The City of San Diego

EMTS Division Laboratory Quality Assurance Report 2005

City of San Diego
Ocean Monitoring Program

Metropolitan Wastewater Department
Environmental Monitoring & Technical Services Division

March 2006

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2005

Prepared by:

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Credits and Acknowledgments

EMTS DIVISION LABORATORY
QUALITY ASSURANCE REPORT
2005

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Cover photo - the armed box crab, *Platymera gaudichaudii* (Crustacea Calappidae)
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Photo Credits: Daniel A. Ituarte

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CITY OF SAN DIEGO OCEAN MONITORING PROGRAM

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SUMMARY AND OVERVIEW OF WORK PERFORMED IN 2005

The Environmental Monitoring and Technical Services (EMTS) Division Laboratory, Metropolitan Wastewater Department, City of San Diego performs effluent, influent, and receiving waters monitoring according to NPDES permit requirements for the City of San Diego E.W. Blom, Point Loma Wastewater Treatment Plant (PLWTP), South Bay Water Reclamation Plant (SBWRP), and International Boundary and Water Commission International Wastewater Treatment Plant (IWTP). A total of 8518 discrete samples were collected by the Laboratory in 2005. Of these, 868 (~10%) were quality control (QC) samples, such as field duplicate samples (see Table 3). In addition, a number of quality assurance (QA) procedures for macrofaunal identifications (i.e., resort and re-identifications), microbiological analyses (i.e., split samples), and toxicology (i.e., reference toxicant and control water samples) were also conducted. These QA/QC procedures were used to support the accuracy, precision, and performance of the resultant data.

The comprehensive QA/QC activities of the Laboratory are documented separately in the Laboratory's Quality Assurance Plan (City of San Diego in prep). Additionally, the EMTS Division maintains International Standards Organization (ISO) 14001 Environmental Management Systems certification.

The following report summarizes the QA/QC activities during calendar year 2005, which were used to validate the data used in NPDES and other permit monitoring or environmental testing and reporting.

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General Introduction

Environmental Monitoring & Technical Services Division Laboratory
Metropolitan Wastewater Department
City of San Diego

INTRODUCTION

The Quality Assurance/Quality Control Program for the Environmental Monitoring and Technical Services (EMTS) Division Laboratory, Metropolitan Wastewater Department (MWWD), City of San Diego includes various practices that have been instituted to ensure the accuracy and reliability of monitoring data reported to regulatory agencies in response to the reporting requirements of 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. Documents describing these and other procedures are maintained in accordance with the EMTS Division Laboratory Quality Assurance Plan (in prep) and (MWWD-EMTS) ISO 14001 certification.

This report provides the results of the QA procedures conducted in 2005 that were performed in support of the permit mandated work conducted by the EMTS Laboratory in accordance the applicable NPDES Permits.

FACILITIES AND STAFF

The EMTS Division includes three 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; and (3) Wastewater Chemistry Laboratory. The Marine Biology and Marine Microbiology laboratories are responsible for conducting most of the receiving waters monitoring activities, while the Chemistry Laboratory performs analytical tests on various samples. 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 below. Detailed descriptions of the Marine Biology and

Table 1

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

Facility	Owner/Operator	NPDES Permit No	Effective date	Comment
E.W. Blom 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. 2000-129	September 13, 2000	
International Wastewater Treatment Plant	International Boundary and Water Commission	CA0108928, Order No. 96-50	November 14, 1996	

Marine Microbiology laboratory organization, personnel, and personnel classifications are provided in the EMTS Laboratory QA Plan. Additional quality assurance procedures conducted by the Wastewater Chemistry Laboratory are presented in a separate report (e.g., City of San Diego 2006).

Marine Biology and Ocean Operations

Data Management and Reporting Group: The primary responsibility of the DM&R 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 together with the IT/GIS Systems 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 (e.g., Oracle, Access), manipulations (e.g., Excel), statistical analysis (e.g., SAS, PRIMER), and presentation (e.g., Sigma Plot, Microsoft PowerPoint) are used to manage, manipulate, 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, quarterly, semiannual, and annual reports.

Information Technology and GIS Systems Group: The IT/GIS Systems Group is primarily responsible for the administration of the lab's database and the analysis of spatial data. Daily responsibilities for members of 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 lab staff. This group is also responsible for spatial data analysis, GIS analyses and map preparation, and the posting of data and regulatory reports to the internet.

