Marine Monitoring Annual Report

Program Year 2022 - 2023

OCSAN
ORANGE COUNTY SANITATION DISTRICT

OC SAN
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10844 Ellis Avenue
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www.ocsan.gov

March 14, 2024

Jayne Joy, Executive Officer
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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) 2022-23 Marine Monitoring Annual Report.

This report focuses on the final effluent and receiving water findings and conclusions for the monitoring period of July 1, 2022, to June 30, 2023. During this reporting period, OC San's final effluent met all permit requirements and exhibited no discernable impact on the receiving environment.

If you have any questions or comments, please contact me at (714) 593-7450 or Dr. Danny Tang, Ocean Monitoring Supervisor, at (714) 593-7427.

Lan C. Wiborg
Director of Environmental Services

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Enclosure

CC: T. Torres, EPA (via email)

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March 14, 2024

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

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CC: J. Joy, RWQCB (via email)

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

70 Years

ORANGE COUNTY SANITATION DISTRICT
10844 Ellis Avenue
Fountain Valley, CA 92708
714.962.2411
www.ocsan.gov

March 14, 2024

SUBJECT: **OC San 2022-23 Marine Monitoring Annual Report 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 2022-23 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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Acknowledgements

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List of Abbreviations

AhR	aryl hydrocarbon receptor
ATL	Advisory Tissue Level
BOD	biochemical oxygen demand
BRI	Benthic Response Index
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CBOD	carbonaceous biochemical oxygen demand
CECs	contaminants of emerging concern
CDOM	colored dissolved organic matter
COP	California Ocean Plan
CRKSC	Central Region Kelp Survey Consortium
CRM	certified reference material
CTD	conductivity, temperature and depth
DDT	dichlorodipheynyltrichloroethane; also defined as the sum of 4,4′-DDT, 2,4′-DDT, 4,4′-DDE, 2,4′-DDE, 4,4′-DDD, 2,4′-DDD, and 4,4′-DDMU
DO	dissolved oxygen
DS	dissolved sulfides
ELAP	State Water Resources Control Board Environmental Laboratory Accreditation Program
ELOM	Environmental Laboratory and Ocean Monitoring
EMI	epibenthic macroinvertebrate
ENSO	El Niño Southern Oscillation
EPA	US Environmental Protection Agency
ERα	estrogen receptor-alpha
ERM	effects range median
FIB	fecal indicator bacteria
FRI	Fish Response Index
FSU	Florida State University
GC-MS	gas chromatography/mass spectrometry
GR	glucocorticoid receptor
GWRS	Groundwater Replenishment System
H′	Shannon-Wiener Diversity
HRGC/HRMS	high resolution gas chromatography with high resolution mass spectrometry
ICPMS	inductively coupled plasma mass spectroscopy
IEDC	industrial endocrine disrupting compounds
IFCB	Imaging FlowCytobot
ITI	Infaunal Trophic Index
LAB	linear alkylbenzenes
LIMS	Laboratory Information Management System
MBARI	Monterey Bay Aquarium Research Institute
MBI	Michael Baker International
MDL	method detection limit
MGD	million gallons per day
MLD	mixed layer depth
MOCI	California Multivariate Ocean Climate Index
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable

ND	not detected
nMDS	non-metric multidimensional scaling
NPDES	National Pollutant Discharge Elimination System
NPGO	North Pacific Gyre Oscillation
NTU	nephelometric turbidity units
OAH	ocean acidification and hypoxia
OC San	Orange County Sanitation District
OCHCA	Orange County Health Care Agency
OCWD	Orange County Water District
OOC	out of compliance
OMP	Ocean Monitoring Program
ORO	out of range occurrence
PAH	polycyclic aromatic hydrocarbon
PAR	photosynthetically active radiation
PBDE	polybrominated diphenyl ether
PCB	polychlorinated biphenyl
PDO	Pacific Decadal Oscillation
PFAS	per- and polyfluoroalkyl substances
PFBS	perfluorobutanesulfonic acid
PFCAs	perfluoroalkyl carboxylic acids
PFDA	perfluorodecanoic acid
PFDoA	perfluorododecanoic acid
PFHpA	perfluoroheptanoic acid
PFHxA	perfluorohexanoic acid
PFHxS	perfluororhexanesulfonic acid
PFNA	perfluorononanoic acid
PFOA	perfluorooctanoic acid
PFOS	pefluorosulfonic acid
PFSAs	perfluoroalkyl sulfonic acid
PFTeDA	perfluorotetradecanoic acid
PFTrDA	perfluorotridecanoic acid
PFUnDA	perfluoroundecanoic acid
PPCP	pharmaceuticals and personal care products
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RL	reporting limit
RO	reverse osmosis
ROMS-BEC	Regional Ocean Model System-Biogeochemical Elemental Cycling Model
RPD	relative percent difference
RWQCB	Regional Water Quality Control Board
SCB	Southern California Bight
SCBRWQP	Southern California Bight Regional Water Quality Program
SCCOOS	Southern California Coastal Ocean Observing System
SCCWRP	Southern California Coastal Water Research Project
SDI	Swartz's 75% Dominance Index
SDR	Synoptic Data Review
SIMPROF	similarity profile
SOP	standard operating procedure
SPS	strategic process studies
SRM	standard reference material

SWB	State Water Board
TKN	total Kjeldahl nitrogen
TN	total nitrogen
TOC	total organic carbon
TP	total phosphorus
TSS	total suspended solids
WET	whole effluent toxicity
ZID	zone of initial dilution

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 protect public health and the environment by providing effective wastewater collection, treatment, and recycling. To evaluate potential environmental and human health impacts from its discharge of final effluent into the Pacific Ocean, OC San conducts extensive monitoring 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 reverse osmosis concentrate from the Orange County Water District's Groundwater Replenishment System, is released through a 120-in (305-cm) outfall extending 5 miles (8.0 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 1, 2022, through June 30, 2023.

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 one of the 80 final effluent constituents monitored were detected above its respective performance goal value for two or more consecutive months. As required by our NPDES permit, OC San conducted an internal investigation into the cause of the performance goal exceedances, and the issue has not recurred for the constituent in question.

WATER QUALITY

Compliance for all three 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 they 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 (species richness, abundance, Shannon-Wiener Diversity Index, and Swartz's 75% Dominance Index) 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 rockfish samples were similar between outfall and non-outfall locations. Furthermore, the concentration of all contaminants measured in sport fish samples were below California's "Do not consume" Advisory Tissue Levels.

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 recorded in less than 1% of the fish samples captured in the monitoring area, and large external parasites were observed in less than 1% of the fish samples examined. Liver tissue damage was minimal in the flatfish samples collected at outfall and non-outfall locations.

Conclusion

The 2022-23 final effluent monitoring results indicated that OC San's pretreatment and treatment systems are robust, and OC San employs sound operation practices at Plant No. 1 and Plant No. 2. The results of the bacterial, physical, and chemical parameters measured in the water column during the 2022-23 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 in the monitoring area, as well as from the absence of sediment toxicity in controlled laboratory tests of sediment collected at outfall-depth stations. The assemblages of sediment-dwelling animals and contaminant concentrations in fish tissue samples were comparable between outfall and non-outfall areas. Negligible disease symptoms were recorded in fish samples and minimal liver pathologies were observed in flatfish 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 secondary-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 (COP), and the RWQCB Basin Plan. OC San's specific discharge and monitoring requirements for the 2022-23 program year are contained in its 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.

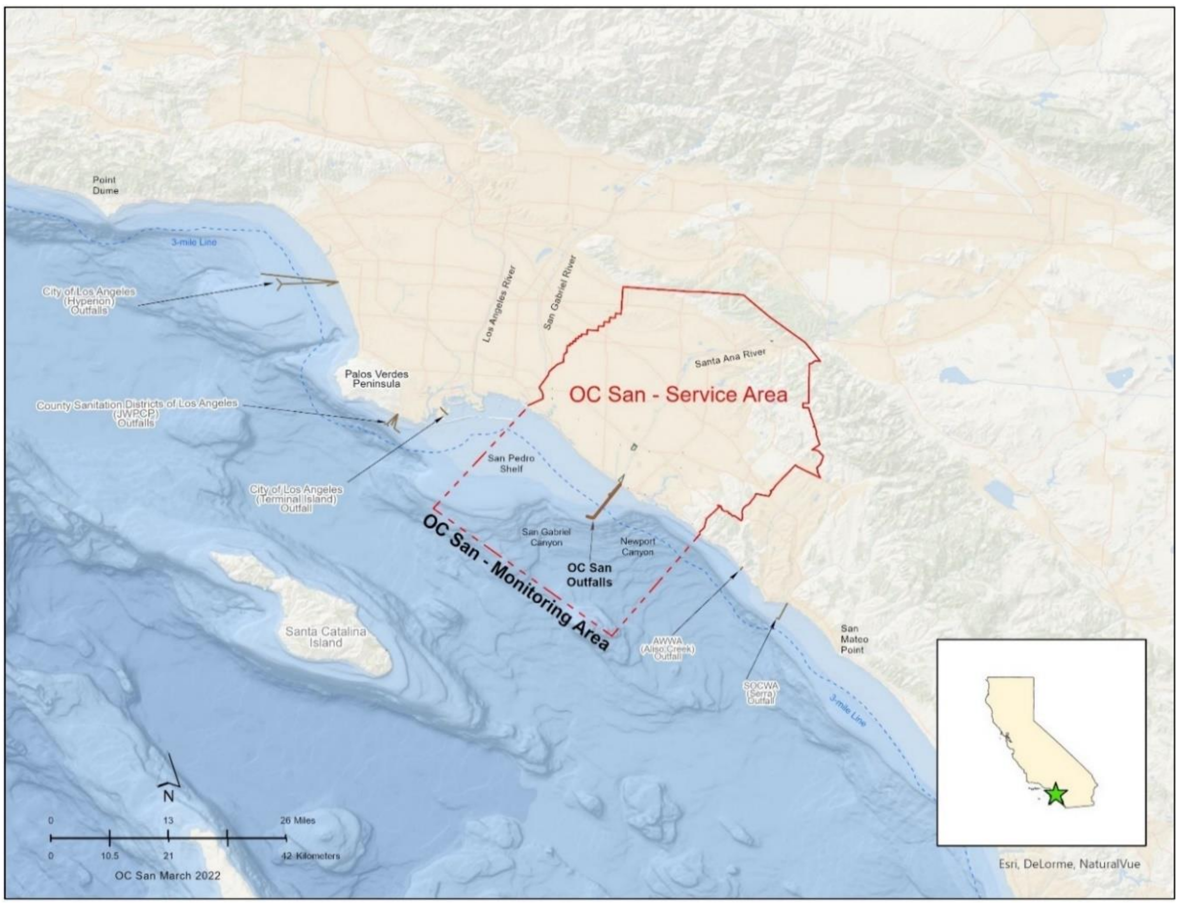

Figure 1-1 Regional setting and sampling area for OC San's Ocean Monitoring Program. Inset shows the general location of OC San's sampling area relative to the State.

REGULATORY SETTING FOR THE OCEAN MONITORING PROGRAM

OC San's NPDES permit includes requirements to monitor influents, 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 three 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 understand the coastal ocean environment and improve interpretations of the monitoring data. These program components are summarized below and further described throughout this report.

The Core monitoring component is designed to measure compliance with permit conditions and for temporal trend analysis. Four major elements comprise this component: (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 special studies, to provide information about relevant coastal and ecotoxicological processes, emerging contaminants, and modern monitoring tools to provide further insight into the Core monitoring component. 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 7 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, Bight '18, and Bight '23. 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 the 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 Los Angeles County Sanitation Districts, 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.
- Participating in the Central Region Kelp Survey Consortium Monitoring Program for tracking the extent and magnitude of surface canopy kelp measured by aerial survey within the central Bight region.
- Ocean Acidification and Hypoxia (OAH) Mooring to monitor OAH at a single location.

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., the 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 2023) 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).

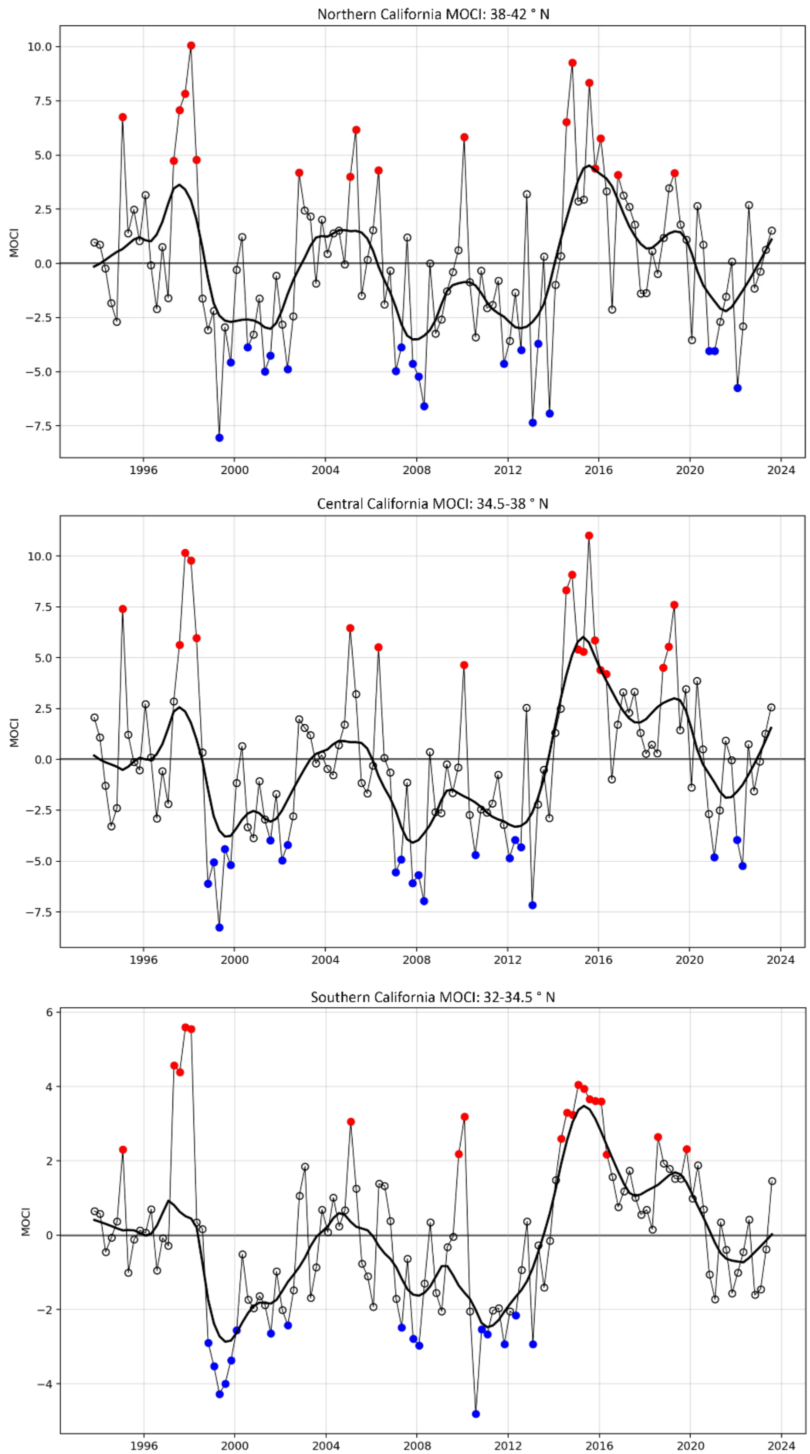

Figure 1-2 California Multivariate Ocean Climate Index for Northern (top figure), Central (middle figure) and Southern (bottom figure) California Red circles represent values one standard deviation above the mean (i.e., they indicate warm conditions and weak upwelling); blue circles represent values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

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).

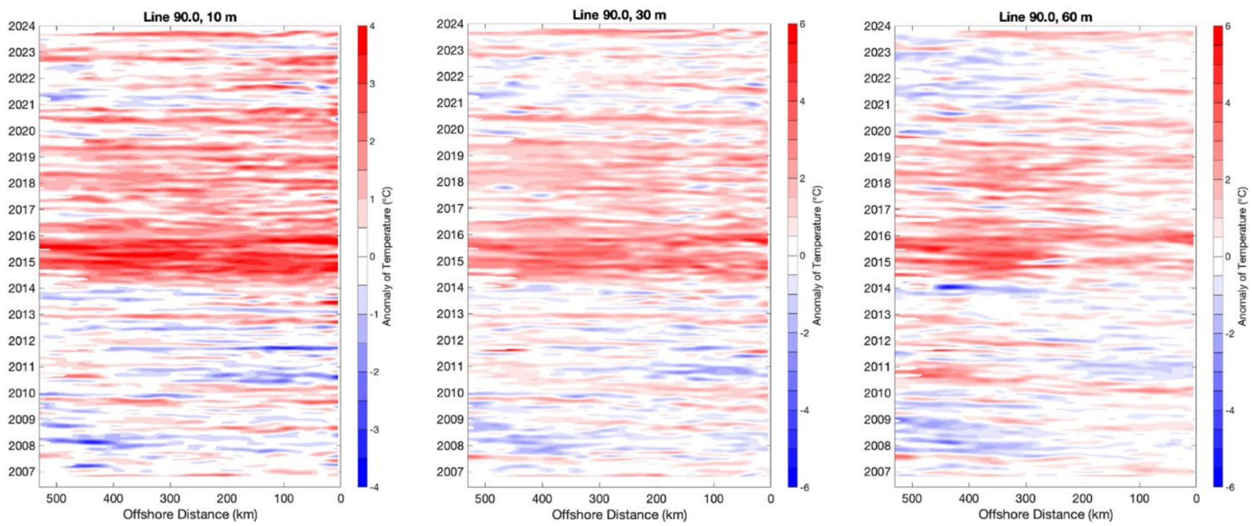

Figure 1-3 Temperature anomalies measured from the shoreline to 311 miles (500 km) offshore along CalCOFI Line 90 at 32 ft (10 m) below the surface (left figure), at OC San's typical plume trapping depth of 98 ft (30 m) (middle figure), and at OC San's nominal outfall depth of 197 ft (60 m) (right figure).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

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 dynamics 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 2022-23 program year, during non-rainfall periods, up to 98% of monitored Orange County Beaches received grades of either "A" or "B", while after wet weather events, the proportion of beaches with "A" or "B" grades dropped down to 63% (Heal the Bay 2023).

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 detailed in OCSD (2023).

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 designated beneficial uses.

This report presents OMP compliance determinations for data collected from July 1, 2022, through June 30, 2023. 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 protect public health and the environment by providing effective wastewater collection, treatment, and recycling. 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 2022-23 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 2.6 million residents, industrial wastewater from 533 permitted businesses within its service area and, for the past 24 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 two 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 to recharge local groundwater supplies (primarily for indirect potable use and secondarily as a saltwater intrusion barrier). The influent at Plant No. 2 is split into a reclaimable stream and a non-reclaimable stream. The reclaimable stream undergoes secondary treatment through a trickling filter solids-contact process whereas the non-reclaimable stream undergoes secondary treatment by a high purity oxygen activated sludge. The treated reclaimable stream is pumped from Plant No. 2 to OCWD for the GWRS, while the treated non-reclaimable stream discharges to the outfall. The final effluent consists of non-reclaimable secondary effluent mixed with reverse osmosis (RO) concentrate from OCWD, and it is discharged under normal operations through the 120-in ocean outfall (Discharge Point 001). The 120-in outfall extends 5 miles (8.0 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 has a 78-in emergency outfall (Discharge Point 002) that is 1.3 miles (0.8 km) long (Figure 3-1). 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 2022-23 program year, OC San received and processed influent volumes averaging 186 MGD (7.0×10^8 L/day). After diversions to OCWD and the return of their reject flows (e.g., RO concentrate), OC San discharged an average of 102 MGD (3.9×10^8 L/day) of treated wastewater through the 120-in outfall. The 78-in outfall was not used during the 2022-23 program year.

RESULTS

No permit exceedances were recorded among the 42 final effluent parameters measured for compliance during the 2022-23 program year (Table 2-1). The 12-month averages of most parameters were considerably lower than their respective permit limits. For example, the 12-month average for the monthly total suspended solids (TSS) was 5,550 lbs/day compared to the 51,541 lbs/day permit limit. Likewise, the 12-month average for the instantaneous maximum of total chlorine residual was 156 lbs/day compared to the 18,658 lbs/day permit limit. Among the three radioactive parameters measured in the final effluent, only three 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 values[2] were all below the stipulated criterion of 5 pCi/L. No anomalies were detected among the 51 miscellaneous parameters measured in the final effluent (Table 2-1). Furthermore, the results of the nitrogen-based nutrient parameters were within expected ranges.

Among the 80 constituents analyzed for mass emission benchmarks, all had a 12-month average value below their respective benchmarks (see Table 2.7 in OCSD (2023)). Results for 73% (58 out of 80) of the measured constituents were below their respective detection limits.

Among the 80 constituents monitored for performance goals, chlorinated phenols was detected above its respective performance goal of 0.54 µg/L for two consecutive months in the 2022-23 program year (see Table 2.12 in OCSD (2023). Upon investigation, the performance goal was set by the highest maximum effluent concentration observed between May 2015 and December 2019; during that period there was one detection of 2,4,6-trichlorophenol at a concentration of 0.54 µg/L. However, that value was an estimated value due to the concentration being above the laboratory's detection limit but below the laboratory's reporting limit. This calls into question whether it is appropriate to use an estimated value in the establishment of a performance goal as using a value below a reporting limit may result in an unreasonable performance goal. Please review Section 2.8.4 in the 2022-2023 Pretreatment Program Annual Report OCSD (2023) for a full discussion of chlorinated phenols.

CONCLUSION

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

SUMMARY OF NON-COMPLIANCE

There were no exceedances of effluent limitations in the 2022-23 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 12-month averages of parameters measured in the final effluent during the 2022-23 program year. ND = Not Detected; NA = Not Applicable.

Parameter	Units	7/22	8/22	9/22	10/22	11/22	12/22	1/23	2/23	3/23	4/23	5/23	6/23	12-month Average	Permit Limit or Criterion
		Month/Year													
Parameters with Effluent Limitations															
Turbidity Monthly Avg	NTU	3.9	2.9	3.5	3.6	3.3	2.6	3.8	3.2	3.3	3.1	4.5	3.2	3.4	75
Turbidity Weekly Avg [a]	NTU	3.9	2.9	3.5	3.6	3.3	2.6	3.8	3.2	3.3	3.1	4.5	3.2	3.4	100
Turbidity Instantaneous Max [a]	NTU	3.9	2.9	3.5	3.6	3.3	2.6	3.8	3.2	3.3	3.1	4.5	3.2	3.4	225
pH Instantaneous Min	Standard Units	7.28	7.23	7.18	7.33	7.15	7.29	7.32	7.32	7.26	7.2	7.34	7.44	7.3	6
pH Instantaneous Max	Standard Units	7.43	7.89	7.78	7.98	7.87	7.88	7.95	7.5	7.97	7.50	7.54	7.58	7.7	9
TSS Monthly Avg	mg/L	5.8	5.6	6.5	5	6.7	7.1	7.5	7.1	8.1	8	6.4	5.1	6.6	30
TSS Weekly Avg	mg/L	7.0	6.8	6.3	8.1	9.1	8.5	8.5	7.5	9.0	9.6	6.8	6.6	7.8	45
TSS Monthly Avg	lbs/day	4,571	4,138	5,258	3,648	4,667	4,947	5,771	5,836	11,516	8,591	4,264	3,389	5,550	51,541
TSS Weekly Avg	lbs/day	5,567	4,940	5,498	6,386	6,532	5,295	7,729	6,131	13,812	10,617	5,016	5,022	6,879	77,312
TSS Monthly Avg Removal	%	99.0	99.1	98.8	99.2	98.9	98.9	98.8	98.7	97.7	98.0	99.0	99.2	98.8	≥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	0.5	ND	2.5	ND	ND	ND	0.2	ND	ND	ND	0.3	3
Oil & Grease Monthly Avg	mg/L	0.795	2.17	0.22	2.42	1.38	1.02	0.968	0.722	1.16	0.957	1.17	0.851	1.2	25
Oil & Grease Weekly Avg [b]	mg/L	0.795	2.17	0.22	2.42	1.38	1.02	0.968	0.722	1.16	0.957	1.17	0.851	1.2	40
Oil & Grease Instantaneous Max [b]	mg/L	0.795	2.17	0.22	2.42	1.38	1.02	0.968	0.722	1.16	0.957	1.17	0.851	1.2	75
Oil & Grease Monthly Avg	lbs/day	555	1,537	166	2,133	800	702	973	477	1,524	1,812	999	484	1,014	42,951
Oil & Grease Weekly Avg [c]	lbs/day	555	1,537	166	2,133	800	702	973	477	1,524	1,812	999	484	1,014	68,722
Oil & Grease Instantaneous Max [c]	lbs/day	555	1,537	166	2,133	800	702	973	477	1,524	1,812	999	484	1,014	128,853
Total Chlorine Residual Daily Max	mg/L	0.10	0.10	0.10	0.10	0.08	0.10	0.10	0.10	0.07	0.20	0.20	0.10	0.10	1.45
Total Chlorine Residual Instantaneous Max	mg/L	0.17	0.13	0.13	0.15	0.11	0.21	0.19	0.17	0.11	0.21	0.19	0.24	0.20	10.86
Total Chlorine Residual 6-Month Median	mg/L	0.08	0.07	0.07	0.07	0.07	0.04	0.04	0.04	0.04	0.05	0.08	0.08	0.10	0.36
Total Chlorine Residual Daily Max	lbs/day	92	83	95	76	62	143	115	86	97	109	96	100	96	2,491
Total Chlorine Residual Instantaneous Max	lbs/day	142	152	185	109	89	232	179	119	164	208	134	156	156	18,658
Total Chlorine Residual 6-Month Median	lbs/day	52	50	48	47	46	25	28	29	30	33	58	59	42	618
$CBOD_5$ Monthly Avg	mg/L	7.0	7.5	7.3	6.4	10.8	12.6	12.7	13.8	9.5	9.2	9.7	9.4	9.7	25

Table 2-1 Monthly and 12-month averages of parameters measured in the final effluent during the 2022-23 program year. ND = Not Detected; NA = Not Applicable.

		Month/Year													
Parameter	**Units**	**7/22**	**8/22**	**9/22**	**10/22**	**11/22**	**12/22**	**1/23**	**2/23**	**3/23**	**4/23**	**5/23**	**6/23**	**12-month Average**	**Permit Limit or Criterion**
$CBOD_5$ Weekly Avg	mg/L	8.1	8.6	9.7	6.8	13.5	18.2	14.5	15.6	11.7	10.0	11.1	10.3	11.5	40
$CBOD_5$ Monthly Avg	lbs/day	5,516	5,514	5,820	4,639	7,463	8,407	9,605	10,479	13,243	9,626	6,478	6,122	7,743	42,951
$CBOD_5$ Weekly Avg	lbs/day	6,318	6,297	7,146	5,289	9,701	10,609	11,096	9,974	16,261	12,390	7,284	7,049	9,118	68,722
$CBOD_5$ Monthly Avg Removal	%	98.4	98.3	98.3	98.5	97.9	97.7	97.4	97.1	96.4	97.4	98.1	98.2	97.8	≥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	0.0034
PCBs Monthly Avg	lbs/day	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	4.92	6.30	2.93	1.98	9.58	7.13	9.82	11.90	1.66	8.42	3.95	7.58	6.30	15
Gross Beta Radioactivity Monthly [d]	pCi/L	-4.9	-14.0	3.7	42.0	10.0	150.0	67.0	4.0	-6.4	8.6	17.0	58.0	27.9	50
Radium-226 & 228 Monthly	pCi/L	—	—	—	—	—	0.8	1.0	—	—	—	—	0.3	—	5
Strontium-90	pCi/L	-0.234	-0.047	0.112	-0.217	0.4	1.35	1.06	0.985	1.62	-0.295	1.48	0.886	—	—
Tritium	pCi/L	202	608	644	422	241	111	27.5	121	349	-172	-111	74.7	—	—
Uranium	pCi/L	10	9.4	7.9	9.4	11	12	12	15	9.6	12	12	17	—	—
Miscellaneous Parameters															
Fecal Coliform Density Monthly Avg	MPN/100 mL	660,000	290,000	650,000	580,000	750,000	91,000	92,000	100,000	160,000	210,000	180,000	210,000	331,083	N/A
Fecal Coliform Density Daily Max	MPN/100 mL	5,400,000	790,000	5,400,000	2,400,000	9,200,000	460,000	330,000	790,000	490,000	790,000	1,700,000	1,300,000	2,420,833	N/A
Enterococcus Density Monthly Avg	MPN/100 mL	7,460	4,915	6,896	6,826	8,887	4,315	3,540	5,111	4,862	6,663	6,555	5,617	5,971	N/A
Enterococcus Density Daily Max	MPN/100 mL	24,196	10,462	24,196	24,196	24,196	24,196	17,329	24,196	10,462	24,196	24,196	11,199	20,252	N/A
Nitrite Nitrogen Monthly	mg/L	6.9	5.6	3.4	3.3	4.6	3.1	9.2	5.6	2.6	2.9	1.8	4.8	4.5	N/A
Nitrate Nitrogen Monthly	mg/L	17.0	11.0	9.3	12.0	19.0	14.0	22.0	14.0	7.6	11.0	14.0	18.0	14.1	N/A
Organic Nitrogen Monthly	mg/L	3.2	2.6	2.1	2.2	5.9	0.8	0.2	7.1	2.9	1.8	4.7	3.6	3.1	N/A

Table 2-1 Monthly and 12-month averages of parameters measured in the final effluent during the 2022-23 program year. ND = Not Detected; NA = Not Applicable.

		Month/Year													
Parameter	**Units**	**7/22**	**8/22**	**9/22**	**10/22**	**11/22**	**12/22**	**1/23**	**2/23**	**3/23**	**4/23**	**5/23**	**6/23**	**12-month Average**	**Permit Limit or Criterion**
Total Nitrogen Annually	lbs/year	—	—	—	—	—	—	—	—	—	—	—	—	13,259,529 e	N/A
Total Phosphorus (as P) Monthly	mg/L	2.75	3.10	2.30	2.07	2.92	1.27	2.61	2.81	1.43	0.86	3.24	2.42	2.31	N/A
BOD_5 Monthly Avg	mg/L	16.1	15.1	17.3	14.9	22.1	26.5	26.6	27.1	22.7	24.5	21.6	18.8	21.1	N/A
Ammonia (as N) Monthly Avg	mg/L	29.4	28.2	28.8	27.7	30.7	32.5	34.7	38.0	21.7	22.6	33.1	33.5	30.1	N/A
PCB-18 Annually [f]	pg/L	64.0	—	—	—	—	—	—	—	—	—	—	—	64.0	N/A
PCB-28 Annually [f]	pg/L	33.0	—	—	—	—	—	—	—	—	—	—	—	33.0	N/A
PCB-37 Annually [f]	pg/L	5.0	—	—	—	—	—	—	—	—	—	—	—	5.0	N/A
PCB-44 Annually [f]	pg/L	50.0	—	—	—	—	—	—	—	—	—	—	—	50.0	N/A
PCB-49 Annually [f]	pg/L	12.0	—	—	—	—	—	—	—	—	—	—	—	12.0	N/A
PCB-52 Annually [f]	pg/L	33.0	—	—	—	—	—	—	—	—	—	—	—	33.0	N/A
PCB-66 Annually [f]	pg/L	10.0	—	—	—	—	—	—	—	—	—	—	—	10.0	N/A
PCB-70 Annually [f]	pg/L	24.0	—	—	—	—	—	—	—	—	—	—	—	24.0	N/A
PCB-74 Annually [f]	pg/L	24.0	—	—	—	—	—	—	—	—	—	—	—	24.0	N/A
PCB-77 Annually [f]	pg/L	2.1	—	—	—	—	—	—	—	—	—	—	—	2.1	N/A
PCB-81 Annually [g]	pg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-87 Annually [f]	pg/L	15.0	—	—	—	—	—	—	—	—	—	—	—	15.0	N/A
PCB-99 Annually [f]	pg/L	7.9	—	—	—	—	—	—	—	—	—	—	—	7.9	N/A
PCB-101 Annually [f]	pg/L	15.0	—	—	—	—	—	—	—	—	—	—	—	15.0	N/A
PCB-105 Annually [f]	pg/L	4.1	—	—	—	—	—	—	—	—	—	—	—	4.1	N/A
PCB-110 Annually [f]	pg/L	21.0	—	—	—	—	—	—	—	—	—	—	—	21.0	N/A
PCB-114 Annually	pg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-118 Annually [f]	pg/L	12.0	—	—	—	—	—	—	—	—	—	—	—	12.0	N/A
PCB-119 Annually [f]	pg/L	15.0	—	—	—	—	—	—	—	—	—	—	—	15.0	N/A
PCB-123 Annually [g]	pg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-126 Annually [g]	pg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-128 Annually [f]	pg/L	1.3	—	—	—	—	—	—	—	—	—	—	—	1.3	N/A
PCB-138 Annually [f]	pg/L	15.0	—	—	—	—	—	—	—	—	—	—	—	15.0	N/A
PCB-149 Annually [f]	pg/L	13.0	—	—	—	—	—	—	—	—	—	—	—	13.0	N/A
PCB-151 Annually [f]	pg/L	7.0	—	—	—	—	—	—	—	—	—	—	—	7.0	N/A
PCB-153/168 Annually	pg/L	12.0	—	—	—	—	—	—	—	—	—	—	—	12.0	N/A

Table 2-1 Monthly and 12-month averages of parameters measured in the final effluent during the 2022-23 program year. ND = Not Detected; NA = Not Applicable.

		Month/Year													
Parameter	**Units**	**7/22**	**8/22**	**9/22**	**10/22**	**11/22**	**12/22**	**1/23**	**2/23**	**3/23**	**4/23**	**5/23**	**6/23**	**12-month Average**	**Permit Limit or Criterion**
PCB-156 Annually [f]	pg/L	2.5	—	—	—	—	—	—	—	—	—	—	—	2.5	N/A
PCB-157 Annually [f]	pg/L	2.5	—	—	—	—	—	—	—	—	—	—	—	2.5	N/A
PCB-158 Annually [f]	pg/L	1.1	—	—	—	—	—	—	—	—	—	—	—	1.1	N/A
PCB-167 Annually [g]	pg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-169 Annually [g]	pg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-170 Annually [f]	pg/L	3.2	—	—	—	—	—	—	—	—	—	—	—	3.2	N/A
PCB-177 Annually [f]	pg/L	1.8	—	—	—	—	—	—	—	—	—	—	—	1.8	N/A
PCB-180 Annually [f]	pg/L	8.0	—	—	—	—	—	—	—	—	—	—	—	8.0	N/A
PCB-183 Annually [f]	pg/L	2.8	—	—	—	—	—	—	—	—	—	—	—	2.8	N/A
PCB-187 Annually [f]	pg/L	3.2	—	—	—	—	—	—	—	—	—	—	—	3.2	N/A
PCB-189 Annually [g]	pg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-194 Annually [f]	pg/L	1.8	—	—	—	—	—	—	—	—	—	—	—	1.8	N/A
PCB-201 Annually [g]	pg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	N/A
PCB-206 Annually [g]	pg/L	ND	—	—	—	—	—	—	—	—	—	—	—	ND	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] Since the contract laboratory reported "Detected, but no Quantified (DNQ)" for the PCB constituent, i.e., the sample result was less than the reported Minimum Level, but greater than or equal to the laboratory's Method Detection Limit, the result provided represents an estimated concentration.
[g] The result is reported as ND (Not Detected) because the sample result was less than the contract laboratory's Method Detection Limit.

Chapter 3. Receiving Water Compliance Monitoring

INTRODUCTION

This chapter provides OC San's Ocean Monitoring Program's receiving water compliance results for the 2022-23 program year. 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 NPDES permit (Table 3-1). Permit compliance must be determined each monitoring year based on the Federal Clean Water Act, the COP, and the RWQCB Basin Plan.

The Core OMP sampling locations include 28 offshore water quality stations, 22 benthic stations to assess sediment quality (geochemistry and toxicity) and infaunal communities, 14 trawl stations to evaluate demersal fish and macroinvertebrate communities, and two 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 offshore water quality sampling to annual fish tissue assessments (see Appendix A).

WATER QUALITY

Offshore Bacteria

The majority (71–88%) of samples for three 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 water quality objective. Over 93% of total coliform measured below the SWB shellfish harvesting median density objective, and over 97% 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 2,755, 317, and 670 MPN/100 mL, respectively. Compliance for all 3 FIB in the 2022-23 program year was achieved in 100% of the samples (Table B-2, Table B-3, and Table B-4), indicating OC San's discharge of treated wastewater did not affect water contact recreation in the monitoring area.

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 2022-23 program year (Table B-5 and Table B-6). Therefore, compliance was achieved.

Ocean Discoloration and Transparency

Overall, transmissivity (water clarity) standards were met 91% 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). 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 2022-23 program year.

	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).

