SD Public Utilities

ANNUAL RECEIVING WATERS MONITORING & TOXICITY TESTING QUALITY ASSURANCE REPORT

2020

Environmental Monitoring and Technical Services
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ANNUAL RECEIVING WATERS MONITORING & TOXICITY TESTING QUALITY ASSURANCE REPORT

2020

Prepared By:

City of San Diego
Ocean Monitoring Program
Public Utilities Department
Environmental Monitoring and Technical Services Division

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Introduction

The Environmental Monitoring and Technical Services (EMTS) Division of the City of San Diego Public Utilities Department (PUD) performs comprehensive Quality Assurance (QA)/Quality Control (QC) procedures. These procedures ensure the accuracy and reliability of data collected from receiving waters monitoring and toxicity testing, which are provided to regulatory agencies in compliance with the reporting requirements specified in several National Pollutant Discharge Elimination System (NPDES) permits (Table 1). Furthermore, these QA/QC procedures ensure the quality and consistency of field sampling, laboratory analysis, record keeping, data entry, and electronic data collection/transfer, as well as data analysis and reporting. The procedures are regularly reviewed and revised as necessary to reflect ongoing changes in permit requirements, sample collection methods, technology, and applicability of new analytical methods.

Details of the EMTS Division's QA/QC program for receiving waters monitoring are documented in a separate Quality Assurance Plan (QAP) (City of San Diego 2020b). Additionally, the EMTS Division maintains its certification through the International Organization for Standardization (ISO) 14001 Environmental Management Systems program. As a part of continuation of the ISO 14001 certification process, EMTS underwent and passed an external audit in 2020 conducted by a third-party auditor. The next audit will take place in 2023.

This report summarizes the QA/QC activities that were conducted during calendar year 2020 by City of San Diego staff in support of NPDES permit requirements for receiving waters monitoring and toxicity testing for the City's Point Loma Wastewater Treatment Plant (PLWTP) and South Bay Water Reclamation Plant (SBWRP), as well as similar ocean monitoring activities required for the South Bay International Wastewater Treatment Plant (SBIWTP), owned and operated by the International Boundary and Water Commission, U.S. Section.

Facilities and Staff

The EMTS Division includes laboratories from three sections that participate in the receiving waters monitoring and toxicity testing activities associated with the above NPDES permits. These sections include: (1) the Marine Biology and Ocean Operations (MBOO) section; (2) the Microbiology section (Marine Microbiology Laboratory - MML, and Toxicology Laboratory - TL); (3) Environmental Chemistry Services (ECS) section.

MBOO, MML, and TL are located at the EMTS Division's laboratory facility at 2392 Kincaid Road, San Diego, CA 92101. Functions of these labs are described below. ECS comprises work groups located at other City laboratory facilities. Descriptions of the ECS laboratory functions and their QA procedures are presented in a separate QA report each year (City of San Diego 2020a).

Marine Biology and Ocean Operations

Staff scientists from the MBOO section are responsible for conducting most field sampling operations, some laboratory analyses, and subsequent biological and oceanographic assessments associated with the City's

Table 1

NPDES permits and associated orders issued by the San Diego Regional Water Quality Control Board for the City of San Diego's PLWTP and SBWRP, and the U.S. Section of the International Boundary and Water Commission's SBIWTP.

Facility	NPDES Permit	Order No.	Effective Dates
PLWTP	CA0107409	R9-2017-0007	October 1, 2017 – September 30, 2022
SBWRP	CA0109045	R9-2013-0006[a]	April 4, 2013 – April 3, 2018
SBIWTP	CA0108928	R9-2014-0009[b]	August 1, 2014 – July 31, 2019

[a]Amended by Order Nos. R9-2014-0071 and R9-2017-0023
[b]Amended by Order Nos. R9-2014-0094, R9-2017-0024, and R9-2019-0012

Ocean Monitoring Program (water quality, benthic sediments and macrofauna, trawl caught fishes and invertebrates, contaminant accumulation in marine fishes). Staff in this section are organized into different work groups based on primary responsibilities and areas of expertise. Brief descriptions of the areas of emphasis for each work group are provided below. Staff with overlapping expertise work across groups.

Program Coordination, Assessment and Reporting: One of the primary responsibilities of this work group is to oversee the assessment of receiving waters monitoring data. This includes data QA, data analysis, and the interpretation of results from the receiving waters monitoring activities and other contract work. Staff on this team work closely with other staff to perform QA of all receiving waters monitoring data. Various industry standard software packages for data management, data manipulation, statistical analysis, and presentation are used to manage and analyze data from every aspect of receiving waters monitoring. The results and interpretation of these analyses are reported to regulatory and contract agencies in the form of monthly and annual reports.

Quality Assurance and Safety: This work group manages MBOO QA policies and procedures including the QAP, standard operating procedures, work instructions, ISO and hazardous material documentation, and serves as the MBOO administrator of Qualtrax, a compliance software used throughout the division. Furthermore, this group manages lab and field operational safety through Cal/OSHA and US Coast Guard compliance, hazardous materials and universal waste management, and safety training. Staff in this work group coordinate with members of other work groups to produce this annual report of quality assurance activities.

Ocean Operations: This work group comprises two subsections, Ocean Operations and Vessel Operations. Ocean Operations staff manage and conduct water quality sampling, benthic sediment and macrofauna sampling, trawling and rig-fishing, and ocean outfall inspections. These staff members maintain and calibrate all oceanographic instrumentation, including the laboratory's remote operated vehicle (ROV), remotely operated towed vehicle (ROTV), and static/real-time oceanographic moorings. Vessel Operations staff (boat operators) are primarily responsible for the operation and maintenance of the City's two monitoring vessels, MV Oceanus and MV Monitor III. When in port, boat operators schedule and oversee all regular vessel maintenance as well as any modifications as necessary. While at sea, they are responsible for ensuring the safety of the crew, locating and maintaining boat position at monitoring stations, and assisting with various deck activities as appropriate.

Laboratory Operations: The Laboratory Operations work group coordinates the processing of all benthic macrofauna, trawl-caught fish and invertebrates, and rig fish samples including label

Table 2
ELAP certifications for EMTS Division's Marine Microbiology and Toxicology labs.

Laboratory	Phone	EPA Lab ID	ELAP Cert. No.
Marine Microbiology	619-758-2314	CA01393	2185
Toxicology	619-758-2345	CA01302	1989

preparation, sample login, and data entry. In addition, they maintain the taxonomic literature and voucher collections, produce in-house identification/voucher sheets and keys, and conduct taxonomic training. This group also oversees fish dissections as part of the analysis of contaminant accumulation in marine fishes. Members of this and other work groups participate in and are members of the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT), and the Southern California Association of Ichthyological Taxonomists and Ecologists (SCAITE), regional taxonomic standardization programs, and perform all QA/QC procedures to ensure the accuracy of the taxonomic identifications made by laboratory staff.

