant difference in the liver histopathology scores for English Sole at the 2 sites. The results of this analysis suggest negligible outfall-related effects on the health of demersal fishes in OC San's monitoring area.

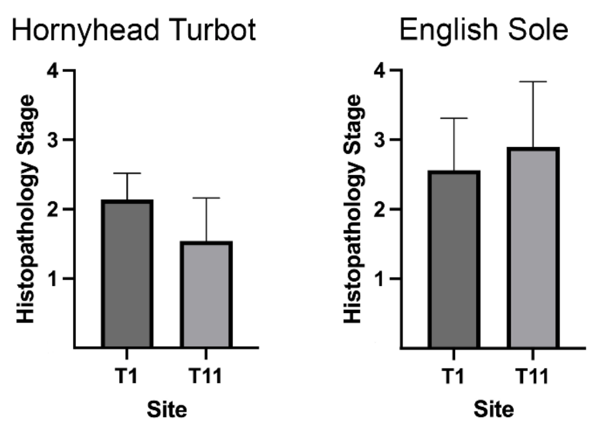

Figure 3-8 Histopathology stage (mean and standard error) of liver tissue samples excised from Hornyhead Turbot and English Sole collected at outfall Station T1 and non-outfall Station T11 during the 2021-22 program year. Histopathology stage 1 indicates no tissue damage present, stage 2 signifies minimal tissue damage, stage 3 denotes moderate tissue damage, and stage indicates acute tissue damage.

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Table 3-12 Percent lipid and contaminant concentrations (ng/g) in composite liver samples of flatfishes collected in the Summer 2021 and Winter 2022 trawl surveys at Stations T1 (Outfall) and T11 (Non-outfall), including historical values (mean and range). ND = Not detected.

OC San Environmental Laboratory and Ocean Monitoring Division

Species	Station	Composite Sample Number	n [a]	Mean Standard Length (mm)	Percent Lipid	Mercury	Arsenic	Selenium	ΣDDT	ΣPCB	ΣChlordane
Pleuronichthys verticalis (Hornyhead Turbot)	Non-outfall	2331334	5	177	8.53	45	10,900	1,150	311.60	84.90	0.80
		2365303	5	160	5.56	60	19,300	1,560	326.60	84.40	1.20
	Outfall	2331130	2	165	5.35	96	9,460	2,300	93.70	53.60	2.10
Parophrys vetulus (English Sole)	Non-outfall	2365307	10	186	5.10	37	18,300	2,750	1,121.60	172.90	1.20
		2366212	8	193	10.20	33	8,840	3,500	359.10	134.90	2.40
	Outfall	2366216	10	200	7.31	47	11,800	3,640	317.40	123.90	2.50
OC San Historical Values (July 2011–June 2021) [mean (range)] [b]											
Pleuronichthys verticalis (Hornyhead Turbot)	Non-outfall	—	71	149 (98–208)	4.63 (0–30.40)	176 (46–484)	—	—	393.79 (ND–2,002.79)	32.84 (ND–290.39)	ND (All ND)
	Outfall	—	79	152 (110–195)	6.93 (0–22.50)	180 (12–532)	—	—	379.57 (ND–1,806.20)	74.25 (ND–457.80)	3.06 (ND–81.70)
Parophrys vetulus (English Sole)	Non-outfall	—	80	187 (125–268)	10.54 (1.93–26.80)	64 (18–191)	—	—	1,200.30 (42.60–14,300.00)	151.60 (ND–1,694.70)	0.07 (ND–5.27)
	Outfall	—	74	189 (138–290)	11.28 (0.58–27.10)	68 (20–162)	—	—	1,179.98 (58.80–20.967.00)	162.34 (ND–1,627.29)	0.95 (ND–30.80)

[a] The value given for the 2021-22 program year represents the number of individuals used for the composite sample.
[b] The historical values are based on analysis of individual fish samples.

Table 3-13 Percent lipid and contaminant concentrations (ng/g) in composite muscle tissue samples of sport fishes collected in Summer 2021 rig fishing surveys at Zones 1 (Outfall) and 3 (Non-outfall), including historical values (mean and range). ND = Not detected.

OC San Environmental Laboratory and Ocean Monitoring Division

Zone	Species	Composite Sample Number	n [a]	Mean Standard Length (mm)	Percent Lipid	Mercury	Arsenic	Selenium	ΣDDT	ΣPCB	ΣChlordane
Non-Outfall	*Sebastes hopkinsi* (Squarespot Rockfish)	2335436	5	189	2.33	38	2,100	670	14.60	4.90	0.60
	Sebastes miniatus (Vermilion Rockfish)	2335612	3	266	1.16	39	1,740	489	27.70	4.10	0.10
	Sebastes paucispinis (Bocaccio)	2335609	2	353	0.39	129	421	731	10.30	1.80	0.10
Outfall	*Sebastes hopkinsi* (Squarespot Rockfish)	2335424	2	199	2.21	35	1,740	883	12.10	3.30	0.50
	Sebastes miniatus (Vermilion Rockfish)	2335606	3	271	0.88	42	3,090	581	5.10	1.10	ND
OC San Historical Values (July 2011–June 2021) [mean (range)] [b]											
Non-outfall	*Sebastes hopkinsi* (Squarespot Rockfish)	—	19	190 (161–225)	1.50 (0.65–2.41)	157 (79–312)	1,657 (598–2,600)	430 (201–764)	19.56 (8.74–44.96)	2.74 (ND–18.20)	ND (All ND)
	Sebastes miniatus (Vermilion Rockfish)	—	27	244 (210–295)	0.80 (ND–2.45)	70 (35–203)	2,749 (1,070–10,300)	616 (66–1,540)	17.00 (2.57–99.20)	0.71 (ND–8.02)	ND (All ND)
	Sebastes paucispinis (Bocaccio)	—	5	332 (338–354)	0.81 (0.24–1.32)	141 (64–189)	474 (129–653)	447 (256–592)	19.70 (15.10–31.20)	1.42 (ND–3.62)	ND (All ND)
Outfall	*Sebastes miniatus* (Vermilion Rockfish)	—	57	260 (149–317)	1.09 (ND–3.82)	54 (25–93)	2,673 (679–5,890)	535 (170–1,070)	12.99 (ND–58.30)	1.65 (ND–17.24)	0.18 (ND–8.80)

[a] The value given for the 2021-22 program year represents the number of individuals used for the composite samples.
[b] The historical values are based on analysis of individual fish samples.

CONCLUSION

Overall, the results of the bacterial, physical, and chemical parameters measured in the water column during the 2021-22 program year indicate good water quality in OC San's monitoring area. Additionally, the sediment quality appeared to be minimally impacted based on the relatively low concentrations of chemical contaminants measured in samples collected at select depth strata, as well as from the absence of sediment toxicity in controlled laboratory tests of sediment collected at outfall-depth stations. The animal communities and contaminant concentrations in fish tissue samples were comparable between outfall and non-outfall areas, and negligible disease symptoms and minimal liver pathologies were observed in fish samples. These results suggest that the receiving environment was not degraded by OC San's discharge of treated wastewater.

SUMMARY OF NON-COMPLIANCE

All permit compliance criteria were met in the 2021-22 program year (Table 3-1).

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Chapter 4. Strategic Process Studies and Regional Monitoring

INTRODUCTION

The Orange County Sanitation District (OC San) operates under the requirements of a National Pollutant Discharge Elimination System (NPDES) permit issued jointly by the U.S. Environmental Protection Agency (EPA) and the State of California Regional Water Quality Control Board (RWQCB), Region 8 (Order No. R8-2021-0010, NPDES Permit No. CA0110604) on June 23, 2021, with the effective date starting on August 1, 2021. To document the effectiveness of its source control and wastewater treatment operations in protecting the coastal ocean, OC San conducts an Ocean Monitoring Program (OMP) that includes Strategic Process Studies (SPS) and regional monitoring programs.

SPS are designed to address unanswered questions raised by the Core monitoring program and/or focus on issues of interest to OC San and/or its regulators, such as the effect of contaminants of emerging concern on local fish populations. SPS are proposed and must be approved by RWQCB to ensure appropriate focus and level of effort.

Regional monitoring studies focus on the larger Southern California Bight (the coastline extending from Point Conception to the United States-Mexican Border). These 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 of the latter 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 SPS and may include information from prior program year(s) since some SPS may span multiple years. Additionally, coronavirus disease 2019 (COVID-19) occupational safety precautions and restrictions were in effect, which impacted several SPS during the 2021-22 program year. Specific program impacts and changes to overall project goals and objectives are detailed in their respective final reports, along with project findings and OC San’s final recommendations.

STRATEGIC PROCESS STUDIES

For the 2021-22 program year, OC San had 6 SPS, of which 3 were designed to better understand potential changes in the quantity and quality of its discharged effluent when the Groundwater Replenishment System (GWRS) Final Expansion project is completed in 2023.

ROMS-BEC Modeling of Outfall Plume

OC San last modeled and characterized its discharge plume in the early 2000s. Since then, significant changes have occurred in both the quantity and quality of the effluent discharged due to water conservation and wastewater reclamation (e.g., GWRS) efforts. To evaluate the spatial extent and temporal variability of the discharge plume, OC San has contracted SCCWRP for a multi-stage effort to model (1) the transport and fate of OC San’s discharged effluent at progressive stages of the GWRS Final Expansion (Table 4-1), (2) the seasonality of the plume distribution with varying ocean conditions between 1997 to 2016 (Table 4-2), and (3) the potential biogeochemical influence of land-based inputs on ocean processes. This study uses a high-resolution numerical model co-developed by scientists at SCCWRP and the University of California, Los Angeles, which couples the Regional Ocean Model System with the Biogeochemical Elemental Cycling model (ROMS-BEC). During the 2021-22 program year, community stakeholders and members of the Ocean Acidification and Hypoxia Technical Advisory Committee charged with the ROMS-BEC model evaluation identified gaps in the formulation, validation, and uncertainty of the BEC model when coupled to ROMS. Strategies are currently being developed to assess these critical model features that will determine and enhance the reliability and accuracy of ROMS-BEC. With this in mind, this SPS was initiated using the well-established ROMS model to focus on the primary goal of understanding plume dispersal over time and space under a variety of scenarios related to changing flows, ocean states, and seasons as agreed upon with the RWQCB in June 2022. ROMS modeling of the plume visitation frequencies at progressive phases of the GWRS Final Expansion will commence in 2023. Future stages using the coupled ROMS-BEC model, or a better prediction model, will commence upon satisfactory demonstration of the reliability and reproducibility of the coupled modeling tool.

Table 4-1 Pre- and post-GWRS modeling scenarios. The common ocean base year used in all model runs is 2000.

OC San Environmental Laboratory and Ocean Monitoring Division

Phase	Model Year
Pre-GWRS	2000
GWRS Phase 1	2008
GWRS Initial Expansion	2016
GWRS Final Expansion	2023 [a]

[a] Effluent flows estimated.

Table 4-2 List of climate variability simulations. Abbreviations: El Niño Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), mixed layer depth (MLD), and North Pacific Gyre Oscillation (NPGO).

OC San Environmental Laboratory and Ocean Monitoring Division

Period	Ocean Climate Conditions
1997–98	Negative to neutral NPGO; positive PDO, positive ENSO, deep MLD
1999	Positive NPGO, negative PDO, negative ENSO, deep MLD
2004	Neutral climate signals; warm, weak ocean transport
2008	Positive NPGO, negative PDO, neutral ENSO, cold and shallow MLD
2009	Positive NPGO, neutral PDO, transition to a quick positive ENSO event, cold and shallow MLD
2014	Strong marine heatwave, neutral climate signal
2015	Strong marine heatwave, negative NPGO, positive ENSO starting in summer, positive PDO, deep MLD
2016	Marine heatwave, neutral NPGO, positive (winter) to negative (summer) ENSO and PDO

Characterization of Microplastics in Wastewater

Wastewater treatment plants are a passive recipient of microplastics (<0.2 in (<5 mm) in size) from upstream residential and industrial sources to aquatic, marine, and terrestrial environments (Ziajahromi et al. 2016, Okoffo et al. 2019). In the last several years, significant gains have been made in demonstrating how different wastewater treatment technologies can lead to effective removal of microplastics from the influent (Freeman et al. 2020). Despite this, very few studies have characterized microplastics in Southern California wastewater treatment plants, including at OC San. This SPS specifically aims to address these data gaps by characterizing the relative quantity and types of microplastics found at various points throughout OC San's treatment system. A secondary goal of this study is to develop methods to extract, measure, and quantify microplastics from different types of wastewater matrices.

In-house method development was initiated in 2019 for the collection, processing, and analysis of microplastics in various wastewater matrices. Composite samples were subsequently collected throughout the treatment trains at both Plant No. 1 and Plant No. 2, and immediately processed in the lab to remove interfering organic material. All suspected microplastic particles between 1.8×10^{-3} to 0.39×10^{-2} in (45–1,000 µm) were visually identified, counted, and characterized by optical microscopy. A subset of particles across color and morphology categories were manually removed from samples, photographed and measured, and isolated for further chemical confirmation and characterization. In 2021, OC San purchased a Fourier Transform Infrared microscope which will allow further confirmation and polymeric characterization of a subset of suspected microplastic particles. Remaining project tasks include the development of reference spectral libraries and spectroscopic analysis of selected particles. Ultimately this project will inform a preliminary assessment of the transport and fate of microplastics through OC San's wastewater treatment process to the receiving environment.

In-Vitro Cell Bioassay Monitoring for Contaminants of Emerging Concern

Contaminants of Emerging Concern (CECs) include hundreds of thousands of chemicals that may be present in the environment alone or in complex mixtures. Many are known or suspected to be detrimental to living organisms, including humans, with continued exposure over time. Due to the diverse analytical challenges associated with monitoring for individual CECs, non-targeted screening methods may be useful to more efficiently evaluate and prioritize sites for continued monitoring. This study was developed to address current gaps of knowledge regarding CECs in OC San's coastal receiving environment using a modern monitoring tool, in-vitro cell bioassays. The study goals were to characterize the bioactivity of known and unknown CECs in wastewater and the receiving environment, improve our understanding of the applicability of cell bioassays in coastal habitats, and to determine whether standard CECs measured across sites with elevated bioactivity could explain the observed responses.

Sampling of influent, final effluent, seawater, and sediment occurred from May through July of 2019 at selected stations with varying discharge plume influence. Aqueous and sediment samples were all processed and analyzed using 3 in-vitro cell bioassays that screen for estrogen receptor-alpha (ERα), aryl hydrocarbon receptor (AhR), and glucocorticoid receptor (GR) activity. Cell bioassay receptors were selected to cover a range of bioactivity pathways and were based on recommendations from the State Water Resources Control Board 2012 Science Advisory Panel on the Monitoring of CECs in Ambient Waters (Maruya et al. 2014). Statistically significant reductions in mean ERα and GR bioassay responses were observed in the effluent relative to the influent, while AhR bioactivity was comparable in both samples. There was no cell bioassay activity detected in any of the seawater samples collected from nearfield or farfield stations across all depths. All sediment samples had measurable ERα and AhR bioactivity levels, particularly at Stations C2 and C4 (sites in the Newport Canyon) and Station 44 (a historical depositional site in the San Gabriel Canyon). No GR activity was detected in any receiving environment station. A mass balance approach comparing targeted CECs measured in samples with bioactivity revealed that <6% of bioactivity could be associated with the targeted contaminants in the 3 sediment stations (44, C2, and C4) that were studied. Far more bioactivity could be associated with the traditional chemicals and CECs measured in wastewater samples, particularly for the influent (63.8%) and secondary effluent samples (21.9%).

This study resulted in one of the first datasets of in-vitro cell bioassay responses used to assess the impacts of wastewater discharges in marine habitats. Complementary measurements of targeted CECs could not fully explain bioactivity patterns, indicating that suites of commonly measured CECs are likely not those causing bioactivity, particularly in the receiving environment. Lessons learned and data gaps were identified where further methodological development, refinement, and investment into this screening tool are needed before application for widespread monitoring. Moving forward, this study points to the potential for cell bioassays to be used either for a preliminary investigation of contamination in new sites or samples, or as a complementary validation tool to understand the bioactivity potential of sites with known contamination issues. However, further development and refinement of bioanalytical screening methods will need to occur before they can be widely used as a monitoring tool by OC San to track and quantify broad changes in the receiving environment.

Effluent Monitoring for Targeted Contaminants of Emerging Concern

Since 2014, OC San has annually monitored a suite of CECs listed in the agency's NPDES permit. For the 2021-22 program year, OC San targeted 12 pharmaceuticals and personal care products (PPCPs), 7 hormones, 7 industrial endocrine disrupting compounds (IEDCs), and 9 polybrominated diphenyl ether (PBDE) flame retardants in the final effluent (Table 4-3). Eleven of the 12 PPCPs analyzed were detected at concentrations ranging from 0.033 µg/L (fluoxetine hydrochloride) to 3.4 µg/L (caffeine), while triclosan was not detected. Of the 7 hormones measured, 3 were detected with concentrations ranging from 0.0086 µg/L (17α-estradiol) to 0.140 µg/L (estrone), while 17α-ethinyl estradiol, estriol, progesterone, and testosterone were below their respective detectable limit. Of the 7 IEDCs analyzed, 4 were detected ranging from 0.7 µg/L (bisphenol A) to 7.0 µg/L (nonylphenol diethoxylate). Although nonylphenol monoethoxylate and nonylphenol diethoxylate were detected, their degradation product, 4-para-nonylphenol, was not detected. By contrast, while octylphenol monoethoxylate and octylphenol diethoxylate were not detected, their transformation product, octylphenol, was detected at a concentration of 5.55 µg/L. Prior to the 2020-21 program year, the concentrations of PBDE flame retardants were below their respective method detection limit (MDL), as for example BDE-47 and BDE-99 were not detected above the 0.0014 µg/L and 0.0016 µg/L MDL, respectively. However, since the adoption of a more sensitive analytical method (EPA 2010) in 2020, most PBDEs have been detected in the final effluent. For example, BDE-47 and BDE-99 were detected at a concentration of 0.00103 µg/L and 0.000616 µg/L, respectively, for the 2021-22 program year. Overall, the concentrations of CECs measured in this program year were comparable to those of the previous program year.

Table 4-3 Contaminants of emerging concern monitored in OC San's final effluent. OC San Environmental Laboratory and Ocean Monitoring Division

	Hormones	
17α-Estradiol	17α-Ethinyl estradiol	Progesterone
17β-Estradiol	Estriol	Testosterone
	Estrone	
	Industrial Endocrine Disrupting Compounds	
Bisphenol A	Nonylphenol diethoxylate	4-n-Octylphenol diethoxylate
4-para-Nonylphenol	Nonylphenol monoethoxylate	Octylphenol monoethoxylate
	Octylphenol	
	Pharmaceuticals and Personal Care Products	
Acetaminophen	Erythromycin	Oxybenzone
Caffeine	Fluoxetine hydrochloride	Primidone
Carbamazepine	Gemfibrozil	Sulfmethoxazole
DEET	Ibuprofen	Triclosan
	Flame Retardants	
BDE-28	BDE-99	BDE-154
BDE-47	BDE-100	BDE-183
BDE-85	BDE-153	BDE-209

Sediment Linear Alkylbenzenes

Linear Alkylbenzenes (LABs) are raw materials found in the production of commonly used detergents. These organic contaminants have been found to be concentrated in wastewater effluent, and as a result, have been used to track the presence and settling of wastewater particles in the offshore environment. From 1998–2014, OC San used LABs to measure its discharge footprint and investigate whether other contaminants present in the sediment were associated with the effluent discharge. This study will provide updated data and a recalibrated baseline for evaluating future changes in effluent quality, quantity, and dispersion due to the GWRS Final Expansion.

In the Summer of 2020, OC San laboratory staff initiated improvements to the GC-MS LAB analytical method by enhancing quantitation reliability through the addition of several commercially available surrogate and internal standards. In the Fall of 2020, OC San laboratory staff subsequently analyzed LAB signatures from a total of 68 sediment samples collected from semi-annual and annual monitoring stations. LAB measurements were added to a database of historical LAB data measured throughout OC San's monitoring region. Data analysis and comparisons are ongoing to determine spatial and temporal changes in the amount of total LABs detected among the benthic sediment stations. The remaining steps include a summarization of historical LAB discharge patterns and a brief literature review of potential alternative sewage tracers that may be used to complement or enhance the current LAB tracers for potential future applications.

Meiofauna Baseline Study

The increase of reverse osmosis concentrate (brine) return flows from the GWRS Final Expansion may negatively affect marine biota in the receiving water. While meiofauna (animals less than 0.02 in (500 µm) in size) are known to be more sensitive to anthropogenic impacts than macrofauna, baseline information on meiofauna diversity and abundance in OC San's monitoring area was previously unexamined. On April 21, 2022, OC San awarded a contract to Dr. Jeroen Ingels at Florida State University to characterize the meiofauna communities in the receiving environment and to evaluate the suitability of using meiofauna for a Before-After Control-Impact study of the GWRS Final Expansion. Dr. Ingels will join OC San staff on a cruise in the summer of 2022 and winter of 2023 to collect sediment and meiofauna samples within OC San's coastal monitoring area. OC San's analytical chemistry team and contractors will measure the grain size and concentrations of total organic carbon, total nitrogen, total phosphorus, dissolved sulfides, metals, and persistent organic pollutants in the sediment samples. Dr. Ingels will process and analyze the meiofauna samples in 2022 and 2023, and he will synthesize the sediment chemistry and meiofauna results in a report expected in 2024.

SPECIAL STUDY

Orange County Oil Spill

On October 2, 2021, a crude oil spill amounting to nearly 25,000 gallons (95,000 L) and 13 square miles (34 square km) in size was detected 3 miles (4.8 km) off the coast of Newport Beach, California (Pipeline P00547 Incident). The spill originated from an underwater pipe connected to the Elly platform located about 4.5 miles (7.2 km) offshore from Long Beach (Figure 4-1). A Unified Command, consisting of the Coast Guard, California Department of Fish and Wildlife's Office of Spill Prevention and Response, the Orange County Sheriff's Department, Amplify Energy and the cities of Long Beach, Newport Beach, and Huntington Beach, was established on October 3rd. The Unified Command worked to coordinate efforts to ensure the safety of the response personnel and the public, to control the source of the spilled oil, to protect environmentally sensitive areas, and to minimize impacts to the maritime industry. Mitigation measures included cleanup efforts for 86 days, closure of Newport Harbor for 4 days, closure of beaches along Orange County for 9 days, closure of fisheries activities from Seal Beach to San Clemente for 58 days, and a risk assessment of seafood consumption in Orange and San Diego Counties following the oil spill incident (OEHHA 2022). The Unified Command stood down on February 2, 2022, after no further indications of shoreline oiling were reported since January 4, 2022.

Two days after the oil spill was detected, OC San suspended all offshore monitoring efforts for a total of 35 days to ensure the safety of OMP staff and to maintain the integrity of OC San's M/V *Nerissa*, water quality instrumentation, and monitoring data. To evaluate potential impacts of the oil spill on the sediment quality at OC San's offshore monitoring stations, OC San staff collected sediment samples at 11 quarterly benthic stations in December 2021 and January 2022 and prioritized the analysis of 20 polycyclic aromatic hydrocarbons (ΣPAH) for comparisons with historical data from the same 11 benthic stations that were previously sampled semi-annually. Additional sediment samples were also collected in December 2021 and January 2022 and archived for analysis of total petroleum hydrocarbon fingerprinting, total PAH characterization, and biomarker analysis if any of the core sediment PAH values were anomalous. Comparison of the ΣPAH data revealed no impacts to the sediment quality in OC San's monitoring area as the ΣPAH concentrations post-oil spill were within historical ranges and were far below the Effects Range-Low and Effects Range-Median sediment quality guidelines (Long et al. 1998; Figure 4-2). This conclusion is bolstered by the presence of healthy infauna communities in OC San's monitoring area following the oil spill (see Chapter 3).

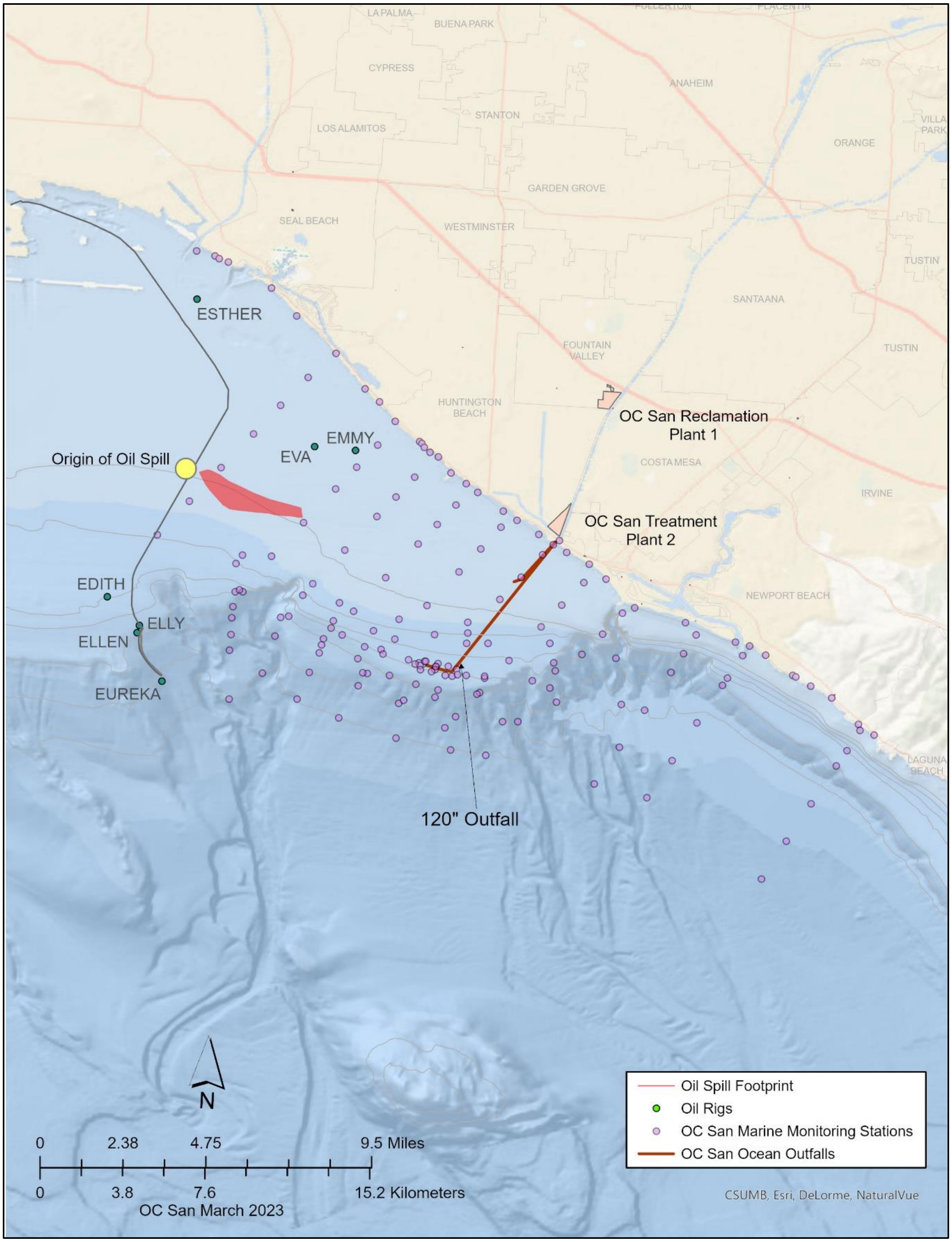

Figure 4-1 Estimated oil footprint on the water surface of the Pacific Ocean off Huntington Beach, California, on Day 1 of the Pipeline P00547 Incident. Note the oil footprint in relation to OC San's monitoring stations.

OC San Environmental Laboratory and Ocean Monitoring Division

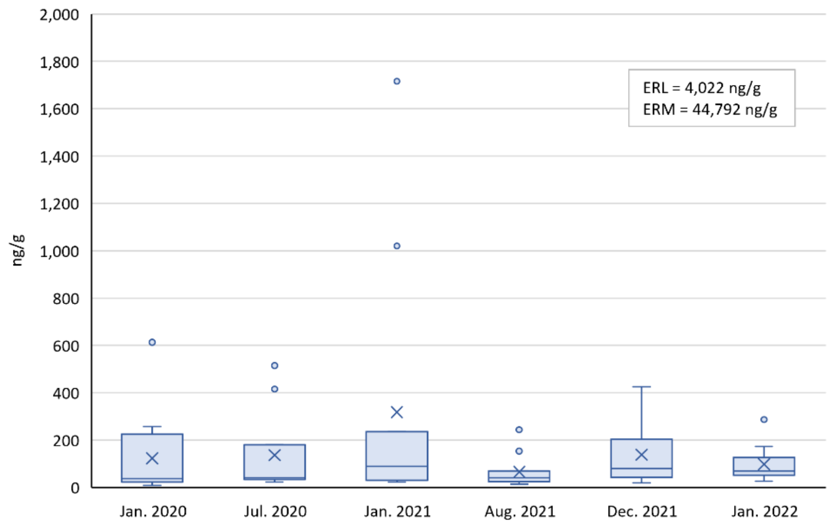

Figure 4-2 Polycyclic aromatic hydrocarbon (PAH) concentrations in sediment samples collected from January 2020 to January 2022 at 11 benthic stations in OC San's monitoring area. Data are pooled by station for each sampling date and represent the minimum and maximum, median, upper and lower quartiles, outliers (solid circles), and mean (x symbol).

OC San Environmental Laboratory and Ocean Monitoring Division

REGIONAL MONITORING

Regional Shoreline (Surfzone) Bacterial Sampling

OC San partners with the Orange County Health Care Agency (OCHCA), the South Orange County Wastewater Authority, and the Orange County Public Works in the Ocean Water Protection Program, a regional bacterial sampling program that samples 126 stations along 42 miles (68 km) of coastline (from Seal Beach to San Clemente State Beach) and 70 miles (113 km) of harbor and bay frontage. OC San samples 36 stations 1–2 days/week along 19 miles (31 km) of beach from Seal Beach to Crystal Cove State Beach (Figure 4-3).

