The City of San Diego

EMTS Division Laboratory
Quality Assurance Report
2008

Prepared by:

City of San Diego
Ocean Monitoring Program
Metropolitan Wastewater Department
Environmental Monitoring and Technical Services Division

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2008 Quality Assurance Report

INTRODUCTION

The Quality Assurance/Quality Control (QA/QC) Program for the Environmental Monitoring and Technical Services (EMTS) Division Laboratory, Metropolitan Wastewater Department (MWWD), City of San Diego (City) includes various practices that have been instituted to ensure the accuracy and reliability of ocean monitoring data reported 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 of field sampling, laboratory analysis, records keeping, data entry, electronic data collection/transfer, as well as data analysis and reporting. The procedures are regularly reviewed and updated to reflect ongoing changes in NPDES permit requirements, sample collection, methods, technology, and applicability of new analytical methods.

The comprehensive QA/QC activities of the EMTS Division Laboratory are documented separately in the laboratory's Quality Assurance Plan, which is currently under revision (City of San Diego in prep). Additionally, the EMTS Division maintains certification through the International Standards Organization (ISO) 14001 Environmental Management Systems program (ISO 14001). As part of continuation in the ISO certification process, the EMTS Division underwent and passed an external audit in 2008 conducted by a third-party auditor. This report summarizes the QA/QC activities that were conducted during calendar year 2008 by EMTS staff in support of NPDES permit mandated monitoring for the City's Point Loma Wastewater Treatment Plant and South Bay Water Reclamation Plant, as well as similar activities required for the International Wastewater Treatment Plant operated by the International Boundary and Water Commission.

FACILITIES AND STAFF

The EMTS Division includes three sections (laboratories) that participate in the receiving waters monitoring activities associated with the above NPDES permits: (1) Marine Biology and Ocean Operations; (2) Marine Microbiology and Vector Management; (3) Wastewater Chemistry Services. The Marine Biology and Microbiology sections are located at the EMTS Division Laboratory (2392 Kincaid Road, San Diego, CA 92101). These two sections are responsible for conducting most field operations and performing subsequent biological and oceanographic assessments associated with the City's Ocean Monitoring Program (e.g., water quality, benthic sediments and macrofauana, trawl-caught fishes and invertebrates, contaminant bioaccumulation in fishes). Marine Biology and Microbiology personnel are organized into technical work groups based on their major work responsibilities and areas of expertise. Brief descriptions of the areas of emphasis for each work group are given in the next section.

The Wastewater Chemistry Services (WCS) section is located at other City facilities and performs chemical analyses of the various seawater, sediment and fish tissue samples collected by the program. Descriptions of the WCS organization and additional quality assurance procedures conducted in support of the receiving waters monitoring programs are presented in a separate report (e.g., City of San Diego 2009).

Table 1

National Pollutant Discharge Elimination System (NPDES) permits subject to receiving waters monitoring by the EMTS Division Laboratories.

Facility	Owner/Operator	NPDES Permit No	Effective date	Comment
Point Loma Wastewater Treatment Plant	City of San Diego	CA0107409, Order No. R9-2002-0025	October 16, 2002	Addendum No. 1 adopted on June 11, 2003, with an effective date of August 1, 2003
South Bay Water Reclamation Plant	City of San Diego	CA0109045, Order No. R9-2006-0067	January 1, 2007	
International Wastewater Treatment Plant	International Boundary and Water Commission	CA0108928, Order No. 96-50	November 14, 1996	

Marine Biology and Ocean Operations

Data Management and Reporting (DM&R): The primary responsibility of the DM&R work group is the analysis and reporting of receiving waters monitoring data. This work includes data QA, data analysis, and the interpretation of results from the receiving waters monitoring activities and other contract work. DM&R personnel work with the IT/GIS group (described below) to perform QA of all receiving waters monitoring data that is entered into the laboratory's database. Various software packages for data management, data manipulations, statistical analysis, and presentation are used to manage and analyze data from every aspect of receiving waters monitoring. Interpretation of these analyses are reported to regulatory and contract agencies in the form of monthly and annual reports.

Information Technology and Geographic Information Systems (IT/GIS): The IT/GIS work group is primarily responsible for the administration of the lab's database and the analysis of spatial data. Daily responsibilities for the IT/GIS group include the entry and archiving of sampling data, validation of data accuracy, database structure and integrity, oversight of database access/security issues as well as enhancements to the database structure, and project planning/application development to support the needs of EMTS laboratory staff. This group is also responsible for timely and accurate data entry, spatial data analysis, GIS mapping and analysis, and assistance with report production.

Ocean Operations: This work group is comprised of two subsections, including Ocean Operations and Vessel Operations. Ocean Operations personnel oversee and conduct water quality sampling, benthic sediment and macrofauna sampling, trawling and rig-fishing, diving operations, and ocean outfall inspections. These staff maintain and calibrate all oceanographic instrumentation, SCUBA equipment, and the laboratory's remotely operated vehicle (ROV). Vessel Operations personnel are responsible for the operation and maintenance of the City's two monitoring vessels, the 48' *Oceanus* and the 42' *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 of the crew, locating and maintaining position at the monitoring stations, and assisting with various deck activities during field operations.

Table 2

ELAP certifications for the Environmental Monitoring and Technical Services Division Laboratories.

