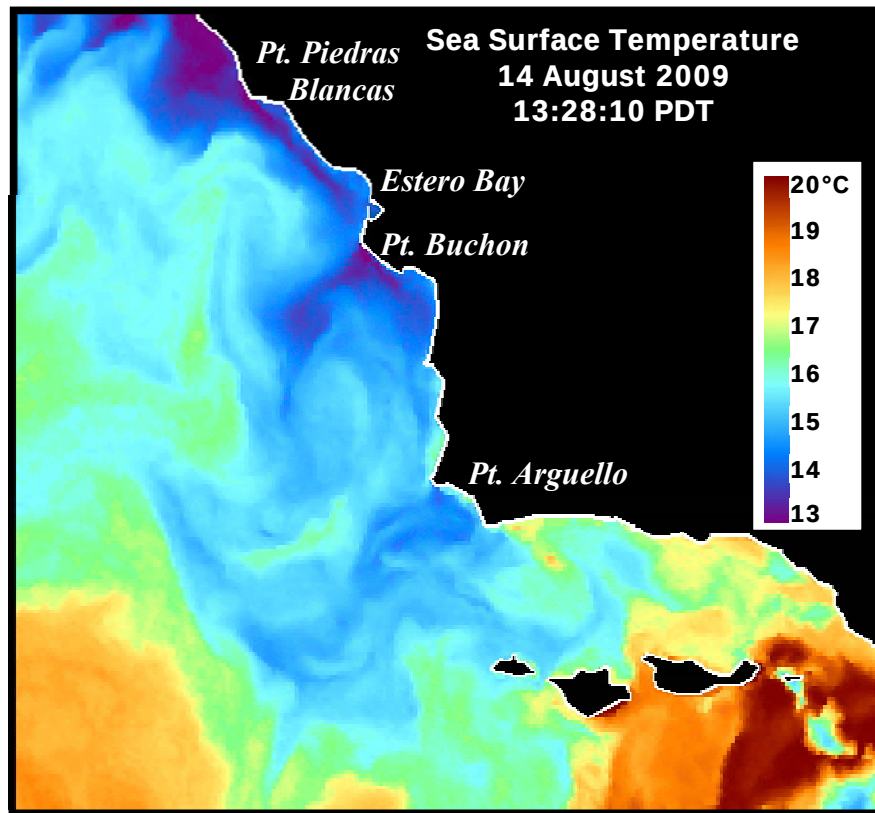


**City of Morro Bay and
Cayucos Sanitary District**

OFFSHORE MONITORING AND REPORTING PROGRAM

2009 ANNUAL REPORT



Marine Research Specialists

**3140 Telegraph Rd., Suite A
Ventura, California 93003**

**Report to the
City of Morro Bay and
Cayucos Sanitary District**

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Morro Bay, California 93442
(805) 772-6272

**OFFSHORE MONITORING
AND REPORTING PROGRAM**

2009 ANNUAL REPORT

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March 2010

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Mr. Bruce Keogh
Wastewater Division Manager
City of Morro Bay
955 Shasta Avenue
Morro Bay, CA 93442

31 March 2010

Reference: 2009 Annual Monitoring Report

Dear Mr. Keogh:

Enclosed is the referenced report. It documents the continued effectiveness of the treatment process, the absence of marine impacts, and compliance with the discharge limitations and reporting requirements specified in the NPDES discharge permit.

Please contact the undersigned if you have any questions regarding this report.

Sincerely,

Bonnie Luke
Program Manager

Enclosures (5)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Mr. Rob Livick
Acting Director of Public Services
City of Morro Bay

Date

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LIST OF ACRONYMS AND DEFINITIONS

ACOE	U.S. Army Corps of Engineers
Anomaly	An anomaly is a deviation or departure from ambient (mean) conditions in one of the six measured seawater properties: salinity, temperature, density, dissolved oxygen, alkalinity, or transmissivity. The amplitude of the anomaly is quantified as the difference between the measured seawater property at a given station and the mean of that property measured at all other stations at the same depth level or distance above the bottom.
Anthropogenic	Changes to the environment induced by human activities
ASP	Amnesic Shellfish Poisoning
BCCE	Brown and Caldwell Consulting Engineers
BEHP	Bis 2-Ethyl Hexyl Phthalate is a compound that leaches out of plastics and is ubiquitous in the environment.
BIP	A Balanced Indigenous Population is as an ecological community that exhibits characteristics similar to those of nearby, healthy communities existing under comparable but unpolluted environmental conditions.
BBL	A benthic boundary layer is often synonymous with a bottom nepheloid layer (<i>see below</i> BNL) and is associated with increased turbulence and mixing caused by the decrease in current flow immediately above the seafloor that is required to meet the zero-velocity boundary condition at the seafloor.
BNL	The bottom nepheloid layer is a common phenomenon on continental shelves where increased turbidity near the seafloor is caused by the presence of naturally occurring particulates formed from light-weight flocs of detritus. Oscillatory bottom currents generated by passing surface gravity waves easily suspend these flocs.
BOD₅	Five-day biochemical oxygen demand
BTEX	Benzene, toluene, ethyl benzene, and xylene
Cal/OSHA	California Department of Industrial Relations, Division of Occupational Safety and Health
CAM-17	CAM is the California Administrative Manual and CAM-17 refers to the list of 17 heavy metals identified in the California Code of Regulations (CCR 2003), Title 22, Chapter 11: Identification and Listing of Hazardous Waste.
CCLEAN	<u>Central Coast Long-term Environmental Assessment Network</u>
CEQA	California Environmental Quality Act
CCR	California Code of Regulations (CCR 2003)
CDFG	California Department of Fish and Game
Coordinate Datum	All coordinates cited in this report are referenced to the WGS84 datum

LIST OF ACRONYMS AND DEFINITIONS

(Continued)

COP	The California Ocean Plan (SWRCB 1997), which has been revised but the 1997 edition was in force when the current NPDES discharge permit was issued to MBCSD.
CTD	CTD is an instrument package that continuously records conductivity, temperature, and depth, in addition to a number of other physical oceanographic parameters in the water column.
CV	A coefficient of variation is used to compare the relative amounts of variation in populations having different means. It is the standard deviation expressed as a percentage of the mean.
DDT	Dichloro Diphenyl Trichloroethane, a chlorinated pesticide
DEHP	Di(2-ethylhexyl) phthalate synonymous with Bis(2-ethylhexyl) phthalate
DHS	California Department of Health Services
DMR-QA	Discharge Monitoring Report Quality Assurance (DMR-QA) Study administered by the United States Environmental Protection Agency
DO	Dissolved Oxygen
ELAP	California Department of Health Services, Environmental Laboratory Accreditation Program
EQ	Exceptional Quality is a standard for compost that meets the Federal and State requirements for beneficial reuse as a soil amendment in the local community.
ERL	Effects Range Low is a sediment toxicity concentration below which adverse biological effects are not expected to occur.
ERM	Effects Range Median is a sediment toxicity concentration above which adverse biological effects are expected to occur.
GPM	Gallons per Minute
HAB	Harmful Algal Bloom
Hazwopper	Hazardous Waste Operations and Emergency Response
HCl	Hydrochloric Acid
HCH	Isomers of hexachlorocyclohexane including alpha, beta, gamma (lindane), and delta
I&I	Inflow and Infiltration
Isopycnal	A surface of constant seawater density
Leachate	A solution formed by leaching, especially a solution containing contaminants picked up through the leaching of soil
LC₅₀	Lethal 50% Concentration is a toxicity endpoint where 50% of the specimens will die after a 96-hour exposure period.
LOE	Line of Evidence used to evaluate whether a receiving-water measurement is out of compliance with permit limits

LIST OF ACRONYMS AND DEFINITIONS

(Continued)

MBCSD	The City of Morro Bay and Cayucos Sanitary District
MTBE	Methyl Tertiary Butyl Ether is an additive to gasoline that boosts octane to reduce air emissions but has contaminated groundwater in many regions after accidentally leaking from underground storage tanks.
MDL	Method Detection Limit is the lowest concentration that can be reported under ideal conditions where the sample contains only the compound of interest with a concentration in an optimal calibration range and in a medium that does not interfere with the performance of the analytical instrument.
mg/Kg	Milligrams per Kilogram = $\mu\text{g/g}$ dry weight = parts per million
mg/L	Milligrams per Liter = aqueous parts per million
Mixed liquor	A mixture of activated sludge, wastewater, and oxygen where organic sewage constituents are biologically assimilated
ML	The Minimum Level is the method-specific minimum concentration of a substance that can be quantitatively measured in a sample given the current analytical performance used by most certified laboratories within California, as specified in the 2005 Ocean Plan.
MLLW	Mean Lower Low Water
MMS	Minerals Management Service
MPN	Most Probable Number
MRS	Marine Research Specialists
MT	Metric Ton = 1,000 kg
NEP	National Estuary Program
NOAA	National Oceanic and Atmospheric Administration
NOEC	No Observable Effect Concentration
NORM	Naturally Occurring Radioactive Material
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Units
O&G	Oil and Grease
O&M	Operations and Maintenance
OIT	Operator-in-Training
P1 – P12	Individual identifiers for discharge-related perturbations in seawater properties
PAH	Polynuclear Aromatic Hydrocarbons