Marine Microbiology Laboratory

The MML is accredited by the California State Water Resources Control Board Environmental Laboratory Accreditation Program (ELAP) (Table 2), which is renewed on a biennial basis. Microbiology staff are responsible for the identification and quantification of bacteria found in environmental samples. Responsibilities include preparation of microbiological media, reagents, sample bottles, supplies and equipment, collection of field samples along the shore, and laboratory analyses using approved and accredited methods to measure concentrations of fecal indicator bacteria. Analyses include membrane filtration, multiple tube fermentation, Colilert/Colilert-18, Enterolert chromogenic/fluorogenic substrate analyses as appropriate for the parameter and as required by the NPDES permits. In addition, the group is responsible for the physical maintenance, calibration, and QA of large equipment and instruments such as autoclaves, incubators, water baths, ultra-freezers, a biological safety cabinet, and reagent-grade water point-of-use systems. Members are also responsible for developing sampling, analytical, and QA protocols for special microbiological projects or studies.

Members of the MML also provide for monitoring, surveillance, control, and prevention of insects and other pests that can transmit diseases or cause harm to humans as part of the Vector Control Program. The primary methods of control include environmental conservation measures, education, and water management techniques aided by appropriate chemical and biological control technology. This program uses methods to census animal populations to determine control effectiveness and trends. Areas of responsibility include wastewater treatment plants, pump stations, buildings, and office facilities. Biological assessments of urban creeks and streams are also conducted to evaluate and analyze short and long-term impacts of sewage spills into watersheds and receiving waters. In such cases, field samples of aquatic communities are collected, and field water quality indicators are measured. Physical habitat characteristics and anthropogenic changes are evaluated. Measures, evaluations, and comparisons are made to yield relative ratings of conditions within a specified community. In addition to being summarized here, the MML maintains a separate, detailed Quality Assurance Manual that contains up-to-date revisions to reflect current laboratory practices and procedures and ensures timely document version control in accordance with ELAP requirements and ISO 14001 standards.

Toxicology Laboratory

The TL is also certified by ELAP (Table 2), with renewal on a biennial basis. Toxicology staff are responsible for conducting or overseeing all acute and chronic toxicity testing required by the City's NPDES permits and contractual obligations. Primary responsibilities include collection of wastewater effluent or other types of samples, maintaining test organisms and laboratory supplies, calibration of test instruments, conducting acute and chronic bioassays, record keeping, and the statistical evaluation, interpretation and reporting of all toxicology data. In addition to being summarized here, the TL maintains a separate, detailed Quality Assurance Manual that contains up-to-date revisions reflecting current laboratory practices and procedures and ensures timely document version control in accordance with ELAP requirements and ISO 14001 standards.

Scope of Work

The City of San Diego Ocean Monitoring Program is responsible for monitoring the coastal San Diego area to document and analyze possible effects on the marine environment due to the discharge of treated municipal wastewater (effluent) to the Pacific Ocean via the Point Loma Ocean Outfall (PLOO) and the South Bay Ocean Outfall (SBOO). Treated effluent from the PLWTP is discharged to the ocean through the PLOO, whereas commingled effluent from the SBWRP and SBIWTP is discharged through the SBOO. The separate orders and permits associated with these treatment facilities define the requirements for receiving waters monitoring and toxicity testing including sampling plans, compliance criteria, laboratory and statistical analyses, and reporting guidelines.

The core requirements for the Point Loma and South Bay monitoring and reporting programs that were in effect throughout 2020 are summarized in Tables 3, 4, and 5. Core receiving waters monitoring for the Point Loma region is conducted at 82 different stations located from the shore seaward to a depth of about 116 m and includes 12 primary core stations along the 98-m discharge depth contour and 10 secondary core stations located along or adjacent to the 88-m and 116-m depth contours (Figure 1). Receiving water monitoring in the South Bay outfall region is conducted at a total of 53 stations ranging from along the shore to offshore depths of about 61 m, including 12 primary core stations located along the 28-m discharge depth contour and 15 secondary core stations located along or adjacent to the 19, 38, and 55-m depth contours.

Core receiving waters monitoring activities include: (1) weekly sampling of ocean waters from recreational areas located along the shoreline and within the Point Loma and Imperial Beach kelp beds to assess nearshore water quality conditions; (2) quarterly sampling of ocean waters at offshore sites to document water quality conditions throughout the region; (3) semi-annual benthic sampling to monitor sediment conditions and the status of resident macrobenthic invertebrate communities; (4) semi-annual trawl surveys to monitor the ecological health of demersal fish and megabenthic invertebrate communities; (5) annual collection of fish tissue samples to monitor levels of chemical constituents that may have ecological or human health implications.

The results of the above receiving waters monitoring activities and effluent toxicity tests are analyzed and presented in various regulatory reports that are submitted to the San Diego Regional Water Quality Control Board (SDRWQCB) and United States Environmental Protection Agency (USEPA) on an

ongoing basis. A Sediment Toxicity Monitoring Plan for the SBOO and PLOO monitoring regions was implemented in 2016 (City of San Diego 2015). The results of this three-year pilot study, including associated QA/QC activities, were presented separately in a final project report that was submitted to the SDRWQCB and USEPA on June 30, 2019 (City of San Diego 2019). As per recommendations in this final project report, MBOO collected and the TL collected and analyzed sediment toxicity samples in 2020 and will continue to do so until 2023.

In addition to the above core monitoring efforts, the City may conduct "strategic process studies" (special projects) as part of its regulatory requirements and as defined by the Model Monitoring Program developed for large ocean dischargers in southern California (Schiff et al. 2002). These special studies are determined by the City in coordination with the SDRWQCB and USEPA and are generally designed to address recommendations for enhanced environmental monitoring of the San Diego coastal region as put forth in a peer-reviewed report coordinated by scientists at the Scripps Institution of Oceanography (SIO 2004). Data for such studies are typically subject to the same QA/QC procedures as the routine monitoring data, although the analysis and reporting schedules will likely be customized to meet the targeted study goals. Thus, details and results of ongoing QA/QC activities associated with these special studies are not included in this report unless otherwise indicated.

As a part of its regulatory requirements, the City also participates in regional monitoring activities for the entire Southern California Bight coordinated by the Southern California Coastal Water Research Project (SCCWRP). The intent of these regional programs is to optimize the efforts of the various partner agencies, such as municipal dischargers and research agencies, and leverage their considerable scientific expertise and resources to survey the entire southern California coastal region using a cost-effective monitoring design. These bight-wide surveys have included the 1994 Southern California Bight Pilot Project and subsequent Bight regional monitoring efforts that took place in 1998, and every subsequent five years until the most recent survey in 2018. During these programs, the City's regular sampling and analytical efforts may be reallocated as necessary with approval from the SDRWQCB and USEPA. As with special studies, the regional monitoring efforts are typically subject to QA/QC procedures like those for routine monitoring data, although the analysis and reporting schedules may vary. Thus, the details and results of the bight-wide monitoring efforts are not included in these annual QA reports unless otherwise indicated. However, planning documents for the current Bight′18 project, including its QAP, are available on SCCWRP's website (www.sccwrp.org).

Summary of Work Performed in 2020

During 2020, a total of 6581 discrete samples were collected by EMTS staff as part of the above scope of work and as part of permit-mandated special studies (Table 6). Of these, about 9% (n = 592) were QC samples, such as lab or field duplicates. In addition, a total of 1643 QA tests pertaining to macrofauna sorting, microbiological analyses, and toxicity tests were conducted to validate the quality of specific analyses. The results of the QA/QC activities presented in the following sections support the precision and accuracy of the resultant data and validate their use in permit-mandated monitoring, environmental testing, and reporting. These include: (1) intercalibration of the Conductivity-Temperature-Depth (CTD) instruments used to sample water quality parameters; (2) results of the bacteriological QA procedures; (3) results of the macrofaunal community sample re-sorts and re-IDs; (4) results of toxicology QA procedures.