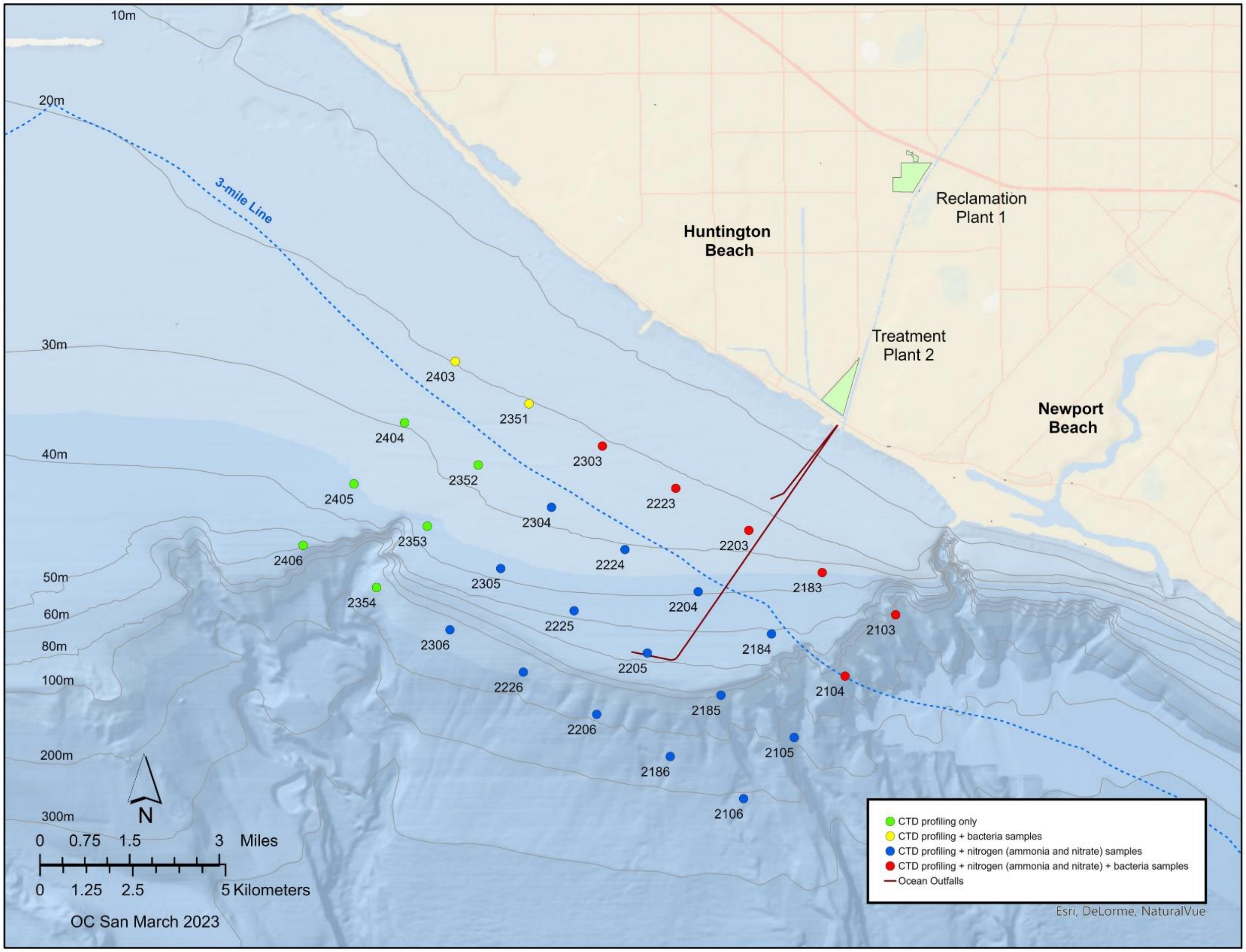


Figure 3-1 Offshore water quality monitoring stations for the 2022-23 program year.

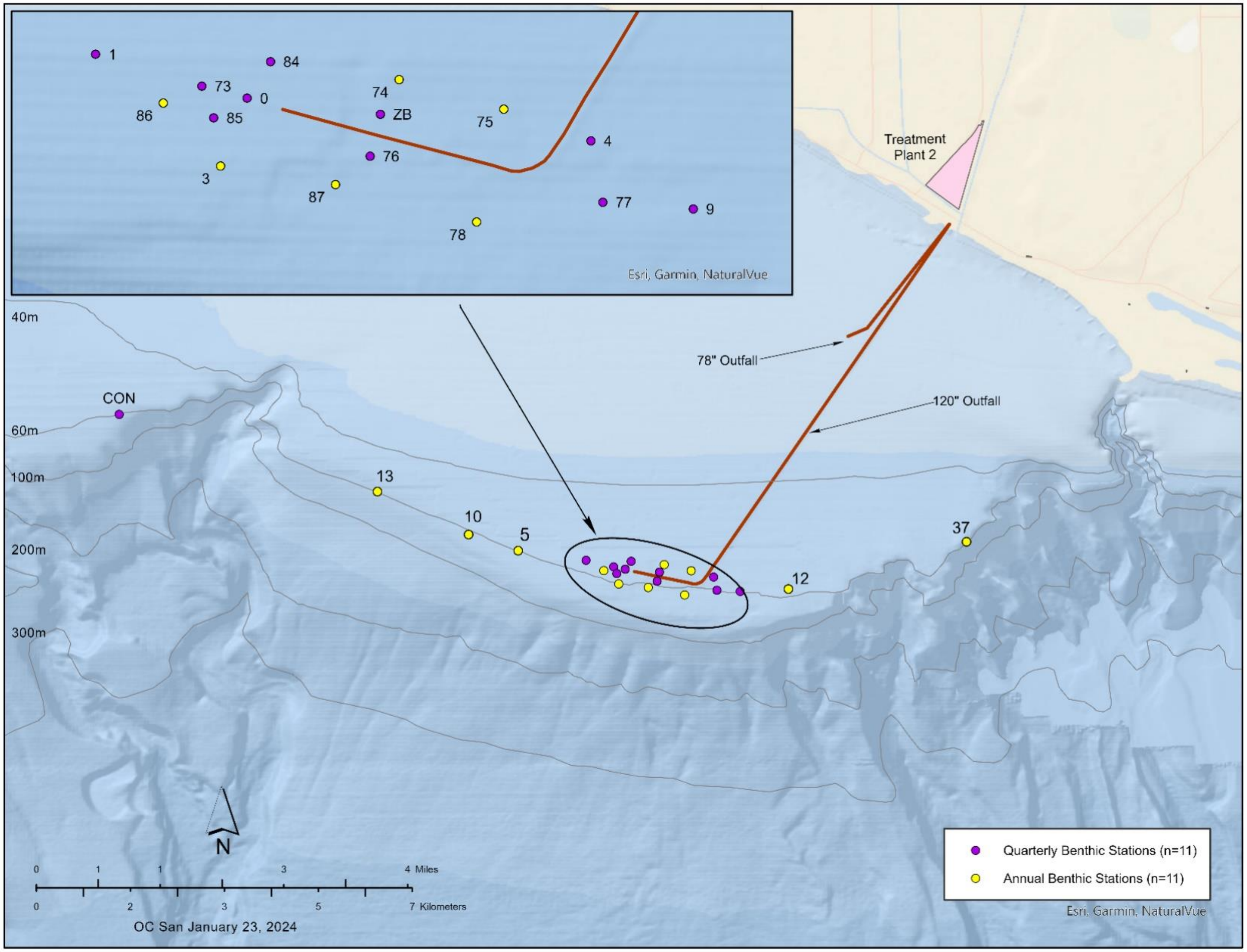


Figure 3-2 Benthic monitoring stations for the 2022-23 program year.

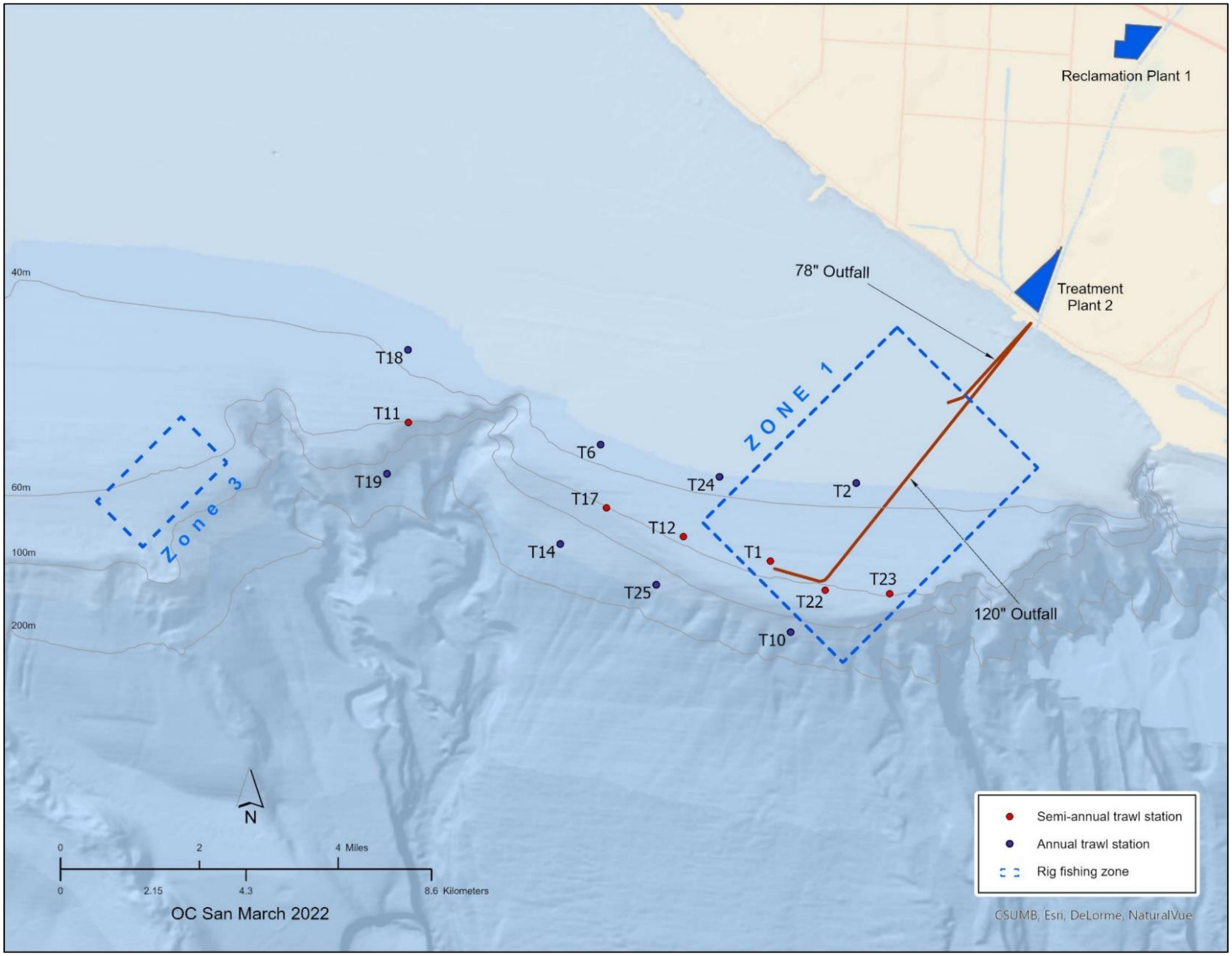


Figure 3-3 Trawl monitoring stations, as well as rig fishing locations, for the 2022-23 program year.

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 2022-23 program year, over 94% 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 and reporting limit of 0.04 mg/L (Table B-8). The small fraction of detectable NH_3-N concentrations ranged from 0.04 to 0.22 mg/L. Plume-related changes in NH_3-N were not considered environmentally significant as maximum values were nearly 18 times less than the chronic (4 mg/L) and 27 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 2022-23 program year, over 28% of the monthly Core water quality samples for nitrate nitrogen (NO_3-N) analysis were below the reporting limit of 0.015 mg/L (Table B-9). The higher percentage of samples not detected in the previous fiscal year (62%) was due to the contract lab's higher reporting limit, at 0.2 mg/L.

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 2022-23 program year indicated that federal standards were consistently met.

Table 3-2 Summary of OC San's monthly offshore water quality compliance testing results for dissolved oxygen, pH, and transmissivity for the 2022-23 program year.

Survey Date	Number of Stations [a]	Dissolved Oxygen		pH		Transmissivity	
		ORO [b]	OOC [c]	ORO	OOC	ORO	OOC
7/20/2022	27	0%	0%	0%	0%	26%	26%
8/24/2022	27	0%	0%	0%	0%	11%	4%
9/27/2022	27	0%	0%	0%	0%	7%	4%
10/19/2022	27	0%	0%	0%	0%	15%	7%
11/15/2022	27	0%	0%	0%	0%	7%	7%
12/1/2022	27	0%	0%	0%	0%	7%	4%
1/19/2023	27	0%	0%	0%	0%	11%	11%
2/16/2023	27	0%	0%	0%	0%	11%	7%
3/13/2023	27	0%	0%	0%	0%	15%	11%
4/20/2023	27	0%	0%	0%	0%	11%	0%
5/8/2023	27	0%	0%	0%	0%	11%	7%
6/5/2023	27	4%	0%	0%	0%	26%	22%
Annual	**324**	**0%**	**0%**	**0%**	**0%**	**13%**	**9%**

[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.

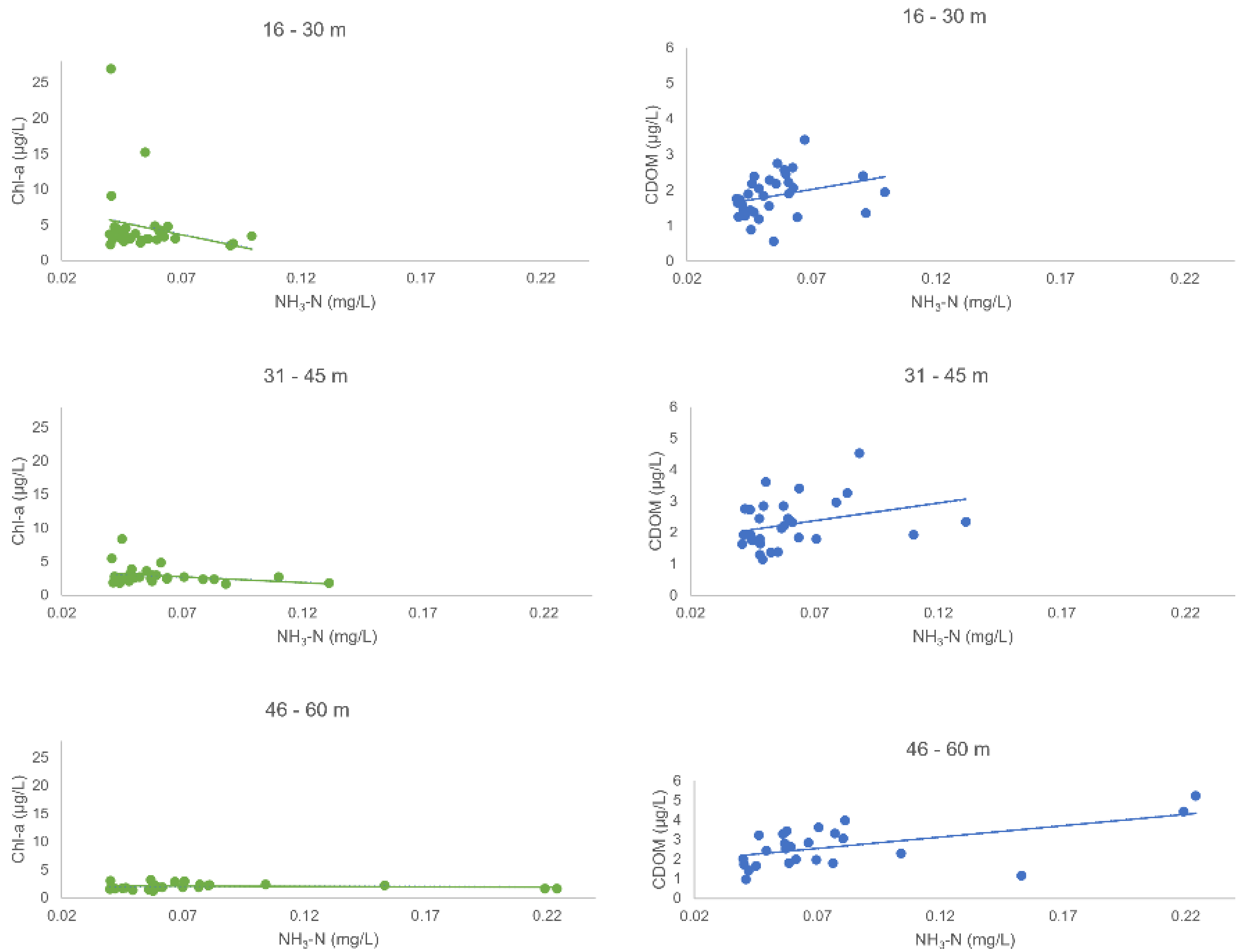


Figure 3-4 Linear regression plots of detectable ammonia nitrogen (NH_3-N) versus chlorophyll-*a* (left column) and colored dissolved organic matter (CDOM) (right column) by 15-m depth bins for the 2022-23 Core monthly water quality cruises. Note: plots from 0–15 m were not included because NH_3-N measurements at that depth bin were all below the method detection limit of 0.04 mg/L.

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 for 2022-23 were lower than those of the 2018 Southern California Bight Regional Monitoring Program (Bight '18; Du et al. 2020), and nearly all station values were below applicable sediment quality guidelines. The following analytes either exceeded Bight '18 values or were outside of OC San historical ranges. Silver was comparatively higher than the Bight '18 value at Station 0 during all four quarters; however, the elevated silver values were well below the 3.70 µg/kg Effects Range-Median (ERM) threshold of biological concern (Long et al. 1995). Values outside of the historical range in the total phosphorus and total polycyclic aromatic hydrocarbons (∑PAH) analyses were observed at Station 0 during the fall and winter quarters; however, the values returned within historical ranges during the spring quarter. Moreover, the elevated values for ∑PAH were well below the 44,792 µg/kg ERM threshold of biological concern (Long et al. 1995). A value above the historical range for the polychlorinated biphenyls (∑PCB) analysis was observed at Station 0 during the winter quarter and exceeded the 180 µg/kg ERM threshold; however, in the following spring quarter that value returned within the observed historical range. The Benthic Response Index (BRI) value at Station 0 in the same winter quarter was low (Table 3-6), which demonstrated that the benthic community was not impacted by this exceedance. The single ∑PCB exceedance in the winter survey was not cause for concern as it is a known legacy contaminant with the Southern California Bight (Schiff 2000). There was no measurable sediment toxicity at any of the 11 quarterly stations monitored in the summer benthic survey (Table 3-5). 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 2022-23 program year compared to Effects Range-Median (ERM), regional, and historical values. ND = Not Detected; ZID = zone of initial dilution.

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	3.23	10.3	0.42	2.08	920	430	148.61	2.39	ND	5.14
9	59	2.92	5.4	0.46	1.13	780	350	16.84	1.47	ND	1.18
73	55	3.12	6.6	0.37	ND	960	390	62.82	3.29	0.31	8.95
77	60	3.09	10.0	0.36	3.25	840	380	33.47	1.49	ND	1.40
84	54	3.10	7.6	0.46	2.63	940	510	186.18	3.03	ND	8.67
85	57	3.05	5.4	0.49	1.68	1,100	570	139.52	3.25	ND	11.75
CON	59	3.18	7.0	0.38	1.73	1,300	540	19.44	2.88	ND	1.23
	Mean	**3.10**	**7.5**	**0.42**	**1.79**	**977**	**453**	**86.70**	**2.54**	**0.04**	**5.47**
Middle Shelf Zone 2, Within-ZID (51–90 m)											
0	56	3.08	9.8	0.52	2.15	1,100	370	200.10	4.90	0.83	26.47
4	56	3.06	8.4	0.32	1.95	880	490	21.30	1.73	ND	1.86
76	58	3.07	4.5	0.37	1.22	840	270	139.90	2.32	0.10	5.34
ZB	56	3.14	9.6	0.48	1.76	800	530	141.90	2.00	ND	9.26
	Mean	**3.09**	**8.1**	**0.42**	**1.77**	**905**	**415**	**125.80**	**2.74**	**0.23**	**10.73**
Quarter 2 (October–December)											
Middle Shelf Zone 2, Non-ZID (51–90 m)											
1	56	3.18	8.3	0.44	2.03	930	370	132.45	ND	ND	3.27
9	59	3.03	9.9	0.32	2.00	910	320	4.93	ND	ND	0.70
73	55	3.04	4.7	0.51	2.30	1,100	580	182.80	ND	ND	23.00
77	60	2.98	5.4	0.37	1.57	880	360	8.78	ND	ND	1.24
84	54	3.15	9.8	0.35	1.32	1,100	470	44.56	ND	ND	6.49
85	57	3.08	6.6	0.44	1.45	1,100	430	36.95	ND	ND	22.20
CON	59	3.17	7.6	0.38	1.27	1,000	440	12.98	ND	ND	1.29
	Mean	**3.09**	**7.5**	**0.40**	**1.71**	**1,003**	**424**	**60.50**	**0.00**	**0**	**8.31**

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 2022-23 program year compared to Effects Range-Median (ERM), regional, and historical values. ND = Not Detected; ZID = zone of initial dilution.

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	3.02	8.3	0.60	3.92	2,700	490	3,189.67	ND	ND	21.06
4	56	2.99	8.0	0.44	1.55	920	270	9.77	ND	ND	1.50
76	58	3.03	5.7	0.38	1.86	890	350	120.44	ND	ND	2.74
ZB	56	3.00	5.7	0.33	2.75	900	400	14.43	ND	ND	2.45
	Mean	**3.01**	**6.9**	**0.44**	**2.52**	**1,352**	**378**	**833.60**	**0.00**	**0**	**6.94**
Quarter 3 (January–March) **Middle Shelf Zone 2, Non-ZID (51–90 m)**											
1	56	3.14	7.0	0.45	1.82	950	360	99.18	ND	ND	5.75
9	59	2.98	5.7	0.36	1.90	820	450	10.98	ND	ND	1.06
73	55	3.02	7.8	0.51	2.38	1,400	360	132.01	ND	ND	9.78
77	60	3.04	9.3	0.38	2.83	870	360	18.10	ND	ND	0.97
84	54	3.12	8.7	0.40	2.41	970	340	217.52	ND	ND	7.14
85	57	3.03	5.9	0.44	1.87	1,100	310	108.51	ND	ND	12.13
CON	59	3.13	6.5	0.40	2.24	730	430	12.43	ND	ND	1.34
	Mean	**3.07**	**7.3**	**0.42**	**2.21**	**977**	**373**	**85.50**	**0.00**	**0**	**5.45**
Middle Shelf Zone 2, Within-ZID (51–90 m)											
0	56	2.78	5.2	0.97	3.76	2,900	580	2,276.53	ND	ND	343.17
4	56	2.96	5.1	0.35	3.06	830	300	12.21	ND	ND	1.65
76	58	3.07	7.9	0.39	2.73	1,000	280	30.28	ND	ND	2.49
ZB	56	3.04	7.2	0.49	2.58	830	420	68.72	ND	ND	4.22
	Mean	**2.96**	**6.4**	**0.55**	**3.03**	**1,390**	**395**	**596.90**	**0.00**	**0**	**87.88**

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 2022-23 program year compared to Effects Range-Median (ERM), regional, and historical values. ND = Not Detected; ZID = zone of initial dilution.

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	3.24	9.8	0.43	4.22	1,000	420	93.45	ND	ND	4.56
9	59	2.98	9.7	0.34	2.96	890	390	11.22	ND	ND	0.97
73	55	3.19	13.2	0.50	2.86	1,300	450	214.63	ND	ND	12.54
77	60	3.03	10.8	0.38	3.81	830	280	62.47	ND	ND	0.95
84	54	3.13	9.2	0.48	3.28	1,100	600	46.17	ND	ND	5.19
85	57	3.08	8.8	0.48	3.34	1,100	300	122.39	ND	ND	50.75
CON	59	3.22	11.6	0.38	4.25	910	440	10.53	ND	ND	0.90
	Mean	**3.12**	**10.4**	**0.43**	**3.53**	**1,019**	**411**	**80.10**	**0.00**	**0**	**10.84**
Middle Shelf Zone 2, Within-ZID (51–90 m)											
0	56	3.01	7.5	0.41	3.17	1,400	460	307.44	ND	ND	11.22
4	56	3.07	10.8	0.34	2.66	870	400	90.55	ND	ND	1.75
76	58	3.08	10.2	0.38	2.28	920	300	17.59	ND	ND	2.17
ZB	56	3.08	7.8	0.51	3.86	890	420	126.17	ND	ND	2.25
	Mean	**3.06**	**9.1**	**0.41**	**2.99**	**1,020**	**395**	**135.40**	**0.00**	**0**	**4.35**

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 2022-23 program year compared to Effects Range-Median (ERM), regional, and historical values. ND = Not Detected; ZID = zone of initial dilution.

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	3.34	15.2	0.43	2.03	860	330	35.30	1.73	ND	4.10
5	59	3.36	9.4	0.44	2.55	840	380	52.94	1.20	0.40	1.95
10	62	3.51	8.8	0.42	1.52	860	480	18.75	2.06	0.50	4.96
12	58	2.86	5.2	0.38	1.79	780	410	11.09	1.04	0.60	0.47
13	59	3.42	8.3	0.42	1.62	790	88	23.83	1.82	0.40	1.49
37	56	2.11	4.9	0.29	1.41	530	110	9.63	0.81	ND	0.32
74	57	3.22	12.2	0.44	1.79	950	91	130.37	1.27	0.50	11.00
75	60	3.05	7.3	0.37	1.96	820	65	48.09	0.84	0.40	1.47
78	63	3.03	6.3	0.35	1.81	870	420	15.41	0.94	ND	1.01
86	57	3.18	8.2	0.46	1.53	820	390	122.03	1.72	ND	4.09
87	60	3.11	8.2	0.37	1.63	740	290	18.50	1.05	ND	1.92
	Mean	**3.11**	**8.5**	**0.40**	**1.79**	**805**	**278**	**44.20**	**1.32**	**0.25**	**2.98**
Sediment Quality Guidelines											
ERM		—	—	—	—	—	—	44,792.0	46.10	—	180.00
Regional Bight ′18 Summer Values (area weighted mean)											
Middle Shelf		—	35.0	0.74			600	67	13		4.3
OC San Historical Values (July 2012–June 2022) [mean (range)]											
Middle Shelf Zone 2, Non-ZID		3.36 (2.38–5.41)	17.92 (4.0–87.01)	0.38 (0.14–2.70)	4.25 (ND–198)	906.3 (360–2,000)	394.3 (ND–2,100)	77.6 (2.7–1,713.9)	1.76 (ND–52.90)	0.18 (ND–36.26)	3.67 (ND–244.30)
Middle Shelf Zone 2, Within-ZID		3.23 (2.92–3.47)	13.23 (4.3–33.1)	0.39 (0.23–0.65)	3.21 (ND–19)	968.8 (490–2,200)	395.7 (90–610)	114.7 (6.5–758.3)	1.87 (ND–58.25)	0.43 (ND–21.40)	3.63 (ND–34.20)

Table 3-4 Metal concentrations (mg/kg) in sediment samples collected at each quarterly and annual station sampled during the 2022-23 program year compared to Effects Range-Median (ERM), regional, and historical values. ZID = zone of initial dilution.

Station	Depth (m)	Al	Sb	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	7,990.33	0.08	3.19	40.1	0.27	0.19	18.4	9.12	14,624.78	6.89	0.02	22.50	2.11	0.14	40.4
9	59	6,766.46	0.05	2.88	30.7	0.23	0.09	15.5	5.21	13,825.92	4.71	0.01	6.80	1.56	0.06	32.8
73	55	7,739.85	0.08	3.58	39.8	0.27	0.31	18.6	10.70	14,694.73	6.85	0.05	8.06	1.82	0.16	43.2
77	60	7,633.53	0.06	2.98	33.4	0.27	0.09	16.9	5.90	14,612.99	5.37	0.03	7.89	1.99	0.07	36.3
84	54	7,925.82	0.07	3.99	38.9	0.27	0.22	18.2	8.33	14,914.09	6.63	0.02	8.49	2.36	0.14	41.5
85	57	7,431.50	0.07	3.38	35.3	0.27	0.29	20.5	10.40	14,458.08	6.63	0.06	7.94	1.96	0.23	41.6
CON	59	8,311.90	0.08	2.95	52.9	0.27	0.09	18.1	6.68	14,911.36	6.46	0.01	8.70	2.10	0.07	37.4
	Mean	**7,685.63**	**0.07**	**3.28**	**38.7**	**0.26**	**0.18**	**18.03**	**8.05**	**14,577.42**	**6.22**	**0.03**	**10.05**	**1.99**	**0.12**	**39.03**
Middle Shelf Zone 2, Within-ZID (51–90 m)																
0	56	7,458.39	0.08	3.80	36.4	0.26	0.37	21.3	15.30	14,408.16	7.33	0.04	8.20	1.76	0.21	43.0
4	56	7,926.76	0.07	3.07	37.4	0.29	0.12	17.7	6.60	15,036.25	6.12	0.01	8.11	1.94	0.08	39.6
76	58	8,008.91	0.06	3.17	37.5	0.29	0.12	17.5	6.98	15,875.10	5.97	0.01	8.17	2.28	0.08	40.5
ZB	56	8,343.38	0.06	5.23	39.3	0.28	0.14	18.1	7.19	16,916.86	5.63	0.01	8.60	1.85	0.08	42.4
	Mean	**7,934.36**	**0.07**	**3.82**	**37.6**	**0.28**	**0.19**	**18.65**	**9.02**	**15,559.09**	**6.26**	**0.02**	**8.27**	**1.96**	**0.11**	**41.38**
Quarter 2 (October–December)																
Middle Shelf Zone 2, Non-ZID (51–90 m)																
1	56	7,224.37	0.08	2.71	39.8	0.25	0.15	17.5	8.74	14,468.54	6.48	0.03	7.88	1.48	0.13	39.1
9	59	6,694.80	0.06	2.99	30.6	0.24	0.11	15.7	5.96	13,774.54	4.80	0.01	7.30	1.29	0.08	34.5
73	55	7,369.79	0.09	3.33	38.8	0.25	0.31	19.9	11.30	14,958.32	7.57	0.03	8.00	1.50	0.19	43.0
77	60	7,350.13	0.07	2.89	33.1	0.26	0.10	16.5	6.33	15,054.04	5.38	0.01	7.62	1.42	0.08	37.6
84	54	7,196.63	0.08	3.24	38.3	0.25	0.26	18.9	10.20	14,277.70	6.71	0.16	8.26	1.28	0.14	41.5
85	57	7,125.61	0.08	3.28	35.8	0.25	0.25	19.2	9.12	14,772.41	6.37	0.02	8.06	1.50	0.14	41.8
CON	59	7,920.17	0.09	2.99	47.6	0.25	0.10	18.1	6.85	15,629.62	5.99	0.01	8.73	1.45	0.07	38.0
	Mean	7,268.79	0.08	3.06	37.7	0.25	0.18	17.97	8.36	14,705.02	6.19	0.04	7.98	1.42	0.12	39.36

Table 3-4 Metal concentrations (mg/kg) in sediment samples collected at each quarterly and annual station sampled during the 2022-23 program year compared to Effects Range-Median (ERM), regional, and historical values. ZID = zone of initial dilution.

Station	Depth (m)	Al	Sb	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Se	Ag	Zn
Middle Shelf Zone 2, Within-ZID (51–90 m)																
0	56	7,259.54	0.08	4.95	38.4	0.26	0.41	26.5	20.40	15,086.04	9.22	0.05	8.54	1.39	0.26	49.1
4	56	7,056.99	0.07	3.68	34.9	0.25	0.13	16.9	6.61	14,513.51	5.57	0.01	7.65	1.40	0.09	38.3
76	58	7,658.03	0.07	3.23	36.8	0.27	0.13	17.2	6.97	15,697.20	5.33	0.02	7.94	1.48	0.10	40.8
ZB	56	7,415.54	0.07	4.05	36.2	0.25	0.15	17.2	6.61	15,414.64	5.26	0.07	8.17	1.21	0.07	39.5
	Mean	**7,347.52**	**0.07**	**3.98**	**36.6**	**0.26**	**0.20**	**19.45**	**10.15**	**15,177.85**	**6.34**	**0.04**	**8.08**	**1.37**	**0.13**	**41.92**
Quarter 3 (January–March) Middle Shelf Zone 2, Non-ZID (51–90 m)																
1	56	7,510.00	0.07	3.43	40.6	0.27	0.16	18.5	8.58	15,010.00	6.67	0.02	8.11	1.68	0.13	40.9
9	59	7,067.00	0.06	3.12	31.4	0.26	0.10	16.7	6.08	14,580.00	5.35	0.01	7.44	1.44	0.07	36.2
73	55	7,364.00	0.08	3.52	36.1	0.27	0.35	22.0	10.40	15,100.00	6.80	0.03	8.42	1.58	0.19	44.2
77	60	7,099.00	0.07	2.93	38.8	0.27	0.13	17.4	6.52	14,390.00	5.60	0.01	7.81	1.65	0.09	37.6
84	54	7,517.00	0.07	3.39	38.5	0.27	0.22	18.3	8.73	15,000.00	6.16	0.02	8.12	1.51	0.13	41.3
85	57	7,039.00	0.07	3.49	33.0	0.25	0.23	18.2	7.88	14,610.00	5.91	0.02	7.53	1.54	0.13	40.1
CON	59	8,305.00	0.09	2.99	48.4	0.27	0.10	18.1	6.78	16,080.00	6.12	0.02	8.57	1.58	0.08	39.8
	Mean	**7,414.43**	**0.07**	**3.27**	**38.1**	**0.27**	**0.18**	**18.46**	**7.85**	**14,967.14**	**6.09**	**0.02**	**8.00**	**1.57**	**0.12**	**40.01**
Middle Shelf Zone 2, Within-ZID (51–90 m)																
0	56	7,331.00	0.12	4.06	35.5	0.28	0.47	26.9	18.30	14,210.00	10.50	0.04	8.12	1.45	0.27	45.1
4	56	7,184.00	0.08	4.12	32.6	0.27	0.13	17.4	6.02	15,300.00	5.56	0.01	7.58	1.53	0.07	38.7
76	58	7,552.00	0.06	2.94	33.3	0.28	0.12	17.3	7.14	15,950.00	5.11	0.02	7.87	1.51	0.09	40.1
ZB	56	7,186.00	0.07	2.80	33.5	0.26	0.20	17.6	8.72	14,060.00	6.24	0.02	7.74	1.42	0.16	39.5
	Mean	**7,313.25**	**0.08**	**3.48**	**33.7**	**0.27**	**0.23**	**19.8**	**10.04**	**14,880.00**	**6.85**	**0.02**	**7.83**	**1.48**	**0.15**	**40.85**

Table 3-4 Metal concentrations (mg/kg) in sediment samples collected at each quarterly and annual station sampled during the 2022-23 program year compared to Effects Range-Median (ERM), regional, and historical values. ZID = zone of initial dilution.

Station	Depth (m)	Al	Sb	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	7,803.00	0.08	3.71	40.0	0.27	0.16	18.7	8.44	15,570.00	6.75	0.02	8.38	1.88	0.13	41.2
9	59	7,328.00	0.07	3.01	32.9	0.27	0.11	17.0	5.96	14,570.00	7.90	0.01	7.59	1.62	0.08	37.0
73	55	7,551.00	0.08	3.44	37.9	0.27	0.35	19.8	10.10	14,900.00	7.20	0.02	8.12	1.40	0.17	44.3
77	60	7,645.00	0.07	3.01	35.2	0.27	0.11	16.7	6.16	15,130.00	5.47	0.01	7.46	1.49	0.08	39.1
84	54	7,899.00	0.09	3.52	41.9	0.28	0.27	19.1	8.80	15,570.00	8.90	0.04	8.38	1.67	0.57	45.6
85	57	7,357.00	0.08	3.16	35.6	0.27	0.32	18.9	9.53	14,970.00	7.66	0.02	7.82	1.60	0.70	42.2
CON	59	8,059.00	0.09	3.09	48.7	0.27	0.10	18.3	6.63	15,570.00	6.09	0.01	8.65	1.78	0.07	39.3
	Mean	7,663.14	0.08	3.28	38.9	0.27	0.20	18.36	7.95	15,182.86	7.14	0.02	8.06	1.63	0.26	41.24
Middle Shelf Zone 2, Within-ZID (51–90 m)																
0	56	7,196.00	0.08	3.57	36.2	0.27	0.31	19.9	11.10	14,760.00	6.58	0.06	7.98	1.73	0.47	42.6
4	56	7,794.00	0.08	3.17	38.4	0.29	0.12	17.6	6.67	15,540.00	5.63	0.01	7.74	1.43	0.09	40.6
76	58	7,620.00	0.07	3.14	36.2	0.29	0.12	17.2	6.92	15,880.00	5.34	0.01	7.88	1.52	0.08	40.8
ZB	56	7,812.00	0.08	3.15	36.7	0.28	0.22	17.8	6.98	15,640.00	5.19	0.02	8.38	1.42	0.16	43.0
	Mean	**7,605.50**	**0.08**	**3.26**	**36.9**	**0.28**	**0.19**	**18.12**	**7.92**	**15,455.00**	**5.68**	**0.02**	**8.00**	**1.52**	**0.20**	**41.75**
Annual (July–September)																
Middle Shelf Zone 2, Non-ZID (51–90 m)																
3	60	8,486.49	0.06	2.97	37.9	0.28	0.12	18.4	7.42	16,140.66	5.87	0.04	8.27	1.94	0.10	41.3
5	59	8,354.34	0.06	3.03	46.9	0.27	0.14	18.0	7.71	15,092.60	6.38	0.02	8.62	1.74	0.13	40.6
10	62	7,730.52	0.07	3.51	49.3	0.26	0.15	18.6	8.19	15,385.56	6.38	0.02	8.86	1.84	0.12	39.9
12	58	7,431.93	0.08	3.12	33.2	0.27	0.11	16.0	5.51	14,543.48	5.57	0.01	8.06	1.75	0.07	35.5
13	59	7,440.20	0.07	3.32	49.1	0.24	0.12	18.5	6.97	14,503.28	5.83	0.01	8.22	1.59	0.09	37.4
37	56	6,859.33	0.06	2.79	34.1	0.23	0.12	12.5	4.68	11,711.44	5.09	0.01	7.10	1.34	0.04	31.6
74	57	7,323.38	0.11	3.54	39.3	0.30	0.22	17.5	7.75	14,721.34	5.96	0.01	7.95	2.00	0.15	39.8
75	60	6,893.24	0.06	3.71	35.3	0.24	0.16	16.0	6.17	14,223.40	4.83	0.01	7.41	1.64	0.08	37.0
78	63	6,952.21	0.06	2.68	31.6	0.25	0.09	16.5	5.95	14,233.39	5.12	0.01	7.28	1.75	0.07	34.4
86	57	6,756.94	0.06	3.08	38.6	0.25	0.18	17.6	8.91	13,811.81	5.72	0.21	7.46	1.70	0.23	38.9
87	60	8,062.44	0.06	3.28	39.7	0.29	0.09	17.4	6.59	15,762.75	5.41	0.01	8.13	2.26	0.08	39.2
	Mean	7,481.00	0.07	3.18	39.5	0.26	0.14	17.0	6.90	14,557.25	5.65	0.03	7.94	1.78	0.11	37.78
Sediment Quality Guidelines																
ERM		—	—	70.00	—	—	9.60	370.00	270.00	—	218.00	0.71	51.6	—	3.70	410.0

Table 3-4 Metal concentrations (mg/kg) in sediment samples collected at each quarterly and annual station sampled during the 2022-23 program year compared to Effects Range-Median (ERM), regional, and historical values. ZID = zone of initial dilution.