LIST OF ACRONYMS AND DEFINITIONS

(Continued)

PCA	Principal Component Analysis is a multivariate technique that arranges samples along an axis based on species composition. This arrangement is conducted independently along a number of dimensions (usually 2 or 3) that approximate some pattern of response of the intertidal community to underlying environmental gradients. PCA condenses the complex species-abundance database to a few factors responsible for observed variability within the intertidal community structure, while retaining ecologically meaningful biological information.
PCB	Polychlorinated Biphenyl
PCi/L	Pico-Curies per liter is a measure of aqueous radioactivity.
Perturbation	A perturbation is a small but detectable variation (anomaly) in one or more seawater properties caused by the presence of dilute effluent within the receiving waters. Individual Perturbations identified in this report are designated P1 through P12.
PG&E	Pacific Gas and Electric
POTW	Publicly Owned Treatment Works
Power (1-β)	The probability correctly rejecting the null hypothesis depending on the significance criterion, the variability of the sample results, and the size of the impact
ppm	Parts per million = mg/L in solution , or mg/Kg = µg/g dry weight
PQL	Practical Quantification Limit is the lowest concentration that can be measured with statistical reliability given the sample size and analytical method.
PSDWF	Peak seasonal dry-weather flow
PSP	Paralytic Shellfish Poisoning
<i>p</i>-value	Low <i>p</i>-values (<0.05) indicate a high degree of confidence that the computed quantity is statistically significant.
PWWF	Peak wet-weather flow
Pycnocline	A region of rapid vertical change in the density field of the seawater column
QA/QC	Quality Assurance and Quality Control
RAS	Return Activated Sludge is continuously returned to the aeration tank to provide a seed of developed bacteria for rapid digestion of incoming wastewater. Some sludge is wasted (WAS) to prevent excessive solids buildup.
RPA	The Reasonable Potential Analysis procedures in Appendix IV of the California Ocean Plan provide a quantitative methodology for statistically analyzing historical effluent data to determine the likelihood of exceeding permit limits in the future, and thus, whether continued monitoring is warranted.
RWQCB	State of California Regional Water Quality Control Board - Central Coast Region
SAIC	Science Applications International Corporation

LIST OF ACRONYMS AND DEFINITIONS

(Continued)

SBE	Sea-Bird Electronics, Inc.
SCBPPFCT	Southern California Bight Pilot Project Field Coordination Team
SCCWRP	Southern California Coastal Water Research Project
SEP	Supplemental Environmental Project
Sigma-T	σ_t units are a measure of the density of water equal to the 1000 times the specific gravity minus one.
SJCF	San Joaquin Composting Facility located in Kern County California and owned by McCarthy Family Farms, Inc.
STLC	Soluble Threshold Limit Concentration applies to the measured concentration in the liquid extract from a biosolid sample, as determined by a Waste Extraction Test. The State of California classified biosolids with leachate concentrations exceeding the STLC as hazardous.
SWRCB	State Water Resources Control Board
Thermocline	A region of rapid vertical change in the temperature field of the seawater column
TIC	Tentatively Identified Compound is a compound that can be seen by the analytical testing method, but its identity and concentration cannot be confirmed without further analytical investigation. Many analytical methods can report TICs but the analysis is not targeted specifically for their detection.
TKN	Total Kjeldahl Nitrogen
TRC	Total Residual Chlorine in effluent is determined from grab samples collected beyond the chlorine contact chamber.
TSS	Total Suspended Solids
TTLC	Total Threshold Limit Concentration applies to the total wet-weight concentration of a contaminant within a bulk biosolid sample consisting of the entire millable solid matrix rather than just the leachate. Biosolids are designated as hazardous wastes in the State of California if measured bulk concentrations exceed the TTLC.
TUa	Acute Toxicity Units
TUc	Chronic Toxicity Units
TVS	Total Volatile Solids
USEPA	United States Environmental Protection Agency
USGPO	United States Government Printing Office
USMMS	United States Minerals Management Service
VFD	Variable-Frequency Drives are electronic-motor-speed controllers used at the MBCSD WWTP to precisely control the influent pumping rate at the plant headworks by adjusting the frequency of electrical power sent to the pump motors.

LIST OF ACRONYMS AND DEFINITIONS

(Continued)

WAS	Waste Activated Sludge is removed from the treatment process to prevent excessive solids buildup.
WERF	The Water Environment Research Foundation is a nonprofit organization that helps utilities and corporations manage water resources.
WET	Waste Extraction Tests measure the soluble leachate or the extractable amount of a substance contained within a bulk sample of biosolids. A WET is indicated if the bulk wet-weight concentration of a contaminant in a biosolids sample exceeds ten times the STLC.
WWTP	City of Morro Bay-Cayucos Sanitary District Waste Water Treatment Plant
Zeolite	A zeolite is an inorganic porous material having a highly regular structure of pores and chambers that allows some molecules to pass through, and causes others to be either excluded or broken down.
ZID	The Zone of Initial Dilution is a limited volume of water surrounding the outfall where wastewater rapidly mixes with receiving waters. Most receiving-water objectives of the Ocean Plan do not apply within the ZID.

EXECUTIVE SUMMARY

The City of Morro Bay and the Cayucos Sanitary District (MBCSD) jointly own the wastewater treatment plant operated by the City of Morro Bay. The treatment plant discharges effluent to the open ocean environment of northern Estero Bay under the authority of National Pollutant Discharge Elimination System (NPDES) permit No. CA0047881. The current permit was issued in January 2009. The permit allows discharge of blended primary- and secondary-treated wastewater, although the vast majority of the wastewater receives full secondary treatment. The discharge permit requires a monitoring and reporting program that evaluates short- and long-term effects of the effluent discharge on receiving waters, benthic sediments, and infaunal communities. This 2009 Annual Report partially satisfies those reporting requirements.

This document presents a comprehensive analysis of the extensive monitoring data collected over the last 24 years. Virtually every aspect of the treatment process, receiving waters, and seafloor sediments is monitored. An exhaustive quantitative analysis of all measured parameters demonstrates that the effluent discharge consistently meets the discharge requirements and has no discernible effect on the ocean environment. A comparison of the properties of the influent and effluent affirms the treatment plant's proficiency at removing contaminants and reducing organic loads within the wastewater stream. All offshore water-quality measurements indicate that the effluent plume was primarily restricted to a narrow 15-m zone of initial dilution (ZID) around the outfall. Measurements within the effluent plume collected a few feet from a diffuser port quantified the plume's rapid dispersion, and demonstrated that the structure was operating better than predicted by modeling. Finally, the absence of adverse discharge-related impacts to the physics, chemistry, and biology of benthic sediments verified the effectiveness of the treatment process, the high dilution of effluent within receiving waters, and the low toxicity of the discharged effluent. The additional data presented in this report are consistent with conclusions based on historical data insofar as the treatment plant's continued low mass-emission of contaminants, low toxicity of the effluent stream, and absence of impacts to the marine environment.

The plant operates under a 301(h)-permit that modifies the general NPDES requirements on suspended-solid and biochemical oxygen demand (BOD) emissions. All other NPDES limits, including restrictions on the discharge of toxic substances, apply to the MBCSD discharge without exception. Regardless, the partial-secondary treatment currently performed by the plant routinely achieves reductions in suspended solids and BOD that are close to, and often exceed, full secondary requirements. In fact, the effluent usually consists entirely of wastewater that has received full secondary treatment.

Effluent monitoring during 2009 documented a year of exceptionally high operational performance by the treatment plant. Major effluent constituents, including suspended solids, BOD, and oil and grease (O&G), all had much lower concentrations and mass emissions than the permitted maximums, as they did in prior years. In fact, in 2009 key measures of treatment performance were some of the best recorded since monitoring began more than two decades ago. The discharge of O&G and BOD over the past several years has been exceptionally low, while their corresponding removal rates were high compared to the average rates achieved over the entire 24 years of monitoring. In fact, the BOD removal rate in 2009 was the second highest on record, while its emission was the lowest on record.

Reduced emissions in recent years were partially responsible to the lower overall flow in 2009 compared to prior years. Some of the reduction in plant throughput was due to moderate-to-low rainfall accumulations in recent years, which generated less inflow and infiltration (I&I) into the collection system. However, in the past few years, repairs to the collection system also successfully eliminated some major sources of I&I. In addition, a more accurate flow meter was commissioned in 2002. As a result of these efforts, the average plant throughput in 2009 ranked among the lowest on record. However, even

with the low flow in 2009, the plant continued to remove major wastewater constituents from the influent at consistently high rates.