Table 3

Core receiving waters monitoring requirements for the Point Loma Ocean Outfall region. Sampling effort excludes FIB resamples, QA/QC activities, new plume tracking requirements, and special studies.

Monitoring Component	Location	No. of Stations/ Zones	Sample Type	Discrete No. Samples/Site	Sampling Frequency	Sampling Times/Yr	Discrete No. Samples/Yr	Parameters	No. "Samples" Analyzed/Yr	Notes
Water Quality, Microbiology, Oceanographic Conditions	shore	8	Seawater - FIB	1	1/Week	52	416	T, F, E[a]	1248	1 sample/station
	kelp/ nearshore	8	Seawater - FIB	3	1/Week	52	1248	T, F, E[a]	3744	3 depths/station
		8	CTD	1	1/Week	52	416	CTD profile[c]	3744	1 cast/station (1-m batch avg samples)
	offshore	3	Seawater - FIB	3	1/Quarter	4	36	E[b]	36	3 depths/station (18-m stns)
		11	Seawater - FIB	3	1/Quarter	4	132	E[b]	132	3 depths/station (60-m stns)
		11	Seawater - FIB	4	1/Quarter	4	176	E[b]	176	4 depths/station (80-m stns)
		11	Seawater - FIB	5	1/Quarter	4	220	E[b]	220	5 depths/station (98-m stns)
		36	CTD	1	1/Quarter	4	144	CTD profile[c]	1296	1 cast/station (1-m batch avg samples)
Sediment Chemistry	offshore	22	Grab	1	2/Year	2	44	sed chem[d]	352	1° and 2° core stations (Jan, Jul)
	offshore	12	Grab	1	2/Year	2	24	sed chem[e]	24	1° core stations (Jan, Jul)
	offshore	40	Grab	1	1/Year	1	40	sed chem[d]	320	Randomized stations (Jul)[g]
Benthic Infauna	offshore	22	Grab	1	2/Year	2	44	community structure	44	1° and 2° core stations (Jan, Jul)
	offshore	40	Grab	1	1/Year	1	40		40	Randomized stations (Jul)[g]
Sediment Toxicity	offshore	8-28	Grab	1	1/Year	1	8-28	acute toxicity	8-28	Rotating offshore stations[h]
Demersal Fishes & Invertebrates	offshore	6	Trawl	1	2/Year	2	12	community structure	12	1 trawl/station (Jan, Jul)
Bioaccumulation in Fish Tissues	offshore	4	Trawl/ Hook & Line	3	1/Year	1	12	liver tissue[f]	60	3 composites/zone (Oct)
	offshore	2	Hook & Line	3	1/Year	1	6	muscle tissue[f]	30	3 composites/zone (Oct)
Totals							**3038**		**11,506**	

[a] Fecal Indicator Bacteria (FIB) parameters = total coliform (T), fecal coliform (F), *Enterococcus* bacteria (E); n = 3 parameters required at shore and kelp water quality stations.
[b] *Enterococcus* = only FIB indicator required at offshore water quaility stations.
[c] CTD profile = temperature, depth, pH, salinity, dissolved oxygen, light transmittance (transmissivity), and chlorophyll *a* (n = 7 required parameters), plus density and CDOM (n = 9 parameters total)
[d] Sediment constituents = sediment particle size, total organic carbon, total nitrogen, sulfides, metals, PCBs, chlorinated pesticides, PAHs (n = 8 parameter categories; see NPDES permit for complete list of constituents).
[e] Sediment constituents = BOD at 12 primary core stations only (voluntary sampling per agreement with USEPA Region IX)
[f] Fish tissue constituents = lipids, metals, PCBs, chlorinated pesticides, and PAHs (n = 5 parameter categories; see NPDES permit for complete list of constituents)
[g] Random (regional) benthic survey = joint requirement of Point Loma and South Bay outfall monitoring programs (i.e., 40 stations/year total)
[h] Continued Sediment Toxicity Monitoring as recommended by the Final Project Report for the Sediment Toxicity Pilot Study for the San Diego Ocean Outfall Monitoring Regions (City of San Diego 2019)

Table 4

Core receiving waters monitoring requirements for the South Bay Ocean Outfall region. Sampling effort excludes FIB resamples, QA/QC activities, new plume tracking requirements, and special studies.

Monitoring Component	Location	No. of Stations/ Zones	Sample Type	Discrete No. Samples/Site	Sampling Frequency	Sampling Times/Yr	Discrete No. Samples/Yr	Parameters	No. "Samples" Analyzed/Yr	Notes
Water Quality, Microbiology, Oceanographic Conditions	shore	11	Seawater - FIB	1	1/Week	52	572	T, F, E[a]	1716	1 sample/station
	kelp/ nearshore	7	Seawater - FIB	3	1/Week	52	1092	T, F, E[a]	3276	3 depths/station
		7	CTD	1	1/Week	52	364	CTD profile[b]	3276	1 cast/station (1-m batch avg samples)
	offshore	21	Seawater - FIB	3	1/Quarter	4	252	T, F, E[a]	756	3 depths/station
		33	CTD	1	1/Quarter	4	132	CTD profile[b]	1188	1 cast/station (1-m batch avg samples)
Sediment Chemistry	offshore	27	Grab	1	2/Year	2	54	sed chem[c]	432	1° and 2° core stations (Jan, Jul)
	offshore	40	Grab	1	1/Year	1	40	sed chem[c]	320	Randomized stations (Jul)[e]
Benthic Infauna	offshore	27	Grab	1	2/Year	2	54	community structure	54	1° and 2° core stations (Jan, Jul)
	offshore	40	Grab	1	1/Year	1	40		40	Randomized stations (Jul)[e]
Sediment Toxicity	offshore	8-28	Grab	1	1/Year	1	8-28	acute toxicity	8-28	Rotating offshore stations[f]
Demersal Fishes & Invertebrates	offshore	7	Trawl	1	1/Year	2	14	community structure	14	1 trawl/station (Jan, Jul)
Bioaccumulation in Fish Tissues	offshore	5	Trawl/Hook & Line	3	1/Year	1	15	liver tissue[d]	75	3 composites/zone (Oct)
	offshore	2	Hook & Line	3	1/Year	1	6	muscle tissue[d]	30	3 composites/zone (Oct)
Totals							**2663**		**11,205**	

[a] Fecal Indicator Bacteria (FIB) = total coliform (T), fecal coliform (F), and *Enterococcus* bacteria (E); n = 3 parameters required at all shore, kelp nearshore and offshore water quality stations

[b] CTD profile = temperature, depth, pH, salinity, dissolved oxygen, light transmittance (transmissivity), chlorophyll *a* (n = 7 required parameters), plus density and CDOM (n = 9 parameters total)

[c] Sediment constituents = sediment particle size, total organic carbon, total nitrogen, sulfides, metals, PCBs, chlorinated pesticides, PAHs (n = 8 parameter categories; see NPDES permit for complete list of constituents)

[d] Fish tissue constituents = lipids, metals, PCBs, chlorinated pesticides, and PAHs (n = 5 parameter categories; see NPDES permit for complete list of constituents)

[e] Random (regional) benthic survey = joint requirement of Point Loma and South Bay outfall monitoring programs (i.e., 40 stations/year total)

[f] Continued Sediment Toxicity Monitoring as recommended by the Final Project Report for the Sediment Toxicity Pilot Study for the San Diego Ocean Outfall Monitoring Regions (City of San Diego 2019)

Table 5

Toxicity testing required in accordance with various NPDES permits. Listed effort excludes accelerated testing requirements (e.g., triggered by Notice of Violation), additional QA/QC procedures, and special studies.