Station	Depth (m)	Al	Sb	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Hg	Ni	Se	Ag	Zn
Regional Bight '18 Summer Values (area weighted mean)																
Middle Shelf		9600	1.2	4.4	170.0	0.38	0.56	28.0	6.80	19,000	6.40	0.05	12.0	0.75	0.08	45.0
OC San Historical Values (July 2012–June 2022) [mean (range)]																
Middle Shelf Zone 2, Within-ZID		7,286.09 (2,100-12,800)	0.06 (0.00-0.69)	3.26 (2.07-4.90)	35.95 (25.7-117)	0.27 (0.2-0.45)	0.27 (0.08-0.89)	21.16 (15.9-98.4)	11.61 (6.16-119)	14,667.59 (4,460-21,400)	6.38 (2.68-71.2)	0.05 (0.01-1.13)	9.35 (7.28-35)	1.00 (0-2.47)	0.22 (0.06-7.0)	42.71 (35.30-65.6)
Middle Shelf Zone 2, Non-ZID		7,616.13 (2,120-22,504)	0.06 (0-5.12)	3.04 (1.56-9.6)	38.38 (22.9-202)	0.46 (0.12-95.2)	0.25 (0.06-8.78)	20.37 (5.65-95)	9.67 (4.13-45.5)	14,839 (4,310-35,228)	5.80 (2.79-21.8)	0.02 (0.01-1.23)	9.46 (3.54-26.8)	0.95 (0-8.88)	0.18 (0.03-5.46)	41.86 (20-132)

Table 3-5 Whole-sediment *Eohaustorius estuarius* (amphipod) toxicity test results at select outfall-depth stations for the 2022-23 program year. The home sediment represents the control; within-ZID stations are indicated by an asterisk. N/A = Not Applicable.

Station	Percent Survival	Percent of Home	p-value	Assessment
home	100	N/A	N/A	N/A
0 *	98	98	0.50	Nontoxic
1	100	100	0.92	Nontoxic
4 *	97	97	0.28	Nontoxic
9	100	100	0.92	Nontoxic
73	97	97	0.25	Nontoxic
76 *	94	94	0.01	Nontoxic
77	100	100	0.92	Nontoxic
84	98	98	0.50	Nontoxic
85	93	93	0.00	Nontoxic
CON	97	97	0.25	Nontoxic
ZB *	94	94	0.01	Nontoxic
ZB Dup *	97	97	0.28	Nontoxic

Biological Communities

Infaunal Communities

A total of 490 invertebrate taxa comprising 22,513 individuals were collected in the 2022-23 program year. Annelida (segmented worms) was the consistently dominant taxonomic group (Table B-10). Mean community measure values were comparable between within- and non-ZID stations, and all station values were within regional (Gillett et al. 2022) and OC San historical ranges in all surveys (Table 3-6). The infaunal community at all within-ZID and non-ZID stations in both surveys can be classified as reference condition based on their low (<25) Benthic Response Index (BRI) values and/or high (>60) Infaunal Trophic Index (ITI) values. The community composition at within-ZID stations was similar to that of 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. Infaunal communities were not degraded by the outfall discharge, and as such, compliance was met.

Epibenthic Macroinvertebrate Communities

A total of 53 epibenthic macroinvertebrate (EMI) species, comprising 18,574 individuals and a total weight of 163.5 kg, was collected from 20 trawls conducted in the 2022-23 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=9,032; 48.6% of total and having been collected at 19 of 20 stations). By contrast, *Strongylocentrotus fragilis* (sea urchin) was the leading species in respect to biomass (106.2 kg; 65% of total, and collected at 5 of 20 stations). 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 (Wisenbaker et al. 2021) and OC San historical ranges (Table 3-7). These results suggest that the outfall discharge had no adverse effect on the EMI community structure within the monitoring area. EMI communities within the monitoring area were not degraded by the outfall discharge, and compliance was met.

Fish Communities

A total of 41 fish taxa, comprising 25,210 individuals and a total weight of 355.2 kg, was collected from the monitoring area during the 2022-23 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 (Wisenbaker et al. 2021) and/or OC San historical ranges (Table 3-6). 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) (Figure 3-7). These results suggest compliance was met, because the outfall discharge had no adverse effect on the fish community structure within the monitoring area.

Table 3-6 Community measure values for each quarterly and annual station sampled during the 2022-23 infauna surveys, including regional and historical values.

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	113	399	4.07	37	79	16
9	59	93	320	4.03	36	74	14
73	55	67	311	3.52	20	78	16
77	60	106	388	4.07	34	76	16
84	54	97	567	3.74	25	75	15
85	57	84	380	3.71	25	76	20
CON	59	74	243	3.75	30	80	15
	Mean	**91**	**373**	**3.84**	**30**	**77**	**16**
Middle Shelf Zone 2, Within-ZID (51–90 m)							
0	56	89	390	3.85	27	82	15
4	56	87	286	3.83	33	77	13
76	58	83	283	4.01	33	81	13
ZB	56	106	490	4.06	32	77	12
	Mean	**91**	**362**	**3.94**	**31**	**79**	**13**
Quarter 2 (October–December)							
Middle Shelf Zone 2, Non-ZID (51–90 m)							
1	56	100	490	3.66	28	76	20
9	59	83	264	3.93	32	81	13
73	55	95	713	3.59	21	73	16
77	60	83	314	3.77	29	75	16
84	54	119	552	3.89	31	73	16
85	57	98	600	3.70	26	73	19
CON	59	85	401	3.52	22	76	15
	Mean	**95**	**476**	**3.72**	**27**	**75**	**16**
Middle Shelf Zone 2, Within-ZID (51–90 m)							
0	56	98	397	3.76	29	74	21
4	56	97	376	3.97	33	81	14
76	58	73	316	3.69	25	75	16
ZB	56	93	518	3.80	27	77	13
	Mean	**90**	**402**	**3.81**	**29**	**77**	**16**
Quarter 3 (January–March)							
Middle Shelf Zone 2, Non-ZID (51–90 m)							
1	56	93	603	3.60	23	74	14
9	59	57	140	3.62	23	77	13
73	55	96	484	3.82	28	80	15
77	60	88	435	3.74	26	78	18
84	54	70	331	3.25	17	75	16
85	57	93	532	3.64	22	78	16
CON	59	59	198	3.42	19	90	10
	Mean	**79**	**389**	**3.58**	**23**	**79**	**15**

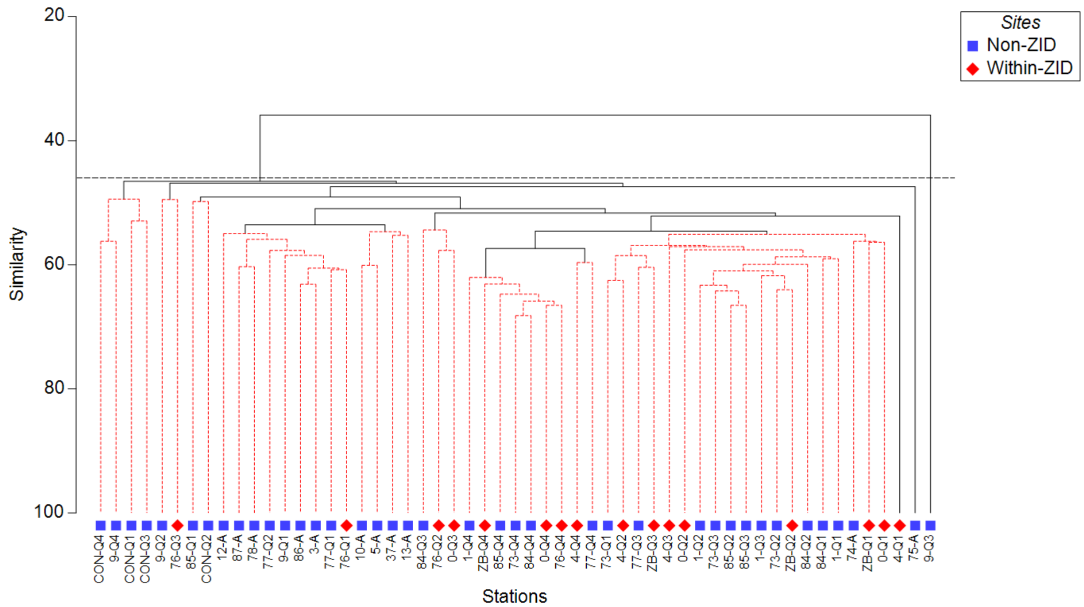
Table 3-6 **Community measure values for each quarterly and annual station sampled during the 2022-23 infauna surveys, including regional and historical values.**

Station	Depth (m)	Species Richness	Abundance	H′	SDI	ITI	BRI
Middle Shelf Zone 2, Within-ZID (51–90 m)							
0	56	72	269	3.65	25	79	17
4	56	76	325	3.56	23	77	18
76	58	77	249	3.80	30	82	14
ZB	56	79	368	3.69	24	81	15
	Mean	**76**	**303**	**3.68**	**26**	**80**	**16**
Quarter 4 (April–June)							
Middle Shelf Zone 2, Non-ZID (51–90 m)							
1	56	124	608	4.09	31	77	15
9	59	70	267	3.55	22	73	12
73	55	119	756	3.95	30	72	15
77	60	108	442	4.10	35	78	11
84	54	130	747	4.15	36	74	13
85	57	112	551	4.02	32	74	11
CON	59	59	234	3.47	17	79	16
	Mean	**103**	**515**	**3.90**	**29**	**75**	**13**
Middle Shelf Zone 2, Within-ZID (51–90 m)							
0	56	108	562	3.95	31	78	14
4	56	109	519	4.04	33	75	14
76	58	109	576	4.00	31	75	15
ZB	56	122	723	4.11	32	74	13
	Mean	**112**	**595**	**4.03**	**32**	**76**	**14**
Annual (July–September)							
Middle Shelf Zone 2, Non-ZID (51–90 m)							
3	60	96	377	4.02	32	78	13
5	59	81	297	3.76	25	79	15
10	62	79	260	3.96	33	82	11
12	58	96	273	4.17	40	79	10
13	59	76	219	3.96	33	82	14
37	56	113	371	4.25	46	80	16
74	57	106	434	4.01	33	78	13
75	60	80	305	3.87	29	75	13
78	63	82	233	3.88	32	84	11
86	57	100	402	3.93	33	75	10
87	60	111	430	4.10	36	78	12
	Mean	**93**	**327**	**3.99**	**34**	**79**	**13**

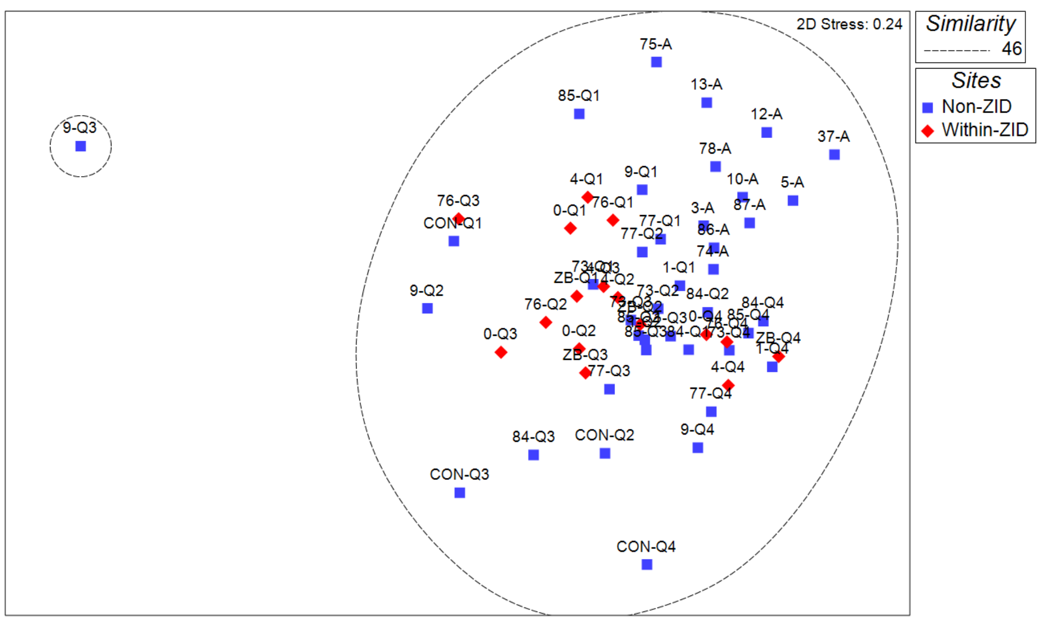
Table 3-6 Community measure values for each quarterly and annual station sampled during the 2022-23 infauna surveys, including regional and historical values.

Station	Depth (m)	Species Richness	Abundance	H′	SDI	ITI	BRI
Regional Bight '18 Summer Values [mean (range)]							
Middle Shelf		90 (45–6,427)	417 (68-1,150)	3.72 (2.90–4.20)	—	—	16 (5-28)
OC San Historical Values (July 2012–June 2022) [mean (range)]							
Middle Shelf Zone 2 Within-ZID		88 (50-138)	374 (88-782)	3.74 (3.15-4.68)	27 (14-76)	76 (45-91)	17 (8-27)
Middle Shelf Zone 2 Non-ZID		86 (20-142)	368 (90-1,080)	3.64 (2.24-4.31)	26 (6-45)	78 (40-95)	16 (8-45)

ZID = zone of initial dilution, H′ = Shannon-Wiener Diversity, SDI = Swartz's Dominance Index, ITI = Infaunal Trophic Index, BRI = Benthic Response Index

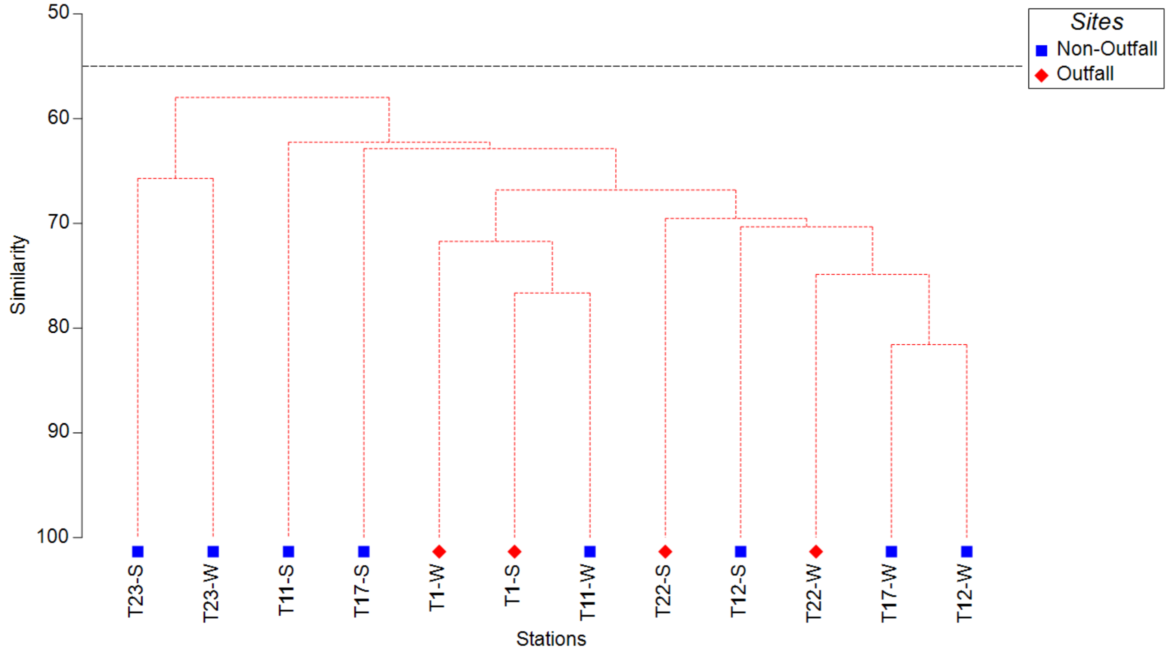


Stations connected by red dashed lines are not significantly different based on the SIMPROF test. Station labels also have a suffix for the quarter they were collected (e.g., CON-Q4); an A suffix denotes an annual station (collected during the summertime).

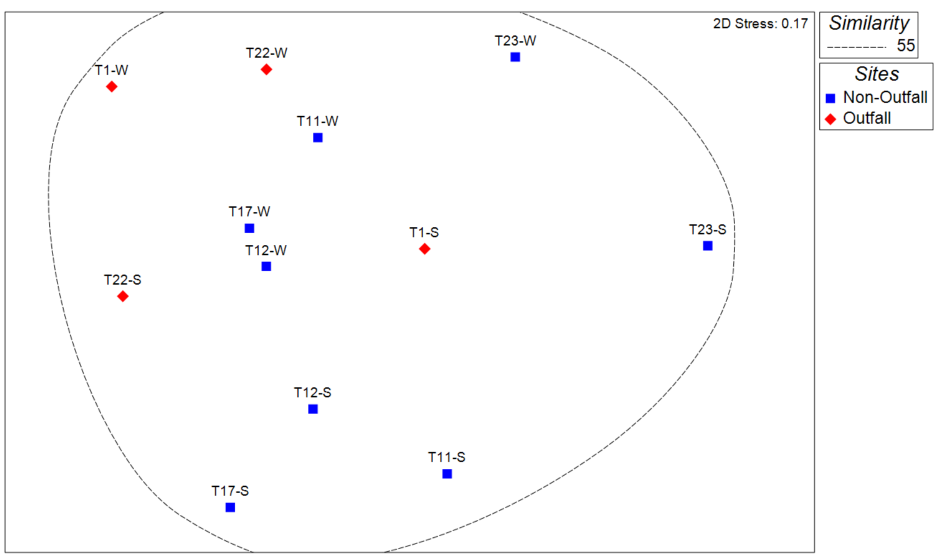


The two main clusters formed at a 46% similarity on the dendrogram are superimposed on the nMDS plot. Station labels also have a suffix for the quarter they were collected (e.g., CON-Q4); an A suffix denotes an annual station (collected during the summertime).

Figure 3-5 Dendrogram (top panel) and nMDS plot (bottom panel) of the infauna collected at within- and non-ZID stations along the Middle Shelf Zone 2 stratum for the 2022-23 program year.



Stations connected by red dashed lines are not significantly different based on the SIMPROF test.



The single cluster formed at a 55% similarity on the dendrogram is superimposed on the nMDS plot.

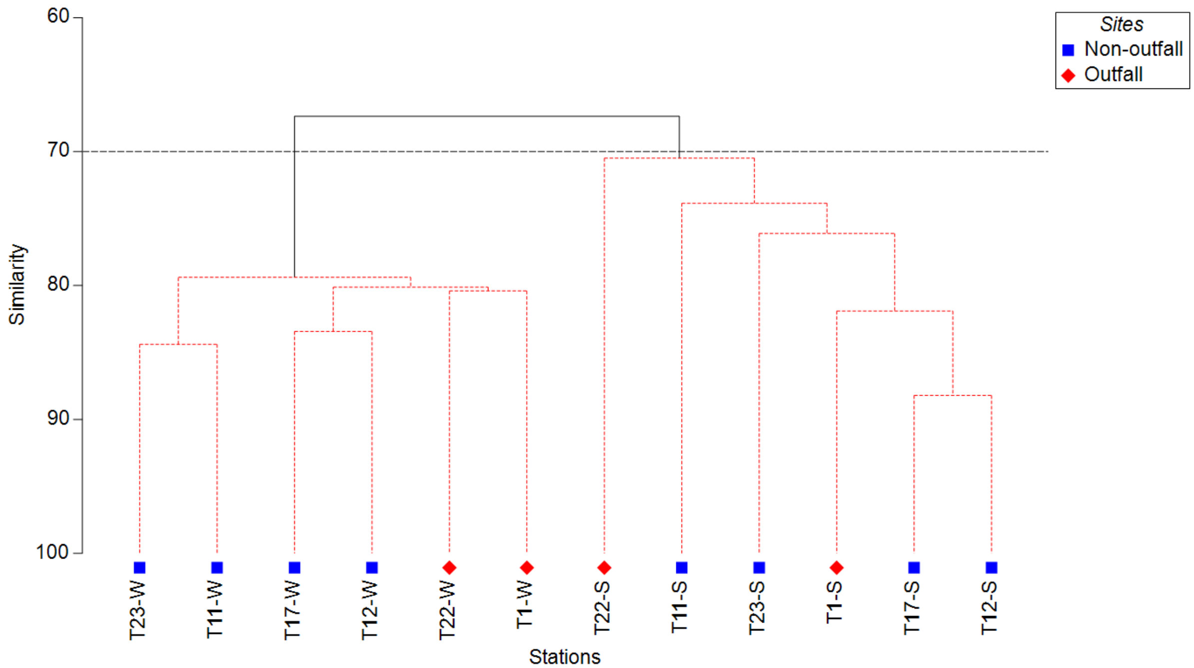
Figure 3-6 Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the epibenthic macroinvertebrates collected at outfall and non-outfall stations along the Middle Shelf Zone 2 stratum for the Summer 2022 (S) and Winter 2023 (W) trawl surveys.

Table 3-7 **Summary of epibenthic macroinvertebrate community measures for each semi-annual and annual (*) station sampled during the Summer 2022 and Winter 2023 trawl surveys, including regional and historical values.**

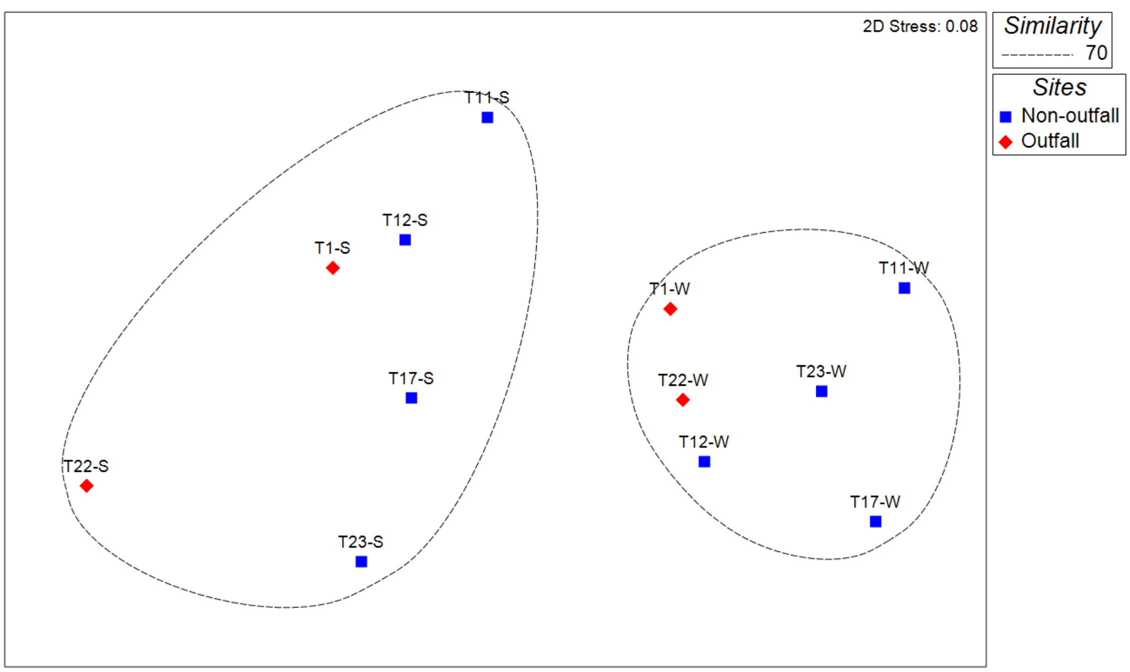
Season	Station	Depth (m)	Species Richness	Total Abundance	Biomass (kg)	H′	SDI
		Middle Shelf Zone 1 (31–50 m)					
Summer	T2*	35	13	1,146	2.12	0.22	1
	T24*	36	17	1,272	1.93	0.73	1
	T6*	36	12	1,564	2.02	0.75	1
	T18*	36	7	237	1.28	0.48	1
		Mean	**12**	**1,055**	**1.84**	**0.55**	**1**
		Middle Shelf Zone 2, Non-outfall (51–90 m)					
	T23	58	13	2,918	9.01	0.16	1
	T12	57	10	306	1.26	0.89	1
	T17	60	11	1,425	2.40	0.58	1
	T11	60	15	266	0.90	1.56	3
		Mean	**12**	**1,229**	**3.39**	**0.80**	**2**
		Middle Shelf Zone 2, Outfall (51–90 m)					
	T22	60	17	160	0.93	2.22	5
	T1	55	17	822	2.06	1.25	2
		Mean	**17**	**491**	**1.50**	**1.74**	**4**
		Outer Shelf (121–200 m)					
	T10*	137	9	1,149	65.05	0.31	1
	T25*	137	8	575	25.35	0.79	2
	T14*	137	13	601	24.00	0.89	2
	T19*	137	12	198	3.11	0.86	1
		Mean	**11**	**631**	**29.38**	**0.71**	**2**
		Middle Shelf Zone 2, Non-outfall (51–90 m)					
Winter	T23	58	15	4,264	13.80	0.27	1
	T12	57	11	292	2.39	1.49	3
	T17	60	15	180	1.84	1.91	4
	T11	60	20	388	1.36	1.93	4
		Mean	**15**	**1,281**	**4.85**	**1.40**	**3**
		Middle Shelf Zone 2, Outfall (51–90 m)					
	T22	60	21	398	1.78	1.92	4
	T1	55	24	413	0.88	2.13	4
		Mean	**23**	**406**	**1.33**	**2.03**	**4**
		Regional Bight '18 Summer Values [area-weighted mean (range)]					
Middle Shelf			10 (3–21)	208 (4–1,026)	2.40 (0.09–24.80)	1.16 (0.35–2.57)	—
Outer Shelf			13 (1–25)	2,299 (15–27,474)	27.00 (0.06–268.60)	1.17 (0–2.30)	—
		OC San Historical Values (July 2012–June 2022) [mean (range)]					
Middle Shelf Zone 1			12 (2–26)	765 (2–3,926)	1.02 (0.02–3.78)	1.01 (0.01–2.22)	2 (1–5)
Middle Shelf Zone 2, Non-outfall			11 (5–21)	562 (18–2,498)	1.73 (0.04–11.16)	1.2 (0.06–2.14)	3 (1–5)
Middle Shelf Zone 2, Outfall			13 (9–22)	412 (55–1,420)	1.31 (0.08–4.92)	1.38 (0.22–2.15)	3 (1–5)
Outer Shelf			9 (3–15)	268 (33–980)	7.49 (0.09–40.8)	0.98 (0.12–1.97)	2 (1–5)

Table 3-8 Summary of demersal fish community measures for each semi-annual and annual (*) station sample during the Summer 2022 and Winter 2023 trawl surveys, including regional and historical values.

Season	Station	Depth (m)	Species Richness	Total Abundance	Biomass (kg)	H′	SDI	FRI
	Middle Shelf Zone 1 (31–50 m)							
Summer	T2*	35	10	568	6.56	1.37	2	19
	T24*	36	11	599	5.02	1.61	3	22
	T6*	36	13	593	4.31	1.57	3	21
	T18*	36	8	1,004	6.27	0.37	1	21
		Mean	**11**	**691**	**5.54**	**1.23**	**2**	**21**
	Middle Shelf Zone 2, Non-outfall (51–90 m)							
	T23	58	13	434	9.06	1.08	2	22
	T12	57	12	1,900	43.38	1.47	3	16
	T17	60	12	1,339	11.62	1.20	2	16
	T11	60	15	1,327	17.66	0.99	1	20
		Mean	**13**	**1250**	**20.43**	**1.19**	**2**	**18**
	Middle Shelf Zone 2, Outfall (51–90 m)							
	T22	60	10	540	13.21	0.86	1	15
	T1	55	17	1,327	40.52	1.43	2	21
		Mean	**14**	**934**	**26.87**	**1.15**	**2**	**18**
	Outer Shelf (121–200 m)							
	T10*	137	20	1,208	25.77	1.83	4	30
	T25*	137	21	1,580	24.22	1.63	3	26
	T14*	137	19	1,655	24.37	1.48	3	24
	T19*	137	22	1,481	14.07	1.26	2	18
		Mean	**21**	**1,481**	**22.11**	**1.55**	**3**	**25**
	Middle Shelf Zone 2, Non-outfall (51–90 m)							
Winter	T23	58	19	1,762	24.94	1.49	2	20
	T12	57	15	1,520	21.48	1.62	3	21
	T17	60	15	1,545	15.27	1.61	3	20
	T11	60	18	2,294	21.05	1.41	2	16
		Mean	**17**	**1,780**	**20.69**	**1.53**	**3**	**19**
	Middle Shelf Zone 2, Outfall (51–90 m)							
	T22	60	16	1,473	14.36	1.44	2	18
	T1	55	16	1,061	12.08	1.71	3	16
		Mean	**16**	**1,267**	**13.22**	**1.58**	**3**	**17**
Regional Bight ’18 Summer Values [area-weighted mean (range)]								
Middle Shelf			13 (6–27)	392 (37–3,197)	6.10 (1.30–33.00)	1.49 (0.54–2.22)	—	22 (12–34)
Outer Shelf			12 (1–22)	328 (2–1,146)	10.2 (0.10–40.10)	1.44 (0–2.17)	—	25 (6–49)
OC San Historical Values (July 2012–June 2022) [mean (range)]								
Middle Shelf Zone 1			10 (2–14)	199 (54–445)	4.33 (0.66–14.63)	1.47 (0.56–2.1)	3 (1–5)	22 (16–27)
Middle Shelf Zone 2, Non-outfall			14 (7–25)	499 (45–2,736)	11.25 (1.25–55.85)	1.7 (0.89–2.2)	3 (1–6)	22 (11–34)
Middle Shelf Zone 2, Outfall			13 (2–18)	361 (110–802)	11.92 (2.47–46.27)	1.71 (0.67–2.18)	3 (1–6)	22 (11–32)
Outer Shelf			18 (4–25)	763 (27–1,610)	15.88 (0.96–39.19)	1.55 (0.74–2.07)	3 (1–4)	19 (3–45)



Stations connected by red dashed lines are not significantly different based on the SIMPROF test.



The two main clusters formed at a 70% similarity on the dendrogram are superimposed on the NMDS plot.

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 2022 (S) and Winter 2023 (W) trawl surveys.

FISH BIOACCUMULATION AND HEALTH

Demersal and Sport Fish Tissue Chemistry

Contaminant concentrations in composited liver tissue of Hornyhead Turbot and English Sole were similar between outfall and non-outfall locations (Table 3-9). Additionally, the contaminant concentrations in the composite samples were similar to the values from the 2021-22 program year.

Contaminant concentrations in composited muscle tissue of rockfishes were similar between outfall and non-outfall zones (Table 3-10). Moreover, the contaminant concentrations in the composite samples were similar to the values from the 2021-22 program year.

Among the composited muscle tissue of sport fish samples, the DDT, PCB and chlordane contaminant concentrations were all below the least restrictive seven 8-ounce servings per week advisory tissue level (ATL). There were four trace metal values that fell within more restrictive ATL ranges. Two mercury concentration values fell within the five 8-ounce servings per week ATL, and one mercury value fell within the two 8-ounce servings per week ATL (for women aged 18-45 and children age 1-17). For selenium, one value fell within the four 8-ounce servings per week ATL (Table 3-10 and Table A-9)

Of the contaminants measured in the Bight '18 survey, mercury concentrations in one or more target species exceeded the "consume not more than two servings per week" threshold in most fishing zones (McLaughlin et al. 2020). The 2022-23 monitoring results demonstrate that demersal fishes residing near the outfall are not more prone to bioaccumulation of contaminants than those fished regionally, and that human health risk from consuming demersal fishes captured in the monitored area is not elevated.

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 recorded in less than 1% of 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; Wisenbaker et al. 2021). 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 (outfall) and T11 (non-outfall). Among the seven types of tissue damage that were screened for in the serial tissue sections (see Appendix A), steatosis (fatty liver) was the most prevalent, ranging from 50–75% in the Hornyhead Turbot samples and 80–91% in the English Sole samples. The mean histopathology (health) score for Hornyhead Turbot was 0.29 at both stations, indicating comparable yet minimal tissue damage in the fish samples at both sites (Figure 3-8). While the mean histopathology scores for English Sole (0.40 at T1 and 0.37 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 two sites. The results of this analysis indicate negligible outfall-related effects on the health of demersal fishes in OC San's monitoring area.

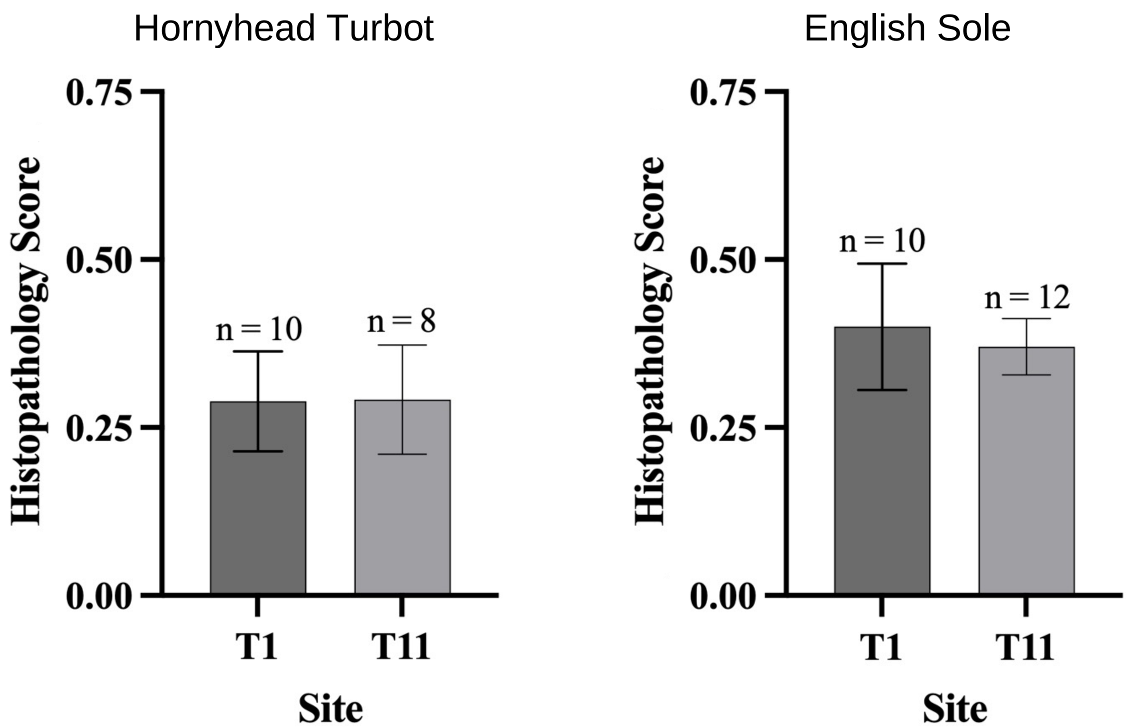


Figure 3-8 Histopathology score (mean and standard error) of liver tissue samples excised from Hornyhead Turbot and English Sole collected at outfall Station T1 and non-outfall Station T11 during the 2022-23 program year. Average scores were between zero and one, indicating minimal tissue damage.