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. Results are available on the OCHCA's website.

Of the 36 regional surfzone stations sampled by OC San, 18 are classified as Core stations because they have been sampled since the 1970s (Figure 4-3). Bacteriology results at these stations during the 2021-22 program year were similar to, but generally less than, those of recent years with fecal indicator bacteria counts varying by quarter, location, and bacteria (Table B-15). A general spatial pattern was associated with the confluence of the mouth of the Santa Ana River and Talbert Marsh. Quarterly geometric means tended to peak near the river mouth and tapered off upcoast and downcoast.

OC San's Dry Weather Urban Runoff Diversion Program continues its successful track record of helping to maintain the quality of the receiving waters along the Orange County coastline. For a sixth year in a row, Orange County Beaches have received favorable ratings in Heal the Bay's annual Beach Report Card (Heal the Bay 2022). Grades for dry summer periods were excellent and just above the 5-year average, with 99% of beaches receiving "A" or "B" grades. Grades for dry winter periods were also stellar, with 95% of the beaches receiving "A" or "B" grades. Grades for rainy winter periods were better than average, with 66% of the beaches receiving "A" or "B" grades. Lastly, a total of 19 beaches made it on the honor roll, which is more than any other county.

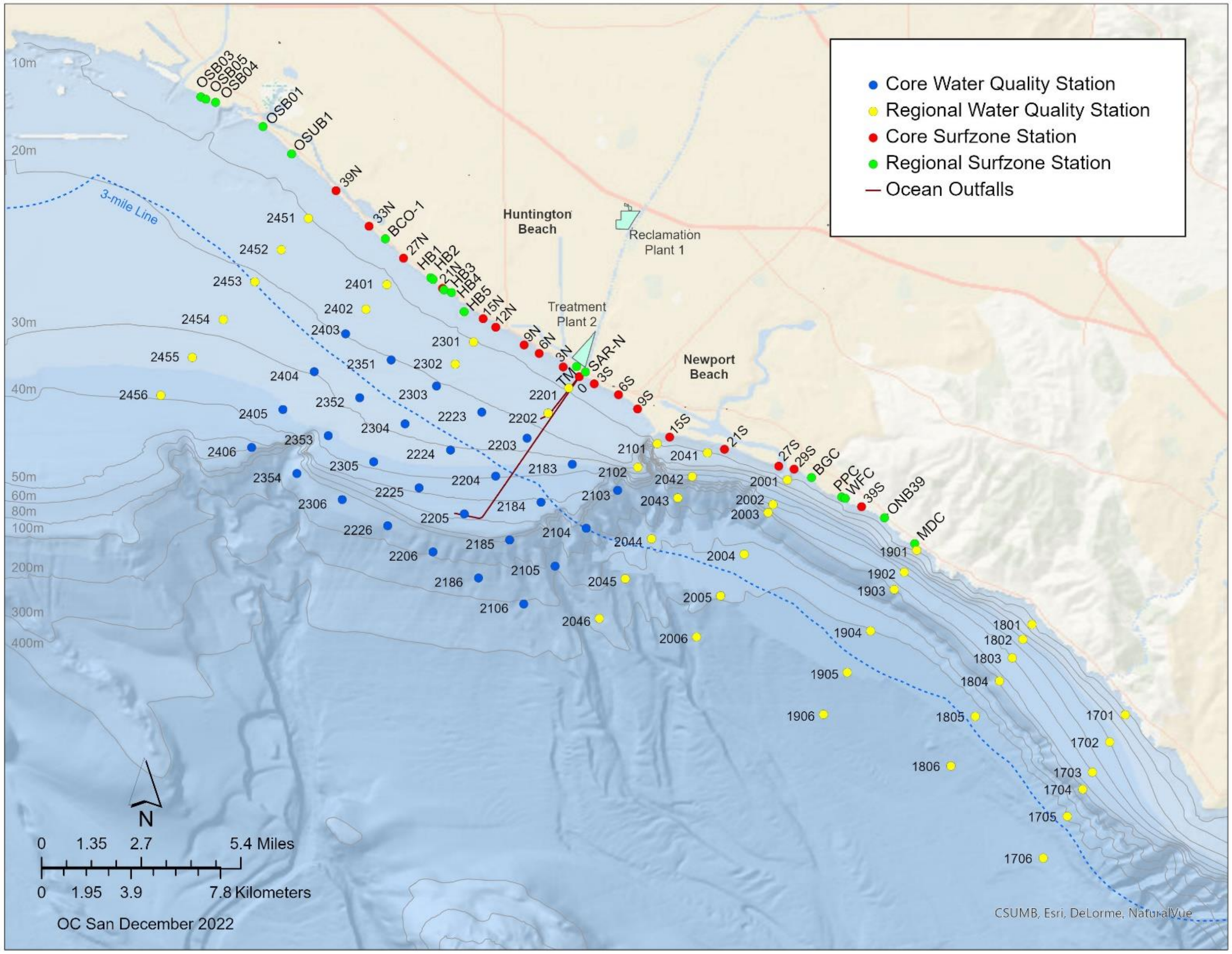

Figure 4-3 OC San's offshore and shoreline (aka surfzone) water quality monitoring stations for the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Southern California Bight Regional Water Quality Program

OC San is a member of a cooperative regional 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 Los Angeles, the County Sanitation Districts of Los Angeles, and the City of San Diego. Each quarter, the participating agencies sample 251 stations that cover the coastal waters from Los Angeles County to Crystal Cove State Beach and from Point Loma to the United States–Mexico Border (Figure 4-4). The participants use comparable conductivity-temperature-depth (aka CTD) profiling systems and field sampling methods. OC San samples 72 stations, which includes the 28 Core water quality program stations, as part of this program (Figure 4-3). 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 OC San's monitoring results. The SCBRWQP serves as the basis for SCCWRP's Bight water quality sampling (see section below).

Bight Regional Monitoring

Since 1994, OC San has participated in all 6 studies that comprise the Southern California Bight Regional Monitoring Program: 1994 Southern California Bight Pilot Project (SCBPP), Bight '98, Bight '03, Bight '08, Bight '13, and Bight '18 (Southern California Bight Regional Monitoring Program – Southern California Coastal Water Research Project (SCCWRP)). OC San has played a considerable role in all aspects of this program, including study design, sampling, quality assurance, data analysis, and reporting. Results from these efforts provide information that is used by individual dischargers, resource managers, and the public to improve understanding of SCB environmental conditions and to provide a regional perspective for comparisons with data collected from individual point sources. For Bight '18, OC San staff conducted field operations, ranging from Dana Point in southern Orange County to the Long Beach breakwater in southern Los Angeles County and southwest to the southern end of Santa Catalina Island (Figure 4-5). Sampling included sediment grabs (geochemistry and benthic infauna) and trawling (epibenthic fish and macroinvertebrates) from July to September 2018, and quarterly water column and ocean acidification sampling from January to December 2019. Bight assessment reports are available at Bight Program Documents – Southern California Coastal Water Research Project .

Central Region Kelp Survey Consortium

OC San 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 was modeled after the San Diego Regional Water Quality Control Board, Region 9 Kelp Survey Consortium, which began in 1983. Both consortiums sample 3–4 times/year 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 typically presented annually by MBC Aquatic Sciences to both consortium groups, regulators, and the public and is published as a report biennially for the CRKSC region. Although 2021 is between reporting years, a preliminary report is available which is summarized below.

2021 CRKSC Summary

Total combined kelp surface canopy in the Central Region decreased by 22% in 2021 compared to 2020 (1.1 square miles (2.9 km^2) versus 1.4 square miles (3.7 km^2)). While 13 kelp beds increased in size, 6, including the 4 largest beds in the region off the Palos Verdes peninsula, were all reduced in size causing an overall decrease in kelp bed coverage in the region. For the 4 survey areas nearest to OC San's outfall, 3 (Horseshoe Kelp, Huntington Flats and Huntington Flats to Newport Harbor) continued to show no surface canopy while the Corona Del Mar kelp beds reappeared in 2021. There was no evidence of any adverse effects on giant kelp resources from any of the region's dischargers. Rather, the regional kelp surveys continue 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.

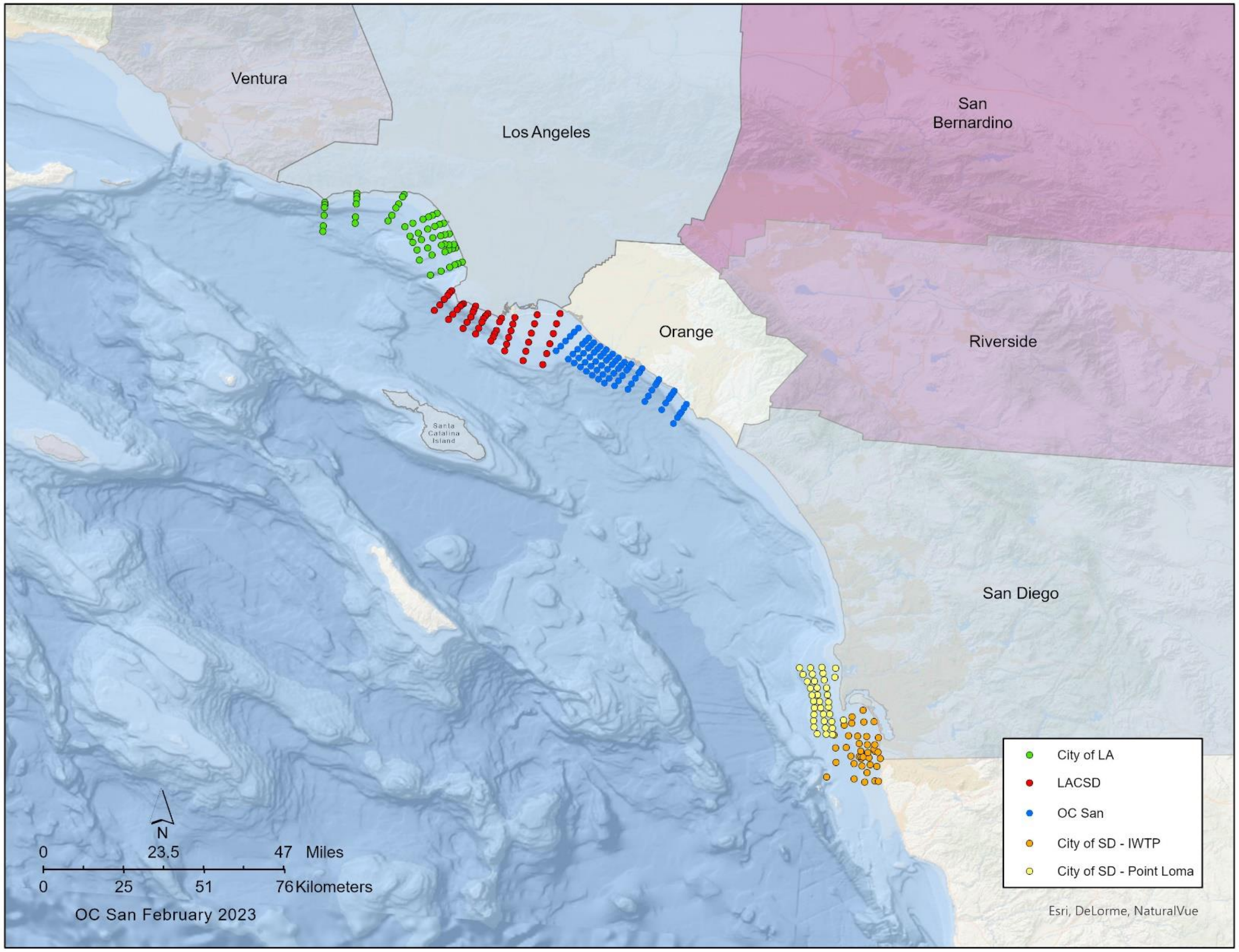

Figure 4-4 Southern California Bight Regional Water Quality Program monitoring stations for the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

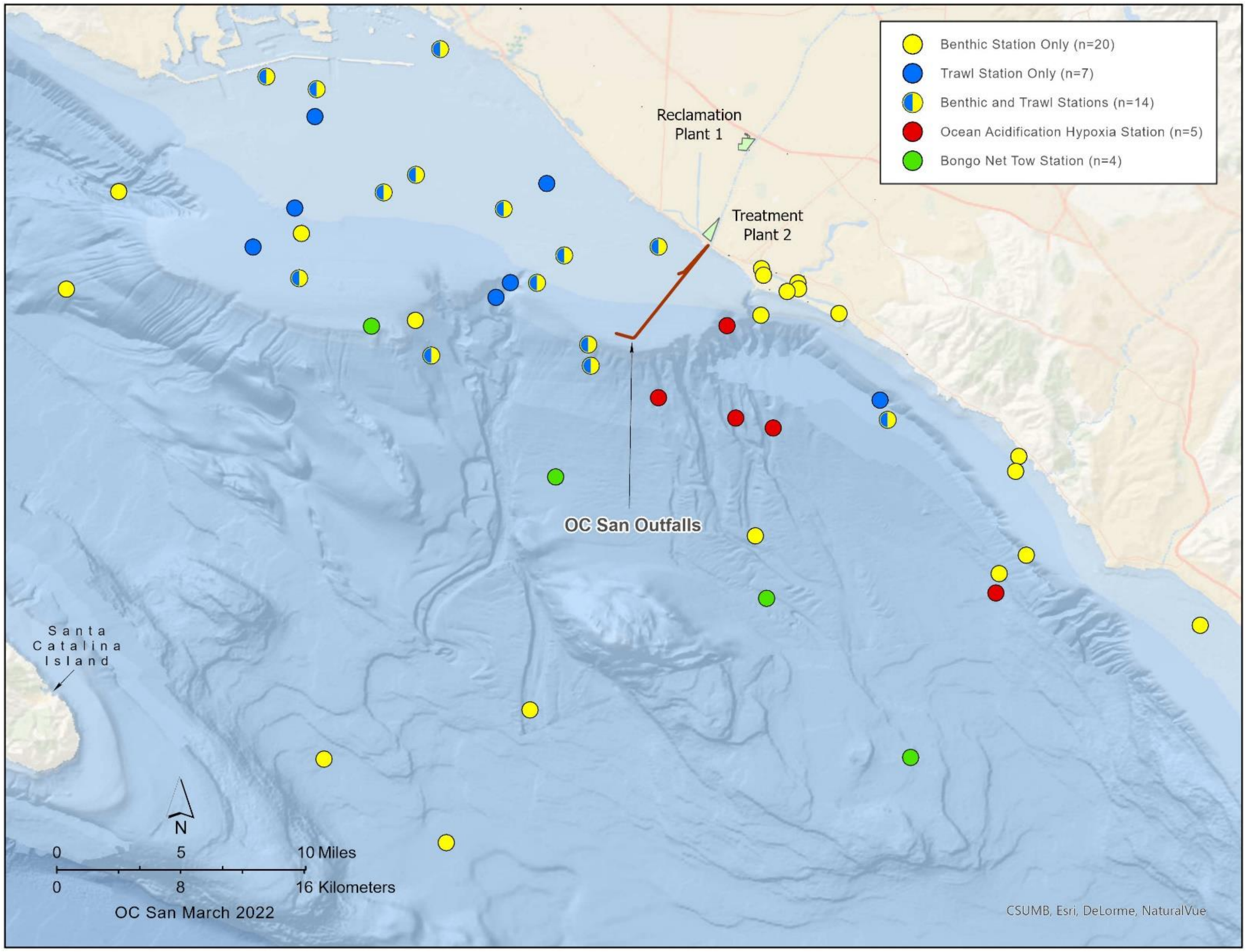

Figure 4-5 OC San's Bight '18 sampling stations.
OC San Environmental Laboratory and Ocean Monitoring Division

Ocean Acidification and Hypoxia Mooring

In 2012, OC San became the first publicly owned treatment works in Southern California to deploy an Ocean Acidification and Hypoxia (OAH) mooring to support the Bight '13 Water Quality studies (and the Bight '18 Water Quality surveys later on). This voluntary mooring program was established to better understand the temporal variability (frequency and duration) in oxygen and pH trends off the San Pedro Shelf. The original telemetry mooring system was custom designed by the Monterey Bay Aquarium Research Institute (MBARI) to measure surface pH and partial pressure of carbon dioxide. It was also equipped with 3 subsurface instrument packages for measuring temperature, depth, salinity, oxygen, pH, and chlorophyll-*a* fluorescence (mid-water depth only). Additionally, MBARI developed and provided OC San staff with a private website for accessing and reviewing the output data.

Over the last 2 program years, OMP staff experienced challenges in the deployment and recovery of its existing OAH mooring system. The mooring was last deployed in spring of 2021 and was due for recovery and redeployment in October 2021, as it had stopped collecting data. However, recovery was delayed until January 2022 due to the Orange County oil spill. The prolonged deployment of the OAH mooring resulted in the loss or damage of some sensors. Several factors subsequently prevented the redeployment of the OAH mooring since its recovery in January 2022. Staff reported safety concerns during mooring deployments and recoveries due to the age of and space constraints aboard OC San's M/V *Nerissa*. These issues were exacerbated by the large size, weight, and complexity of the current mooring design. Redeployment was additionally hindered by long lead times in sensor replacements, repairs, and calibrations by the vendor, as well as frequent cruise cancellations due to unfavorable ocean conditions in the spring of 2022. Due to the aforementioned constraints, OC San is exploring the design and development of a new mooring system, namely the OAH mini-mooring system developed by Dr. Uwe Send of the Ocean Time Series Lab at the Scripps Institution of Oceanography, that can be more safely and easily deployed and recovered while providing a more reliable set of OAH time-series data.

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Appendix A. Methods

INTRODUCTION

This appendix contains a summary of the field sampling, laboratory testing, and data analysis methods used for the effluent and receiving water monitoring requirements of the Orange County Sanitation District (OC San) during the 2021-22 program year.

EFFLUENT MONITORING

Field Methods

Composite and grab samples of final effluent were collected by OC San staff at the final effluent sampling building located at Plant 2. Two Hach AS950 autosamplers were set up to collect 24-hour composite samples. One sampler is flow-paced and was used for permit compliance determinations, whereas the other sampler is time-paced and was used as a backup when needed. Grab samples were collected using the auto, pump, or grab functions on the autosampler. Sampling frequencies varied from daily to annually (see Table E-4 in OC San's National Pollutant Discharge Elimination System (NPDES) permit). Care was taken to collect composite and grab samples according to the respective preservation method and container type listed in Table A-1. All samples were transported to the OC San laboratory at Plant 1 for contractor lab distribution or in-house analysis.

Laboratory Methods

Final effluent samples were processed and analyzed using the methods listed in Table A-1. The measured parameters are listed in Table A-2, of which 14 have effluent limitations, 7 have stipulated criteria, 80 have performance goals and mass emission benchmarks, and 10 are monitored.

Data Analyses

Compliance determinations were made by comparing measurements of constituents in the final effluent samples, including acute and chronic toxicity testing results, to the criteria specified in OC San's NPDES permit. The mass emission for each analyte was computed based on the measured concentration and the final effluent flow. Among the 6 radionuclides that were measured, the results of tritium, strontium-90, and uranium are not provided in Chapter 2 since the combined radium-226 & 228 results did not exceed the stipulated criterion of 5 pCi/L.

Table A-1 Final effluent collection and analysis summary for the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	Sample Type	Container	Preservation	Holding Time	Method
pH	Grab	Plastic or Glass	None	15 min	ELOM SOP 4500-H+B, Rev. 11
Enterococcus	Grab	Plastic	Sodium Thiosulfate, ≤6 ºC	6 hr	ELOM SOP 9223B–9230D, Rev. F
Fecal Coliforms	Grab	Plastic	Sodium Thiosulfate, ≤6 ºC	6 hr	ELOM SOP 9221E, Rev. 5
Oil and Grease	Grab	Amber glass	≤6 ºC, H_2SO_4 to pH ≤2	28 days	ELOM SOP 400 1664B, Rev. 8
Nitrite Nitrogen	24-hr Composite	Plastic or Glass	≤6 ºC	2 days	EPA Method 353.2
Nitrate Nitrogen	24-hr Composite	Plastic or Glass	≤6 ºC	2 days	EPA Method 353.2
Organic Nitrogen	Calculated	—	—	—	Calculated
Total Nitrogen	Calculated	—	—	—	Calculated
Total Phosphorus (as P)	24-hr Composite	Plastic	HNO_3	180 days	EPA Method 200.7
Ammonia (as N)	24-hr Composite	Plastic or Glass	≤6 ºC, H_2SO_4 to pH ≤2	28 days	ELOM SOP 4500-NH3-350.1, Rev. 1
Settleable Solids	Grab	Plastic or Glass	—	48 hr	ELOM SOP 2540 F, Rev. 9
Total Chlorine Residual	Grab	Plastic or Glass	—	Immediate	ELOM SOP 4500-Cl G, Rev. 4 & 5
Purgeable Organic Compounds	Grab	Glass	Sodium Thiosulfate, ≤6 ºC	7 days	ELOM SOP 624.1, Rev. 4
Base/Neutrals and Acids Semi-volatile Organic Compounds	Grab	Glass	≤6 ºC	90 days	ELOM SOP 625.1, Rev. 5
TCDD	24-hr Composite	Amber glass	Dark at 0 to 4 ºC	30 days	EPA Method 1613b, Rev. B
Metals	24-hr Composite	Acid Washed Plastic or Glass	HNO3	6 months	EPA Method 1631; ELOM SOP 200.8, Rev. 15
Tributyltin	24-hr Composite	Glass	HCl	14 days	SM 6710 B
Cyanide	24-hr Composite	Plastic	10N NaOH to pH >10, ≤6 ºC	14 days	ELOM SOP 4500-CN, Rev. 9
Turbidity	24-hr Composite	Plastic or Glass	≤6 ºC	—	ELOM SOP 2130 B, Rev. 6
Radionuclides	24-hr Composite	Plastic or Amber Glass	≤6 ºC, HNO_3 to pH ≤2	6 months	SM 7110C; EPA Methods 200.8, 900.0, 903.1, 904.0, 905.0 & 906.0
Total Suspended Solids	24-hr Composite	Plastic or Glass	≤6 ºC	7 days	ELOM SOP 2540 D/E
Organochlorine Pesticides and Polychlorinated Biphenyls	24-hr Composite	Glass	≤6 ºC	7 days	EPA Methods 608.3 & 1668 C
Acute Whole Effluent Toxicity Testing	24-hr Composite	Plastic	≤6 ºC	36 hr	ELOM SOP 8510, Rev. 6
Chronic Whole Effluent Toxicity Testing	24-hr Composite	Plastic	≤6 ºC	36 hr	ELOM SOP 8210, Rev. 7
Carbonaceous Biochemical Oxygen Demand	24-hr Composite	Plastic or Glass	≤6 ºC	48 hr	ELOM SOP 5210 B

Table A-2 Parameters measured in final effluent samples during the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Parameters with Effluent Limitations		
Carbonaceous Biochemical Oxygen Demand	Turbidity	Hexachlorobenzene [b]
Total Suspended Solids	Total Chlorine Residual	Toxaphene [c]
pH	Acute toxicity	PCBs
Oil and Grease	Chronic toxicity	TCDD Equivalents
Settleable Solids	Benzidine [b]	
Parameters with Stipulated Criteria		
Gross Alpha Radioactivity	Radium-226	Tritium
Gross Beta Radioactivity	Radium-228	Strontium-90
		Uranium
Parameters with Performance Goals and Mass Emission Benchmarks		
Marine Aquatic Life Toxicants		
Arsenic, total recoverable	Nickel, total recoverable	Total Chlorine Residual
Cadmium, total recoverable	Selenium, total recoverable	Non-chlorinated Phenols [a]
Chromium (VI)	Silver, total recoverable	Chlorinated Phenols [a]
Copper, total recoverable	Zinc, total recoverable	Endosulfan [c]
Lead, total recoverable	Cyanide, total recoverable	Endrin [c]
Mercury, total recoverable	Ammonia as Nitrogen	Hexachlorocyclohexane [c]
Human Health Toxicants – Non-Carcinogens		
Acrolein [a]	Dichlorobenzenes [a]	Hexachlorocyclopentadiene [b]
Antimony	Diethyl phthalate [b]	Nitrobenzene [b]
Bis(2-chloroethoxy) methane [b]	Dimethyl phthalate [b]	Thallium
Bis(2-chloroiso-propyl) ether [b]	4,6-dinitro-2-methylphenol [b]	Toluene [a]
Chlorobenzene [a]	2,4-dinitrophenol [b]	Tributyltin
Chromium (III)	Ethylbenzene [a]	1,1,1-trichloroethane [a]
Di-n-butyl-phthalate [b]	Fluoranthene [b]	
Human Health Toxicants – Carcinogens		
Acrylonitrile [a]	1,2-dichloroethane [a]	Isophorone [b]
Aldrin [c]	1,1-dichloroethylene [a]	N-nitrosodimethylamine [b]
Benzene [a]	Dichlorobromomethane [a]	N-nitrosodi-n-propylamine [b]
Benzidine [b]	Dichloromethane [a]	N-nitrosodiphenylamine [b]
Beryllium	1,3-dichloropropene [a]	PAHs [a]
Bis(2-chloroethyl) ether [b]	Dieldrin [c]	PCBs
Bis(2-ethylhexyl) phthalate [b]	2,4-dinitrotoluene [b]	TCDD equivalents
Carbon tetrachloride [a]	1,2-diphenylhydrazine [b]	1,1,2,2-tetrachloroethane [a]
Chlordane [c]	Halomethanes [b]	Tetrachloroethylene [a]
Chlorodibromomethane [b]	Heptachlor [c]	Toxaphene [c]
Chloroform [a]	Heptachlor epoxide [c]	Trichloroethylene [a]
DDT [c]	Hexachlorobenzene [b]	1,1,2-trichloroethane [a]
1,4-dichlorobenzene [a]	Hexachlorobutadiene [b]	2,4,6-trichlorophenol [b]
3,3′-dichlorobenzidine [b]	Hexachloroethane [b]	Vinyl chloride [a]
Miscellaneous Parameters		
Fecal Coliform Density	Nitrate Nitrogen	Biochemical Oxygen Demand
Enterococcus Density	Organic Nitrogen	Individual PCB Congeners
Ammonia (as N)	Total Nitrogen	
Nitrite Nitrogen	Total Phosphorus (as P)	

[a] Purgeable Organic Compound
[b] Base/Neutrals and Acids Semi-volatile Organic Compound
[c] Organochlorine Pesticide

Receiving Water Quality Monitoring

Field Methods

Offshore Zone

Permit-specified water quality monitoring was conducted 6 times per quarter for California Ocean Plan (COP 2019) compliance determinations. Three surveys sampled the full 28-station grid monthly for dissolved oxygen (DO), acidity/basicity (pH), water clarity, and nutrient compliance determinations. During 2 of these surveys, bacteriological samples were also collected at a subset of 8 stations (REC-1 stations) located within 3 miles (4.8 km) of the coast. These samples, when combined with those from the 3 additional REC-1 station surveys, were used for quarterly REC-1 water-contact compliance determinations (Table A-3; Figure 3-1).

Each survey included measurements of pressure (from which depth is calculated), water temperature, conductivity (from which salinity is calculated), DO, pH, water clarity (light transmissivity, beam attenuation coefficient [beam-c], and photosynthetically active radiation [PAR]), chlorophyll-*a* fluorescence, and colored dissolved organic matter (CDOM). Measurements were conducted using a Sea-Bird Electronics SBE911 plus conductivity-temperature-depth (CTD) profiling system deployed from the M/V *Nerissa*. Profiling was conducted at each station from 3.3 ft (1 m) below the surface to 6.6 ft (2 m) above the bottom or to a maximum depth of 246 ft (75 m), when water depths exceeded 75 m. SEASOFT V2 (2018a) 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). Weather conditions, 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 ammonia nitrogen (NH_3-N), nitrate nitrogen (NO_3-N), and fecal indicator bacteria (FIB) analyses at specified stations and depths. Six liters of surface seawater (control sample) were collected at Station 2106 during each survey for NH_3-N and NO_3-N quality assurance/quality control (QA/QC) analysis. All bottled samples were kept on wet ice in coolers and transported within 6 hours to OC San's laboratory where they were logged into the Laboratory Information Management System (LIMS) and then delivered to laboratory staff under chain of custody protocols. A summary of the sampling and analysis methods is presented in Table A-3.

Southern California Bight Regional Water Quality

An expanded grid of 44 water quality stations was sampled quarterly as part of the Southern California Bight Regional Water Quality monitoring program. These stations were sampled by OC San in conjunction with 28 Core water quality stations (Figure 4-3) and those of the City of Los Angeles, County Sanitation Districts of Los Angeles, and City of San Diego. The total sampling area extends from the Santa Monica Bay 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 4-4). Data were collected using CTDs within a fixed-grid pattern comprising 299 stations during a targeted period of 3–4 days. Parameters measured included pressure, water temperature, conductivity, DO, pH, chlorophyll-*a*, PAR, and light transmissivity. Profiling was conducted from the surface to 2 m from the bottom or to a maximum depth of 328 ft (100 m). OC San's sampling and analytical methods were the same as those presented in Table A-3.

Shoreline Zone

Regional shoreline (also referred to as "surfzone") FIB samples were collected 1–2 days per week at a total of 36 stations (Figure 4-3). When water at the creek/storm drain stations flowed to the ocean, 3 bacteriological samples were collected at the source and 25 yards (nearly 23 m) up- and downcoast. When flow was absent, a single sample was collected 25 yards downcoast.

Samples were collected in ankle-deep seawater, with the mouth of a 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.