ELAP Laboratory	Address	Phone	ELAP Code	Cert.No.
Marine Microbiology	2392 Kincaid Rd., San Diego, CA, 92101-0811	619-758-2360	CA01393	2185
Toxicology	2392 Kincaid Rd., San Diego, CA, 92101-0811	619-758-2348	CA01302	1989

Taxonomy: The Taxonomy work group coordinates and manages the processing of all benthic macrofauna and trawl invertebrate samples, maintains the taxonomic literature and voucher collections, and conducts taxonomic training. In addition, they produce in-house identification sheets and keys to important species and other taxa. Members of this 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.

Toxicology: The Toxicology Laboratory is certified by the State of California Department of Health Services, Environmental Laboratory Accreditation Program (ELAP), which is renewed on a biennial basis. The current ELAP certification is scheduled for renewal on April 30, 2010 (**Table 2**). Toxicology personnel are responsible for conducting 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, the Toxicology Lab maintains a separate Quality Assurance Manual in accordance with ELAP requirements, which contains up-to-date revisions to reflect current laboratory practices and procedures, and to ensure timely document version control.

Marine Microbiology and Vector Management

Marine Microbiology: The Marine Microbiology Laboratory (MML) is also certified by ELAP and the current ELAP certification for the MML is in effect until November 30, 2010 (Table 2). The Marine Microbiology work group is responsible for the quantification and identification 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 a variety of analyses (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, 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.

Vector Management: The Vector Management group provides 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 MWWD treatment plants, pump stations, buildings and office facilities. Biological assessment (bioassessment) of urban creeks and streams are conducted to evaluate and analyze short and long term impacts of sewage spills into watersheds and receiving waters. 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.

SCOPE OF WORK

Treated effluent from the Point Loma Wastewater Treatment Plant (PLWTP) is discharged to the Pacific Ocean through the Point Loma Ocean Outfall (PLOO), whereas the South Bay Ocean Outfall (SBOO) accepts treated effluent from the South Bay Water Reclamation Plant (SBWRP) and International Wastewater Treatment Plant (IWTP). The separate NPDES permits associated with each of these treatment facilities define the requirements for toxicity testing and the monitoring of receiving waters for each discharge site. The permits define the sampling plans, compliance criteria, laboratory analyses, statistical analyses and reporting guidelines. In 2008, a total of 8701 discrete samples were collected by EMTS staff, including samples collected as part of permit-mandated special studies (**Table 3**). Of these, 462 (~5%) represent quality control (QC) samples such as field duplicates. In addition, 1139 quality assurance (QA) tests were also 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 herein support the accuracy and precision of the resultant data and validate their use in permit-mandated monitoring or environmental testing and reporting.

The core receiving waters monitoring efforts for both the Point Loma and South Bay monitoring programs are summarized in **Tables 4** and **5**, while the fixed-grid sampling sites for each program are shown in **Figure 1**. These core monitoring activities include weekly sampling of seawater from recreational areas along the shoreline and within the Point Loma and Imperial Beach kelp beds, as well as monthly or quarterly offshore sampling in order to document water quality conditions in the region. Benthic samples are collected semiannually to monitor sediment conditions and macrofaunal communities. Trawl surveys are performed quarterly in the South Bay region and semiannually off Point Loma to monitor the ecological health of demersal fish and epibenthic invertebrate communities. Additionally, fish tissue samples are collected and analyzed on either a semiannual or annual basis to monitor levels of chemical constituents that may have ecological or human health implications. Toxicity testing consists of acute and chronic bioassays of influent, effluent, and groundwater samples. The general toxicity testing required by the NPDES permits is outlined in **Table 6.** The results of these receiving waters monitoring activities and toxicity tests are analyzed and presented in various regulatory reports that are submitted to the Regional Water Quality Control Board (RWQCB).

In addition to the above core monitoring efforts, the City also conducts “strategic process studies” (i.e., special projects) as part of the regulatory requirements for the PLWTP and as defined by the Model Monitoring Program developed for large ocean dischargers in southern California (Schiff et al. 2001).

Table 3

Number of discrete samples collected and analyzed by the EMTS Division Laboratory for NPDES permit-related activities during 2008. NA=not applicable; WCS=Wastewater Chemistry Services.

Sample Type	Number of Samples Collected		Number of Analyses per Sample Type	
	Regular	QC	Regular	QA
Sediment				
Particle Size	132[a]	NA	(performed by WCS)	
Chemistry	530[a]	NA	(performed by WCS)	
Benthic Macrofauna	220[a]	NA	184	38 resorts
Trawl	55[a]	NA	36	NA
Fish Tissue	66	NA	(performed by WCS)	
Water Quality				
CTD Casts	1249			
Microbiology	5050	282	15,150[b]	846(dups)[b] 168(splits)[b]
Suspended Solids	1008	108	(performed by WCS)	
Oil and Grease	336	72	(performed by WCS)	
Toxicology				
Acute Bioassay	12	NA	15	15
Chronic Bioassay	31	NA	93	66
Sediment Bioassay	12[a]	NA	13[a]	6[a]

[a]includes Bight'08 samples

[b]includes three analyses (total coliform, fecal coliform, enterococcus)

These special studies are determined by the City in coordination with the RWQCB and the United States Environmental Protection Agency (USEPA), and are generally designed to address recommendations for enhanced environmental monitoring of the San Diego coastal region put forth recently in a peer-reviewed report prepared by scientists at the Scripps Institution of Oceanography (SIO 2004). Data for these directed studies are subject to similar QA/QC procedures as the routine monitoring data, although the projects themselves do not necessarily conform to the same analysis and reporting schedules. Thus, details and results of ongoing QA/QC activities associated with these special studies are not included in this report unless otherwise indicated.

