SD Public Utilities

ANNUAL RECEIVING WATERS MONITORING & TOXICITY TESTING QUALITY ASSURANCE REPORT

2017

Environmental Monitoring and Technical Services
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CERTIFIED
Public Utilities Department
Continual Improvement, Prevention of Pollution, Regulatory Compliance
ISO 14001

Annual Receiving Waters Monitoring & Toxicity Testing Quality Assurance Report

2017

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City of San Diego
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Public Utilities Department
Environmental Monitoring & 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 performs comprehensive Quality Assurance (QA)/Quality Control (QC) activities to ensure the accuracy and reliability of both receiving waters monitoring and toxicity testing data provided to regulatory agencies in compliance with the reporting requirements specified in several National Pollutant Discharge Elimination System (NPDES) permits (Table 1). These QA/QC procedures assure the quality and consistency of field sampling, laboratory analysis, record keeping, data entry, 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 division's QA/QC program for receiving waters monitoring is documented in a separate Quality Assurance Plan that is currently under revision (City of San Diego, in prep). Additionally, the EMTS Division maintains certification through the International Organization for Standardization 14001 Environmental Management Systems program (ISO 14001). As a part of continuation in the ISO 14001 certification process, EMTS underwent and passed an external audit in 2017 conducted by a third-party auditor.

This report summarizes the QA/QC activities that were conducted during calendar year 2017 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 and South Bay Water Reclamation Plant, as well as similar ocean monitoring activities required for the South Bay International Wastewater Treatment Plant owned and operated by the International Boundary and Water Commission, U.S. Section.

Facilities and Staff

The EMTS Division includes laboratories from three different sections that participate in the receiving waters monitoring and toxicity testing activities associated with the above NPDES permits: (1) the Marine Biology and Ocean Operations section (Marine Biology Lab); (2) the Microbiology section (Marine Microbiology Lab and Toxicology Lab); (3) Environmental Chemistry Services section (Environmental Chemistry Lab).

The Marine Biology, Marine Microbiology, and Toxicology Labs are located at the EMTS Division's laboratory facility at 2392 Kincaid Road, San Diego, CA 92101. Staff scientists from these three labs are responsible for conducting most field sampling operations and subsequent biological and oceanographic laboratory assessments associated with the City's Ocean Monitoring Program (e.g., water quality, benthic sediments and macrofauna, trawl-caught fishes and invertebrates, contaminant accumulation in marine fishes). Laboratory personnel are organized into different work groups based on main responsibilities and areas of expertise (see Appendices A.1, A.2). Brief descriptions of the areas of emphasis for each work group are given in the following sections.

Table 1

NPDES permits and associated Orders issued by the San Diego Regional Water Quality Control Board for the City of San Diego's Point Loma Wastewater Treatment Plant (PLWTP) and South Bay Water Reclamation Plant (SBWRP), and the U.S. Section of the International Boundary and Water Commission's South Bay International Wastewater Treatment Plant (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 and R9-2017-0024

The Environmental Chemistry Services (ECS) section is located at other City facilities and is responsible for performing chemical analyses of the various seawater, sediment, and fish tissue samples collected by Marine Biology staff. Descriptions of the ECS section and their QA procedures are presented in a separate QA report each year.

Marine Biology and Ocean Operations

Project Coordination and Assessment: One of the primary responsibilities of the PCA work group is to oversee the analysis and reporting 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. Personnel in this group work closely with the Information Management and GIS group described below to perform QA of all receiving waters monitoring data that are entered into the laboratory's database. 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.

Information Management and GIS: The IM/GIS work group is primarily responsible for the administration of the laboratory's database, performing geospatial data analysis, and generating all map products needed for the ocean monitoring program. Daily responsibilities include entry and archiving of ocean monitoring data, validation of data accuracy, maintenance of database structure and integrity, oversight of database access/security issues, and management of database enhancements. This group is also responsible for IM project planning, workflow automation programming, and website maintenance to support Marine Biology and other EMTS laboratory staff.

Ocean Operations: This work group comprises two subsections, Ocean Operations and Vessel Operations. Ocean Operations personnel oversee 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 lab's remotely operated vehicle (ROV). Vessel operations personnel are primarily responsible for the operation and maintenance of the City's two monitoring vessels (Oceanus and Monitor III). When in port, the group's boat operators schedule and oversee all regular vessel maintenance as well as any modifications that may become necessary. While at sea, they are responsible for ensuring the safety

Table 2
ELAP certifications for EMTS Division Marine Microbiology and Toxicology labs located at 2392 Kincaid Road, San Diego, California, 92101.

Laboratory	Phone	EPA Lab ID	ELAP Cert. No.
Marine Microbiology	619-758-2360	CA01393	2185
Toxicology	619-758-2348	CA01302	1989

of the crew, locating and maintaining position at monitoring stations, and assisting with various deck activities during field operations.

Taxonomy: The Taxonomy work group coordinates processing of all benthic macrofauna and trawl invertebrate samples, maintains the taxonomic literature and voucher collections, and conducts taxonomic training. In addition, taxonomy staff produce in-house identification sheets and keys to various species and other higher-level taxa groups. Members of this work group participate in a regional taxonomic standardization program and perform all QA/QC procedures to ensure the accuracy of the taxonomic identifications made by laboratory personnel.

Microbiology

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

Members of the Marine Microbiology Lab also provide for monitoring, surveillance, control and prevention of insects and other pests that are capable of transmitting diseases or causing harm to humans. The primary methods of control include environmental conservation measures, education, and water management techniques aided by appropriate chemical and biological control technology. The vector control 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 (bioassessments) 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.