CONCLUSION

The results of the bacterial, physical, and chemical parameters measured in the water column during the 2022-23 program year indicate good water quality in OC San's monitoring area. Additionally, the sediment quality was minimally impacted based on the relatively low concentrations of chemical contaminants measured in sediment samples and the absence of sediment toxicity in controlled laboratory tests. The benthic 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 indicate that the receiving environment was not impaired by OC San's discharge of treated wastewater.

SUMMARY OF NON-COMPLIANCE

All permit compliance criteria were met in the 2022-23 program year (Table 3-1).

Table 3-9 **Percent lipid and contaminant concentrations (ng/g) in composite liver samples of flatfishes collected in the Winter 2023 trawl surveys at Stations T1 (Outfall) and T11 (Non-outfall), including historical values (mean and range).**

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	2459128	10	149	3.54	71	11,800	1,240	361.30	70.50	1.00
	Outfall	2459243	10	155	5.90	59	10,700	2,480	116.60	78.20	3.00
Parophrys vetulus (English Sole)	Non-outfall	2459129	10	196	8.87	56	13,800	2,070	2335.00	329.10	1.30
	Outfall	2459244	10	220	6.61	66	15,900	2,620	1145.00	193.10	1.50
OC San Historical Values (August 2021-February 2022)											
Pleuronichthys verticalis (Hornyhead Turbot)	Non-outfall	—	2	169 (160-177)	7.05 (5.56-8.53)	53 (45-60)	15,300 (10,900-19,300)	1,355 (1,560-1,560)	319.10 (311.60-326.60)	84.65 (84.40-84.90)	1.00 (0.80-1.20)
	Outfall	—	1	165	5.35	96	9,460	2,300	93.70	53.60	2.10
Parophrys vetulus (English Sole)	Non-outfall	—	2	190 (186-193)	7.65 (5.10-10.20)	35 (33-37)	13,570 (8,840-18,300)	3,125 (2,750-3,500)	740.35 (359.10-1,121.60)	153.90 (134.90-172.90)	1.80 (1.20-2.40)
	Outfall	—	1	200	7.31	47	11,800	3,640	317.40	123.90	2.50

[a] The value given for the 2022-23 program year represents the number of individuals used for the composite sample; the historical value represents the number of composites.

Table 3-10 Percent lipid and contaminant concentrations (ng/g) in composite muscle tissue samples of sport fishes collected in Summer 2022 rig fishing surveys at Zones 1 (Outfall) and 3 (Non-outfall), including historical values (mean and range). ND = Not detected.

Zone	Species	Composite Sample Number	n [a]	Mean Standard Length (mm)	Percent Lipid	Mercury	Arsenic	Selenium	ΣDDT	ΣPCB	ΣChlordane
Non-Outfall	*Sebastes miniatus* (Vermilion Rockfish)	2420280	7	240	0.71	44	1,360	462	8.70	0.60	ND
	Sebastes paucispinis (Bocaccio)	2420277	3	285	0.43	76	374	490	5.20	ND	ND
Outfall	*Sebastes dallii* (Calico Rockfish)	2418825	1	159	1.35	25	1,630	1,780	4.00	0.40	0.20
	Sebastes miniatus (Vermilion Rockfish)	2420051	9	236	1.11	39	1,410	414	9.70	1.30	ND
OC San Historical Values (September 2021)											
Non-outfall	*Sebastes miniatus* (Vermilion Rockfish)	—	1	266	1.16	39	1,740	489	27.70	4.10	0.10
	Sebastes paucispinis (Bocaccio)	—	1	353	0.39	129	421	731	10.30	1.80	0.10
Outfall	*Sebastes dallii* (Calico Rockfish)		—	—	—	—	—	—	—	—	—
	Sebastes miniatus (Vermilion Rockfish)	—	1	271	0.88	42	3,090	581	5.10	1.10	ND

[a] The value given for the 2022-23 program year represents the number of individuals used for the composite samples; the historical value represents the number of composites.

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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. 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), smaller special studies, 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. SPS are proposed by OC San 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, special studies, and regional monitoring efforts. Updates on SPS and special studies may include information from prior program year(s) since some SPS and special studies may span multiple years.

STRATEGIC PROCESS STUDIES

For the 2022-23 program year, OC San had five SPS, three of which were designed to better understand potential impacts of the GWRS final expansion project on the quantity and quality of OC San's discharged effluent.

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 (i.e., GWRS) efforts. To evaluate the spatial extent and temporal variability of the discharge plume, OC San contracted SCCWRP in 2018 for a multi-stage study comprised of:

- Validating the simulations of OC San's discharge against observational data and conducting a model ensemble comparison with the Roberts-Snyder-Baumgartner plume model.
- Modeling the transport and fate of OC San's discharged effluent at progressive stages of the GWRS final expansion (Table 4-1)
- Modeling the seasonality of the plume distribution with varying ocean conditions between 1997 and 2016 (Table 4-2)
- Modeling the potential biogeochemical influence of land-based inputs on coastal processes.

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

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

Table 4-2 List of climate variability simulations.

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

El Niño Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), mixed layer depth (MLD), and North Pacific Gyre Oscillation (NPGO).

This SPS was initially designed to use 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 (ROMS) with the Biogeochemical Elemental Cycling (BEC) 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 SCCWRP-UCLA coupled ROMS-BEC model. Based on the uncertainty of the SCCWRP-UCLA coupled ROMS-BEC model, this SPS was modified to use 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. Future stages using the SCCWRP-UCLA coupled ROMS-BEC model, or a better prediction model, will commence upon satisfactory demonstration of the reliability and reproducibility of the coupled modeling tool.

OC San released a request for proposals on March 15, 2023, to procure a consultant to provide a technical review of SCCWRP's study design and deliverables for this SPS. Three bids were submitted on April 18, 2023. After a two-month evaluation process, Michael Baker International, Inc. (MBI) was awarded the contract on June 29, 2023. MBI will evaluate SCCWRP's model validation report in the second half of 2023.

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, different wastewater treatment technologies have been developed to improve the 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 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.

Evaluation of In-Vitro Cell Bioassay 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. While not all synthetic chemical mixtures pose an immediate threat to aquatic organisms, prolonged exposure to chemicals, such as endocrine disrupting compounds, can have harmful synergic effects on aquatic organisms. Similarly, many natural chemicals are essential to humans, but some, such as mercury and lead, can be harmful to aquatic life (Kortei, et al. 2020). Recent advancements in analytical tools have made it possible to detect chemicals at concentrations as low as part per quadrillion. However, these traditional instrumental approaches have their limitations (Snyder and Leusch 2018). For example, the instrumental approaches do not provide toxicology information, and chemicals can only be detected by instruments using either reference standards or more costly non-targeted analyses. To overcome these limitations, bioanalytical screening tools are used to evaluate and prioritize sites for continued monitoring. This SPS was developed to address current gaps of knowledge regarding CECs in OC San's coastal receiving environment using in-vitro cell bioassays. The study goals were to characterize the bioactivity of known and unknown CECs in wastewater and the receiving environment, to 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.

Influent, final effluent, seawater, and sediment samples were collected from May through July of 2019 at the following locations:

1) influent and final effluent at OC San Plant No. 2,
2) seawater at surface, subsurface based on maximum colored dissolved organic matter, and bottom or maximum of 100 m depth from three stations with increasing distance from the zone of initial dilution, and
3) marine sediment from eight stations within the monitoring area, including one reference station (CON) and three known depositional sites (44, C2, and C4) (Figure 4-1).

Aqueous and sediment samples were all processed and analyzed using three 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. Bioactivity in wastewater samples was primarily attributed to ERα chemical agonists measured in the influent (63.8%) and final effluent samples (21.9%), while less than 1% of the AhR bioassay equivalent concentrations contributed to the contaminants measured in this study. No cell bioassay activity was detected in any of the seawater samples collected from nearfield (near outfall) or farfield (non-outfall) stations across all depths. All sediment stations, except reference station CON, had measurable ERα and AhR bioactivity levels, although most values were relatively low, ranging from non-detect to 1.43 ng E2/g for ERα and non-detect to 1.7 ng TCDD/g for AhR. Stations C2, C4 and 44 had consistently higher ERα and AhR bioactivities above the pre-determined bioscreening threshold of 0.5 ng/g. Samples with bioactivity greater than the screening threshold underwent chemistry analysis. Bioactivity did not vary significantly among all sediment stations, with the exception of the historical deposition site (Station 44) for ERα and AhR. ERα signatures were highest at Station 44. For AhR bioactivity, stations in Newport Canyon and Station 44 had the highest bioactivity, while AhR bioactivity at discharge sites was similar to the reference station. No GR activity was detected in any sediment samples. The mass balance analysis revealed that the presence of targeted contaminants at the sediment stations could only explain a minimal percentage of the observed bioactivity, i.e. less than 6% for ERα and less than 1% for AhR.

This study resulted in one of the first datasets of in-vitro cell bioassay responses related to wastewater discharges in marine habitats. The results indicate that complementary measurements of targeted CECs could only partially explain the observed 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 preliminary screening 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.

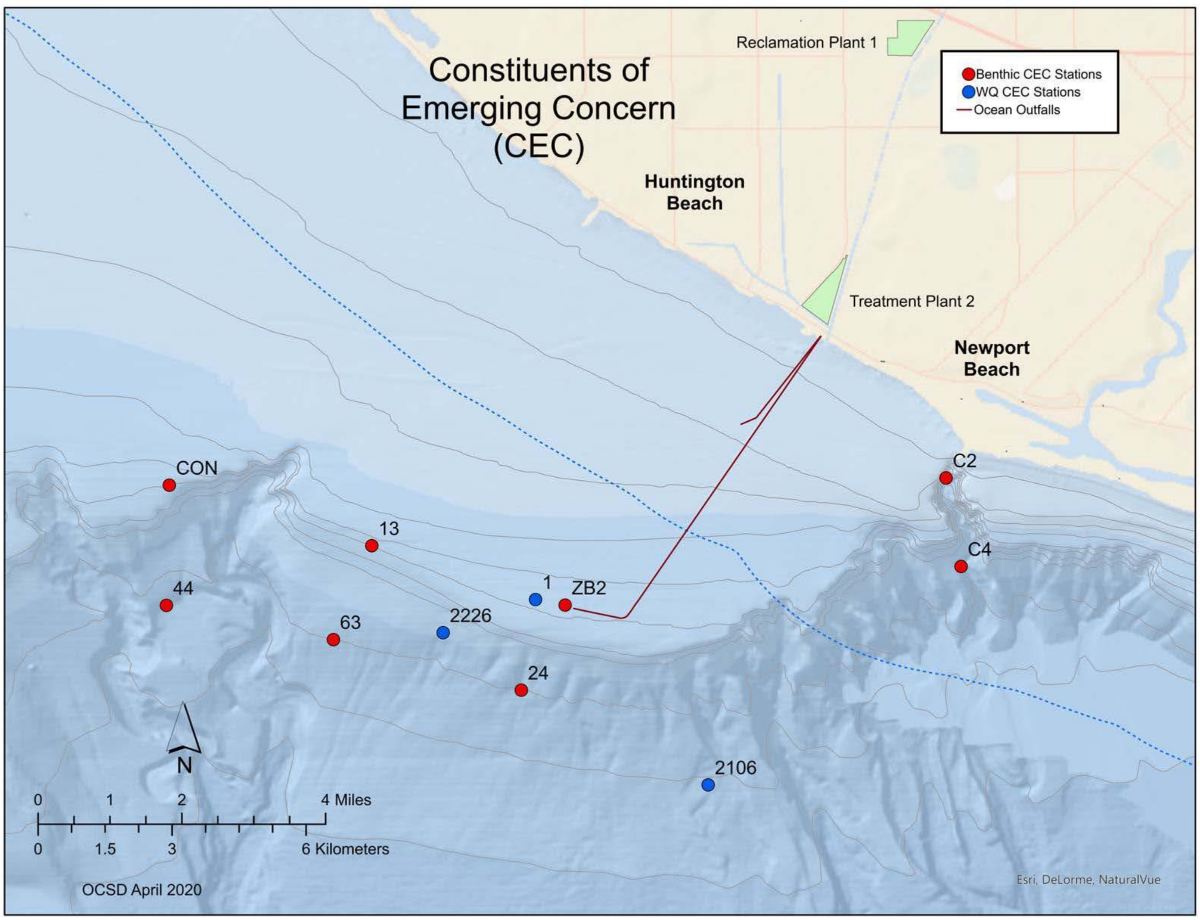

Figure 4-1 Benthic and sea water sampling stations for the cell bioassay study.

Sediment Linear Alkylbenzenes

Linear Alkylbenzenes (LABs) are a class of organic compounds that consist of linear alkyl chains attached to a benzene ring. They are used as raw materials 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 SPS 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 monitored 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 return flows from the GWRS final expansion may negatively affect marine biota in the receiving water. While meiofauna, which are sediment-dwelling 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 (FSU) 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 for this SPS.

In August and December 2022, a multicorer or box corer was used to collect three replicate sediment chemistry and meiofauna samples at four stations on the San Pedro Shelf (Figure 4-2). For the sediment chemistry samples, the three sediment cores were extruded, sliced in 0–1 cm (0–0.4 in), 1–3 m (0.4–1.2 in) and 3–5 cm (1.2–2.0 in) sections, and combined into a single sample. Sediment from each composite sample was transferred into containers using a stainless-steel scoop and kept on wet ice in the field. For the meiofauna samples, each sediment core was extruded, sliced in 0–1 cm, 1–3 m, and 3–5 cm sections, and preserved separately in DESS preservative in HDPE Nalgene bottles. Samples were transported to OC San's Laboratory where they were logged into the Laboratory Information Management System. Meiofauna samples were subsequently shipped to FSU whereas sediment chemistry samples were stored at OC San's Laboratory for further processing. Identification of meiofauna samples and analysis of grain size and concentrations of total organic carbon, total nitrogen, total phosphorus, dissolved sulfides, metals, and persistent organic pollutants in the sediment samples are currently underway.

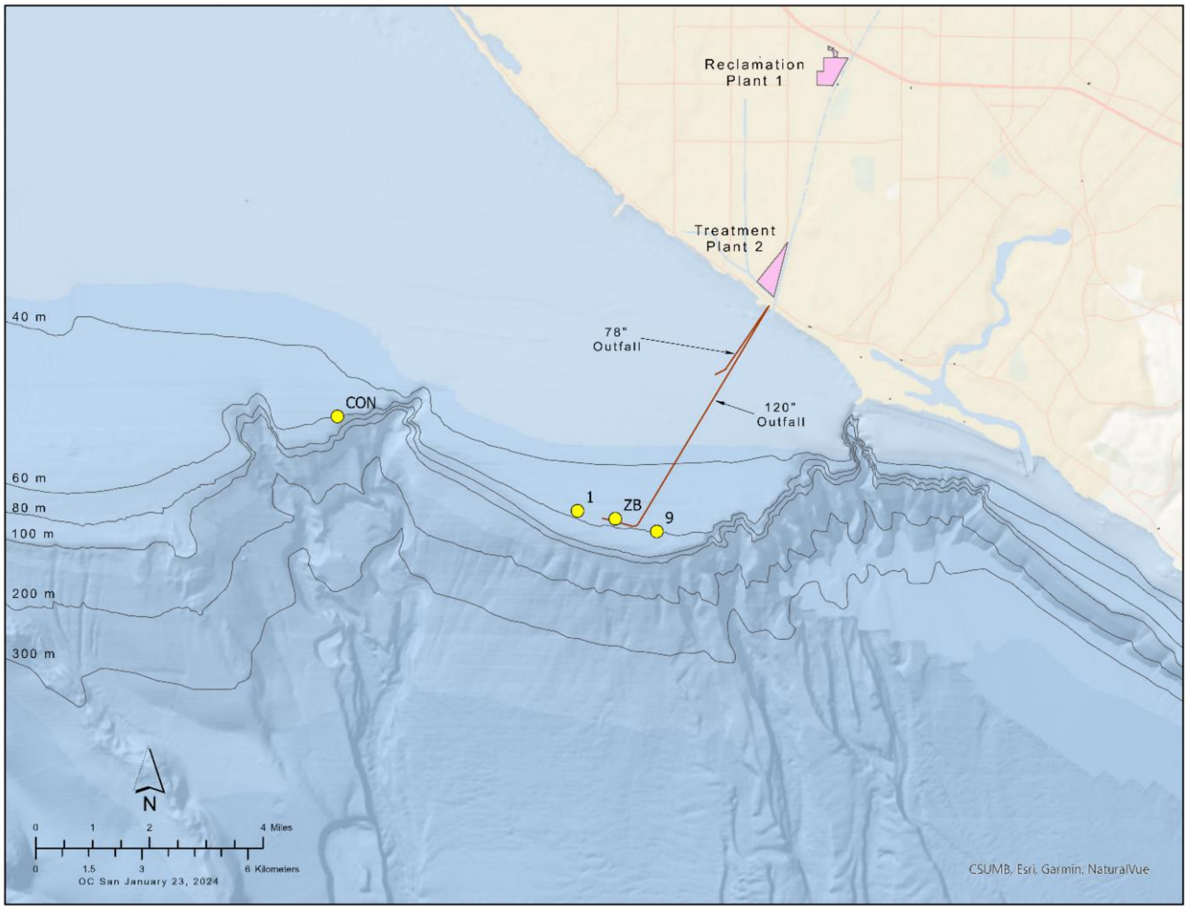

Figure 4-2 Benthic sampling stations for the meiofauna baseline study.

SPECIAL STUDIES

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 2022-23 program year, OC San targeted 14 pharmaceuticals and personal care products (PPCPs), seven hormones, seven industrial endocrine disrupting compounds (IEDCs), six pesticides and insecticides, four polybrominated diphenyl ether (PBDE) flame retardants and three organophosphate esters flame retardants, and 12 per- and polyfluoroalkyl substances (PFAS) in the final effluent for this special study (Table 4-3).

Table 4-3 Contaminants of emerging concern monitored in OC San's final effluent.

	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	Galaxolide	Sulfmethoxazole
DEET	Gemfibrozil	Triclosan
Diclofenac	Ibuprofen	
	Flame Retardants	
BDE-47	BDE-183	TCEP
BDE-99	BDE-100	TCPP
		TDCPP
	Pesticides and Insecticides	
Fipronil	Bifenthrin	Chloropyrifos
Fipronil Sulfone	Total Permethrin	Diazinon
	Per- and Polyfluoroalkyl Substances	
PFDA	PFNA	PFUnDA
PFDoA	PFOA	PFBS
PFHxA	PFTeDA	PFHxS
PFHpA	PFTrDA	PFOS

Pharmaceuticals and Personal Care Products

One final effluent sample was collected in August 2022 and analyzed using the Modified EPA Method 1694 for various classes of PPCPs, including analgesics (acetaminophen and ibuprofen), anti-inflammatory (diclofenac), antibiotics (erythromycin and sulfamethoxazole), antiseptic (triclosan), anticonvulsant drugs (carbamazepine and primidone), antidepression drug (fluoxetine hydrochloride), lipid-regulating drug (gemfibrozil), insect repellant (DEET), stimulant (caffeine), sunscreen (oxybenzone), and synthetic musk (galaxolide).The analysis revealed the presence of all 14 PPCPs in the sample. Galaxolide had the highest concentration measured at 7,500 ng/L, followed by gemfibrozil, diclofenac, caffeine, and sulfamethoxazole measured at 860 ng/L, 790 ng/L, 790 ng/L and 750 ng/L, respectively (Figure 4-3). The third highest concentration group were carbamazepine, DEET, primidone, ibuprofen, and erythromycin, ranging from 110 ng/L to 310 ng/L. The concentration of the remaining PPCPs was comparatively lower, with concentrations ranging from 11 ng/L to 77 ng/L.

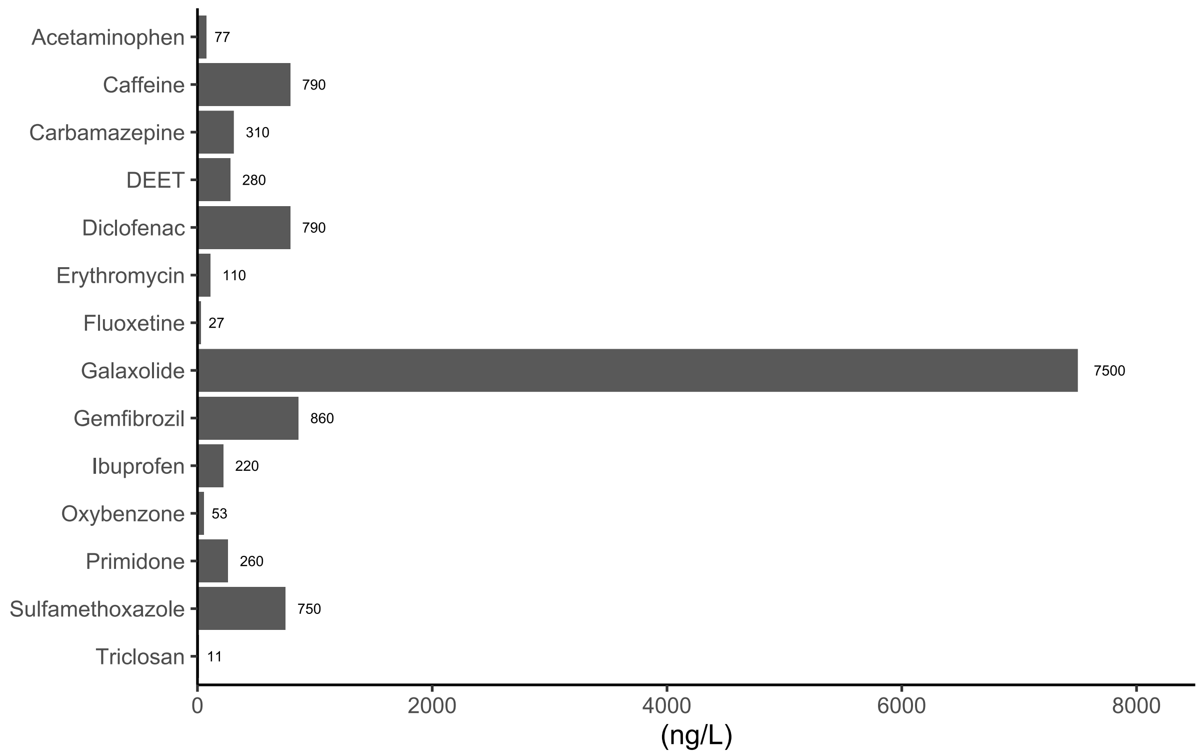

Figure 4-3 Pharmaceuticals and personal care products analyzed in a final effluent sample collected in August 2022.

Hormones

Two final effluent samples were collected over the course of the 2022-23 program year - one sample was collected in November 2022 and the other in March 2023. Both samples were analyzed by isotope dilution using tandem liquid chromatography-mass spectrometry (LC-MS/MS). Three out of the 7 hormones measured in November 2022 were detected (Figure 4-4), with concentrations ranging from 7.4 ng/L (estriol) to 76.8 ng/L (estrone). 17α-estradiol, 17α-ethinyl estradiol, progesterone, and testosterone were not detected in any sample. Four hormones were detected at concentrations ranging from 1.23 ng/L (17α-ethinyl estradiol) to 190 ng/L (estrone) in the March 2023 sample,

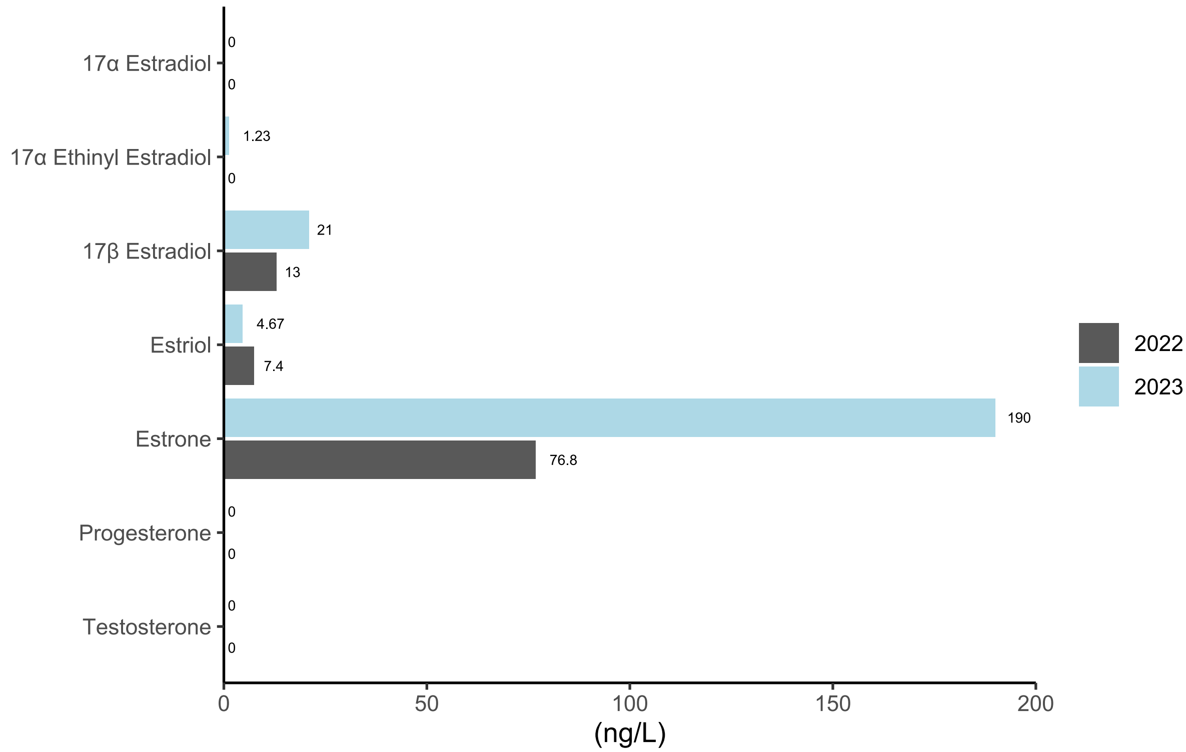

Figure 4-4 Hormones analyzed in a final effluent sample collected in November 2022 and March 2023, where 0=ND.

Industrial Endocrine Disrupting Compounds

One final effluent was collected in October 2022 and analyzed for alkylphenols and alkylphenol ethoxylates based on the American Society for Testing and Material (ASTM) D7065 Method using tandem gas chromatography-mass spectrometry (GC-MS/MS). Bisphenol A was not detected in the sample (Figure 4-5). Similarly, 4-para-Nonylphenol was found to be below the reportable limit. On the other hand, Nonylphenol monoethoxylate was detected in the sample with a concentration of 2,100 ng/L, whereas Nonylphenol diethoxylate and 4-tert-Octylphenol were measured at 1,200 ng/L and 970 ng/L, respectively. Octylphenol monoethoxylate and Octylphenol diethoxylate were not detected in the sample.

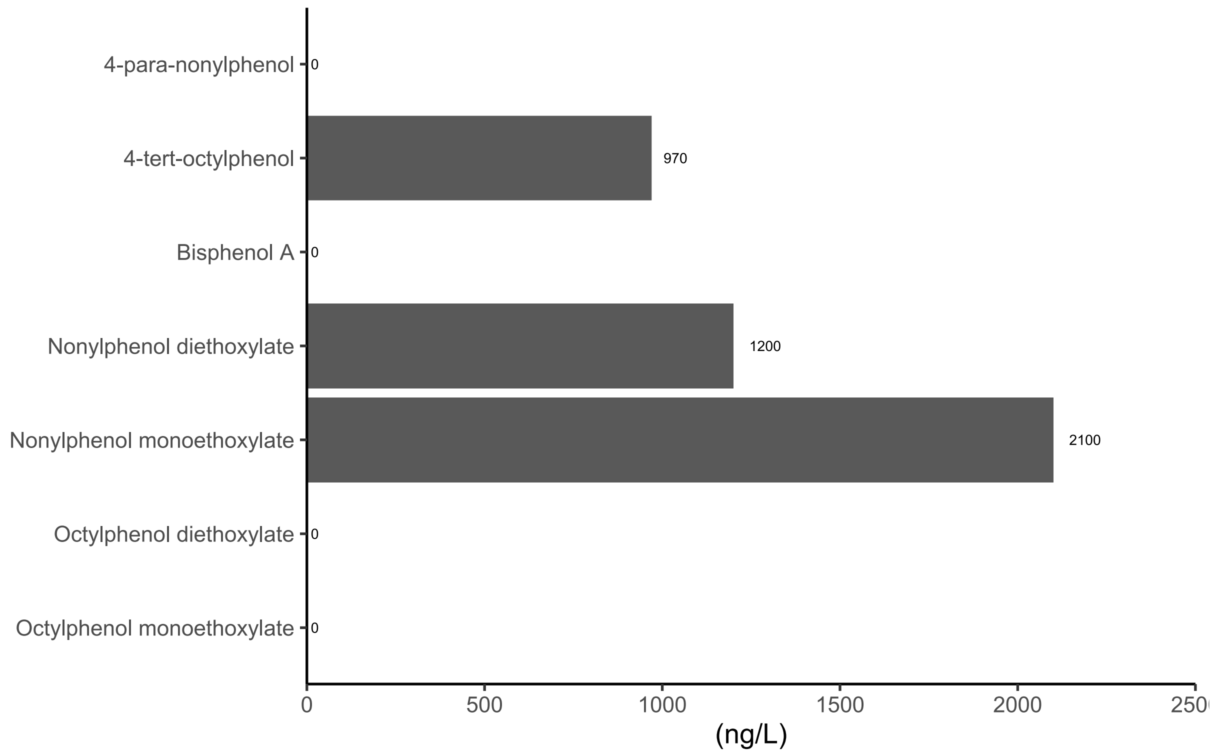

Figure 4-5 Industrial endocrine disrupting compounds measured in an October 2022 final effluent sample, where 0=ND.

Flame Retardants

One final effluent sample was collected in August 2022 and analyzed for flame retardants based on EPA Method 1614A using high resolution gas chromatography combined with high resolution mass spectrometry (HRGC/HRMS). Of the four target polybrominated diphenyl ethers (PBDEs) flame retardants, BDE 100, BDE 47 and BDE 99 were detected at concentrations below 1 ng/L (Figure 4-6). All three organophosphate esters flame retardants were detected, with concentrations varying from 0.25 ng/L (TCEP) to 1.2 ng/L (TDCPP).

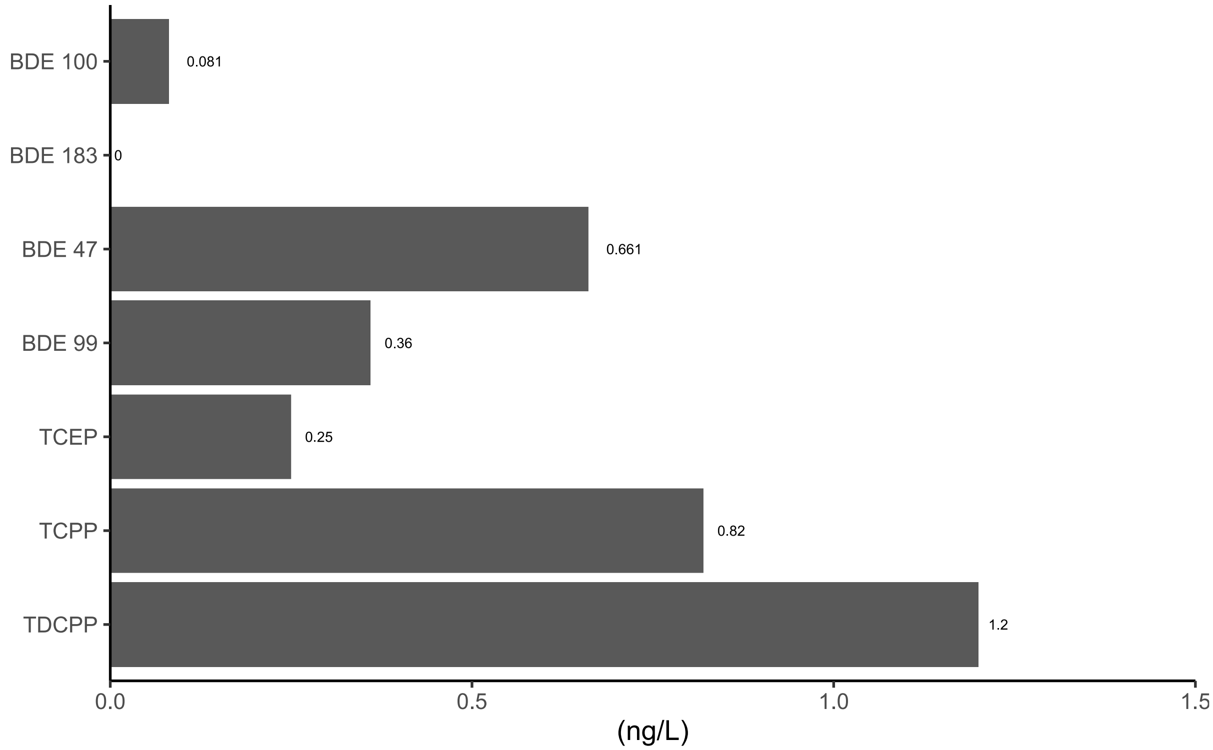

Figure 4-6 Flame retardants measured in an August 2022 final effluent sample, where 0=ND.

Pesticides and Insecticides

One final effluent sample was collected in September 2022 and analyzed for pesticides and insecticides based on a modified EPA Method 8270 using gas chromatography-mass spectrometry (GC-MS). Among the measured chlorpyrifos and diazinon insecticides, only chlorpyrifos was detected at a concentration of 11 ng/L (Figure 4-7). Of the four measured pesticides, fipronil, fipronil sulfone and total permethrin were detected, with concentrations ranging from 4 ng/L (total permethrin) to 65 ng/L (fipronil).

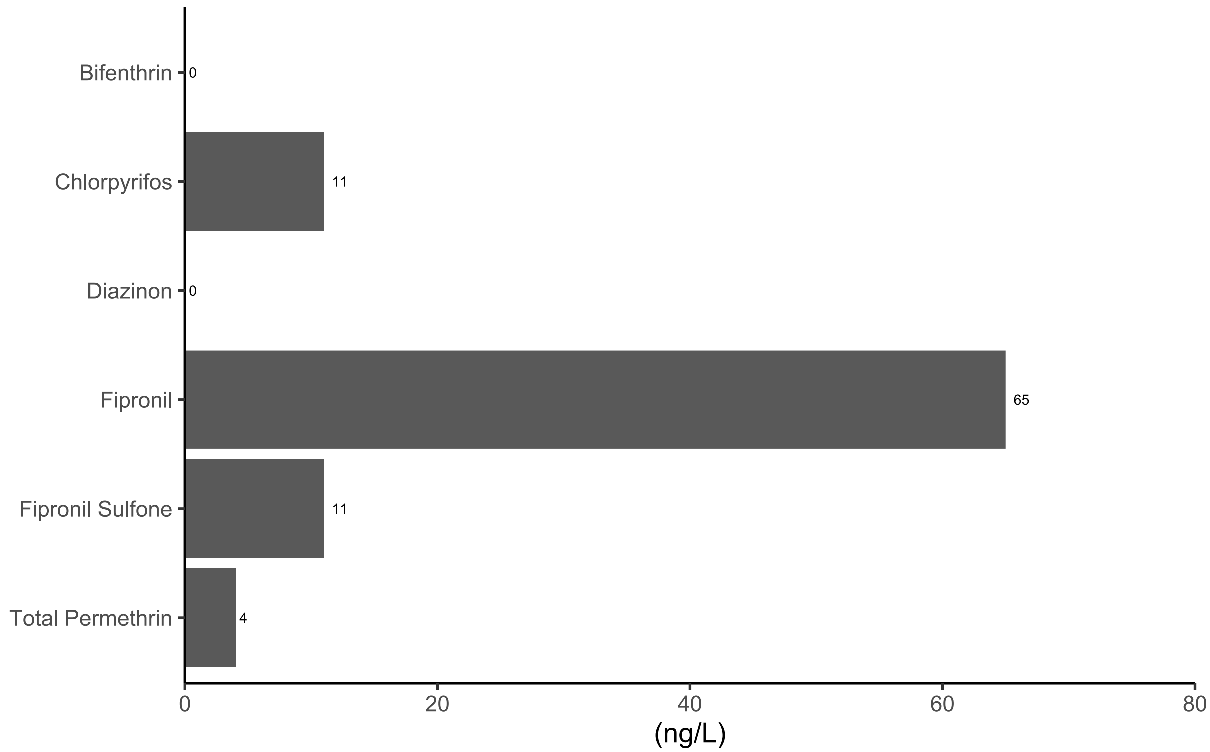

Figure 4-7 Pesticides and insecticides measured in a September 2022 final effluent sample, where 0=ND.

Per- and Polyfluoroalkyl Substances

During the 2022-23 monitoring period, 2 final effluent samples were collected and analyzed using LC-MS/MS for short-chain and long-chain perfluoroalkyl carboxylic acids (PFCAs) and perfluoroalkyl sulfonic acids (PFSAs). The results showed that five out of nine short-chain PFCAs were detected in the samples, with perfluorohexanoic acid (PFHxA) having the highest concentration in both samples (Figure 4-8). In comparison, perfluorooctanoic acid (PFOA), perfluoroheptanoic acid (PFHpA), perfluorononanoic acid (PFNA) and perfluorodecanoic acid (PFDA) were detected at much lower concentrations. The long-chain PFCAs, perfluorotridecanoic acid (PFTrDA), perfluorododecanoic acid (PFDoA), perfluorotetradecanoic acid (PFTeDA) and perfluoroundecanoic acid (PFUnDA), were not detected in the samples. All three PFSAs, including perfluorobutanesulfonic acid (PFBS), perfluorohexanesulfonic acid (PFHxS) and perfluorosulfonic acid (PFOS), were detected in the effluent samples. Overall, the concentration of PFCAs and PFSAs varies depending on the length of the carbon chain. These findings may have important implications for understanding the fate and transport of these compounds in wastewater treatment trains.