As 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 the regional programs is to maximize the efforts of the various partners (e.g., municipal dischargers, research agencies) using a more cost-effective monitoring design and to best utilize the pooled scientific resources of the region. These bight-wide surveys include the 1994 Southern California Bight Pilot Project (SCBPP) and subsequent Bight'98, Bight'03 and Bight'08 regional monitoring efforts in 1998, 2003 and 2008, respectively. During these coordinated programs, the City's regular sampling and analytical effort may be reallocated as necessary with approval of the RWQCB and USEPA. Similar to special studies, the regional monitoring efforts are typically subject to similar QA/QC procedures as the routine monitoring data, although these projects also do not conform to the same analysis and reporting schedules. Thus, the details and results of the current Bight'08 project efforts are not included in this report

Table 4

NPDES-permit mandated receiving waters sampling effort for the Point Loma monitoring program, excluding resamples, QA/QC analyses (e.g., duplicate/split samples), or special studies.

Monitoring component	Location	No. of sites/ zones	Sample type	No. discrete samples per site	Sampling frequency	Sampling times per Yr	No. discrete samples per Yr	Parameters	No. "samples" analyzed per Yr	Notes (per site/zone)
Water Quality	shore	8	seawater - bacti	1	weekly	52	416	T, F, E [a]	1248	1 sample/station
Microbiology	kelp	8	seawater - bacti	3	5x/month	60	1440	T, F, E [a]	4320	3 depths/station
&		8	CTD	1	5x/month	60	480	CTD profile [c]	3840	1 cast/station
Oceanographic	voluntary "kelp"	3	seawater - bacti	3	5x/month	60	180	T, F, E [a]	1620	Non-NPDES, 3 depths/stn
conditions	offshore	3	seawater - bacti	3	quarterly	4	36	T, F, E [b]	108	3 depths (18-m stns)
	(n=36)	11	seawater - bacti	3	quarterly	4	132	T, F, E [b]	396	3 depths (60-m stns)
		11	seawater - bacti	4	quarterly	4	176	T, F, E [b]	528	4 depths (80-m stns)
		11	seawater - bacti	5	quarterly	4	220	T, F, E [b]	660	5 depths (98-m stns)
		36	CTD	1	quarterly	4	144	CTD profile [c]	1152	1 cast
Sediment Quality	offshore	22	grab	1	semiannual	2	44	sediment constituents [d]	396	1 grab (Jan, Jul)
Benthic Macrofauna	offshore	22	grab	2	semiannual	2	88	community structure	88	2 replicate grabs (Jan, Jul)
Demersal Fishes & Invertebrates	offshore	6	trawl	1	semiannual	2	12	community structure	12	1 trawl (Jan, Jul)
Fish Tissue Contaminants	offshore	4	trawl	3	annual	1	12	liver tissue [e]	48	3 composites/zone (Oct) (6 trawl sites, 4 zones)
	offshore	2	rig fishing	3	annual	1	6	muscle tissue [f]	24	3 composites/site (Oct)
Totals							3,386		14,440	

[a] T, F, E = total coliform, fecal coliform, and enterococcus bacteria (n = 3 parameters); T, F, E = all NPDES mandated

[b] T, F, E = total coliform, fecal coliform, and enterococcus bacteria (n = 3 parameters); E = NPDES mandated, T & F = voluntary

[c] CTD profile = depth, temperature, salinity, dissolved oxygen, light transmittance (transmissivity), chlorophyll a, pH, density (n = 8 parameters)

[d] Sediment constituents = sediment grain size, total organic carbon, total nitrogen, sulfides, metals, PCBs, chlorinated pesticides, PAHs, BOD (n = 9 parameter categories; see NPDES permit for complete list of constituents; BOD=voluntary)

[e] Fish tissue contaminants (liver) = lipids, PCBs, chlorinated pesticides, metals (n = 4 parameter categories; see NPDES permit for complete list of constituents); 3 metals analyzed (mercury, arsenic, selenium)

[f] Fish tissue contaminants (muscle) = lipids, PCBs, chlorinated pesticides, metals (n = 4 parameter categories; see NPDES permit for complete list of constituents); 9 metals analyzed (arsenic, cadmium, chromium, copper, lead, mercury, selenium, tin, zinc)

Table 5

NPDES-permit mandated receiving waters sampling effort for the South Bay monitoring program, excluding resamples, QA/QC analyses (e.g., duplicate/split samples), or special studies. Note: No regional surveys were conducted in 2008 due to participation in the Bight'08 Regional Monitoring Program.