Toxicology: The Toxicology Laboratory is also certified by ELAP with renewal on a biennial basis (see Table 2). Toxicology personnel 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 Toxicology Lab 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.

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 impacts on the marine environment due to the discharge of municipal wastewater to the Pacific Ocean via the Point Loma Ocean Outfall (PLOO) and the South Bay Ocean Outfall (SBOO). Treated effluent from the Point Loma Wastewater Treatment Plant (PLWTP) is discharged to the ocean through the PLOO, whereas commingled effluent from the South Bay Water Reclamation Plant (SBWRP) and South Bay International Wastewater Treatment Plant (SBIWTP) is discharged through the SBOO. The separate orders and permits associated with these treatment facilities (see Table 1) define the requirements for receiving waters monitoring and toxicity testing in terms of sampling plans, compliance criteria, laboratory analyses, statistical analyses, and reporting guidelines.

The core receiving waters monitoring requirements for the Point Loma and South Bay monitoring programs that were in effect throughout calendar year (CY) 2017 are summarized in Tables 3 and 4, respectively, and the permanent, fixed position sampling sites for each program are shown in Figure 1. These core 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 in order 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. In addition to the receiving waters monitoring activities described above, toxicity testing (acute and chronic bioassays) is required for influent, effluent, and groundwater samples as outlined in Table 5. 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 on-going basis. Although not included in this report, a Sediment Toxicity Monitoring Plan for the South Bay and Point Loma ocean outfall monitoring regions was implemented in 2016 (City of San Diego, 2015). The results of this 3-year pilot study, including associated QA/QC activities, will be presented separately in a final project report expected within six months of the completion of the Year 3 survey scheduled for summer 2018.

In addition to the above core monitoring efforts, the City also conducts "strategic process studies" (i.e., special projects) as part of its regulatory requirements and as defined by the Model Monitoring

Table 3

NPDES-permit mandated receiving waters sampling effort for the Point Loma Ocean Outfall region, excluding resamples, QA/QC analyses (e.g., field and laboratory duplicates), or 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	shore	8	Seawater - FIB	1	1/week	52	416	T, F, E[a]	1248	1 sample/station
&	kelp	8	Seawater - FIB	3	1/week	52	1248	T, F, E[a]	3744	3 depths/station
Oceanographic Conditions		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/Quarterly	4	36	E[b]	36	3 depths/station (18-m stns)
	(n=36)	11	Seawater - FIB	3	1/Quarterly	4	132	E[b]	132	3 depths/station (60-m stns)
		11	Seawater - FIB	4	1/Quarterly	4	176	E[b]	176	4 depths/station (80-m stns)
		11	Seawater - FIB	5	1/Quarterly	4	220	E[b]	220	5 depths/station (98-m stns)
		36	CTD	1	1/Quarterly	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	I° and II° core stations (Jan, Jul)
	offshore	12	Grab	1	2/Year	2	24	sed chem[e]	24	I° 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 II° core stations (Jan, Jul)
	offshore	40	Grab	1	1/Year	1	40		360	Randomized stations (Jul)[g]
Sediment Toxicity	offshore	8-28	Grab	1	1/Year	1	28	acute toxicity	28	3 year Pilot Project (2016-2018)[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]	24	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 grain size, total organic carbon, total nitrogen, sulfides, metals, PCBs, chlorinated pesticides, PAHs (n=8 parameter categories; see NPDES permit for complete list).
[e] Sediment constituents = BODs 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 Pt Loma and South Bay outfall monitoring programs (i.e., 40 stations/year total)
[h] Sediment Toxicity Monitoring Plan for the South Bay Ocean Outfall and Point Loma Ocean Outfall Monitoring regions, San Diego, California

Table 4

NPDES-permit mandated receiving waters sampling effort for the South Bay Ocean Outfall region, excluding resamples, QA/QC analyses (e.g., field and laboratory duplicates), or special studies.

Monitoring Component	Location	Number of Stations	Sample Type	Discrete No. Samples/Site	Sampling Frequency	Sampling Times/Yr	Discrete No. Samples/Yr	Parameters	No. "Samples" Analyzed/Yr	Notes
Water Quality, Microbiology	shore	11	Seawater - FIB	1	1/weekly	52	572	T, F, E[a]	1716	1 sample/station
&	kelp/	7	Seawater - FIB	3	1/week	52	1092	T, F, E[a]	3276	3 depths/station
Oceanographic	nearshore	7	CTD	1	1/week	52	364	CTD profile[b]	3276	1 cast/station (1-m batch avg samples)
Conditions	offshore	21	Seawater - FIB	3	1/Quarterly	4	252	T, F, E[a]	756	3 depths/station
	(n=33)	33	CTD	1	quarterly	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	I[o] and II[o] 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	I[o] and II[o] core stations (Jan, Jul)
	offshore	40	Grab	1	1/Year	1	54			Randomized stations (Jul)[e]
Sediment Toxicity	offshore	8-28	Grab	1	1/Year	1	28	Acute toxicity	28	3 year Pilot Project (2016-2018)[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							2,663		11,205	

[a] Fecal Indicator Bacteria (FIB) parameters = total coliform (T), fecal coliform (F), and *Enterococcus* (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 grain size, total organic carbon, total nitrogen, sulfides, metals, PCBs, chlorinated pesticides, PAHs (n = 8 parameter categories; see permit for complete list of constituents)
[d] Fish tissue constituents = lipids, metals, PCBs, chlorinated pesticides, PAHs (n = 5 parameter categories; see 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 Sediment Toxicity Monitoring Plan for the South Bay Ocean Outfall and Point Loma Ocean Outfall Monitoring regions, San Diego, California