Testing Component	Location/ Project	Sample Type	No. samples	Sampling Frequency	Sampling Times/Yr	No. test Species	Effluent/Ref Tox Tests/Yr[b]	Total Tests/Yr	Endpoints[c]	Dilutions per bioassay	Notes
Point Loma Chronic toxicity	PLWTP	final effluent	1	Monthly	12	1	12 + 12 Ref Tox	24	sensitive lifestage	1[a] + control	species: giant kelp
	(Biennial screening)	final effluent	1	3 x per 2 yrs	3 x per 2 yrs	3	9 + 9 Ref Tox per 2 yrs	18 per 2 yrs	sensitive lifestage	1[a] + control	screening spp: giant kelp, red abalone, and topsmelt
South Bay Chronic toxicity	SBWRP	final effluent	1	Quarterly	4	1	4 + 4 Ref Tox	8	sensitive lifestage	5 + control	species: giant kelp
	(Biennial screening)	final effluent	1	3 x per 2 yrs	3 x per 2 yrs	3	9 + 9 Ref Tox per 2 yrs	18 per 2 yrs	sensitive lifestage	5 + control	screening spp: giant kelp, red abalone, and topsmelt

[a] The In-stream Waste Concentration (IWC) of 0.49% effluent, using the of Test of Significant Toxicity (TST)

[b] Ref Tox = Reference Toxicant Test

[c] Sensitive lifestage endpoints: (1) red abalone = development; (2) giant kelp = germination and growth; (3) topsmelt = survival and growth

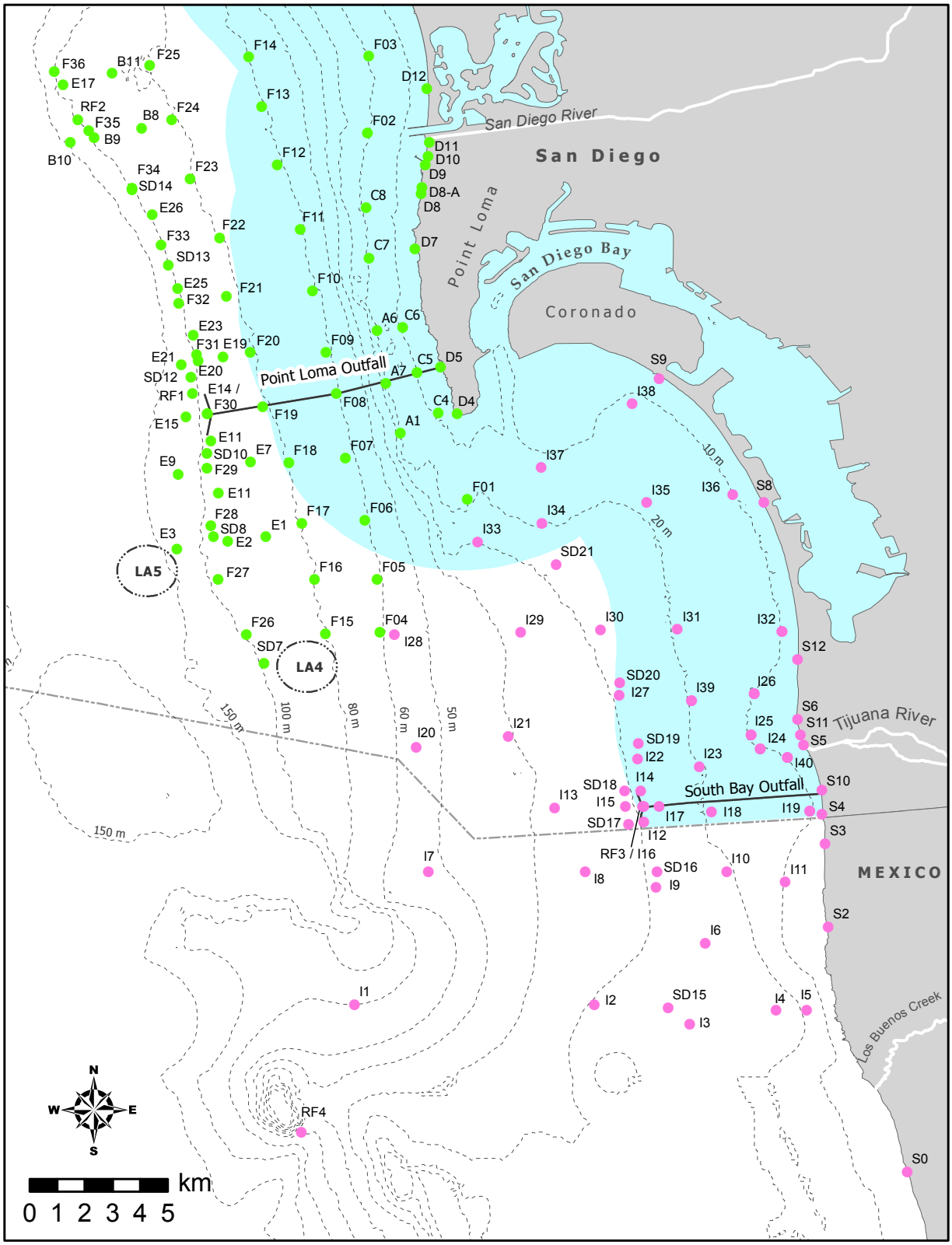

Figure 1

Core receiving waters monitoring stations for the PLOO (green) and SBOO (pink) sampled as part of the City of San Diego's Ocean Monitoring Program. Light blue shading represents State jurisdictional waters.

Table 6

Number of discrete samples collected and analyzed by EMTS staff for NPDES permit-related activities during 2020. NA = not applicable; ECS = Environmental Chemistry Services.