Monitoring component	Location	No. of sites/ zones	Sample type	No. discrete samples per site	Sampling frequency	Sampling times per Yr	No. discrete samples per Yr	Parameters	No. "Samples" analyzed per Yr	Notes (per site/zone)
Water Quality Microbiology & Oceanographic conditions	shore	11	seawater–bacti	1	weekly	52	572	T, F, E[a]	1716	1 sample
	kelp	3	seawater–bacti	3	5x/month	60	540	T, F, E[a]	1620	3 depths
		3	CTD	1	5x/month	60	180	CTD profile [b]	1440	1 cast
	offshore	25	seawater–bacti	3	monthly	12	900	T, F, E[a]	2700	3 depths
	(n=37)	37	CTD	1	monthly	12	444	CTD profile [b]	3552	1 cast
		28	TSS	3	monthly	12	1008	TSS	1008	3 depths
		28	oil & grease	1	monthly	12	336	O&G	336	1 depth
Sediment Quatity	offshore	27	grab	1	semiannual	2	54	sediment constituents[c]	432	1 grab (Jan, Jul)
Benthic Macrofauna	offshore	27	grab	2	semiannual	2	108	community structure	108	2 replicate grabs (Jan, Jul)
Demersal Fishes & Invertebrates	offshore	7	trawl	1	quarterly	4	28	community structure	28	1 trawl (Jan, Apr, Jul, Oct)
Fish Tissue Contaminants	offshore	7	trawl	3	semiannual	2	42	Liver tissue[d]	210	3 composites (Apr, Oct) (trawl sites)
	offshore	2	rig fishing	3	semiannual	2	12	Muscle tissue[d]	60	3 composites (Apr, Oct) (rig-fishing sites)
Regional Survey Sediment quatity	random array	40	grab	1	annual	1	40	sediment constituents[c]	320	1 grab (Jul)
Benthic macrofauna	random array	40	grab	1	annual	1	80	community structure	40	1 grabs (Jul)
Totals							4,304		13,570	

[a] T, F, E = total coliform, fecal coliform, and enterococcus bacteria (n = 3 parameters)

[b] CTD profile 2 = depth, temperature, salinity, dissolved oxygen, light transmittance (transmissivity), chlorophyll a, pH, density (n = 8 parameters)

[c] 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 of constituents).

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

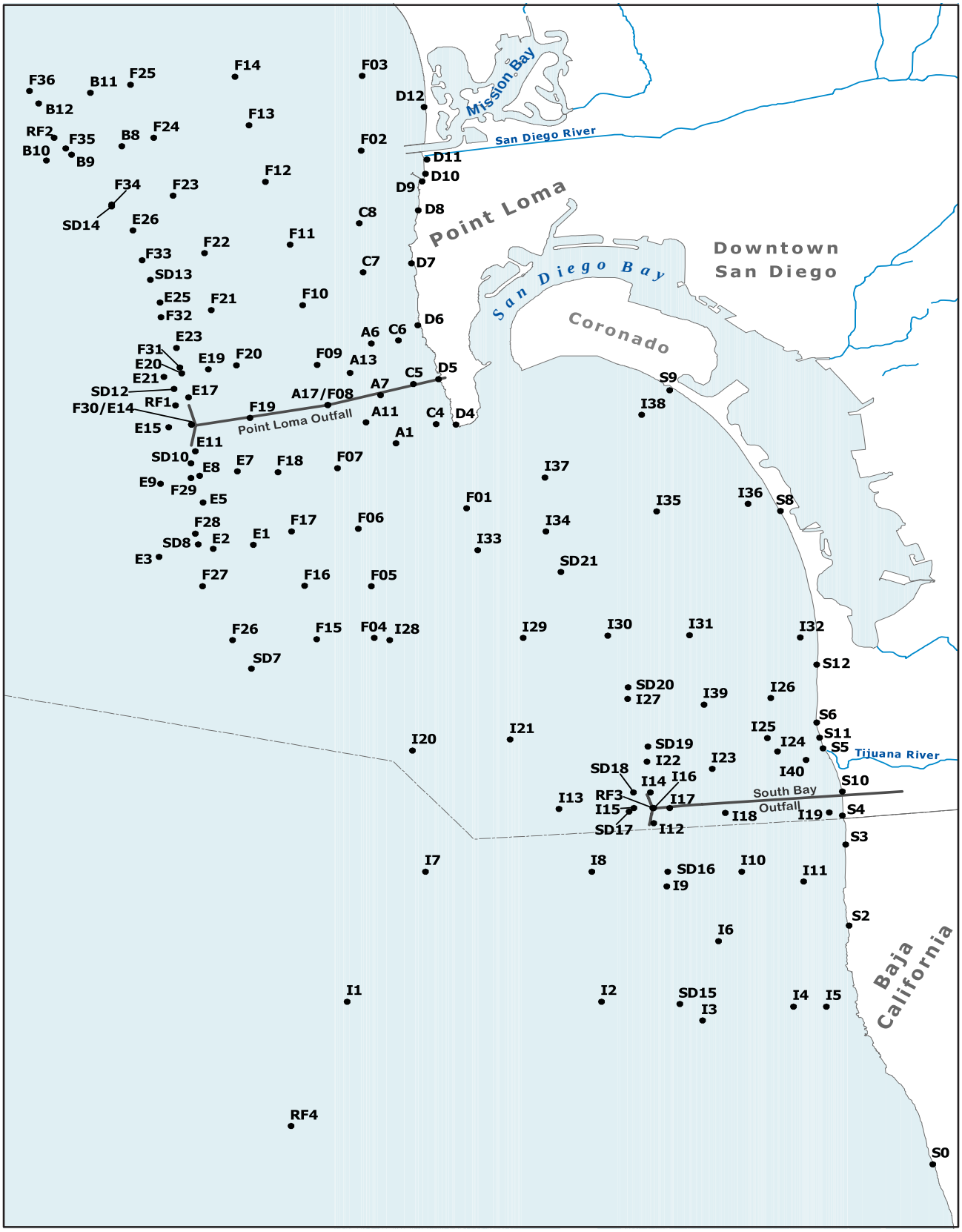

Figure 1
Regular fixed monitoring stations for the Point Loma and South Bay Ocean Monitoring Programs.