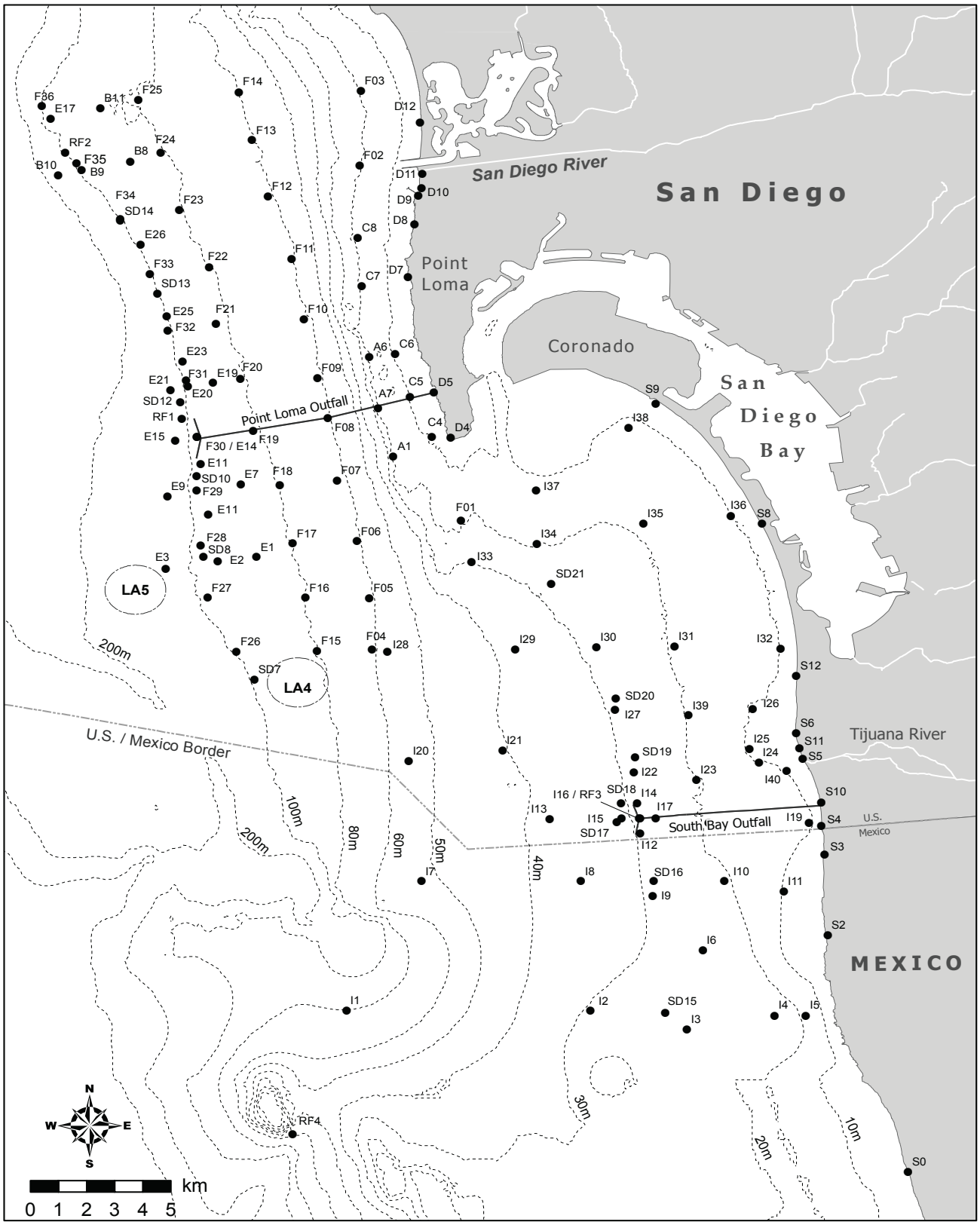


Figure 1
NPDES permit mandated (fixed-grid) water quality, benthic, trawl and rig fishing stations for the City of San Diego's Ocean Monitoring Program for the Point Loma and South Bay Ocean Outfall regions.

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, or special studies.

Testing Component	Location/ Project	Sample Type	No. samples	Sampling Frequency	Sampling Times/Yr	No. test Species	Effluent/ Ref Tox Tests/Yr	Total Tests/Yr	Endpoints	Dilutions per bioassay	Notes
Point Loma											
Acute toxicity[a]	PLWTP	final effluent	1	semi-annual	2	1	2 + 2 Ref Tox	4	survival	5 + control	species = topsmelt
	(Biennial screening)	final effluent	1	3 x per 2 yrs	3 x per 2 yrs	2	6+ 6 Ref Tox per 2 yrs	12 per 2 yrs	survival	5 + control	screening spp: mysid and topsmelt
Chronic toxicity[b]	PLWTP	final effluent	1	monthly	12	1	12 + 12 Ref Tox	24	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
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]As of October 1, 2017, acute toxicity monitoring is no longer required per PLWTP NPDES Permit CA0107409, Order No. R9-2017-0007
[b]As of October 1, 2017, chronic toxicity monitoring for PLWTP NPDES Permit CA0107409 requires testing of only one concentration, the In-stream Waste Concentrations (IWC) of 0.49% effluent, using the test of significant toxicity (TST)
Ref Tox = Reference Toxicant Test
Sensitive lifestage endpoints: (1) red abalone = development; (2) giant kelp = germination and growth; (3) topsmelt = survival and growth

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 these directed studies are 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 goals of the special study. 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 (e.g., municipal dischargers, 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 (SCBPP) and subsequent Bight'98, Bight'03, Bight'08 and Bight'13 regional monitoring efforts that began in 1998, 2003, 2008 and 2013, respectively. During these programs, the City's regular sampling and analytical efforts may be reallocated as necessary with approval of the SDRWQCB and USEPA. As with special studies, the regional monitoring efforts are typically subject to QA/QC procedures similar to 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 this report unless otherwise indicated. The planning documents for the most recent Bight'13 project, including its Quality Assurance Plan, are available upon request or for download from SCCWRP's website (www.sccwrp.org).