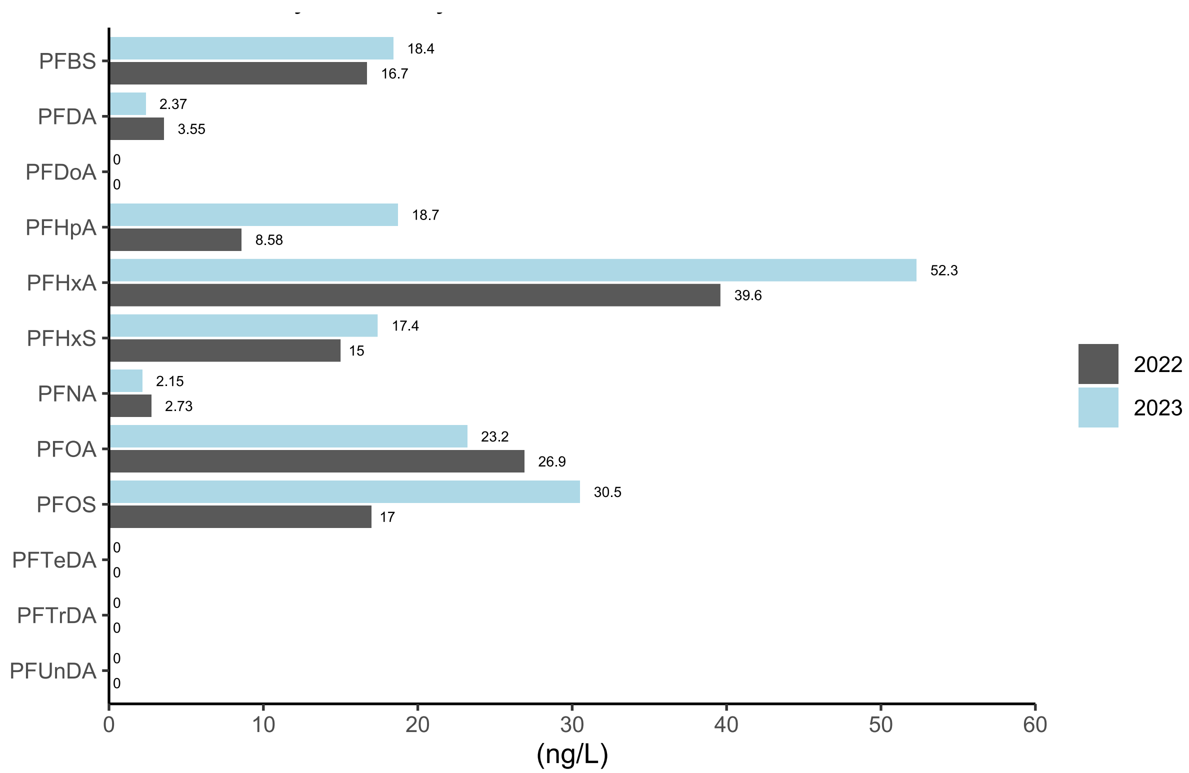

Figure 4-8 Per- and polyfluoroalkyl substances measured in final effluent samples collected in August 2022 and March 2023, where 0=ND.

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 Orange County Public Works in the Ocean Water Protection Program. Samples for this regional bacterial monitoring program are collected from 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 coastline from Seal Beach to Crystal Cove State Beach (Figure 4-9).

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 4-9). Overall, mean FIB concentrations were generally low across all core stations, where results from winter quarter were typically higher than other quarters (Table B-15).

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. The 2022-2023 Annual Heal the Bay Beach Report Card showed that Orange County beaches surpassed the historical 5-year average for all three seasons (Summer Dry, Winter Dry, and Wet Weather), with 98%, 94%, and 63% of beaches receiving A and B grades, respectively. Heal the Bay (2023) reported the shortest Honor Roll list ever seen and no Orange County beaches made it on the honor roll. The report noted that to make the honor roll, there needs to be zero bacterial exceedances during the year under all weather conditions, which is extremely difficult to achieve with so much rain that fell across California during the 2022-2023 winter.

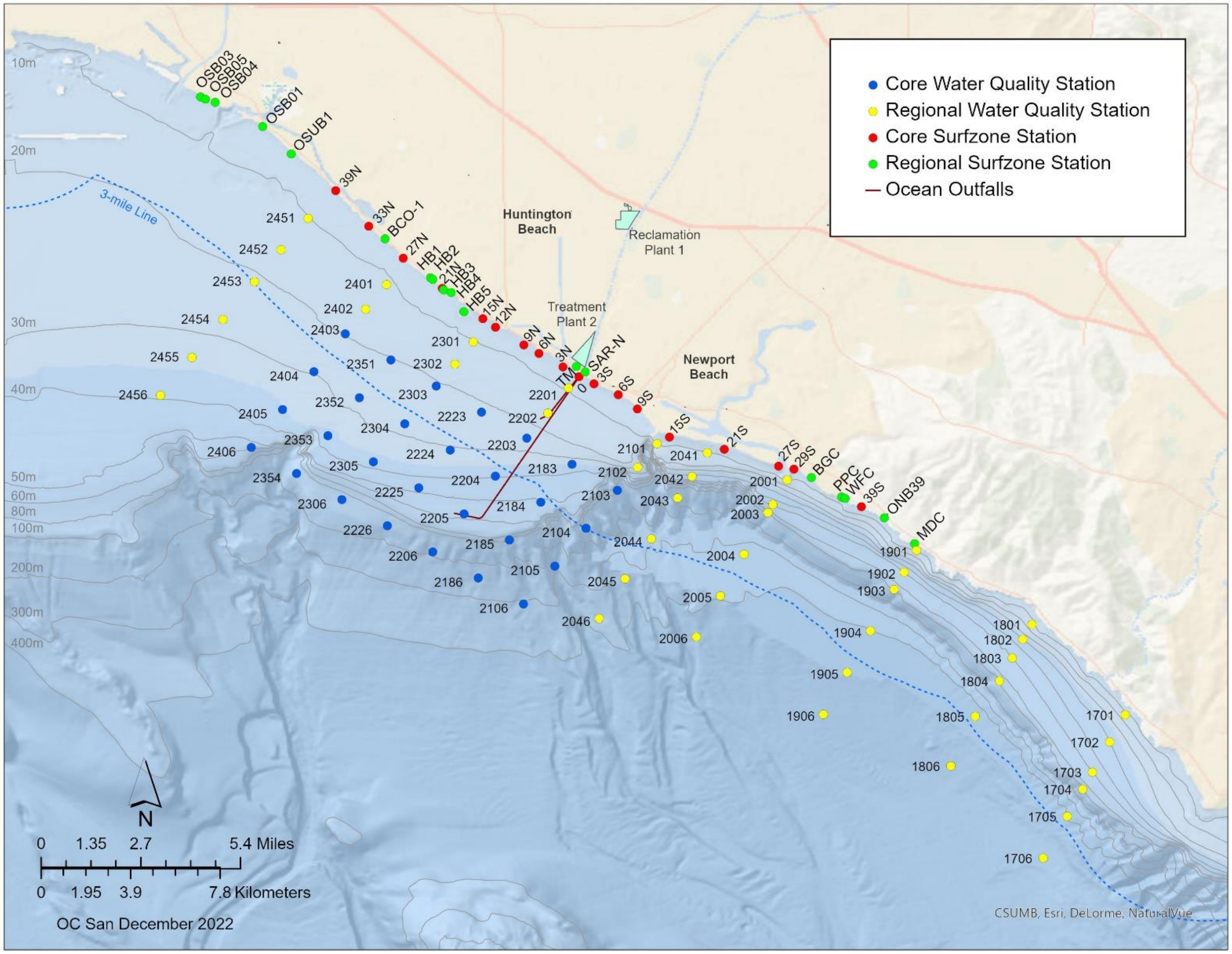

Figure 4-9 OC San's offshore and shoreline (aka surfzone) water quality monitoring stations for the 2022-23 program year.

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 Los Angeles County Sanitation Districts, 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 4-10). The participants use comparable conductivity-temperature-depth (CTD) profiling systems and field sampling methods. OC San samples 72 stations, which includes the 28 Core water quality stations, as part of this program (Figure 4-9). 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).

Southern California Bight Regional Monitoring Program

Since 1994, OC San has participated in all seven studies that comprise the Southern California Bight Regional Monitoring Program: 1994 Southern California Bight Pilot Project, Bight '98, Bight '03, Bight '08, Bight '13, Bight '18, and Bight '23. 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. Bight assessment reports are available at Bight Program Documents – Southern California Coastal Water Research Project.

During the 2022-23 program year, OC San staff served on technical committees for the Sediment Quality, Microbiology, Water Quality, Harmful Algal Blooms, Trash and Microplastic, and Field components of the Bight '23 program. In addition, OC San staff participated in toxicity and sediment chemistry intercalibration studies. In July 2023, OC San's Ocean Monitoring staff will commence Bight '23 sampling in lower Newport Bay and at offshore sites ranging from 5 m (16 ft) to 1,000 m (3,281 ft) in depth (Figure 4-11).

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 surface canopy of 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 consortia 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 consortia, regulators, and the public and is published as a report biennially for the CRKSC region. Findings from the most recent report (MBC 2023) covering 2021 and 2022 are summarized below.

2022 CRKSC Summary

In 2022, Central Region kelp canopy coverage decreased 31% from 2021 areal extent (0.8 square miles (2.0 km^2) from 1.1 square miles (2.9 km^2)). Since 2021 four beds increased in size, 13 decreased in size, and two beds disappeared from 2022 survey observations: Malibu Point and Sunset. Horseshoe Kelp, Huntington Flats and the area from Huntington Flats to Newport Harbor experienced no changes: there has been and continues to be no observable surface canopy. Corona del Mar beds decreased in size from 0.003 square miles (0.007 km^2) in 2021 to 0.001 square miles (0.003 km^2) in 2022. 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.

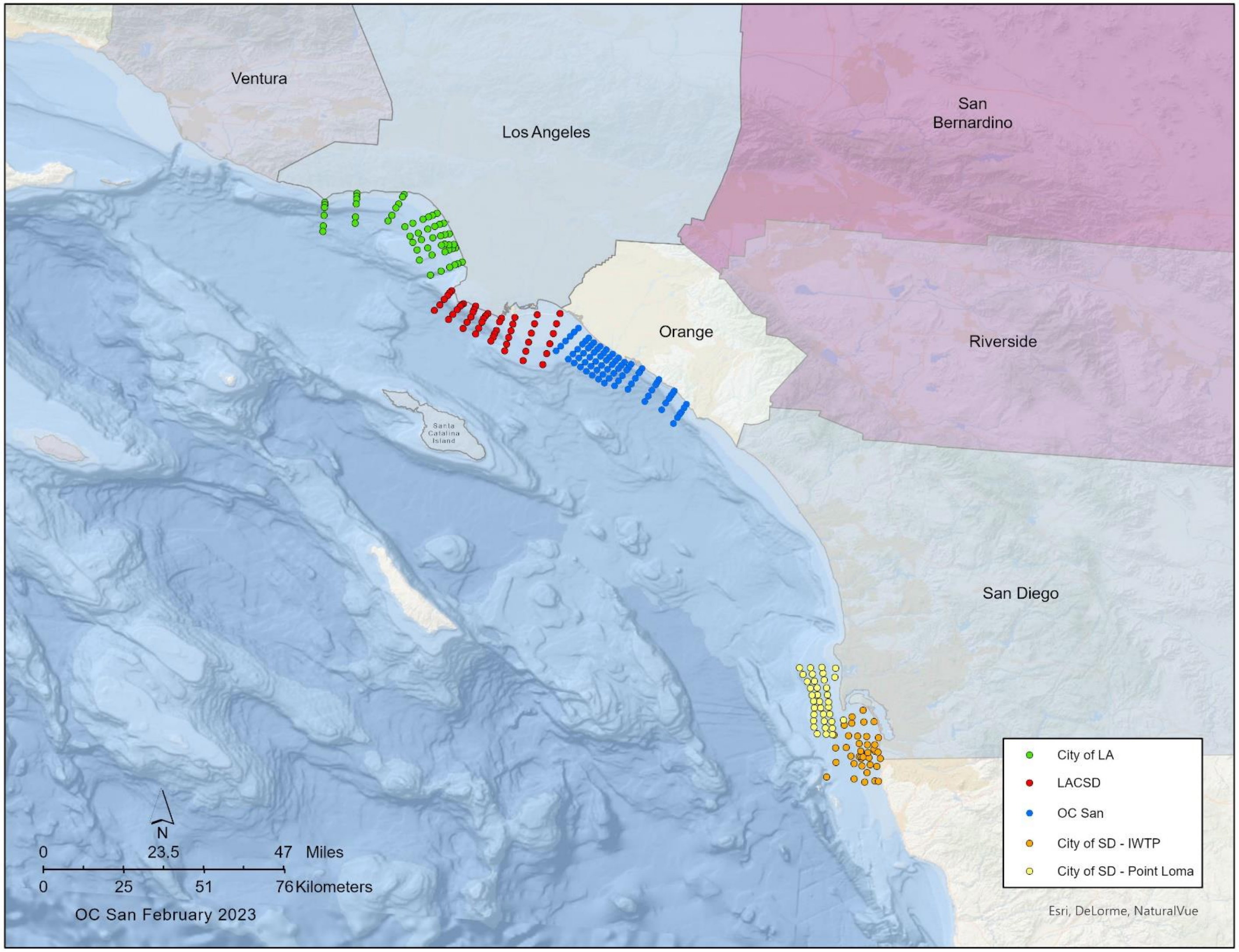

Figure 4-10 Southern California Bight Regional Water Quality Program monitoring stations for the 2022-23 program year.

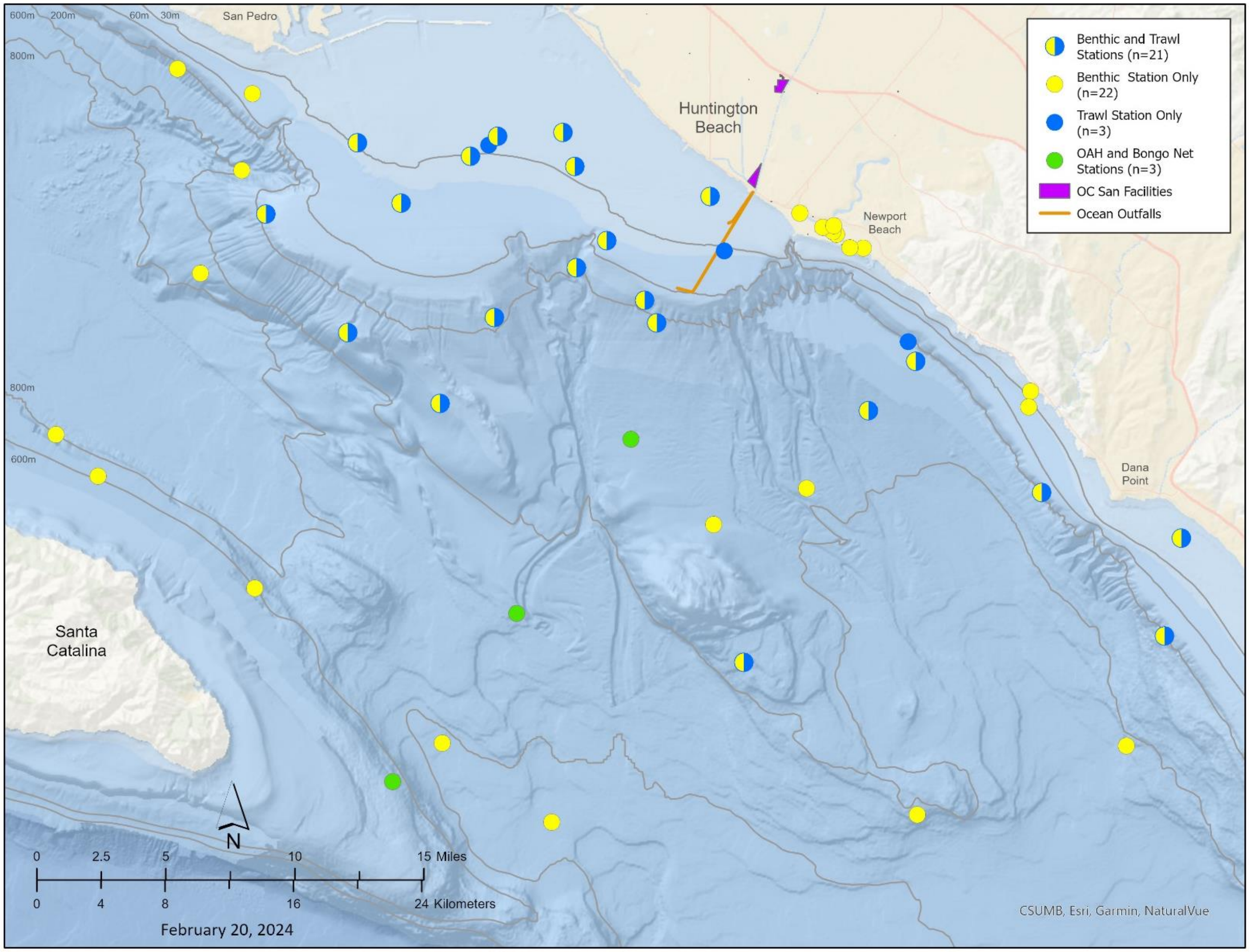

Figure 4-11 **OC San's assigned Bight '23 sampling stations.**

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 and Bight ‘23 Water Quality surveys later on). This 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 three 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.

The MBARI OAH mooring was decommissioned in January 2022 due to various challenges including inconsistent deployment and recovery, loss or damage of sensors, long lead times in sensor replacements, repairs and calibrations, and staff safety concerns during deployments. A new mooring system named the OAH mini-mooring system was developed by Dr. Uwe Send of the Ocean Time Series Lab at the Scripps Institution of Oceanography. This OAH mini-mooring can be more safely and easily deployed and recovered while providing a more reliable set of OAH time-series data. In May 2023, the OAH mini-mooring was successfully deployed and has collected temperature, salinity, oxygen, pH and chlorophyll-*a* fluorescence data at a 30-meter location near the outfall. A private website has been established to review the near real-time data and monitor environmental conditions and instrumentation performance.

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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 final effluent and receiving water monitoring requirements for OC San during the July 1, 2022 through June 30, 2023 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 Treatment Plant No. 2 in Huntington Beach. Two Hach AS950 autosamplers were set up to collect 24-hour composite samples. One sampler is flow-paced and was used as the primary sampler, whereas the other sampler is time-paced and was used as a backup when needed. Grab samples were collected using the auto, pump, and grab functions on the autosampler. Sampling frequencies varied from every 12 hours to annually (see Table E-4 in OC San's National Pollutant Discharge Elimination System (NPDES) permit). Samples were collected using the respective container types and respective preservation methods listed in Table A-1. All samples were refrigerated then transported to the OC San laboratory at Reclamation Plant No. 1 in Fountain Valley, where they were received into the Laboratory Information Management System (LIMS) and then distributed for contractor lab 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, seven have stipulated criteria, and 80 have performance goals and mass emission benchmarks.

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 six 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 in the 2022-23 program year did not exceed the stipulated criterion of 5 pCi/L.

Table A-1 Final effluent collection and analysis summary for the 2022-23 program year.

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, <10 ºC	6 hr	ELOM SOP 9223B–9230D, Rev. F
Fecal Coliforms	Grab	Plastic	Sodium Thiosulfate, <10 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 (as N)	24-hr Composite	Plastic or Glass	≤6 ºC	2 days	EPA Method 353.2
Nitrate Nitrogen (as N)	24-hr Composite	Plastic or Glass	≤6 ºC	2 days	EPA Method 353.2
Total Kjeldahl Nitrogen (TKN)	24-hr Composite	Plastic or Glass	≤6 ºC	28 days	EPA Method 351.2
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 350.1, Rev. 2
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	3 days	ELOM SOP 624.1, Rev. 4
Base/Neutrals and Acids Semi-volatile Organic Compounds	Grab	Glass	≤6 ºC	7 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	Grab	Plastic	10N NaOH to pH >10, ≤6 ºC	14 days	ELOM SOP 4500-CN-N-335.4, Rev. 10
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. 7
Chronic Whole Effluent Toxicity Testing	24-hr Composite	Plastic	≤6 ºC	36 hr	ELOM SOP 8210, Rev. 7; ELOM SOP 8230, 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 2022-23 program year.

	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 [b]
Chromium (VI)	Silver, total recoverable	Chlorinated Phenols [b]
Copper, total recoverable	Zinc, total recoverable	Endosulfan [c]
Lead, total recoverable	Cyanide, total recoverable	Endrin [c]
Mercury, total recoverable	Ammonia (as N)	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 (as N)	Biochemical Oxygen Demand
Enterococcus Density	Organic Nitrogen	Individual PCB Congeners
Ammonia (as N)	Total Nitrogen	
Nitrite Nitrogen (as N)	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 six times per quarter for California Ocean Plan (COP 2019) compliance. Monthly surveys (3 per quarter) sampled the full 28-station grid for dissolved oxygen (DO), pH , water clarity, and nutrient compliance determinations (Figure 3-1). During two of these surveys bacteriological samples were also collected at eight REC-1 stations, located within 3 miles (4.8 km) of the coast. These samples, when combined with those from the three additional REC-1 station surveys, were used for quarterly REC-1 water-contact compliance determinations.

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. A Sea-Bird Electronics Carousel Water Sampler (SBE32) equipped with Niskin bottles was used to collect discrete water samples at specified stations and depths for analysis of ammonia nitrogen (NH_3-N), nitrate nitrogen (NO_3-N), and fecal indicator bacteria (FIB). 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 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 addition to the 28-station grid (Figure 4-9) and provided regional continuity with the station assignments of the City of Los Angeles, Los Angeles County Sanitation Districts, 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 4-10). Data were collected using CTD instrumentation 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 as part of the Ocean Water Protection Program. When water at the creek/storm drain stations flowed to the ocean, three 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. All samples were transported to OC San's Laboratory where they were received into the LIMS by laboratory staff for analysis within 6 hours of collection.

Table A-3 Receiving water quality sample collection and analysis methods by parameter for the 2022-23 program year. NA = Not Applicable.

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 (<10 °C)	125 mL HDPE (sterile container)	8 hr (field + lab)	Ankle-deep water	At least 10% of samples
Fecal Coliforms	1-2/week	Grab	SM 9222 D [i]	Ice (<10 °C)	125 mL HDPE (sterile container)	8 hr (field + lab)	Ankle-deep water	At least 10% of samples
Enterococci	1-2/week	Grab	EPA Method 1600 [j]	Ice (<10 °C)	125 mL HDPE (sterile container)	8 hr (field + lab)	Ankle-deep water	At least 10% of samples
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 350.1, Rev. 2 [i]	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 (NO_3-N)	6/quarter	Niskin	ELOM SOP 353.2-NO2NO3_WQ, Rev. --	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 (<10 °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 (<10 °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 2022-23 program year. NA = Not Applicable.

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 (<10 °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

Analysis 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 FIB), other analytical quality control samples (matrix spikes, matrix spike replicates, and blank spikes), and standard reference materials (for NH_3-N and NO_3-N). All data underwent at least three 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 Esri ArcGIS Pro 3.1.3 software. The steps included retaining the data collected as the unit is lowered through the water column 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 SCCWRP in conjunction with its member agencies and the State Water Resources Control Board. The methodology involves 4 steps:

1. identification of the stations affected by the effluent plume using CDOM,
2. selection of reference sampling sites representing non-plume impacted conditions using CDOM,
3. a per meter comparison between water quality profiles in the reference and plume-affected zones, and
4. 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 FIB compliance was determined using the following thresholds (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

Compliance determinations for aesthetics and nutrients were 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 and 11 annual (summer quarter, August 2022) stations during the 2022-23 program year (Figure 3-2). In addition, 2–3 L of sediment was collected from the 11 quarterly stations in November 2022 for whole sediment toxicity testing. Each station was assigned to a Middle Shelf Zone 2, within-ZID (167–295 ft or 51–90 m) or a Middle Shelf Zone 2, non-ZID (51–90 m) station group. 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 three 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 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.

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

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 2022-23 program year.

Parameter	Container	Preservation	Holding Time	Method
Dissolved Sulfides	HDPE container	Freeze	6 months	ELOM SOP 4500-S2 G, Rev. 4
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

The measured sediment chemistry parameters are listed in Table A-5. 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. Method blanks, analytical quality control samples (duplicates, matrix spikes, and blank spikes), and standard reference materials were prepared and analyzed with each sample batch as required for each method. 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 '18 sediment geochemistry data (Du et al. 2020), 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 2022-23 program year.

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	
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 quarter.

BENTHIC INFAUNA MONITORING

Field Methods

A tandem 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 in the sediment geochemistry field methods section (Figure 3-2). The purpose of the quarterly surveys was to determine potential impacts on the benthic infauna community from treated effluent discharged at the outfall depth of 197-ft (60-m). Results were evaluated for comparison with long-term trends along the 197-ft (60-m) depth contour and for variations potentially attributable to the final expansion of the GWRS.

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 three consecutive sediment grabs each yielded a depth of less than 2 in at a station, then the depth threshold was lowered to less than or equal to 1.6 in (≤4 cm). 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. 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 five 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 five major taxonomic groups was identified by two 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 '18 infauna data (Gillett et al. 2022), 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 2022-23 program year.

Quarter	Survey (No. of Samples)	Taxonomic Aliquots	Contractor	OC San
Summer 2022	Quarterly (11)	Annelida	0	11
		Arthropoda	0	11
		Echinodermata	0	11
		Mollusca	11	0
		Miscellaneous Phyla	0	11
	Annual (11)	Annelida	11	0
		Arthropoda	11	0
		Echinodermata	11	0
		Mollusca	11	0
		Miscellaneous Phyla	11	0
Fall 2022	Quarterly (11)	Annelida	0	11
		Arthropoda	0	11
		Echinodermata	0	11
		Mollusca	11	0
		Miscellaneous Phyla	0	11
Winter 2023	Quarterly (11)	Annelida	0	11
		Arthropoda	0	11
		Echinodermata	0	11
		Mollusca	11	0
		Miscellaneous Phyla	0	11
Spring 2023	Quarterly (11)	Annelida	11	0
		Arthropoda	0	11
		Echinodermata	0	11
		Mollusca	11	0
		Miscellaneous Phyla	0	11
		Total	**110**	**165**

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).

TRAWL COMMUNITIES MONITORING

Field Methods

Demersal fishes and epibenthic macroinvertebrates (EMIs) were collected by trawling in July, August and September 2022 (summer) and in February and March 2023 (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 (Bight '18 Field Sampling & Logistics Committee 2018). 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 for each species. Individual lengths and weights of fish samples from T1 and T11 were recorded to maintain a historical record of these data sets. 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 abundance was calculated later using the weight of the first 100 individuals proportionally. EMI specimens that could not be identified in the field were preserved in 10% buffered formalin for subsequent taxonomic analysis in OC San's taxonomy 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 laboratory. Species names used in this report follow those given in Cadien and Lovell (2021) and Love and Passarelli (2020).

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 ’18 trawl data (Wisenbaker et al. 2021), 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 abundant 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., 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 winter of 2023, ten Hornyhead Turbot and ten English Sole were collected at each station..

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 2022 (Figure 3-3). Nine Vermillion Rockfish (*Sebastes miniatus*) and one Calico Rockfish (*Sebastes dallii*) were collected at Zone 1 and three Bocaccio (*Sebastes paucispinis*) and seven Vermillion 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 and muscle tissue samples were sorted into two composite samples per station. One composite at rig fishing Zone 1 contained only one individual Calico Rockfish, whereas all other composites were comprised of more than one individual fish. . 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 2022-23 program year. N/A = Not Applicable.

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	EPA Method 3545 / 8270 E
DDTs	Ziplock bag	Freeze	6 months	EPA Method 3545 / 8270 E
Lipids	Ziplock bag	Freeze	N/A	EPA Method 3545
Mercury	Ziplock bag	Freeze	6 months	ELOM SOP 245.1B, Rev. G
Polychlorinated Biphenyls	Ziplock bag	Freeze	6 months	EPA Method 3545 / 8270 E

Table A-8 Parameters measured in fish tissue samples during the 2022-23 program year.

	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 (Klasing and Brodberg 2008; Table A-9).

Table A-9 Advisory tissue levels (ATLs) for selected contaminants in 8-ounce servings of uncooked fish.

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 2022-23 program year were visually inspected for lesions, tumors, large, non-mobile external parasites, and other signs of disease (e.g., skeletal deformities). 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 March 2023 trawl survey. Ten English Sole and 10 Hornyhead Turbot were collected at Station T1, and 12 English Sole and eight 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).

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 post-fixation; the 70% ethanol was changed every 3–4 days until histological processing. Liver tissues were dehydrated in a graded ethanol series (i.e., 70%, 95%, 100%), cleared with xylene, embedded in paraffin wax, and cut into 2×10^{-4} in (5 µm) thick serial sections using a Leica Biosystems Microm HM 325 rotary microtome. Tissues were then stained with hematoxylin and eosin and examined using an Olympus BX41 compound microscope. Photomicrographs were taken with a Q Imaging Digital Camera attached to the microscope. Five sections from each paraffin-embedded liver tissue sample were examined under the compound microscope by two independent assessors to determine the frequency and severity of liver tissue damage in each fish sample collected at both stations. The tissue damage screened for included fibrosis, steatosis, cytoplasmic vacuolization, lipofuscin, necrosis, granulocytoma, and parasites. The overall health of the liver tissue from each fish was evaluated by the presence of tissue damage and scored on a scale of 0–3 based on Van Dyk et al. (2012). The scale was changed to 0–3 in this report from 1–4 in the previous report (OCSD 2023) to improve the data visualization of the bar graph. The 4 scores of liver tissue damage were classified as follows: 0) no tissue damage present; 1) minimal tissue damage (<30% of tissue) which is likely to have little to no impact on liver function; 2) moderate tissue damage (30–70% of tissue) which may cause impairment of liver function; and 3) 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 five 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) by quarter and select depth strata for the REC-1 water quality surveys (5 surveys/quarter; 8 stations/survey) conducted during the 2022-23 program year.

			Total Coliform				Fecal Coliform				Enterococci			
Quarter	**Depth Strata (m)**	**n**	<10 [a]	10–70	71–230 [b]	>230 [c]	<10 [a]	10–200	201–400 [d]	>400 [e]	<10 [a]	10–30	31–110 [f]	>110 [c]
Summer	1–15	80	97.5%	2.5%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	83.8%	16.2%	0.0%	0.0%
	16–30	60	91.7%	8.3%	0.0%	0.0%	91.7%	8.3%	0.0%	0.0%	88.3%	11.7%	0.0%	0.0%
	31–45	15	86.7%	13.3%	0.0%	0.0%	93.3%	6.7%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
	46–60	20	90.0%	10.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	95.0%	5.0%	0.0%	0.0%
	Water Column	**175**	**93.8%**	**6.2%**	**0.0%**	**0.0%**	**96.6%**	**3.4%**	**0.0%**	**0.0%**	**88.0%**	**12.0%**	**0.0%**	**0.0%**
Fall	1–15	80	75.0%	25.0%	0.0%	0.0%	95.0%	5.0%	0.0%	0.0%	83.8%	15.0%	1.2%	0.0%
	16–30	60	58.4%	33.3%	3.3%	5.0%	80.0%	18.3%	1.7%	0.0%	80.0%	15.0%	5.0%	0.0%
	31–45	15	40.0%	46.7%	0.0%	13.3%	40.0%	53.3%	6.7%	0.0%	93.3%	6.7%	0.0%	0.0%
	46–60	20	25.0%	65.0%	5.0%	5.0%	40.0%	60.0%	0.0%	0.0%	75.0%	20.0%	5.0%	0.0%
	Water Column	**175**	**60.6%**	**34.3%**	**1.7%**	**3.4%**	**78.9%**	**20.0%**	**1.1%**	**0.0%**	**82.3%**	**14.3%**	**3.4%**	**0.0%**
Winter	1–15	79	51.9%	26.6%	12.7%	8.8%	87.3%	12.7%	0.0%	0.0%	69.6%	19.0%	8.9%	2.5%
	16–30	60	36.7%	50.0%	13.3%	0.0%	86.7%	13.3%	0.0%	0.0%	73.4%	23.3%	3.3%	0.0%
	31–45	15	20.0%	33.3%	46.7%	0.0%	40.0%	60.0%	0.0%	0.0%	33.3%	60.0%	6.7%	0.0%
	46–60	20	50.0%	40.0%	10.0%	0.0%	75.0%	25.0%	0.0%	0.0%	80.0%	20.0%	0.0%	0.0%
	Water Column	**174**	**43.7%**	**36.8%**	**15.5%**	**4.0%**	**81.6%**	**18.4%**	**0.0%**	**0.0%**	**69.0%**	**24.1%**	**5.8%**	**1.1%**
Spring	1–15	80	96.3%	3.7%	0.0%	0.0%	98.8%	1.2%	0.0%	0.0%	80.0%	18.8%	1.2%	0.0%
	16–30	60	85.0%	15.0%	0.0%	0.0%	95.0%	5.0%	0.0%	0.0%	85.0%	13.3%	1.7%	0.0%
	31–45	15	66.7%	33.3%	0.0%	0.0%	86.7%	13.3%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
	46–60	20	70.0%	25.0%	5.0%	0.0%	85.0%	15.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
	Water Column	**175**	**86.9%**	**12.6%**	**0.5%**	**0.0%**	**94.9%**	**5.1%**	**0.0%**	**0.0%**	**85.8%**	**13.1%**	**1.1%**	**0.0%**
Annual	1–15	319	80.3%	14.4%	3.1%	2.2%	95.3%	4.7%	0.0%	0.0%	79.3%	17.3%	2.8%	0.6%
	16–30	240	67.9%	26.7%	4.2%	1.2%	88.3%	11.3%	0.4%	0.0%	81.7%	15.8%	2.5%	0.0%
	31–45	60	53.3%	31.7%	11.7%	3.3%	65.0%	33.3%	1.7%	0.0%	81.7%	15.0%	3.3%	0.0%
	46–60	80	58.8%	35.0%	5.0%	1.2%	75.0%	25.0%	0.0%	0.0%	87.5%	11.3%	1.2%	0.0%
	Water Column	**699**	**71.2%**	**22.5%**	**4.4%**	**1.9%**	**88.0%**	**11.7%**	**0.3%**	**0.0%**	**81.3%**	**15.9%**	**2.6%**	**0.2%**

[a] Method detection limit.
[b] Range for exceedance of the median density criterion.
[c] Value for exceedance of the <10% of the samples criterion.
[d] Range for exceedance of the 30-day geometric mean criterion.
[e] Value for exceedance of the single sample maximum criterion.
[f] Range for exceedance of 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 2022-23 program year. Results were compared to the State Water Board (SWB) Water-Contact Objectives.

Quarter	Station	Date					Met SWB 30-day geometric mean of ≤200/100mL	Met SWB single sample standard of ≤400/100 mL
		7/19/2022	**7/20/2022**	**7/21/2022**	**8/1/2022**	**8/2/2022**		
Summer	2103	<10	<10	<10	<10	<10	YES	YES
	2104	<10	<10	<10	<10	<10	YES	YES
	2183	<10	<10	<10	<10	<10	YES	YES
	2203	<10	<10	<10	<10	<10	YES	YES
	2223	<10	<10	<10	<10	<10	YES	YES
	2303	<10	<10	<10	<10	<10	YES	YES
	2351	<10	<10	<10	<10	<10	YES	YES
	2403	<10	<10	<10	<10	<10	YES	YES
		10/18/2022	**10/19/2022**	**10/20/2022**	**11/14/2022**	**11/15/2022**		
Fall	2103	39.6	11.7	<10	<10	10.5	YES	YES
	2104	<10	29.8	<10	<10	<10	YES	YES
	2183	<10	10.3	<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
		1/18/2023	**1/19/2023**	**1/24/2023**	**2/7/2023**	**2/8/2023**		
Winter	2103	<10	<10	<10	17.6	11.3	YES	YES
	2104	<10	<10	<10	10.9	13.2	YES	YES
	2183	12.5	<10	<10	16.7	<10	YES	YES
	2203	<10	<10	<10	<10	<10	YES	YES
	2223	13.6	<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 2022-23 program year. Results were compared to the State Water Board (SWB) Water-Contact Objectives.

Quarter	Station	Date					Met SWB 30-day geometric mean of ≤200/100mL	Met SWB single sample standard of ≤400/100 mL
		4/18/2023	**4/20/2023**	**4/24/2023**	**5/2/2023**	**5/3/2023**		
Spring	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-3 Median total coliform densities (MPN/100 mL) in discrete samples collected in offshore waters during the 2022-23 program year. Results were compared to the State Water Board (SWB) Shellfish Harvesting Standards.