Table 6

Toxicity testing effort for the Point Loma and South Bay monitoring programs. 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 per Yr	No. test species	Effluent/ ref tox tests per Yr	Total tests per Yr	Endpoints	Dilutions per bioassay	Notes
Point Loma											
Acute toxicty	PLWTP	final effluent	1	semi-annual	2	1	2 + 2 Ref Tox	4	survival	5 + control	species = mysid
	(One-time 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: mysids & topsmelt
Chronic toxicity	PLWTP	final effluent	1	monthly	12	2	24 + 24 Ref Tox	48	sensitive lifestage	5 + control	species = red abalone & 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, topsmelt
South Bay											
Acute toxicty	SBWRP	final effluent	1	monthly	12	1	12 + 12 Ref Tox	24	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: mysids & topsmelt
	SBWRP/ IWTP	comb. effluent	1	quarterly	4	1	4 + 4 Ref Tox	8	survival	5 + control	species = mysids
	(Biennial screening)	comb. 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: mysids & topsmelt
Chronic toxicity	SBWRP	final effluent	1	monthly	12	1	12 + 12 Ref Tox	24	sensitive lifestage	5 + control	species = red abalone
	(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, topsmelt
	SBWRP/ IWTP	comb. effluent	1	quarterly	4	1	4 + 4 Ref Tox	8	sensitive lifestage	5 + control	species = red abalone
	(Biennial screening)	comb. 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, topsmelt

Comb. Effluent = combined SBWRP + IWTP effluent samples
Ref Tox = Reference Toxicant Test
Sensitive lifestage endpoints: (1) red abalone = development; (2) giant kelp = germination and growth

Table 7
Summary of the CTD intercalibration casts performed during 2008. Data include mean difference (Δ), maximum difference, cast number (i.e., 1, 2, or 3), and depth (m) at which the maximum difference occurred.

Parameter	MeanΔ	MaxΔ	Cast	Depth
Temperature (°C)	0.05	0.41	3	43
Salinity (ppt)	0.008	0.048	2	59
DO (mg/L)	0.54	0.77	1	2
pH	0.04	0.06	1&2	44
Transmissivity (%)	0.08	1.19	3	3
Fluorometry (µg/L)	0.09	0.89	1	3

unless otherwise indicated. Instead, these data and results will be reported separately according to the prescribed schedule set forth for Bight'08.

SUMMARY OF WORK PERFORMED IN 2008

The results of various QA procedures are presented in the following sections. These include: (1) intercalibration of the Conductivity-Temperature-Depth (CTD) instrument used to sample water quality parameters; (2) results of the bacteriological quality assurance procedures; (3) results of the macrofaunal community sample resorts; (4) results of toxicology quality assurance procedures.

CTD Intercalibration Exercise

An in-house CTD intercalibration exercise is conducted annually in order to ensure consistency between the CTD instruments used to collect all of the permit-mandated water quality profiling data for the City's ocean monitoring program. Two Sea-Bird Electronics model 25 CTD instruments were used in the intercalibration exercise for 2008. The instrument designated as Unit #3 was a combination CTD/carousel sampler, while Unit #4 was a stand-alone CTD unit. The two CTD units were attached to each other during the exercise and deployed to a depth of 110 m three different times. After the three casts were completed a comparison of the measurements from six sensors (temperature, salinity, dissolved oxygen, pH, fluorometer, transmissometer) and one calculated parameter (density) was performed to assess whether deviations between the instruments and sensors were within acceptable limits (see City of San Diego, in prep).

The results of the annual in-house intercalibration exercise are summarized in **Table 7** and **Figure 2** (Cast 3 only), and compared to the results from previous years in **Table 8**. Five out of six sensors (i.e., temperature probe, salinity probe, pH probes, fluorometer, transmissometer) displayed acceptable variation between instruments. However, the dissolved oxygen (DO) probes displayed more variability between CTD units than in previous years. This increase in variability was most likely due to a cracked manifold in the conductivity probe that leaked into the DO intake plenum on Unit #3. The cracked plenum was discovered after the intercalibration when all probes were replaced with freshly calibrated ones. A new intercalibration exercise will be conducted to verify the new DO probes and other sensors display acceptable variations between CTD units.

Table 8

Results of annual intercalibration exercises for CTD instruments over the past five years. Values are the differences between Unit #3 and Unit #4 averaged over all depths (0–100 m).