Summary of Work Performed in 2017

During CY 2017, a total of 7936 discrete samples were collected by EMTS staff, including samples collected as part of permit-mandated special studies (Table 6). Of these, about 8% (n = 645) were QC samples such as field duplicates. In addition, a total of 1727 QA tests were conducted to validate the quality of specific analyses such as macrofauna sorting, microbiological analyses and toxicity tests. 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) inter-calibration 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; (4) results of toxicology QA procedures.

CTD Calibration and Maintenance

Ocean Operations personnel carry out semi-annual in-house CTD inter-calibration exercises to ensure consistency between the two Sea-Bird Electronics SBE-25plus CTD instruments used to collect water column profiling data for the City's ocean monitoring program. During these exercises, the two CTDs are attached to each other with similar probes aligned and then deployed to a depth of 120 m and

Table 6

Number of discrete samples collected and analyzed by EMTS staff for NPDES permit-related activities during 2017. NA = not applicable; ECS = Environmental Chemistry Services.

	Number of Samples Collected		Number of Analyses per Sample Type	
Sample Type	**Regular**	**QC**	**Regular**	**QA**
Sediment Grabs				
Particle Size Subsample	138	NA	(performed by ECS)	
Chemistry Subsamples	596[a]	NA	(performed by ECS)	
Benthic Infauna Grabs	160[b]	NA	138	24
Otter Trawl	26	NA	26	NA
Fish Tissue	39	NA	(performed by ECS)	
Water Quality				
CTD Casts	1131	NA	10,175[d]	NA
Microbiology	4542[c]	605	12,349[e]	1687[e]
Suspended Solids	306	28	(performed by ECS)	
Oil and Grease	112	12	(performed by ECS)	
Ammonia (as nitrogen)	216	NA	216	NA
Toxicology				
Acute Bioassay	1	NA	1	1
Sediment Bioassay[f]	8	NA	8[f]	1[f]
Chronic Bioassay	16	NA	16	14

[a] PLOO stations had five subsamples per grab; all other stations had four subsamples per grab

[b] Includes 22 additional grabs from PLOO stations that were collected in January, but not analyzed

[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 from the San Diego Ocean Outfall Sediment Toxicity Monitoring Plan (City of San Diego 2015)

retrieved three separate times. For each cast, data from depths greater than 100 meters are discarded in an effort to minimize bottom effects. After all three casts are completed, comparisons of the results for temperature, salinity, dissolved oxygen (DO), pH, transmissivity, and chlorophyll *a* are performed to assess whether deviations between the instruments and sensors are within acceptable limits. For CY 2017, the first inter-calibration exercise was conducted in August 2017, while the second exercise was deferred until January 2018; these results are summarized in Table 7A and Figure 2, and compared to results from previous years in Table 7B. Acceptable variability was found between the CTDs for all parameters.

In addition to the semi-annual CTD inter-calibration exercises, manufacturers of various probes recommend annual re-calibrations at their factories. Therefore the overall rotation schedule of probes

Table 7

Summary of the CTD intercalibration casts: (A) casts conducted during August 2017 and January 2018. Values are the mean difference (MeanΔ) and maximum difference (MaxΔ) between Unit #5 and Unit #6, as well as the cast number (i.e., 1, 2, or 3), and depth (m) at which the maximum difference occurred; (B) results of CTD intercalibration exercises conducted from 2012 through 2018. Values are the differences between Unit #3 and Unit #4 (2011–2015) and Unit #5 and Unit #6 (2016–2018) averaged over all depths (0–100 m).

A

	August 2017				January 2018			
Parameter	**MeanΔ**	**MaxΔ**	**Cast**	**Depth (m)**	**MeanΔ**	**MaxΔ**	**Cast**	**Depth (m)**
Temperature (°C)	0.096	0.310	3	37	0.041	0.485	1	22
Salinity (ppt)	0.036	0.283	1	11	0.016	0.078	1	25
DO (mg/L)	0.135	0.917	3	10	0.026	0.202	2	53
pH	0.221	0.302	1	67	0.026	0.052	3	1
Transmissivity (%)[a]	1.840	3.050	1	67	—	—	—	—
Chlorophyll *a* (µg/L)	0.106	0.473	1	7	0.100	0.463	1	27

B

Parameter	**Aug 2012**	**Dec 2012**	**Jun 2013**	**Dec 2013**	**Jul 2014**	**Dec 2014**	**Sep 2015**	**Dec 2015**	**Dec 2016**	**Aug 2017**	**Jan 2018**
Temperature (°C)	0.04	0.04	0.02	0.01	0.06	0.01	0.03	0.03	0.02	0.10	0.04
Salinity (psu)	0.01	0.01	0.01	0.01	0.01	0.00	0.02	0.01	0.01	0.04	0.02
DO (mg/L)	0.37	0.5	0.06	0.05	0.08	0.07	0.20	0.12	0.54	0.13	0.03
pH	0.03	0.31	0.03	0.04	0.05	0.02	0.02	0.02	0.02	0.22	0.03
Transmissivity (%)	0.65	1.02	2.92	1.44	4.43	4.27	4.57	4.59	2.41	1.84	—
Chlorophyll *a* (µg/L)	1.63	2.55	0.76	0.07	0.04	0.03	0.26	0.06	—	0.11	0.11

[a]Transmissivity results not available from January 2018 inter-calibration casts due to probe failure

between CTDs is staggered by six months to ensure that each instrument receives a replacement set within the annual calibration period. However, if in-house calibration results indicate a problematic probe, it will be serviced earlier than scheduled.