Quarter	Station	Date					Met SWB Standard of median ≤70/100 mL	Met SWB Standard of ≤10% of samples ≥230/100 mL
		7/19/2022	**7/20/2022**	**7/21/2022**	**8/1/2022**	**8/2/2022**		
Summer	2103	<10	<10	<10	<10	<10	YES	YES
	2104	<10	<10	<10	<10	<10	YES	YES
	2183	<10	<10	<10	<10	<10	YES	YES
	2203	<10	<10	<10	<10	<10	YES	YES
	2223	<10	<10	<10	<10	<10	YES	YES
	2303	<10	<10	<10	<10	<10	YES	YES
	2351	<10	<10	<10	<10	<10	YES	YES
	2403	<10	<10	<10	<10	<10	YES	YES
		10/18/2022	**10/19/2022**	**10/20/2022**	**11/14/2022**	**11/15/2022**		
Fall	2103	149.5	10	10	<10	<10	YES	YES
	2104	<10	115.5	<10	<10	<10	YES	YES
	2183	10	25.5	13.75	<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	20	10	YES	YES
	2403	<10	<10	<10	41	20	YES	YES
		1/18/2023	**1/19/2023**	**1/24/2023**	**2/7/2023**	**2/8/2023**		
Winter	2103	15	57.5	<10	65.5	10	YES	YES
	2104	<10	10	<10	<10	20.5	YES	YES
	2183	128.5	63.5	<10	36	13.75	YES	YES
	2203	146	121	10	20	<10	YES	YES
	2223	74	41	<10	<10	<10	YES	YES
	2303	20	20	<10	<10	<10	YES	YES
	2351	31	31	<10	<10	<10	YES	YES
	2403	10	20	<10	<10	<10	YES	YES

Table B-3 Median total coliform densities (MPN/100 mL) in discrete samples collected in offshore waters during the 2022-23 program year. Results were compared to the State Water Board (SWB) Shellfish Harvesting Standards.

Quarter	Station	Date					Met SWB Standard of median ≤70/100 mL	Met SWB Standard of ≤10% of samples ≥230/100 mL
		4/18/2023	4/20/2023	4/24/2023	5/2/2023	5/3/2023		
Spring	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	20	<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-4 Depth-averaged enterococci densities (MPN/100 mL) based on discrete samples collected in offshore waters during the 2022-23 program year. Results were compared to the State Water Board (SWB) Water-Contact Objectives and U.S. EPA Water Quality Criteria.

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	11	11	11	11	<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	13	12	12	10	10	<10	YES	YES
	2104	11	10	10	<10	<10	<10	YES	YES
	2183	24	16	16	12	12	<10	YES	YES
	2203	16	13	13	10	10	<10	YES	YES
	2223	11	<10	<10	<10	<10	<10	YES	YES
	2303	11	11	11	<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) based on discrete samples collected in offshore waters during the 2022-23 program year. Results were compared to the State Water Board (SWB) Water-Contact Objectives and U.S. EPA Water Quality Criteria.

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	11	<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 2022-23 program year. Total number of station visits = 336.

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	1	3	0	0	1	2	1	8
Biological Material (kelp)	2	1	0	0	1	0	2	6
Material of Sewage Origin	0	0	0	0	0	0	0	0
Totals	**3**	**4**	**0**	**0**	**2**	**2**	**3**	**14**

Table B-6 Summary of floatable material by station group observed during the REC-1 water quality surveys for the 2022-23 program year. Total number of station visits = 120.

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	4	0	6	10
Biological Material (kelp)	2	0	0	2
Material of Sewage Origin	0	0	0	0
Totals	**6**	**0**	**6**	**12**

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 2022-23 program year.

		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	6.05	7.96	9.77	0.67	7.96	8.19	8.35	0.10	73.45	82.29	87.63	2.79
	16–30	5.02	6.81	9.16	0.95	7.87	8.12	8.33	0.11	61.66	82.51	88.53	2.84
	31–45	4.60	5.48	7.19	0.41	7.88	8.04	8.23	0.08	75.23	85.00	88.68	1.67
	46–60	4.40	4.98	6.13	0.32	7.90	8.02	8.14	0.06	77.47	85.21	88.15	1.66
	61–75	4.27	4.68	5.48	0.23	7.92	8.02	8.14	0.06	81.43	85.55	88.36	1.69
	Water Column	**4.27**	**6.45**	**9.77**	**1.40**	**7.87**	**8.10**	**8.35**	**0.11**	**61.66**	**83.58**	**88.68**	**2.78**
Fall	1–15	5.49	7.43	10.62	0.41	7.98	8.12	8.27	0.06	67.62	83.06	86.87	3.03
	16–30	5.34	6.90	7.73	0.53	7.89	8.06	8.19	0.05	80.88	84.64	86.61	1.10
	31–45	5.30	6.13	7.41	0.38	7.82	7.99	8.11	0.07	82.81	85.96	87.57	0.92
	46–60	4.76	5.55	6.52	0.33	7.79	7.95	8.09	0.08	83.19	86.42	87.86	1.00
	61–75	4.33	5.01	5.81	0.28	7.76	7.93	8.07	0.08	83.11	86.60	88.06	1.03
	Water Column	**4.33**	**6.52**	**10.62**	**0.94**	**7.76**	**8.04**	**8.27**	**0.09**	**67.62**	**84.86**	**88.06**	**2.33**
Winter	1–15	4.28	8.16	10.87	0.80	7.85	8.09	8.32	0.07	48.38	76.80	86.50	6.23
	16–30	3.32	7.00	8.50	1.21	7.74	7.99	8.12	0.10	61.73	83.00	88.13	4.18
	31–45	3.08	6.03	8.40	1.56	7.68	7.88	8.10	0.12	73.62	85.92	88.82	2.52
	46–60	2.97	5.20	7.89	1.41	7.66	7.79	7.97	0.08	81.41	87.56	89.40	1.04
	61–75	2.71	4.58	6.76	1.20	7.65	7.76	7.91	0.07	81.70	87.72	89.41	1.29
	Water Column	**2.71**	**6.69**	**10.87**	**1.74**	**7.65**	**7.95**	**8.32**	**0.15**	**48.38**	**82.69**	**89.41**	**6.09**
Spring	1–15	3.78	8.40	11.57	1.22	7.75	8.09	8.40	0.12	59.72	81.35	88.20	5.39
	16–30	3.06	6.28	10.78	1.74	7.62	7.89	8.31	0.12	60.91	83.58	88.10	4.19
	31–45	2.84	4.45	8.05	1.17	7.59	7.75	8.01	0.08	63.61	86.70	88.73	2.08
	46–60	2.75	3.73	5.36	0.69	7.60	7.72	7.80	0.06	83.48	87.64	89.21	1.04
	61–75	2.64	3.37	4.70	0.55	7.58	7.71	7.80	0.06	84.28	87.91	89.37	1.09
	Water Column	**2.64**	**5.96**	**11.57**	**2.30**	**7.58**	**7.89**	**8.40**	**0.18**	**59.72**	**84.45**	**89.37**	**4.65**
Annual	1–15	3.78	7.98	11.57	0.90	7.75	8.12	8.40	0.10	48.38	80.91	88.20	5.18
	16–30	3.06	6.75	10.78	1.21	7.62	8.02	8.33	0.13	60.91	83.46	88.53	3.39
	31–45	2.84	5.53	8.40	1.20	7.59	7.92	8.23	0.14	63.61	85.89	88.82	1.96
	46–60	2.75	4.89	7.89	1.06	7.60	7.87	8.14	0.14	77.47	86.69	89.40	1.56
	61–75	2.64	4.43	6.76	0.92	7.58	7.86	8.14	0.14	81.43	86.93	89.41	1.60
	Water Column	**2.64**	**6.41**	**11.57**	**1.68**	**7.58**	**8.00**	**8.40**	**0.16**	**48.38**	**83.92**	**89.41**	**4.28**

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 2022-23 program year.

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	93.9%	6.1%	0%	0%
	31–45	48	85.4%	14.6%	0%	0%
	46–60	62	91.9%	8.1%	0%	0%
	Water Column	**344**	**94.5%**	**5.5%**	**0%**	**0%**
Fall	1–15	120	100.0%	0%	0%	0%
	16–30	114	99.1%	0.9%	0%	0%
	31–45	47	93.6%	6.4%	0%	0%
	46–60	63	90.5%	9.5%	0%	0%
	Water Column	**344**	**97.1%**	**2.9%**	**0%**	**0%**
Winter	1–15	120	100.0%	0%	0%	0%
	16–30	114	95.6%	4.4%	0%	0%
	31–45	48	89.6%	10.4%	0%	0%
	46–60	63	92.1%	7.9%	0%	0%
	Water Column	**345**	**95.9%**	**4.1%**	**0%**	**0%**
Spring	1–15	120	99.2%	0.8%	0%	0%
	16–30	114	89.5%	10.5%	0%	0%
	31–45	48	75.0%	25.0%	0%	0%
	46–60	63	90.5%	9.5%	0%	0%
	Water Column	**345**	**91.0%**	**9.0%**	**0%**	**0%**
Annual	1–15	480	99.8%	0.2%	0%	0%
	16–30	456	94.5%	5.5%	0%	0%
	31–45	191	85.9%	14.1%	0%	0%
	46–60	251	91.2%	8.8%	0%	0%
	Water Column	**1,378**	**94.6%**	**5.4%**	**0%**	**0%**

[a] Method detection limit (MDL) = 0.04 mg/L.
[b] California Ocean Plan (COP) chronic toxicity criteria.
[c] COP acute toxicity criteria

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 2022-23 program year.

Quarter	Depth Strata (m)	n	<MDL	MDL–RL	>RL
Summer [a]	1–15	120	74.2%	17.5%	8.3%
	16–30	114	9.7%	12.3%	78.0%
	31–45	48	4.2%	0%	95.8%
	46–60	62	0%	0%	100%
	Water Column	**344**	**29.7%**	**10.2%**	**60.1%**
Fall [a]	1–15	120	44.2%	43.3%	12.5%
	16–30	114	7.9%	14.9%	77.2%
	31–45	47	0%	0%	100%
	46–60	63	0%	0%	100%
	Water Column	**344**	**18%**	**20.1%**	**61.9%**
Winter [a]	1–15	120	5.8%	9.2%	85%
	16–30	114	0.9%	2.6%	96.5%
	31–45	48	0%	0%	100%
	46–60	63	0%	0%	100%
	Water Column	**345**	**2.3%**	**4.1%**	**93.6%**
Spring [a]	1–15	120	45%	25.8%	29.2%
	16–30	114	4.4%	5.3%	90.3%
	31–45	48	0%	0%	100%
	46–60	63	0%	0%	100%
	Water Column	**345**	**17.1%**	**10.7%**	**72.2%**
Annual [a]	1–15	480	42.3%	24%	33.7%
	16–30	456	5.7%	8.8%	85.5%
	31–45	191	1.1%	0%	98.9%
	46–60	251	0%	0%	100%
	Water Column	**1,378**	**16.8%**	**11.3%**	**71.9%**

[a] OC San's laboratory used a method detection limit (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 2022-23 program year. Values represent the mean and range (in parentheses).

Season	Parameter	Stratum	Annelida	Arthropoda	Echinodermata	Misc. Phyla	Mollusca
Summer	Species Richness	Middle Shelf Zone 2 Within-ZID (51–90 m)	47 (41-57)	27 (24-31)	3 (1-4)	5 (3-8)	8 (4-11)
		Middle Shelf Zone 2, Non-ZID (51–90 m)	49 (37-65)	21 (0-30)	3 (2-6)	6 (0-12)	10 (0-21)
	Abundance	Middle Shelf Zone 2 Within-ZID (51–90 m)	245 (177-331)	83 (65-127)	8 (7-12)	8 (5-14)	17 (12-23)
		Middle Shelf Zone 2, Non-ZID (51–90 m)	245 (116-456)	58 (0-134)	9 (4-24)	12 (0-24)	18 (0-48)
Fall	Species Richness	Middle Shelf Zone 2 Within-ZID (51–90 m)	51 (40-59)	23 (18-32)	2 (2-4)	5 (0-10)	7 (5-13)
		Middle Shelf Zone 2 Non-ZID (51–90 m)	51 (39-61)	23 (16-31)	3 (1-6)	7 (0-12)	11 (7-15)
	Abundance	Middle Shelf Zone 2 Within-ZID (51–90 m)	288 (212-377)	82 (51-119)	9 (6-11)	10 (0-19)	12 (10-16)
		Middle Shelf Zone 2 Non-ZID (51–90 m)	358 (162-574)	78 (54-107)	7 (3-12)	13 (0-22)	18 (16-22)
Winter	Species Richness	Middle Shelf Zone 2 Within-ZID (51–90 m)	41 (38-44)	23 (20-28)	2 (1-4)	3 (0-5)	5 (4-7)
		Middle Shelf Zone 2 Non-ZID (51–90 m)	45 (29-59)	20 (17-25)	3 (2-5)	4 (2-8)	5 (1-9)
	Abundance	Middle Shelf Zone 2 Within-ZID (51–90 m)	220 (164-289)	59 (57-62)	8 (2-15)	5 (0-11)	9 (5-16)
		Middle Shelf Zone 2 Non-ZID (51–90 m)	308 (69-518)	55 (26-83)	6 (5-9)	8 (3-21)	9 (1-18)
Spring	Species Richness	Middle Shelf Zone 2 Within-ZID (51–90 m)	65 (60-70)	26 (25-29)	4 (3-5)	9 (8-11)	7 (4-11)
		Middle Shelf Zone 2 Non-ZID (51–90 m)	59 (36-76)	24 (11-38)	3 (2-5)	8 (3-12)	7 (3-14)
	Abundance	Middle Shelf Zone 2 Within-ZID (51–90 m)	447 (386-537)	97 (72-127)	10 (7-17)	22 (18-28)	17 (12-28)
		Middle Shelf Zone 2 Non-ZID (51–90 m)	389 (182-608)	79 (34-145)	8 (6-13)	20 (3-44)	17 (3-33)

Table B-11 Abundance and species richness of epibenthic macroinvertebrates collected in the Summer 2022 and Winter 2023 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	Total	%
Lytechinus pictus		118	193	212	2,847	4,058	26	132	556	89	244	143	78	23	85	130	38	38	19	3	9,032	48.6
Ophiura luetkenii	1,105	1,063	1,263		9	8	18	8	40	1			1,250	8	1	38					4,812	25.9
Strongylocentrotus fragilis								2									1,079	426	378	4	1,889	10.2
Hamatoscalpellum californicum	6	15	26		8	108	30	108	48	108	4	62	23	72	98	105					821	4.4
Sicyonia ingentis	1	2			1	8	1	57	5	65	9	6	3	5	2	3	3	103	192	162	628	3.4
Thesea sp B	1	14	11		36	49	32	27	96	29	20	49	22	33	46	34					499	2.7
Astropecten californicus	1	12	8	10		2	8	22	36	51	9	11	3	15	17	30	4	1	2	1	243	1.3
Pleurobranchaea californica	2	10	20	2	5	2	19	5	2	8	9	4	6	2	1	5	16		1	8	127	0.7
Luidia foliolata			10	9			4	6	3	12	6	6	18	5	1	4	4	3	1	2	94	0.5
Philine auriformis	13	11	27	1	3		2	1	12	1	3		1								75	0.4
Ophiothrix spiculata	3	6	1		2	3	9	2	10	7	1	1		3	1	7					56	0.3
Luidia armata	10	2				1			1	2			20		7	1					44	0.2
Luidia asthenosoma			3			4	5	12	3	1	1	4	1	3		4			1		42	0.2
Sicyonia penicillata						3		6		6		2		7		15					39	0.2
Acanthodoris brunnea	1							2	1	19					1	1					25	0.1
Orthopagurus minimus		10	1						5	3						3					22	0.1
Astropecten sp						14															14	0.1
Octopus rubescens							1	1		1		4		1		1	3				12	0.1
Neocrangon zacae																			2	9	11	0.1
Apostichopus californicus					1	1	1	1						1		1	1				7	<0.1
Octopus veligero							1										1		1	4	7	<0.1
Acanthoptilum sp		1				1				1				1		2					6	<0.1
Pyromaia tuberculata		1		2			1			2											6	<0.1
Amphichondrius granulatus					3										1	1					5	<0.1
Coryrhynchus lobifrons					1				2							2					5	<0.1
Paguristes parvus					1		1		1	1										1	5	<0.1
Heterogorgia tortuosa		3													1						4	<0.1
Platymera gaudichaudii				1	1										2						4	<0.1

Table B-11 Abundance and species richness of epibenthic macroinvertebrates collected in the Summer 2022 and Winter 2023 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	Total	%
Baptodoris mimetica						2										1					3	<0.1
Cancellaria cooperii																		2	1		3	<0.1
Loxorhynchus crispatus		1	1							1											3	<0.1
Rossia pacifica																		1		2	3	<0.1
Dendronotus iris								2													2	<0.1
Flabellinopsis iodinea		2																			2	<0.1
Heterogorgia sp								1						1							2	<0.1
Luidia sp															2						2	<0.1
Pteropurpura macroptera									1	1											2	<0.1
Tritia insculpta																		1	1		2	<0.1
Tritonia sp										2											2	<0.1
Armina californica		1																			1	<0.1
Calinaticina oldroydii																			1		1	<0.1
Calliostoma turbinum								1													1	<0.1
Cancellaria crawfordiana								1													1	<0.1
Crossata ventricosa							1														1	<0.1
Doryteuthis opalescens	1																				1	<0.1
Ericerodes hemphillii								1													1	<0.1
Latulambrus occidentalis	1																				1	<0.1
Megasurcula carpenteriana	1																				1	<0.1
Megasurcula sp										1											1	<0.1
Metacarcinus anthonyi																				1	1	<0.1
Metacrangon spinosissima																				1	1	<0.1
Octopus californicus																			1		1	<0.1
Stylasterias forreri										1											1	<0.1
Total Abundance	**1,146**	**1,272**	**1,564**	**237**	**2,918**	**4,264**	**160**	**398**	**822**	**413**	**306**	**292**	**1,425**	**180**	**266**	**388**	**1,149**	**575**	**601**	**198**	**18,574**	**100**
Total No. of Species	**13**	**17**	**12**	**7**	**13**	**15**	**17**	**21**	**17**	**24**	**10**	**11**	**11**	**15**	**15**	**20**	**9**	**8**	**13**	**12**	**53**	

Table B-12 Biomass (kg) of epibenthic macroinvertebrates collected in the Summer 2022 and Winter 2023 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	Total	%
Strongylocentrotus fragilis								0.004									62.5	23.5	20.0	0.219	106.263	65
Lytechinus pictus		0.260	0.309	1.016	7.972	12.6	0.053	0.080	1.635	0.065	0.916	0.155	0.219	0.030	0.170	0.050	0.245	0.266	0.134	0.012	26.166	16
Sicyonia ingentis	0.003	0.005			0.006	0.010	0.001	0.060	0.015	0.067	0.070	0.003	0.015	0.004	0.010	0.001	0.022	1.416	3.116	1.616	6.440	3.9
Ophiura luetkenii	1.916	1.515	1.516		0.003	0.003	0.030	0.004	0.059	0.001			1.316	0.001	0.001	0.019					6.384	3.9
Pleurobranchaea californica	0.018	0.050	0.052	0.020	0.095	0.260	0.515	1.195	0.012	0.004	0.070	1.695	0.259	0.566	0.022	0.140	0.465		0.055	0.609	6.102	3.7
Apostichopus californicus					0.645	0.660	0.010	0.125						0.966		0.645	0.845				3.896	2.4
Luidia foliolata			0.045	0.011			0.008	0.095	0.157	0.360	0.180	0.046	0.216	0.003	0.030	0.028	0.766	0.116	0.013	0.095	2.169	1.3
Platymera gaudichaudii				0.210	0.230										0.410						0.850	0.5
Sicyonia penicillata						0.110		0.085		0.102		0.070		0.110		0.310					0.787	0.5
Luidia armata	0.160	0.010				0.003			0.028	0.030			0.336		0.115	0.006					0.688	0.4
Thesea sp B	0.001	0.008	0.007		0.050	0.140	0.035	0.070	0.063	0.120	0.015	0.027	0.020	0.017	0.065	0.047					0.685	0.4
Octopus rubescens							0.017	0.008		0.007		0.315		0.106		0.050	0.085				0.588	0.4
Astropecten californicus	0.001	0.040	0.024	0.017		0.004	0.010	0.015	0.043	0.033	0.003	0.070	0.017	0.027	0.055	0.040	0.085	0.001	0.030	0.005	0.520	0.3
Octopus californicus																			0.520		0.520	0.3
Metacarcinus anthonyi																				0.416	0.416	0.3
Octopus veligero							0.019										0.040		0.039	0.115	0.213	0.1
Hamatoscalpellum californicum	0.001	0.005	0.005		0.001	0.025	0.023	0.021	0.010	0.039	0.001	0.004	0.001	0.008	0.020	0.020					0.184	0.1
Paguristes parvus					0.001		0.130		0.001	0.001										0.001	0.134	0.1
Calinaticina oldroydii																			0.085		0.085	0.1
Luidia asthenosoma			0.045			0.001	0.005	0.009	0.004	0.001	0.003	0.006	0.001	0.001		0.001			0.006		0.083	0.1
Crossata ventricosa							0.070														0.070	<0.1
Philine auriformis	0.005	0.010	0.010	0.001	0.004		0.001	0.001	0.008	0.001	0.001		0.001								0.043	<0.1
Ophiothrix spiculata	0.001	0.001	0.001		0.001	0.003	0.003	0.001	0.007	0.002	0.001	0.001		0.001	0.001	0.002					0.026	<0.1
Pteropurpura macroptera									0.012	0.012											0.024	<0.1
Loxorhynchus crispatus		0.020	0.001							0.002											0.023	<0.1
Rossia pacifica																		0.001		0.015	0.016	<0.1
Acanthodoris brunnea	0.001							0.001	0.001	0.008					0.001	0.001					0.013	<0.1
Cancellaria cooperii																		0.002	0.007		0.009	<0.1

Table B-12 Biomass (kg) of epibenthic macroinvertebrates collected in the Summer 2022 and Winter 2023 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	Total	%
Megasurcula sp										0.009											0.009	<0.1
Tritonia sp										0.009											0.009	<0.1
Orthopagurus minimus		0.003	0.001						0.001	0.001						0.001					0.007	<0.1
Coryrhynchus lobifrons					0.001				0.004							0.001					0.006	<0.1
Pyromaia tuberculata		0.001		0.003			0.001			0.001											0.006	<0.1
Acanthoptilum sp		0.001				0.001				0.001				0.001		0.001					0.005	<0.1
Megasurcula carpenteriana	0.005																				0.005	<0.1
Amphichondrius granulatus					0.001										0.001	0.001					0.003	<0.1
Baptodoris mimetica						0.002										0.001					0.003	<0.1
Neocrangon zacae																			0.001	0.002	0.003	<0.1
Astropecten sp						0.002															0.002	<0.1
Heterogorgia sp								0.001						0.001							0.002	<0.1
Heterogorgia tortuosa		0.001													0.001						0.002	<0.1
Latulambrus occidentalis	0.002																				0.002	<0.1
Tritia insculpta																		0.001	0.001		0.002	<0.1
Armina californica		0.001																			0.001	<0.1
Calliostoma turbinum								0.001													0.001	<0.1
Cancellaria crawfordiana								0.001													0.001	<0.1
Dendronotus iris								0.001													0.001	<0.1
Doryteuthis opalescens	0.001																				0.001	<0.1
Ericerodes hemphillii								0.001													0.001	<0.1
Flabellinopsis iodinea		0.001																			0.001	<0.1
Luidia sp															0.001						0.001	<0.1
Metacrangon spinosissima																				0.001	0.001	<0.1
Stylasterias forreri										0.001											0.001	<0.1
Total	**2.115**	**1.932**	**2.016**	**1.278**	**9.010**	**13.8**	**0.931**	**1.779**	**2.060**	**0.877**	**1.260**	**2.392**	**2.401**	**1.842**	**0.903**	**1.365**	**65.0**	**25.3**	**24.0**	**3.106**	**163.473**	**100**

Table B-13 Abundance and species richness of demersal fishes collected in the Summer 2022 and Winter 2023 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	**T2**	**T24**	**T6**	**T18**	**T23**		**T22**		**T1**		**T12**		**T17**		**T11**		**T10**	**T25**	**T14**	**T19**		
Nominal Depth (m)	**35**	**36**	**36**	**36**	**58**		**60**		**55**		**57**		**60**		**60**		**137**	**137**	**137**	**137**		
Season	**S**	**S**	**S**	**S**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**S**	**S**	**S**	**Total**	**%**
Citharichthys sordidus		218	148		311	1,037	418	619	591	271	724	585	658	464	1,029	726	299	682	897	1,007	10,684	42.4
Icelinus quadriseriatus	129	144	120	13	59	293	39	544	177	441	529	277	495	331	106	1129				1	4,827	19.1
Citharichthys stigmaeus	310	83	193	924					1												1,511	6.0
Zaniolepis latipinnis					2	58		31	2	68	27	406	2	501		114				5	1,216	4.8
Citharichthys xanthostigma	44	15	1		12	30	56	8	427	37	424	25	98	2	13	2					1,194	4.7
Microstomus pacificus					1	19		3	1			33	1	59		15	256	317	280	92	1,077	4.3
Chitonotus pugetensis	33	97	104	52	10	71	4	107	25	70	134	65	25	17	57	99	20		3	57	1,050	4.2
Sebastes saxicola																	281	253	180	172	886	3.5
Symphurus atricaudus	15	1	6	2	16	82	9	87	34	107	24	91	30	100	22	93	2	3			724	2.9
Zaniolepis frenata						3				1				1		6	212	124	116	44	507	2.0
Lyopsetta exilis																	78	126	103	39	346	1.4
Hippoglossina stomata	24	35	10	4	3	36	3	9	11	13	2	5	6	2	16	11	7	1	3		201	0.8
Parophrys vetulus					1	71			17	12		3		6	4	43	1		15	1	174	0.7
Zalembius rosaceus						37		40		8		9		47	12	8		2			163	0.6
Pleuronichthys verticalis	2	2	3	2	3	16	2	4	6	16	5	7	4	9	8	29	2	1	3		124	0.5
Scorpaena guttata	5	1	1		14	1	2	7	20	1	18	1	11		33			2	1	3	121	0.5
Odontopyxis trispinosa		2	2		1	2	6	4	5	11	9	5	7	3	6	12					75	0.3
Lycodes pacificus																	18	15	22	15	70	0.3
Sebastes semicinctus						1		2		3				1			5	23	4	1	40	0.2
Sebastes elongatus																	5	11	9	14	39	0.2
Porichthys notatus						1		4						2		1	3	1	1	17	30	0.1
Sebastes chlorostictus																	11	11	1	1	24	0.1
Raja inornata				1			1	2	1	1		7			2		2			2	19	0.1
Argentina sialis															16	2					18	0.1
Synodus lucioceps		1	1						7	1	3		2		2						17	0.1
Xystreurys liolepis	5		2	6							1				1	1					16	0.1
Merluccius productus																			9	1	10	<0.1
Sebastes macdonaldi																	1	2	3	2	8	<0.1
Chilara taylori						1										2	1	1		2	7	<0.1

Table B-13 Abundance and species richness of demersal fishes collected in the Summer 2022 and Winter 2023 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	**T2**	**T24**	**T6**	**T18**	**T23**		**T22**		**T1**		**T12**		**T17**		**T11**		**T10**	**T25**	**T14**	**T19**		
Nominal Depth (m)	**35**	**36**	**36**	**36**	**58**		**60**		**55**		**57**		**60**		**60**		**137**	**137**	**137**	**137**		
Season	**S**	**S**	**S**	**S**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**S**	**S**	**S**	**Total**	**%**
Agonopsis sterletus					1	2		2								1					6	<0.1
Glyptocephalus zachirus																		1	2	2	5	<0.1
Sebastes levis																	2	2		1	5	<0.1
Paralabrax nebulifer	1		2																		3	<0.1
Sebastes rosenblatti																			3		3	<0.1
Plectobranchus evides																				2	2	<0.1
Syngnathus californiensis						1						1									2	<0.1
Xeneretmus ritteri																	2				2	<0.1
Engraulis mordax									1												1	<0.1
Kathetostoma averruncus																		1			1	<0.1
Rhinogobiops nicholsii									1												1	<0.1
Sebastes sp																		1			1	<0.1
Total Abundance	**568**	**599**	**593**	**1,004**	**434**	**1762**	**540**	**1,473**	**1,327**	**1,061**	**1,900**	**1,520**	**1,339**	**1,545**	**1,327**	**2,294**	**1,208**	**1,580**	**1,655**	**1,481**	**25,210**	**100**
Total No. of Species	**10**	**11**	**13**	**8**	**13**	**19**	**10**	**16**	**17**	**16**	**12**	**15**	**12**	**15**	**15**	**18**	**20**	**21**	**19**	**22**	**41**	

Table B-14 Biomass (kg) of demersal fishes collected in the Summer 2022 and Winter 2023 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	Total	%
Citharichthys sordidus		1.216	0.617		3.590	11.792	7.876	5.036	3.230	1.632	4.402	7.198	3.406	3.816	5.078	8.185	5.715	5.255	10.29	4.032	92.366	26
Citharichthys xanthostigma	1.916	0.160	0.015		0.555	1.466	3.586	0.230	28.266	1.213	27.828	1.370	3.796	0.100	1.104	0.196					71.801	20.2
Microstomus pacificus					0.076	0.771		0.110	0.054			1.230	0.010	2.516		0.572	8.586	8.332	5.816	2.786	30.859	8.7
Scorpaena guttata	1.416	0.138	0.220		3.540	0.180	0.346	1.496	3.284	0.142	7.086	0.120	2.086		7.100			0.391	0.220	0.816	28.581	8.0
Zaniolepis latipinnis					0.008	1.056		0.690	0.037	1.060	0.014	5.032	0.009	5.080		1.127				0.095	14.208	4.0
Icelinus quadriseriatus	0.219	0.340	0.212	0.011	0.215	0.906	0.140	1.656	0.635	1.435	1.766	0.746	1.316	0.710	0.258	3.615				0.005	14.185	4.0
Sebastes saxicola																	5.002	5.432	0.216	2.786	13.436	3.8
Hippoglossina stomata	0.734	2.216	0.684	0.466	0.250	3.216	0.476	0.696	0.439	1.003	0.140	0.234	0.170	0.160	0.594	1.004	0.329	0.090	0.356		13.257	3.7
Parophrys vetulus					0.150	2.130			1.870	1.820		0.150		0.450	0.071	2.632	0.280		2.716	0.150	12.419	3.5
Symphurus atricaudus	0.259	0.016	0.115	0.035	0.270	1.316	0.158	1.556	0.616	1.919	0.350	2.016	0.470	1.360	0.373	1.344	0.004	0.055			12.232	3.4
Raja inornata				0.530			0.446	0.916	0.920	0.220		2.694			0.917		0.100			1.180	7.923	2.2
Pleuronichthys verticalis	0.109	0.048	0.430	0.066	0.305	0.966	0.140	0.540	0.468	0.938	0.316	0.260	0.060	0.372	0.456	1.466	0.446	0.130	0.186		7.702	2.2
Citharichthys stigmaeus	1.116	0.410	0.630	4.050					0.005												6.211	1.7
Zaniolepis frenata						0.065				0.008				0.009		0.065	2.986	1.073	1.036	0.365	5.607	1.6
Chitonotus pugetensis	0.119	0.410	0.242	0.095	0.085	0.339	0.030	0.496	0.170	0.320	1.120	0.281	0.160	0.100	0.179	0.611	0.159		0.030	0.510	5.456	1.5
Lyopsetta exilis																	1.246	1.666	1.316	0.405	4.633	1.3
Zalembius rosaceus						0.696		0.807		0.261		0.135		0.535	0.332	0.124		0.080			2.970	0.8
Xystreurys liolepis	0.209		0.160	1.016							0.180				1.000	0.009					2.574	0.7
Merluccius productus																			1.391	0.180	1.571	0.4
Paralabrax nebulifer	0.466		0.916																		1.382	0.4
Sebastes semicinctus						0.001		0.001		0.003				0.001			0.159	0.816	0.140	0.028	1.149	0.3
Synodus lucioceps		0.060	0.060						0.505	0.085	0.160		0.110		0.150						1.130	0.3
Porichthys notatus						0.018		0.100						0.060		0.034	0.099	0.018	0.003	0.370	0.702	0.2
Lycodes pacificus																	0.179	0.183	0.180	0.115	0.657	0.2
Sebastes chlorostictus																	0.245	0.230	0.030	0.012	0.517	0.1
Glyptocephalus zachirus																		0.110	0.275	0.120	0.505	0.1
Kathetostoma averruncus																		0.240			0.240	0.1
Sebastes elongatus																	0.110	0.050	0.027	0.024	0.211	0.1
Odontopyxis trispinosa		0.003	0.010		0.004	0.004	0.015	0.008	0.012	0.024	0.020	0.010	0.030	0.003	0.012	0.026					0.181	0.1

Table B-14 Biomass (kg) of demersal fishes collected in the Summer 2022 and Winter 2023 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	Total	%
Sebastes macdonaldi																	0.040	0.040	0.038	0.012	0.130	<0.1
Chilara taylori						0.006										0.028	0.013	0.013		0.055	0.115	<0.1
Sebastes rosenblatti																			0.100		0.100	<0.1
Sebastes levis																	0.030	0.014		0.016	0.060	<0.1
Agonopsis sterletus					0.009	0.015		0.019								0.008					0.051	<0.1
Argentina sialis															0.037	0.005					0.042	<0.1
Xeneretmus ritteri																	0.038				0.038	<0.1
Plectobranchus evides																				0.012	0.012	<0.1
Rhinogobiops nicholsii									0.006												0.006	<0.1
Engraulis mordax									0.003												0.003	<0.1
Syngnathus californiensis						0.001						0.002									0.003	<0.1
Sebastes sp																		0.001			0.001	<0.1
Total	**6.563**	**5.017**	**4.311**	**6.269**	**9.057**	**24.94**	**13.21**	**14.36**	**40.52**	**12.08**	**43.38**	**21.48**	**11.62**	**15.27**	**17.66**	**21.05**	**25.77**	**24.22**	**24.37**	**14.07**	**355.226**	**100**

Table B-15 Summary statistics of OC San's Core shoreline (surfzone) stations for total coliform, fecal coliform, and enterococci by station during the 2022-23 program year. Station 0 = mouth of the Santa Ana River.

	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	<17.00	15	67	1	<17.00	28	380	2	<17.00	54	1200	5	<17.00	14	17	1	<17.00	24	1200	3
33N	<17.00	15	50	1	<17.00	19	300	2	<17.00	42	600	4	<17.00	13	17	1	<17.00	20	600	2
27N	<17.00	15	67	1	<17.00	21	2500	4	<17.00	35	1400	5	<17.00	13	17	1	<17.00	20	2500	3
21N	<17.00	14	33	1	<17.00	18	130	2	<17.00	54	1600	6	<17.00	13	33	1	<17.00	21	1600	3
15N	<17.00	21	150	2	<17.00	25	300	3	<17.00	49	2100	6	<17.00	17	50	1	<17.00	26	2100	3
12N	<17.00	19	67	1	<17.00	27	270	3	<17.00	57	1100	5	<17.00	16	50	1	<17.00	26	1100	3
9N	<17.00	25	120	2	<17.00	23	900	2	<17.00	53	>1200	5	<17.00	16	120	1	<17.00	27	>1200	3
6N	<17.00	34	700	3	<17.00	44	1100	4	<17.00	58	1400	4	<17.00	16	67	1	<17.00	36	1400	3
3N	<17.00	21	400	2	<17.00	26	1600	2	<17.00	109	>2800	5	<17.00	18	67	1	<17.00	32	>2800	3
0	<17.00	19	130	1	<17.00	41	1900	4	<17.00	240	>20000	10	<17.00	20	83	1	<17.00	43	>20000	5
3S	<17.00	15	50	1	<17.00	55	>20000	10	<17.00	335	>20000	17	<17.00	19	130	2	<17.00	48	>20000	9
6S	<17.00	13	17	1	<17.00	34	>8900	6	<17.00	159	>3900	8	<17.00	15	67	1	<17.00	32	>8900	5
9S	<17.00	14	33	1	<17.00	28	>2200	4	<17.00	107	>3000	8	<17.00	18	130	2	<17.00	30	>3000	4
15S	<17.00	13	17	1	<17.00	26	>3800	5	<17.00	79	>3400	8	<17.00	16	50	1	<17.00	26	>3800	4
21S	<17.00	16	33	1	<17.00	19	100	2	<17.00	64	>4900	5	<17.00	14	33	1	<17.00	23	>4900	2
27S	<17.00	14	33	1	<17.00	15	33	1	<17.00	47	2900	6	<17.00	16	100	1	<17.00	20	2900	2
29S	<17.00	15	33	1	<17.00	21	100	2	<17.00	49	>1200	5	<17.00	14	33	1	<17.00	22	>1200	2
39S	<17.00	14	33	1	<17.00	17	230	2	<17.00	42	>3300	6	<17.00	14	83	1	<17.00	20	>3300	3
All	<17.00	17	700	0.57	<17.00	27	>20000	2.11	<17.00	91	>20000	3.05	<17.00	16	130	0.32	<17.00	28	>20000	1.65

Table B-15 Summary statistics of OC San's Core shoreline (surfzone) stations for total coliform, fecal coliform, and enterococci by station during the 2022-23 program year. Station 0 = mouth of the Santa Ana River.