Parameter	2008	2007	2006	2005	2004	2003
Temperature (°C)	0.05	0.03	0.06	0.04	0.05	0.05
Salinity (ppt)	0.008	0.006	0.01	0.01	0.01	0.01
DO (mg/L)	0.54	0.14	0.34	0.08	0.46	0.19
pH	0.04	0.06	0.05	0.03	0.05	0.02
Transmissivity (%)	0.87	0.80	0.39	0.21	0.28	0.71
Fluorometry (µg/L)	0.10	0.25	0.11	0.12	0.08	1.30

In addition to the annual in-house intercalibration exercise, each instrument is calibrated individually. The temperature, pressure and conductivity probes are calibrated semi-annually by Sea-Bird Electronics at their facility. The fluorometer and transmissometer probes are calibrated annually by Wetlab at their facility. The transmissometer is also calibrated in-house once every two years. The DO probes are calibrated semi-annually at Sea-Bird and calibrated monthly in-house to check for sensor drift. Although the pH probe is factory calibrated annually, it is also calibrated prior to each monitoring cruise. The pH sensors are serviced in-house when showing slow response times by replacing the electrode component of the sensor. The electrodes are kept in service for a maximum of 12 months.

Bacteriological Quality Assurance Analyses

Duplicate and split bacteriological analyses are run throughout the year as quality assurance checks to measure variability between samples and analyst precision, respectively. Duplicate analyses are obtained by taking two separate samples at a given station in the field and then analyzing them in exactly the same way. Split analyses are obtained by taking aliquots of a single field sample and then having two different analysts perform the dilutions, filtration, and plating. During 2008, duplicate analyses were performed on approximately 5% (n= 282) of the water quality samples, while split analyses were performed on one sample approximately four times a month (n=56). The raw data for these analyses have been reported previously in Monthly Receiving Waters Monitoring Reports for their respective ocean monitoring programs.

The sign test (see Gilbert 1987) was used to compare the results from the paired duplicate and split analyses performed between January and December 2008 **(Table 9)**. 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. The split field samples were not significantly different ($p > 0.05$) for each of the three tested parameters (i.e., total coliforms, fecal coliforms, enterococcus), indicating that variability between techniques of different analysts was not significant. The duplicate field samples were not significantly different for the fecal coliform and enterococcus parameters, however, there was a significant difference ($p < 0.05$) for total coliform, indicating sample variability. This may be attributed to the limitation of the method, particularly in samples with high turbidity or large numbers of non-coliform (background) bacteria. Further, even though duplicate samples are collected within a small amount of time, they are still considered two distinct samples with varying matrices of bacterial densities**.**