Although the treatment process efficiently removed major organic wastewater constituents such as suspended solids, BOD, O&G, and coliform bacteria, the general lack of other chemical contaminants within effluent was largely due to their absence within the influent stream. Like most publicly owned treatment works, the MBCSD plant is not designed to extract heavy metals and synthetic organic compounds, such as pesticides and polychlorinated biphenyl (PCB), from wastewater. Instead, the MBCSD effluent's low toxicity is primarily due to the lack of heavy industry within its service area. The few businesses that discharge to the sewer system produce wastewater that is similar to that of domestic sources, only on a larger scale. A comprehensive industrial waste survey, maintained and periodically updated by collections system personnel, documents these sources. In addition, an ongoing public-outreach program and the convenience of an onsite household hazardous waste recycling facility further reduced the introduction of pollutants into the waste stream.

Throughout the more than two decades of operation, the treatment plant has consistently outperformed expectations for wastewater treatment based on regulatory standards. During this time, there has been no indication of deterioration in plant performance, and effluent quality has consistently exceeded the performance criteria anticipated in the original design. On rare occasions where exceptions to standards or criteria have occurred, they have been the direct result of unforeseen external events, or the brief, unavoidable mechanical failure of a treatment-system component. In light of their diligent adherence to a program of preventative maintenance, the main challenge for plant personnel has been to respond quickly to unanticipated failures in system components or unforeseeable events.

Among the thousands of samples and measurements collected as part of the monitoring program during 2009, there was only one, unavoidable exception to the waste-discharge requirements specified in the NPDES permit. Nevertheless, this near-perfect level of compliance is laudable and represents the culmination of many years of hard work by dedicated and experienced MBCSD personnel. Their knowledge and experience regularly enables them to enact appropriate proactive measures that ensure the smooth operation of this facility.

Quarterly offshore water-column surveys evaluated receiving-water quality. The high-precision measurements collected during the surveys were capable of resolving minute changes in ambient water properties. These measurements detected and delineated effluent as it mixed with receiving waters upon discharge from the diffuser. Slight anomalies in water properties associated with the presence of dilute effluent were observed very close to the diffuser structure within the ZID. These highly localized anomalies were still within the limits specified in the NPDES permit, even those collected well within the ZID, where such limits do not apply. The high degree of effluent dilution observed close to a diffuser port attested to the continued effectiveness of the diffuser structure in rapidly mixing the wastewater within receiving waters.

The physics, chemistry, and biology of benthic sediments around the outfall have also been monitored for 24 years. As has been the case throughout more than two decades of monitoring, all measurements fully complied with requirements of the discharge permit and the objectives of the California Ocean Plan (COP). Benthic environments are important indicators of the presence of marine pollution because they act as a major reservoir for most contaminants that enter the ocean. The lack of perceptible impacts to the benthic environment around the diffuser structure during 2009 confirmed that the treatment process effectively removed contaminants from the influent stream and that the diffuser structure efficiently diluted wastewater upon its discharge into receiving waters.

Three sediment-chemistry analyses document the absence of discharge-related benthic impacts. First, chemical concentrations measured within Estero Bay sediments during 2009, and in prior years of monitoring, were below thresholds identified as toxic to marine organisms. This includes samples collected close to the diffuser structure, as well as those collected more than 1 km away. In fact, measured concentrations were comparable to those found in benthic sediments collected throughout the region, but they were generally much less than those found within the Southern California Bight. Second, benthic samples collected during 2009 did not exhibit significant gradients of increasing contaminant concentration with increasing proximity to the outfall. Finally, although the concentrations of several metals have exhibited a slight but steady increase over time, these increases are regional in nature and unrelated to effluent discharge. Specifically, the volumes of metals discharged within the effluent were too small to account for the slight increases in sediment concentrations observed throughout Estero Bay. Additionally, the trace-metal concentrations measured in the bulk sediment samples arise from metal that is bound into the mineral matrix of sand grains, where its effect on marine organisms is minimal. This is apparent from the comparatively low dissolved-metal concentrations found in the pore water surrounding the seafloor sediments.

Infauna residing within seafloor sediments also serve as indicators of marine contamination because of their limited mobility and well-defined responses to pollution. Numbers of species, abundance, biomass and other parameters describing infaunal communities can indicate the presence of contaminant-induced stresses if, for example, gradients extending from a pollutant source to distant, unaffected areas are observed. More than 229,000 infaunal organisms have been collected and examined since the beginning of the benthic monitoring program 24 years ago. Throughout the monitoring program, there has never been any indication of outfall-related impacts to benthic biota. Instead, the data have revealed a consistently healthy indigenous infaunal community, with uniformly high diversity that does not decline with proximity to the diffuser. These observations hold true despite widespread and significant temporal variation in the abundance of individual organisms. Over the years, different taxa have dominated the infaunal community and then declined in response to natural environmental changes. For instance, the strong El Niño in late 1997 and early 1998 resulted in one of the most diverse infaunal communities observed in more than a decade. El Niños have also been responsible for huge influxes of juvenile sand dollars in 1988, 1999, and 2009. The infaunal trophic index independently measures the overall health of the benthic community. The index was among the highest measured during 2009 and, and its consistently high value in prior years demonstrates that the sediments surrounding the outfall support an extraordinarily healthy marine community dominated by suspension-feeding organisms living in clean sediments.

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1.0 INTRODUCTION

The City of Morro Bay and the Cayucos Sanitary District (MBCSD) jointly own the wastewater treatment plant operated by the City of Morro Bay. A 301(h)-modified National Pollutant Discharge Elimination System (NPDES) permit was originally issued to the MBCSD in March 1985 (Permit Number CA0047881). Region IX of the U.S. Environmental Protection Agency (USEPA) and the Central Coast California Regional Water Quality Control Board (RWQCB) jointly issued the permit. Following extensive evaluation processes, the USEPA and the RWQCB reissued the permit three times: March 1993 (RWQCB-USEPA 1993ab), December 1998 (RWQCB-USEPA 1998ab), and January 2009 (RWQCB-USEPA 2009ab). This report addresses compliance with the provisions of the most recent permit.

Marine Research Specialists began conducting the Offshore Monitoring and Reporting Program for the MBCSD in July 1993. Since then, the treatment plant staff, Marine Research Specialists, and subcontracted laboratories, which include BC Laboratories and Aquatic Testing Laboratories, have collected and analyzed samples as part of the monitoring program.

1.1 REPORT ORGANIZATION

This 2009 annual report summarizes results from the four major monitoring components that analyze the treatment plant, receiving waters, marine sediments, and benthic biota. The organization of this document is similar to that of previous annual reports for continuity with these four reporting aspects of the monitoring program. Other than this brief introductory chapter, the major sections include the following:

Chapter 2	Treatment Plant Performance
Chapter 3	Receiving Water Quality
Chapter 4	Bottom Sediments and Biota
Chapter 5	Conclusions and Recommendations

Chapter 2 details all aspects of the onshore portion of the monitoring program, including the operation and performance of the treatment plant and the disposition of biosolids during 2009. Chapter 3 documents the four offshore surveys that were conducted during 2009 to assess the quality of ocean waters where the effluent is discharged. Chapter 4 documents the analysis of sediment samples collected during an offshore survey in October 2009. It places the chemical and biological measurements in historical context by incorporating time-series analyses of the entire 24-year database. Finally, Chapter 5 reiterates the major conclusions of this report, and presents recommendations for future actions concerning the monitoring program.

In addition to these chapters, a large set of appendices provides detailed supporting documentation for the analyses in the body of this report. Appendix A lists the design specifications of the wastewater treatment plant. Appendix B details the biological analysis of the offshore sediment samples and contains information about the taxonomists who performed the species-level identification of the specimens. Appendix C contains sample descriptions, including the location, depth, and grain-size characteristics of sediment samples. Appendix D contains the annual outfall inspection report. The original benthic chemistry report and quality assessment and quality control (QA/QC) analyses performed by BC Laboratories are provided in Appendix E, which is included on the compact disk (CD) attached to the cover of this report. QA/QC procedures for the analytical laboratories are provided in Appendix F, which is also on the CD. It also contains a summary of the analytical methods used by BC Laboratories in their chemical analyses of the samples.

CHAPTER 2

Treatment Plant Performance

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2.0 TREATMENT PLANT PERFORMANCE

During 2009, the treatment plant efficiently removed nearly all organics and other solids from the wastewater stream. Analyses of key diagnostic constituents, including suspended solids, biochemical oxygen demand (BOD), and oil and grease (O&G), demonstrated the high operational performance of the plant. Similarly, periodic analyses of effluent for trace metals, pesticides, priority pollutants, and toxicity demonstrated the benign environmental character of the effluent. A proactive operation and maintenance program ensured that there were no avoidable exceptions to the limits specified in the NPDES discharge permit during 2009. The sections below use these analyses to evaluate regulatory compliance through a comparison of measured wastewater characteristics with limits cited in the NPDES discharge permit issued to the City of Morro Bay and Cayucos Sanitary District in January 2009 (RWQCB-USEPA 2009).