Ocean Operations and Toxicology Group: This group is comprised of three subsections, Ocean Operations, Vessel Operations, and Toxicology. Members of the Ocean Operations section oversee and conduct water quality sampling, benthic sediment chemistry and infauna sampling, trawl, long-line, and diving operations, and remotely operated vehicle (ROV) inspections of the ocean outfalls. They also maintain and calibrate all oceanographic instrumentation, including SCUBA equipment and the ROV. The Vessel Operations section is responsible for the operation and maintenance of the City's two oceanographic survey vessels, the 48' *Oceanus* and the 42' *Monitor III*. When in port, Boat Operators schedule and oversee all of the 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 and for accurately locating and maintaining position at the sampling stations, and assist with various deck activities during a variety of sampling operations. Marine Biologists working in the Toxicology Laboratory are primarily responsible for coordinating sample collection, and for conducting the required chronic and acute toxicity testing as required by the City's NPDES permits. The Toxicology Laboratory is certified by the State of California Department of Health Services, Environmental Laboratory Accreditation Program (ELAP), which is renewed on a bi-annual basis. The current certification is scheduled for renewal on April 30, 2006 (**Table 2**).

Taxonomy Group: This group coordinates and manages the processing of all benthic infauna and trawl invertebrate samples, maintains the taxonomic literature and voucher collections, and conducts taxonomic training. In addition, Marine Biologists working in the Taxonomy section produce in-house species identification sheets and keys, participate in a regional taxonomic standardization program, and perform all QA/QC procedures to ensure the accuracy of all taxonomic identifications made by laboratory personnel.

Table 2
Environmental Monitoring and Technical Services Division Laboratory ELAP certifications.

Laboratory Facility	EAP Lab Laboratory	Address	Phone	ELAP Code	Cert. No.
Environmental Monitoring & Technical Services	Marine Microbiology	2393 Kincaid Rd., San Diego, CA, 92101-0811	619-758-2360	CA01393	2185
Environmental Monitoring & Technical Services	Toxicology	2393 Kincaid Rd., San Diego, CA, 92101-0811	619-758-2348	CA01302	1989

Marine Microbiology and Vector Management

Marine Microbiology Group: The Marine Microbiology technical staff prepare and sterilize microbiological media, reagents, sample bottles, supplies and equipment. They also collect field samples and transport them to the laboratory for analysis. Professional staff perform 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. 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. The Marine Microbiology Laboratory presently receives certification from the State of California Department of Health Services. Certification is approved as per the Environmental Laboratory Accreditation Program (ELAP) and consists of lab audits and proficiency testing. The current certification is in effect until November 30, 2006 (Table 2).

Vector Management Group: Vector Management Laborary staff 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 Metropolitan Wastewater Department 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 City of San Diego Point Loma Wastewater Treatment Plant (PLWTP) is discharged to the Pacific Ocean through the Point Loma Ocean Outfall (PLOO). The South Bay Ocean Outfall (SBOO) accepts treated effluent from two sources, the International Boundary and Water Commission International Wastewater Treatment Plant (IWTP), and the City of San Diego South Bay Water Reclamation Plant (SBWRP). The NPDES permits associated with each of these outfalls define the requirements for toxicity testing of plant operations and monitoring of receiving waters surrounding each discharge site. The permits define the sampling plans, compliance criteria, laboratory analyses, statistical analyses and reporting guidelines. In 2005, a total of 8518 discrete samples were collected by the EMTS Division Laboratory, including samples collected as part of the permit-mandated special studies (**Table 3**). Of these, 868 (~10%) represent quality control (QC) samples such as field duplicates. In addition, 123 quality assurance (QA) procedures were also conducted to validate the quality of specific analyses (i.e., macrofaunal sorting, microbiological and toxicological analyses). 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 permit-mandated receiving waters monitoring effort for each monitoring program is summarized in **Tables 4** and **5**. The fixed-grid sampling sites are shown in **Figure 1**. Receiving waters monitoring includes monthly seawater measurements of physical, chemical and bacteriological parameters in order to document water quality conditions in the area. Benthic sediment samples are collected semiannually to monitor macrofaunal communities and sediment conditions. Trawl surveys are performed quarterly or semiannually to monitor communities of demersal fish and large, bottom-dwelling megabenthic invertebrates. Additionally, analyses of fish tissues are performed semi-annually or annually to monitor levels of chemical constituents that may have ecological or human health implications. Toxicity testing consists of acute and chronic bioassay testing of influent, and effluent. The general, permit-required toxicity testing is outlined in **Table 6.** The results of these testing and monitoring activities are analyzed and presented in monthly, quarterly, semiannual, and annual receiving waters monitoring reports.