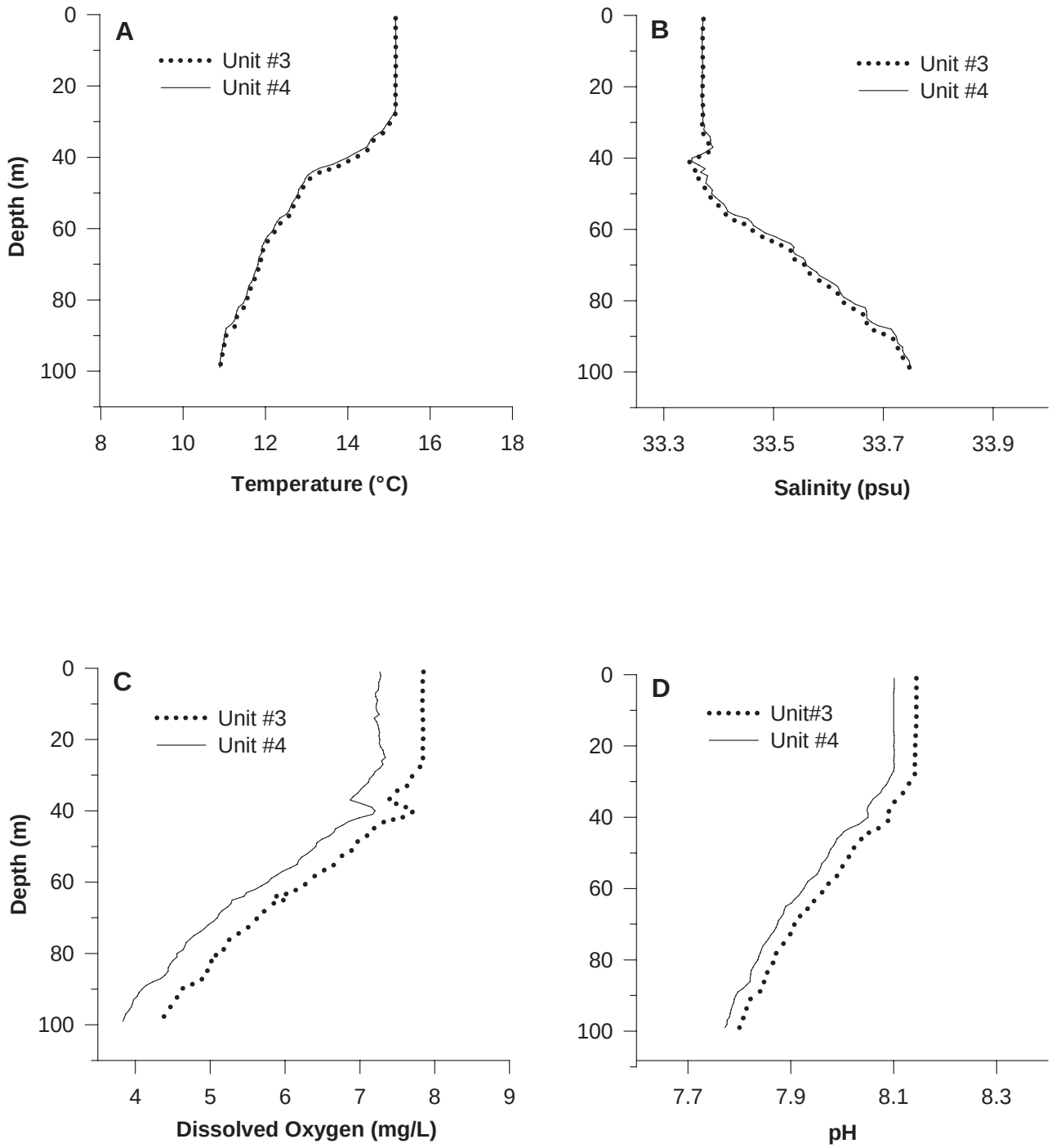

Figure 2

Comparison of results from CTD Units #3 and #4 from one representative cast made during the 2008 CTD intercalibration exercise. Data include cast profiles for (A) temperature, (B) salinity, (C) dissolved oxygen, (D) pH, (E) transmissivity, (F) fluorometry (before and after intercalibration), and (G) density.

In addition to these duplicate and split sample analyses, the Marine Microbiology and Vector Management Laboratory conducts monthly comparisons of bacterial colony counts to quantify the counting precision of each analyst. These comparisons include repeat counts made by the same individual

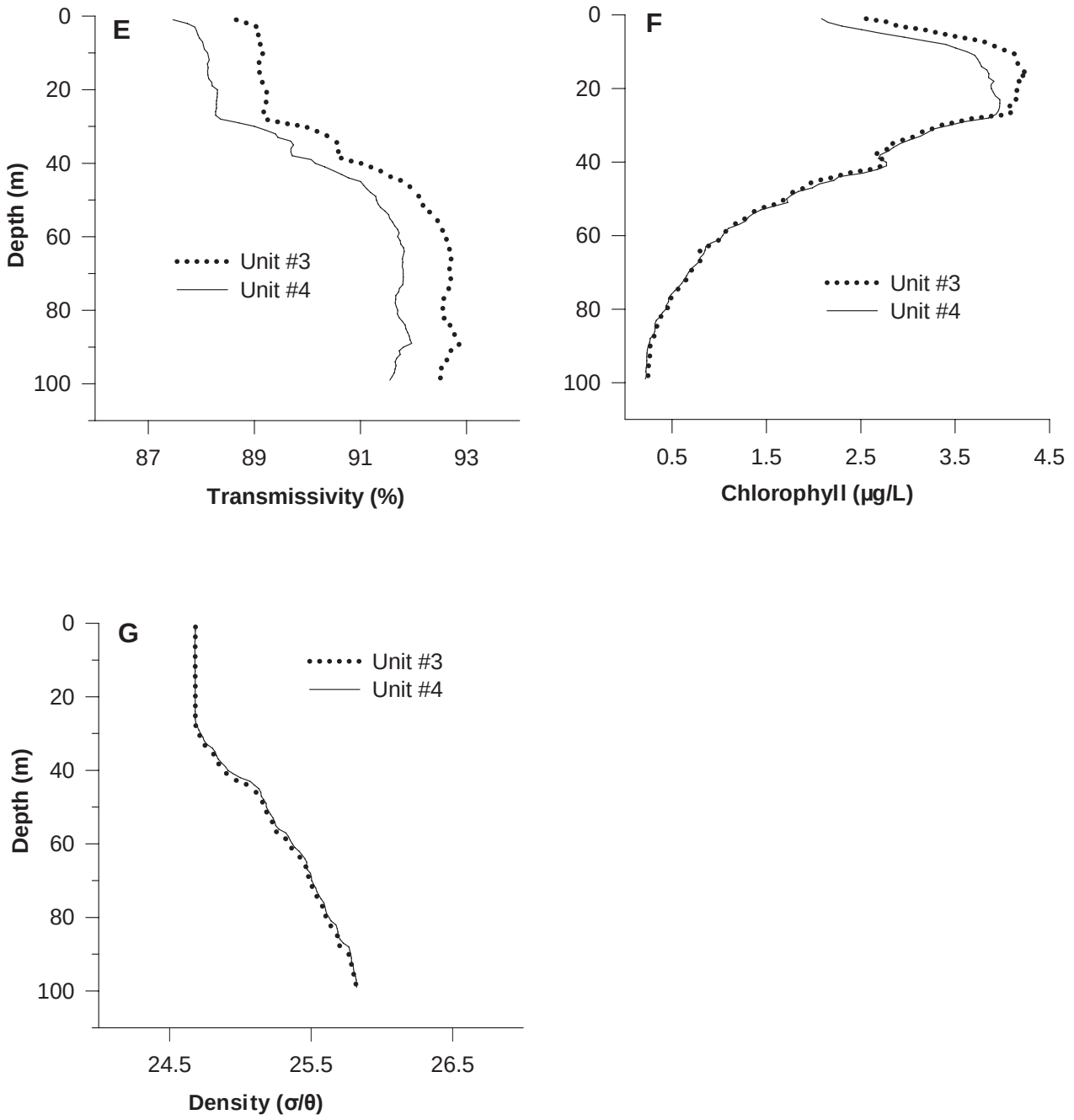

Figure 2 *continued*

analyst, as well as counts completed by pairs of analysts. Each analyst must be able to duplicate his/her own prior colony counts within 5%, and counts by any two analysts must fall within 10% of each other. For 2008, all counts fell within 5% agreement for each individual analyst and amongst pairs of analysts.