Data collected during 2009 augment 23 years of prior monitoring information, chronicling the consistently high level of performance achieved by the treatment process over the last two decades. As in previous years, removal of suspended solids and oxygen-demanding materials during 2009 consistently and substantially exceeded permit-required minimum limits. The treatment plant's performance routinely approached and exceeded the requirements for full secondary treatment; in fact, nearly all wastewater receives secondary treatment. Blending of primary- and secondary-treated wastewater is only required during infrequent periods of particularly high flow, such as during rainstorms. Consequently, the blending valve was open less than 2% of the time during 2009.

Despite processing a large volume of sewage during 2009, the plant discharged only 19% of the allowed solids, while still attaining removal rates 17% higher than the permitted minimum. Throughout the year, the treatment plant removed solids at a rate significantly exceeding the 85% requirement for full secondary treatment. Additionally, the average effluent suspended solids concentrations during 11 months of the year remained met or exceeded the 30-mg/L criteria for full secondary treatment. The annual average effluent suspended-solids concentration (25 mg/L) was less than half of the permitted maximum (70 mg/L), and the total solids emission (38 MT¹) was only 19% of the allowed (199 MT).

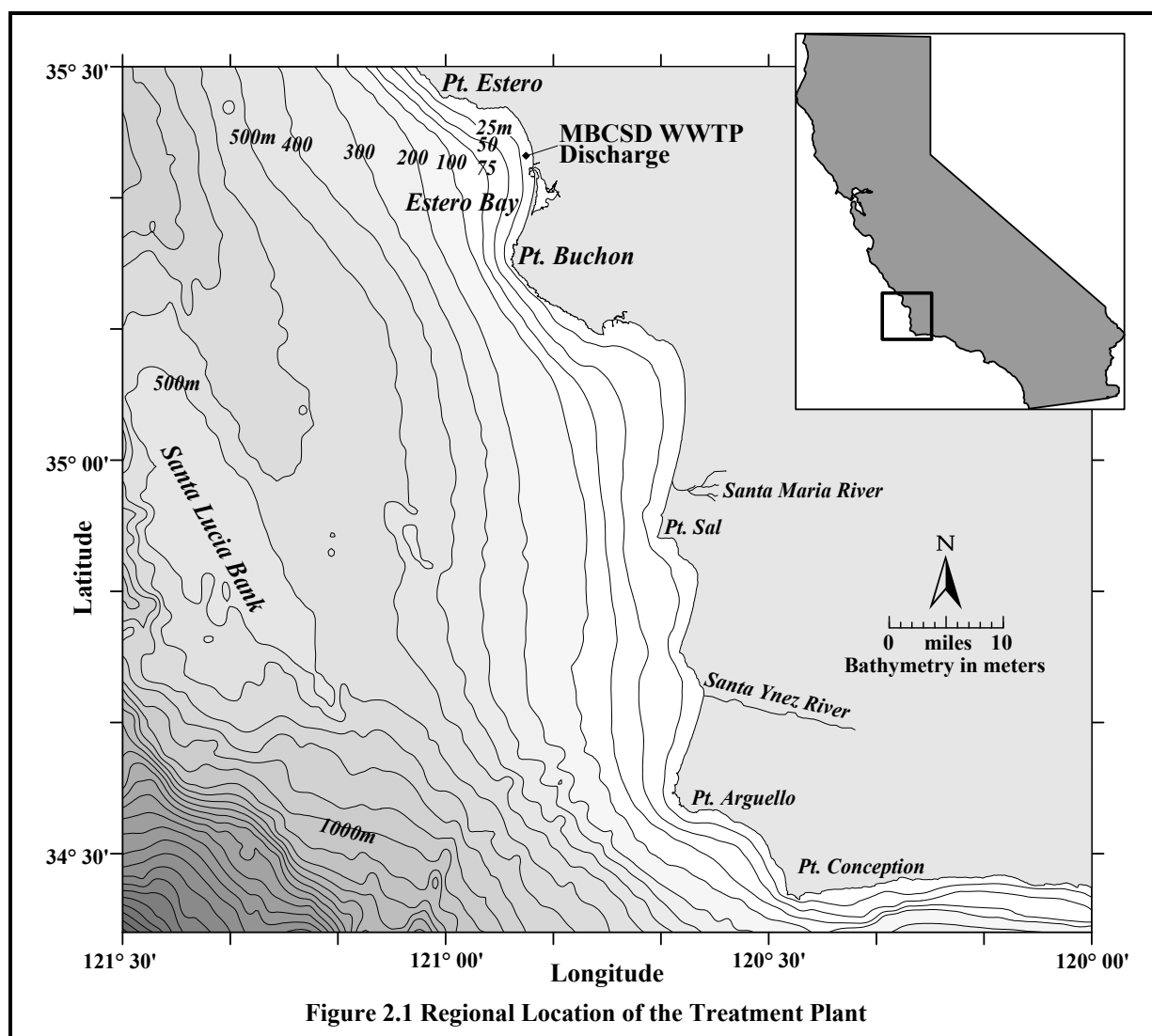
During 2009, the treatment plant also removed the vast majority (87%) of oxygen-demanding material from the influent stream. The average BOD removal during 11 months exceeded the 85% monthly removal standard for full secondary treatment while the lowest monthly removal rate of 83.6% was still nearly three times the minimum required rate of 30%. Because oxygen depletion is of little concern in the open ocean, technology-based requirements on BOD are generally unimportant for marine discharges (National Academy of Sciences 1993), so the MBCSD discharge was effectively meeting secondary treatment requirements for all of 2009. The annual average effluent BOD concentration (38 mg/L) was only about one-third of the permitted maximum (120 mg/L), and the total mass emission (56 MT) was only about one-sixth of the allowed BOD discharge (342 MT).

The general absence of industrial contaminants in the wastestream attests to the benign nature of the influent, which is almost entirely generated by nonindustrial residential sources. Chemical analyses for 79 chemical compounds quantified low-level concentrations of only three common wastewater constituents and three naturally occurring trace metals. All measured concentrations were well below permit limitations. Chronic bioassays conducted on effluent samples that were collected during 2009 determined that discharge had a very low toxicity to marine organisms, results that were consistent with the prior 16-year record of testing.

¹ Metric tons or 1,000 Kg (1.1 short tons)

2.1 WASTEWATER TREATMENT PLANT

The Morro Bay/Cayucos Wastewater Treatment Plant (WWTP) is publicly owned and operated by the City of Morro Bay and the Cayucos Sanitary District (MBCSD). The WWTP is located in the City of Morro Bay, within San Luis Obispo County along the central coast of California (Figure 2.1). The plant serves the Morro Bay and Cayucos communities, which, according to the 2000 census, have a combined population of approximately 13,293 (10,350 in Morro Bay and 2,943 in Cayucos). The WWTP discharged, on average, 1.09 million gallons per day (MGD) during 2009. The plant was designed to accommodate an average dry-weather flow of 2.06 MGD, a peak seasonal dry-weather flow (PSDWF) of 2.36 MGD, and a peak wet-weather flow (PWWF) of 6.64 MGD. The plant's flow did not approach any of these design limits during 2009.



2.1.1 Operations

During 2009, nine trained personnel operated the WWTP (Table 2.1). Bruce Keogh served as both the Wastewater Division Manager and the Laboratory Director; Les Girvin continued to serve as WWTP Supervisor.

The WWTP personnel provided laboratory workspace to the National Estuary Program (NEP), which is dedicated to protecting and restoring the natural resources of Morro Bay and its watershed. NEP volunteers used the WWTP laboratory to analyze bacterial samples collected throughout the Morro Bay watershed.

WWTP personnel attended a number of workshops, seminars, and continuing education classes throughout 2009. Course topics included CPR and first aid, confined space entry, snowy plover identification and training, forklift safety, odor control, hearing conservation and heat stress, and preventing discrimination and harassment. WWTP personnel also conducted plant tours for the public, other public agencies (including the California Integrated Waste Management Board staff, the California Joint Powers Authority Insurance Agency, and Air Pollution Control District staff), equipment suppliers, and Regional Water Quality Control Board (RWQCB) staff.

In addition to performing the periodic effluent analyses required by the NPDES Permit, during 2009 the laboratories involved in the analyses of the MBCSD WWTP samples participated in laboratory performance evaluations intended to evaluate the accuracy of effluent measurements and assure the overall quality of the monitoring reports. The WWTP laboratory analyzes effluent parameters reported on a daily and weekly basis, including residual chlorine, suspended solids, turbidity, coliform, pH, and biochemical oxygen demand. Aquatic Testing Laboratories evaluates the toxicity of effluent to marine organisms with semiannual bioassay tests. BC Laboratories determines the concentration of a wide range of chemical compounds within effluent with semiannual chemical analyses. BC Laboratories also performs the annual analysis of biosolid samples. Finally, BC Laboratories performs the chemical analyses of benthic sediments described in Chapter 4 of this report. Each laboratory's quality assurance and control plan is included in Appendix E of this report.