Table A-3 Receiving water quality sample collection and analysis methods by parameter for the 2021-22 program year. NA = Not Applicable. OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	# Sampling Events	Sampling Method	Method Reference	Field Preservation	Container	Holding Time	Sampling Depth	Field Replicates
Shoreline (Surfzone)								
Total Coliforms	1-2/week	Grab	SM 9222 B [i]	Ice (<6 °C)	125 mL HDPE (sterile container)	8 hr (field + lab)	Ankle-deep water	At least 10% of samples
Fecal Coliforms	1-2/week		SM 9222 D [i]					
Enterococci	1-2/week		EPA Method 1600 [j]					
Offshore								
Temperature [a]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m [k]	At least 10% of stations
Salinity (conductivity) [b]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m [k]	At least 10% of stations
pH [c]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m [k]	At least 10% of stations
Dissolved Oxygen [d]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m [k]	At least 10% of stations
Transmissivity [e]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m [k]	At least 10% of stations
Photosynthetically Active Radiation (PAR) [f]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m [k]	At least 10% of stations
Chlorophyll-*a* fluorescence [f]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m [k]	At least 10% of stations
Color Dissolved Organic Matter (CDOM) [f]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m [k]	At least 10% of stations
Ammonia Nitrogen (NH_3-N)	6/quarter	Niskin	ELOM SOP 4500-NH3.G, Rev. L [j]	Ice (<6 °C)	125 mL HDPE	28 days	Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, Bottom	At least 10% of stations
Nitrate Nitrogen	6/quarter	Niskin	EPA Method 353.2	Ice (<6 °C)	125 mL HDPE	28 days	Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, Bottom	At least 10% of stations
Total Coliforms and *Escherichia coli* [g]	5/quarter [h]	Niskin	SM 9222 B [i, j] & 9223 C [i]	Ice (<6 °C)	125 mL HDPE (sterile container)	8 hr (field + lab)	Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, Bottom	At least 10% of stations
Enterococci	5/quarter [h]	Niskin	EPA Method 1600 [j]; SM 9230 D [i]	Ice (<6 °C)	125 mL HDPE (sterile container)	8 hr (field + lab)	Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, Bottom	At least 10% of stations

Table A-3 Receiving water quality sample collection and analysis methods by parameter for the 2021-22 program year. NA = Not Applicable. OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	# Sampling Events	Sampling Method	Method Reference	Field Preservation	Container	Holding Time	Sampling Depth	Field Replicates
Fecal Coliforms	5/quarter [h]	Niskin	SM 9222 D [i, j] & 9223 C [i]	Ice (<6 °C)	125 mL HDPE (sterile container)	8 hr (field + lab)	Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, Bottom	At least 10% of stations
Surface Observations	6/quarter	Visual observations	NPDES Permit	N/A	N/A	N/A	Surface	N/A

[a] Calibrated reference cells (0.0005 °C accuracy) annually.
[b] Calibrated to IAPSO Standard and Guildline 8400B Autosal annually.
[c] Referenced and calibrated to NIST buffers of pH 7, 8, and 9 prior to each survey.
[d] Referenced and calibrated each survey by comparison with the lab dissolved oxygen probe, which is calibrated daily.
[e] Referenced and calibrated to known transmittance in air.
[f] Factory calibrated annually.
[g] Fecal coliform count calculation: *Escherichia coli* MPN/100 mL × 1.1.
[h] REC-1 surveys completed within 30 days for geometric mean calculations.
[i] APHA (2012).
[j] During the transition period related to ELAP accreditation and 2021 NPDES permit adoption, the surfzone FIB method was used for some offshore FIB samples.
[k] Sampled continuously at 24 scans/second but data are processed at 1 m intervals.

Laboratory Methods

Laboratory analyses of NH_3-N, NO_3-N, and FIB samples followed methods listed in Table A-3. QA/QC procedures included, with each sample batch, analysis of laboratory blanks and duplicates for bacteria samples and analysis of laboratory method blanks, analytical quality control samples (matrix spikes, matrix spike replicates, and blank spikes), and standard reference materials for NH_3-N and NO_3-N samples. All data underwent at least 3 separate validations prior to being included in the final database used for summary statistics and compliance determination.

Data Analyses

Raw CTD data were processed using both SEASOFT V2 (2018b) and third party (IGODS 2012) software. The steps included retaining down-cast data and removing potential outliers (i.e., data that exceeded specific sensor response 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 air bubbles) rather than by actual oceanographic events. After outlier removal, averaged 1-m depth values were prepared from the down-cast data; if there were any missing 1-m depth values, then the up-cast data were used as a replacement.

Compliance Determinations

COP compliance was assessed based on: (1) specific numeric criteria for DO, pH, and FIB (REC-1 zone only); and (2) narrative (non-numeric) criteria for transmissivity, floating particulates, oil and grease, water discoloration, beach grease, and nutrients (e.g., NH_3-N).

<u>DO, pH, and Transmissivity</u>

- DO cannot be depressed >10% below the reference profile mean;
- pH cannot exceed ±0.2 pH units of the reference profile mean; and
- Natural light (defined as transmissivity) shall not be significantly reduced, where statistically different from the reference profile mean is defined as the lower 95% confidence limit.

Compliance was calculated using a method developed by Southern California Coastal Water Research Project (SCCWRP) in conjunction with its member agencies and the State Water Resources Control Board. The methodology involves 4 steps: (A) identification of the stations affected by the effluent plume using CDOM, (B) selection of reference sampling sites representing non-plume impacted conditions using CDOM, (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 Out-of-Range-Occurrences (OROs). Reference density profiles are calculated and the profiles below the mixed layer at plume (CDOM) stations are compared and a maximum difference value is used to establish the number of OROs. Detailed methodology, as applied to DO, can be found in Nezlin et al. (2016). In accordance with the NPDES 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 an Out-of-Compliance (OOC) event, each ORO was evaluated to determine if it represented a logical OOC event. These evaluations were based on: (A) current direction; (B) confirmation of wastewater with FIB and nutrients (i.e., NH_3-N and NO_3-N), when available; and (C) water column features relative to naturally occurring events (i.e., low transmissivity due to elevated phytoplankton as measured by chlorophyll-*a*). ORO and OOC percentages were calculated according to the total number of observations (n=297).

<u>Fecal Indicator Bacteria</u>

FIB compliance used corresponding bacterial standards at each REC-1 station. FIB counts were depth-averaged by station and sampling date, and compliance determined using the following State Water Board Water-Contact objectives for fecal coliform and enterococci, State Water Board Shellfish Harvesting standards for total coliform, and the U.S. Environmental Protection Agency Recreational Water Quality Criteria for enterococci (EPA 2012, SWRCB 2019):

Fecal coliform (State Water Board REC-1 objectives)

- A 30-day geometric mean of fecal coliform[3] density shall not exceed 200 per 100 mL.
- A single sample maximum of fecal coliform density shall not exceed 400 per 100 mL.

Enterococci (State Water Board REC-1 objectives)

- A 6-week rolling geometric mean of enterococci, calculated weekly, shall not exceed 30 CFU or MPN per 100 mL.
- A statistical threshold value of 110 CFU or MPN per 100 mL shall not be exceeded by >10% of all enterococci samples collected in a calendar month.

Total coliform (State Water Board shellfish harvesting standards)

- The median total coliform density shall not exceed 70 per 100 mL.
- Not more than 10% of the samples shall exceed 230 per 100 mL.

Enterococci (U.S. EPA recreational water quality criteria)

- A 30-day geometric mean shall not exceed 30 CFU or MPN per 100 mL.
- A statistical threshold value corresponding to the 90th percentile of the same water quality distribution shall not exceed 110 CFU or MPN per 100 mL in the same 30-day interval.

OC San has no NPDES permit compliance criteria for FIB at the shoreline (surfzone) stations. These data were given to the Orange County Health Care Agency (which follows State Department of Health Service AB411 standards) for the Ocean Water Protection Program (http://ocbeachinfo.com/) as part of a cooperative regional monitoring program.

Nutrients and Aesthetics

These compliance determinations were done based on presence/absence and level of potential effect at each station. Station groupings for aesthetic evaluations are shown in Table B-5 and Table B-6 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 NH_3-N compared to COP objectives for chronic (4 mg/L) and acute (6 mg/L) toxicity to marine organisms.

SEDIMENT GEOCHEMISTRY MONITORING

Field Methods

Sediment samples were collected for geochemistry analyses from 11 quarterly, 11 annual (summer quarter), and 35 quinquennial (summer quarter) stations during the 2021-22 program year (Figure 3-2). In addition, 2–3 L of sediment was collected from the 11 quarterly stations in August 2021 for whole sediment toxicity testing. Each station was assigned to 1 of 6 station groups: (1) Middle Shelf Zone 1 (101–164 ft or 31–50 m); (2) Middle Shelf Zone 2, within-ZID (167–295 ft or 51–90 m); (3) Middle Shelf Zone 2, non-ZID (51–90 m); (4) Middle Shelf Zone 3 (299–394 ft or 91–120 m); (5) Outer Shelf (397–656 ft or 121–200 m); and (6) Upper Slope/Canyon (659–1,640 ft or 201–500 m). In Chapter 3, 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 2 in (5 cm). However, if 3 consecutive sediment grabs each yielded a depth of less than 5 cm at a station, then the depth threshold was lowered to less than or equal to 1.6 in (≤4 cm). The top 0.8 in (2 cm) of the sample was transferred into containers using a stainless steel scoop (Table A-4). The sampler and scoop were rinsed thoroughly

[3] Fecal coliform compliance was determined by multiplying detected *E. coli* counts by 1.1 to obtain calculated fecal coliform counts.

with filtered seawater prior to sample collection. All sediment samples were transported on wet ice to OC San's laboratory where they were logged into the LIMS and then stored for further processing. Sample storage and holding times followed specifications in OC San's Environmental Laboratory and Ocean Monitoring Standard Operating Procedures (ELOM SOP) (OCSD 2016; Table A-4).

Table A-4 Sediment collection and analysis summary for the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	Container	Preservation	Holding Time	Method
Dissolved Sulfides	HDPE container	Freeze	6 months	ELOM SOP 4500-S G, Rev. B
Grain Size	Plastic bag	4 °C	6 months	Plumb (1981)
Mercury	Amber glass jar	Freeze	6 months	ELOM SOP 245.1B, Rev. G
Metals	Amber glass jar	Freeze	6 months	ELOM SOP 200.8B_SED, Rev. F
Sediment Toxicity	HDPE container	4 °C	2 months	ELOM SOP 8810
Total Chlorinated Pesticides	Glass jar	Freeze	12 months	ELOM SOP 8000-SPP
Total DDT	Glass jar	Freeze	12 months	ELOM SOP 8000-SPP
Total Nitrogen	Glass jar	Freeze	6 months	EPA Methods 351.2M & 353.2M
Total Organic Carbon	Glass jar	Freeze	6 months	ASTM D4129-05
Total Phosphorus	Glass jar	Freeze	6 months	EPA Method 6010B
Total Polychlorinated Biphenyls	Glass jar	Freeze	12 months	ELOM SOP 8000-SPP
Total Polycyclic Aromatic Hydrocarbons	Glass jar	Freeze	12 months	ELOM 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 LIMS. All other analyses were conducted by OC San lab staff.

Sediment chemistry and grain size samples were processed and analyzed using the methods listed in Table A-4. The measured sediment chemistry parameters are listed in 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. 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-5. Total dichlorodiphenyltrichloroethane (ΣDDT) represents the summed values of 4,4'-DDMU and the 2,4- and 4,4'-isomers of DDD, DDE, and DDT. Total chlorinated pesticides (ΣPest) represent the summed values of 13 chlordane derivative compounds plus dieldrin.

Whole sediment toxicity testing was conducted using the *Eohaustorius estuarius* amphipod survival test (EPA 1994). Amphipods were exposed to test and home (control) sediments for 10 days, and the percent survival of amphipods in each treatment was determined.

Data Analyses

All analytes that were undetected (i.e., with resultant concentration 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 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. OC San's historical sediment geochemistry data from the past 10 monitoring periods, as well as Bight '13 sediment geochemistry data (Dodder et al. 2016), were also used as benchmarks. Data analysis consisted of summary statistics and qualitative comparisons only.

For whole sediment toxicity testing, a station sample is categorized as non-toxic if the result is not statistically significant using a standard t-test and the magnitude of difference compared to the control is less than 20%.

Table A-5 Parameters measured in sediment samples during the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Metals			
Aluminum	Beryllium	Iron	Selenium
Antimony	Cadmium	Lead	Silver
Arsenic	Chromium	Mercury	Zinc
Barium	Copper	Nickel	
Organochlorine Pesticides [a]			
Chlordane Derivates 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 169
PCB 28	PCB 87	PCB 128	PCB 170
PCB 37	PCB 99	PCB 138	PCB 177
PCB 44	PCB 101	PCB 149	PCB 180
PCB 49	PCB 105	PCB 151	PCB 183
PCB 52	PCB 110	PCB 153/168	PCB 187
PCB 66	PCB 114	PCB 156	PCB 189
PCB 70	PCB 118	PCB 157	PCB 194
PCB 74	PCB 119	PCB 158	PCB 201
PCB 77	PCB 123	PCB 167	PCB 206
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	1-Methylphenanthrene
Benzo[b+j]fluoranthene		Phenanthrene	2,3,6-Trimethylnaphthalene
Benzo[e]pyrene		Pyrene	
Miscellaneous Parameters			
Dissolved Sulfides	Total Nitrogen	Total Organic Carbon	Total Phosphorus
Grain Size	Whole Sediment Toxicity		

[a] Pesticides were analyzed only in the summer at the quarterly, annual, and quinquennial stations.

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 the same stations and frequencies as described above in the sediment geochemistry field methods section (Figure 3-2). The purpose of the quarterly and quinquennial surveys was to determine, respectively, potential effects of treated effluent discharge on the benthic infauna community from changes due to the Groundwater Replenishment System Final Expansion Project and long-term trends along the 197-ft (60-m) depth contour.

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 25 in × 18 in × 8 in (63.5 cm × 45.7 cm × 20.3 cm) plastic tray and then decanted onto a sieving table whereupon a hose with an attached fan spray nozzle was used to gently wash the sediment with filtered seawater into a 16 in × 16 in, 0.04 in (40.6 cm × 40.6 cm, 1.0 mm) sieve. Organisms retained on the sieve were rinsed with 7% magnesium sulfate anesthetic into 1 or more 0.3-gallon (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 OC San's laboratory where they were logged into the LIMS and then stored 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 under chain of custody protocols to Aquatic Bioassay and Consulting, Inc. (Ventura, CA), where they were sorted to 5 major taxonomic groups (aliquots): Annelida (bristle 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-6). A subset of the samples from each of the 5 major taxonomic groups was identified by 2 taxonomists as part of the QC analysis (see Appendix C). Taxonomic differences arising from the QC analysis were resolved, and the database was edited accordingly. Species names used in this report follow those given in Cadien and Lovell (2021).

Data Analyses

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 SDI value indicates high dominance (i.e., a community dominated by a few species). The ITI was developed by Word (1978, 1990) to provide a measure of infaunal community "health" based on a species' mode of feeding (e.g., primarily suspension vs. deposit feeder). ITI values greater than 60 are considered indicative of a "normal" community, while 30–60 represent a "changed" community, and values less than 30 indicate a "degraded" community. The BRI measures the pollution tolerance of species on an abundance-weighted average basis (Smith et al. 2001). This measure is scaled inversely to ITI with low values (<25) representing reference conditions and high values (>72) representing defaunation or the exclusion of most species. The intermediate value range of 25–34 indicates a marginal deviation from reference conditions, 35–44 indicates a loss of biodiversity, and 45–72 indicates a loss of community function. The BRI was used to determine compliance with NPDES permit conditions, as it is a commonly used southern California benchmark for infaunal community structure and was developed with the input of regulators (Ranasinghe et al. 2007, 2012). OC San'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* (brittle star) 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.

Table A-6 Benthic infauna taxonomic aliquot distribution for the 2021-22 program year. OC San Environmental Lab and Ocean Monitoring Division

Quarter	Survey (No. of Samples)	Taxonomic Aliquots	Contractor	OC San
Summer 2021	Quarterly (11)	Annelida	0	11
		Arthropoda	0	11
		Echinodermata	0	11
		Mollusca	9	2
		Miscellaneous Phyla	0	11
	Annual (11)	Annelida	11	0
		Arthropoda	11	0
		Echinodermata	11	0
		Mollusca	11	0
		Miscellaneous Phyla	11	0
	Quinquennial (35)	Annelida	35	0
		Arthropoda	35	0
		Echinodermata	35	0
		Mollusca	35	0
		Miscellaneous Phyla	35	0
Fall 2021	Quarterly (11)	Annelida	0	11
		Arthropoda	0	11
		Echinodermata	0	11
		Mollusca	9	2
		Miscellaneous Phyla	0	11
Winter 2022	Quarterly (11)	Annelida	1	10
		Arthropoda	0	11
		Echinodermata	0	11
		Mollusca	11	0
		Miscellaneous Phyla	0	11
Spring 2022	Quarterly (11)	Annelida	3	8
		Arthropoda	0	11
		Echinodermata	0	11
		Mollusca	11	0
		Miscellaneous Phyla	0	11
		Total	**274**	**176**

PRIMER v7 (2015) multivariate statistical software was also used to examine the spatial patterns of infaunal invertebrate communities at the 11 quarterly and 11 annual stations. 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 to down-weight the highly abundant species and to incorporate the less common species (Clarke and Warwick 2014). The quinquennial 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.

TRAWL COMMUNITIES MONITORING

Field Methods

Demersal fishes and epibenthic macroinvertebrates (EMIs) were collected by trawling in August and September 2021 (summer) and in January 2022 (winter). Sampling was conducted at 14 stations: Middle Shelf Zone 1 (118 ft or 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 (449 ft or 137 m) Stations T10, T25, T14, and T19 (Figure 3-3). Only Middle Shelf Zone 2 stations were sampled in both summer and winter; the remaining stations were sampled in summer only.

OC San'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 and bottom-time duration of the trawl should range from 2.5–3.3 ft/s (0.77–1.0 m/s) and 8–15 minutes, respectively. A minimum of 1 trawl was conducted from the M/V *Nerissa* at each station using a 25 ft (7.6 m) wide and 1 in (2.54 cm) mesh, Marinovich, semi-balloon otter trawl with a 0.3 in (0.64 cm) mesh cod-end liner, a 29 ft (8.9 m) chain-rigged foot rope, and 75 ft (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 and usually in the same direction at each station. 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.

Upon retrieval of the trawl net, the contents (fishes and EMIs) were emptied into a large flow-through water tank. Fishes were sorted by species into separate containers; EMIs were placed together in one or more containers. The identity of individual fish in each container was checked for sorting accuracy. Fish samples collected at Stations T1 and T11 were processed as follows: (1) up to 15 arbitrarily selected specimens of each species were weighed to the nearest gram and measured individually to the nearest millimeter (standard length for most species; total length for some species); and (2) if a trawl catch contained more than 15 individuals of a species, then the excess specimens were enumerated in 1 cm size classes and a bulk weight was recorded. Fish samples collected at the other stations were enumerated in 1 cm size classes and a bulk weight was recorded for each species. EMIs were sorted to species, counted, and batch weighed. For each invertebrate species with large abundances (n>100), 100 individuals were counted and then 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 taxonomic analysis in the laboratory.

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 OC San's Taxonomy Lab. Species and common names used in this report follow those given in Page et al. (2013) and Cadien and Lovell (2021).

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 OC San'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). OC San'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. Analyses included (1) hierarchical clustering with group-average linking based on Bray-Curtis similarity indices and SIMPROF permutation tests of the clusters and (2) ordination of the same data using nMDS to confirm hierarchical clustering. Prior to the calculation of the Bray-Curtis indices, the data were fourth root transformed to down-weight the highly abundant species and incorporate the importance of the less common species (Clarke and Warwick 2014). Stations at the other strata 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.

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

To assess contaminant impacts on demersal fishes, three flatfish species, English Sole (*Parophrys vetulus*), Hornyhead Turbot (*Pleuronichthys verticalis*) and Pacific Sanddab (*Citharichthys sordidus*), in the size range of 6 to 8 in (15 to 20 cm) standard length were targeted during trawls for analysis of liver tissue chemistry. 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).

To assess contaminant impacts on local sport fishes, demersal fishes in the family Scorpaenidae (e.g., California Scorpionfish and Vermilion Rockfish) were targeted using hook-and-line fishing, 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 and provide information for the management of local seafood consumption advisories.

Field Methods

For the trawl surveys described above, fish tissue chemistry samples were collected at the outfall (T1) and non-outfall (T11) stations. The sampling objective was to collect a maximum of 20 individual flatfish at Stations T1 and T11. In the summer of 2021, a total of 5 hauls conducted at each station yielded only 2 Hornyhead Turbot at Station T1 and 5 Hornyhead Turbot at Station T11. Additional hauls conducted in the winter of 2022 yielded 18 English Sole at Station T1 and 5 Hornyhead Turbot plus 10 English Sole at Station T11.

For sport fish muscle tissue chemistry, hook-and-line fishing gear (“rig fishing”) was used to target a maximum of 10 individuals of scorpaenid fishes at each outfall (Zone 1) and non-outfall (Zone 3) areas in September 2021 (Figure 3-3). Two Squarespot Rockfish (*Sebastes hopkinsi*) and 3 Vermilion Rockfish (*Sebastes miniatus*) were collected at Zone 1 and 2 Bocaccio (*Sebastes paucispinis*), 5 Squarespot Rockfish, and 3 Vermilion Rockfish were collected at Zone 3.

Each fish collected for bioaccumulation analysis was weighed to the nearest gram and its standard length measured to the nearest millimeter, placed in a pre-labelled, re-sealable plastic bag, and temporarily stored on wet ice in an insulated cooler. Bioaccumulation samples were subsequently transported whole to OC San’s laboratory where they were logged into the LIMS and then delivered to laboratory staff under chain of custody protocols. Sample storage and holding times for bioaccumulation analyses followed specifications in OC San’s ELOM SOP (OCSD 2016; Table A-7).

Laboratory Methods

Individual fish were dissected in the laboratory under clean conditions. Liver tissue samples were sorted into 3 composite samples per station whereas muscle tissue samples were sorted into a total of 5 composite samples. While OC San’s NPDES permit requires only 2 composite samples per trawl station or rig fishing zone, lab staff created 1 composite from the summer liver tissue samples and 2 composites from the winter liver tissue samples at each station. By contrast, lab staff created 2 muscle tissue composites from Zone 1 and 3 muscle tissue composites from Zone 3. Muscle and liver tissues were analyzed using methods shown in Table A-7 for various parameters listed in Table A-8. 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.

Table A-7 Fish tissue handling and analysis summary for the 2021-22 program year. N/A = Not Applicable.
OC San Environmental Laboratory and Ocean Monitoring Division

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

Table A-8 Parameters measured in fish tissue samples during the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

	Metals	
Arsenic	Mercury	Selenium
	Organochlorine Pesticides	
	Chlordane Derivatives	
cis-Chlordane	*trans*-Chlordene	*cis*-Nonachlor
trans-Chlordane	Heptachlor	*trans*-Nonachlor
cis-Chlordene	Heptachlor epoxide	Oxychlordane
	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 105	PCB 158
PCB 28	PCB 110	PCB 167
PCB 37	PCB 114	PCB 169
PCB 44	PCB 118	PCB 170
PCB 49	PCB 119	PCB 177
PCB 52	PCB 123	PCB 180
PCB 66	PCB 126	PCB 183
PCB 70	PCB 128	PCB 187
PCB 74	PCB 138	PCB 189
PCB 77	PCB 149	PCB 194
PCB 81	PCB 151	PCB 201
PCB 87	PCB 153/168	PCB 206
PCB 99	PCB 156	
PCB 101	PCB 157	
	Miscellaneous Parameter	
	Percent Lipids	

ΣDDT and ΣPCB were calculated as described in the sediment geochemistry section. Total chlordane (ΣChlordane) represents the sum of 9 derivative compounds (*cis*- and *trans*-chlordane, *cis*- and *trans*-chlordene, heptachlor, heptachlor epoxide, *cis*- and *trans*-nonachlor and oxychlordane). Organic contaminant data were not lipid normalized.

Data Analyses

All analytes that were undetected (i.e., with result concentration below the method detection limit) are reported as 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 State of California Office of Environmental Health Hazard Assessment advisory tissue levels for ΣDDT, ΣPCB, methylmercury, selenium, and ΣChlordane were used to assess human health risk in rig fishing samples (Table A-9; Klasing and Brodberg 2008).

Table A-9 Advisory tissue levels (ATLs) for selected contaminants in 8-ounce servings of uncooked fish. OC San Environmental Laboratory and Ocean Monitoring Division

Contaminant	ATLs for the number of 8-ounce servings per week (in ng/g) [a]							
	7	6	5	4	3	2	1	Do not consume
Mercury (Women 18–45; Children 1–17)	≤31	>31–36	>36–44	>44–55	>55–70	>70–150	>150–440	>440
Mercury (Women >45; men)	≤94	>94–109	>109–130	>130–160	>160–220	>220–440	>440–1,370	>1,370
Selenium	≤1,000	>1,000–1,200	>1,200–1,400	>1,400–1,800	>1,800–2,500	>2,500–4,900	>4,900–15,000	>15,000
ΣDDT	≤220	>220–260	>260–310	>310–390	>390–520	>520–1,000	>1,000–2,100	>2,100
ΣPCB	≤9	>9–10	>10–13	>13–16	>16–21	>21–42	>42–120	>120
ΣChlordane	≤80	>80–90	>90–110	>110–140	>140–190	>190–280	>280–560	>560

[a] Serving sizes are based on an average 160-pound person. Individuals weighing less than 160 pounds should eat proportionately smaller amounts (for example, individuals weighing 80 pounds should eat one 4-ounce serving in a week when the table recommends eating one 8-ounce serving a week).

FISH HEALTH MONITORING

Assessment of the overall health of fish populations is also required by OC San's NPDES permit. This entails documenting physical symptoms of disease and abnormalities in fish samples collected during each trawl survey, as well as conducting annual liver histopathology analysis.

Field Methods

All trawl fish samples collected during the 2021-22 program year 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. A maximum of 20 individual flatfish (English Sole, Hornyhead Turbot, and Pacific Sanddab) were targeted for liver histopathology analysis at each outfall (T1) and non-outfall (T11) station during the January 2022 trawl survey. Eighteen English Sole and 2 Hornyhead Turbot were collected at Station T1, and 10 English Sole and 10 Hornyhead Turbot were collected at Station T11. Each fish collected for liver histopathology analysis was weighed to the nearest gram and its standard length measured to the nearest millimeter, placed in a pre-labelled, plastic, re-sealable bag, and temporarily stored on wet ice in an insulated cooler. Flatfish samples were hand delivered under chain of custody protocols to Dr. Kristy Forsgren (California State University, Fullerton) at the guest dock located adjacent to the Newport Beach Harbor Patrol building.

Laboratory Methods

At the CSU Fullerton laboratory, a 0.08–0.16 in (2–4 mm) section of liver tissue was removed from each fish sample and placed in 10% neutral-buffered formalin for 48 hours. Liver tissues were stored in 70% ethanol postfixation; the 70% ethanol was changed every 3–4 days until histological processing. Liver tissues were dehydrated in a graded ethanol series, cleared with xylene, embedded in paraffin wax, and cut into 2×10^{-4} in (5 µm) thick serial sections using a rotary microtome. Tissues were then stained with hematoxylin and eosin and examined using an Olympus BX41 compound microscope. Photomicrographs were taken with a QImaging Digital Camera attached to the microscope. Three sections from each paraffin-embedded liver tissue sample were examined under the compound microscope to determine the frequency and severity of liver tissue damage in each fish sample collected at both stations. The tissue damage screened for in the sections included fibrosis, steatosis, vacuolization, lipofuscin, necrosis, and granulocytoma. The overall health of the liver tissue from each fish was evaluated by the presence of tissue damage and scored on a scale of 1–4 based on Van Dyk et al. (2012). The 4 scores of liver tissue damage were classified as follows: 1) no tissue damage present; 2) minimal tissue damage (<30% of tissue) which is likely to have little to no impact on liver function; 3) moderate tissue damage (30–70% of tissue) which may cause impairment of liver function; and 4) acute tissue damage (>70% of tissue) which may lead to irreparable damage to liver function.

Data Analyses

Analysis of fish disease data consisted of qualitative comparisons only. For the liver histopathology samples, the scores of the 3 sections per sample were averaged for statistical analysis. A two-tailed t-test was performed to determine significant differences between the species (Hornyhead Turbot and English Sole) and stations (T1 and T11). The level of statistical significance was determined at $p<0.05$.

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Appendix B. Supporting Data

Table B-1 Percentages of fecal indicator bacteria densities (MPN/100 mL, CFU/100 mL) by quarter and select depth strata for the REC-1 water quality surveys (5 surveys/quarter; 8 stations/survey) conducted during the 2021-22 program year.