In addition to these efforts, special strategic process studies, as determined by the City in coordination with the Executive Officer of the RWQCB and the USEPA, were also conducted in 2005 (see City of San Diego 2004). Data for these directed studies are subject to the same QA/QC procedures as the routine monitoring data, but the projects themselves do not necessarily conform to the same analysis and reporting schedules. For example, Table 3 includes the sampling effort for the 16 samples collected in 2005 as part of a deep benthic pilot study initiated in 2004, but not the macrofaunal analyses or some of the QA procedures (e.g., re-identifications) which have yet to be completed.

Table 3

Number of discrete samples collected and analyzed by the EMTS Division Laboratory for NPDES permit-related activities during 2005.

Type of Sampling & Analyses	
Sample collection (# field samples collected)	
Macrofaunal community (# grab samples)	280
Sediment quality – grain size (# samples)	148
Sediment quality – chemistry (# samples) [1]	734
Demersal fish and megabenthic invertebrate community (# otter trawl hauls)	40
Bioaccumulation – fish muscle and liver tissues (# composite samples collected) [2]	72
Water quality – CTD casts (# casts)	1204
Water quality – seawater (# samples)	6000
Toxicology (# samples)	40
Total	**8518**
Quality control samples (# field duplicate samples)	
Sediment grain size	4
Sediment chemistry	180
Seawater samples	684
Total	**868**
Analyses performed (# analyses per sample type)	
Macrofaunal sample sorting [3]	280
Macrofaunal community sample identifications	280
Otter trawl – community analyses performed	40
Water quality – microbiology [4]	4680
Water quality – suspended solids	1012
Water quality – oil and grease	308
Toxicology – Acute bioassay (saltwater)	21
Toxicology – Chronic bioassay (saltwater)	42
Quality assurance procedures performed	
Macrofaunal processing resort analysis	24
Macrofaunal community sample re-identifications	0
Microbiology (split samples)	36
Acute bioassay – saltwater (reference toxicant)	21
Chronic bioassay – saltwater (reference toxicant)	42

[1] Total number of total organic carbon, total nitrogen, BOD, total sulfides, trace metals, chlorinated pesticides, PCB and PAH samples collected for subsequent analysis by the Wastewater Chemistry Laboratory.

[2] Each composite tissue sample is analyzed for 4 parameter types (trace metals, chlorinated pesticides, PCBs, and PAHs) by the Wastewater Chemistry Laboratory.

[3] Sample sorting performed by a sub-contractor, Merkel & Associates, Inc.

[4] Total number of total coliform, fecal coliform, and enterococcus analyses performed.

Table 4

NPDES-permit mandated receiving waters sampling effort for the Point Loma Ocean Outfall monitoring program, excluding resamples or QA/QC (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
Microbiology	kelp	8	Seawater–Bacti	3	5x/month	60	1440	T, F, E [a]	4320	3 depths
&		8	CTD	1	5x/month	60	480	CTD profile [c]	3840	1 cast
Oceanographic	voluntary "kelp"	3	Seawater–Bacti	1	5x/month	60	180	T, F, E [a]	540	Non-NPDES, bottom depths
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)
Bioaccumulation	offshore	4	Trawl	3	annual	1	12	liver tissue contaminants [e]	48	3 composites/3 species (Oct) (6 trawl sites, 4 zones)
Fish Tissues	offshore	2	Hook & Line/Trap	3	annual	1	6	muscle tissue[f]	24	3 composites (Oct)
Totals							**3,386**		**13,360**	

[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, aresenic, selinium)

[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 Ocean Outfall monitoring program, excluding resamples or QA/QC (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	11	Seawater–Bacti	1	weekly	52	572	T, F, E [a]	1716	1 sample
Microbiology	kelp	3	Seawater–Bacti	3	5x/month	60	540	T, F, E [a]	1620	3 depths
&		3	CTD	1	4x/month	48	144	CTD profile 1 [b]	432	1 cast
Oceanographic		3	CTD	1	1x/month	12	36	CTD profile 2 [c]	288	1 cast
Conditions	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 2 [c]	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[d]	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
Bioaccumulation	offshore	7	Trawl	3	semiannual	2	42	liver tissue contaminants[e]	210	3 composites (Apr, Oct) (trawl sites)
Fish Tissues	offshore	2	Hook & Line/Trap	3	semiannual	2	12	muscle tissue contaminants[e]	60	3 composites (Apr, Oct) (rig-fishing sites)
"Regional Survey"										
Sediment Quatity	random array	40	Grab	1	annual	1	40	sediment constituents[d]	320	1 grab (Jul)
Benthic Macrofauna	random array	40	Grab	2	annual	1	80	community structure	80	2 replicate grabs (Jul)
Totals							**4,344**		**12,890**	

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

[b] CTD profile 1 = depth, temperature, light transmittance (transmissivity) (n = 3 parameters)

[c] CTD profile 2 = 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 (n = 8 parameter categories; see NPDES permit for complete list of constituents)