Several State and Federal laboratory performance evaluations were successfully completed during 2009. The regulatory agencies found the results from all of these studies to be within acceptable ranges. These included:

- The California Department of Health Services Environmental Laboratory Accreditation Program (ELAP) review of general laboratory protocols,
- The United States Environmental Protection Agency's (USEPA) Discharge Monitoring Report-Quality Assurance Study #29 (DMR-QA-29), which assessed analytical chemistry capabilities, and
- The USEPA DMR-QA Whole Effluent Toxicity Test (WETT) determination of the accuracy of bioassay capabilities.

In recent years, both the City of Morro Bay and the Cayucos Sanitary District have actively sought to identify and eliminate sources of inflow (rainwater runoff) and infiltration (of groundwater), known as I&I, within their respective collection systems. Reducing the volume of groundwater infiltration entering the collection system minimizes the amount of non-wastewater throughput processed by the WWTP.

Table 2.1 Morro Bay/Cayucos WWTP Personnel During 2009

Name	Grade and Certification No.
Bruce Keogh	IV – 8978
Les Girvin	III – 8499
Steven Aschenbrenner	II – 7548
David Williams	II – 9601
John Gunderlock	III – 10500
Eric Zatt	II – 10621
Steve Sibley	I – 8005
George Helms	I – 28158
David Bierman	OIT

Meanwhile, at the WWTP, personnel maintain a diligent, proactive preventative maintenance program that includes major preemptive repairs of various components of the treatment process. The WWTP documented these activities during 2009 in monthly operations summaries submitted to the RWQCB (MBCSD 2009a-l). To assist WWTP staff in the operation and maintenance (O&M) of major plant components, an O&M Manual, dated November 1987, was completed following the plant upgrade in 1986. The O&M manual includes both preventative and contingency plans for controlling and minimizing the affect of accidental discharges. The manual is reviewed and updated as new major equipment is placed on-line or when procedures are updated. The last time this occurred was July 2009, when procedures relating to the operation of the boilers and the variable frequency drives for the main influent pumps were revised and updated.

As part of routine maintenance procedures, SCUBA divers inspect the ocean outfall's exterior and the diffuser structure for signs of damage annually. On 20 December 2009 the outfall was found to be in good condition, with no broken or plugged diffuser ports. The divers conducting the inspection noted the presence of kelp and debris around the outfall from recent storms as well as an abundance of starfish and anemones. The annual outfall inspection report is included herein as Appendix D.

Figure 2.2 is a photograph of a diffuser port taken during a previous outfall inspection. It shows a dense cover of marine epifaunal organisms thriving on the outer surface of the diffuser port. A large colony of club-tipped anemones (*Corynactis californica*), bright pinkish-red in color, covers the top surface of the port. The continued presence of these filter-feeding organisms attests to the benign nature of the effluent discharge and to the outfall's value as an artificial reef. Based on quantitative biological surveys conducted within the region, these anemones are typically observed on high-relief rock surfaces only occasionally found within Estero Bay, and then only in deeper water (>85 m) (Morro Group, Inc. 1999). Ostensibly, their susceptibility to elevated suspended sediment loads explains their rarity on nearshore, lower-relief rocks. The preponderance of anemones on the diffuser confirms the minimal negative impact of the outfall particulate discharge on marine organisms.



Figure 2.2 Photograph of a Diffuser Port Discharging Effluent

Other routine maintenance and minor repairs were regularly conducted on various treatment-plant components. For example, the emergency standby generator was regularly tested under full load. Every quarter, the standby generator was inspected, and a certified contractor performed scheduled maintenance. Annual inspections were also performed on the Plant's cathodic protection system and back-flow prevention devices.

In addition, the WWTP staff instituted several major repairs and preventative-maintenance measures during 2009. For example, from May through July, the plant underwent an extensive boiler retrofit and reconditioning program. The program included replacement of all the gas valves, piping, safety relays and devices, rebuilding of the burner, rewiring the controller, and installation of new expansion tanks. In addition, repairs to the hot water loop used to heat the digester were made, and new hour meters and switches were installed to ease in switching from the lead to lag operational mode. These upgrades ensured boilers compliance with current code specifications, and should also allow them to burn more efficiently. In conjunction with these major maintenance efforts in 2009, WWTP staff performed the following maintenance actions:

- Replaced a faulty Return Activated Sludge (RAS) blower and the site glass on the sodium bisulfate chemical storage (January);
- Replaced the batteries for the emergency auxiliary generator and installed new air filter housings on both RAS blowers (February);
- Installed a new motor starter and new switches on the electrical controls for the chlorine collector drive unit (March);
- Installed new switches on Waste Activated Sludge (WAS) pump #P6512 and new motor control relays on sludge pump #P3512 (March);
- Removed the in-line grinder on the digester recirculation piping for Digester #2 (April);
- Replaced the electric motor on service air compressor CP9301 due to a faulty electrical connection and a bad bearing (April);
- Replaced the flow and residual paced sodium bisulphate pumps used for dechlorination, and repaired a minor leak on the discharge tubing of the flow paced sodium hypochlorite pump used for disinfection (April);
- Reinstalled secondary effluent pump #P4504 and biofilter circulation pump #P4502 at the interstage pumping station following inspection, repair, and maintenance. New bushings bearings, and a drive shaft were installed while the circulation pump was offline (May);
- Installed a new WAS pump. Replaced the motor, motor stand, and installed new sheaves on the pump and motor. (May);
- Replaced the chemical dosing pump used to dose ferrous chloride at the headworks (May);
- Replaced the drive motors on the primary and secondary clarifier drive units, and began replacing the diffuser socks in the solids contact channel (June);
- Replaced the supply and discharge tubing and fittings on the residual paced sodium hypochlorite pump used for disinfection, installed a new timer on the control system for WAS pump #P6511, and replaced the drive belts on grit pump #1 (June);
- Finished replacing the diffuser socks in the solids contact channel (July);
- Installed new relay switches and solenoids on the control systems for primary sludge pump #1 and scum pumps #1 and #2 (July);
- Installed a new pressure regulator, oiler and air-water separator on scum pump #2 (July);
- Installed a new battery back-up system for the main plant control panel and the auto dialer alarm system for the plant (July);

- Replaced the sensors for the atmospheric monitors and gas detection system at the headworks (July);
- Replaced and calibrated the oxygen sensor on the Industrial Scientific MG140 hand-held atmospheric gas monitor (July);
- Replaced a broken sheer pin in the chlorine contact drive unit for the north contact tank (August);
- Replaced the vacuum pressure gauges on the hot water loops for boiler #1 and #2 (August);
- Installed and calibrated the manometer used to monitor the gas pressure in the digesters and the gas feed line to the boilers (August);
- Removed and replaced the sand in the center column of sludge drying beds #5 and #6 to allow better percolation (August);
- Replaced the sheer pin in the chlorine contact drive unit for the north contact tank. (September)
- Replaced the flow paced dosing pumps for the sodium hypochlorite dosing system used for disinfection with two chemical dosing pumps (September).
- Removed the main influent sluice gate for repair and maintenance of the pneumatic ram used to control the sluice gate. Additionally, installed a new set of pneumatic controls and piping used to control the position of the sluice gate (September - October);
- Replaced the pump motor on main influent pump #1. (October);
- Removed and repaired main influent pump #3. Repairs included the epoxy coating of the volute and impeller to increase pumping efficiency; rebuilding of the pump, including installation of new bearing and seals; and the rewinding of the pump motor (November);
- Calibrated the influent flow meter and verified the calibration of the flow meter used to calculate flow to the secondary clarifier (December);
- Completed installation of a new modulating sluice gate at the interstage pumping station and of a new total chlorine residual analyzer (December); and
- Replaced the sheer pin in the chlorine contact drive unit for the north contact tank (December).

2.1.2 Plant History

The original WWTP, built in 1954, had a nominal capacity of 0.7 MGD and a 1-MGD maximum throughput. The original plant included a headworks structure, primary and secondary clarifiers, a biofilter, a single-stage digester, chlorination facilities, biosolids drying beds, and a short ocean outfall.

In 1964 the plant upgraded to a nominal capacity of 1 MGD and a 1.3-MGD maximum throughput to meet the demands of the growing coastal community. This upgrade added a pump station, a splitter box, a primary clarifier, a secondary clarifier, a biofilter, chlorination facilities, biosolids beds, and another primary digester, which allowed conversion of the existing digester to a secondary capacity. A new office and laboratory were also constructed during this upgrade.

During the 1970s, the City of Morro Bay developed a plan for additional upgrades to the WWTP facilities intended to further augment the plant's capacity. In 1980, the City began designing these planned improvements, including construction of a new outfall to better protect the marine environment, and a facilities upgrade providing full secondary treatment.

Following a year-long study of oceanographic conditions within Estero Bay, design of the new outfall was completed in April 1981. The new outfall and diffuser system extended the discharge from the

surfzone to a point far off shore. The deeper discharge increased dilution of wastewater within the open-ocean environment. The new outfall was completed and placed in service in June 1982.