The probes actively in use on each CTD undergo further in-house evaluations prior to and during each survey. The DO probe on each instrument is calibrated monthly to check for sensor drift. If the sensor drift is ≥5% from factory calibration, the sensor coefficients are adjusted accordingly. If the sensor drift deviates 10% from factory calibration, it is removed from service, returned to manufacturer for service and replaced with a newly factory calibrated probe. The pH and transmissivity probes are checked in the morning prior to each sampling cruise to ensure proper function. For pH calibrations, three buffer solutions (7.0, 8.0 and 9.0) are used to bracket the expected pH range. If the reading of a particular buffer solution deviates by more than 0.05 pH units, the probe is adjusted electronically using factory provided software and then re-calibrated. The transmissometer is checked by cleaning the windows of the LED light path and then noting the zero reading by blocking the light path and the full range reading by removing the obstruction. If any probe fails to calibrate or seems to have drifted out of range, it is removed from the instrument and replaced with a newly calibrated spare.

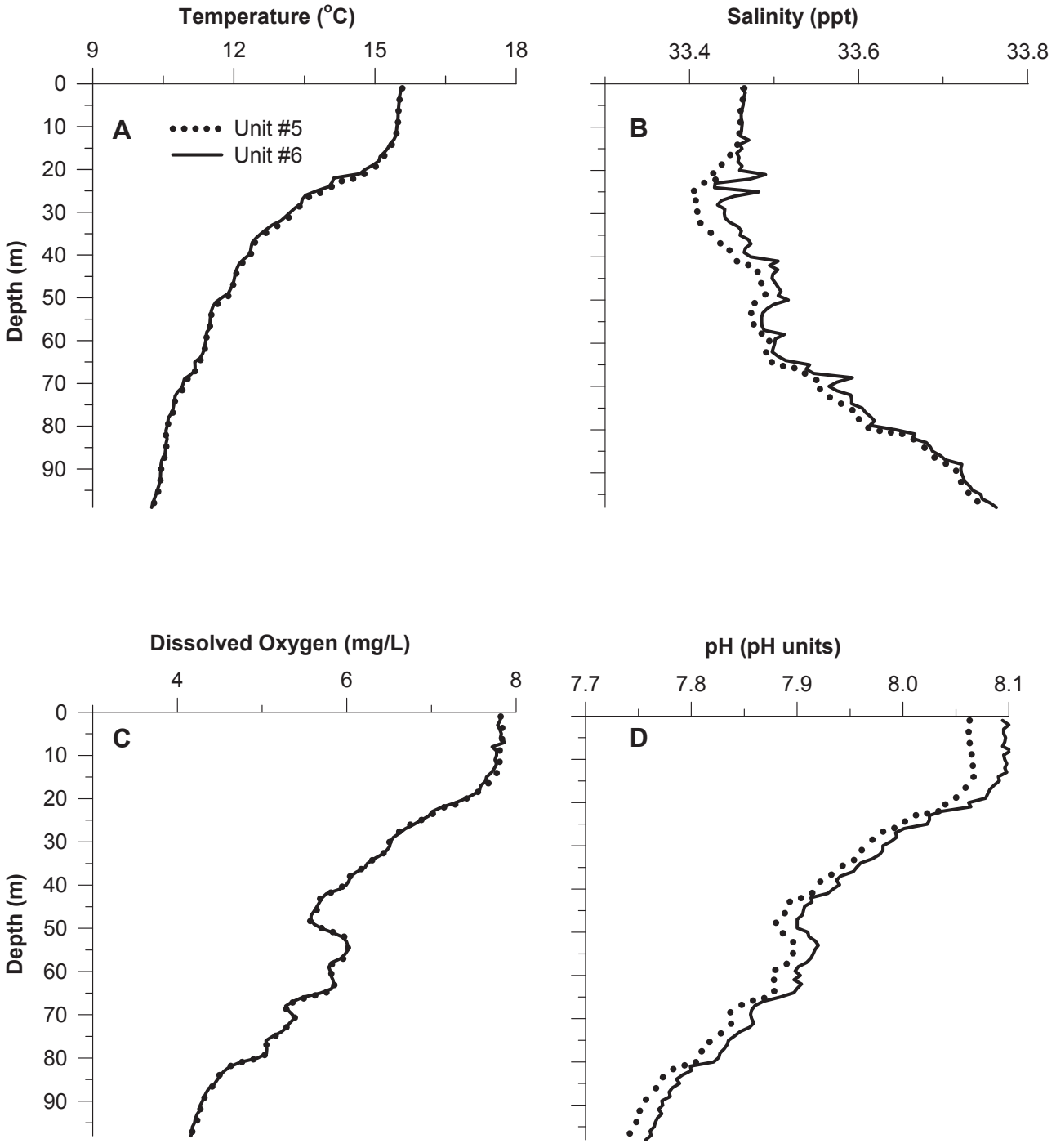


Figure 2

Comparison of results from CTD Unit #5 and Unit #6 from one representative cast made during the August 2017 or January 2018 CTD inter-calibration exercises. Data include cast profiles for (A) temperature, (B) salinity, (C) dissolved oxygen, (D) pH, (E) transmissivity, and (F) chlorophyll *a*.