Macrofaunal Community – Resort Analysis

Laboratory analysis of benthic macrofaunal samples involves three processes: sample washing and preservation, sample sorting, and identification and enumeration of all organisms. Quality control

Table 9

Summary of duplicate bacteriological anaylses for the Point Loma and South Bay Ocean Monitoring Programs conducted from January through December 2008. The paired duplicate samples were compared using the sign test (see Gilbert, 1987) at a p=0.05 level of significance.

Duplicate samples

Parameter	N	B	Zb	P	Accept Ho
Total coliform	149	64	-1.72	<0.05	Reject
Fecal coliform	89	43	-0.32	>0.05	Accept
Enterococcus	75	34	-0.81	>0.05	Accept

Split samples

Parameter	N	B	Zb	P	Accept Ho
Total coliform	35	18	-0.17	>0.05	Accept
Fecal coliform	36	15	-0.00	>0.05	Accept
Enterococcus	31	15	-0.18	>0.05	Accept

Ho = The probability of observing positive and negative differences in plate counts between paired samples is equal (see text).

N = Number of sample pairs with different colony counts; samples without differences are not considered.

B = The number of positive differences between pairs.

Zb = Sign test outcome.

of sorting is essential to assure the value of the subsequent steps in the sample analysis process. The sorting of benthic samples is contracted to an outside laboratory, with a 95% removal efficiency expected. Ten percent of the sorted samples from each technician (sorter) are subject to resorting as QA for the contract. The original sorting of a sample fails the QA criteria level if the resorted sample contains more than 5% of the total abundance of organisms from that sample. Failure requires the re-sorting of all samples previously sorted by that sorter. The resort results for the period from January and July 2008 are shown in **Table 10**. For the January 2008 sampling period, resorts of SBOO station I-7 replicate 2 (13.04%) exceeded the 5.0% resort criteria. All samples sorted by this sorter were completely resorted and the organisms added to the samples for subsequent identifications. The percentages of animals found in the remaining samples were $\leq$ 5.0% of the total sample abundance.

Toxicology Quality Assurance Analyses

The Toxicology Laboratory routinely conducts reference toxicant testing as a part of the quality assurance program. A reference toxicant is a standard chemical used to measure the sensitivity of the test organisms in order to establish confidence in the toxicity data obtained from the test material. A specific reference toxicant is used for each test method, and the material is chosen from a list developed by the USEPA. The reference toxicant is purchased from a 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 toxicity test with a reference toxicant is performed to assess the sensitivity of the test organisms at the same time the test material (e.g. effluent) is evaluated. A control chart containing

Table 10

Results of benthic macrofauna sample resort analyses for the Point Loma Ocean Outfall (E and B stations) and South Bay Ocean Outfall (I stations) Monitoring Programs conducted during 2008. Percent = (the # of animals found in the resorted sample/the total sample abundance) X 100. [1] and [2] indicate sample replicate number. * = indicates samples that failed QA/QC check.

	PLOO		SBOO	
Quarter	Station	Percent	Station	Percent
Jan-08	B-8[2]	2.5	I-3[2]	0.0
	B-10[1]	0.0	I-4[1]	3.0
	E-1[2]	0.3	I-7[2]	13.0*
	E-3[2]	3.9	I-10[2]	0.8
	E-5[2]	0.0	I-14[1]	1.4
	E-7[1]	0.0	I-16[2]	0.7
	E-7[2]	0.8	I-22[1]	0.9
	E-17[1]	1.0	I-22[2]	0.4
	E-19[2]	2.4	I-23[1]	3.1
	E-23[1]	0.0	I-27[1]	0.9
	E-25[2]	3.7	I-27[2]	1.0
			I-30[1]	0.9
			I-31[1]	0.0
			I-34[2]	1.1
Jul-08	B-8[2]	0.0	I-2[2]	1.9
	E-5[2]	1.0	I-6[1]	0.0
	E-8[2]	0.4	I-10[2]	1.4
	E-15[2]	0.0	I-14[1]	0.0
	E-21[1]	0.0	I-18[1]	0.0
			I-21[2]	0.4
			I-23[2]	0.0
			I-31[1]	0.3

no fewer than 20 of the most recent reference toxicant test results for each test method is maintained by the QA officer and is used to monitor test organism sensitivity. Results from a minimum of 19 of the most recent 20 reference toxicant tests must fall within the control chart boundaries (two standard deviations of the mean). Failure to do so triggers an investigation of animal supply, reference toxicant stock quality, and laboratory practices. Additional testing is also conducted to determine whether an exceedance is anomalous or if remedial measures are needed. All NPDES mandated tests conducted with the affected animals are to be flagged, reviewed for anomalous responses, and, in certain cases, repeated with a new batch of animals. In 2008, all reference toxicant control charts were reviewed and accepted by ELAP.

Also in 2008, the Toxicology Laboratory conducted whole effluent toxicity tests on samples collected at the PLWTP and the SBWRP. A set of concurrent standard reference toxicant tests was conducted with each toxicity test. These tests were mandated by the City's NPDES permits, and the results were included in monthly reports submitted to the RWQCB, EPA Region IX, State Department of Public Health and San Diego County Department of Public Health. Results from these tests will also be summarized and submitted to the agencies above as part of Wastewater Chemistry's annual report.

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