The design of the facility improvements, completed in September 1981, called for a final effluent suspended-solids concentration of 30 mg/L and an equivalent limit on BOD. However, aid from state or federal agencies to finance the construction to meet these full-secondary treatment levels was not available. Since discharge through the new outfall was not causing any apparent adverse environmental impact and the projected future throughput was low, the State determined that additional financial aid for upgrading the MBCSD WWTP to full secondary was not warranted. Instead, the City modified the design to provide secondary treatment to a majority (1 MGD) of the projected flow to comply with the state water-quality standards, set forth in the California Ocean Plan (COP) (SWRCB 1990). State officials agreed with this level of treatment, provided that the USEPA approved a 301(h)-modified NPDES discharge permit that adjusted secondary-treatment requirements on suspended-solid and BOD emissions.

In a 16 March 1983 letter, the staff of the RWQCB determined that the proposed discharge would comply with applicable state laws, including water-quality standards, and would not require additional treatment, pollution control, or other requirements on any other point or nonpoint source. This tentative determination was pursuant to Title 40 of the Code of Federal Regulations, Section 125.60(b)(2) [40 CFR 125.60(b)(2)] (USGPO 1982a) and 40 CFR 125.63(b) of the 301(h) regulations dated November 1982 (USGPO 1982b).

The treatment-plant upgrades between 1983 and 1985 increased the plant capacity to a 2.06-MGD average dry-weather flow and a peak flow of 6.6 MGD. The plant now includes primary treatment of all influent by screening, grit removal, and primary sedimentation. Depending on the hydraulic conditions within the plant, most of the flow (up to 1 MGD) can be diverted through a secondary treatment process of trickling filters, clarifiers, and a solids contact chamber. This removes at least 75% of the solids in the subsequent blend of primary and secondary effluent. The new secondary-treatment process utilized the two existing trickling filters, a new aerated solids contact channel, and a new secondary sedimentation tank. The original 1954 sedimentation tank was converted into a chlorination system where the primary and secondary effluents are mixed and disinfected prior to dechlorination and discharge through the ocean outfall.

On 29 March 1985, an NPDES permit based on the previously approved Section-301(h) modification established water-quality standards for the MBCSD WWTP. The permit required the treatment plant achieve a suspended solids content of no more than 70 mg/L (75% removal) and a maximum BOD of 120 mg/L. The permit also required an extensive monitoring program to assure maintenance of environmental quality. The permit was valid for five years and expired on 8 March 1990. After an evaluation process, the permit was reissued in December 1992. During this period, improvements to the treatment facilities included the installation of a sludge removal system in the mixing chamber of the chlorine contact tank.

The MBCSD again applied for renewal of the permit in May 1997, supporting its application with an extensive technical review of more than ten years of monitoring data (MRS 1997a). An administrative extension until 11 December 1998 allowed regulatory agencies additional time to review and issue the new permit (RWQCB 1998). In July 1998, RWQCB staff determined that the discharge described in the MBCSD application “*would comply with applicable state laws, including water quality standards, and would not result in additional treatment, pollution control, or other requirements on any other point or nonpoint source.*” This permit was finalized and issued by USEPA on 26 January 1999, with an effective date of 1 March 1999.

Based on discussions between RWQCB, USEPA, and MBCSD staff and their consultants, the following revisions were also implemented in the 1999 permit:

- A 12.7% reduction in the allowed mass emission of suspended solids, BOD, and O&G;
- More extensive reporting requirements for biosolids;
- Elimination of shellfish monitoring;
- A revised benthic sampling pattern eliminating seasonal sampling and increasing the number of stations close to the diffuser structure;
- A revised receiving-water sampling program eliminating bottle casts and doubling the number of CTD casts close to the diffuser structure; and
- Specification of mass emission goals for toxic chemicals.

Based on the historical absence of perceptible impacts and continued projected high effluent quality, on 3 July 2003 the MBCSD again applied for a renewal of the discharge permit (MBCSD 2003). As with the previous permits, the application requested a continued discharge under the 301(h) provision with minor modifications of BOD and suspended solids requirements. On 4 February 2004, the RWQCB (2004) administratively extended the existing permit to allow time for further review. On 10 September 2005, the USEPA Region IX (2005) issued a tentative decision concurring with the issuance of a permit to the MBCSD in accordance with Section 301(h) of the Clean Water Act. On 6 April 2006, the USEPA and RWQCB staff issued a joint notice for a proposed action to reissue the 301(h) modified NPDES discharge permit to the MBCSD. However, on 11 May 2006, the RWQCB and the USEPA conducted a joint public hearing on reissuing the MBCSD permit wherein the RWQCB voted to continue the hearing pursuant to the issuance of a biological evaluation by the USEPA.

In 2008, the USEPA issued an Endangered Species Act (ESA) biological evaluation of continued discharge under a 301(h) modified discharge permit wherein they determined:

that the continued wastewater discharge from the Morro Bay/Cayucos facility is not likely to adversely affect the brown pelican or southern sea otter, both of which occur in the vicinity of the subject discharge. EPA finds that any potential direct or indirect effects of the continued wastewater discharge would be insignificant to the brown pelican and southern sea otter.

Pursuant to Section 7 of the ESA, the proposed action of the USEPA required consultation with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS), which protect federally listed endangered species and designate critical habitat that may be affected by the proposed action. On 21 December 2007, the USFWS concurred with the USEPA “*determination that the proposed project is not likely to adversely affect the brown pelican or southern sea otter.*”

Nevertheless, the USEPA incorporated three conservation measures into the new NPDES discharge permit to address concerns about potential contributions to otter morbidity by cat litter and domoic acid poisoning. First, the MBCSD would implement a public outreach program to minimize the input of cat litter-box waste into the municipal sewer system. Second, the MBCSD would regularly monitor nutrient loading from the WWTP. Third, the facility would upgrade to at least full secondary treatment levels by 2014.

Based on the foregoing findings and the incorporated conservation measures, the RWQCB unanimously adopted the new discharge permit on 4 December 2008. Subsequently on 9 January 2009, the California Coastal Commission unanimously determined that the new discharge permit complied with the California Coastal Zone Management Act. And on 14 January 2009, the USEPA issued the new NPDES permit, effective 1 March 2009. In addition to the conservation measures noted above, the following revisions were also implemented in the 2009 permit:

- Elimination of acute toxicity testing;
- Implementation of triggered shoreline coliform monitoring;
- Addition of nutrient monitoring;
- Revision of benthic sampling pattern eliminating cross-shore stations and shifting from grab to composite sediment chemistry samples;
- Revision of receiving-water sampling program reducing the number of vertical CTD casts, and implementing a tow-survey component; and
- Implementation of a cat litter disposal public outreach program.

Although the current NPDES permit was not finalized until January 2009, the MBCSD had actually begun to implement several of the proposed conservation measures years before. For example, in April 2006, the MBCSD, working to address the concerns of the EPA and RWQCB, adopted an eight-year time schedule to rehabilitate and upgrade the treatment plant to tertiary treatment, including onsite composting, as the preferred alternative for upgrading the WWTP by 2014. The MBCSD subsequently adopted a draft facilities master plan that outlined the facilities necessary for a tertiary treatment capacity of 1.5 MGD in September 2007. Meanwhile, in August 2007, the City of Morro Bay and CSD individually adopted revenue programs that identified the sewer-rate fees required for each community to finance the proposed plant upgrade and to provide revenue for needed sewer-system capital improvement projects. In July 2008, the City of Morro Bay implemented new residential and commercial water-use rates that increased the existing fees by 50%.

During 2009, the City of Morro Bay and District staff continued work with staff from Environmental Science Associates (ESA) on the environmental review process for the proposed upgrade. The environmental review process included a flood hazard analysis and the impacts on the upgrade project. As a result of the flood hazard analysis, the City and District voted to move the new treatment plant site to an area adjacent to the existing treatment plant. On October 13, 2009, the City of Morro Bay released a Revised Notice of Preparation (NOP) for the upgrade project. The Revised NOP includes a modified project description that reflects construction of the new treatment plant in the new location, and the demolition of the existing plant after the new treatment plant is constructed and brought on-line. On October 1, 2009, the MBCSD public noticed an RFP for Engineering Design Services for the upgrade. Based on the proposals received the City and District awarded a contract to Montgomery, Watson, Harza (MWH) at the February 16, 2010 JPA meeting. The design process is expected to take fifteen months to complete. The upgrade is currently on target for completion in March 2014.