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

Table 6

Toxicity testing effort for the Point Loma and South Bay Ocean Outfall monitoring program, PLWTP, SBWRP, AND IWTP 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 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	sem-iannual	2	1	2 + 2 Ref Tox	4	survival	5 + Control	2005 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	2005 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	2005 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	2005 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	2005 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	2005 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
** Saltwater species

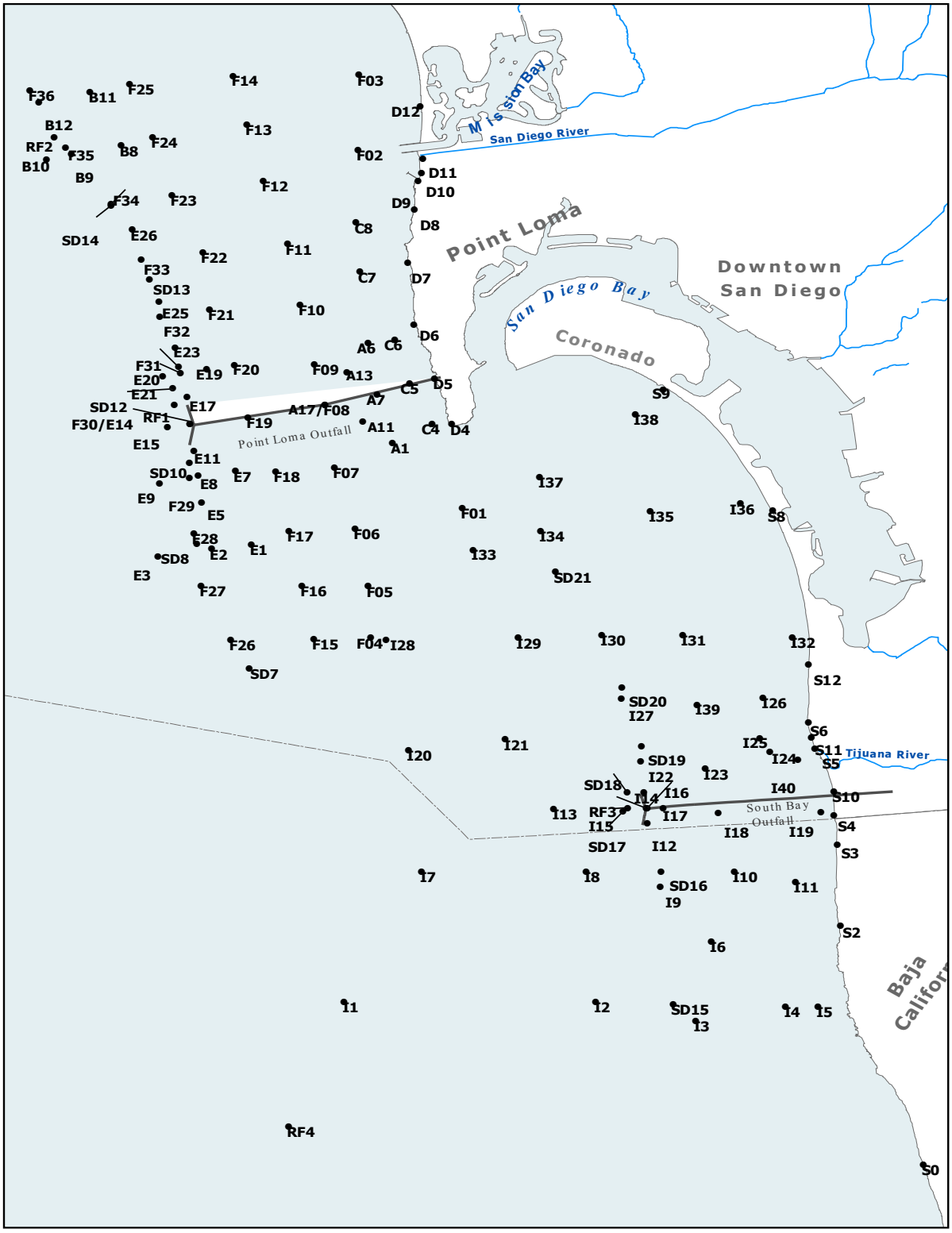

Figure 1
Recieving waters monitoring stations surrounding the Point Loma and South Bay Ocean Outfalls.