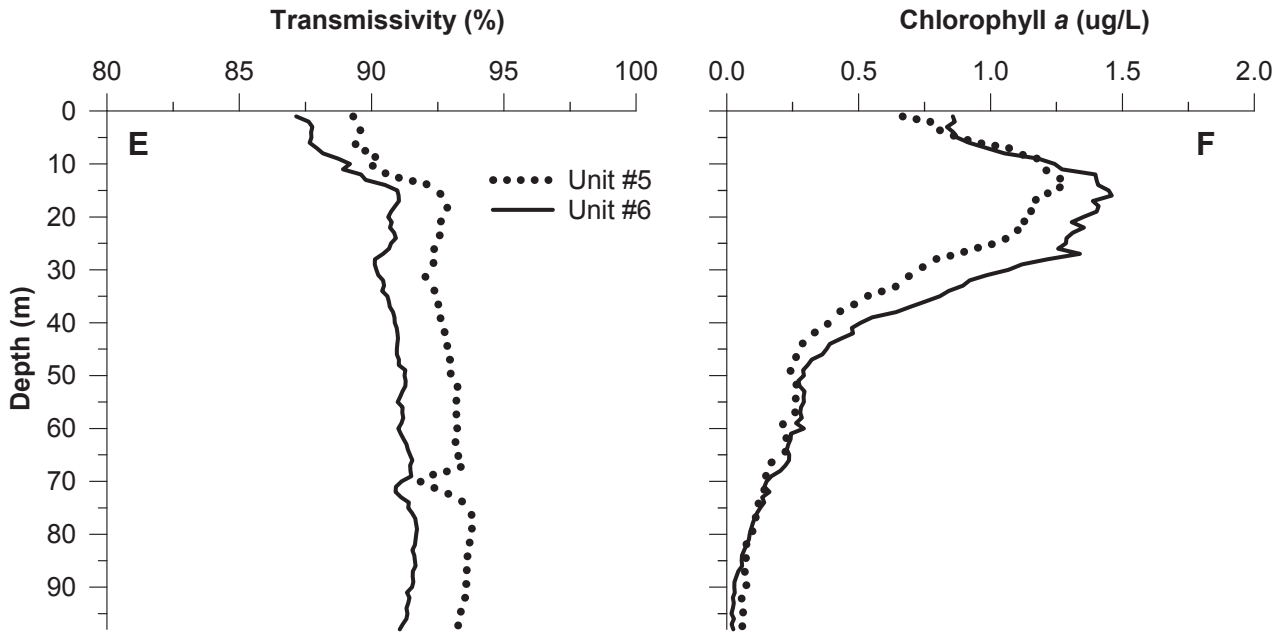


Figure 2 *continued*

Additionally, the results of each probe are evaluated by reviewing the data 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 QA checks 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 whether analysts can replicate their own results, and consist of two samples that are diluted, filtered, and plated from a single sample container by a single analyst to measure analyst precision. During CY 2017, a total of 605 QA/QC water samples were collected, and comprised of 491 laboratory and 114 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 CY 2017 (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 (i.e., A - B = 0) are ignored. During 2017, results from duplicate field and laboratory samples were not significantly different ($p > 0.05$) for each of the three tested indicator bacteria (i.e., total coliforms, fecal coliforms, *Enterococcus*), indicating low variability between samples and high repeatability of laboratory measurements.

In addition to the above QA analyses, the Marine Microbiology Lab conducts monthly comparisons of bacterial colony counts to quantify the counting precision of each analyst. Counts are performed on a

Table 8

Summary of bacteriological QA analyses conducted during 2017 for the City of San Diego's Ocean Monitoring Program. n = number of sample pairs with different colony counts (samples without differences are not considered); 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	178	91	0.2998	> 0.05	Accept
	Fecal	91	45	-0.1048	> 0.05	Accept
	Entero	144	67	-0.8333	> 0.05	Accept
Field Duplicate	Total	50	23	-0.5657	> 0.05	Accept
	Fecal	40	17	-0.9487	> 0.05	Accept
	Entero	46	25	0.5898	> 0.05	Accept

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 2017, 100% of the total coliform comparisons fell within the RPD threshold, while 93% of the fecal coliform and 92% of the *Enterococcus* fell within the RPD threshold.

Macrofaunal Community – Resort 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 the lowest taxonomic level possible. Quality control of sorting is essential to assuring 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 a 95% removal efficiency expected. Ten percent of the sorted samples from each technician (sorter) 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% from the total abundance of all animals from that sample. More than one failure requires the re-sorting of all samples previously sorted by that sorter. The re-sort results for the January and July 2017 benthic samples are shown in Table 9. All samples re-sorted from the 2017 surveys met the QA criteria for sorting with values $\leq 2.70\%$.

Toxicology Quality Assurance Analyses

All of the required whole effluent toxicity analyses in 2017 were performed by the City of San Diego Toxicology Laboratory (CSDTL). CSDTL is accredited by the California State Water Resources Control Board Environmental Laboratory Accreditation Program (ELAP) (Certificate No. 1989). Sediment toxicity tests in 2017 were performed by the CSDTL's external contract lab for toxicology services, Nautilus Environmental (4340 Vandever Ave, San Diego, CA 92120). Nautilus Environmental is accredited in accordance with National Environmental Laboratory Accreditation Program (NELAP) by the State of Oregon Environmental Laboratory Accreditation Program (Certificate No. 4053). It is also certified by the California State Water Resources Control

Table 9

Results of benthic macrofauna sample resort analyses conducted during 2017 for the City of San Diego's Ocean Monitoring Program. Percent = (the # of animals found in the resorted sample/the total sample abundance) X 100.