	Number of Samples Collected		Number of Analyses per Sample Type	
Sample Type	**Regular**	**QC**	**Regular**	**QA**
Sediment Grab				
Particle Size Subsample	138	NA	(performed by ECS)	
Chemistry Subsample	576 [a]	NA	(performed by ECS)	
Benthic Infauna Grab	138	NA	138	4
Otter Trawl	26	NA	26	NA
Fish Tissue	37 [b]	NA	(performed by ECS)	
Water Quality				
CTD Cast	1071	NA	9624 [d]	NA
Microbiology	4473 [c]	583	12,171 [e]	1621 [e]
Toxicology				
Sediment Toxicity	8 [f]	NA	8 [f]	1 [f]
Chronic Bioassay	21	NA	21	17
Bight '18 Ocean Acidification				
CTD Cast	20	NA	180 [d]	NA
Ocean Acidification	61	9	(performed by Dickson Lab)	
Coccolithophore	4	NA	(performed by UCLA)	
Pteropod RNA	4	NA	(performed by SCCWRP)	
Pteropod Shell Condition	4	NA	(performed by SCCWRP)	
Totals	**6581**	**592**	**22,168**	**1643**

[a] PLOO primary core stations had five subsamples per grab; all other stations had four subsamples per grab
[b] Second and third replicate samples for Trawl Zone 9 missing due to insufficient number of fish collected
[c] Includes resamples
[d] Includes up to nine parameters per cast (depth, temperature, salinity, dissolved oxygen, light transmittance, chlorophyll *a*, pH, density, CDOM)
[e] Includes up to three types of fecal indicator bacteria (total coliform, fecal coliform, *Enterococcus*)
[f] Includes samples for continued Sediment Toxicity Monitoring following the Final Project Report (City of San Diego 2019)

CTD Calibration and Maintenance

The City of San Diego's MBOO section uses two Sea-Bird Scientific SBE-25plus CTDs. Both systems are configured with Sea-Bird SBE-55 mini carousel packages and outfitted with six 4-liter Niskin bottles. Typically, laboratory staff carry out semi-annual in-house CTD intercalibration exercises to ensure consistency between the two CTD instruments used to collect water column profiling data for the City's Ocean Monitoring Program. For 2020, the intercalibration exercises were conducted in July 2020 and January 2021. During these exercises, two CTDs configured with similar probes were attached to each other, deployed to a depth of 120 m, and retrieved three separate times, creating three comparable casts. For each cast, depths greater than 100 m were discarded to minimize bottom effects. After the three casts were completed, comparisons of the results for six different parameters (temperature, salinity, dissolved oxygen (DO), pH, transmissivity, chlorophyll *a* fluorescence) were performed to assess whether deviations between the instrument assemblies were within acceptable limits determined here using published manufacturer sensor accuracies and historical intercalibration

Table 7

Summary of the CTD intercalibration results for casts conducted during 2020-2021, including (A) Mean difference (MeanΔ) and max difference (MaxΔ) between Unit #5 and Unit #6 across casts and depths, and the cast number (1, 2, 3) and depth (0–100 m) at which the maximum difference occurred and (B) results of CTD intercalibration exercises conducted during the last five years. Values are the MeanΔ between Unit #3 and Unit #4 (2015) and Unit #5 and Unit #6 (2016–2021).

A

	July 2020[a]				January 2021			
Parameter	**MeanΔ**	**MaxΔ**	**Cast**	**Depth (m)**	**MeanΔ**	**MaxΔ**	**Cast**	**Depth (m)**
Temperature (°C)	0.005	0.039	3	22	0.014	0.184	2	33
Salinity (ppt)	0.014	0.109	3	17	0.006	0.034	2	33
DO (mg/L)	0.060	0.197	2	18	0.290	0.420	3	83
pH	0.182	0.252	2	39	0.072	0.090	3	17
Transmissivity (%)	3.970	5.663	3	1	5.557	6.017	3	43
Chlorophyll *a* (µg/L)	0.301	1.332	3	25	0.078	0.307	3	4

B

Parameter	**Sep 2015**	**Dec 2015**	**Dec 2016**	**Aug 2017**	**Jan 2018**	**Nov 2018**	**Jul 2019**	**Dec 2019**	**Jul 2020**	**Jan 2021**
Temperature (°C)	0.03	0.03	0.02	0.10	0.04	0.03	0.02	0.01	0.01	0.01
Salinity (ppt)	0.02	0.01	0.01	0.04	0.02	0.02	0.00	0.02	0.01	0.01
DO (mg/L)	0.20	0.12	0.12	0.14	0.03	0.11	0.31	0.39	0.06	0.29
pH	0.02	0.02	0.02	0.22	0.03	0.06	0.11	0.06	0.18	0.07
Transmissivity (%)[b]	4.57	4.59	2.41	1.84	—	2.39	2.84	3.88	3.97	5.56
Chlorophyll *a* (µg/L)[c]	0.26	0.07	—	—	0.11	0.11	0.22	0.74	0.30	0.08

[a]First cast was not recorded properly internally and was excluded from this analysis
[b]Transmissivity results not available from January 2018 intercalibration casts due to probe failure
[c]Chlorophyll *a* results not available from December 2016 and August 2017 intercalibration casts due to probe failure

exercises. Acceptability criteria differ among sensors, but generally fall below 10% difference between sensors. In July 2020, the first cast was not recorded properly internally and was therefore excluded from this analysis. This was an isolated issue that did not affect any of the other subsequent casts. As such, acceptability of the mean and max difference between CTDs across depths for the July 2020 event was determined from the second and third casts only. The results are summarized in Table 7A, and Figures 2 and 3, and compared to results from previous years in Table 7B. The intercalibration exercises conducted for instruments used in July 2020 and January 2021 demonstrated acceptable variability between CTDs for all measurable parameters.

In addition to the semi-annual CTD intercalibration exercises, manufacturers of various probes recommend annual recalibrations at their factories. Since four sets of conductivity, temperature, pressure, pH, and DO probes and pumps are inventoried in-house, each instrument is rotated out of service and sent back to the factory every six months for recalibration along with the system pump. As there are only three sets of fluorometers and transmissometers, and two colored dissolved organic matter (CDOM) probes, these sensors are rotated out for external/factory recalibration service on an annual basis. However, if in-house calibration results indicate a problematic probe, it will be serviced earlier than scheduled. The overall rotation schedule of probes between CTD assemblies is staggered by six months to ensure that each instrument receives a replacement set within the annual calibration period.