	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	<17.00	13	17	1	<17.00	22	420	2	<17.00	22	700	2	<17.00	13	17	1	<17.00	17	700	2
33N	<17.00	15	83	1	<17.00	15	67	1	<17.00	16	33	1	<17.00	13	17	1	<17.00	15	83	1
27N	<17.00	13	17	1	<17.00	18	500	2	<17.00	17	83	1	<17.00	13	17	1	<17.00	15	500	1
21N	<17.00	13	17	1	<17.00	13	17	1	<17.00	19	180	2	<17.00	12	<17	1	<17.00	14	180	1
15N	<17.00	13	17	1	<17.00	15	67	1	<17.00	20	130	2	<17.00	15	83	1	<17.00	15	130	1
12N	<17.00	14	33	1	<17.00	19	83	1	<17.00	17	67	1	<17.00	13	17	1	<17.00	16	83	1
9N	<17.00	17	83	1	<17.00	18	150	1	<17.00	20	220	2	<17.00	15	100	1	<17.00	17	220	1
6N	<17.00	36	560	2	<17.00	37	4700	4	<17.00	21	130	2	<17.00	18	100	1	<17.00	29	4700	3
3N	<17.00	17	380	2	<17.00	18	220	2	<17.00	27	400	2	<17.00	15	83	1	<17.00	19	400	2
0	<17.00	16	67	1	<17.00	19	270	2	<17.00	49	4400	4	<17.00	14	33	1	<17.00	21	4400	2
3S	<17.00	13	17	1	<17.00	27	1700	4	<17.00	100	>20000	11	<17.00	13	17	1	<17.00	26	>20000	5
6S	<17.00	13	17	1	<17.00	19	1600	3	<17.00	30	540	3	<17.00	13	17	1	<17.00	17	1600	2
9S	<17.00	13	17	1	<17.00	19	620	2	<17.00	27	370	3	<17.00	14	33	1	<17.00	17	620	2
15S	<17.00	13	17	1	<17.00	18	450	2	<17.00	32	1700	4	<17.00	14	33	1	<17.00	18	1700	2
21S	<17.00	13	17	1	<17.00	13	17	1	<17.00	25	250	2	<17.00	13	17	1	<17.00	15	250	1
27S	<17.00	12	<17	1	<17.00	13	33	1	<17.00	20	220	2	<17.00	15	67	1	<17.00	15	220	1
29S	<17.00	13	17	1	<17.00	14	50	1	<17.00	22	300	2	<17.00	16	33	1	<17.00	16	300	1
39S	<17.00	13	17	1	<17.00	15	33	1	<17.00	22	2400	4	<17.00	13	33	1	<17.00	15	2400	2
All	<17.00	15	560	0.32	<17.00	18	4700	1.00	<17.00	28	>20000	2.26	<17.00	14	100	0.00	<17.00	18	>20000	1.02

Table B-15 Summary statistics of OC San's Core shoreline (surfzone) stations for total coliform, fecal coliform, and enterococci by station during the 2022-23 program year. Station 0 = mouth of the Santa Ana River.

	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	3	18	2	<2.00	10	140	4	<2.00	11	>400	6	<2.00	3	12	2	<2.00	5	>400	4
33N	<2.00	3	24	2	<2.00	7	98	4	<2.00	11	150	5	<2.00	2	22	2	<2.00	5	150	4
27N	<2.00	4	52	3	<2.00	7	>400	5	<2.00	11	356	6	<2.00	2	10	1	<2.00	5	>400	4
21N	<2.00	5	38	3	<2.00	5	20	2	<2.00	13	408	8	<2.00	3	10	2	<2.00	6	408	4
15N	<2.00	3	14	2	2	8	142	3	<2.00	12	236	6	<2.00	1	4	1	<2.00	5	236	3
12N	<2.00	3	14	2	4	12	54	2	<2.00	10	238	5	<2.00	2	10	1	<2.00	5	238	3
9N	<2.00	6	42	3	<2.00	9	146	3	<2.00	13	196	5	<2.00	2	24	2	<2.00	7	196	3
6N	<2.00	14	>400	4	2	23	>400	4	<2.00	19	174	4	<2.00	4	40	2	<2.00	14	>400	4
3N	<2.00	3	>400	3	<2.00	8	202	3	<2.00	28	338	4	<2.00	2	16	2	<2.00	6	>400	4
0	<2.00	2	14	1	<2.00	10	300	5	<2.00	42	>400	6	<2.00	2	16	1	<2.00	7	>400	5
3S	<2.00	3	76	3	<2.00	12	>400	7	14	88	>400	4	<2.00	3	34	3	<2.00	11	>400	7
6S	<2.00	2	10	2	<2.00	8	>400	5	<2.00	46	>400	6	<2.00	4	24	2	<2.00	8	>400	6
9S	<2.00	2	6	1	<2.00	7	>400	6	2	48	>400	6	<2.00	3	44	2	<2.00	7	>400	6
15S	<2.00	2	8	1	<2.00	8	>400	5	2	40	>400	5	<2.00	4	20	2	<2.00	7	>400	5
21S	<2.00	2	8	1	<2.00	4	>400	5	4	26	>400	4	<2.00	3	14	2	<2.00	5	>400	4
27S	<2.00	2	10	1	<2.00	3	34	3	<2.00	22	>400	5	<2.00	3	28	2	<2.00	4	>400	4
29S	<2.00	5	34	2	<2.00	9	50	3	<2.00	18	>400	5	<2.00	4	12	2	<2.00	7	>400	3
39S	<2.00	2	14	2	<2.00	2	62	2	<2.00	11	>2000	9	<2.00	2	8	1	<2.00	3	>2000	4
All	<2.00	4	>400	0.90	<2.00	8	>400	1.43	<2.00	26	>2000	1.34	<2.00	3	44	0.55	<2.00	6	>2000	1.13

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

INTRODUCTION – FINAL EFFLUENT MONITORING QA/QC

The Orange County Sanitation District's (OC San) Final 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 Final Effluent Monitoring Program complies with OC San's 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 2022 and 2023). The objectives of the quality assurance program are as follows:

- 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 2022-23 Final 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 2022-23 program year.

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	0.02	0.05	Turbidity	0.1	0.2
Parameter	**MDL (mg/L)**	**RL (mg/L)**	**Parameter**	**MDL (µg/L)**	**RL (µg/L)**
Nutrients					
Ammonia Nitrogen [b]	0.649	1	TKN	0.670	1
Ammonia Nitrogen [c]	0.272	1	Cyanide [f]	2.32	5
Ammonia Nitrogen [d]	0.250	1	Cyanide [g]	2.22	5
Ammonia Nitrogen [e]	0.376	1			
Parameter	**MDL (mg/L)**	**RL (mg/L)**	**Parameter**	**MDL (mg/L)**	**RL (mg/L)**
Aggregate Organics					
BOD (Total)	—	0.2	Oil and Grease	1.36	2.5
BOD (Carbonaceous)	—	0.2			
Parameter	**MDL (mg/L)**	**RL (mg/L)**	**Parameter**	**MDL (mL/L)**	**RL (mL/L)**
Solids					
Total Suspended Solids (TSS)	0.0029	1	Settleable solids	—	0.1

Table C-1 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at OC San's laboratory during the 2022-23 program year.

Parameter	**MDL (µg/L)**	**RL (µg/L)**	**Parameter**	**MDL (µg/L)**	**RL (µg/L)**
Metals					
Antimony	0.094	0.1	Manganese	0.462	0.5
Arsenic	0.121	0.2	Molybdenum	0.079	1
Barium	0.138	0.2	Nickel	0.196	0.2
Beryllium	0.037	0.1	Phosphorus	0.070	0.2
Cadmium	0.054	0.1	Selenium	0.355	0.4
Chromium	0.169	0.2	Silver	0.115	0.125
Copper	0.429	0.45	Thallium	0.058	0.1
Lead	0.09	0.1	Zinc	1.81	1.9
Parameter	**MDL (µg/L)**	**RL (µg/L)**	**Parameter**	**MDL (µg/L)**	**RL (µg/L)**
Purgeable Organic Compounds					
Acrolein	0.37	5	1,1-Dichloroethane	0.55	1
Acrylonitrile	0.97	2	1,2-Dichloroethane	1.37	2
Benzene	1.17	2	1,1-Dichloroethene	1.25	2
Bromodichloromethane	1.24	2	trans-1,2-Dichloroethene	0.49	—
Bromoform	0.81	2	1,2-Dichloropropane	0.57	—
Bromomethane	0.65	2	cis-1,3-Dichloropropene	1.20	[h]
Carbon Tetrachloride	1.17	2	trans-1,3-Dichloropropene	1.23	[h]
Chlorobenzene	0.88	2	Ethylbenzene	1.07	2
Chloroethane	1.29	—	Methylene chloride	0.94	2
2-Chloroethylvinyl ether	0.62	—	1,1,2,2-Tetrachloroethane	0.50	2
Chloroform	1.56	2	Tetrachloroethene	1.26	2
Chloromethane	0.55	2	Toluene	1.19	2
Dibromochloromethane	1.14	2	1,1,1-Trichloroethane	1.28	2
1,2-Dichlorobenzene	1.03	2	1,1,2-Trichloroethane	1.17	2
1,3-Dichlorobenzene	1.08	2	Trichloroethene	1.23	2
1,4-Dichlorobenzene	0.97	2	Vinyl chloride	1.09	2

Table C-1 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at OC San's laboratory during the 2022-23 program year.

Parameter	MDL (ng/L)	RL (ng/L)	Parameter	MDL (ng/L)	RL (ng/L)
Per- and Polyfluoroalkyl Substances (PFAS)					
PFDA (Perfluorodecanoic acid)	1.26	3	PFTeDA (Perfluorotetradecanoic acid)	0.91	3
PFDoA (Perfluorododecanoic acid)	0.90	3	PFTrDA (Perfluorotridecanoic acid)	1.26	3
PFHxA (Perfluorohexanoic acid)	1.58	3	PFUnDA (Perfluoroundecanoic acid)	0.91	3
PFHpA (Perfluoroheptanoic acid)	1.18	3	PFBS (Perfluorobutane sulfonic acid)	0.60	3
PFNA (Perfluorononanoic acid)	0.89	3	PFHxS (Perfluorohexane sulfonic acid)	2.20	3
PFOA (Perfluorooctanoic acid)	1.17	3	PFOS (Perfluorooctane sulfonic acid)	0.81	3
Parameter	**MDL (ng/L)**	**RL (ng/L)**	**Parameter**	**MDL (ng/L)**	**RL (ng/L)**
Hormone Compounds					
17a-Estradiol	1.83	4	Estrone	0.64	4
17a-Ethynylestradiol	1.41	4	Progesterone	0.29	4
17b-Estradiol	0.40	4	Testosterone	1.05	4
Estriol	0.41	4			

[a] Traditional MDLs and RLs do not apply to pH measurements.
[b] July 2022 – December 2022
[c] January 2023 – February 2023
[d] February 2023 – June 2023
[e] June 2023
[f] July 2022 – October 2022
[g] November 2022 – June 2023
[h] 1,3-Dichloropropene @ 2 µg/L

Table C-2 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at OC San's laboratory during the 2022-23 program year.

Parameter	MDL [a] (µg/L)	RL [a] (µg/L)	MDL [b] (µg/L)	RL [b] (µg/L)
Base/Neutral Extractables				
Azobenzene	0.19	1	0.42	1
1,2,4-Trichlorobenzene	0.64	2	0.55	1
1,2-Dichlorobenzene	0.81	2	0.72	1
1,3-Dichlorobenzene	0.83	1	0.67	1
1,4-Dichlorobenzene	0.85	1	0.78	1
Acenaphthene	0.34	1	0.43	1
Acenaphthylene	0.24	1	0.34	1
Anthracene	0.21	1	0.4	1
Benzidine	2.23	5	3.19	5
Benz(a)anthracene	0.32	1	0.47	1
Benzo(a)pyrene	0.28	1	0.47	1
Benzo(b)fluoranthene	0.34	1	0.43	1
Benzo(k)fluoranthene	0.28	1	0.4	1
Benzo(g,h,i)perylene	0.37	1	0.36	1
Butyl benzyl phthalate	0.43	2	0.48	1
bis(2-Chloroethoxy)methane	0.45	2	0.49	1
bis(2-Chloroethyl)ether	0.78	1	0.6	1
bis(2-Ethylhexyl)phthalate	0.23	1	0.54	1
4-Bromophenyl phenyl ether	0.22	1	0.39	1
2-Chloronaphthalene	0.38	1	0.39	1
4-Chlorophenyl phenyl ether	0.26	1	0.34	1
Chrysene	0.24	1	0.44	1
Dibenz(a,h)anthracene	0.23	1	0.38	1
Di-n-butylphthalate	0.33	1	0.5	1
3,3'-Dichlorobenzidine	0.25	1	0.4	1
Diethyl phthalate	0.56	2	0.5	1
Dimethyl phthalate	1.01	2	0.77	1
2,4-Dinitrotoluene	0.23	1	0.43	1
2,6-Dinitrotoluene	0.12	1	0.29	1
Di-n-octylphthalate	0.35	2	0.61	2
Fluoranthene	0.32	1	0.45	1
Fluorene	0.27	1	0.36	1
Hexachlorobenzene	0.21	1	0.45	1
Hexachlorobutadiene	0.66	1	0.56	1
Hexachlorocyclopentadiene	1.52	5	1.34	5
Hexachloroethane	0.69	1	0.69	1
Indeno(1,2,3-c,d)pyrene	0.32	1	0.37	1
Isophorone	0.43	1	0.45	1
Naphthalene	0.67	2	0.54	1
Nitrobenzene	0.71	1	0.6	1
n-Nitrosodimethylamine	1.06	5	0.82	2
n-Nitrosodi-n-propylamine	0.55	2	0.46	1

Table C-2 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at OC San's laboratory during the 2022-23 program year.

Parameter	MDL [a] (µg/L)	RL [a] (µg/L)	MDL [b] (µg/L)	RL [b] (µg/L)
n-Nitrosodiphenylamine	0.2	1	0.45	1
2,2′-Oxybis(1-chloropropane)	0.73	2	0.58	1
Phenanthrene	0.17	0.5	0.4	1
Pyrene	0.37	1	0.46	1
Acid Extractables				
4-Chloro-3-methylphenol	0.25	1	0.42	1
2-Chlorophenol	0.15	0.5	0.56	1
2,4-Dichlorophenol	0.15	0.5	0.57	1
2,4-Dimethylphenol	0.16	0.5	0.71	1
2,4-Dinitrophenol	1.2	5	2.15	5
4,6-Dinitro-2-methylphenol	0.53	2	0.87	2
2-Nitrophenol	0.16	0.5	0.54	1
4-Nitrophenol	0.19	1	0.26	1
Pentachlorophenol	0.21	1	0.51	1
Phenol	0.1	0.5	0.33	1
2,4,6-Trichlorophenol	0.18	1	0.37	1

[a] July 2022–March 2023.
[b] April 2023–June 2023.

Table C-3 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at contract laboratories during the 2022-23 program year.

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)**		**MDL (ng/L)**	**RL (ng/L)**
Metals					
Chromium	0.089	0.2	Mercury	0.1	0.5
Chromium, Hexavalent	0.0079	0.02			
Parameter	**MDL (µg/L)**	**RL (µg/L)**	**Parameter**	**MDL (µg/L)**	**RL (µg/L)**
Organochlorine Pesticides					
2,4'-DDD	0.0011	0.005	Dieldrin	0.0017	0.005
2,4'-DDE	0.00094	0.005	Endosulfan I	0.0019	0.005
2,4'-DDT	0.0019	0.005	Endosulfan II	0.0019	0.005
4,4´-DDD	0.0027	0.005	Endosulfan sulfate	0.0013	0.005
4,4´-DDE	0.0018	0.005	Endrin	0.0017	0.005
4,4´-DDT	0.0028	0.005	Endrin aldehyde	0.0019	0.005
Aldrin	0.001	0.005	Heptachlor	0.0023	0.005
alpha-BHC	0.0011	0.005	Heptachlor epoxide	0.0018	0.005
beta-BHC	0.0015	0.005	Methoxychlor	0.0038	0.005
delta-BHC	0.0019	0.005	Mirex	0.0012	0.005
gamma-BHC (Lindane)	0.0015	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

Table C-3 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at contract laboratories during the 2022-23 program year.

Parameter	MDL (µg/L)	RL (µg/L)	Parameter	MDL (µg/L)	RL (µg/L)
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	0.083	0.1	PCB 1260	0.055	0.1
PCB 1242	0.095	0.1			
Parameter	**MDL (pg/L)**	**RL (pg/L)**	**Parameter**	**MDL (pg/L)**	**RL (pg/L)**
PCBs as Congeners					
PCB 18	0.59	400	PCB 128	0.53	400
PCB 28	0.95	400	PCB 138	0.56	600
PCB 37	1.1	200	PCB 149	0.56	400
PCB 44	1	600	PCB 151	0.57	400
PCB 49	0.93	400	PCB 153	0.45	400
PCB 52	1.1	200	PCB 156	0.52	40
PCB 66	0.69	200	PCB 157	0.52	40
PCB 70	0.73	800	PCB 158	0.42	200
PCB 74	0.73	800	PCB 167	0.4	20
PCB 77	0.89	20	PCB 168	0.45	400
PCB 81	0.99	20	PCB 169	0.45	20
PCB 87	0.83	1200	PCB 170	0.52	200
PCB 99	0.77	200	PCB 177	0.46	200
PCB 101	0.89	600	PCB 180	0.4	400
PCB 105	0.7	20	PCB 183	0.38	200
PCB 110	0.72	400	PCB 187	0.38	200
PCB 114	0.8	20	PCB 189	0.26	20
PCB 118	0.68	20	PCB 194	0.33	200
PCB 119	0.83	1200	PCB 201	0.3	200
PCB 123	0.77	20	PCB 206	0.72	200
PCB 126	0.8	20			

Table C-3 Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at contract laboratories during the 2022-23 program year.

Parameter	MDA Range (pCi/L)	RL (pCi/L)	Parameter	MDA Range (pCi/L)	RL (pCi/L)
Radiation [a]					
Gross Alpha	0.149-0.336	—	Strontium-90	0.565-1.86	—
Gross Beta	6.08-17.7	—	Tritium	245-647	—
Radium-226	0.176-1.46	—	Uranium	0.015	0.13
Radium-228	0.733-2.84	—			
Parameter	**MDL (mg/L)**	**RL (mg/L)**	**Parameter**	**MDL (mg/L)**	**RL (mg/L)**
Potassium	0.2	0.5	Total Dissolved Solids	4	10
Parameter	**MDL (µg/L)**	**RL (µg/L)**	**Parameter**	**MDL (µg/L)**	**RL (µg/L)**
Miscellaneous					
Tributyltin (Summer)	0.0023	0.005	Tributyltin (Fall-Spring)	0.0023	0.005
Pharmaceuticals and Primary Care Products					
Acetaminophen	5	5	Ibuprofen	4	4
Caffeine	4	4	Oxybenzone	4	4
Carbamazepine	4	4	Primidone	4	4
DEET	4	4	Sulfamethoxazole	4	4
Diclofenac	4	4	TCEP	10	10
Erythromycin	5	5	TCPP	50	50
Fluoxetine	4	4	TDCPP	50	50
Galaxolide	40	40	Triclosan	8	8
Gemfibrozil	4	4			
Parameter	**MDL (ng/L)**	**RL (ng/L)**	**Parameter**	**MDL (ng/L)**	**RL (ng/L)**
Pesticides and Insecticides					
Bifenthrin	1.1	2	Fipronil sulfone	1.2	2
Fipronil	1.7	2	Permethrin	1.4	5
Chlorpyrifos	1.3	10	Diazinon	1.0	10

Table C-3 **Method detection limit (MDL) and reporting limit (RL) for final effluent constituents analyzed at contract laboratories during the 2022-23 program year.**

Parameter	MDL (ng/L)	RL (ng/L)	Parameter	MDL (ng/L)	RL (ng/L)
Industrial Endocrine Disrupting Compounds – Alkylphenols and Alkylphenol Ethoxylates					
4-n-Octylphenol diethoxylate	72	100	4-tert-Octylphenolmonoethoxylate	28	100
4-n-Octylphenol m o n o e t h	38	100	Bisphenol A	116	200
4-Nonylphenol	10	100	Nonylphenol	19	100
4-Octylphenol	17	100	Nonylphenol diethoxylate	32	100
4-tert-Octylphenol	18	100	Nonylphenol monoethoxylate	16	100
4-tert-Octylphenol diethoxylate	44	100			
Parameter	**MDL (pg/L)**	**RL (pg/L)**	**Parameter**	**MDL (pg/L)**	**RL (pg/L)**
Flame Retardants (PBDEs)					
BDE-47	25.6	87.8	BDE-99	21	87.8
BDE-100	11.4	87.8	BDE-183/176	26.6	176
Parameter	**MDL Range (pg/L)**	**RL Range (pg/L)**	**Parameter**	**MDL Range (pg/L)**	**RL Range (pg/L)**
TCDD-Equivalents [a]					
1,2,3,4,6,7,8-Hepta CDD	4.3–5.3	24–47	1,2,3,7,8-Penta CDD	2.4–8.0	24–47
1,2,3,4,6,7,8-Hepta CDF	4.4–6.1	24–47	1,2,3,7,8-Penta CDF	2.6–6.4	24–47
1,2,3,4,7,8,9-Hepta CDF	4.8–7.0	24–47	2,3,4,6,7,8-Hexa CDF	4.0–5.9	24–47
1,2,3,4,7,8-Hexa CDD	4.3–6.3	24–47	2,3,4,7,8-Penta CDF	2.3–7.2	24–47
1,2,3,4,7,8-Hexa CDF	4.7–7.0	24–47	2,3,7,8-Tetra CDD	1.8–3.8	4.8–9.4
1,2,3,6,7,8-Hexa CDD	3.6–5.6	24–47	2,3,7,8-Tetra CDF	1.7–2.0	4.8–9.4
1,2,3,6,7,8-Hexa CDF	4.2–6.5	24–47	Octa CDD	12–17	48–94
1,2,3,7,8,9-Hexa CDD	4.6–5.8	24–47	Octa CDF	11–13	48–94
1,2,3,7,8,9-Hexa CDF	4.3–6.1	24–47			

[a] MDA values varied per testing period depending on verification studies performed, amount of sample used, and dilution factor.
[b] 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 is given in Table C-4, unless noted otherwise.

Physical Characteristics

Total Suspended Solids (TSS) were analyzed at the OC San laboratory using ELOM SOP 2540 D/E. For the 2022-23 program year, nearly all QC samples associated with this analysis met the method acceptance criteria. One blank spike sample failed to meet the method percent recovery range. The blank spike failed slightly low due to some residue being lost from the filter during the drying setup. Nine 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 at 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 four duplicate samples which were 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. This is a known potential issue with this analysis, and while the laboratory takes steps to ensure homogeneity, occasionally the issue cannot be avoided.

pH was analyzed at 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 from July 1, 2022, to April 3, 2023, and the field pH meter from April 4 through June 30, 2023. For this program year, all QC samples associated with this analysis met the method acceptance criteria.

Turbidity was analyzed at 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 at the OC San laboratory using ELOM SOP 9221E. During the monitoring period, 2 sample duplicates exceeded the precision criterion, possibly due to a non-homogenous sample.

Enterococci were analyzed at the OC San laboratory using ELOM SOP 9223B-9230D. During the monitoring period, all sample duplicates met the precision criterion. One enterococcus sample was not analyzed during the monitoring period due to the sample being lost in a lab accident.

Inorganic Nonmetals

Phosphorus analysis was performed at 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 and matrix spike duplicate set 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 at 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. Four blank samples exhibited detections for ammonia above the MDL, however, these detections in the blanks were judged to not have an adverse impact on the quality of the data within the associated batch of samples. A few issues were observed with the matrix spike and matrix spike duplicate accuracy 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 at 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 the 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 at Weck Laboratories in the City of Industry, CA, using EPA Method 353.2. A summary of the QC associated with this analysis is presented in Table C-5. For this monitoring period, most QC samples associated with the nitrate and nitrite analyses met the method acceptance criteria. One issue was observed with the matrix spike (MS) and matrix spike duplicate (MSD) accuracy where both the MS and MSD failed slightly high for nitrate. This issue was attributed to matrix interference. Overall data quality for that batch was not impacted.

Cyanide was primarily analyzed at 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. A few issues were observed with the 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, two of the monthly cyanide samples were sent to Weck Laboratories for analysis using EPA Method 335.4. A summary of the QC associated with this analysis is provided in Table C-5. For the samples analyzed by Weck Laboratories, the blank and blank spike QC samples associated with this analysis met the method acceptance criteria; one matrix spike duplicate was outside of recovery acceptance criteria, which also resulted in that MS/MSD pair being outside of precision acceptance criteria. Data in the affected batch were accepted after reviewing the other batch QC results.

Total residual chlorine was analyzed at 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. Seven 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 between the results.

Metals

On a monthly basis, final effluent samples were analyzed for a variety of heavy metals. A full list of metals analyzed, along with their associated method detection limits (MDLs), is presented in Table C-2. Metals analysis was performed at 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, final 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 is provided in Table C-5. For this program year, all QC samples associated with the mercury analysis met the method acceptance criteria.

On a monthly basis, from May 2022 through May 2023, samples of final effluent were sent to Weck Laboratories for analysis of total chromium and hexavalent chromium as part of a special study in response to consecutive performance goal exceedances for chromium. It was determined that all of the chromium detected in the final effluent is in the form of trivalent chromium, with all ND results for hexavalent chromium. A summary of the QC associated with these analyses is presented in Table C-5. For this program year, all QC samples associated with the total chromium analysis met the method acceptance criteria. For the hexavalent chromium analysis, one MS duplicate sample failed to meet the percent recovery criterion, which also resulted in a failure of the precision criterion for that MS/MSD pair. These failures were likely due to matrix effects. The associated sample results were accepted based on the other successful QC samples in the batch.

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), is provided in Table C-2 and Table C-3.

Semi-volatile organic compounds were analyzed at the OC San laboratory using ELOM SOP 625.1.

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

Per- and Polyfluoroalkyl Substances (PFAS) were analyzed once per calendar year at the OC San laboratory in accordance with the requirements in our NPDES permit. In August 2022, our annual PFAS compliance sample was analyzed using ELOM SOP 537-MOD. The only QC failures observed were for one single compound which exhibited moderately low recoveries in the matrix spike and matrix spike duplicates. These failures were likely due to matrix effects. The data in the affected batch were deemed acceptable after careful consideration of all the other passing QC samples. In March 2023, our annual PFAS compliance sample was analyzed using OC San Draft SOP 1633. Acceptance criteria for the LFB/LFBD and MS/MSD are derived from Table 5 of Draft 3 of EPA Method 1633. QC failures were observed for three compounds which exhibited low recoveries in the matrix spike and matrix spike duplicates. These failures were likely due to matrix effects. Also, four compounds failed to meet the precision criteria in the MS/MSD pairs. This lack of precision is likely due to a combination of matrix effects, and the manual extraction technique in use at the time. Since then, OC San has validated a method using an automated extraction technique, which should significantly reduce sample-to-sample variability. The data in the affected batch were deemed acceptable after careful consideration of all the other passing QC samples. The compounds which failed in the MS/MSD were not detected in any compliance samples.

Hormones were analyzed at the OC San laboratory using ELOM SOP 539. The only QC failures observed were in the matrix spike and matrix spike duplicates, for both the accuracy and precision criteria. These failures were likely due to matrix effects. The data in the affected batches were deemed acceptable after careful consideration of all the other passing QC samples.

TCDD equivalents were analyzed by Pace Analytical Services in Minneapolis, MN, for the summer quarter, and by Enthalpy Analytical in El Dorado Hills, CA, for the other quarters, using EPA Method 1613B. A summary of the QC associated with this analysis is presented in Table C-5. All QC samples associated with this analysis passed.

Tributyltin was analyzed by Weck Laboratories using Standard Method 6710 B. A summary of the QC associated with this analysis is presented in Table C-5. All QC samples associated with this analysis passed.

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 is provided in Table C-5. In one batch, the blank spike duplicate recovery failed for one compound. 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). All data were qualified with appropriate qualifier codes.

Individual PCB congeners were analyzed by Eurofins Sacramento in Sacramento, CA, using EPA Method 1668 C. A summary of the QC associated with this analysis is presented in Table C-5. All QC samples associated with this analysis passed.

Pharmaceuticals and Personal Care Products (PPCPs) and phosphate flame retardants were analyzed together by Weck Laboratories using EPA Method 1694 (modified). A summary of the QC associated with this analysis is presented in Table C-5. All QC samples associated with this analysis passed.

Pyrethroids were analyzed by Weck Laboratories using EPA Method 8270 (modified). A summary of the QC associated with this analysis is provided in Table C-5. All QC samples associated with this analysis passed.

Polybrominated Diphenyl Ethers (PBDEs) were analyzed by Enthalpy in El Dorado Hills, CA, using EPA Method 1614. A summary of the QC associated with this analysis is provided in Table C-5. All QC samples associated with this analysis passed.

Chlorpyrifos and Diazinon were analyzed by Weck Laboratories using EPA Method 625.1. A summary of the QC associated with this analysis is presented in Table C-5. Diazinon failed slightly low in the LCS (recovery of 66 %, low limit = 75 %). The failure was within the allowable marginal exceedance criteria as described in the TNI Standard (2016). The laboratory reported that analysis of a low-level standard produced acceptable recovery. Diazinon recovery passed in both the MS and MSD, batch data were deemed to be acceptable.

Industrial Endocrine Disrupting Compounds (IEDCs), in the form of alkylphenols and alkylphenol ethoxylates, were analyzed by Weck Laboratories using ASTM Method D7065. A summary of the QC associated with this analysis is provided in Table C-5. All QC samples associated with this analysis passed.

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 is provided in Table C-5. For gross alpha analysis, there was gross alpha detected in one blank. After careful consideration, it was determined that this blank detection did not impact the sample results. For gross beta, one MS/MSD pair did not meet the method precision criteria, possibly due to matrix effects.

Radium-226 and radium-228 were analyzed by Pace Analytical Services in Greensburg, PA, from July to November 2022, and by Gel Laboratories in Charleston, SC, from December 2022 to June 2023, using EPA Methods 903.1 and 904.0, respectively. A summary of the QC associated with these analyses is presented in Table C-5. For both radium-226 and radium-228, all QC samples during the program year met the method acceptance criteria.

Strontium-90 and tritium were analyzed by Pace Analytical Services in Greensburg, PA, from July to November 2022, and by Gel Laboratories in Charleston, SC, from December 2022 to June 2023, using EPA Methods 905.0 and 906.0, respectively. A summary of the QC associated with these analyses is presented 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 one 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 is presented in Table C-5. All QC samples analyzed during the monitoring period met the method acceptance criteria.

Potassium and Total Dissolved Solids (TDS) were analyzed along with the radiation samples to provide supporting data. A summary of the QC associated with this analysis is provided in Table C-5. TDS data are used to determine which analytical method is best suited to the particular sample being analyzed. All QC criteria relating to the TDS analysis were met. Potassium data is used to evaluate the contribution of naturally occurring beta radiation to the gross beta result. For potassium, all QC samples met the method acceptance criteria, except for one MS/MSD pair. Data associated with the failing MS/MSD pair were accepted after reviewing the other successful QC associated with the batch.

Whole Effluent Toxicity

Whole effluent toxicity (WET) testing was performed at the OC San laboratory. On a monthly basis, chronic WET testing was performed using ELOM SOP 8210 and 8230. 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 at the OC San laboratory. QC summary data can be found in Table C-4.

BOD and CBOD were determined by ELOM SOP 5210 B. For BOD and CBOD, most QC samples met the method acceptance criteria. 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 were measured 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 Final effluent QA/QC summary for samples analyzed at OC San's Laboratory during the 2022-23 program year.

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 Duplicate	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 and 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	15	57	853	100
			Blank Spike	16	57	912	100
			Matrix Spike	12	57	682	100
			Matrix Spike Duplicate	12	57	679	99
			Matrix Spike Precision	12	57	637	93

[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 and 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	538	100
			Blank Spike	12	15	195	100
			Matrix Spike	13	15	195	100
			Matrix Spike Duplicate	13	15	195	100
			Matrix Spike Precision	13	15	195	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 2022-23 program year.

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	11	92
			Matrix Spike Duplicate	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.

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	Ammonia Nitrogen	365 (105)	Blank	217	1	213	98
			Blank Spike	215	1	215	100
			Matrix Spike	388	1	361	93
			Matrix Spike Duplicate	388	1	356	92
			Matrix Spike Precision	388	1	388	100

[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.

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	TKN	12 (12)	Blank	15	1	15	100
			Blank Spike	12	1	12	100
			Matrix Spike	12	1	10	83
			Matrix Spike Duplicate	12	1	7	58
			Matrix Spike Precision	12	1	12	100

[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.

Table C-4 Final effluent QA/QC summary for samples analyzed at OC San's Laboratory during the 2022-23 program year.

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	12 (12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Matrix Spike	12	1	8	67
			Matrix Spike Duplicate	12	1	10	83
			Matrix Spike Precision	12	1	8	67
[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	366 (365)	Duplicate	79	1	79	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	1,096 (729)	Blank	359	1	359	100
			Duplicate	1093	1	1086	99
[a] An analysis passed if the following criteria were met: For duplicate: Target precision % RPD ≤50.							
Monthly	Oil & Grease	12 (12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Matrix Spike	13	1	13	100
			Duplicate	12	1	12	100
[a] An analysis passed if the following criteria were met: For duplicate - Target precision % RPD ≤25.							

Table C-4 Final effluent QA/QC summary for samples analyzed at OC San's Laboratory during the 2022-23 program year.

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 (365)	Blank BOD	365	1	340	93
			Blank Spike BOD	365	1	339	93
			Duplicate BOD	668	1	648	97
	Carbonaceous BOD (CBOD)		Blank Spike CBOD	365	1	335	92
			Duplicate CBOD	464	1	461	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 180±28 mg/L. For duplicate BOD T and BOD C - Target precision % RPD ≤30.							
Daily	Total Suspended Solids	365 (364)	Blank	365	1	365	100
			Blank Spike	365	1	364	100
			Duplicate	730	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)	366 (366)	Duplicate	365	1	361	99
Daily	Settleable Solids (Grab)	732 (366)					
[a] An analysis passed if the following criteria were met: For duplicate: Target precision % RPD ≤ 25%.							

Table C-4 Final effluent QA/QC summary for samples analyzed at OC San's Laboratory during the 2022-23 program year.

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
Annually	PFAS (EPA 537.1M)	1(1)	Blank	1	12	12	100
			Blank Spike	1	12	12	100
			Blank Spike Duplicate	1	12	12	100
			Blank Spike Precision	1	12	12	100
			Matrix Spike	1	12	11	92
			Matrix Spike Duplicate	1	12	11	92
			Matrix Spike Precision	1	12	12	100

[a] An analysis passed if the following criteria were met:
For blank - Analyte concentration in the Blank <1/2xLOQ.
For blank spike and blank spike duplicate - Target accuracy % recovery 70–150.
For blank spike precision - Target precision % RPD ≤30.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 70–150.
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 [a]	% Compounds Passed
Annually	PFAS (EPA 1633 Draft)	1 (1)	Blank	1	12	12	100
			Field Blank	1	12	12	100
			Equipment Blank	1	12	12	100
			Blank Spike	1	12	12	100
			Blank Spike Duplicate	1	12	12	100
			Blank Spike Precision	1	12	12	100
			Matrix Spike	1	12	9	75
			Matrix Spike Duplicate	1	12	9	75
			Matrix Spike Precision	1	12	8	67

[a] An analysis passed if the following criteria were met:
For blank, field blank, and equipment blank - Analyte concentration in the Blank <1/2xLOQ.
For blank spike and blank spike duplicate - Target accuracy % recovery varies by analyte.
For blank spike precision - Target precision % RPD ≤30.
For matrix spike and matrix spike duplicate - Target accuracy % recovery varies by analyte.
For matrix spike precision - Target precision % RPD ≤30.

Table C-4 Final effluent QA/QC summary for samples analyzed at OC San's Laboratory during the 2022-23 program year.

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
Annually	Hormones	1 (1)	Blank	1	7	7	100
			Blank Spike	1	7	7	100
			Blank Spike Duplicate	1	7	7	100
			Blank Spike Precision	1	7	7	100
			Matrix Spike	1	7	6	86
			Matrix Spike Duplicate	1	7	5	71
			Matrix Spike Precision	1	7	7	100

[a] An analysis passed if the following criteria were met:
For blank - Analyte concentration in the Blank <3xMDL.
For blank spike and blank spike duplicate - Target accuracy % recovery 70–150.
For blank spike precision - Target precision % RPD ≤30.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 70–150.
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 [a]	% Compounds Passed
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%.
[b] Urchin test used (July 2022 – October 2022).
[c] Kelp test used (November 2022 – June 2023).

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
Annual	Fecal Coliforms	365	Duplicate	52	1	50	96
	Enterococci	364	Duplicate	52	1	52	100

[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 2022-23 program year.

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	12	2	24	100
			Blank Spike	12	2	24	100
			Matrix Spike	23	2	45	98
			Matrix Spike Duplicate	23	2	45	98
			Matrix Spike Precision	23	2	46	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	Cyanide	2 (2)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	1	50
			Matrix Spike Precision	2	1	1	50
* 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	Chromium, Total	11 (11)	Blank	11	1	11	100
			Blank Spike	11	1	11	100
			Matrix Spike	14	1	14	100
			Matrix Spike Duplicate	14	1	14	100
			Matrix Spike Precision	14	1	14	100

[a] 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.

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2022-23 program year.