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			Total Coliform				Fecal Coliform				Enterococci			
Quarter	**Depth Strata (m)**	**n**	<10 [a]	10–70	71–230 [b]	>230 [c]	<10 [a]	10–20	201–400 [d]	>400 [e]	<10 [a]	10–30	31–110 [f]	>110 [c]
Summer	1–15	80	93.8%	6.2%	0.0%	0.0%	98.8%	1.2%	0.0%	0.0%	91.2%	8.8%	0.0%	0.0%
	16–30	60	73.4%	23.3%	3.3%	0.0%	81.7%	18.3%	0.0%	0.0%	93.3%	6.7%	0.0%	0.0%
	31–45	15	40.0%	46.7%	13.3%	0.0%	46.7%	53.3%	0.0%	0.0%	93.3%	6.7%	0.0%	0.0%
	46–60	20	50.0%	30.0%	10.0%	10.0%	70.0%	20.0%	5.0%	5.0%	80.0%	15.0%	5.0%	0.0%
	Water Column	**175**	**77.1%**	**18.3%**	**3.5%**	**1.1%**	**85.1%**	**13.7%**	**0.6%**	**0.6%**	**90.9%**	**8.6%**	**0.5%**	**0.0%**
Fall	1–15	80	95.0%	3.8%	1.2%	0.0%	97.5%	2.5%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
	16–30	60	71.7%	23.3%	3.3%	1.7%	95.0%	5.0%	0.0%	0.0%	96.7%	3.3%	0.0%	0.0%
	31–45	15	60.0%	26.7%	0.0%	13.3%	86.7%	13.3%	0.0%	0.0%	86.7%	13.3%	0.0%	0.0%
	46–60	20	60.0%	40.0%	0.0%	0.0%	85.0%	15.0%	0.0%	0.0%	85.0%	15.0%	0.0%	0.0%
	Water Column	**175**	**80.0%**	**16.6%**	**1.7%**	**1.7%**	**94.3%**	**5.7%**	**0.0%**	**0.0%**	**96.0%**	**4.0%**	**0.0%**	**0.0%**
Winter	1–15	80	92.5%	7.5%	0.0%	0.0%	97.5%	2.5%	0.0%	0.0%	97.5%	2.5%	0.0%	0.0%
	16–30	60	86.7%	13.3%	0.0%	0.0%	95.0%	5.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
	31–45	15	73.3%	26.7%	0.0%	0.0%	86.7%	13.3%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
	46–60	20	65.0%	35.0%	0.0%	0.0%	85.0%	15.0%	0.0%	0.0%	95.0%	5.0%	0.0%	0.0%
	Water Column	**175**	**85.7%**	**14.3%**	**0.0%**	**0.0%**	**94.3%**	**5.7%**	**0.0%**	**0.0%**	**98.3%**	**1.7%**	**0.0%**	**0.0%**
Spring	1–15	80	92.5%	7.5%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	96.2%	3.8%	0.0%	0.0%
	16–30	60	56.7%	35.0%	5.0%	3.3%	73.3%	25.0%	1.7%	0.0%	95.0%	5.0%	0.0%	0.0%
	31–45	15	13.3%	46.7%	20.0%	20.0%	26.7%	60.0%	13.3%	0.0%	53.3%	46.7%	0.0%	0.0%
	46–60	20	20.0%	50.0%	20.0%	10.0%	45.0%	50.0%	5.0%	0.0%	85.0%	10.0%	5.0%	0.0%
	Water Column	**175**	**65.2%**	**25.1%**	**5.7%**	**4.0%**	**93.7%**	**5.7%**	**0.0%**	**0.6%**	**90.9%**	**8.6%**	**0.5%**	**0.0%**
Annual	1–15	320	93.4%	6.3%	0.3%	0.0%	99.0%	1.0%	0.0%	0.0%	96.2%	3.8%	0.0%	0.0%
	16–30	240	72.1%	23.8%	2.9%	1.2%	84.2%	15.4%	0.4%	0.0%	96.3%	3.7%	0.0%	0.0%
	31–45	60	46.7%	35.0%	10.0%	8.3%	60.0%	36.7%	3.3%	0.0%	83.3%	16.7%	0.0%	0.0%
	46–60	80	48.8%	38.7%	7.5%	5.0%	71.2%	25.0%	2.5%	1.3%	86.3%	11.2%	2.5%	0.0%
	Water Column	**700**	**77.0%**	**18.4%**	**2.9%**	**1.7%**	**87.5%**	**11.7%**	**0.7%**	**0.1%**	**94.0%**	**5.7%**	**0.3%**	**0.0%**

[a] Method detection limit.
[b] Value for the median density criterion.
[c] Value for the <10% of the samples criterion.
[d] Value for the 30-day geometric mean criterion.
[e] Value for the single sample maximum criterion.
[f] Value for the 6-week rolling geometric mean criterion.

Table B-2 Depth-averaged fecal coliform densities (MPN/100 mL) in discrete samples collected in offshore waters during the 2021-22 program year. Results were compared to the State Water Board (SWB) Water-Contact Objectives.

OC San Environmental Laboratory and Ocean Monitoring Division

Quarter	Station	Date					Met SWB 30-day geometric mean of ≤200/100mL	Met SWB single sample standard of ≤400/100 mL
		7/26/2021	**7/27/2021**	**7/29/2021**	**8/2/2021**	**8/4/2021**		
Summer	2103	14	<10	<10	<10	<10	YES	YES
	2104	46	12	<10	<10	10	YES	YES [a]
	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
		11/8/2021	**11/9/2021**	**11/15/2021**	**11/16/2021**	**11/17/2021**		
Fall	2103	<10	<10	16	<10	<10	YES	YES
	2104	<10	<10	10	<10	<10	YES	YES
	2183	<10	<10	15	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
		1/17/2022	**1/18/2022**	**1/19/2022**	**2/9/2022**	**2/14/2022**		
Winter	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

Table B-2 Depth-averaged fecal coliform densities (MPN/100 mL) in discrete samples collected in offshore waters during the 2021-22 program year. Results were compared to the State Water Board (SWB) Water-Contact Objectives.

OC San Environmental Laboratory and Ocean Monitoring Division

Quarter	Station	Date					Met SWB 30-day geometric mean of ≤200/100mL	Met SWB single sample standard of ≤400/100 mL
		4/26/2022	4/28/2022	5/2/2022	5/4/2022	5/5/2022		
Spring	2103	14	11	<10	<10	<10	YES	YES
	2104	10	12	<10	36	44	YES	YES
	2183	27	<10	<10	<10	<10	YES	YES
	2203	19	<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

[a] Depth combined, met single sample standard (date 7/26/2021).

Table B-3 Median total coliform densities (MPN/100 mL) in discrete samples collected in offshore waters during the 2021-22 program year. Results were compared to the State Water Board (SWB) Shellfish Harvesting Standards.

OC San Environmental Laboratory and Ocean Monitoring Division

Quarter	Station	Date					Met SWB Standard of median ≤70/100 mL	Met SWB Standard of ≤10% of samples ≥230/100 mL
		7/26/2021	**7/27/2021**	**7/29/2021**	**8/2/2021**	**8/4/2021**		
Summer	2103	<10	<10	<10	10	<10	YES	YES
	2104	80	<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
		11/8/2021	**11/9/2021**	**11/15/2021**	**11/16/2021**	**11/17/2021**		
Fall	2103	<10	<10	40	<10	<10	YES	YES
	2104	<10	<10	<10	<10	<10	YES	YES
	2183	<10	<10	10	10	<10	YES	YES
	2203	<10	<10	<10	14	<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
		1/17/2022	**1/18/2022**	**1/19/2022**	**2/9/2022**	**2/14/2022**		
Winter	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	20	<10	<10	10	<10	YES	YES
	2403	<10	<10	<10	<10	<10	YES	YES

Table B-3 Median total coliform densities (MPN/100 mL) in discrete samples collected in offshore waters during the 2021-22 program year. Results were compared to the State Water Board (SWB) Shellfish Harvesting Standards.

OC San Environmental Laboratory and Ocean Monitoring Division

Quarter	Station	Date					Met SWB Standard of median ≤70/100 mL	Met SWB Standard of ≤10% of samples ≥230/100 mL
		4/26/2022	4/28/2022	5/2/2022	5/4/2022	5/5/2022		
Spring	2103	20	20	30	10	10	YES	YES
	2104	41	<10	<10	63	122	YES	YES
	2183	52	<10	<10	<10	<10	YES	YES
	2203	14	<10	14	<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

Table B-4 Depth-averaged enterococci densities (MPN/100 mL, CFU/100 mL) based on discrete samples collected in offshore waters during the 2021-22 program year. Results were compared to the State Water Board (SWB) Water-Contact Objectives and U.S. EPA Water Quality Criteria.

OC San Environmental Laboratory and Ocean Monitoring Division

Quarter	Station	Calendar Week (starting on Sunday)						Met SWB 6-week rolling geometric mean and EPA 30-day geometric mean of ≤30/100 mL	Met SWB and EPA criteria of ≤10% of all samples ≥110/100 mL in a calendar month
		Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**		
Summer	2103	<10	<10	<10	<10	<10	<10	YES	YES
	2104	<10	<10	<10	<10	<10	<10	YES	YES
	2183	<10	<10	<10	<10	<10	<10	YES	YES
	2203	<10	<10	<10	<10	<10	<10	YES	YES
	2223	<10	<10	<10	<10	<10	<10	YES	YES
	2303	<10	<10	<10	<10	<10	<10	YES	YES
	2351	<10	<10	<10	<10	<10	<10	YES	YES
	2403	<10	<10	<10	<10	<10	<10	YES	YES
		Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**		
Fall	2103	<10	<10	<10	<10	<10	<10	YES	YES
	2104	<10	<10	<10	<10	<10	<10	YES	YES
	2183	<10	<10	<10	<10	<10	<10	YES	YES
	2203	<10	<10	<10	<10	<10	<10	YES	YES
	2223	<10	<10	<10	<10	<10	<10	YES	YES
	2303	<10	<10	<10	<10	<10	<10	YES	YES
	2351	<10	<10	<10	<10	<10	<10	YES	YES
	2403	<10	<10	<10	<10	<10	<10	YES	YES
		Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**		
Winter	2103	<10	<10	<10	<10	<10	<10	YES	YES
	2104	<10	<10	<10	<10	<10	<10	YES	YES
	2183	<10	<10	<10	<10	<10	<10	YES	YES
	2203	<10	<10	<10	<10	<10	<10	YES	YES
	2223	<10	<10	<10	<10	<10	<10	YES	YES
	2303	<10	<10	<10	<10	<10	<10	YES	YES
	2351	<10	<10	<10	<10	<10	<10	YES	YES
	2403	<10	<10	<10	<10	<10	<10	YES	YES

Table B-4 Depth-averaged enterococci densities (MPN/100 mL, CFU/100 mL) based on discrete samples collected in offshore waters during the 2021-22 program year. Results were compared to the State Water Board (SWB) Water-Contact Objectives and U.S. EPA Water Quality Criteria.

OC San Environmental Laboratory and Ocean Monitoring Division

Quarter	Station	Calendar Week (starting on Sunday)						Met SWB 6-week rolling geometric mean and EPA 30-day geometric mean of ≤30/100 mL	Met SWB and EPA criteria of ≤10% of all samples ≥110/100 mL in a calendar month
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6		
Spring	2103	<10	<10	<10	<10	<10	<10	YES	YES
	2104	<10	<10	<10	<10	<10	<10	YES	YES
	2183	<10	<10	<10	<10	<10	<10	YES	YES
	2203	<10	<10	<10	<10	<10	<10	YES	YES
	2223	<10	<10	<10	<10	<10	<10	YES	YES
	2303	<10	<10	<10	<10	<10	<10	YES	YES
	2351	<10	<10	<10	<10	<10	<10	YES	YES
	2403	<10	<10	<10	<10	<10	<10	YES	YES

Table B-5 Summary of floatable material by station group observed during the 28-station grid water quality surveys for the 2021-22 program year. Total number of station visits = 308.

OC San Environmental Laboratory and Ocean Monitoring Division

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

Table B-6 Summary of floatable material by station group observed during the REC-1 water quality surveys for the 2021-22 program year. Total number of station visits = 128.

OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	**Station Groups**			**Totals**
	Upcoast Inshore	**Infield Inshore**	**Downcoast Inshore**	
	2223, 2303, 2351, 2403	**2203**	**2103, 2104, 2183**	
Oil and Grease	0	0	0	0
Trash/Debris	0	0	0	0
Biological Material (kelp)	0	0	0	0
Material of Sewage Origin	0	0	0	0
Totals	0	0	0	0

Table B-7 Summary statistics of water quality compliance parameters by quarter and depth strata for the Core monthly water quality surveys (3 surveys/quarter, 28 stations/survey) conducted during the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

		Oxygen (mg/L)				**pH**				**Transmissivity (%)**			
Quarter	**Depth Strata (m)**	Minimum	Mean	Maximum	Std. Dev.	Minimum	Mean	Maximum	Std. Dev.	Minimum	Mean	Maximum	Std. Dev
Summer	1–15	6.02	8.05	9.10	0.40	7.86	8.06	8.20	0.06	71.17	78.77	87.03	2.54
	16–30	5.19	7.04	9.09	0.78	7.72	7.94	8.15	0.10	52.61	81.95	87.88	4.03
	31–45	4.42	5.76	7.41	0.69	7.63	7.82	8.04	0.09	71.27	86.42	88.61	2.04
	46–60	4.16	4.88	6.40	0.45	7.63	7.75	7.94	0.07	70.77	87.19	88.83	1.51
	61–75	3.68	4.21	5.04	0.22	7.60	7.69	7.85	0.06	83.20	87.77	88.93	0.99
	Water Column	**3.68**	**6.52**	**9.10**	**1.49**	**7.60**	**7.90**	**8.20**	**0.15**	**52.61**	**83.11**	**88.93**	**4.51**
Fall	1–15	6.61	7.63	8.32	0.24	7.93	8.05	8.12	0.04	79.45	85.23	87.38	1.70
	16–30	5.96	6.93	7.84	0.42	7.78	7.95	8.09	0.07	79.46	85.79	88.17	1.39
	31–45	5.28	6.19	7.63	0.38	7.73	7.84	7.94	0.05	83.74	86.90	88.61	1.12
	46–60	4.95	5.59	6.51	0.29	7.68	7.77	7.86	0.04	84.51	87.35	88.79	1.06
	61–75	4.48	5.06	5.64	0.28	7.64	7.73	7.81	0.05	84.47	87.72	88.87	1.06
	Water Column	**4.48**	**6.63**	**8.32**	**0.95**	**7.64**	**7.91**	**8.12**	**0.13**	**79.45**	**86.24**	**88.87**	**1.66**
Winter	1–15	6.66	8.22	9.28	0.41	7.91	8.06	8.16	0.06	73.97	82.20	88.02	3.69
	16–30	5.71	7.53	8.85	0.56	7.76	8.00	8.15	0.07	74.66	83.78	88.10	3.14
	31–45	4.79	6.44	7.91	0.72	7.70	7.89	8.10	0.09	79.57	86.74	88.51	1.71
	46–60	4.30	5.45	7.06	0.57	7.60	7.78	8.04	0.08	82.39	87.57	88.88	0.93
	61–75	4.04	4.77	5.82	0.44	7.59	7.71	7.95	0.06	85.40	87.89	88.98	0.80
	Water Column	**4.04**	**6.97**	**9.28**	**1.33**	**7.59**	**7.94**	**8.16**	**0.14**	**73.97**	**84.78**	**88.98**	**3.57**
Spring	1–15	6.46	8.35	11.07	0.94	7.91	8.03	8.23	0.08	65.42	84.70	87.59	2.91
	16–30	3.81	7.20	11.10	1.29	7.61	7.91	8.22	0.11	67.13	82.30	87.21	4.10
	31–45	3.46	4.98	6.62	0.78	7.54	7.68	7.84	0.06	73.36	85.85	88.56	2.16
	46–60	3.37	4.13	5.49	0.50	7.53	7.60	7.76	0.04	84.15	87.46	88.91	1.05
	61–75	3.32	3.81	4.84	0.33	7.53	7.57	7.65	0.03	84.26	87.45	89.16	1.16
	Water Column	**3.32**	**6.38**	**11.10**	**2.01**	**7.53**	**7.83**	**8.23**	**0.20**	**65.42**	**84.94**	**89.16**	**3.43**
Annual	1–15	6.02	8.11	11.07	0.64	7.86	8.05	8.23	0.06	65.42	82.50	88.02	3.84
	16–30	3.81	7.20	11.10	0.89	7.61	7.95	8.22	0.10	52.61	83.25	88.17	3.74
	31–45	3.46	5.81	7.91	0.89	7.54	7.80	8.10	0.11	71.27	86.44	88.61	1.89
	46–60	3.37	4.96	7.06	0.75	7.53	7.72	8.04	0.10	70.77	87.40	88.91	1.18
	61–75	3.32	4.41	5.82	0.58	7.53	7.67	7.95	0.08	83.20	87.71	89.16	1.02
	Water Column	**3.32**	**6.62**	**11.10**	**1.55**	**7.53**	**7.89**	**8.23**	**0.17**	**52.61**	**84.59**	**89.16**	**3.73**

Table B-8 Percentages of ammonia nitrogen (mg/L) concentrations by quarter and select depth strata for the Core monthly water quality surveys (3 surveys/quarter; 20 stations/survey) conducted during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Quarter	Depth Strata (m)	n	<MDL [a]	MDL–3.9	4–5.9 [b]	≥6 [c]
Summer	1–15	120	100.0%	0%	0%	0%
	16–30	114	95.6%	4.4%	0%	0%
	31–45	46	82.6%	17.4%	0%	0%
	46–60	65	83.1%	16.9%	0%	0%
	Water Column	345	93.0%	7.0%	0%	0%
Fall [d]	1–15	80	100.0%	0%	0%	0%
	16–30	76	96.0%	4.0%	0%	0%
	31–45	30	86.7%	13.3%	0%	0%
	46–60	44	93.2%	6.8%	0%	0%
	Water Column	230	95.7%	4.3%	0%	0%
Winter	1–15	120	100.0%	0%	0%	0%
	16–30	113	99.1%	0.9%	0%	0%
	31–45	46	87.0%	13.0%	0%	0%
	46–60	65	84.6%	15.4%	0%	0%
	Water Column	344	95.1%	4.9%	0%	0%
Spring	1–15	120	100.0%	0.0%	0%	0%
	16–30	113	97.3%	2.7%	0%	0%
	31–45	48	83.3%	16.7%	0%	0%
	46–60	63	92.1%	7.9%	0%	0%
	Water Column	344	95.3%	4.7%	0%	0%
Annual	1–15	440	100.0%	0.0%	0%	0%
	16–30	416	97.1%	2.9%	0%	0%
	31–45	170	86.7%	13.3%	0%	0%
	46–60	237	92.8%	7.2%	0%	0%
	Water Column	1,263	95.6%	4.4%	0%	0%

[a] Method detection limit (MDL) = 0.04 mg/L.
[b] California Ocean Plan (COP) chronic toxicity criteria.
[c] COP acute toxicity criteria
[d] Fewer samples were collected in the fall quarter due to the Orange County oil spill.

Table B-9 Percentages of nitrate nitrogen (mg/L) concentrations by quarter and select depth strata for the Core monthly water quality surveys (3 surveys/quarter; 20 stations/survey) conducted during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Quarter	Depth Strata (m)	n	<MDL	MDL–RL	>RL
Summer [a]	1–15	120	81.7%	18.3%	0%
	16–30	113	31.0%	66.4%	2.6%
	31–45	46	0%	60.9%	39.1%
	46–60	65	0%	15.4%	84.6%
	Water Column	**344**	**38.7%**	**39.2%**	**22.1%**
Fall [a, b]	1–15	80	80.0%	20.0%	0%
	16–30	76	25.0%	73.7%	1.3%
	31–45	30	0%	96.7%	3.3%
	46–60	44	0%	75.0%	25.0%
	Water Column	**230**	**36.1%**	**58.3%**	**5.6%**
Winter [a]	1–15	120	80.0%	20.0%	0%
	16–30	114	55.3%	44.7%	0%
	31–45	46	15.2%	78.3%	6.5%
	46–60	65	3.1%	52.3%	44.6%
	Water Column	**345**	**48.7%**	**42.0%**	**9.3%**
Spring [c]	1–15	120	65%	34.2%	0.8%
	16–30	113	15%	13.3%	71.7%
	31–45	48	0%	0%	100%
	46–60	63	0%	0%	100%
	Water Column	**344**	**28%**	**16.3%**	**56.1%**
Annual [a, c]	1–15	440	76.4%	23.4%	0.2%
	16–30	416	32.2%	47.4%	20.4%
	31–45	170	4.1%	54.7%	41.2%
	46–60	237	0.8%	32.5%	66.7%
	Water Column	**1,263**	**37.9%**	**24.9%**	**37.2%**

[a] The contract laboratory used a method detection limit (MDL) of 0.036 mg/L and a reporting limit (RL) of 0.2 mg/L

[b] For this quarter, fewer samples were collected due to the Orange County oil spill.

[c] OC San's laboratory used an MDL of 0.005 mg/L and a RL of 0.015 mg/L.

Table B-10 Species richness and abundance values of the major infauna groups collected at each depth stratum and season during the 2021-22 program year. Values represent the mean and range (in parentheses).

OC San Environmental Laboratory and Ocean Monitoring Division

Season	Parameter	Stratum	Annelida	Arthropoda	Echinodermata	Misc. Phyla	Mollusca
Summer	Species Richness	Middle Shelf Zone 1 (31–50 m)	51 (40–62)	22 (15–28)	4 (2–7)	10 (5–17)	8 (4–12)
		Middle Shelf Zone 2 Within-ZID (51–90 m)	47 (35–61)	15 (11–21)	1 (0–3)	4 (0–9)	7 (5–13)
		Middle Shelf Zone 2, Non-ZID (51–90 m)	46 (29–70)	17 (13–30)	3 (2–6)	6 (4–11)	7 (3–12)
		Middle Shelf Zone 3 (91–120 m)	34 (26–44)	10 (3–19)	2 (2–4)	5 (3–7)	8 (7–12)
		Outer Shelf (121–200 m)	21 (16–27)	1 (0–3)	1 (0–2)	2 (1–4)	4 (2–5)
		Upper Slope/Canyon (201–500 m)	9 (0–16)	2 (0–4)	0 (0–3)	0 (0–1)	3 (0–7)
	Abundance	Middle Shelf Zone 1 (31–50 m)	326 (171–538)	80 (52–108)	13 (8–32)	17 (15–22)	15 (9–22)
		Middle Shelf Zone 2 Within-ZID (51–90 m)	242 (147–317)	42 (22–62)	5 (0–10)	7 (0–11)	13 (8–16)
		Middle Shelf Zone 2, Non-ZID (51–90 m)	213 (61–444)	41 (21–110)	7 (3–16)	10 (6–23)	11 (4–32)
		Middle Shelf Zone 3 (91–120 m)	136 (94–249)	17 (3–42)	22 (5–114)	11 (4–18)	22 (8–55)
		Outer Shelf (121–200 m)	274 (63–843)	1 (0–4)	1 (0–2)	3 (2–6)	9 (2–22)
		Upper Slope/Canyon (201–500 m)	30 (0–49)	4 (0–8)	1 (0–3)	0 (0–1)	5 (0–15)
Fall	Species Richness	Middle Shelf Zone 2 Within-ZID (51–90 m)	45 (38–54)	16 (15–18)	2 (2–3)	6 (2–9)	4 (2–6)
		Middle Shelf Zone 2 Non-ZID (51–90 m)	51 (32–63)	16 (6–21)	3 (2–6)	6 (4–11)	6 (4–12)
	Abundance	Middle Shelf Zone 2 Within-ZID (51–90 m)	229 (139–356)	38 (27–60)	5 (2–8)	11 (5–19)	7 (2–13)
		Middle Shelf Zone 2 Non-ZID (51–90 m)	313 (114–469)	41 (15–71)	6 (3–12)	11 (6–21)	7 (4–17)

Table B-10 Species richness and abundance values of the major infauna groups collected at each depth stratum and season during the 2021-22 program year. Values represent the mean and range (in parentheses).

OC San Environmental Laboratory and Ocean Monitoring Division

Season	Parameter	Stratum	Annelida	Arthropoda	Echinodermata	Misc. Phyla	Mollusca
Winter	Species Richness	Middle Shelf Zone 2 Within-ZID (51–90 m)	53 (48–59)	20 (15–22)	3 (2–4)	8 (6–10)	5 (4–7)
		Middle Shelf Zone 2 Non-ZID (51–90 m)	53 (42–62)	17 (10–23)	3 (0–5)	8 (5–12)	7 (4–12)
	Abundance	Middle Shelf Zone 2 Within-ZID (51–90 m)	335 (262–442)	52 (44–61)	8 (6–11)	17 (14–21)	8 (7–10)
		Middle Shelf Zone 2 Non-ZID (51–90 m)	337 (195–467)	52 (21–99)	5 (0–10)	17 (9–35)	15 (4–29)
Spring	Species Richness	Middle Shelf Zone 2 Within-ZID (51–90 m)	59 (50–75)	22 (19–30)	4 (4–5)	6 (4–8)	11 (10–13)
		Middle Shelf Zone 2 Non-ZID (51–90 m)	55 (43–68)	23 (21–27)	4 (3–6)	6 (5–9)	8 (6–10)
	Abundance	Middle Shelf Zone 2 Within-ZID (51–90 m)	404 (335–491)	72 (55–92)	12 (9–17)	15 (9–21)	17 (14–19)
		Middle Shelf Zone 2 Non-ZID (51–90 m)	377 (193–537)	70 (57–101)	15 (7–19)	14 (8–23)	13 (7–22)

Table B-11 Abundance and species richness of epibenthic macroinvertebrates collected in the Summer 2021 and Winter 2022 trawl surveys.
OC Sanitation District Environmental Laboratory and Ocean Monitoring Division

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**	**%**
Lytechinus pictus		57	46	92	1,803	1,716	989	135	304	77	99	18	23	4	128	37	20	35	18		5,601	41.3
Ophiura luetkenii	1,955	854	503	136			9	6	1					1		2					3,467	25.6
Strongylocentrotus fragilis																	933	532	226	87	1,778	13.1
Sicyonia ingentis					17		14	9	67	32	78	20	54	6	50	48	9	141	113	272	930	6.9
Thesea sp B	6	41	4	3	68	37	39	32	70	90	7	28	20	26	20	32		6			529	3.9
Hamatoscalpellum californicum	44	17			15	7	21	31	46	77	10	17	14	6	42	67					414	3.1
Astropecten californicus	3	5	3	3	2		17	44		54	21	16	8	14	2	19	6	7	3	2	229	1.7
Philine auriformis		31	14	23					34		19				2						123	0.9
Ophiothrix spiculata	2	5	5		9	10		2	15	18	29	7				4					106	0.8
Luidia asthenosoma		1	1		3		4		4	5	8	1	9	3	6	3	3				51	0.4
Luidia foliolata	7				1		1			2	6	2	2	1	8		4	1	2		37	0.3
Luidia armata	6	12	3	5					1						5						32	0.2
Neocrangon zacae				3							2							3		20	28	0.2
Astropecten armatus									23												23	0.2
Orthopagurus minimus		17	0		1										2	1					21	0.2
Sicyonia penicillata						1		3		1		8		6		1					20	0.1
Pleurobranchaea californica			5				1		3		3				3	1					16	0.1
Octopus rubescens											2		3				5	3		2	15	0.1
Apostichopus californicus					2		1		2	1	4	1	1		2						14	0.1
Acanthodoris brunnea									4	1					1	6					12	0.1
Pyromaia tuberculata	3	4			3					2											12	0.1
Luidia sp				3				1								4					8	0.1
Heterogorgia tortuosa		1			2			1		1		1		1							7	0.1
Tritonia festiva									7												7	0.1
Acanthoptilum sp	1			1					1	2			1								6	<0.1
Simnia sp										1		3		1		1					6	<0.1
Platymera gaudichaudii				1										2		1					4	<0.1

Table B-11 Abundance and species richness of epibenthic macroinvertebrates collected in the Summer 2021 and Winter 2022 trawl surveys.
OC Sanitation District Environmental Laboratory and Ocean Monitoring Division

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	%
Armina californica				1					1							1					3	<0.1
Paguristes turgidus		1				1						1									3	<0.1
Acanthodoris rhodoceras		2																			2	<0.1
Calliostoma turbinum										1										1	2	<0.1
Cancellaria cooperii												1		1							2	<0.1
Coryrhynchus lobifrons							1						1								2	<0.1
Dendronotus albus										2											2	<0.1
Ericerodes hemphillii			1	1																	2	<0.1
Latulambrus occidentalis	1	1																			2	<0.1
Megasurcula carpenteriana									1					1							2	<0.1
Neocrangon resima																				2	2	<0.1
Ophiuridae				2																	2	<0.1
Paguridae															2						2	<0.1
Polycera tricolor	2																				2	<0.1
Ptilosarcus gurneyi									1	1											2	<0.1
Rossia pacifica																				2	2	<0.1
Stylasterias forreri							1			1											2	<0.1
Stylatula elongata	1																		1		2	<0.1
Aglajidae			1																		1	<0.1
Amphichondrius granulatus					1																1	<0.1
Baptodoris mimetica									1												1	<0.1
Crossata ventricosa									1												1	<0.1
Dendronotus venustus								1													1	<0.1
Doryteuthis opalescens							1														1	<0.1
Flabellinopsis iodinea		1																			1	<0.1
Hermissenda opalescens		1																			1	<0.1
Lamellaria diegoensis										1											1	<0.1
Loxorhynchus crispatus									1												1	<0.1

Table B-11 Abundance and species richness of epibenthic macroinvertebrates collected in the Summer 2021 and Winter 2022 trawl surveys.
OC Sanitation District Environmental Laboratory and Ocean Monitoring Division

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	%
Neocrangon sp				1																	1	<0.1
Nudibranchia										1											1	<0.1
Ophiuroconis bispinosa				1																	1	<0.1
Pectinidae									1												1	<0.1
Peltodoris nobilis										1											1	<0.1
Pteropurpura festiva					1																1	<0.1
Total Abundance	**2,031**	**1,051**	**586**	**276**	**1,928**	**1,772**	**1,099**	**265**	**589**	**372**	**288**	**124**	**136**	**73**	**273**	**228**	**980**	**728**	**363**	**388**	**13,550**	**100**
Total No. of Species	**12**	**17**	**12**	**15**	**14**	**6**	**13**	**11**	**22**	**22**	**13**	**14**	**11**	**14**	**14**	**16**	**7**	**8**	**6**	**8**	**61**	

Table B-12 Biomass (kg) of epibenthic macroinvertebrates collected in the Summer 2021 and Winter 2022 trawl surveys.
OC Sanitation District Environmental Laboratory and Ocean Monitoring Division