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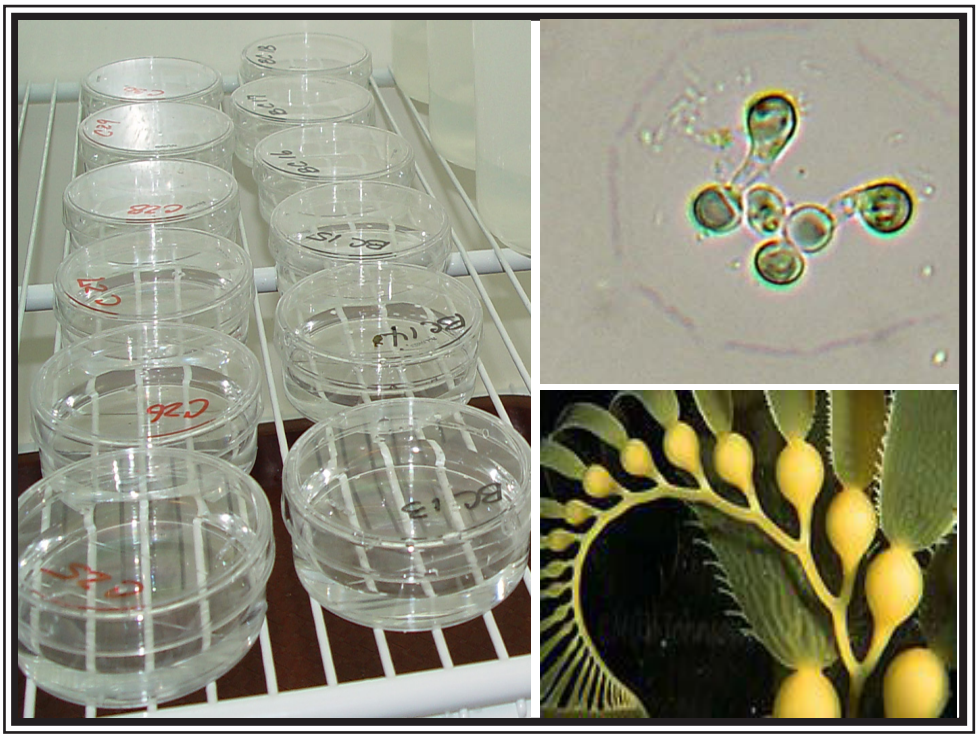
Results of QA/QC Activities Conducted in 2005



Example of kelp sporophyll testing

RESULTS OF QA/QC ACTIVITIES CONDUCTED IN 2005

The results of various quality assurance procedures are presented in the sections that follow. They 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 resort and re-identification analyses; (4) results of toxicology quality assurance procedures.

CTD Intercalibration Exercise

An annual CTD inter-calibration exercise is conducted in order to ensure consistency between two CTD instruments used to collect all of the permit-mandated water quality profiling data for the ocean monitoring programs. Two Sea-Bird Electronics model 25 CTD instruments were used in the inter-calibration exercise for 2005. The instrument designated as Unit #3 is a combination CTD/carousel sampler and Unit #4 is a stand-alone CTD unit. The two CTD units are attached to each other and deployed together to a depth of 120 meters three times. After the three casts were completed a comparison of measurements from six sensors (temperature, salinity, dissolved oxygen, pH, fluorometer and transmissometer) and one calculated parameter (density) was performed to assess whether any observed deviations between the instruments and sensors was within acceptable limits (see City of San Diego, in prep).

The results of the inter-calibration exercise are summarized in **Table 7**. All six sensors (i.e., temperature probe, salinity probe, fluorometer, transmissometer, DO and pH probes) displayed acceptable variation between instruments. In addition, this exercise showed decreased variability relative to previous years (**Table 8**). The mean difference between both DO probes was 0.089 mg/L over the three casts a significant improvement over previous years. This is likely due to revisions Sea-Bird Electronics, the manufacturer of these DO probes, made to their recommended maintenance protocols in December 2004.

The temperature and conductivity probes are factory calibrated at Sea-Bird Electronics semi-annually. Pressure and fluorometer probes are factory calibrated annually at Sea-Bird Electronics and Wetlabs,

Table 7

Summary of the CTD inter-calibration casts performed during 2005. Data include mean difference, maximum difference, and the cast (i.e., 1, 2, or 3) and depth (m) at which the maximum difference occurred

Parameter	Mean [a]	Max [a]	Cast	Depth
Temperature (°C)	0.047	0.363	1	41
Salinity (ppt)	0.014	0.081	1	66
DO (mg/L)	0.089	0.818	1	68
pH	0.032	0.069	2	87
XMS (%)	0.210	2.254	2	87
Density (sigma-t)	0.018	0.113	1	67
Fluorometer (ug/L)	0.129	2.745	3	14

Table 8

Summary of the average variability between probes on Unit #3 and Unit #4 from 2001 to 2005.