2.1.3 Regulatory Setting

The 1972 Federal Clean Water Act and its 1977 amendments established national water-quality goals and created a national permit system (NPDES) of minimum standards for the quality of discharged waters (USGPO 1997a). Pursuant to the new system, states established standards specific to water bodies and designated the types of pollutants to be regulated. Since 1973, the California State Water Resources Control Board and its nine Regional Water Quality Control Boards have been delegated the responsibility for administering permitted discharges into the coastal marine waters of California. The State Board prepares and adopts the COP, which incorporates the state water-quality standards that apply to all NPDES permits. The RWQCB established a Water Quality Control Plan for the basin containing San Luis Obispo County waters (RWQCB 1994). The basin standards incorporate the applicable portions of the COP and specifically address the beneficial uses of marine waters adjacent to the outfall site. Water-quality objectives and toxic material limitations in the basin plan are designed to protect the beneficial uses of ocean waters within specific coastal areas. The basin plan identifies the following existing beneficial uses for the waters of Estero Bay:

- **Water Contact Recreation (REC-1).** Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, and fishing.
- **Noncontact Water Recreation (REC-2).** Uses of water for recreational activities involving proximity to water but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment in conjunction with the above activities.
- **Industrial Service Supply (IND).** Uses of water for industrial activities that do not depend primarily on water quality, including, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.
- **Navigation (NAV).** Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels. The RWQCB interprets NAV as being present within any natural body of water that has sufficient capacity to float watercraft for the purposes of commerce, trade, transportation, and pleasure.
- **Marine Habitat (MAR).** Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats; vegetation such as kelp; fish; shellfish; or wildlife such as marine mammals and shorebirds.
- **Shellfish Harvesting (SHELL).** Uses of water that support habitats suitable for the collection of filter-feeding shellfish such as clams, oysters, and mussels, for human consumption, commercial, or sport purposes. This includes waters that have in the past, or may in the future, contain significant shellfisheries.
- **Ocean Commercial and Sport Fishing (COMM).** Uses of water for commercial or recreational collection of fish, shellfish, or other organisms, including uses involving organisms intended for human consumption or bait purposes.
- **Preservation of Rare, Threatened, or Endangered Species (RARE).** Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.
- **Wildlife Habitat (WILD).** Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Section 301(b) of the Clean Water Act requires publicly owned treatment works to meet effluent limitations based on secondary treatment, which is defined in terms of limits on three technology-based effluent parameters (40 CFR 133; USGPO 1997a). These limitations are:

- Total suspended solids (TSS) concentrations not exceeding 30 mg/L as a 30-day average and removal rates not less than 85%;
- BOD concentrations not exceeding 30 mg/L as a 30-day average and removal rates not less than 85%; and
- Hydrogen-ion concentration (pH) between 6.0 and 9.0.

Section 301(h) of the Act allows an NPDES permit to modify some or all of these full secondary treatment requirements, if certain conditions are met. The MBCSD WWTP is a combined primary and secondary treatment facility that has operated under a Section 301(h)-modified NPDES permit (number CA0047881) since March 1985. The modifications in this NPDES permit apply only to the TSS and BOD requirements, so all other NPDES limitations apply without exception, including those for wastewater pH and toxic compounds. The modification was issued only after the MBCSD satisfied the following additional conditions.

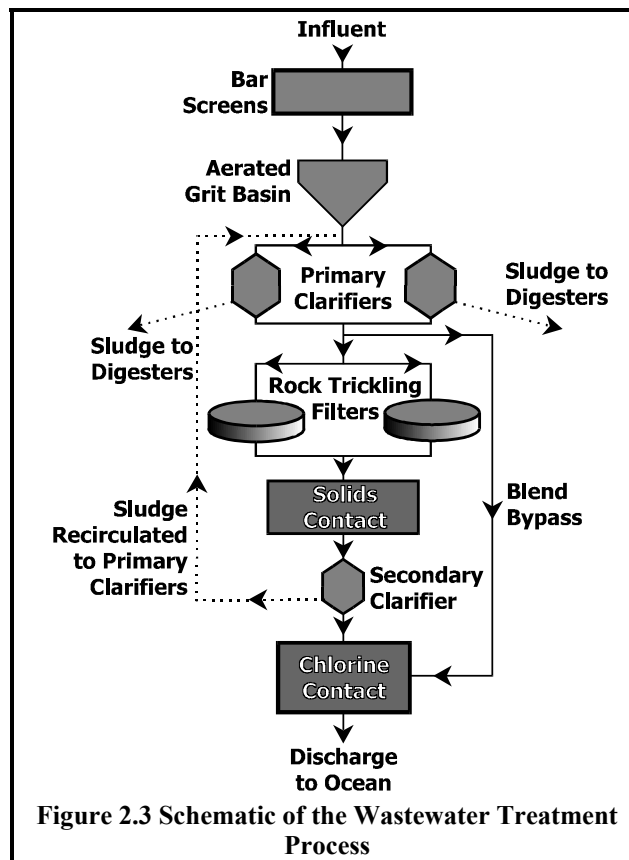
- Demonstrate the existence of a water-quality standard specific to the pollutant for which the modification is requested (40 CFR 125.61; USGPO 1997a). The COP specifies limits on TSS and DO depression (SWRCB 2005). In January 1999, the California Coastal Commission determined that the discharge complies with the State Coastal Zone Program that incorporates COP standards.
- Demonstrate that the discharge does not adversely impact public water supplies or interfere with the protection and propagation of balanced, indigenous biological populations (40 CFR 125.62). The USFWS (USDOJ 1998) and the NMFS (NOAA 1998 2004) determined that the discharge will not adversely impact threatened or endangered species, or critical habitats, pursuant to the ESA.
- Conduct a monitoring and reporting program capable of evaluating the effects of the discharge (40 CFR 125.63). The monitoring program in this report satisfies this requirement.
- Demonstrate that the discharge will not result in any additional treatment requirements on any other point or nonpoint source (40 CFR 125.64). The footprint of the MBCSD discharge does not overlap other discharges.
- Determine whether the WWTP is subject to pretreatment requirements. Since there are no known sources of toxic pollutants or pesticides in the influent, the WWTP is exempt from general pretreatment requirements in lieu of a pollution prevention program. And since the discharge is considered small, it is also exempt from the urban pretreatment requirement (40 CFR 125.65).
- Demonstrate whether the pollution-prevention program meets the requirement for a nonindustrial source control program (40 CFR 125.66). The MBCSD pollution prevention program implements public education and source reduction programs to limit the entrance of toxic pollutants or pesticides into the treatment plant.

- Demonstrate that there will be no new, substantially increased discharges of BOD and TSS beyond those specified in the permit (40 CFR 125.67). The historically high performance of the plant process and the limited projected growth in population and industry within the service area, and the analyses provided in this report demonstrate this.
- Ensure that the WWTP exceeds the minimum requirements for primary treatment (40 CFR 125.60). The WWTP performs “*treatment by screening, sedimentation, and skimming adequate to remove at least 30 percent of the biochemical oxygen demanding material and of the suspended solids in the treatment works influent, and disinfection, where appropriate*” (40 CFR 125.58(r); USGPO 1997a).

The MBCSD WWTP is categorized as a Class III wastewater treatment facility by the Office of Operator Certification within the California State Water Resources Control Board. The Board reclassified the facility in 2001 from a Class-IV facility based on the advanced treatment process and low volume of flow through the plant. A typical Class-IV facility treats more than 20 MGD in the primary process, while the MBCSD plant processes a total flow of approximately 1.1 MGD with partial-secondary treatment. The change in classification acknowledges the exceptionally small volume of flow handled by the plant and reduces the operator grades required by personnel running the plant.

2.1.4 Description of the Treatment and Outfall System

The WWTP operating characteristics are listed in Appendix A. All wastewater is treated through a primary treatment process, which includes screening, grit removal, and primary sedimentation, as shown in Figure 2.3. Typically, the vast majority of the flow (often more than 1 MGD) is diverted for an additional secondary treatment process using biofilters, a solids-contact chamber, and a secondary clarifier. The secondary process consists of parallel single-stage, high-rate, trickling filters whose combined outflow goes to a solids contact channel and then to a secondary sedimentation tank. When flows exceed 1 MGD, secondary-treated effluent can be subsequently blended with primary-treated effluent, before the entire blend is chlorinated for disinfection and then dechlorinated. The disinfected and dechlorinated effluent is discharged into Estero Bay through a 4400-ft (1341-m) outfall terminating in a multi-port diffuser system. Waste biosolids are anaerobically digested, dried, composted and used as soil conditioner and fertilizer. A schematic of the biosolid process is shown in Figure 2.15 on Page 2-34.



The location of the Morro Bay-Cayucos WWTP and outfall within Estero Bay is shown in Figure 2.4. The discharge is released into unstressed, open-ocean waters at 35°23'11"N latitude and 120°52'29"W longitude. Treated effluent flows through a 27-in (0.69-m) diameter outfall that extends approximately 4,400 ft (1,341 m) in a northwesterly direction. The outfall terminates in a multi-port diffuser approximately 2,700 ft (827 m) from shore. The 170-ft (51.8 m) long diffuser lies in 50 ft (15.2 m) of water, referenced to mean lower low water. Twenty-eight of the 34 available diffuser ports are currently open. The remaining six ports can be made operational if the sustained discharge exceeds 6.60 MGD.

Because of its location, the MBCSD discharge does not interfere with maintenance of water quality and designated beneficial uses within Estero Bay (see Section 2.1.3 on Page 2-9). The discharge occurs in well-flushed, open coastal waters where re-entrainment or accumulation of effluent will not violate applicable water-quality standards, even if combined with pollutants from other sources. Intakes and outfalls from other publicly owned treatment works are distant from the MBCSD outfall. For example, water intake for the desalinization plant is from saltwater wells and not from the ocean environment where the MBCSD discharges. Similarly, surface discharge of water from the LS Power Group plant (formerly Duke Energy and PG&E), when it does occur, is far south of the MBCSD discharge point and does not add chemical loads to the ocean environment.