Survey	Station	Percent	Survey	Station	Percent
	PLOO			SBOO	
Jan-17	B-9	0.00	Jan-17	I-4	0.00
	E-7	0.00		I-6	2.70
	E-11	0.00		I-13	0.00
	E-21	0.00		I-31	0.00
				I-35	0.00
Jul-17	B-9	0.69			
	E-8	0.81	Jul-17	I-10	1.05
	E-26	0.00		I-16	0.00
				I-21	0.00
				I-22	0.00
				I-33	0.00
				Regional	
			Jul-17	8613	0.00
				8621	0.00
				8626	0.00
				8634	0.00
				8635	0.00
				8637	0.61
				8657	0.00

Board Environmental Laboratory Accreditation Program (ELAP) (Certificate No. 1802), and the State of Washington Department of Ecology (Lab ID C552).

The CSDTL and Nautilus Environmental conduct routine reference toxicant testing as a part of their quality assurance programs. 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 (e.g., 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.

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 QA Manager and/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 (e.g., LC50 and EC50), control performance, percent minimum significant difference, and coefficient of variability (CV).

Using a nominal error rate of 5%, results from 19 of the most recent 20 reference toxicant tests are expected to fall within two standard deviations of the simple moving average (i.e., unweighted running mean), while one of these tests may fall outside the control chart limits by chance alone. Additionally, a series of EPA-recommended quality control limits are also used to further evaluate test sensitivity.

Each violating run 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 remedial measures 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 2017, all reference toxicant control charts for bioassays conducted by CSDTL and Nautilus Environmental met the acceptability criteria, with two exceptions. One value for giant kelp germination EC50 was greater than two standard deviations above the historical mean, while one value for giant kelp length EC25 was greater than two standard deviations below the historical mean. The data from each reference toxicant test and concurrent sample test were evaluated and deemed acceptable for reporting.

Literature Cited

City of San Diego. (in prep). Quality Assurance Plan for Coastal Receiving Waters Monitoring. City of San Diego Ocean Monitoring Program, Public Utilities Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2015). Sediment Toxicity Monitoring Plan for the South Bay Ocean Outfall and Point Loma Ocean Outfall Monitoring Regions, San Diego, California. Submitted August 28, 2015 by the City of San Diego Public Utilities Department to the San Diego Regional Water Quality Control Board and U.S. Environmental Protection Agency, Region IX. 10 pp.

Gilbert, R.O. (1987). Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Co., New York.

Schiff, K.C., J.S. Brown, and S.B. Weisberg. (2002). Model Monitoring Program for Large Ocean Discharges in Southern California. Technical Report No. 357. Southern California Coastal Water Research Project, Westminster, CA.

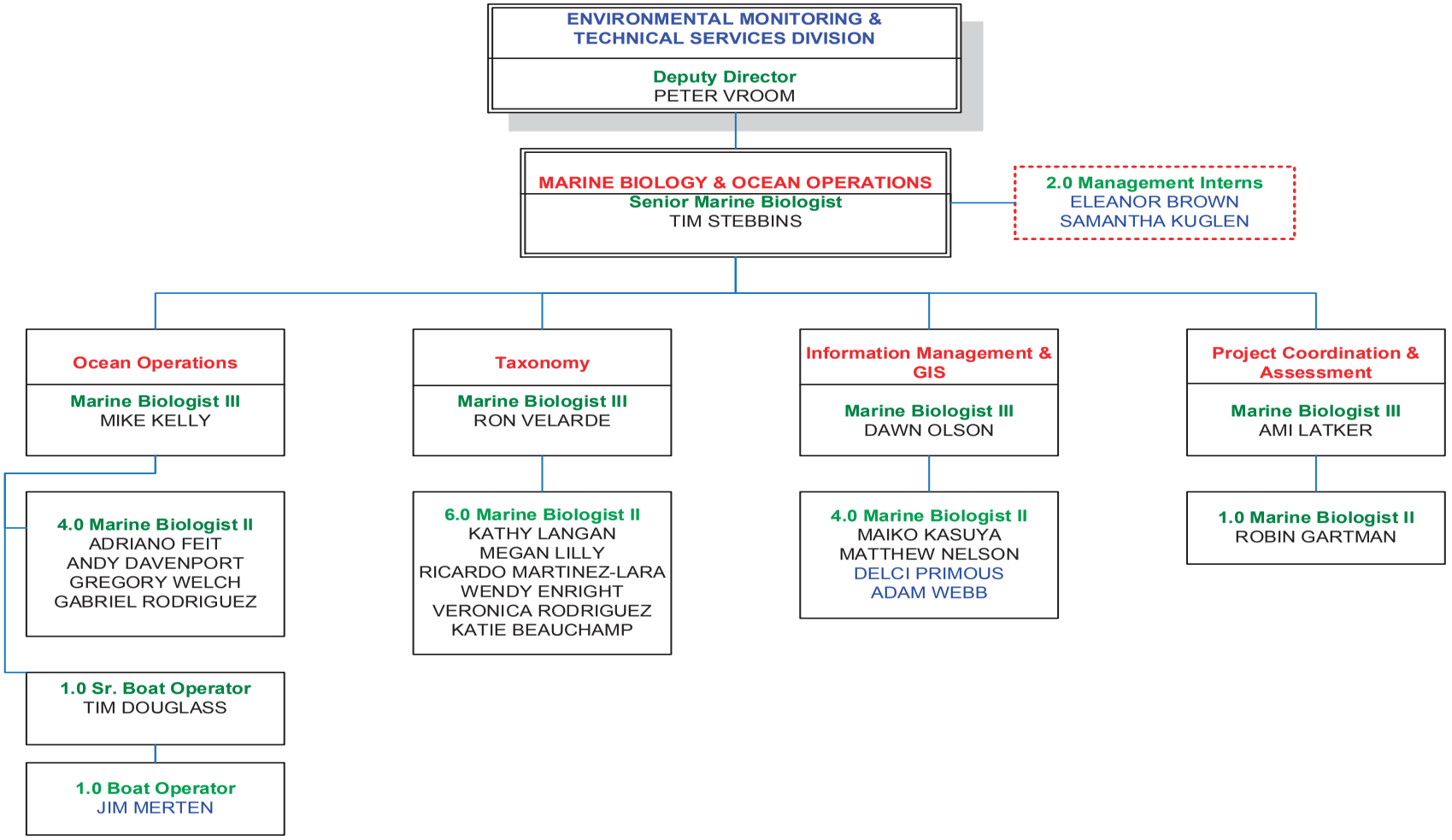
[SIO] Scripps Institution of Oceanography. (2004). Point Loma Outfall Project, Final Report, September 2004. Scripps Institution of Oceanography, University of California, San Diego, CA.