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	%
Strongylocentrotus fragilis																	40.210	22.950	12.220	5.410	80.790	69.7
Lytechinus pictus		0.058	0.103	0.403	3.660	4.290	2.800	0.440	0.790	0.065	0.270	0.025	0.045	0.010	0.215	0.030	0.123	0.193	0.095		13.615	11.7
Sicyonia ingentis					0.068		0.053	0.005	0.240	0.027	0.261	0.015	0.205	0.005	0.180	0.031	0.052	1.253	1.798	2.610	6.803	5.9
Apostichopus californicus					1.195		0.006		0.022	0.470	0.910	0.595	0.795		0.845						4.838	4.2
Ophiura luetkenii	2.440	1.110	0.503	0.113			0.001	0.001	0.001					0.001		0.001					4.171	3.6
Luidia foliolata	1.140				0.001		0.015			0.015	0.100	0.001	0.245	0.001	0.145		0.160	0.039	0.175		2.037	1.8
Astropecten californicus	0.020	0.028	0.007	0.020	0.001		0.013	0.030		0.019	0.130	0.065	0.075	0.010	0.007	0.027	0.090	0.115	0.065	0.030	0.752	0.6
Luidia armata	0.153	0.155	0.055	0.080					0.024						0.080						0.547	0.5
Sicyonia penicillata						0.021		0.083		0.023		0.195		0.145		0.026					0.493	0.4
Octopus rubescens											0.160		0.050				0.158	0.068		0.035	0.471	0.4
Thesea sp B	0.005	0.013	0.005	0.002	0.049	0.038	0.029	0.030	0.085	0.090	0.006	0.032	0.013	0.024	0.003	0.045		0.001			0.470	0.4
Platymera gaudichaudii				0.001										0.250		0.150					0.401	0.3
Hamatoscalpellum californicum	0.009	0.004			0.001	0.001	0.001	0.004	0.009	0.015	0.001	0.002	0.001	0.001	0.009	0.009					0.067	0.1
Luidia asthenosoma		0.001	0.001		0.001		0.001		0.006	0.002	0.010	0.001	0.023	0.004	0.005	0.005	0.004				0.064	0.1
Pleurobranchaea californica			0.013				0.018		0.001		0.004				0.025	0.001					0.062	0.1
Crossata ventricosa									0.060												0.060	0.1
Ophiothrix spiculata	0.001	0.001	0.001		0.002	0.011		0.001	0.008	0.008	0.020	0.001				0.001					0.055	<0.1
Philine auriformis		0.003	0.009	0.002					0.023		0.006				0.001						0.044	<0.1
Megasurcula carpenteriana									0.029					0.013							0.042	<0.1
Rossia pacifica																				0.034	0.034	<0.1
Cancellaria cooperii												0.005		0.014							0.019	<0.1
Astropecten armatus									0.016												0.016	<0.1
Ptilosarcus gurneyi									0.005	0.011											0.016	<0.1
Orthopagurus minimus		0.008	0.000		0.001										0.003	0.001					0.013	<0.1
Neocrangon zacae				0.001							0.001							0.001		0.009	0.012	<0.1
Stylasterias forreri							0.001			0.009											0.010	<0.1
Latulambrus occidentalis	0.001	0.007																			0.008	<0.1

Table B-12 Biomass (kg) of epibenthic macroinvertebrates collected in the Summer 2021 and Winter 2022 trawl surveys.
OC Sanitation District Environmental Laboratory and Ocean Monitoring Division

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**	**%**
Tritonia festiva									0.008												0.008	<0.1
Heterogorgia tortuosa		0.001			0.001			0.001		0.001		0.001		0.001							0.006	<0.1
Paguridae															0.006						0.006	<0.1
Stylatula elongata	0.005																		0.001		0.006	<0.1
Acanthoptilum sp	0.001			0.001					0.001	0.001			0.001								0.005	<0.1
Pyromaia tuberculata	0.001	0.002			0.001					0.001											0.005	<0.1
Acanthodoris brunnea									0.001	0.001					0.001	0.001					0.004	<0.1
Simnia sp										0.001		0.001		0.001		0.001					0.004	<0.1
Armina californica				0.001					0.001							0.001					0.003	<0.1
Luidia sp				0.001				0.001								0.001					0.003	<0.1
Paguristes turgidus		0.001				0.001						0.001									0.003	<0.1
Calliostoma turbinum										0.001										0.001	0.002	<0.1
Coryrhynchus lobifrons							0.001						0.001								0.002	<0.1
Ericerodes hemphillii			0.001	0.001																	0.002	<0.1
Acanthodoris rhodoceras		0.001																			0.001	<0.1
Aglajidae			0.001																		0.001	<0.1
Amphichondrius granulatus					0.001																0.001	<0.1
Baptodoris mimetica									0.001												0.001	<0.1
Dendronotus albus										0.001											0.001	<0.1
Dendronotus venustus								0.001													0.001	<0.1
Doryteuthis opalescens							0.001														0.001	<0.1
Flabellinopsis iodinea		0.001																			0.001	<0.1
Hermissenda opalescens		0.001																			0.001	<0.1
Lamellaria diegoensis										0.001											0.001	<0.1
Loxorhynchus crispatus									0.001												0.001	<0.1
Neocrangon resima																				0.001	0.001	<0.1
Neocrangon sp				0.001																	0.001	<0.1
Nudibranchia										0.001											0.001	<0.1

Table B-12 Biomass (kg) of epibenthic macroinvertebrates collected in the Summer 2021 and Winter 2022 trawl surveys.
OC Sanitation District Environmental Laboratory and Ocean Monitoring Division

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	%
Ophiuridae				0.001																	0.001	<0.1
Ophiuroconis bispinosa				0.001																	0.001	<0.1
Pectinidae									0.001												0.001	<0.1
Peltodoris nobilis										0.001											0.001	<0.1
Polycera tricolor	0.001																				0.001	<0.1
Pteropurpura festiva					0.001																0.001	<0.1
Total	**3.777**	**1.395**	**0.699**	**0.629**	**4.983**	**4.362**	**2.940**	**0.597**	**1.333**	**0.764**	**1.879**	**0.940**	**1.454**	**0.480**	**1.525**	**0.331**	**40.797**	**24.620**	**14.354**	**8.130**	**115.989**	**100**

Table B-13 Abundance and species richness of demersal fishes collected in the Summer 2021 and Winter 2022 trawl surveys.
OC Sanitation District Environmental Laboratory and Ocean Monitoring Division

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					439	627	328	326	154	53	601	343	645	377	373	354	433	576	492	293	6,414	41.7
Icelinus quadriseriatus	11	15	10	1	90	25	90	180	213	74	498	182	610	159	188	300	10	1	1		2,658	17.3
Citharichthys xanthostigma	15				25	51	48	84	153	255	50	48	77	17	7	37	9	11	2		889	5.8
Citharichthys stigmaeus	216	391	137	40																	784	5.1
Sebastes saxicola								1			1	3				8	282	262	72	139	768	5.0
Microstomus pacificus														2		1	31	185	149	134	502	3.3
Symphurus atricaudus	4	3	1	1	19	51	14	37	6	45	11	48	25	89	7	76	6			4	447	2.9
Zaniolepis frenata																	139	148	91	35	413	2.7
Lyopsetta exilis																	42	146	144	68	400	2.6
Zaniolepis latipinnis						32		32		31		17	12	202		10	32	3		1	372	2.4
Parophrys vetulus				1		85		25		44		3		59		19	9	5	4	1	255	1.7
Hippoglossina stomata	7	16	1	3	15	34	11	38	24	29	1	8	3	1	19	17	5	2	4	3	241	1.6
Pleuronichthys verticalis	4	3			2	44	3	19	1	25	1	25	3	58	2	27	2	1	1	1	222	1.4
Chitonotus pugetensis	2	7	9	8	11		11		35	10	42	3	23		8	25	4	3		3	204	1.3
Zalembius rosaceus					8	27	3	51			3	9	10	30		14	4				159	1.0
Scorpaena guttata		2	1		21	1	26		3		8	3	5	3	15	1	12	14	1	6	122	0.8
Sebastes goodei						11											34	4	35		84	0.5
Sebastes semicinctus								3									57	7	5		72	0.5
Porichthys notatus						1		2									9	23	10	20	65	0.4
Synodus lucioceps	4	2				1		1	4	8	5	8	5	5	7	1			2		53	0.3
Lycodes pacificus																		6	28	18	52	0.3
Odontopyxis trispinosa		1			6		1	3	1	3	4	3	3	3	1	3					32	0.2
Sebastes chlorostictus																	13	8	7	4	32	0.2
Merluccius productus																		4	7	18	29	0.2
Sebastes sp		1					1				4	2	10					1			19	0.1
Sebastes elongatus																	3	5	6	1	15	0.1
Sebastes hopkinsi																	1	13		1	15	0.1
Xystreurys liolepis	1	3		1						4											9	0.1

Table B-13 Abundance and species richness of demersal fishes collected in the Summer 2021 and Winter 2022 trawl surveys.
OC Sanitation District Environmental Laboratory and Ocean Monitoring Division

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	%
Argentina sialis					2		6														8	0.1
Raja inornata				1						2		2				1		1	1		8	0.1
Glyptocephalus zachirus																			2	3	5	<0.1
Sebastes levis																	1		1	3	5	<0.1
Paralichthys californicus	1	1				1								1							4	<0.1
Plectobranchus evides																			3	1	4	<0.1
Agonopsis sterletus																1					1	<0.1
Chilara taylori																	1				1	<0.1
Genyonemus lineatus														1							1	<0.1
Kathetostoma averruncus																				1	1	<0.1
Ophiodon elongatus																	1				1	<0.1
Paralabrax nebulifer				1																	1	<0.1
Pleuronichthys decurrens									1												1	<0.1
Xeneretmus triacanthus																	1				1	<0.1
Total Abundance	**265**	**445**	**159**	**57**	**638**	**991**	**542**	**802**	**595**	**583**	**1,229**	**707**	**1,431**	**1,007**	**627**	**895**	**1,141**	**1,429**	**1,068**	**758**	**15,369**	**100**
Total No. of Species	**10**	**12**	**6**	**9**	**11**	**14**	**12**	**14**	**11**	**13**	**13**	**16**	**13**	**15**	**10**	**17**	**25**	**23**	**23**	**22**	**42**	

Table B-14 Biomass (kg) of demersal fishes collected in the Summer 2021 and Winter 2022 trawl surveys.
OC Sanitation District Environmental Laboratory and Ocean Monitoring Division

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					3.500	11.190	1.245	4.795	0.511	0.617	1.398	1.553	1.848	2.345	0.686	1.356	11.370	5.493	7.748	2.228	57.883	23.8
Citharichthys xanthostigma	0.163				0.715	2.503	1.153	3.945	2.369	9.873	0.598	1.800	2.503	1.625	0.029	2.796	0.653	0.743	0.110		31.578	13.0
Parophrys vetulus				0.300		5.600		1.900		6.045		0.233		2.745		1.802	0.940	0.595	0.513	0.043	20.716	8.5
Scorpaena guttata		0.373	0.273		3.990	0.110	4.540		0.465		1.200	0.685	1.100	0.273	0.000 [a]	0.100	2.400	2.600	0.150	0.920	19.179	7.9
Pleuronichthys verticalis	0.233	0.400			0.203	2.400	0.353	1.003	0.038	1.738	0.053	1.695	0.128	2.945	0.150	2.002	0.133	0.045	0.084	0.039	13.642	5.6
Microstomus pacificus														0.083		0.050	0.703	5.990	3.600	3.000	13.426	5.5
Paralichthys californicus	4.000	1.900				4.400								3.100							13.400	5.5
Hippoglossina stomata	0.343	1.061	0.008	0.568	1.385	1.553	0.193	1.350	0.491	1.714	0.170	0.525	0.103	0.012	0.489	1.295	0.485	0.063	0.478	0.243	12.529	5.2
Sebastes saxicola								0.003			0.002	0.004				0.008	4.000	2.290	1.748	1.800	9.855	4.1
Symphurus atricaudus	0.058	0.053	0.015	0.025	0.313	0.763	0.223	0.643	0.104	0.817	0.158	0.783	0.371	1.350	0.114	1.444	0.121			0.087	7.442	3.1
Icelinus quadriseriatus	0.025	0.013	0.018	0.002	0.248	0.068	0.237	0.543	0.551	0.218	1.053	0.413	1.253	0.328	0.403	0.625	0.023	0.003	0.001		6.025	2.5
Zaniolepis latipinnis						0.603		0.573		0.629		0.233	0.193	1.750		0.169	0.633	0.068		0.022	4.873	2.0
Lyopsetta exilis																	0.453	1.590	1.948	0.588	4.579	1.9
Raja inornata				0.240						1.295		2.590				0.250		0.155	0.044		4.574	1.9
Zaniolepis frenata																	1.440	1.153	0.910	0.301	3.804	1.6
Merluccius productus																		0.545	0.800	1.890	3.235	1.3
Citharichthys stigmaeus	0.903	1.053	0.303	0.143																	2.402	1.0
Zalembius rosaceus					0.133	0.373	0.029	0.603			0.023	0.125	0.273	0.373		0.130	0.118				2.180	0.9
Sebastes goodei						0.393											0.703	0.093	0.673		1.862	0.8
Synodus lucioceps	0.073	0.053				0.038		0.023	0.166	0.464	0.100	0.448	0.143	0.203	0.048	0.075			0.010		1.844	0.8
Sebastes semicinctus								0.001									1.190	0.173	0.110		1.474	0.6
Chitonotus pugetensis	0.007	0.026	0.043	0.043	0.078		0.078		0.188	0.054	0.263	0.019	0.153		0.042	0.145	0.028	0.023		0.021	1.211	0.5
Porichthys notatus						0.019		0.033									0.168	0.358	0.253	0.340	1.171	0.5
Lycodes pacificus																		0.093	0.393	0.408	0.894	0.4
Xystreurys liolepis	0.033	0.283		0.061						0.247											0.624	0.3
Paralabrax nebulifer				0.540																	0.540	0.2
Sebastes chlorostictus																	0.138	0.148	0.080	0.053	0.419	0.2
Glyptocephalus zachirus																			0.153	0.250	0.403	0.2

Table B-14 Biomass (kg) of demersal fishes collected in the Summer 2021 and Winter 2022 trawl surveys.
OC Sanitation District Environmental Laboratory and Ocean Monitoring Division

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	%
Sebastes elongatus																	0.200	0.073	0.080	0.001	0.354	0.1
Sebastes hopkinsi																	0.001	0.178		0.012	0.191	0.1
Kathetostoma averruncus																				0.095	0.095	<0.1
Genyonemus lineatus														0.090							0.090	<0.1
Pleuronichthys decurrens									0.065												0.065	<0.1
Sebastes levis																	0.006		0.018	0.038	0.062	<0.1
Odontopyxis trispinosa		0.002			0.013		0.002	0.004	0.002	0.004	0.003	0.003	0.005	0.003	0.001	0.005					0.047	<0.1
Sebastes sp		0.002					0.001				0.002	0.005	0.028					0.008			0.046	<0.1
Argentina sialis					0.010		0.021														0.031	<0.1
Plectobranchus evides																			0.023	0.002	0.025	<0.1
Ophiodon elongatus																	0.016				0.016	<0.1
Chilara taylori																	0.015				0.015	<0.1
Xeneretmus triacanthus																	0.010				0.010	<0.1
Agonopsis sterletus																0.006					0.006	<0.1
Total	**5.838**	**5.219**	**0.660**	**1.922**	**10.588**	**30.013**	**8.075**	**15.419**	**4.950**	**23.715**	**5.023**	**11.114**	**8.101**	**17.225**	**1.962**	**12.258**	**25.947**	**22.480**	**19.927**	**12.381**	**242.817**	**100**

[a] The fish samples were accidentally tossed overboard before length and weight measurements were recorded.

Table B-15 Summary statistics of OC San's Core shoreline (surfzone) stations for total coliform, fecal coliform, and enterococci by station during the 2021-22 program year. Station 0 = mouth of the Santa Ana River.

OC San Environmental Laboratory and Ocean Monitoring Division

	Summer				Fall				Winter				Spring				Annual			
Station	Min	Geometric Mean	Max	Std. Dev	Min	Geometric Mean	Max	Std Dev	Min	Geometric Mean	Max	Std. Dev.	Min	Geometric Mean	Max	Std. Dev.	Min	Geometric Mean	Max	Std. Dev.
Total Coliforms (CFU/100 mL)																				
39N	<17	16	67	1	<17	21	230	2	<17	17	83	1	<17	13	17	1	<17	16	230	1
33N	<17	13	17	1	<17	27	500	3	<17	15	33	1	<17	12	<17	1	<17	16	500	1
27N	<17	15	67	1	<17	33	900	4	<17	22	280	2	<17	17	50	1	<17	21	900	2
21N	<17	14	17	1	<17	20	500	2	<17	16	83	1	<17	15	180	2	<17	16	500	1
15N	<17	19	100	1	<17	20	150	2	<17	30	640	3	<17	14	50	1	<17	20	640	2
12N	<17	27	>1,600	4	<17	23	300	2	<17	29	560	3	<17	19	50	1	<17	24	>1,600	2
9N	<17	31	>3,100	3	<17	35	2,900	3	<17	27	1,300	3	<17	18	3,200	2	<17	27	>3,200	3
6N	<17	87	>1,800	4	<17	78	1,900	4	<17	27	2,800	3	<17	16	270	1	<17	40	2,800	3
3N	<17	31	8,700	5	<17	49	1,600	4	<17	28	2,100	3	<17	31	9,500	4	<17	34	9,500	4
0	<17	16	120	1	<17	48	1,700	5	<17	35	2,000	3	<17	24	620	2	<17	27	2,000	3
3S	<17	12	<17	1	<17	42	>9,100	8	<17	37	>3,300	4	<17	15	50	1	<17	23	>9,100	4
6S	<17	13	17	1	<17	27	1,700	5	<17	31	>5,500	5	<17	14	33	1	<17	20	>5,500	3
9S	<17	13	17	1	<17	29	1,700	4	<17	26	>3,900	5	<17	16	83	1	<17	20	>3,900	3
15S	<17	13	17	1	<17	30	700	4	<17	17	280	2	<17	14	33	1	<17	17	700	2
21S	<17	17	50	1	<17	38	350	3	<17	26	170	2	<17	17	50	1	<17	23	350	2
27S	<17	14	>17	1	<17	23	420	3	<17	16	300	2	<17	13	17	1	<17	16	420	2
29S	<17	23	170	2	<17	23	220	2	<17	26	800	3	<17	16	50	1	<17	22	800	2
39S	<17	13	17	1	<17	17	180	2	<17	16	83	1	<17	13	17	1	<17	15	180	1
All	<17	22	8,700	1	<17	32	>9,100	2	<17	24	>5,500	1	<17	16	9,500	1	<17	22	>9,500	1

Table B-15 Summary statistics of OC San's Core shoreline (surfzone) stations for total coliform, fecal coliform, and enterococci by station during the 2021-22 program year. Station 0 = mouth of the Santa Ana River.

OC San Environmental Laboratory and Ocean Monitoring Division

	Summer				Fall				Winter				Spring				Annual			
Station	Min	Geometric Mean	Max	Std. Dev	Min	Geometric Mean	Max	Std Dev	Min	Geometric Mean	Max	Std. Dev.	Min	Geometric Mean	Max	Std. Dev.	Min	Geometric Mean	Max	Std. Dev.
Fecal Coliforms (CFU/100 mL)																				
39N	<17	17	100	1	<17	18	100	1	<17	13	17	1	<17	12	<17	1	<17	15	100	1
33N	<17	13	17	1	<17	16	83	1	<17	13	17	1	<17	13	17	1	<17	14	83	1
27N	<17	13	17	1	<17	16	83	1	<17	22	300	2	<17	13	17	1	<17	15	300	1
21N	<17	13	17	1	<17	16	67	1	<17	14	33	1	<17	15	120	1	<17	14	120	1
15N	<17	17	50	1	<17	17	120	1	<17	26	420	2	<17	14	50	1	<17	18	420	2
12N	<17	23	200	2	<17	16	33	1	<17	23	220	3	<17	15	50	1	<17	19	220	2
9N	<17	28	350	2	<17	19	150	1	<17	22	220	2	<17	18	3,300	2	<17	21	3,300	2
6N	<17	68	940	3	<17	38	440	3	<17	18	130	1	<17	15	370	1	<17	28	940	3
3N	<17	23	12,000	4	<17	27	170	2	<17	26	540	2	<17	22	6	3	<17	24	12,000	3
0	<17	14	50	1	<17	22	170	2	<17	17	50	1	<17	20	330	2	<17	18	330	1
3S	<17	12	<17	1	<17	19	780	3	<17	19	100	2	<17	13	17	1	<17	16	780	1
6S	<17	12	<17	1	<17	21	220	2	<17	16	220	2	<17	14	50	1	<17	15	220	1
9S	<17	12	<17	1	<17	15	67	1	<17	15	67	1	<17	13	17	1	<17	14	67	1
15S	<17	15	50	1	<17	22	220	2	<17	14	33	1	<17	14	50	1	<17	16	220	1
21S	<17	17	83	1	<17	18	67	1	<17	15	50	1	<17	13	17	1	<17	16	83	1
27S	<17	13	17	1	<17	17	120	2	<17	13	17	1	<17	14	33	1	<17	14	120	1
29S	<17	18	120	1	<17	24	67	2	<17	18	200	2	<17	14	33	1	<17	18	200	1
39S	<17	13	33	1	<17	14	33	1	<17	12	<17	1	<17	12	<17	1	<17	13	33	1
All	<17	19	12,000	1	<17	20	780	1	<17	18	540	1	<17	15	6	1	<17	17	12,000	1

Table B-15 Summary statistics of OC San's Core shoreline (surfzone) stations for total coliform, fecal coliform, and enterococci by station during the 2021-22 program year. Station 0 = mouth of the Santa Ana River.

OC San Environmental Laboratory and Ocean Monitoring Division

	Summer				Fall				Winter				Spring				Annual			
Station	Min	Geometric Mean	Max	Std. Dev	Min	Geometric Mean	Max	Std Dev	Min	Geometric Mean	Max	Std. Dev.	Min	Geometric Mean	Max	Std. Dev.	Min	Geometric Mean	Max	Std. Dev.
Enterococci (CFU/100 mL)																				
39N	<2.00	2	10	1	<2.00	9	56	3	<2.00	2	14	1	<2.00	2	8	1	<2.00	3	56	2
33N	<2.00	2	42	2	<2.00	5	72	4	<2.00	2	12	1	<2.00	2	8	1	<2.00	3	72	2
27N	<2.00	3	18	2	<2.00	5	104	4	<2.00	6	84	3	<2.00	3	42	2	<2.00	4	104	3
21N	2	4	14	2	<2.00	4	52	3	<2.00	4	38	3	<2.00	4	86	3	<2.00	4	86	3
15N	<2.00	4	26	2	<2.00	5	62	3	<2.00	10	202	5	<2.00	2	54	2	<2.00	5	202	3
12N	<2.00	4	22	2	2	9	48	2	<2.00	8	124	4	<2.00	3	50	3	<2.00	6	124	3
9N	<2.00	8	120	3	<2.00	10	276	3	<2.00	5	120	3	<2.00	3	58	2	<2.00	6	276	3
6N	<2.00	17	336	5	<2.00	27	390	4	<2.00	7	156	3	<2.00	3	66	3	<2.00	10	390	4
3N	<2.00	5	>400	3	<2.00	13	374	5	<2.00	8	156	4	<2.00	6	84	4	<2.00	7	>400	4
0	<2.00	2	22	2	<2.00	8	366	5	<2.00	6	352	3	<2.00	4	112	3	<2.00	4	366	3
3S	<2.00	2	10	1	<2.00	5	>400	7	2	9	36	2	<2.00	5	50	2	<2.00	5	>400	3
6S	<2.00	2	6	1	2	7	262	4	<2.00	7	36	2	<2.00	3	50	3	<2.00	4	262	3
9S	<2.00	2	14	2	<2.00	10	244	6	<2.00	6	28	2	<2.00	3	44	2	<2.00	4	244	3
15S	<2.00	2	4	1	<2.00	6	>400	9	<2.00	3	8	2	<2.00	4	232	4	<2.00	3	>400	4
21S	<2.00	2	8	1	<2.00	6	90	3	<2.00	3	14	2	<2.00	3	28	2	<2.00	3	90	2
27S	<2.00	2	150	3	<2.00	3	166	4	<2.00	2	8	1	<2.00	2	12	2	<2.00	2	166	2
29S	<2.00	4	38	2	<2.00	6	52	3	<2.00	5	32	2	<2.00	4	46	3	<2.00	5	52	2
39S	<2.00	2	26	2	<2.00	3	34	3	<2.00	1	2	1	<2.00	1	12	1	<2.00	2	34	2
All	<2.00	4	>400	1	<2.00	8	>400	2	<2.00	5	352	1	<2.00	3	232	1	<2.00	4	>400	1

Appendix C. Quality Assurance/Quality Control (QA/QC)

INTRODUCTION – EFFLUENT MONITORING QA/QC

The Orange County Sanitation District's (OC San) Effluent Monitoring Program is designed to measure compliance with permit conditions. The program includes measurements which can be assigned to the following general categories:

- Physical and Aggregate Properties;
- Microbiology;
- Inorganic Nonmetals;
- Metals;
- Individual Organics;
- Radionuclides;
- Whole Effluent Toxicity, and
- Aggregate Organics.

The Effluent Monitoring Program complies with OC San's National Pollutant Discharge Elimination System (NPDES) Permit requirements and applicable federal, state, local, and contract requirements. The quality assurance practices employed are set forth in the OC San laboratory Quality Manual (OCSD 2021 and 2022). 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 generated in accordance with procedures appropriate for the intended use of the data.
- Whenever possible, data will be generated by laboratories certified by the State Water Resources Control Board Environmental Laboratory Accreditation Program (ELAP).
- For each target analyte, the appropriate required quality control samples are analyzed as required by the method and/or the accreditation standards.

The various aspects of the program are conducted on a daily, weekly, monthly, quarterly, semi-annual, or annual schedule.

This appendix details quality assurance/quality control (QA/QC) information for the various samples collected and analyzed for OC San's 2021-22 Effluent Monitoring Program. Detection limits and reporting limits for the various methods are shown in Table C-1, Table C-2, and Table C-3.

Table C-1 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at OC San's laboratory during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	MDL (MPN/100 mL)	RL (MPN/100 mL)	Parameter	MDL (MPN/100 mL)	RL (MPN/100 mL)
Fecal Indicator Bacteria					
Fecal coliform	18	18	Enterococci	10	10
Parameter	**Range (Unit)**	**Resolution (Unit)**			
Wet Chemistry					
pH [a]	4 to 10	0.01			
Parameter	**MDL (mg/L)**	**RL (mg/L)**	**Parameter**	**MDL (NTU)**	**RL (NTU)**
Chlorine, total (July 2021–December 2021)	0.03	0.05	Turbidity (July 2021–October 2021)	0.07	0.2
Chlorine, total (December 2021–June 2022)	0.02	0.05	Turbidity (October 2021–June 2022)	0.1	0.2
Parameter	**MDL (mg/L)**	**RL (mg/L)**	**Parameter**	**MDL (µg/L)**	**RL (µg/L)**
Nutrients					
Ammonia Nitrogen	0.649	1	Cyanide (July 2021–September 2021)	1.47	2.5
TKN	0.670	1	Cyanide (September 2021–June 2022)	2.32	5.0
Parameter	**MDL (mg/L)**	**RL (mg/L)**	**Parameter**	**MDL (mg/L)**	**RL (mg/L)**
Aggregate Organics					
BOD (Total)	—	0.2	Oil and Grease (July 2021–December 2021)	1.36	2.5
BOD (Carbonaceous)	—	0.2	Oil and Grease (December 2021–June 2022)	0.732	2.5

Table C-1 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at OC San's laboratory during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	MDL (mg/L)	RL (mg/L)	Parameter	MDL (mL/L)	RL (mL/L)
Solids					
Total Suspended Solids (TSS) (July 2021–October 2021)	0.5	1	Settleable solids	—	0.1
TSS, 47 mm filter (October 2021–June 2022)	0.0029	1			
TSS, 90 mm filter (October 2021–June 2022)	0.2768	1			

[a] Traditional MDLs and RLs do not apply to pH measurements.