Parameter	2005	2004	2003	2002	2001
Temperature (°C)	0.047	0.054	0.052	0.028	0.05
pH	0.032	0.055	0.023	0.043	0.02
Transmissivity (%)	0.21	0.283	0.713	1.38	0.35
Fluorometer (ug/L)	0.129	0.083	1.303	0.182	3.84
DO (mg/L)	0.089	0.462	0.198	0.215	0.043
Conductivity (ppt)	0.014	0.01	0.011	0.011	0.007

respectively. The DO probes are factory calibrated annually at Sea-Bird and calibrated monthly in-house to check for sensor drifting. The pH sensors when showing slow response times are serviced in-house by replacing the electrode component of the sensor. The transmissometer is calibrated in-house annually and is factory calibrated when needed. **Figure 2** depicts the results of Cast 2 only and represents an approximation of what took place during the inter-calibration exercise.

Bacteriological Quality Assurance Analyses

Duplicate and split bacteriological samples were run as quality assurance checks to measure variability between samples and analyst precision, respectively. A duplicate sample was obtained by taking two distinct samples at a given station in the field and then analyzing them in exactly the same way. A split sample was obtained by taking aliquots of a single field sample and then having two different analysts perform the dilutions, filtration and plating. Duplicate samples were performed on approximately 5% of the water quality samples. Split samples were performed once each month. The sign test (see Gilbert, 1987) was used to statistically compare the results of the paired duplicate and split samples collected between January and December 2005. The results of this test are summarized in **Table 9**. The raw data for these analyses have been reported previously in Monthly Receiving Waters Monitoring Reports for the respective programs (i.e., PLOO, SBOO, and SBWRP).

Results from the analysis of split bacteriological samples indicate that analytical techniques were not significantly different ($p > 0.05$) among analysts for all three tested parameters (i.e., total and fecal coliforms and enterococcus).

In addition to these duplicate and split sample analyses, the Marine Microbiology and Vector Management Laboratory QA officer conducts monthly comparisons of bacterial colony counts to quantify the counting precision of each analyst and the precision counts completed by pairs of