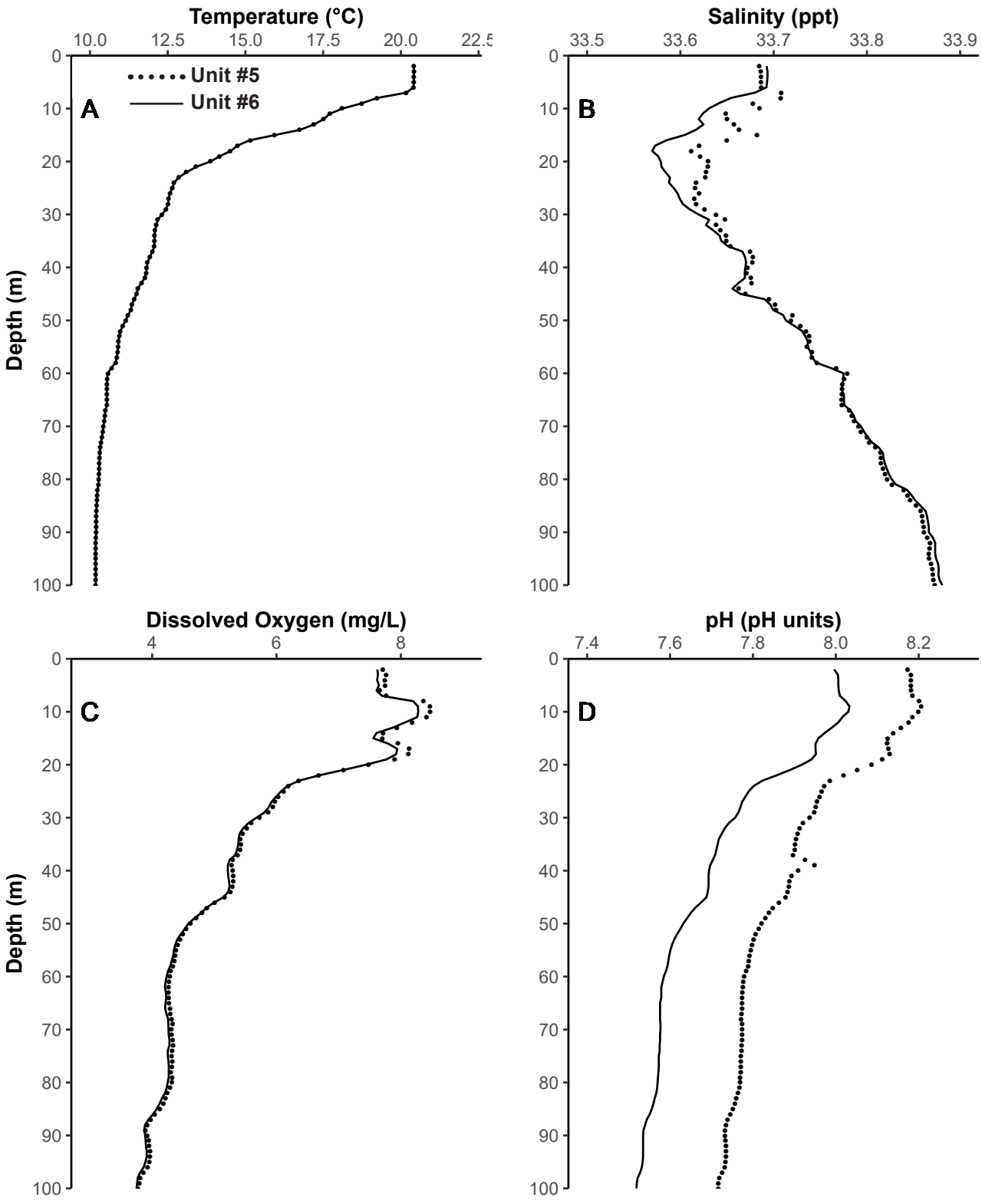

Figure 2

Comparison of results from CTD Unit #5 and Unit #6 from one representative cast made during the July 2020 CTD intercalibration exercise. Data include 1 m bin-averaged cast profiles for (A) temperature, (B) salinity, (C) dissolved oxygen, (D) pH, (E) transmissivity, and (F) chlorophyll *a*.

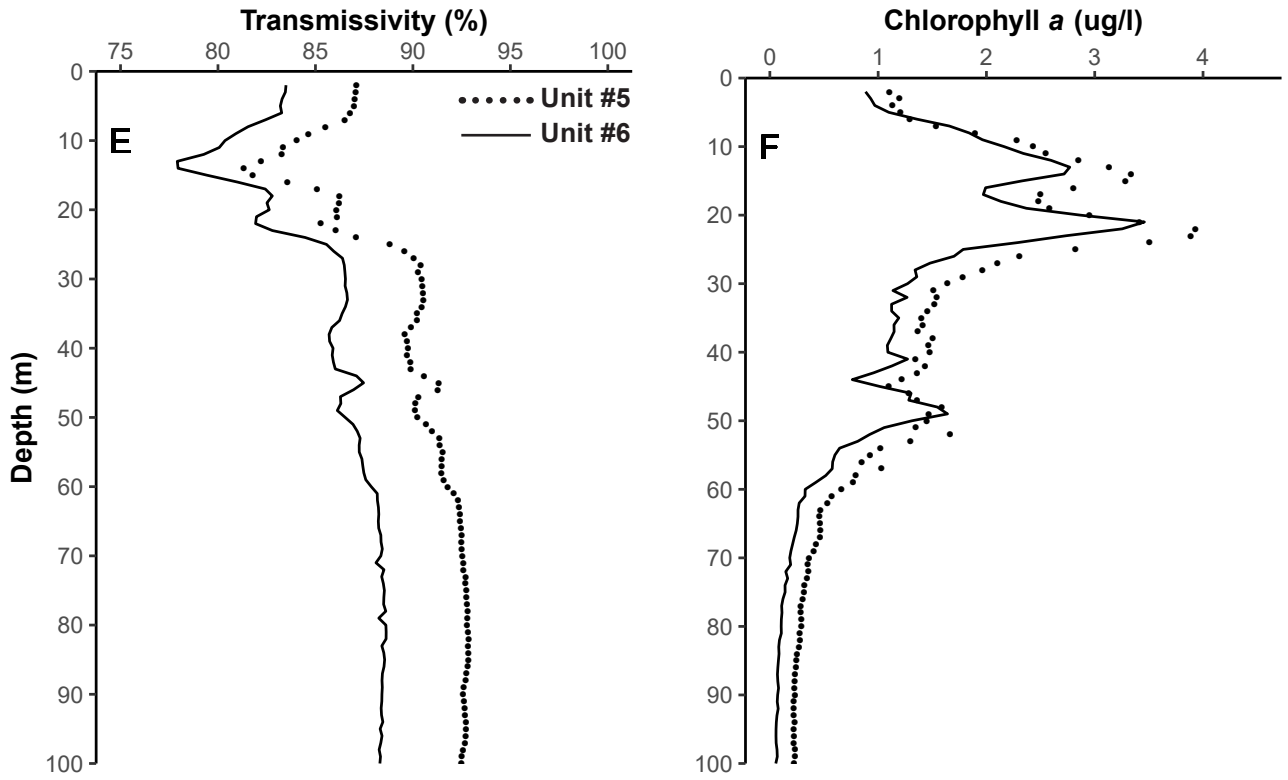

Figure 2 *continued*

The probes actively in use on each CTD undergo further in-house evaluations prior to and during each field survey. The DO probe on each CTD is calibrated monthly to check for sensor drift. If the sensor drift is ≥ 5% from factory calibration, the DO sensor coefficients are changed. If DO sensor drift reaches 10% from factory calibration, it is removed from service, returned to the manufacturer for servicing or repair, and replaced with a newly factory-calibrated probe. The pH and transmissivity probes are inspected prior to each sampling cruise to ensure proper function. For pH calibrations, three buffer solutions (pH = 7.0, 8.0, 9.0) are used to bracket the expected pH range. If the reading of any buffer solution deviates by more than 0.05 pH units, the probe is recalibrated. The transmissometer on each CTD is checked by cleaning the windows of the LED light path, noting the zero reading by blocking the light path, and then noting the maximum-value reading by removing the obstruction. If any specific probe fails to calibrate or has drifted out of its accepted range, it is removed from the CTD and replaced with a newly calibrated spare. Additionally, the results of each probe are evaluated by reviewing the data for each parameter following each cast. If any probe is determined to be faulty and a field repair cannot be completed, sampling will be terminated immediately so that the needed repairs can be completed back at the laboratory.