Table C-2 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at OC San's laboratory during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	MDL [a] (µg/L)	RL [a] (µg/L)	MDL [b] (µg/L)	RL [b] (µg/L)
Base/Neutral Extractables				
Azobenzene	0.88	1	0.19	1
1,2,4-Trichlorobenzene	0.87	1	0.64	2
1,2-Dichlorobenzene	0.58	1	0.81	2
1,3-Dichlorobenzene	0.60	1	0.83	1
1,4-Dichlorobenzene	0.80	1	0.85	1
Acenaphthene	0.57	1	0.34	1
Acenaphthylene	0.96	1	0.24	1
Anthracene	0.51	1	0.21	1
Benzidine	8.27	5	2.23	5
Benz(a)anthracene	0.53	1	0.32	1
Benzo(a)pyrene	0.59	1	0.28	1
Benzo(b)fluoranthene	0.97	1	0.34	1
Benzo(k)fluoranthene	0.53	1	0.28	1
Benzo(g,h,i)perylene	0.60	1	0.37	1
Butyl benzyl phthalate	1.56	2	0.43	2
bis(2-Chloroethoxy)methane	0.96	1	0.45	2
bis(2-Chloroethyl) ether	0.59	1	0.78	1
bis(2-Ethylhexyl)phthalate	2.41	5	0.23	1
bis(2-chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	0.59	1	0.73	2
4-Bromophenyl phenyl ether	0.67	1	0.22	1
2-Chloronaphthalene	0.62	1	0.38	1
4-Chlorophenyl phenyl ether	0.77	1	0.26	1
Chrysene	0.59	1	0.24	1
Dibenz(a,h)anthracene	1.17	2	0.23	1
Di-n-butylphthalate	0.58	2	0.33	1
3,3'-Dichlorobenzidine	0.73	2	0.25	1
Diethyl phthalate	1.45	2	0.56	2
Dimethyl phthalate	1.64	2	1.01	2
2,4-Dinitrotoluene	0.94	2	0.23	1
2,6-Dinitrotoluene	0.88	2	0.12	1
Di-n-octylphthalate	2.33	5	0.35	2
Fluoranthene	0.67	1	0.32	1
Fluorene	0.77	1	0.27	1
Hexachlorobenzene	0.77	1	0.21	1
Hexachlorobutadiene	0.77	1	0.66	1
Hexachlorocyclopentadiene	1.20	2	1.52	5
Hexachloroethane	0.63	1	0.69	1
Indeno(1,2,3-c,d)pyrene	1.07	2	0.32	1
Isophorone	0.75	1	0.43	1
Naphthalene	0.75	1	0.67	2
Nitrobenzene	0.69	1	0.71	1
n-Nitrosodimethylamine	1.06	2	1.06	5
n-Nitrosodi-n-propylamine	0.66	2	0.55	2

Table C-2 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at OC San's laboratory during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	MDL [a] (µg/L)	RL [a] (µg/L)	MDL [b] (µg/L)	RL [b] (µg/L)
n-Nitrosodiphenylamine	1.47	1	0.20	1
Phenanthrene	0.66	1	0.17	0.5
Pyrene	0.96	1	0.37	1
Acid Extractables				
4-Chloro-3-methylphenol	1.85	1	0.25	1
2-Chlorophenol	1.43	2	0.15	0.5
2,4-Dichlorophenol	1.50	2	0.15	0.5
2,4-Dimethylphenol	2.70	2	0.16	0.5
2,4-Dinitrophenol	3.50	5	1.20	5
4,6-Dinitro-2-methylphenol	1.26	5	0.53	2
2-Nitrophenol	0.72	1	0.16	0.5
4-Nitrophenol	2.28	5	0.19	1
Pentachlorophenol	2.47	5	0.21	1
Phenol	0.75	1	0.10	0.5
2,4,6-Trichlorophenol	1.75	2	0.18	1
Parameter	**MDL [c] (µg/L)**	**RL [c] (µg/L)**	**MDL [d] (µg/L)**	**RL [d] (µg/L)**
Purgeable Organic Compounds				
Acrolein	0.47	0.47	0.37	5
Acrylonitrile	0.97	0.97	0.97	2
Benzene	1.17	1.17	1.17	2
Bromodichloromethane	1.24	1.24	1.24	2
Bromoform	0.81	0.81	0.81	2
Bromomethane	1.15	1.15	0.65	2
Carbon Tetrachloride	1.17	1.17	1.17	2
Chlorobenzene	0.88	0.88	0.88	2
Chloroethane	1.29	1.29	1.29	—
2-Chloroethylvinyl ether	0.77	0.77	0.62	—
Chloroform	1.56	1.56	1.56	2
Chloromethane	0.70	0.70	0.55	2
Dibromochloromethane	1.14	1.14	1.14	2
1,2-Dichlorobenzene	1.03	1.03	1.03	2
1,3-Dichlorobenzene	1.08	1.08	1.08	2
1,4-Dichlorobenzene	0.97	0.97	0.97	2
1,1-Dichloroethane	0.55	0.55	0.55	1
1,2-Dichloroethane	1.37	1.37	1.37	2
1,1-Dichloroethene	1.25	1.25	1.25	2
trans-1,2-Dichloroethene	0.49	0.49	0.49	—
1,2-Dichloropropane	0.57	0.57	0.57	—
cis-1,3-Dichloropropene	1.20	1.20	1.20	2 [e]
trans-1,3-Dichloropropene	1.23	1.23	1.23	2 [e]
Ethylbenzene	1.07	1.07	1.07	2
Methylene chloride	0.94	0.94	0.94	2
1,1,2,2-Tetrachloroethane	0.50	0.50	0.50	2
Tetrachloroethene	1.26	1.26	1.26	2

Table C-2 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at OC San's laboratory during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	MDL [c] (µg/L)	RL [c] (µg/L)	MDL [d] (µg/L)	RL [d] (µg/L)
Toluene	1.19	1.19	1.19	2
1,1,1-Trichloroethane	1.28	1.28	1.28	2
1,1,2-Trichloroethane	1.17	1.17	1.17	2
Trichloroethene	1.23	1.23	1.23	2
Vinyl chloride	1.09	1.09	1.90	2
Metals				
Antimony	0.094	0.1	0.838	0.1
Arsenic	0.069	0.2	0.079	0.2
Barium	0.149	0.2	0.308	0.2
Beryllium	0.037	0.1	0.063	0.1
Cadmium	0.054	0.1	0.049	0.1
Chromium	0.169	0.2	0.058	0.2
Copper	0.258	0.5	0.003	0.5
Lead	0.090	0.1	0.090	0.1
Manganese	0.838	0.5	0.462	0.5
Molybdenum	0.079	0.1	0.079	0.1
Nickel	0.308	0.2	0.196	0.2
Selenium	0.402	0.4	0.355	0.4
Silver	0.049	0.1	0.115	0.1
Thallium	0.058	0.1	0.058	0.1
Zinc	1.889	1.9	1.809	1.9
Parameter	**MDL (mg/L)**	**RL (mg/L)**	**MDL (mg/L)**	**RL (mg/L)**
Miscellaneous				
Phosphorus	0.063	0.2	0.070	0.2

[a] July 2021–May 2022.
[b] May 2022–June 2022.
[c] July 2021–March 2022.
[d] March 2022–June 2022.
[e] The unit is µg/L.

Table C-3 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at contract laboratories during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	MDL (mg/L)	RL (mg/L)	Parameter	MDL (µg/L)	RL (µg/L)
Nutrients					
Nitrate as N	0.040	0.2	Cyanide	3.8	5
Nitrite as N	0.042	0.1			
Parameter	**MDL (ng/L)**	**RL (ng/L)**			
Metals					
Mercury	0.100	0.50			
Parameter	**MDL (µg/L)**	**RL (µg/L)**	**Parameter**	**MDL (µg/L)**	**RL (µg/L)**
Organochlorine Pesticides					
2,4'-DDD	0.0011	0.005	Dieldrin	0.0008	0.005
2,4'-DDE	0.00094	0.005	Endosulfan I	0.0009	0.005
2,4'-DDT	0.0019	0.005	Endosulfan II	0.0007	0.005
4,4´-DDD	0.0007	0.005	Endosulfan sulfate	0.0013	0.005
4,4´-DDE	0.0007	0.005	Endrin	0.0017	0.005
4,4´-DDT	0.0011	0.005	Endrin aldehyde	0.0019	0.005
Aldrin	0.001	0.005	Heptachlor	0.0006	0.005
alpha-BHC	0.0011	0.005	Heptachlor epoxide	0.0004	0.005
beta-BHC	0.0015	0.005	Methoxychlor	0.0014	0.005
delta-BHC	0.0019	0.005	Mirex	0.0012	0.005
gamma-BHC (Lindane)	0.0004	0.005	*cis*-Nonachlor	0.0025	0.005
alpha-Chlordane	0.0029	0.005	*trans*-Nonachlor	0.0017	0.005
gamma-Chlordane	0.0023	0.005	Oxychlordane	0.005	0.005
Chlordane (tech)	0.043	0.1	Toxaphene	0.085	0.5
PCBs as Aroclors					
PCB 1016	0.029	0.1	PCB 1248	0.083	0.1
PCB 1221	0.06	0.1	PCB 1254	0.04	0.1
PCB 1232	0.1	0.1	PCB 1260	0.055	0.1
PCB 1242	0.095	0.1			

Table C-3 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at contract laboratories during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	MDL (pg/L)	RL (pg/L)	Parameter	MDL (pg/L)	RL (pg/L)
		PCBs as Congeners			
PCB 18	3.9	360	PCB 126	2.8	18
PCB 28	4.7	360	PCB 128	1.5	360
PCB 37	5.8	180	PCB 138	1.6	550
PCB 44	2.7	550	PCB 149	1.5	360
PCB 49	2.4	360	PCB 151	1.6	360
PCB 52	2.8	180	PCB 153/168	1.3	360
PCB 66	2.1	180	PCB 156	1.1	36
PCB 70	2.1	730	PCB 157	1.1	36
PCB 74	2.1	730	PCB 167	0.87	18
PCB 77	2.7	18	PCB 169	1.1	18
PCB 81	2.7	18	PCB 170	1.4	180
PCB 87	2.4	1,100	PCB 177	1.1	180
PCB 99	2.4	180	PCB 180	1.0	360
PCB 101	2.5	550	PCB 183	1.0	180
PCB 105	2.2	18	PCB 187	1.2	180
PCB 110	2.1	360	PCB 189	1.1	18
PCB 114	2.5	18	PCB 194	0.93	180
PCB 118	2.1	18	PCB 201	0.64	180
PCB 119	2.4	1,100	PCB 206	0.97	180
PCB 123	2.4	18			
Parameter	**MDA Range (pCi/L)**	**RL (pCi/L)**	**Parameter**	**MDA Range (pCi/L)**	**RL (pCi/L)**
		Radiation [a]			
Gross Alpha	0.044–0.616	—	Radium-228	0.518–1.08	—
Gross Beta	0.663–1.039	—	Strontium-90	0.228–0.535	—
Radium-226	0.346–0.954	—	Tritium	221–279	—
Uranium	0.022	0.087			

Table C-3 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at contract laboratories during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	MDL (mg/L)	RL (mg/L)			
Potassium	0.2	0.5			
Parameter	**MDL (µg/L)**	**RL (µg/L)**			
Miscellaneous					
Tributyltin	0.0023	0.005			
Parameter	**MDL Range (pg/L)**	**RL (pg/L)**	**Parameter**	**MDL Range (pg/L)**	**RL (pg/L)**
TCDD-Equivalents [a]					
1,2,3,4,6,7,8-Hepta CDD	1.24–4.1	50	1,2,3,7,8-Penta CDD	0.67–2.7	50
1,2,3,4,6,7,8-Hepta CDF	0.819–4.4	50	1,2,3,7,8-Penta CDF	0.53–3	50
1,2,3,4,7,8,9-Hepta CDF	1.05–5.1	50	2,3,4,6,7,8-Hexa CDF	0.83–3.8	50
1,2,3,4,7,8-Hexa CDD	1.3–3.9	50	2,3,4,7,8-Penta CDF	0.53–2.8	50
1,2,3,4,7,8-Hexa CDF	0.92–4.4	50	2,3,7,8-Tetra CDD	0.85–2.2	10
1,2,3,6,7,8-Hexa CDD	1.07–3.9	50	2,3,7,8-Tetra CDF	0.84–1.8	10
1,2,3,6,7,8-Hexa CDF	0.9–3.8	50	Octa CDD	1.14–12	100
1,2,3,7,8,9-Hexa CDD	1.16–4.9	50	Octa CDF	1.04–11	100
1,2,3,7,8,9-Hexa CDF	1.2–4.5	50			

[a] MDA, MDL, or RL values varied per testing period depending on verification studies performed, amount of sample used, and dilution factor.

EFFLUENT QUALITY NARRATIVE

Physical and Aggregate Properties

A summary of the QC associated with these effluent quality analyses can be seen in Table C-4, unless noted otherwise.

Total Suspended Solids (TSS) were analyzed by the OC San laboratory using ELOM SOP 2540 D/E. For the 2021-22 program year, nearly all QC samples associated with this analysis met the method acceptance criteria. Six duplicate samples failed to meet the method precision criteria, most likely due to a lack of homogeneity between the sample aliquots that were poured for analysis. This is a known potential issue with this analysis, and while the laboratory takes steps to ensure homogeneity, occasionally the issue cannot be avoided.

Settleable solids were analyzed by the OC San laboratory using ELOM SOP 2540 F. For this program year, all QC samples associated with this analysis met the method acceptance criteria, except for a single duplicate which was outside of the target precision acceptance criterion. The failure was likely due to a lack of homogeneity between the parent sample and the duplicate sample.

pH was analyzed by the OC San laboratory using ELOM SOP 4500-H+B. Duplicate determinations were carried out on a process control sample using the laboratory's benchtop pH meter. For this program year, all QC samples associated with this analysis met the method acceptance criteria.

Turbidity was analyzed by the OC San laboratory using ELOM SOP 2130 B. For this monitoring period, all QC samples associated with this analysis met the method acceptance criteria.

Microbiology

Fecal coliforms were analyzed by the OC San laboratory using ELOM SOP 9221E. During the monitoring period, 3 sample duplicates exceeded the precision criterion, possibly due to a non-homogenous sample.

Enterococci were analyzed by the OC San laboratory using ELOM SOP 9223B-9230D. During the monitoring period, 1 sample duplicate exceeded the precision criterion, possibly due to a non-homogenous sample.

Inorganic Nonmetals

Phosphorus analysis was performed by the OC San laboratory using ELOM SOP 200.7. For this program year, most QC samples met the method acceptance criteria, with the exception of 1 matrix spike duplicate which did not meet the required percent recovery criterion, possibly due to matrix interference. The data in the affected batch was deemed acceptable after careful consideration of all the other passing QC samples.

Ammonia (as nitrogen) was analyzed by the OC San laboratory using ELOM SOP 4500-NH_3-350.1. For this program year, most QC samples associated with the ammonia analysis met the method acceptance criteria. One blank spike was outside of established acceptance criteria, and all affected samples were reanalyzed to ensure validity of results. A few issues were observed with matrix spike and matrix spike duplicate accuracy and precision criteria. These issues were usually attributed to matrix interference. For all impacted batches, an assessment of the other batch QC samples was conducted, and batches were accepted only when the totality of the passing QC indicated that the batch results were of sufficient quality.

Total Kjeldahl Nitrogen (TKN) was analyzed by the OC San laboratory using ELOM SOP 4500-Norg D-351.2. For this monitoring period, the majority of QC samples associated with the TKN analysis met the method acceptance criteria. A few issues were observed with matrix spike and matrix spike duplicate accuracy. These issues were usually attributed to matrix interference. For all impacted batches, an assessment of the other batch QC samples was conducted, and batches were accepted only when the totality of the passing QC indicated that the batch results were of sufficient quality.

Nitrate and Nitrite (as nitrogen) were analyzed by Weck Laboratories in the City of Industry, CA, using EPA Method 353.2. A summary of the QC associated with this analysis can be seen in Table C-5. For this monitoring period, most QC samples associated with the nitrate and nitrite analyses met the method acceptance criteria. A few issues were observed with matrix spike and matrix spike duplicate accuracy and precision criteria. These issues were usually attributed to matrix interference. For all impacted batches, an assessment of the other batch QC samples was conducted, and batches were accepted only when the totality of the passing QC indicated that the batch results were of sufficient quality.

Cyanide was primarily analyzed in-house by the OC San laboratory using ELOM SOP 4500-CN. For this program year, the majority of QC samples associated with the cyanide analysis met the method acceptance criteria. One blank spike failed with slightly high recovery. A few issues were observed with matrix spike and matrix spike duplicate accuracy and precision criteria. These issues were usually attributed to matrix interference. Due to issues with OC San's instrument, one of the monthly cyanide samples was sent to Weck Laboratories for analysis using EPA Method 335.4. A summary of the QC associated with this analysis can be seen in Table C-5. For the samples analyzed by Weck Laboratories, all QC samples associated with this analysis met the method acceptance criteria except for 1 matrix spike duplicate which displayed slightly high recovery.

Total residual chlorine was analyzed by the OC San laboratory using ELOM SOP 4500-Cl G. For this program year, the vast majority of QC samples associated with this analysis met the method acceptance criteria. Three duplicate samples had precision results which exceeded the method-specified acceptance criteria. This was due to measuring duplicates at relatively low sample concentrations, where a small difference in concentration can result in a large relative percent difference result.

Metals

On a monthly basis, influent and effluent samples were analyzed for a variety of heavy metals. A full list of metals analyzed, along with their associated method detection limits (MDLs), can be seen in Table C-2. Metals analysis was performed by the OC San laboratory using ELOM SOP 200.8. For this program year, all QC samples associated with the metals analysis met the method acceptance criteria.

On a monthly basis, influent and effluent samples were analyzed for mercury by Weck Laboratories using the low-level EPA Method 1631. A summary of the QC associated with these analyses can be seen in Table C-5. For this program year, all QC samples associated with the mercury analysis met the method acceptance criteria.

Individual Organics

Individual organic compounds encompass a wide range of contaminants. A full list of organic compounds analyzed, along with their associated method detection limits (MDLs), can be seen in Table C-2 and Table C-3.

Semi-volatile organic compounds were analyzed by the OC San laboratory using ELOM SOP 625.1. For method 625.1, 4 compounds failed in the blank spike during the program year, with recoveries outside of the method acceptance range, but within the marginal acceptance criteria as described in the TNI Standard (2016). A few other QC failures were observed in the matrix spike, matrix spike duplicates and precision, likely due to matrix effects. The data in the affected batches were deemed acceptable after careful consideration of all the other passing QC samples.

Volatile (purgeable) organic compounds were analyzed by the OC San laboratory using ELOM SOP 624.1. For method 624.1, the only QC failures observed were in the matrix spike, matrix spike duplicates and precision, likely due to matrix effects. The data in the affected batches were deemed acceptable after careful consideration of all the other passing QC samples.

Organochlorine pesticides and polychlorinated biphenyls (PCBs) were analyzed by Weck Laboratories using EPA Method 608.3. A summary of the QC associated with this analysis can be seen in Table C-5. In 1 batch, the blank spike duplicate recovery and relative percent difference failed for 3 compounds. However, the blank spike displayed passing recoveries for all compounds. The failing components in the blank spike duplicate were within the marginal acceptance criteria as described in the TNI Standard (2016). For the same batch, the blank spike precision exceeded the method-specified acceptance criteria. Sample results for the batch were accepted because both the blank spike and blank spike duplicate recoveries were acceptable. All data were qualified with appropriate qualifier codes.

Individual PCB congeners were analyzed by Eurofins Calscience in Tustin, CA, using EPA Method 1668 C. A summary of the QC associated with this analysis can be seen in Table C-5. All QC samples associated with this analysis passed.

TCDD equivalents were analyzed by Bureau Veritas Laboratories in Mississauga, Canada, for the Summer Quarter, and by Pace Analytical Services in Minneapolis, MN, for the other quarters, using EPA Method 1613b. A summary of the QC associated with this analysis can be seen in Table C-5. One component failed in the blank spike and blank spike duplicate in one of the batches. The failing component was within the marginal acceptance criteria as described in the TNI Standard (2016) in both QC samples. Data from the affected batch were deemed to be acceptable.

Tributyltin was analyzed by Weck Laboratories using Standard Method 6710 B. A summary of the QC associated with this analysis can be seen in Table C-5. The lab experienced some difficulty with the matrix spike and matrix spike duplicate measurements, potentially due to matrix effects. All other required method QC samples passed, and the data from the batches were deemed to be acceptable. OC San will be working with Weck Laboratories to address the potential matrix interferences and improve the matrix spike/matrix spike duplicate recoveries.

Radionuclides

Radionuclides analyzed include gross alpha, gross beta, radium-226, radium-228, strontium-90, tritium, and uranium.

Gross alpha and gross beta were analyzed by Weck Labs using Standard Method 7110 C and EPA Method 900.0, respectively. A summary of the QC associated with this analysis can be seen in Table C-5. For gross alpha analysis, there was gross alpha detected in 3 blanks. After careful consideration, it was determined that these blank detections did not impact the sample results. One matrix spike did not meet the method acceptance criteria, possibly due to matrix effects. For gross beta, all QC samples met the method acceptance criteria.

Radium-226 and radium-228 were analyzed by Pace Analytical Services using EPA Methods 903.1 and 904.0, respectively. A summary of the QC associated with these analyses can be seen in Table C-5. For radium-226, all QC samples during the program year met the method acceptance criteria, except for one blank spike precision measurement. For radium-228, all QC samples met the method acceptance criteria, except for one sample duplicate precision measurement. Data associated with both failing precision measurements were accepted after reviewing the other successful QC associated with the batch.

Strontium-90 and tritium were analyzed by Pace Analytical Services using EPA Methods 905.0 and 906.0, respectively. A summary of the QC associated with these analyses can be seen in Table C-5. For strontium-90, all QC samples during the program year met the method acceptance criteria. For tritium, all QC samples met the method acceptance criteria, except for 1 matrix spike sample. Data associated with the failing matrix spike sample were accepted after reviewing the other successful QC associated with the batch.

Uranium was analyzed by Weck Laboratories using EPA Method 200.8. A summary of the QC associated with this analysis can be seen in Table C-5. All QC samples analyzed during the monitoring period met the method acceptance criteria.

Whole Effluent Toxicity

Whole effluent toxicity (WET) testing was performed by the OC San laboratory. On a monthly basis, chronic WET testing was performed using ELOM SOP 8210. On a quarterly basis, acute WET testing was performed using ELOM SOP 8510. All QC samples for WET testing met the required acceptance criteria during the program year (Table C-4).

Aggregate Organics

Aggregate organics analyses include measurements of Biochemical Oxygen Demand (BOD), Carbonaceous BOD (CBOD), and oil and grease. All analyses were performed by the OC San laboratory.

BOD and CBOD were determined by ELOM SOP 5210 B. For BOD and CBOD, most QC samples met the method acceptance criteria (Table C-4). The BOD method is sensitive to temperature and atmospheric pressure, which can result in occasional QC failures. Data associated with failing QC samples were reported with appropriate qualifiers after reviewing the other successful QC associated with the batch. Corrective action investigations were carried out to identify the root causes of the failures, and to identify ways to prevent those failures from recurring in the future.

Oil and Grease was determined using ELOM SOP 400_1664 B. For oil and grease, all QC samples met the method acceptance criteria during this program year (Table C-4).

Table C-4 Final effluent QA/QC summary for samples analyzed at OC San's Laboratory during the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Quarterly	Purgeable Organic Compounds	4 (4)	Blank	4	32	128	100
			Lab Blank	4	32	128	100
			Trip Blank	4	32	128	100
			Blank Spike	4	32	128	100
			Matrix Spike	4	32	124	97
			Matrix Spike Dup	4	32	124	97
			Matrix Spike Precision	4	32	124	97

[a] An analysis passed if the following criteria were met:
For blank - Analyte concentration in the Blank <MDL.
For blank spike - Target accuracy % recovery varies by analyte.
For matrix spike - Target accuracy % recovery varies by analyte.
For matrix spike duplicate - Target accuracy % recovery varies by analyte.
For matrix spike precision - Target precision % RPD varies by analyte.

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Monthly	Semi-volatile Organic Compounds	12 (12)	Blank	12	57	684	100
			Blank Spike	12	57	680	99
			Matrix Spike	12	57	677	99
			Matrix Spike Dup	12	57	676	99
			Matrix Spike Precision	12	57	677	99

[a] An analysis passed if the following criteria were met:
For blank - Analyte concentration in the Blank <MDL.
For blank spike - Target accuracy % recovery varies by analyte.
For matrix spike - Target accuracy % recovery varies by analyte.
For matrix spike duplicate - Target accuracy % recovery varies by analyte.
For matrix spike precision - Target precision % RPD varies by analyte.

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Monthly	Metals	12 (12)	Blank	36	15	540	100
			Blank Spike	12	15	180	100
			Matrix Spike	12	15	180	100
			Matrix Spike Dup	12	15	180	100
			Matrix Spike Precision	12	15	180	100

[a] An analysis passed if the following criteria were met:
For blank - Analyte concentration in the Blank ≤10% <2.2 × MDL (10% of analyte level determined for sample).
For blank spike - Target accuracy % recovery 85–115.
For matrix spike - Target accuracy % recovery 70–130.
For matrix spike duplicate - Target accuracy % recovery 70–130.
For matrix spike precision - Target precision % RPD <20%.

Table C-4 Final effluent QA/QC summary for samples analyzed at OC San's Laboratory during the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Monthly	Total Phosphorus	12 (12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Matrix Spike	12	1	12	100
			Matrix Spike Dup	12	1	11	92
			Matrix Spike Precision	12	1	12	100
[a] An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank ≤10% <2.2 × MDL (10% of analyte level determined for sample). For blank spike - Target accuracy % recovery 85–115. For matrix spike - Target accuracy % recovery 70–130. For matrix spike duplicate - Target accuracy % recovery 70–130. For matrix spike precision - Target precision % RPD <20%.							
Daily	Ammonia Nitrogen	365 (126)	Blank	210	1	210	100
			Blank Spike	210	1	209	100
			Matrix Spike	371	1	344	93
			Matrix Spike Dup	371	1	335	90
			Matrix Spike Precision	371	1	369	99
[a] An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike - Target accuracy % recovery 90–110. For matrix spike and matrix spike duplicate - Target accuracy % recovery 90–110. For matrix spike precision - Target precision % RPD ≤10.							
Monthly	TKN	12 (12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Matrix Spike	12	1	9	75
			Matrix Spike Dup	12	1	11	92
			Matrix Spike Precision	12	1	12	100
[a] An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <3 × MDL. For blank spike - Target accuracy % recovery 90–110. For matrix spike - Target accuracy % recovery 90–110. For matrix spike duplicate - Target accuracy % recovery 90–110. For matrix spike precision - Target precision % RPD ≤10.							

Table C-4 Final effluent QA/QC summary for samples analyzed at OC San's Laboratory during the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Monthly	Cyanide	11 (10)	Blank	10	1	10	100
			Blank Spike	10	1	9	90
			Matrix Spike	11	1	8	73
			Matrix Spike Dup	11	1	7	64
			Matrix Spike Precision	11	1	10	91
[a] An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike - Target accuracy % recovery 90–110. For matrix spike and matrix spike duplicate - Target accuracy % recovery 90–110. For matrix spike precision - Target precision % RPD ≤10.							
Daily	pH	365 (365)	Duplicate	365	1	365	100
			Check Standard	365	1	365	100
[a] An analysis passed if the following criteria were met: For duplicate - Target precision % RPD ≤5. For check standard - Target accuracy ±0.1 pH units							
Monthly	Turbidity	12 (12)	Blank	12	1	12	100
			Duplicate	12	1	12	100
[a] An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <0.10 NTU. For duplicate - Target precision % RPD ≤25.							
Daily	Total Residual Chlorine	1,095 (727)	Blank	364	1	364	100
			Duplicate	1095	1	1,092	100
[a] An analysis passed if Target precision % RPD ≤50.							
Monthly	Oil & Grease	12 (12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Matrix Spike	12	1	12	100
			Duplicate	12	1	12	100
[a] An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <2 mg/L. For blank spike - Target accuracy % recovery 83–101. For matrix spike - Target accuracy % recovery 78–114. For duplicate - Target precision % RPD ≤18.							

Table C-4 Final effluent QA/QC summary for samples analyzed at OC San's Laboratory during the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Daily	Biochemical Oxygen Demand (BOD)	365 (364)	Blank BOD	364	1	360	99
			Blank Spike BOD	364	1	348	96
			Duplicate BOD	680	1	675	99
	Carbonaceous BOD (CBOD)		Blank Spike CBOD	364	1	354	97
			Duplicate CBOD	467	1	464	99
[a] An analysis passed if the following criteria were met: For blank BOD T - Analyte concentration in the Blank ≤0.20 mg/L. For blank spike BOD T - Target accuracy 198±30.5 mg/L. For blank spike BOD C - Target accuracy 160±30 mg/L (2021). For blank spike BOD C - Target accuracy 180±28 mg/L (2022). For duplicate BOD T and BOD C - Target precision % RPD ≤30.							
Daily	Total Suspended Solids	365 (364)	Blank	364	2	364	100
			Blank Spike	364	1	364	100
			Duplicate	727	1	721	99
[a] An analysis passed if the following criteria were met: For blank – Analyte concentration in the Blank < 0.1 mg/L For blank spike – Target accuracy % recovery 80-120. For duplicate – Target precision % RPD ≤ 20.							
Daily	Settleable Solids (Composite)	365 (364)	Duplicate	365	1	364	100
Daily	Settleable Solids (Grab)	730 (364)					
[a] An analysis passed if Target precision % RPD ≤ 25%.							
Monthly	Chronic Whole Effluent Toxicity	12(12)	Reference Toxicant Test Negative Control Fertilization	12	1	12	100
Quarterly	Acute Whole Effluent Toxicity	4(4)	Reference Toxicant Test Negative Control Survival	4	1	4	100
[a] An analysis passed if the following criteria were met: For reference toxicant test negative control fertilization – Target accuracy ≥70%. For reference toxicant test negative control survival – Target accuracy ≥ 90%.							
Annual	Fecal Coliforms	365	Duplicate	52	1	49	94
	Enterococci	364	Duplicate	53	1	52	98
[a] Analysis passed if the average range of logarithms is less than the precision criterion.							

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Period	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
Monthly	Nitrate as N and Nitrite as N	12 (12)	Blank	13	2	26	100
			Blank Spike	13	2	26	100
			Matrix Spike	25	2	49	98
			Matrix Spike Dup	25	2	48	96
			Matrix Spike Precision	25	2	49	98
* An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike - Target accuracy % recovery 90–110. For matrix spike and matrix spike duplicate - Target accuracy % recovery 90–110. For matrix spike precision - Target precision % RPD <20.							
Summer	Cyanide	1 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	2	100
			Matrix Spike Dup	2	1	1	50
			Matrix Spike Precision	2	1	2	100
* An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike - Target accuracy % recovery 90–110. For matrix spike and matrix spike duplicate - Target accuracy % recovery 90–110. For matrix spike precision - Target precision % RPD <20.							
Monthly	Mercury	3 (3)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Matrix Spike	23	1	23	100
			Matrix Spike Dup	21	1	21	100
			Matrix Spike Precision	21	1	21	100
			Duplicate	1	1	1	100
* An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike - Target accuracy % recovery 85–115. For matrix spike and matrix spike duplicate - Target accuracy % recovery 75–125. For matrix spike precision - Target precision % RPD <20. For duplicate - Target precision % RPD <20.							