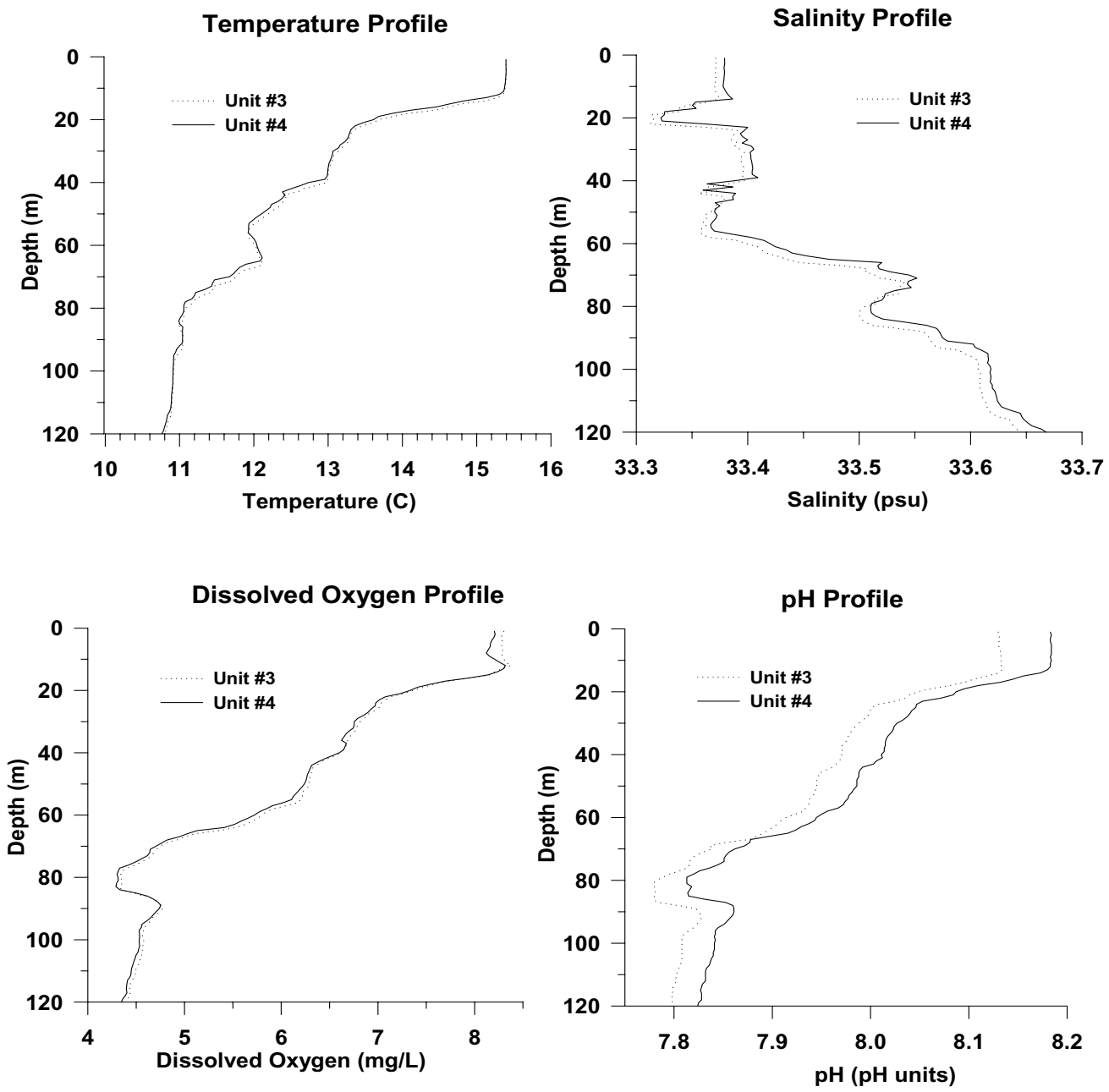
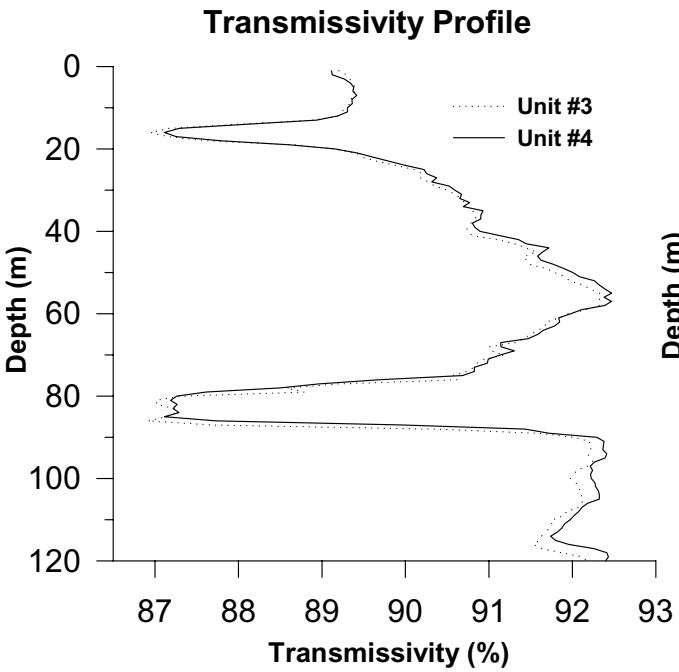
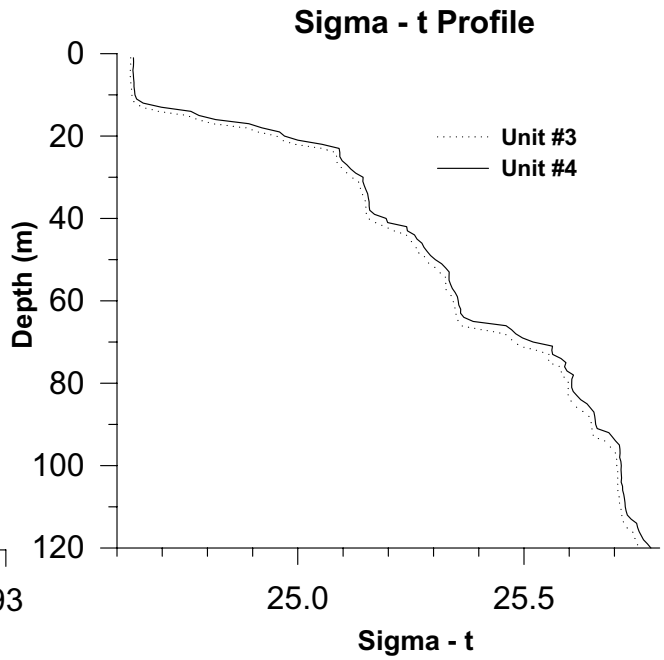


Figure 2

Example results of the 2005 CTD intercalibration casts for CTD units #3 and #4. Data includes cast profiles for transmissivity, density (sigma-t), fluorometry (before and after intercalibration), temperature, salinity, dissolved oxygen and pH.