Bacteriological Quality Assurance Analyses

Duplicate analyses are run throughout the year as a QC check on bacteriological data reported by the City. Field duplicates are two separate samples taken from the same station at the same time and then processed by a single analyst to measure variability between samples. Laboratory duplicates are designed to test an analyst's precision, and consist of two samples that are diluted, filtered, and

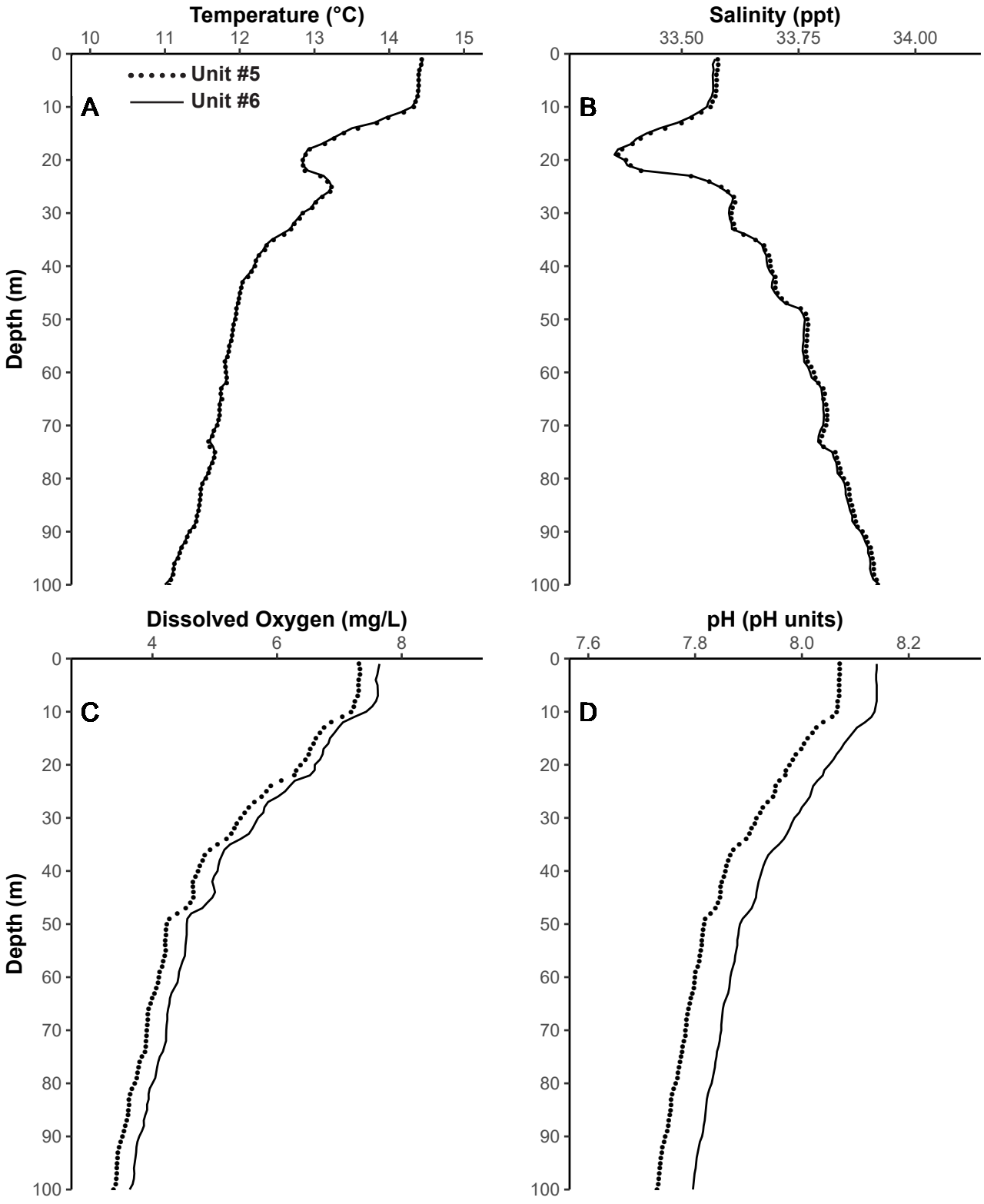

Figure 3

Comparison of results from CTD Unit #5 and Unit #6 from one representative cast made during the January 2021 CTD intercalibration exercise. Data include 1 m bin-averaged cast profiles for (A) temperature, (B) salinity, (C) dissolved oxygen, (D) pH, (E) transmissivity, and (F) chlorophyll *a*.

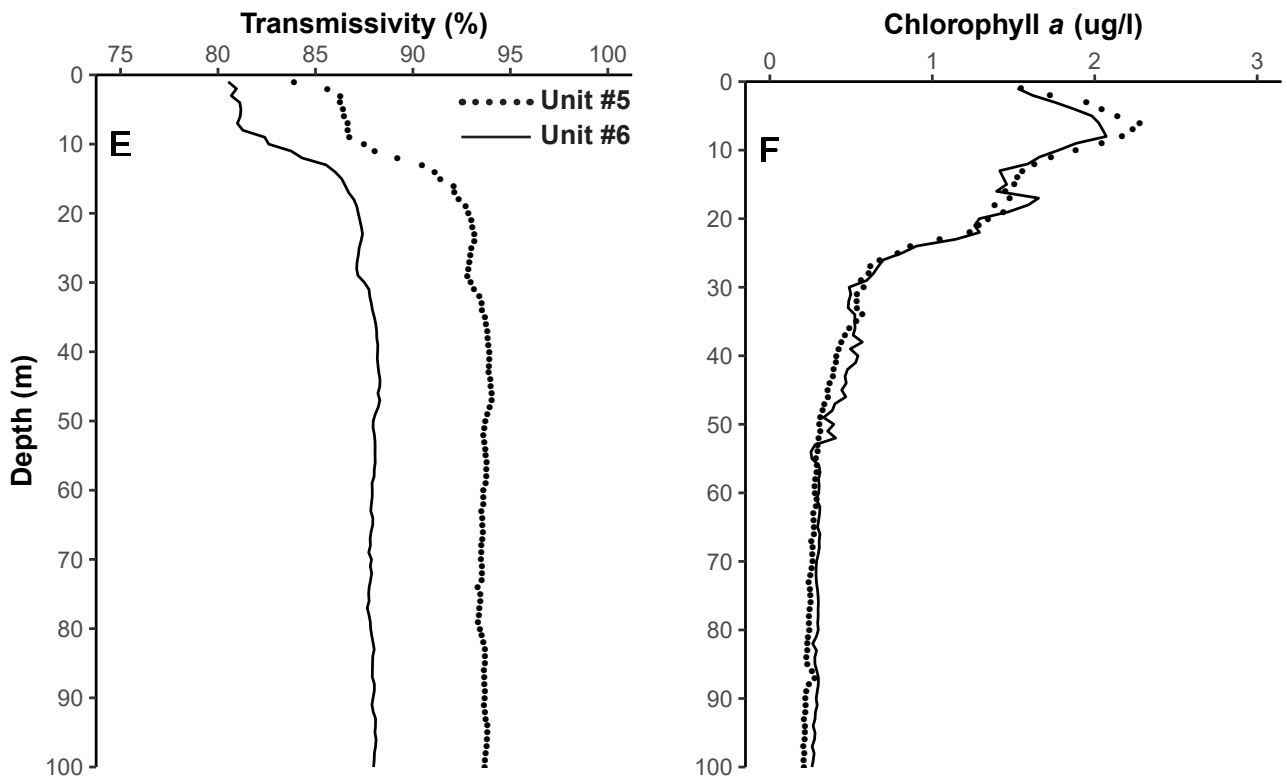

Figure 3 *continued*

plated from a single sample container. During 2020, a total of 583 QC water samples were collected, comprising 474 laboratory and 109 field duplicates (Table 6). The results from analyses performed on these samples have been reported previously in the Point Loma and South Bay monthly receiving waters monitoring reports.