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Period	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
Monthly	Gross Alpha	12 (12)	Blank	15	1	12	80
			Blank Spike	12	1	12	100
			Blank Spike Dup	3	1	3	100
			Blank Spike Precision	3	1	3	100
			Matrix Spike	9	1	8	89
			Matrix Spike Dup	9	1	9	100
			Matrix Spike Precision	9	1	9	100

* An analysis passed if the following criteria were met:
For blank - Analyte concentration in the Blank <MDL.
For blank spike and blank spike duplicate - Target accuracy % recovery 64–139 (July 2021), 55–149 (August to November 2021), 59–145 (December 2021), 58–167 (January to June 2022).
For blank spike precision - Target precision % RPD <30.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 70–130 (October to November 2021), 29–164 (December 2021 to June 2022).
For matrix spike precision - Target precision % RPD <30.

Period	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
Monthly	Gross Beta	12 (12)	Blank	14	1	14	100
			Blank Spike	12	1	12	100
			Blank Spike Dup	3	1	3	100
			Blank Spike Precision	3	1	3	100
			Matrix Spike	9	1	9	100
			Matrix Spike Dup	9	1	9	100
			Matrix Spike Precision	9	1	9	100

* An analysis passed if the following criteria were met:
For blank - Analyte concentration in the Blank <MDL.
For blank spike and blank spike duplicate - Target accuracy % recovery 77–138.
For blank spike precision - Target precision % RPD <30.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 70–130.
For matrix spike precision - Target precision % RPD <30.

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Period	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
Monthly	Radium-226	12 (12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Blank Spike Duplicate	3	1	3	100
			Blank Spike Precision	3	1	2	67
			Matrix Spike	12	1	12	100
			Matrix Spike Dup	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	7	1	7	100

* An analysis passed if the following criteria were met:
For blank - Analyte concentration in the Blank <MDL.
For blank spike and blank spike duplicate - Target accuracy % recovery 73–135.
For blank spike precision - Target precision % RPD <32.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 71–136.
For matrix spike precision - Target precision % RPD <32.
For duplicate - Target precision % RPD <32.

Period	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
Monthly	Radium-228	12 (12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Blank Spike Duplicate	4	1	4	100
			Blank Spike Precision	4	1	4	100
			Matrix Spike	11	1	11	100
			Matrix Spike Dup	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	6	1	5	83

* An analysis passed if the following criteria were met:
For blank - Analyte concentration in the Blank <MDL.
For blank spike and blank spike duplicate - Target accuracy % recovery 60–135.
For blank spike precision - Target precision % RPD <36.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 60–135.
For matrix spike precision - Target precision % RPD <36.
For duplicate - Target precision % RPD <36.

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	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
Monthly	Strontium	12 (12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Blank Spike Duplicate	12	1	12	100
			Blank Spike Precision	12	1	12	100
			Matrix Spike	14	1	14	100
* An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike and blank spike duplicate - Target accuracy % recovery 60–130. For blank spike precision - Target precision % RPD <25. For matrix spike - Target accuracy % recovery 65–130.							
Monthly	Tritium	12 (12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Blank Spike Duplicate	12	1	12	100
			Blank Spike Precision	12	1	12	100
			Matrix Spike	22	1	21	95
* An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike and blank spike duplicate - Target accuracy % recovery 75–125. For blank spike precision - Target precision % RPD <25. For matrix spike - Target accuracy % recovery 75–125.							
Monthly	Uranium	12 (12)	Blank	13	1	13	100
			Blank Spike	13	1	13	100
			Matrix Spike	13	1	13	100
			Matrix Spike Dup	13	1	13	100
			Matrix Spike Precision	13	1	13	100
* An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike - Target accuracy % recovery 85–115. For matrix spike and matrix spike duplicate - Target accuracy % recovery 70–130. For blank spike precision - Target precision % RPD <30.							

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Period	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
Monthly	Potassium	7 (7)	Blank	7	1	7	100
			Blank Spike	7	1	7	100
			Matrix Spike	9	1	9	100
			Matrix Spike Dup	9	1	9	100
			Matrix Spike Precision	9	1	9	100
* An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike - Target accuracy % recovery 85–115. For matrix spike and matrix spike duplicate - Target accuracy % recovery 70–130. For matrix spike precision - Target precision % RPD <30.							
Semi-annually	Organochlorine Pesticides and PCBs	2 (2)	Blank	2	35	70	100
			Blank Spike	2	19	38	100
			Blank Spike Duplicate	2	19	35	92
			Blank Spike Precision	2	19	19	50
* An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike and blank spike duplicate - Target accuracy % recovery varies by analyte. For blank spike precision - Target precision % RPD <30.							
Annual	PCB Congeners	1 (1)	Blank	1	39	39	100
			Blank Spike	1	14	14	100
			Matrix Spike	1	14	14	100
			Matrix Spike Dup	1	14	14	100
			Matrix Spike Precision	1	14	14	100
* An analysis passed if the following criteria were met: For blank - Target accuracy % recovery <2 × ML. For blank spike - Target accuracy % recovery 60–135. For matrix spike - Target accuracy % recovery 60–135. For matrix spike duplicate - Target accuracy % recovery 60–135. For matrix spike precision - Target precision % RPD <50.							

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Period	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
Quarterly	TCDD Equivalents	4 (4)	Blank	4	17	68	100
			Blank Spike	4	17	67	99
			Blank Spike Duplicate	4	17	67	99
			Blank Spike Precision	4	17	68	100
* An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike and blank spike duplicate - Target accuracy % recovery varies by analyte. For blank spike precision - Target precision % RPD <20.							
Quarterly	Tributyltin	3 (3)	Blank	3	1	3	100
			Blank Spike	3	1	3	100
			Matrix Spike	3	1	2	67
			Matrix Spike Dup	3	1	0	0
			Matrix Spike Precision	3	1	3	100
* An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike - Target accuracy % recovery 43–179. For matrix spike and matrix spike duplicate - Target accuracy % recovery 71–149. For matrix spike precision - Target precision % RPD <30.							

INTRODUCTION – CORE OCEAN MONITORING PROGRAM QA/QC

OC San's Core Ocean Monitoring Program (OMP) 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 epibenthic macroinvertebrate community health;
- Fish tissue contaminant concentrations (chemical body burden); and
- Fish health (including external parasites and diseases).

The Core OMP complies with OC San's Quality Assurance Project Plan (QAPP)

(OCSD 2016) 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 weekly, monthly, quarterly, semi-annual, annual, or quinquennial schedule. Sampling and data analyses are designated by Quarters, which are referred to as Winter (January–March), Spring (April–June), Summer (July–September), and Fall (October–December).

This appendix details quality assurance/quality control (QA/QC) information for the collection and analysis of water quality, sediment geochemistry, fish tissue chemistry, and benthic infauna samples for OC San's 2021-22 Core OMP.

RECEIVING WATER QUALITY NARRATIVE

OC San's Environmental Laboratory and Ocean Monitoring (ELOM) staff collected 2,102 combined samples for ammonia nitrogen (NH_3-N) and nitrate nitrogen (NO_3-N) (530 in the Summer Quarter, 450 in the Fall Quarter, 541 in the Winter Quarter, and 581 in the Spring Quarter) during the 2021-22 program year. Twelve surface seawater samples were also collected at a control site (Station 2106) in each quarter. All samples were iced upon collection. Samples were preserved with 1:1 sulfuric acid upon receipt by the ELOM laboratory staff, and then stored at <6.0 °C until analysis according to the ELOM's Standard Operating Procedures (SOPs) (OCSD 2022).

ELOM staff also collected 175 bacteria samples in each quarter of the 2021-22 program year. All samples were iced upon collection and stored at <10 °C until analysis in accordance with ELOM SOPs.

Ammonia as Nitrogen (NH_3-N)

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

For each batch, a blank and a spike in a seawater control were analyzed every 20 or fewer samples. In addition, a matrix spike and matrix spike duplicate were analyzed every 10 or fewer samples. An external reference sample was analyzed once each month. The method detection limit (MDL) for low-level NH_3-N samples using the segmented flow instrument is shown in Table C-6. All samples were analyzed within the required holding time. Table C-7 contains all QA/QC samples analyzed within the 2021-22 program year. All analyses conducted met the QA/QC criteria for blanks and blank spikes. One matrix spike and 1 matrix spike duplicate were outside of the method-specified acceptance criteria for the Summer and Fall Quarters.

Two matrix spike and 2 matrix spike duplicates were outside of the method-specified acceptance criteria for the Winter Quarter. All affected samples were reanalyzed where necessary to ensure validity of results.

Nitrate Nitrite as Nitrogen (NO_3+NO_2-N)

The samples were analyzed for NO_3+NO_2-N on a segmented flow analyzer using EPA Method 353.2. Nitrate in the samples was reduced to nitrite upon passing through a reducing column. The nitrite was diazotized with sulfanilamide and then coupled with N-(1-napthyl) ethylene diamine dihydrochloride to form an azo dye in a concentration proportional to the NO_3+NO_2-N concentration in the sample. The color was measured at 520 nm.

For each batch, a blank and a spike in a seawater control were analyzed every 20 or fewer samples. In addition, a matrix spike and matrix spike duplicate were analyzed every 10 or fewer samples. An external reference sample was analyzed once each month. The MDL for low-level NO_3+NO_2-N samples using the segmented flow instrument is shown in Table C-6. All samples were analyzed within the required holding time.

Samples collected in the Summer, Fall, and Winter Quarters were analyzed by Weck Laboratories. Samples collected in the Spring Quarter were analyzed by OC San's ELOM laboratory. Table C-7 contains all QA/QC samples analyzed within the 2021-22 program year. Analyses conducted by the contract laboratory met all established QA/QC criteria. Three blank samples were outside of the method-specified acceptance criteria for the Spring Quarter. All affected samples were reanalyzed where necessary to ensure validity of results.

Bacteria

Samples collected offshore (i.e., Recreational (aka REC-1)) were analyzed for fecal indicator bacteria (FIB) using Enterolert™ for enterococci and Colilert-18™ for total coliforms and *Escherichia coli*. Fecal coliforms were estimated by multiplying detected *E. coli* results 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 shoreline (aka 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, Standard Methods 9222B and 9222D were used, respectively. MDLs for bacteria are presented in Table C-6.

All samples were analyzed within the required holding time. REC-1 samples were processed and incubated within 8 hours of sample collection. At least 1 duplicate sample was analyzed in each sample batch; additional duplicates were analyzed based on the number of samples in the batch. At a minimum, duplicate analyses were performed on 10% of samples per sample batch. All equipment, reagents, and dilution waters 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 commercially purchased dilution blanks 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. Although the precision criterion is used to measure the precision of duplicate analyses for plate-based methods (APHA 2017), this criterion was used for most probable number methods due to a lack of criterion. Acceptable duplicates ranged from 80% to 100% for the 3 FIB during the program year (Table C-7).

Table C-6 Method detection limit (MDL) and reporting limit (RL) for constituents analyzed in receiving water, sediment, and fish tissue samples during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Receiving Water					
Fecal Indicator Bacteria and Nutrients					
Parameter	**MDL (MPN/100 mL)**	**RL (MPN/100 mL)**	**Parameter**	**MDL (mg/L)**	**RL (mg/L)**
Total coliform	10	10	Ammonia Nitrogen	0.040	0.04
E. coli	10	10	Nitrite Nitrate as N (Contract Lab)	0.036	0.2
Enterococci	10	10	Nitrite Nitrate as N (OC San Lab)	0.005	0.015
Sediment					
Parameter	**MDL (ng/g dry)**	**RL (ng/g dry)**	**Parameter**	**MDL (ng/g dry)**	**RL (ng/g dry)**
Organochlorine Pesticides (Triple Quad)					
2,4'-DDD	0.1	0.3	Endosulfan-alpha	0.1	0.3
2,4'-DDE	0.1	0.3	Endosulfan-beta	0.1	0.3
2,4'-DDT	0.1	0.3	Endosulfan-sulfate	0.1	0.3
4,4'-DDD	0.1	0.3	Endrin	0.1	0.3
4,4'-DDE	0.1	0.3	Heptachlor	0.1	0.3
4,4'-DDT	0.1	0.3	Heptachlor epoxide	0.1	0.3
4,4'-DDMU	0.1	0.3	Hexachlorobenzene	0.4	0.4
Aldrin	0.1	0.3	Mirex	0.1	0.3
gamma-BHC	0.1	0.3	*cis*-Nonachlor	0.1	0.3
cis-Chlordane	0.1	0.3	*trans*-Nonachlor	0.1	0.3
trans-Chlordane	0.1	0.3	Oxychlordane	0.1	0.3
Dieldrin	0.1	0.3			

Table C-6 Method detection limit (MDL) and reporting limit (RL) for constituents analyzed in receiving water, sediment, and fish tissue samples during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Sediment PCB Congeners (Triple Quad)					
Parameter	**MDL (ng/g dry)**	**RL (ng/g dry)**	**Parameter**	**MDL (ng/g dry)**	**RL (ng/g dry)**
PCB 8	0.05	0.1	PCB 128	0.05	0.1
PCB 18	0.05	0.1	PCB 138	0.05	0.1
PCB 28	0.05	0.1	PCB 149	0.05	0.1
PCB 37	0.05	0.1	PCB 151	0.05	0.1
PCB 44	0.05	0.1	PCB 153/168	0.08	0.1
PCB 49	0.05	0.1	PCB 156	0.05	0.1
PCB 52	0.05	0.1	PCB 157	0.05	0.1
PCB 66	0.05	0.1	PCB 158	0.05	0.1
PCB 70	0.05	0.1	PCB 167	0.05	0.1
PCB 74	0.05	0.1	PCB 169	0.05	0.1
PCB 77	0.05	0.1	PCB 170	0.05	0.1
PCB 81	0.05	0.1	PCB 177	0.05	0.1
PCB 87	0.05	0.1	PCB 180	0.05	0.1
PCB 99	0.05	0.1	PCB 183	0.05	0.1
PCB 101	0.05	0.1	PCB 187	0.05	0.1
PCB 105	0.05	0.1	PCB 189	0.05	0.1
PCB 110	0.05	0.1	PCB 194	0.05	0.1
PCB 114	0.05	0.1	PCB 195	0.05	0.1
PCB 118	0.05	0.1	PCB 201	0.05	0.1
PCB 119	0.05	0.1	PCB 206	0.05	0.1
PCB 123	0.05	0.1	PCB 209	0.05	0.1
PCB 126	0.05	0.1			

Table C-6 Method detection limit (MDL) and reporting limit (RL) for constituents analyzed in receiving water, sediment, and fish tissue samples during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Sediment Organochlorine Pesticides (Single Quad)					
Parameter	**MDL (ng/g dry)**	**RL (ng/g dry)**	**Parameter**	**MDL (ng/g dry)**	**RL (ng/g dry)**
2,4'-DDD	0.61	1	Endosulfan-alpha	0.78	1
2,4'-DDE	0.62	1	Endosulfan-beta	0.75	1
2,4'-DDT	0.71	1	Endosulfan-sulfate	1.01	2
4,4'-DDD	1.14	2	Endrin	0.61	1
4,4'-DDE	0.68	1	Heptachlor	2.64	3
4,4'-DDT	0.56	1	Heptachlor epoxide	0.80	1
4,4'-DDMU	0.84	1	Hexachlorobenzene	0.80	1
Aldrin	1.97	2	Mirex	0.43	1
gamma-BHC	0.67	1	*cis*-Nonachlor	0.59	1
cis-Chlordane	0.70	1	*trans*-Nonachlor	0.82	1
trans-Chlordane	0.76	1	Oxychlordane	0.85	1
Dieldrin	0.48	1			

Table C-6 Method detection limit (MDL) and reporting limit (RL) for constituents analyzed in receiving water, sediment, and fish tissue samples during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Sediment PCB Congeners (Single Quad)					
Parameter	**MDL (ng/g dry)**	**RL (ng/g dry)**	**Parameter**	**MDL (ng/g dry)**	**RL (ng/g dry)**
PCB 8	0.23	0.3	PCB 128	0.61	0.7
PCB 18	0.19	0.2	PCB 138	0.71	0.8
PCB 28	0.43	0.5	PCB 149	0.60	0.6
PCB 37	0.47	0.5	PCB 151	0.35	0.4
PCB 44	0.47	0.5	PCB 153/168	0.75	0.8
PCB 49	0.61	0.7	PCB 156	0.67	0.7
PCB 52	0.51	0.6	PCB 157	0.70	0.7
PCB 66	0.62	0.7	PCB 158	0.48	0.5
PCB 70	0.74	0.8	PCB 167	0.55	0.6
PCB 74	0.61	0.7	PCB 169	0.28	0.3
PCB 77	0.51	0.6	PCB 170	0.36	0.4
PCB 81	0.39	0.4	PCB 177	0.61	0.7
PCB 87	0.43	0.5	PCB 180	0.38	0.4
PCB 99	0.41	0.5	PCB 183	0.57	0.6
PCB 101	0.47	0.5	PCB 187	0.55	0.6
PCB 105	0.58	0.6	PCB 189	0.34	0.4
PCB 110	0.58	0.6	PCB 194	0.29	0.3
PCB 114	0.49	0.5	PCB 195	0.35	0.4
PCB 118	0.76	0.8	PCB 201	0.58	0.6
PCB 119	0.32	0.4	PCB 206	0.36	0.4
PCB 123	0.43	0.5	PCB 209	0.26	0.5
PCB 126	0.53	0.6			

Table C-6 Method detection limit (MDL) and reporting limit (RL) for constituents analyzed in receiving water, sediment, and fish tissue samples during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Sediment PAH Compounds					
Parameter	**MDL (ng/g dry)**	**RL (ng/g dry)**	**Parameter**	**MDL (ng/g dry)**	**RL (ng/g dry)**
1,6,7-Trimethylnaphthalene	0.83	1	Benzo(g,h,i)perylene	0.82	1
1-Methylnaphthalene	0.62	1	Benzo(k)fluoranthene	0.78	1
1-Methylphenanthrene	0.86	1	Biphenyl	0.87	1
2,3,6-Trimethylnaphthalene	0.91	1	Chrysene	0.69	1
2,6-Dimethylnaphthalene	2.04	5	Dibenz(a,h)anthracene	0.66	1
2-Methylnaphthalene	2.91	5	Fluoranthene	0.78	1
Acenaphthene	0.88	1	Fluorene	4.59	5
Acenaphthylene	1.59	2	Indeno(1,2,3-c,d)pyrene	0.81	1
Anthracene	0.72	1	Naphthalene	1.2	2
Benz(a)anthracene	0.68	1	Perylene	1.21	2
Benzo(a)pyrene	0.81	1	Phenanthrene	0.87	1
Benzo(b+j)fluoranthene	1.46	2	Pyrene	0.75	1
Benzo(e)pyrene	0.97	1			
Metals					
Parameter	**MDL (µg/kg dry)**	**RL (µg/kg dry)**	**Parameter**	**MDL (µg/kg dry)**	**RL (µg/kg dry)**
Antimony	0.116	0.2	Lead	0.040	0.10
Arsenic	0.054	0.1	Mercury	0.038	0.04
Barium	0.151	0.2	Nickel	0.114	0.2
Beryllium	0.030	0.1	Selenium	0.481	0.5
Cadmium	0.089	0.1	Silver	0.139	0.2
Chromium	0.058	0.1	Zinc	0.862	1.5
Copper	0.138	0.2			

Table C-6 Method detection limit (MDL) and reporting limit (RL) for constituents analyzed in receiving water, sediment, and fish tissue samples during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Sediment					
Miscellaneous Parameters					
Parameter	**MDL (mg/kg dry)**	**RL (mg/kg dry)**	**Parameter**	**MDL (mg/kg dry)**	**RL (mg/kg dry)**
Nitrite Nitrate as N (Summer Quarter)	0.70	2.1	Total Phosphorus (Summer Quarter)	0.24	5.3
Nitrite Nitrate as N (Fall–Winter Quarter)	0.52	1.6	Total Phosphorus (Fall Quarter)	0.18	3.9
Nitrite Nitrate as N (Spring Quarter)	0.49	1.5	Total Phosphorus (Winter Quarter)	0.18	4.0
Total TKN (Summer Quarter)	—	86	Total Phosphorus (Spring Quarter)	0.17	3.8
Total TKN (Fall–Winter Quarter)	—	63	Dissolved Sulfides	1.03	1.03
Total TKN (Spring Quarter)	—	60			
Parameter	**MDL (%)**	**RL (%)**	**Parameter**	**MDL (%)**	**RL (%)**
Total Organic Carbon	--	0.10	Particle Grain Size	0.01	0.01
Fish Tissue					
Parameter	**MDL (µg/kg wet)**	**RL (µg/kg wet)**	**Parameter**	**MDL (µg/kg wet)**	**RL (µg/kg wet)**
Organochlorine Pesticides					
2,4'-DDD	0.1	0.5	*cis*-Chlordane	0.1	0.5
2,4'-DDE	0.1	0.5	*trans*-Chlordane	0.1	0.5
2,4'-DDT	0.3	0.5	Heptachlor	0.1	0.5
4,4'-DDD	0.2	0.5	Heptachlor epoxide	0.2	0.5
4,4'-DDE	0.2	0.5	*cis*-Nonachlor	0.2	0.5
4,4'-DDT	2.9	3	*trans*-Nonachlor	0.1	0.5
4,4'-DDMU	0.1	0.5	Oxychlordane	0.2	0.5

Table C-6 Method detection limit (MDL) and reporting limit (RL) for constituents analyzed in receiving water, sediment, and fish tissue samples during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Parameter	MDL (µg/kg wet)	RL (µg/kg wet)	Parameter	MDL (µg/kg wet)	RL (µg/kg wet)
Fish Tissue PCB Congeners					
PCB 18	0.2	1.0	PCB 126	0.3	1
PCB 28	0.2	1.0	PCB 128	0.2	1
PCB 37	0.2	1.0	PCB 138	0.2	1
PCB 44	0.2	1.0	PCB 149	0.2	1
PCB 49	0.2	1.0	PCB 151	0.2	1
PCB 52	0.2	1.0	PCB 153/168	0.5	1
PCB 66	0.2	1.0	PCB 156	0.2	1
PCB 70	0.2	1.0	PCB 157	0.3	1
PCB 74	0.2	1.0	PCB 167	0.5	1
PCB 77	0.2	1.0	PCB 169	0.2	1
PCB 81	0.2	1.0	PCB 170	0.2	1
PCB 87	0.2	1.0	PCB 177	0.2	1
PCB 99	0.2	1.0	PCB 180	0.2	1
PCB 101	0.2	1.0	PCB 183	0.2	1
PCB 105	0.2	1.0	PCB 187	0.2	1
PCB 110	0.2	1.0	PCB 189	0.2	1
PCB 114	0.2	1.0	PCB 194	0.2	1
PCB 118	0.2	1.0	PCB 201	0.2	1
PCB 119	0.2	1.0	PCB 206	0.2	1
PCB 123	0.2	1.0			
Fish Tissue Metals					
Arsenic	0.054	0.1	Mercury	0.038	0.04
Selenium	0.481	0.5			

Table C-7 Receiving water quality QA/QC summary for the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer	Ammonia Nitrogen	530 (7)	Blank	31	1	31	100
			Blank Spike	31	1	31	100
			Matrix Spike	56	1	55	98
			Matrix Spike Dup	56	1	55	98
			Matrix Spike Precision	56	1	56	100
Fall	Ammonia Nitrogen	450 (8)	Blank	28	1	28	100
			Blank Spike	28	1	28	100
			Matrix Spike	50	1	49	98
			Matrix Spike Dup	50	1	49	98
			Matrix Spike Precision	50	1	50	100
Winter	Ammonia Nitrogen	541 (9)	Blank	33	1	33	100
			Blank Spike	33	1	33	100
			Matrix Spike	59	1	57	97
			Matrix Spike Dup	59	1	57	97
			Matrix Spike Precision	59	1	59	100
Spring	Ammonia Nitrogen	581 (10)	Blank	36	1	36	100
			Blank Spike	36	1	36	100
			Matrix Spike	62	1	62	100
			Matrix Spike Dup	62	1	62	100
			Matrix Spike Precision	62	1	62	100

[a] An analysis passed if the following criteria were met:
For blank - Target amount <2 × 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%.

Table C-7 Receiving water quality QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer [b]	Nitrite Nitrate as N	530 (7)	Blank	38	1	38	100
			Blank Spike	38	1	38	100
			Matrix Spike	69	1	69	100
			Matrix Spike Duplicate	69	1	69	100
			Matrix Spike Precision	69	1	69	100
Fall [b]	Nitrite Nitrate as N	450 (30)	Blank	30	1	30	100
			Blank Spike	30	1	30	100
			Matrix Spike	59	1	59	100
			Matrix Spike Duplicate	59	1	59	100
			Matrix Spike Precision	59	1	59	100
Winter [b]	Nitrite Nitrate as N	542 (32)	Blank	32	1	32	100
			Blank Spike	32	1	32	100
			Matrix Spike	64	1	64	100
			Matrix Spike Duplicate	64	1	64	100
			Matrix Spike Precision	64	1	64	100
Spring	Nitrite Nitrate as N	581 (10)	Blank	36	1	33	92
			Blank Spike	36	1	36	100
			Matrix Spike	62	1	62	100
			Matrix Spike Duplicate	62	1	62	100
			Matrix Spike Precision	62	1	62	100

[a] An analysis passed if the following criteria were met:
For blank - Target amount <2 × 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%.
[b] Analysis performed by contract lab.

Table C-7 Receiving water quality QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer	Total Coliforms	175 (5)	Duplicate	20	1	19	95
	Fecal Coliforms [c]	175 (5)	Duplicate	20	1	18	90
	Enterococci	175 (5)	Duplicate	20	1	19	95
Fall	Total Coliforms	175 (5)	Duplicate	20	1	16	80
	Fecal Coliforms [c]	175 (5)	Duplicate	20	1	19	95
	Enterococci	175 (5)	Duplicate	20	1	20	100
Winter	Total Coliforms	175 (5)	Duplicate	20	1	18	90
	Fecal Coliforms [c]	175 (5)	Duplicate	20	1	19	95
	Enterococci	175 (5)	Duplicate	20	1	17	85
Spring	Total Coliforms	175 (5)	Duplicate	20	1	17	85
	Fecal Coliforms [c]	175 (5)	Duplicate	20	1	17	85
	Enterococci	175 (5)	Duplicate	20	1	18	90
Annual	Total Coliforms	700 (20)	Duplicate	80	1	70	88
	Fecal Coliforms [c]	700 (20)	Duplicate	80	1	73	91
	Enterococci	700 (20)	Duplicate	80	1	74	93

[a] Analysis passed if the average range of logarithms is less than the precision criterion.
[c] Fecal coliforms were estimated by multiplying *E. coli* by a factor of 1.1.

SEDIMENT CHEMISTRY NARRATIVE

OC San's ELOM laboratory received 57 sediment samples from ELOM's OMP staff from July and August 2021 and 11 samples each in December 2021, January 2022, and April 2022. All samples were stored according to ELOM SOPs. All samples were analyzed for organochlorine pesticides (dieldrin and derivatives of dichlorodiphenyltrichloroethane and chlordane), polychlorinated biphenyl congeners (PCBs), polycyclic aromatic hydrocarbons (PAHs), trace metals, mercury, dissolved sulfides, total organic carbon (TOC), total nitrogen, total phosphorus, and grain size. All samples were analyzed within the required holding times.

PAHs, PCBs, and Organochlorine Pesticides

The analytical methods used to detect PAHs, organochlorine pesticides, and PCBs in the samples are described in the ELOM SOPs. All sediment samples were extracted using an accelerated solvent extractor (ASE). Approximately 10 g (dry weight) of sample was 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 gas chromatography/mass spectrometry (GC/MS) and GC/MS/MS.

A typical sample batch included 20 field samples with required QC samples. Sample batches that were analyzed for PAHs, organochlorine pesticides, and PCBs included the following QC samples: 1 blank, 1 blank spike, 1 standard reference material (SRM), and 1 matrix spike set. In addition, a sample batch may also include the trip blank, instrument (rinse) blank, and 1 blank spike duplicate. MDLs and SRM acceptance criteria for each PAH, PCB, and pesticide constituent are presented in Table C-6 and Table C-8, respectively. Two sets of MDL values are included for the PCB and pesticides constituents due to different instruments being utilized for this reporting year, one for the GC/MS (single quad) and the other for the GC/MS/MS instrument (triple quad).

All analyses were performed with appropriate QC measures, as stated in OC San's QAPP, with most compounds tested during the 4 quarters meeting QA/QC criteria (Table C-9). As is usual for an analysis in which such a large number of analytes are measured in a complex matrix, there were a few instances of QC failures in the matrix spike, matrix spike duplicate, and SRM. The one notable QC failure was the PCB/Pesticide blank spike analyzed during the Fall Quarter which failed the accuracy criteria for all analytes. The matrix spike, matrix spike duplicate, matrix spike precision, and the SRM were used to gauge the acceptability of the data besides the blank spike. Those other passable QC elements indicated that the data was deemed acceptable and reportable by the customer and laboratory management personnel. When constituent concentrations in a sample exceeded the calibration range of the instrument, the sample was diluted and reanalyzed. Any deviations from standard protocol that occurred during sample preparation or analysis are noted in the raw data packages.

Trace Metals

Dried sediment samples were analyzed for trace metals in accordance with methods in the ELOM 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, matrix spikes, and matrix spike duplicates were analyzed at least once for 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 plasma mass spectroscopy (ICPMS). If any analyte in a sample exceeded both the appropriate calibration curve and linear dynamic range, the sample was diluted and reanalyzed. MDLs for metals are presented in Table C-6. Acceptance criteria for trace metal SRMs are presented in Table C-8. Some matrix spike and matrix spike duplicates in each quarter were outside of the method-specified acceptance criteria possibly due to matrix interference (Table C-9). Duplicate samples in the Summer Quarter did not meet established target precision RPD for antimony, copper, and zinc. In the Spring Quarter, 1 duplicate sample for lead was also outside of the method-specified acceptance criteria. All other samples met the QA/QC criteria for all compounds tested (Table C-9).