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	Chromium, Hexavalent	11 (11)	Blank	11	1	11	100
			Blank Spike	11	1	11	100
			Matrix Spike	20	1	20	100
			Matrix Spike Duplicate	20	1	19	95
			Matrix Spike Precision	20	1	18	90

[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 88–112.
For matrix spike precision - Target precision % RPD <10.

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	Mercury	12 (12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Matrix Spike	20	1	20	100
			Matrix Spike Duplicate	20	1	20	100
			Matrix Spike Precision	20	1	20	100
			Duplicate	12	1	12	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.

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2022-23 program year.

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	12	1	11	92
			Blank Spike	12	1	12	100
			Matrix Spike	12	1	12	100
			Matrix Spike Duplicate	12	1	12	100
			Matrix Spike Precision	12	1	12	100

* An analysis passed if the following criteria were met:
For blank - Analyte concentration in the Blank <20% sample results.
For blank spike - Target accuracy % recovery 58-167 (Jul. 2022 to Jan 2023), 75-183 (Feb to Jun 2023).
For matrix spike and matrix spike duplicate - Target accuracy % recovery 29-164 (Jul 2022 to Jan 2023), 17-172 (Feb to Jun 2023).
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
			Matrix Spike	13	1	13	100
			Matrix Spike Duplicate	13	1	13	100
			Matrix Spike Precision	12	1	11	92

* An analysis passed if the following criteria were met:
For blank - Analyte concentration in the Blank <20% sample results.
For blank spike - Target accuracy % recovery 77–138 (Jul 2022 to Jan 2023), 72-123 (Feb to Jun 2023).
For matrix spike and matrix spike duplicate - Target accuracy % recovery 77-138 (Jul 2022 to Jan 2023), 61-125 (Feb to Jun 2023).
For matrix spike precision - Target precision % RPD <30.

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2022-23 program year.

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	4	1	4	100
			Blank Spike Precision	4	1	4	100
			Matrix Spike	10	1	10	100
			Duplicate	11	1	11	100

* An analysis passed if the following criteria were met:
For blank – Analyte concentration in the Blank <20% sample results.
For blank spike and blank spike duplicate - Target accuracy % recovery 73–135 (Jul to Nov 2022), 75-125 (Dec 2022 to Jun 2023).
For blank spike precision - Target precision % RPD <20.
For matrix spike - Target accuracy % recovery 71–136 (Jul to Nov 2022), 75-125 (Dec 2022 to Jun 2023).
For duplicate - Target precision % RPD <32 (Jul to Nov 2022), <20 (Dec 2022 to Jun 2023) at 3xMDA.

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	1	1	1	100
			Blank Spike Precision	1	1	1	100
			Matrix Spike	3	1	3	100
			Duplicate	11	1	11	100

* An analysis passed if the following criteria were met:
For blank – Analyte concentration in the Blank <20% sample results.
For blank spike and blank spike duplicate - Target accuracy % recovery 73-135 (Jul to Nov 2022), 75-125 (Dec 2022 to Jun 2023).
For blank spike precision - Target precision % RPD <20.
For matrix spike - Target accuracy % recovery 71-136 (Jul to Nov 2022), 75-125 (Dec 2022 to Jun 2023).
For duplicate - Target precision % RPD <32. (Jul to Nov 2022), <20 (Dec 2022 to Jun 2023) at 3xMDA.

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2022-23 program year.

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-90	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	3	100
			Matrix Spike	4	1	4	100
			Duplicate	9	1	9	100

* An analysis passed if the following criteria were met:
For blank – Analyte concentration in the Blank <20% sample results.
For blank spike and blank spike duplicate - Target accuracy % recovery 60–130 (Jul 2022 to Nov 2022), 75-125 (Dec 2022 to Jun 2023).
For blank spike precision – Target precision % RPD <25 (Jul to Nov 2022).
For matrix spike - Target accuracy % recovery 65–130. (Jul to Nov. 2022)
For duplicate – Target precision % RPD < 25 (Jul to Nov 2022, <20 (Dec 2022 to Jun 2023) at 3xMDA.

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	Tritium	12(12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Blank Spike Duplicate	1	1	1	100
			Blank Spike Precision	1	1	1	100
			Matrix Spike	15	1	13	87
			Duplicate	11	1	11	100

* An analysis passed if the following criteria were met:
For blank – Analyte concentration in the Blank <20% sample results.
For blank spike and blank spike duplicate - Target accuracy % recovery 75–125.
For blank spike precision - Target precision % RPD <25 (Jul. to Nov. 2022).
For matrix spike - Target accuracy % recovery 75–125.
For duplicate – Target precision % RPD <25 (Jul. to Nov. 2022), <20 (Dec. 2022 to Jun. 2023) at 3xMDA.

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2022-23 program year.

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	Uranium	12(12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Matrix Spike	17	1	17	100
			Matrix Spike Duplicate	17	1	17	100
			Matrix Spike Precision	17	1	17	100
			Duplicate	1	1	1	100
* An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <20% sample results. 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. For duplicate – Target precision % RPD <30 at 3xMDL.							
Monthly	Potassium	12(12)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Matrix Spike	17	1	16	94
			Matrix Spike Duplicate	17	1	16	94
			Matrix Spike Precision	18	1	18	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.							
Monthly	Total Dissolved Solids	12(12)	Blank	13	1	13	100
			Blank Spike	13	1	13	100
			Duplicate	25	1	25	100
[a] An analysis passed if the following criteria were met: For blank - Target amount <RL. For blank spike - Target accuracy % recovery 96–102. For matrix spike precision - Target precision % RPD <10.							

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2022-23 program year.

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
Semi-annually (2022)	Organochlorine Pesticides and PCBs	1(1)	Blank	1	35	35	100
			Blank Spike	1	19	19	100
			Blank Spike Duplicate	1	19	18	95
			Blank Spike Precision	1	19	19	100
Semi-annually (2023)	Organochlorine Pesticides and PCBs	1(1)	Blank	1	35	35	100
			Blank Spike	1	19	19	100
			Blank Spike Duplicate	1	19	19	100
			Blank Spike Precision	1	19	19	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 <30.							
Annual	PCB Congeners	1(1)	Blank	1	41	41	100
			Blank Spike	1	14	14	100
			Blank Spike Duplicate	1	14	14	100
			Blank Spike Precision	1	14	14	100
* An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank < 2xML in Table 2 of EPA Method 1668C. For blank spike and blank spike duplicate - Target accuracy % recovery 60–135. For blank spike precision - Target precision % RPD <50.							
Quarterly	TCDD Equivalents	4(4)	Blank	4	17	68	100
			Blank Spike	4	17	68	100
			Blank Spike Duplicate	1	17	17	100
			Blank Spike Precision	1	17	17	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.							

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2022-23 program year.

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
Annually	Pharmaceuticals and Personal Care Products	1(3)	Blank	3	17	51	100
			Blank Spike	3	17	51	100
			Matrix Spike	3	17	51	100
			Matrix Spike Duplicate	3	17	51	100
			Matrix Spike Precision	3	17	51	100
[a] An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank < 2xMDL For blank spike - Target accuracy % recovery 50–150. For matrix spike and matrix spike duplicate - Target accuracy % recovery 50–150. For matrix spike precision - Target precision % RPD <30.							
Annually	Pyrethroids	1(1)	Blank	1	4	4	100
			Blank Spike	1	4	4	100
			Matrix Spike	1	4	4	100
			Matrix Spike Duplicate	1	4	4	100
			Matrix Spike Precision	1	4	4	100
[a] An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike - Target accuracy % recovery 50–150. For matrix spike and matrix spike duplicate - Target accuracy % recovery 50–150. For matrix spike precision - Target precision % RPD <30.							
Annually	PBDEs	1(1)	Blank	1	4	4	100
			Blank Spike	1	4	4	100
[a] An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank <MDL. For blank spike - Target accuracy % recovery 50–150.							
Annually	Chlorpyrifos & Diazinon	1(1)	Blank	1	2	2	100
			Blank Spike	1	2	1	50
			Matrix Spike	1	2	2	100
			Matrix Spike Duplicate	1	2	2	100
			Matrix Spike Precision	1	2	2	100
[a] An analysis passed if the following criteria were met: For blank - Analyte concentration in the Blank < MDL. For blank spike - Target accuracy % recovery 72–144 (Chlorpyrifos); 75–151 (Diazinon). For matrix spike and matrix spike duplicate - Target accuracy % recovery 48–151 (Chlorpyrifos); 46–139 (Diazinon). For matrix spike precision - Target precision % RPD <30.							

Table C-5 Final effluent QA/QC summary for samples analyzed at contract laboratories during the 2022-23 program year.

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
Annually	Ethoxylates	1(1)	Blank	1	11	11	100
			Blank Spike	1	11	11	100
			Matrix Spike	1	11	11	100
			Matrix Spike Duplicate	1	11	11	100
			Matrix Spike Precision	1	11	11	100

a An analysis passed if the following criteria were met:
For blank - Analyte concentration in the Blank <MDL.
For blank spike - Target accuracy % recovery 50–150.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 50–150.
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
Quarterly	Tributyltin	4(4)	Blank	4	1	4	100
			Blank Spike	4	1	4	100
			Blank Spike Duplicate	4	1	4	100
			Blank Spike Precision	4	1	4	100

* An analysis passed if the following criteria were met:
For blank – Analyte concentration in the Blank <MDL.
For blank spike – Target accuracy % recovery 50-150.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 50-150.
For matrix spike precision - Target precision % RPD <40.

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 2022-23 Core OMP.

RECEIVING WATER QUALITY NARRATIVE

OC San's Environmental Laboratory and Ocean Monitoring (ELOM) staff collected 2,289 combined samples for ammonia nitrogen (NH_3-N) and nitrate-nitrite nitrogen (NO_3-N_NO_2-N) (582 in the summer, winter and spring quarters, and 543 in the fall quarter during the 2022-23 program year). Twelve surface seawater samples were also collected at a control site (Station 2106) in each quarter. All samples were stored on wet ice 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 2022-23 program year. One bottle was damaged during transport in the winter quarter resulting in an unusable sample 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 2022-23 program year. Most analyses conducted met the QA/QC acceptance criteria. One blank spike failed with slightly high recovery (111% vs acceptance limit of 110%). One matrix spike and one matrix spike precision for the winter quarter and two matrix spikes and matrix spike duplicates for the spring quarter were outside of the method-specified acceptance criteria. Sample results associated with failing MS/MSD were accepted after careful review of the other QC results within the batch.

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.

Table C-7 contains all QA/QC samples analyzed within the 2022-23 program year. Analyses conducted at OC San's laboratory met all established QA/QC criteria. All blank spike, matrix spike, and matrix spike duplicate recoveries, and the associated matrix spike precision for the monitoring year were found to be within the method-specified acceptance criteria. The numbers of blank samples outside of the method-specified acceptance criteria are as follows: three in the fall quarter and five in both the winter and spring quarters. Due to the laboratory's very low MDL, it takes very little for the blank acceptance criterion of <2x MDL to be exceeded. Overall, blank exceedances occurred in less than 10% of blank samples analyzed, and at levels that had minimal, if any, impact on field sample 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 one 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 70% to 100% for the three 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 2022-23 program year.

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	0.04	0.04
E. coli	18	18	Nitrite Nitrate as N	0.005	0.015
Enterococci	18	18			
Sediment					
Parameter	**MDL (ng/g dry)**	**RL (ng/g dry)**	**Parameter**	**MDL (ng/g dry)**	**RL (ng/g dry)**
Organochlorine Pesticides					
2,4'-DDD	0.1	0.5	Endosulfan-alpha	0.6	1
2,4'-DDE	0.1	0.5	Endosulfan-beta	0.3	1
2,4'-DDT	0.1	0.5	Endosulfan-sulfate	0.1	0.5
4,4'-DDD	0.1	0.5	Endrin	0.4	1
4,4'-DDE	0.1	0.5	Heptachlor	0.1	0.5
4,4'-DDT	0.1	0.5	Heptachlor epoxide	0.1	0.5
4,4'-DDMU	0.1	0.5	Hexachlorobenzene	0.1	0.5
Aldrin	0.1	0.5	Mirex	0.1	0.5
gamma-BHC	0.1	0.5	*cis*-Nonachlor	0.1	0.5
cis-Chlordane	0.1	0.5	*trans*-Nonachlor	0.1	0.5
trans-Chlordane	0.1	0.5	Oxychlordane	0.1	0.5
Dieldrin	0.2	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 2022-23 program year.

Sediment PCB Congeners					
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 2022-23 program year.

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	1.41	2	Benzo(g,h,i)perylene	2.06	5
1-Methylnaphthalene	1.19	2	Benzo(k)fluoranthene	5.97	6
1-Methylphenanthrene	2.67	5	Biphenyl	1.33	2
2,6-Dimethylnaphthalene	1.12	2	Chrysene	3.37	5
2-Methylnaphthalene	1.25	2	Dibenz(a,h)anthracene	1.72	2
Acenaphthene	1.31	2	Fluoranthene	4.84	5
Acenaphthylene	1.41	2	Fluorene	1.4	2
Anthracene	1.53	2	Indeno(1,2,3-c,d)pyrene	5.19	6
Benz(a)anthracene	3.16	5	Naphthalene	3.24	5
Benzo(a)pyrene	2.25	5	Perylene	1.64	2
Benzo(b+j)fluoranthene	3.96	5	Phenanthrene	3.18	5
Benzo(e)pyrene	1.12	2	Pyrene	5.03	6
Metals					
Parameter	**MDL (µg/kg dry)**	**RL (µg/kg dry)**	**Parameter**	**MDL (µg/kg dry)**	**RL (µg/kg dry)**
Antimony	57.8	100	Lead	20.2	50
Arsenic	26.9	50	Mercury	0.75	0.8
Barium	75.6	100	Nickel	57.1	100
Beryllium	15.0	50	Selenium	241	250
Cadmium	44.7	50	Silver	69.5	50
Chromium	29.2	50	Zinc	431	750
Copper	69.1	100			

Table C-6 Method detection limit (MDL) and reporting limit (RL) for constituents analyzed in receiving water, sediment, and fish tissue samples during the 2022-23 program year.

Parameter	MDL (mg/kg dry)	RL (mg/kg dry)	Parameter	MDL (mg/kg dry)	RL (mg/kg dry)
Sediment					
Miscellaneous Parameters					
Nitrite Nitrate as N (Summer)	0.52	1.6	Total TKN (Winter – Spring)	—	68
Nitrite Nitrate as N (Fall)	0.59	1.8	Total Phosphorus (Summer)	3.9	15
Nitrite Nitrate as N (Winter – Spring)	0.56	1.7	Total Phosphorus (Fall)	4.5	18
Total TKN (Summer)	—	63	Total Phosphorus (Winter – Spring)	4.3	17
Total TKN (Fall)	—	71	Dissolved Sulfides	1.03	1.03
Parameter	**MDL (%)**	**RL (%)**	**Parameter**	**MDL (%)**	**RL (%)**
Total Organic Carbon	—	0.1	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 2022-23 program year.

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	PCB 126	0.3	1
PCB 28	0.2	1	PCB 128	0.2	1
PCB 37	0.2	1	PCB 138	0.2	1
PCB 44	0.2	1	PCB 149	0.2	1
PCB 49	0.2	1	PCB 151	0.2	1
PCB 52	0.2	1	PCB 153/168	0.5	1
PCB 66	0.2	1	PCB 156	0.2	1
PCB 70	0.2	1	PCB 157	0.3	1
PCB 74	0.2	1	PCB 158	0.3	1
PCB 77	0.2	1	PCB 167	0.5	1
PCB 81	0.2	1	PCB 169	0.2	1
PCB 87	0.2	1	PCB 170	0.2	1
PCB 99	0.2	1	PCB 177	0.2	1
PCB 101	0.2	1	PCB 180	0.2	1
PCB 105	0.2	1	PCB 183	0.2	1
PCB 110	0.2	1	PCB 187	0.2	1
PCB 114	0.2	1	PCB 189	0.2	1
PCB 118	0.2	1	PCB 194	0.2	1
PCB 119	0.2	1	PCB 201	0.2	1
PCB 123	0.2	1	PCB 206	0.2	1
Fish Tissue Metals					
Arsenic	10.8	20	Mercury	0.75	0.8
Selenium	96.2	100			

Table C-7 Receiving water quality QA/QC summary for the 2022-23 program year.

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	582 (9)	Blank	35	1	35	100
			Blank Spike	35	1	35	100
			Matrix Spike	62	1	62	100
			Matrix Spike Duplicate	62	1	62	100
			Matrix Spike Precision	62	1	62	100
Fall	Ammonia Nitrogen	543 (9)	Blank	33	1	33	100
			Blank Spike	33	1	33	100
			Matrix Spike	57	1	57	100
			Matrix Spike Duplicate	57	1	57	100
			Matrix Spike Precision	57	1	57	100
Winter	Ammonia Nitrogen	582 (10)	Blank	37	1	37	100
			Blank Spike	37	1	37	100
			Matrix Spike	63	1	62	98
			Matrix Spike Duplicate	63	1	63	100
			Matrix Spike Precision	63	1	62	98
Spring	Ammonia Nitrogen	582 (11)	Blank	36	1	36	100
			Blank Spike	36	1	35	97
			Matrix Spike	61	1	59	97
			Matrix Spike Duplicate	61	1	59	97
			Matrix Spike Precision	61	1	61	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 2022-23 program year.

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 and Nitrate as N	582 (8)	Blank	34	1	34	100
			Blank Spike	34	1	34	100
			Matrix Spike	62	1	62	100
			Matrix Spike Duplicate	62	1	62	100
			Matrix Spike Precision	62	1	62	100
Fall	Nitrite and Nitrate as N	543 (12)	Blank	33	1	30	91
			Blank Spike	33	1	33	100
			Matrix Spike	58	1	58	100
			Matrix Spike Duplicate	58	1	58	100
			Matrix Spike Precision	58	1	58	100
Winter	Nitrite and Nitrate as N	582 (11)	Blank	38	1	33	87
			Blank Spike	38	1	38	100
			Matrix Spike	64	1	64	100
			Matrix Spike Duplicate	64	1	64	100
			Matrix Spike Precision	64	1	64	100
Spring	Nitrite and Nitrate as N	582 (10)	Blank	38	1	33	87
			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.

Table C-7 Receiving water quality QA/QC summary for the 2022-23 program year.

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	20	100
	Fecal Coliforms [c]	175 (5)	Duplicate	20	1	20	100
	Enterococci	175 (5)	Duplicate	20	1	19	95
Fall	Total Coliforms	175 (5)	Duplicate	20	1	14	70
	Fecal Coliforms [b]	175 (5)	Duplicate	20	1	16	80
	Enterococci	175 (5)	Duplicate	20	1	17	85
Winter	Total Coliforms	174 (5)	Duplicate	20	1	19	95
	Fecal Coliforms [b]	174 (5)	Duplicate	20	1	15	75
	Enterococci	174 (5)	Duplicate	20	1	18	90
Spring	Total Coliforms	175 (5)	Duplicate	20	1	20	100
	Fecal Coliforms [b]	175 (5)	Duplicate	20	1	20	100
	Enterococci	175 (5)	Duplicate	20	1	16	80
Annual	Total Coliforms	699 (20)	Duplicate	80	1	73	91
	Fecal Coliforms [b]	699 (20)	Duplicate	80	1	71	89
	Enterococci	699 (20)	Duplicate	80	1	70	88

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

SEDIMENT CHEMISTRY NARRATIVE

OC San's ELOM laboratory received 34 sediment samples from ELOM's OMP staff in the summer quarter and 11 samples each in the fall, winter, and spring quarters. An additional 18 samples were received for the Meiofauna Baseline Strategic Process Study (SPS) in August and December 2022. All samples were stored according to ELOM SOPs. All samples were analyzed for polychlorinated biphenyl congeners (PCBs), polycyclic aromatic hydrocarbons (PAHs), trace metals, mercury, dissolved sulfides, total organic carbon (TOC), total nitrogen, total phosphorus, and grain size. Summer quarter and meiofauna SPS samples were also analyzed for organochlorine pesticides (dieldrin and derivatives of dichlorodiphenyltrichloroethane and chlordane). 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. Approximately 10 g (dry weight) of sample was used for PAH analysis and 5 g (dry weight) was used for the analysis of organochlorine pesticides and PCBs. A separatory funnel extraction was performed using 100 mL of sample when field and rinse blanks were included in the batch. PAH sediment extracts were analyzed by GC-MS while PCB and organochlorine pesticides were detected by 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: one sand blank, one blank spike, one standard reference material (SRM), and one matrix spike/matrix spike duplicate set. In addition, a sample batch may also include the trip blank, instrument (rinse) blank, and one 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.

All analyses were performed with appropriate QC measures, as defined in OC San's QAPP, with most compounds tested during the monitoring period 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 blank spike, blank spike duplicate, matrix spike, matrix spike duplicate, and SRM. Each failure was carefully evaluated, and the data associated with any failing QC parameters was only deemed acceptable after a thorough review of all the batch QC. Gross QC failures resulted in re-processing of samples followed by re-analysis. 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 three blanks, a blank spike, and one 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 two 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). MS/MSD precision criteria passed for all samples, showing that there is no issue with precision. In the CRM samples, antimony failed slightly low in the two fall batches. Cadmium failed slightly high in the winter/spring batch. Results for antimony and cadmium within the affected batches were deemed to be acceptable based on the other passing QC samples within each batch. 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 2022-23 program year. One duplicate sample precision in the fall quarter was outside of the method-specified acceptance criteria. This was most likely due to a lack of homogeneity in the aliquots taken from the parent sample. Precision for the matrix spike and matrix spike duplicate within the same batch met 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 2022-23 program year met the QC acceptance criteria (Table C-9) with the exception of one blank sample in the spring quarter. A spiking solution was accidentally introduced into the sample and was not detected after completion of the analysis.

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 experienced one blank failure, with the target amount being more than 10% of some sample results. Some issues were observed with MS/MSD sets due to the inherent high TKN concentration in the sample, or due to matrix effects. 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 2022-23 program year. The following QC sample results were outside of the relevant acceptance ranges: one matrix spike and one matrix spike duplicate sample in the summer quarter; one duplicate sample in the fall Quarter; and two matrix spike and one matrix spike duplicate samples in the spring quarter. 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. The RPD was outside of QC acceptance limits in the spring quarter due to possible matrix interference. 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 2022-23 program year.

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	71.4
PCB 28	80.8	48.5	113
PCB 44	60.2	36.1	84.3
PCB 49	53	31.8	74.2
PCB 52	79.4	47.6	111
PCB 66	71.9	43.1	101
PCB 87	29.9	17.9	41.9
PCB 99	37.5	22.5	52.5
PCB 101	73.4	44	103
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	5.08	11.9
PCB 138	62.1	37.3	86.9
PCB 149	49.7	29.8	69.6
PCB 151	16.93	10.2	23.7
PCB 153/168	74	44.4	104
PCB 156	6.52	3.91	9.13
PCB 170	22.6	13.6	31.6
PCB 180	44.3	26.6	62.02
PCB 183	12.19	7.31	17.1
PCB 187	25.1	15.1	35.1
PCB 194	11.2	6.72	15.7
PCB 195	3.75	2.25	5.25
PCB 206	9.21	5.53	12.9
PCB 209	6.81	4.09	9.53
2,4'-DDD [a]	38	22.8	53.2
2,4'-DDE [a]	19	11.4	26.6
4,4'-DDD [a]	108	64.8	151
4,4'-DDE [a]	86	51.6	120
4,4'-DDT [a]	170	102	238
gamma-BHC [a]	2	1.2	2.8
cis-Chlordane	16.51	9.91	23.1
trans-Chlordane [a]	19	11.4	26.6
Hexachlorobenzene	6.03	3.62	8.44
cis-Nonachlor [a]	3.7	2.22	5.18
trans-Nonachlor	8.2	4.92	11.5
Percent Dry Weight	98.70%	—	—

Table C-8 Acceptance criteria for standard reference materials for sediment and fish tissue analyses during the 2022-23 program year.

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 2022-23 program year.

Sediment			
Parameter	**True Value (µg/L)**	**Acceptance Range (µg/g)**	
		Minimum	**Maximum**
Metals (CRM-540 ERA Metals in Soil, Lot No. D107-540) July 2022 – March 2023			
Aluminum	8460	4260	12700
Antimony	120	5.76	234
Arsenic	95.5	79.1	112
Barium	300	247	353
Beryllium	103	85.3	120
Cadmium	135	112	159
Chromium	147	121	173
Copper	150	126	174
Iron	14400	8830	20000
Lead	92.3	76.7	108
Mercury	18.4	11.2	25.5
Nickel	59.8	49.4	70.3
Selenium	42	33.4	50.6
Silver	40.3	32.5	48.1
Zinc	369	298	440
Metals (CRM-540 ERA Metals in Soil, Lot No. D119-540) April 2023 – June 2023			
Aluminum	8040	3830	12200
Antimony	129	12.7	245
Arsenic	183	152	214
Barium	297	244	351
Beryllium	78.8	65.4	92.2
Cadmium	221	182	259
Chromium	200	163	237
Copper	136	114	158
Iron	14000	8420	19600
Lead	257	211	303
Mercury	18.2	13.3	23.1
Nickel	169	139	198
Selenium	217	172	263
Silver	67.8	54.1	81.4
Zinc	224	180	268

Table C-8 Acceptance criteria for standard reference materials for sediment and fish tissue analyses during the 2022-23 program year.

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 2022-23 program year.

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 2022-23 program year.

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	34 (4)	Blank	3	24	72	100
			Trip Blank	2	24	48	100
			Instrument Blank	2	24	48	100
			Blank Spike	3	24	71	99
			Blank Spike Duplicate	3	24	71	99
			Blank Spike Precision	3	24	71	99
			Matrix Spike	3	24	70	97
			Matrix Spike Duplicate	3	24	59	82
			Matrix Spike Precision	3	24	52	72
			SRM Analysis	3	21	54	86
Fall	PAHs	29 (2)	Blank	2	24	48	100
			Trip Blank	1	24	24	100
			Instrument Blank	1	24	24	100
			Blank Spike	2	24	48	100
			Blank Spike Duplicate	2	24	48	100
			Blank Spike Precision	2	24	48	100
			Matrix Spike	2	24	48	100
			Matrix Spike Duplicate	2	24	48	100
			Matrix Spike Precision	2	24	48	100
			SRM Analysis	2	21	36	86
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	24	100
			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	18	86

Table C-9 Sediment QA/QC summary for the 2022-23 program year.

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	24	100
			Blank Spike Duplicate	1	24	24	100
			Blank Spike Precision	1	24	24	100
			Matrix Spike	1	24	24	96
			Matrix Spike Duplicate	1	24	24	96
			Matrix Spike Precision	1	24	24	100
			SRM Analysis	1	21	18	86
Summer	PCBs and Pesticides	34 (3)	Blank	3	61	183	100
			Trip Blank	2	61	122	100
			Instrument Blank	2	61	122	100
			Blank Spike	3	61	179	98
			Matrix Spike	3	61	178	97
			Matrix Spike Duplicate	3	61	177	96
			Matrix Spike Precision	3	61	183	100
			SRM Analysis	3	33	94	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 2022-23 program year.

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	PCBs	11 (1)	Blank	1	40	40	100
			Trip Blank	1	40	40	100
			Instrument Blank	1	40	40	100
			Blank Spike	1	40	40	100
			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
	PCBs and Pesticides	18(1)	Blank	1	61	60	98
			Trip Blank	1	61	61	100
			Instrument Blank	1	61	61	100
			Blank Spike	1	61	61	100
			Matrix Spike	1	61	61	100
			Matrix Spike Duplicate	1	61	61	100
			Matrix Spike Precision	1	61	61	100
			SRM Analysis	1	33	33	100
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	40	100
			Matrix Spike	1	40	40	100
			Matrix Spike Duplicate	1	40	40	100
			Matrix Spike Precision	1	40	40	100
			SRM Analysis	1	24	24	100

Table C-9 Sediment QA/QC summary for the 2022-23 program year.

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	40	100
			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

[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 2022-23 program year.

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	34 (3)	Blank	6	12	72	100
			Trip Blank	2	12	24	100
			Instrument Blank	2	12	24	100
			Blank Spike	2	12	24	100
			Matrix Spike	4	12	44	92
			Matrix Spike Duplicate	4	12	44	92
			Matrix Spike Precision	4	12	48	100
			Duplicate	4	12	48	100
			SRM Analysis	2	12	24	100
	Mercury	34 (2)	Blank	2	1	2	100
			Trip Blank	2	1	2	100
			Instrument Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	4	1	4	100
			Matrix Spike Duplicate	4	1	4	100
			Matrix Spike Precision	4	1	4	100
			Duplicate	4	1	4	100
			SRM Analysis	2	1	2	100

Table C-9 Sediment QA/QC summary for the 2022-23 program year.

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	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	29 (2)	Blank	6	12	72	100
			Trip Blank	2	12	24	100
			Instrument Blank	2	12	24	100
			Blank Spike	2	12	24	100
			Matrix Spike	4	12	43	90
			Matrix Spike Duplicate	4	12	44	92
			Matrix Spike Precision	4	12	48	100
			Duplicate	4	12	48	100
			SRM Analysis	2	12	22	92
	Mercury	29 (2)	Blank	2	1	2	100
			Trip Blank	2	1	2	100
			Instrument Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	4	1	4	100
			Matrix Spike Duplicate	4	1	4	100
			Matrix Spike Precision	4	1	4	100
			Duplicate	4	1	2	50
			SRM Analysis	2	1	2	100

Table C-9 Sediment QA/QC summary for the 2022-23 program year.

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 and Spring	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	22 (2)	Blank	4	12	48	100
			Trip Blank	2	12	24	100
			Instrument Blank	2	12	24	100
			Blank Spike	2	12	24	100
			Matrix Spike	3	12	32	89
			Matrix Spike Duplicate	3	12	32	89
			Matrix Spike Precision	3	12	36	100
			Duplicate	3	12	36	100
			SRM Analysis	1	12	11	92
	Mercury	22 (2)	Blank	2	1	2	100
			Trip Blank	2	1	2	100
			Instrument Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	3	1	3	100
			Matrix Spike Duplicate	3	1	3	100
			Matrix Spike Precision	3	1	3	100
			Duplicate	3	1	3	100
			SRM Analysis	1	1	1	100

[a] An analysis passed if the following criteria were met.
For blank, trip blank, and instrument 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 2022-23 program year.

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	Dissolved Sulfides	33 (2)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	5	1	5	100
			Matrix Spike Duplicate	5	1	5	100
			Matrix Spike Precision	5	1	5	100
			Duplicate	5	1	5	100
Fall	Dissolved Sulfides	29 (3)	Blank	3	1	3	100
			Blank Spike	3	1	3	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
Winter	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
Spring	Dissolved Sulfides	11 (1)	Blank	1	1	0	0
			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.

Table C-9 Sediment QA/QC summary for the 2022-23 program year.

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	34 (3)	Blank	3	1	3	100
			Blank Spike	3	1	3	100
			Matrix Spike	4	1	4	100
			Matrix Spike Duplicate	4	1	4	100
			Matrix Spike Precision	4	1	4	100
			Duplicate	4	1	4	100
			SRM Analysis	3	1	3	100
Fall	TOC	29 (2)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	4	1	4	100
			Matrix Spike Duplicate	4	1	4	100
			Matrix Spike Precision	4	1	4	100
			Duplicate	4	1	4	100
			SRM Analysis	2	1	2	100
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
			SRM Analysis	1	1	1	100

Table C-9 Sediment QA/QC summary for the 2022-23 program year.

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	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
			SRM Analysis	1	1	1	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.
For SRM analysis – Target accuracy % recovery 77-122 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	Grain Size	34 (2)	Duplicate	3	1	3	100
Fall	Grain Size	29 (2)	Duplicate	5	1	5	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 the following criteria were met:
For duplicate - Target precision mean % RPD <10% of mean phi.

Table C-9 Sediment QA/QC summary for the 2022-23 program year.

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	Nitrite Nitrate as N	34 (3)	Blank	3	1	3	100
			Blank Spike	3	1	3	100
			Matrix Spike	6	1	5	83
			Matrix Spike Duplicate	6	1	5	83
			Matrix Spike Precision	6	1	6	100
			Duplicate	6	1	6	100
Fall	Nitrite Nitrate as N	29 (3)	Blank	3	1	3	100
			Blank Spike	3	1	3	100
			Matrix Spike	5	1	5	100
			Matrix Spike Duplicate	5	1	5	100
			Matrix Spike Precision	5	1	5	100
			Duplicate	5	1	5	100
Winter	Nitrite Nitrate as N	11 (1)	Blank	2	1	2	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 2022-23 program year.

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	34 (4)	Blank	5	1	4	80
			Blank Spike	5	1	5	100
			Matrix Spike	5	1	4	80
			Matrix Spike Duplicate	5	1	4	80
			Matrix Spike Precision	5	1	5	100
			Duplicate	2	1	2	100
Fall	Total Kjeldahl Nitrogen	29 (2)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	4	1	3	75
			Matrix Spike Duplicate	4	1	3	75
			Matrix Spike Precision	4	1	4	100
			Duplicate	4	1	4	100
Summer	Total Kjeldahl Nitrogen	11 (1)	Blank	2	1	2	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	1	50
			Matrix Spike Duplicate	2	1	1	50
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	2	100
Spring	Total Kjeldahl Nitrogen	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 <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%.

Table C-9 Sediment QA/QC summary for the 2022-23 program year.

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 Phosphorus	34 (3)	Blank	3	1	3	100
			Blank Spike	3	1	3	100
			Matrix Spike	6	1	5	83
			Matrix Spike Duplicate	6	1	5	83
			Matrix Spike Precision	6	1	6	100
			Duplicate	6	1	6	100
Fall	Total Phosphorus	29 (2)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	3	1	3	100
			Matrix Spike Duplicate	3	1	3	100
			Matrix Spike Precision	3	1	3	100
			Duplicate [c]	4	1	3	75
Winter	Total Phosphorus	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	Total Phosphorus	11 (1)	Blank	1	1	1	100
			Blank Spike	1	1	1	100
			Matrix Spike	2	1	0	0
			Matrix Spike Duplicate	2	1	1	50
			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.

FISH TISSUE CHEMISTRY NARRATIVE

For the 2022-23 program year, the ELOM laboratory received 20 rig fish samples in September 2022 and a total of 40 trawl fish samples from both the July/August 2022 and January/February 2023 sampling events. The individual samples were stored, dissected, composited, and homogenized according to methods described in the ELOM SOPs. The rig fish muscle tissue samples and trawl liver tissue samples were composited according to species and zones or stations. There were a total of four muscle and four liver tissue composite samples. There was a slight deviation from the NPDES permit procedures for the compositing of the rig fish tissues. The number of individual rig fish composited per zone was exceeded. According to the NPDES permit, the maximum number of the same species to be composited for rig fish per zone is five. On day one, lab staff composited nine fish of one species, and one fish of a different species. On day two, lab staff composited seven fish from one species and three fish from a different species. On both days, the species with more than five fish should have been split into two composites per zone. This error was due to a misinterpretation of the language in Table E-12 of the NPDES permit. Instead of four total composites, there should have been six total composite samples. The deviation was noted, and management was informed. The guidance from management was that although the deviation was not intentional, the lab should proceed with analyzing and reporting all of the sample data. 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. 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 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 SRM. Results associated with the failing SRM components were deemed acceptable based on all the other QC samples in the batch meeting their acceptance criteria. 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 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 ten 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 three 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 and met the QC criteria (Table C-10).

Table C-10 Fish tissue QA/QC summary for the 2022-23 program year.

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) and Winter (Trawl samples)	PCBs and Pesticides	8 (1)	Blank	1	54	54	100
			Blank Spike	1	54	54	100
			Matrix Spike	1	54	54	100
			Matrix Spike Duplicate	1	54	54	100
			Matrix Spike Precision	1	54	54	100
			Duplicate	1	54	54	100
			SRM Analysis	1	41	37	90

[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	4 (1)	Blank [b]	1	1	—	—
	Muscle	4 (1)	Duplicate	1	1	1	100
Winter (Trawl samples)	Liver	8 (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 (Rig fish samples) and Winter (Trawl samples)	Mercury	8 (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
			SRM Analysis	1	1	1	100

Table C-10 Fish tissue QA/QC summary for the 2022-23 program year.

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) and Winter (trawl samples)	Arsenic & Selenium	8 (1)	Blank	3	2	6	100
			Blank Spike	1	2	2	100
			Matrix Spike	1	2	2	100
			Matrix Spike Dup	1	2	2	100
			Matrix Spike Precision	1	2	2	100
			Duplicate	1	2	2	100
			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 2022-23 taxonomy QA/QC follow OC San's QAPP. Benthic infauna samples from one annual and two quarterly stations underwent comparative taxonomic analysis by two 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: $$\%\ Error_{\#\ Individuals} = \left(\frac{\left|\#\ Individuals_{Resolved} - \#\ Individuals_{Original}\right|}{\#\ Individuals_{Resolved}}\right) \times 100$$

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 two 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 of ≤10% error for identification accuracy (Equation 3) were met in the 2022-23 program year (Table C-11). No significant changes were made to the 2022-23 infauna dataset based on the SDR.

Table C-11 Percent error rates calculated for the 2022-23 infauna QA samples.

Error Type	Station			Mean
	1	**84**	**37**	
1. % Error $_{\#\ Individuals}$	3.0	1.3	-4.8	-0.2
2. % Error $_{\#\ ID\ Taxa}$	3.4	4.7	0.0	2.7
3. % Error $_{\#\ ID\ Individuals}$	1.8	1.4	0.0	1.1

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

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