The sign test (Gilbert 1987) was used to compare the results from the paired laboratory and field duplicate analyses performed in 2020 (Table 8). When matched pairs of samples are used, the sign test assumes that the probability of observing samples with differing plate counts is equally distributed among positive (sample A > sample B) and negative (sample A < sample B) results. Samples that do not differ (A – B = 0) are ignored. During 2020, results from duplicate field and laboratory samples were not significantly different ($p > 0.05$) for each of the three tested indicator bacteria (total coliforms, fecal coliforms, *Enterococcus*), indicating low variability between samples and high repeatability of laboratory measurements.

In addition to the above QA analyses, the MML conducts monthly comparisons of bacterial colony counts to quantify the counting precision across analysts. Counts are performed on a single plate by pairs of analysts with the requirement that counts by any two analysts must fall within 10% of each other. This calculation is known as the Relative Percent Difference (RPD). During 2020, 186 count comparisons were performed. For total coliform counts, 3 out of 64 comparisons had an RPD greater than 10%, 3 out of 64 comparisons had an RPD greater than 10% for fecal coliform counts, and all 58 count comparisons were within 10% RPD for *Enterococcus* counts. In addition to these QA procedures, all analysts maintain their competency to perform certified methods through regular proficiency tests or demonstrations of capability.

Table 8

Summary of bacteriological QA analyses conducted during 2020 for the City of San Diego's Ocean Monitoring Program. n = number of sample pairs with different colony counts (samples without differences are not included); B = the number of positive differences between pairs; Z_b = sign test outcome; H_o = the probability of observing positive and negative differences in plate counts between paired samples is equal (see text). Paired samples were compared using the sign test (see Gilbert 1987) at a $p = 0.05$ level of significance.

Sample Type	Parameter	n	B	Z_b	p	H_o
Lab Duplicate	Total Coliform	197	97	-0.2137	> 0.05	Fail to reject
	Fecal Coliform	143	71	-0.0836	> 0.05	Fail to reject
	Enterococcus	131	64	-0.2621	> 0.05	Fail to reject
Field Duplicate	Total Coliform	43	19	-0.7625	> 0.05	Fail to reject
	Fecal Coliform	41	24	1.0932	> 0.05	Fail to reject
	Enterococcus	36	19	0.3333	> 0.05	Fail to reject

Macrofaunal Community Quality Assurance Analysis

Laboratory analyses of benthic macrofaunal samples involve three processes: (1) sample washing and preservation; (2) sample sorting; (3) identification and enumeration of all invertebrate organisms down to species level or the lowest taxon possible. Sorting QC is essential to ensuring the validity of the subsequent steps in the sample analysis process. The sorting of benthic samples into major taxonomic groups is contracted to an outside laboratory, with the contract specifying an expected 95% removal efficiency. Ten percent of the sorted samples from each taxonomist at the contract lab are subjected to re-sorting as QA for the contract. The original sorting of a sample fails the QA criterion if the abundance in the re-sorted sample deviates more than 5.0% from the total abundance of all animals from that sample. If more than one failure occurs, the contract requires the re-sorting of all samples previously sorted by an individual contract sorter. All samples re-sorted from the 2020 surveys met the acceptance QA criteria for sorting (Table 9).

Additionally, the laboratory performs re-identifications (re-IDs) as a QA measure to maintain consistency among taxonomists. For 2020, these were performed on four of the 138 grabs, and are included in the total count for Benthic Infauna Grab QA (Table 6). All re-identification sample analyses are conducted by taxonomists other than those who originally analyzed the samples and are completed without access to original results. All re-IDs conducted in 2020 met acceptance criteria as specified in the Bight′18 benthic laboratory manual (SCCWRP 2018).

Toxicology Quality Assurance Analyses

All required whole effluent toxicity and sediment toxicity analyses in 2020 were performed by the TL, which conducts routine reference toxicant testing as a part of its quality assurance program. A reference toxicant is a standard chemical used to measure the sensitivity of the test organisms and test precision. Consistency among the reference toxicant test results enhances confidence in the toxicity data concurrently obtained from the test material (wastewater effluent). A specific reference toxicant is used for each combination of test material, test species, test conditions and endpoints, and the material is chosen from a list developed by the USEPA. The reference toxicant is purchased from an approved supplier in aqueous form (stock solution), and the supplier must verify the concentration of the stock solution and provide written documentation of such analysis.

Table 9

Results of benthic macrofauna sample re-sort analyses conducted during 2020 by the City of San Diego's Ocean Monitoring Program. Percent = (# of animals found in the resorted sample/total sample abundance) X 100.

PLOO			SBOO			REGIONAL		
Survey	**Station**	**Percent**	**Survey**	**Station**	**Percent**	**Survey**	**Station**	**Percent**
Jan-20	B10	0.0%	**Jan-20**	I4	4.4%	**Jul-20**	8901	0.0%
	E2	0.6%		I14	0.6%		8912	0.0%
	E15	0.0%		I15	3.3%		8920	0.0%
	E21	0.0%		I18	0.0%		8928	0.0%
	E23	0.0%		I22	0.0%		8932	0.4%
Jul-20	B8	0.0%	**Jul-20**	I2	0.0%		8939	0.0%
	B10	0.0%		I8	0.0%		8944	4.6%
	E19	0.0%		I10	0.0%			
	E21	0.0%		I13	0.0%			
	E26	0.0%		I20	1.0%			
				I33	0.0%			

In most instances, a reference toxicant test is performed at the same time the test material is evaluated. A control chart for each test method is maintained by the division QA Manager or Laboratory Supervisor using results from no fewer than 20 of the most recent reference toxicant tests when available. The charted parameters that may be used include effect concentrations (LC_{50}, EC_{50}), control performance, percent minimum significant difference, and coefficient of variability.

Using a nominal error rate of 5.0%, results from 19 of the most recent 20 reference toxicant tests are expected to fall within two standard deviations of the simple moving average (unweighted running mean), while one of these tests may fall outside the control chart limits by chance alone. Additionally, a series of USEPA-recommended quality control limits are used to further evaluate test sensitivity. Each run that is in violation of control limits would trigger an investigation of animal supply, reference toxicant stock quality, and laboratory practices. Additional testing may also be conducted to determine whether an exceedance is anomalous or if corrective actions are needed. All NPDES-mandated tests conducted with the affected animals are flagged, reviewed for anomalous responses, and in certain cases, tests are repeated with a new batch of animals. In 2020, all reference toxicant control charts for bioassays conducted by the TL met the acceptability criteria as specified in Standard Operating Procedures and USEPA Methods.

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