Mercury

Dried sediment samples were analyzed for mercury in accordance with methods described in the ELOM SOPs. QC for a typical batch included a blank, blank spike, and SRM. A set of sediment sample duplicates, matrix spike, and matrix spike duplicates were run once for 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-6. Acceptance criteria for the mercury SRM are presented in Table C-8. Table C-9 contains all mercury QA/QC samples analyzed within the 2021-22 program year. One matrix spike precision in the Summer and Fall Quarters and 1 duplicate sample precision in the Spring Quarter were outside of the method-specified acceptance criteria.

Dissolved Sulfides (DS)

DS samples were analyzed in accordance with methods described in the ELOM SOPs. The MDL for DS is presented in Table C-6. All QC samples within the 2021-22 program year met the QC acceptance criteria (Table C-9).

Total Organic Carbon (TOC)

TOC samples were analyzed by ALS Environmental Services in Kelso, WA. The RL for TOC is presented in Table C-6. All analyzed TOC QC samples passed the QC acceptance criteria (Table C-9).

Grain Size

Grain size samples were analyzed by Integral Consulting Inc. in Santa Cruz, CA, using a laser diffraction method. The smallest detectable grain size with this method is 0.375 µm. The method can distinguish differences between Phi size ranges to a level of 0.01%. All analyzed grain size QC samples passed the QA/QC criteria of RPD ≤10% (Table C-9).

Total Nitrogen (TN)

TN is calculated by analyzing each sample for combined nitrate + nitrite (as N) and for Total Kjeldahl Nitrogen (TKN) and summing the results. Samples were analyzed by Weck Laboratories. The MDL values for nitrate + nitrite (as N) and RL values for TKN are presented in Table C-6. All samples analyzed for nitrate + nitrite (as N) met the designated QC acceptance criteria (Table C-9). For TKN, the laboratory did not analyze matrix spikes and matrix spike duplicates as required by the OMP QAPP. All other samples analyzed for TKN met the designated QC acceptance criteria (Table C-9). The issue with missing QC samples has been addressed with the contract laboratory.

Total Phosphorus (TP)

TP samples were analyzed by Weck Laboratories. The MDL for TP is presented in Table C-6. Table C-9 contains all TP QA/QC samples analyzed within the 2021-22 program year. The following QA/QC samples were out of holding: blank samples for all 4 quarters; 1 matrix spike and 2 matrix spike duplicate samples in the Summer Quarter; and 1 matrix spike in the Spring Quarter. The contract lab did not perform any duplicate analysis in the Fall Quarter. Blank samples have results less than their respective RL but greater than three times the MDL. Matrix spike and matrix spike duplicate failures resulted from the parent samples having inherently high concentrations of phosphorus, which negatively impacted both accuracy and precision. All other QC sample results for all batches analyzed met the QC acceptance criteria (Table C-9).

Table C-8 Acceptance criteria for standard reference materials for sediment and fish tissue analyses during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Sediment			
Parameter	**True Value (ng/g)**	**Acceptance Range (ng/g)**	
		Minimum	**Maximum**
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	13.4	31.2
PCB 18	51	30.6	71
PCB 28	80.8	48.5	113.1
PCB 44	60.2	36.1	84.3
PCB 49	53	31.8	74
PCB 52	79.4	47.6	111
PCB 66	71.9	43.1	100.7
PCB 87	29.9	17.9	41.9
PCB 99	37.5	22.5	52.5
PCB 101	73.4	44.0	102.8
PCB 105	24.5	14.7	34.3
PCB 110	63.5	38.1	88.9
PCB 118	58	34.8	81.2
PCB 128	8.47	5.1	11.9
PCB 138	62.1	37.3	86.9
PCB 149	49.7	29.8	69.6
PCB 151	16.9	10.2	24
PCB 153/168	74	44.4	103.6
PCB 156	6.52	3.9	9.1
PCB 170	22.6	13.6	31.6
PCB 180	44.3	26.58	62.0
PCB 183	12.19	7.3	17.1
PCB 187	25.1	15.06	35.1
PCB 194	11.2	6.72	15.7
PCB 195	3.75	2.25	5.3
PCB 206	9.21	5.53	12.9
PCB 209	6.81	4.09	9.5
2,4'-DDD [a]	38.0	22.8	53.2
2,4'-DDE [a]	19.0	11.4	26.6
4,4'-DDD [a]	108.0	64.8	151
4,4'-DDE [a]	86.0	51.6	120
4,4'-DDT [a]	170	102	238
gamma-BHC [a]	2	1.20	2.8
cis-Chlordane	16.5	9.9	23.1
trans-Chlordane [a]	19.0	11.40	26.6
Hexachlorobenzene	6.03	3.62	8.44
cis-Nonachlor [a]	3.70	2.22	5.2
trans-Nonachlor	8.20	4.92	11.5
Percent Dry Weight	98.7%	—	—

Table C-8 Acceptance criteria for standard reference materials for sediment and fish tissue analyses during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Sediment			
Parameter	**True Value (ng/g)**	**Acceptance Range (ng/g)**	
		Minimum	**Maximum**
PAH Compounds and Percent Dry Weight (SRM 1944; New York/New Jersey Waterway Sediment, National Institute of Standards and Technology			
1-Methylnaphthalene [a]	470	282	658
1-Methylphenanthrene [a]	1700	1020	2380
2-Methylnaphthalene [a]	740	444	1036
Acenaphthene [a]	390	234	546
Anthracene [a]	1130	678	1582
Benz[a]anthracene	4720	2832	6608
Benzo[a]pyrene	4300	2580	6020
Benzo[b+j]fluoranthene	5960	3576	8344
Benzo[e]pyrene	3280	1968	4592
Benzo[g,h,i]perylene	2840	1704	3976
Benzo[k]fluoranthene	2300	1380	3220
Biphenyl [a]	250	150	350
Chrysene	4860	2916	6804
Dibenz[a,h]anthracene	424	254	594
Fluoranthene	8920	5352	12488
Fluorene [a]	480	288	672
Indeno[1,2,3-c,d]pyrene	2780	1668	3892
Naphthalene [a]	1280	768	1792
Perylene	1170	702	1638
Phenanthrene	5270	3162	7378
Pyrene	9700	5820	13580
Percent Dry Weight	98.7%		

Table C-8 Acceptance criteria for standard reference materials for sediment and fish tissue analyses during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Sediment			
Parameter	**True Value (µg/L)**	**Acceptance Range (µg/g)**	
		Minimum	**Maximum**
Metals (CRM-540 ERA Metals in Soil, Lot No. D107-540)			
Aluminum	8460	4270	12700
Antimony	120	22.8	302
Arsenic	95.5	66.9	124
Barium	300	225	375
Beryllium	103	77.2	129
Cadmium	135	101	169
Chromium	147	103	191
Copper	150	113	188
Iron	14400	5160	23700
Lead	92.3	64.6	120
Mercury	18.4	11	29.3
Nickel	59.8	41.9	77.8
Selenium	42	23.4	60.7
Silver	40.3	27.9	52.7
Zinc	369	258	480

Table C-8 Acceptance criteria for standard reference materials for sediment and fish tissue analyses during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Fish Tissue			
Parameter	**True Value (ng/g)**	**Acceptance Range (ng/g)**	
		Minimum	**Maximum**
Organochlorine Pesticides and PCB Congeners (SRM 1946, Lake Superior Fish Tissue; National Institute of Standards and Technology)			
2,4'-DDD	2.20	1.32	3.08
2,4'-DDE [a]	1.04	0.62	1.46
2,4'-DDT [a]	22.3	13.4	31.2
4,4'-DDD	17.7	10.6	24.8
4,4'-DDE	373	224	522
4,4'-DDT	37.2	22	52.1
cis-Chlordane	32.5	19.5	45.5
trans-Chlordane	8.36	5.02	11.7
Dieldrin	32.5	19.5	45.5
Heptachlor epoxide	5.5	3.30	7.7
cis-Nonachlor	59.1	35.5	82.7
trans-Nonachlor	99.6	59.8	139
Oxychlordane	18.9	11.3	26.5
PCB 101	34.6	20.8	48.4
PCB 105	19.9	11.9	27.9
PCB 110	22.8	13.7	31.9
PCB 118	52.1	31.3	72.9
PCB 126	0.38	0.228	0.532
PCB 128	22.8	13.7	31.9
PCB 138	115	69.0	161
PCB 149	26.3	15.8	36.8
PCB 153/168	170	102	238
PCB 156	9.52	5.71	13.3
PCB 170	25.2	15.1	35.3
PCB 18 a	0.84	0.50	1.18
PCB 180	74.4	44.6	104
PCB 183	21.9	13.1	30.7
PCB 187	55.2	33.1	77.3
PCB 194	13.00	7.80	18.2
PCB 201 [a]	2.83	1.70	3.96
PCB 206	5.40	3.24	7.56
PCB 28 [a]	2.00	1.20	2.80
PCB 44	4.66	2.80	6.52
PCB 49	3.80	2.28	5.32
PCB 52	8.10	4.86	11.3
PCB 66	10.8	6.48	15.1
PCB 70	14.9	8.94	20.9
PCB 74	4.83	2.90	6.76
PCB 77	0.327	0.20	0.458
PCB 87	9.40	5.64	13.2
PCB 99	25.6	15.4	35.8

Table C-8 Acceptance criteria for standard reference materials for sediment and fish tissue analyses during the 2021-22 program year.

OC San Environmental Laboratory and Ocean Monitoring Division

Fish Tissue			
Parameter	**True Value (%)**	**Acceptance Range (%)**	
		Minimum	**Maximum**
Lipid (SRM 1946, Lake Superior Fish Tissue; National Institute of Standards and Technology)			
Lipid [a]	10.2	6.10	14.2
Parameter	**True Value (mg/kg)**	**Acceptance Range (mg/kg)**	
		Minimum	**Maximum**
Metals (SRM DORM-4; National Research Council Canada)			
Arsenic	6.87	4.81	8.93
Selenium [a]	3.45	2.42	4.49
Mercury	0.412	0.288	0.536

[a] Parameter with non-certified value(s).

Table C-9 **Sediment QA/QC summary for the 2021-22 program year.**
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer	PAHs	57 (40)	Blank	4	24	96	100
			Trip Blank	3	24	72	100
			Instrument Blank	3	24	72	100
			Blank Spike	4	24	95	99
			Blank Spike Duplicate	3	24	72	100
			Blank Spike Precision	3	24	72	100
			Matrix Spike	4	24	96	100
			Matrix Spike Duplicate	4	24	94	98
			Matrix Spike Precision	4	24	87	91
			SRM Analysis	4	21	76	90
Fall	PAHs	11 (1)	Blank	1	24	24	100
			Trip Blank	1	24	24	100
			Instrument Blank	1	24	24	100
			Blank Spike	1	24	24	100
			Blank Spike Duplicate	1	24	24	100
			Blank Spike Precision	1	24	24	100
			Matrix Spike	1	24	18	75
			Matrix Spike Duplicate	1	24	24	100
			Matrix Spike Precision	1	24	13	54
			SRM Analysis	1	21	19	90
Winter	PAHs	11 (1)	Blank	1	24	24	100
			Trip Blank	1	24	24	100
			Instrument Blank	1	24	24	100
			Blank Spike	1	24	24	100
			Blank Spike Duplicate	1	24	23	96
			Blank Spike Precision	1	24	24	100
			Matrix Spike	1	24	24	100
			Matrix Spike Duplicate	1	24	24	100
			Matrix Spike Precision	1	24	24	100
			SRM Analysis	1	21	19	90

Table C-9 Sediment QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Spring	PAHs	11 (1)	Blank	1	24	24	100
			Trip Blank	1	24	24	100
			Instrument Blank	1	24	24	100
			Blank Spike	1	24	23	96
			Blank Spike Duplicate	1	24	24	100
			Blank Spike Precision	1	24	24	100
			Matrix Spike	1	24	22	92
			Matrix Spike Duplicate	1	24	14	58
			Matrix Spike Precision	1	24	24	100
			SRM Analysis	1	21	20	95

[a] An analysis passed if the following criteria were met:
For blank, trip blank, and instrument blank - Target amount <3 × MDL.
For blank spike and blank spike duplicate - Target accuracy % recovery 60–120.
For blank spike precision - Target precision % RPD <30%
For matrix spike and matrix spike duplicate - Target accuracy % recovery 40–120.
For matrix spike precision - Target precision % RPD <30%.
For SRM analysis - Target accuracy % recovery 60–140 or certified value, whichever is greater.

Table C-9 Sediment QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer	PCBs and Pesticides	57 (4)	Blank	4	61	244	100
			Trip Blank	3	54	162	100
			Instrument Blank	3	54	162	100
			Blank Spike	7	61	311	73
			Matrix Spike	4	61	206	84
			Matrix Spike Duplicate	4	61	196	80
			Matrix Spike Precision	4	61	243	100
			SRM Analysis	4	33	112	85
Fall	PCBs	11 (1)	Blank	1	40	40	100
			Trip Blank	1	40	40	100
			Instrument Blank	1	40	40	100
			Blank Spike	1	40	0	0
			Matrix Spike	1	40	40	100
			Matrix Spike Duplicate	1	40	40	100
			Matrix Spike Precision	1	40	40	100
			SRM Analysis	1	24	23	96
Winter	PCBs	11 (1)	Blank	1	40	40	100
			Trip Blank	1	40	40	100
			Instrument Blank	1	40	40	100
			Blank Spike	1	40	39	98
			Matrix Spike	1	40	40	100
			Matrix Spike Duplicate	1	40	40	100
			Matrix Spike Precision	1	40	39	98
			SRM Analysis	1	24	24	100

Table C-9 Sediment QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Spring	PCBs	11 (1)	Blank	1	40	40	100
			Trip Blank	1	40	40	100
			Instrument Blank	1	40	40	100
			Blank Spike	1	40	31	78
			Matrix Spike	1	40	33	83
			Matrix Spike Duplicate	1	40	37	93
			Matrix Spike Precision	1	40	40	100
			SRM Analysis	1	24	24	100

[a] An analysis passed if the following criteria were met:
For blank, trip blank, and instrument blank - Target amount <3 × 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 <30%.
For SRM analysis - Target accuracy % recovery 60–140 or certified value, whichever is greater.

Table C-9 Sediment QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	57 (2)	Blank	8	12	96	100
			Blank Spike	4	12	48	100
			Matrix Spike	6	12	64	89
			Matrix Spike Duplicate	6	12	63	88
			Matrix Spike Precision	6	12	72	100
			Duplicate	6	12	69	96
			SRM Analysis	2	12	24	100
	Mercury	57 (3)	Blank	3	1	3	100
			Blank Spike	3	1	3	100
			Matrix Spike	6	1	6	100
			Matrix Spike Duplicate	6	1	6	100
			Matrix Spike Precision	6	1	5	83
			Duplicate	6	1	6	100
			SRM Analysis	3	1	3	100
Fall	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	11 (1)	Blank	3	12	36	100
			Blank Spike	1	12	12	100
			Matrix Spike	2	12	21	88
			Matrix Spike Duplicate	2	12	22	92
			Matrix Spike Precision	2	12	24	100
			Duplicate	2	12	24	100
			SRM Analysis	1	12	12	100
	Mercury	11 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	1	50
			Duplicate	2	1	2	100
			SRM Analysis	1	1	1	100

Table C-9 Sediment QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Winter	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	11 (1)	Blank	3	12	36	100
			Blank Spike	1	12	12	100
			Matrix Spike	2	12	22	92
			Matrix Spike Duplicate	2	12	22	92
			Matrix Spike Precision	2	12	24	100
			Duplicate	2	12	24	100
			SRM Analysis	1	12	12	100
	Mercury	11 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	2	100
			SRM Analysis	1	1	1	100

Table C-9 Sediment QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Spring	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	11 (1)	Blank	3	12	36	100
			Blank Spike	1	12	12	100
			Matrix Spike	2	12	22	92
			Matrix Spike Duplicate	2	12	22	92
			Matrix Spike Precision	2	12	24	100
			Duplicate	2	12	23	96
			SRM Analysis	1	12	12	100
	Mercury	11 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	1	50
			SRM Analysis	1	1	1	100
Summer	Dissolved Sulfides	57 (4)	Blank	4	1	1	100
			Blank Spike	2	1	1	100
			Matrix Spike	1	1	1	100
			Matrix Spike Duplicate	3	1	1	100
			Matrix Spike Precision	3	1	1	100
			Duplicate	2	1	1	100

[a] An analysis passed if the following criteria were met.
For blank - Target amount <3 × MDL or <10% of sample result, whichever is greater.
For blank spike - Target accuracy % recovery 90–110 for mercury and 85–115 for other metals.
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 10 × MDL of sample mean.
For SRM analysis - Target accuracy % recovery 80–120% or certified value, whichever is greater.

Table C-9 Sediment QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Fall and Winter	Dissolved Sulfides	22 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	1	100
			Matrix Spike Duplicate	2	1	1	100
			Matrix Spike Precision	2	1	1	100
			Duplicate	2	2	2	100
Spring	Dissolved Sulfides	11 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	1	1	1	100
			Matrix Spike Duplicate	1	1	1	100
			Matrix Spike Precision	1	1	1	100
			Duplicate	1	1	1	100

[a] An analysis passed if the following criteria were met:
For blank - Target amount <2 × MDL.
For blank spike - Target accuracy % recovery 80–120.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 70–130.
For matrix spike precision - Target precision % RPD <30%.
For duplicate - Target precision % RPD <30% at 3 × MDL of sample mean.

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer	TOC	57 (4)	Blank	4	1	4	100
			Blank Spike	4	1	4	100
			Matrix Spike	7	1	7	100
			Matrix Spike Duplicate	7	1	7	100
			Matrix Spike Precision	7	1	7	100
			Duplicate	7	1	7	100
Fall	TOC	11 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	2	100

Table C-9 Sediment QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Winter	TOC	11 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	2	100
Spring	TOC	11 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	2	100
[a] An analysis passed if the following criteria were met: For blank - Target amount <3 × MDL. For blank spike, matrix spike, and matrix spike duplicate - Target accuracy % recovery 80–120. For matrix spike precision - Target precision % RPD <10%. For duplicate - Target precision % RPD <20% at 10 × MDL of sample mean.							
Summer	Grain Size	57 (2)	Duplicate	7	1	7	100
Fall	Grain Size	11 (1)	Duplicate	2	1	2	100
Winter	Grain Size	11 (1)	Duplicate	2	1	2	100
Spring	Grain Size	11 (1)	Duplicate	2	1	2	100
[a] An analysis passed if Target precision mean % RPD <10% of mean phi.							
Summer	Nitrite Nitrate as N	57 (5)	Blank	5	1	5	100
			Blank Spike	5	1	5	100
			Matrix Spike	6	1	6	100
			Matrix Spike Duplicate	6	1	6	100
			Matrix Spike Precision	6	1	6	100
			Duplicate	3	1	3	100

Table C-9 Sediment QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Fall	Nitrite Nitrate as N	11 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	2	100
Winter	Nitrite Nitrate as N	11 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	2	100
Spring	Nitrite Nitrate as N	11 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	2	100

[a] An analysis passed if the following criteria were met:
For blank - Target amount <3 × MDL.
For blank spike - Target accuracy % recovery 80–120.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 70–130.
For matrix spike precision - Target precision % RPD <30%.
For duplicate - Target precision % RPD <20% at 10 × MDL of sample mean.

Table C-9 Sediment QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer	Total Kjeldahl Nitrogen	57 (5)	Blank	5	1	5	100
			Blank Spike	5	1	5	100
			Matrix Spike [b]	—	—	—	—
			Matrix Spike Duplicate [b]	—	—	—	—
			Matrix Spike Precision [b]	—	—	—	—
			Duplicate	9	1	9	100
Fall	Total Kjeldahl Nitrogen	11 (2)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike [b]	—	—	—	—
			Matrix Spike Duplicate [b]	—	—	—	—
			Matrix Spike Precision [b]	—	—	—	—
			Duplicate	3	1	3	100
Summer	Total Kjeldahl Nitrogen	11 (2)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike [b]	—	—	—	—
			Matrix Spike Duplicate [b]	—	—	—	—
			Matrix Spike Precision [b]	—	—	—	—
			Duplicate	2	1	2	100
Spring	Total Kjeldahl Nitrogen	11 (2)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike [b]	—	—	—	—
			Matrix Spike Duplicate [b]	—	—	—	—
			Matrix Spike Precision [b]	—	—	—	—
			Duplicate	2	1	2	100

[a] An analysis passed if the following criteria were met:
For blank - Target amount <10% of sample result.
For blank spike - Target accuracy % recovery 80–120.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 70–130.
For matrix spike precision - Target precision % RPD <30%.
For duplicate - Target precision % RPD <20% at 10 × MDL of sample mean.
b Contract lab did not perform all of the QC required by the OMP QAPP.

Table C-9 Sediment QA/QC summary for the 2021-22 program year. OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer	Total P	57 (5)	Blank	5	1	0	0
			Blank Spike	5	1	5	100
			Matrix Spike	7	1	6	86
			Matrix Spike Duplicate	7	1	5	71
			Matrix Spike Precision	7	1	7	100
			Duplicate	3	1	3	100
Fall	Total P	11 (2)	Blank	3	1	0	0
			Blank Spike	3	1	3	100
			Matrix Spike	3	1	3	100
			Matrix Spike Duplicate	3	1	3	100
			Matrix Spike Precision	3	1	3	100
			Duplicate [c]	—	1	—	—
Winter	Total P	11 (1)	Blank	1	1	0	0
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	2	100
Spring	Total P	11 (1)	Blank	1	1	0	0
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	1	50
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	2	100

[a] An analysis passed if the following criteria were met:
For blank - Target amount <3 × MDL.
For blank spike - Target accuracy % recovery 80–120.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 70–130.
For matrix spike precision - Target precision % RPD <30%.
For duplicate - Target precision % RPD <20% at 10 × MDL of sample mean.
[c] Contract lab did not perform all QC required by the OMP QAPP.

FISH TISSUE CHEMISTRY NARRATIVE

For the 2021-22 program year, the ELOM laboratory received 15 rig fish samples in September 2021 and a total of 40 trawl fish samples from both the July/August 2021 and January/February 2022 sampling events. The individual samples were stored, dissected, composited, and homogenized according to methods described in the ELOM SOPs. For this new permit reporting year, the rig fish muscle tissue samples and trawl liver tissue samples were composited according to species and zones or stations with the conditions described in the ELOM SOPs. There was a total of 5 muscle and 6 liver tissue composite samples. After the composited samples were homogenized, equal aliquots of the composited tissue and liver samples were kept frozen and distributed to the metals and organic chemistry sections of the analytical chemistry laboratory for analyses.

Organochlorine Pesticides and PCBs

The analytical methods used for organochlorine pesticides and PCB congeners are described in the ELOM SOPs. The composite tissue and liver samples were extracted using an ASE 350 and analyzed by GC/MS/MS.

All analyses were performed within the required holding time and with appropriate QC measures. A typical organic sample batch included up to 20 field samples with required QC samples. The QC samples included a laboratory blank, sample duplicate, matrix spike, matrix spike duplicate, SRM, and reporting level spike (using hydromatrix as the spike media). The MDLs for pesticides and PCBs in fish tissue are presented in Table C-6. The reported ending period date is July 2022 and not June 2022 due to the MDL values being determined after the June 2022 cutoff date. Acceptance criteria for PCBs and pesticides SRM in fish tissue are presented in Table C-8.

Most compounds tested in each parameter group met the QA/QC criteria (Table C-10). As is usual for an analysis in which many analytes are measured in a complex matrix, there were a few instances of QC failures in the matrix spike duplicate, matrix spike precision, and SRM. For this program year, samples were composited according to species, therefore, fewer samples per batch were analyzed as compared to previous program years. In cases where constituent concentrations in a sample exceeded the calibration range of the instrument, the sample was diluted and reanalyzed. Any variances that occurred during sample preparation or analyses were noted in the Comments/Notes section of each batch summary.

Lipid Content

Percent lipid content was determined for each composited fish muscle and liver tissue samples using methods described in the ELOM SOPs. Lipids were extracted with 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 tared aluminum weighing boat and allowed to evaporate to dryness. The remaining residue was weighed, and the percent lipid content calculated. Acceptance criteria for lipid SRMs are presented in Table C-8. All analyses were performed within the required holding time and with appropriate QC measures. All analyzed samples passed the QC acceptance criteria (Table C-10).

Mercury

Fish tissue samples were analyzed for mercury in accordance with ELOM 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 sample duplicates, matrix spikes, and matrix spike duplicates, which were run approximately once every 10 samples.

The MDL for fish mercury is presented in Table C-6. Acceptance criteria for the mercury SRMs are presented in Table C-8. All samples were analyzed within their 6-month holding time and met the QC criteria (Table C-10).

Arsenic and Selenium

Fish tissue samples were analyzed for arsenic and selenium in accordance with ELOM SOPs. Typical QC analyses for a tissue sample batch included 3 blanks, a blank spike, and an SRM (muscle). Additional QC samples included a sample duplicate, a matrix spike, and a matrix spike duplicate, which were run at least once every 10 samples.

The MDLs for arsenic and selenium in fish tissue are presented in Table C-6. Acceptance criteria for the arsenic and selenium SRMs are presented in Table C-8. All samples were analyzed within a 6-month holding time. One duplicate sample target precision RPD for selenium was outside of the method-specified acceptance criteria, but all other QC samples met established criteria (Table C-10).

Table C-10 Fish tissue QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer (Rig fish samples)	PCBs and Pesticides	5 (1)	Blank	1	54	54	100
			Blank Spike	1	54	54	100
Summer (Trawl samples)	PCBs and Pesticides	2 (1)	Matrix Spike	1	54	54	100
			Matrix Spike Dup	1	54	52	96
			Matrix Spike Precision	1	54	53	98
Winter (Trawl samples)	PCBs and Pesticides	4 (1)	Duplicate	1	54	54	100
			SRM Analysis	1	41	35	85

[a] An analysis passed if the following criteria were met:
For blank - Target amount <3 × 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 3 × MDL of sample mean.
For SRM analysis - Target accuracy % recovery 60–140 or certified value, whichever is greater.

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer (Rig fish samples)	Percent Lipid – Muscle	5 (1)	Blank [b]	1	1	—	—
Summer (Trawl samples)	Percent Lipid – Liver	2 (1)	Duplicate	1	1	1	100
Winter (Trawl samples)	Percent Lipid – Liver	4 (1)	SRM Analysis	1	1	1	100

[a] An analysis passed if the following criteria were met:
For duplicate - Target precision % RPD <25%.
For SRM analysis - Target % recovery 60–140.
[b] Data are provided for information only since there is no criterion for lipid blanks.

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer (Trawl and Rig fish samples) and Winter (Trawl samples only)	Mercury	11 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	2	100
			Matrix Spike Dup	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	2	100
			SRM Analysis	1	1	1	100

Table C-10 Fish tissue QA/QC summary for the 2021-22 program year.
OC San Environmental Laboratory and Ocean Monitoring Division

Period	Parameter	Total Samples (Total Batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed [a]	% Compounds Passed
Summer (Trawl and Rig fish samples) and Winter (Trawl samples only)	Arsenic & Selenium	11 (1)	Blank	3	2	6	100
			Blank Spike	1	2	2	100
			Matrix Spike	2	2	4	100
			Matrix Spike Dup	2	2	4	100
			Matrix Spike Precision	2	2	4	100
			Duplicate	2	2	3	75
			SRM Analysis	1	2	2	100

[a] An analysis passed if the following criteria were met:
For blank - Target amount <3 × MDL.
For blank spike - Target accuracy % recovery 85–115.
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 10 × MDL of sample mean.
For SRM analysis - Target accuracy % recovery 70–130 or certified value, whichever is greater.

BENTHIC INFAUNA NARRATIVE

The 2021-22 sorting and taxonomy QA/QC follow OC San's QAPP. These QA/QC procedures were conducted on infauna samples collected from 11 quarterly, 11 annual (Summer Quarter), and 35 quinquennial (Summer Quarter) stations (Table A-6).

Sorting

The sorting procedure involved removal by Aquatic Bioassay and Consulting Laboratories, Inc. (ABC) of all organisms, including their fragments, from sediment samples into separate vials by major taxa (aliquots). The abundance of countable organisms (i.e., specimens with a head) per station was recorded. After ABC's in-house sorting efficiency criteria were met, the organisms and remaining particulates (grunge) were returned to OC San. Ten percent (9/90) of these samples were randomly selected for re-sorting by OC San staff. A tally was made of any countable organisms missed by ABC. 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. Sorting results for all QA samples ranged from 0–0.38%, which were well below the 5% QC limit.

Taxonomy

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 datasets 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: $$\%\ Error_{\#\ Individuals} = \left(\frac{|\#\ Individuals_{Resolved} - \#\ Individuals_{Original}|}{\#\ Individuals_{Resolved}}\right) \times 100$$

Equation 2: $$\%\ Error_{ID\ Taxa} = \left(\frac{\#\ Taxa_{Misidentification}}{\#\ Taxa_{Resolved}}\right) \times 100$$

Equation 3: $$\%\ Error_{ID\ Individuals} = \left(\frac{\#\ Individuals_{Misidentification}}{\#\ Individuals_{Resolved}}\right) \times 100$$

Please refer to OC San's QAPP for detailed explanation of the variables. The first 2 equations are considered gauges of errors in accounting (e.g., recording on a wrong line, miscounting, etc.), which, by their random nature, are difficult to predict. Equation 3 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 (SDR) 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 for further investigation.

QC objectives for identification accuracy (Equation 3) were met in the 2021-22 program year (Table C-11). No significant changes to the 2021-22 infauna dataset were made based on the SDR.

Table C-11 Percent error rates calculated for the July 2021 infauna QA samples.
OC San Environmental Laboratory and Ocean Monitoring Division

Error Type	Station				Mean
	0	**9**	**76**	**13**	
1. % Error $_{\#\ Individuals}$	1.4	4.5	-1.6 [a]	3.0	**2.6**
2. % Error $_{\#\ ID\ Taxa}$	7.9	9.4	7.7	2.8	**7.0**
3. % Error $_{\#\ ID\ Individuals}$	3.4	3.7	2.3	1.2	**2.7**

[a] The negative value indicates an undercount by the original taxonomist.

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