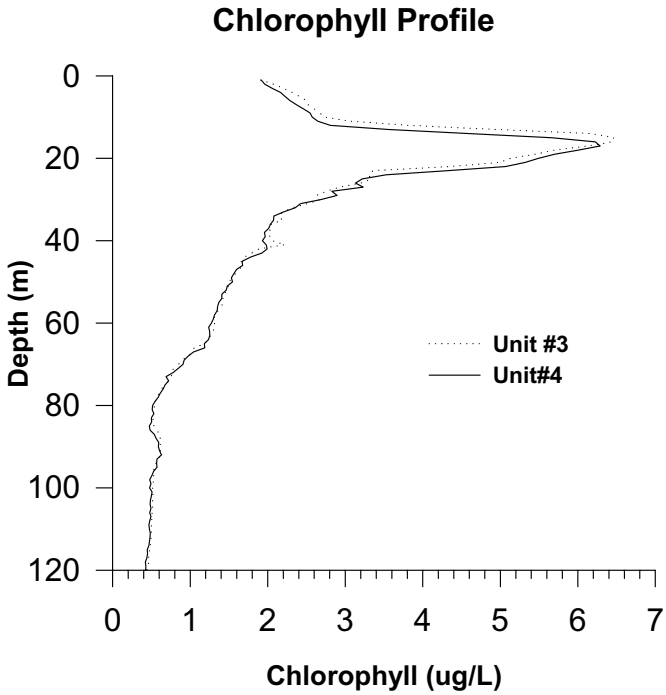


Figure 2 *(continued)*

Table 9

Summary of duplicate and split bacteriological anaylses for the Point Loma Ocean Outfall and South Bay Ocean Outfall monitoring programs conducted from January through December 2005. The paired duplicate and split samples were each compared using the sign test (see Gilbert, 1987) at a p=0.05 level of significance.

Parameter	N	B	Zb	P	Accept H_o
Duplicate samples					
Total	157	80	0.24	>0.05	Accept
Fecal	133	57	-1.65	>0.05	Accept
Enterococcus	119	53	-1.19	>0.05	Accept
Split samples					
Total	7	2	-1.13	>0.05	Accept
Fecal	6	2	-0.82	>0.05	Accept
Enterococcus	6	2	-0.82	>0.05	Accept

H_o = There is no significant difference between the samples being compared
N = Number of pairs of data
B = The number of positive differences between pairs
Zb = Sign test result

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. In 2005, no test exceeded either measure.

Macrofaunal Community Analyses – Resort Analysis

The laboratory analysis of macrofaunal community samples involves three processes: sample washing and preservation, sample sorting, and organism identification and enumeration. Quality control 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 (Merkel & Associates, Inc.), with a 95% removal efficiency expected. Ten percent of the sorted samples of each sorter are subject to resorting as QA for the contract and macrofaunal community analyses. The original sorting of a sample fails the QA criteria level if the resort has more than 5% of the total abundance of organisms from that sample. Failure to achieve 95% removal efficiency requires the re-sorting of all samples previously sorted by that sorter. The resort results for the period from January and July 2005 are shown in **Table 10**. Every one of the 24 samples resorted met the 5% QA level. The percentage of animals found in the resorted samples ranged from 0 to 2.0% 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. Typically, the reference toxicant is purchased from a supplier in aqueous

Table 10

Results of benthic resort analyses for the Point Loma Ocean Outfall (E and B stations) and South Bay Ocean Outfall (I stations) monitoring programs conducted during 2005. Percent = (the # of animals found in the resorted sample/the total sample abundance) X 100. ¹ and ² indicate sample replicate number.

Quarter	Station	Percent	Quarter	Station	Percent
Jan-05	E-20²	0.00	*Jan-05*	I-4²	1.61
	E-5²	0.00		I-15¹	0.00
	E-14²	0.00		I-14²	0.63
	B-9²	0.26		I-27¹	1.92
				I-35¹	0.00
				I-8¹	0.00
				I-22¹	2.03
Jul-05	E-8²	0.00	*Jul-05*	I-3¹	0.49
	E-17²	0.00		I-8¹	0.27
	E-19¹	0.00		I-21¹	0.48
	E-26¹	0.00		I-15²	0.38
	B-8¹	0.00		I-31¹	1.00
	E-5¹	0.00		I-14¹	0.00
				I-30¹	0.00

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 time the test material (e.g. effluent) is evaluated. A control chart containing no fewer than 20 of the most recent reference toxicant 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 (within 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 will also be conducted to determine whether the exceedance is anomalous or if remedial measures are needed. All NPDES tests conducted with the affected animals will be flagged, reviewed for anomalous responses, and, in certain cases, repeated With a new batch of animals. In 2005, all reference toxicant control charts were reviewed and accepted by the State of California Environmental Laboratory Accreditation Program.

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