APPENDIX A

Organizational Charts

Appendix A.1

Organizational chart for the Marine Biology and Ocean Operations section of EMTS.



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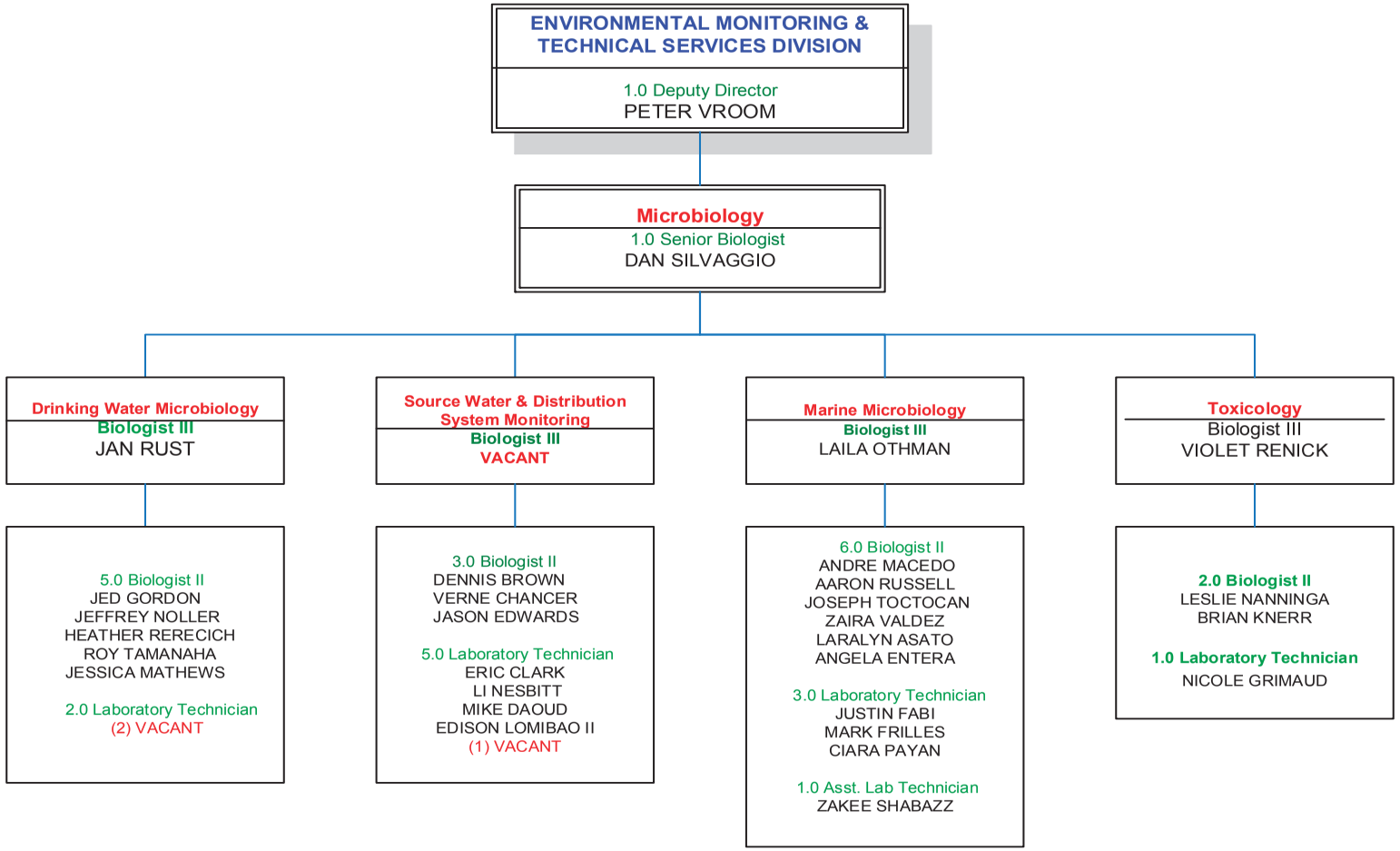
Appendix A.2

Organizational chart for the Microbiology section of EMTS.



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