2.1.5 Pollution Prevention Program

The MBCSD continued to advance its Pollution Prevention Program along several fronts during 2009. The program's purpose is to minimize the introduction of pollutants and pesticides into the treatment process. The NPDES permit requires an annual status report detailing efforts to comply with the requirements for a Pollution Prevention Program. This section serves as that report. Additionally, the current permit includes a specific requirement to document educational and outreach efforts regarding proper cat waste disposal. As in previous years, three aspects of pollution prevention were emphasized during 2009: public outreach, industrial waste source control and identification, and diligent monitoring of influent and effluent for industrial contaminants.

Industrial Waste Survey

The local economy within the MBCSD service area relies on tourism and commercial fishing, with no heavy industry or manufacturing of any environmental significance. Accordingly, an average of slightly more than 50 restaurants are found in the service area during any given year.

Comprehensive monitoring for more than 16 years indicates that effluent discharged from the treatment plant consists primarily of benign constituents. Industrial waste surveys conducted during 2009 and prior years support these findings; they quantify a comparatively low volume of influent from light industrial sources containing nontoxic constituents typical of wastewater from domestic sources. During 2009, the absence of significantly elevated levels of industrial pollutants within the wastewater stream confirmed the continuous lack of substantive industrial input.

The industrial-waste survey activities rely heavily on a digital database originally developed by MBCSD plant staff in 1999. The database includes business names, addresses, contacts, telephone numbers, inventories of chemicals, discharge volumes, and other pertinent information for all potential industrial users in the service area. As businesses turnover, the database is updated with new information. Using this database expedites quantitative assessments of industrial usage and annual updates of contact information.

The master list of businesses in the database is adapted from business license applications filed with the City of Morro Bay and input provided by the CSD. The master list is subdivided into businesses with no potential for industrial discharges, such as offices and retail stores, and those with the potential for industrial waste discharge. All businesses with potential industrial discharges are either interviewed in person or asked to complete a Commercial User Questionnaire.

Based on the detailed information provided in the questionnaire, some businesses are excluded from classification as industrial dischargers because they either do not generate wastewater at all or they discharge only domestic wastewater. These businesses included theaters, beauty shops, barbershops, and various retail firms. For the remaining industries, waste discharge volumes are estimated proportionate to water usage history from City Water Department billing records. Follow-up activities for these businesses include scheduled return visits, surprise onsite inspections, and formal tours of the facilities. Based on this phase of the survey, certain industrial dischargers are identified for continued close monitoring with scheduled, annual future site visits. These include commercial laundries, car washes, dry cleaners, print shops, and the oil-water separator maintained by the City of Morro Bay. A series of businesses were also targeted with unannounced inspections in 2009.

Overall water use within the communities has changed little between 1999 and 2009. Although domestic sources contributed the majority of the wastewater processed by the plant in 2009, commercial businesses and government agencies contributed approximately 0.20 MGD, about 18% of the influent. However, a substantial portion of the water use attributed to the City of Morro Bay, Morro Bay High School, the San Luis Coastal School District (Del Mar Elementary School), and the State Department of Parks (Morro Bay State Park) is utilized for the irrigation of landscaping, sports fields and agricultural uses, and would not be expected to flow to the collection system. These large water users add compounds to the wastestream that are not particularly toxic to humans or aquatic organisms and do not generally interfere with the treatment process.

Mission Linen is currently the only large discharger in the service district of a slightly industrial nature. This commercial laundry uses several industrial-grade detergents, bleaches, surfactants, and brighteners that can potentially harm the bacteria within the secondary treatment system. In addition, solvents, oils, and other substances removed from soiled laundry have the potential to release contaminants into the wastestream. Although Mission Linen's discharge constitutes only a small percentage (1.5%, or 0.017 MGD in 2009) of the wastewater processed by the treatment plant, MBCSD staff actively work with this discharger to minimize potential risks from their wastestream. For example, in 2002 Mission Linen installed a pretreatment system that includes pH buffering with phosphoric acid to neutralize excessive increases in wastewater alkalinity that can potentially interfere with the plant's treatment process.

Other light industrial users with smaller discharges include car washes. Car wash discharge is considered industrial in nature because of the volume of solids, oils, and greases washed from vehicles. As mitigation, the car washes pretreat their wastewater with grease separators before discharging it into the collection system. The sewer-use ordinance of the City of Morro Bay municipal code prohibits smaller contributors, like gas stations and repair garages, from disposing known contaminants into the collection system. Similarly, the municipal code requires restaurants and self-service car washes to install and maintain grease traps within sewer line connections.

In addition to chemicals from the industrial sources that contributed to the influent, the WWTP intentionally introduces three chemicals, ferrous chloride, sodium hypochlorite, and sodium bisulfate into the treatment process. Ferrous chloride is used primarily to control odor in the collection system, although it also reduces hydrogen sulfide emissions during flaring of digester gas and heating of the digesters at the WWTP, as required by the Air Pollution Control Board. Wastewater facilities commonly disinfect effluent prior to discharge with some form of chlorine; the WWTP uses sodium hypochlorite. Because residual chlorine can react with organic matter in the wastewater, and even low concentrations of residual chlorine can be hazardous to aquatic life, the MBCSD treatment plant utilizes sodium bisulfite to remove excess free and combined chlorine ions once chlorination is complete.

Not surprisingly, the sodium bisulfate added to the MBCSD treatment process for dechlorination generally tracks the monthly sodium hypochlorite dose used by the plant. In 2009, the lowest monthly sodium hypochlorite usage (2,897 gallons) occurred in May. Bisulfite usage was uniformly low in the months of February (2,294 gallons), May (2,298 gallons), and June (2,280 gallons). Meanwhile, the highest monthly doses of both compounds occurred during July 2009 when organic loading and bacterial densities within the waste stream were largest. During that time, monthly hypochlorite (3,778 gallons) and bisulfite (2,640 gallons) dosages increased by 30% and 15%.

Public Outreach

The MBCSD reaches out to the public with education through online and written literature, direct communication through presentations and talks, and resource availability, such as implementation and oversight of the on-site hazardous-waste disposal facility.

The most substantial public outreach effort during 2009, came from the modernization of the City of Morro Bay's website. The City's website now includes a series of pages devoted to an overview of the wastewater treatment plant and the collection system operations. The pages contain links to pertinent information on: collection system do's and don'ts, composted biosolids, the household hazardous waste facility, and the ongoing treatment plant upgrade. Also available are searchable copies of all of the treatment plant's self-monitoring reports from 2005 onward, as well as a copy of the current NPDES permit.

The updated website provides information on specific disposal concerns, like the appropriate disposal methods for pharmaceuticals and personal care products, biomedical wastes, oils and grease, explosives, and pet wastes, as well as links to the EPA website and other outside sources of information on these and other relevant topics. Pursuant to the conservation measures recommended by the USEPA (2007) in the biological evaluation they conducted in preparation for issuance of the current NPDES discharge permit, the City's website incorporates updated information on best management practices for cat litter disposal to avoid introduction of cat litter into the collection system. During the permit renewal process, EPA staff had postulated that minimizing the input of cat litter-box waste into the municipal sewer system would help reduce the introduction of the parasite *T. gondii* into the marine environment, thereby mitigating a known disease vector affecting southern sea otters. RWQCB staff incorporated the EPA's concerns into a special provision within the plant's final NPDES permit requiring the creation of a cat litter public outreach program.

Shortly following the finalization of the permit, on 21 January 2009 however, Johnson et al. (2009) published the results of a detailed field study of southern sea otter exposure to *Toxoplasma gondii* which essentially refuted the claims that the MBCSD discharge could be responsible for observed impacts on otter morbidity from *Toxoplasma gondii* infection through the incidental disposal of cat litter to the collection system. The authors of the 2009 study not only confirmed that the epicenter of *T. gondii* exposure in otters was not located within Estero Bay as erroneously asserted by NRDC (2006) during their attempts to block reissuance of the 301h permit, but also hypothesized that, based in part on the new epicenter location, instead of housecats "*a more important source of infection might be bobcats and mountain lions.*" In fact, the world's largest reported outbreak of human toxoplasmosis was linked to a municipal drinking-water reservoir in British Columbia that had been contaminated by cougar feces (Bowie et al. 1997; Aramini et al. 1998).

Nevertheless, during 2009, MBCSD staff extended existing public outreach and education efforts on the proper disposal of cat litter and the postulated link between *T. gondii* and cats and its potential effects on marine organisms. The MBCSD cat litter outreach program incorporated the distribution of newsletters to water users in the March and October 2009 water bills, presentations at various realtor groups, presentations at televised City Council and JPA board meetings, and discussions of best management practices during numerous tours at the treatment plant. In addition, MBCSD continued to provide "*don't flush the mush*" posters to interested parties.

MBCSD does not anticipate any changes to the cat litter public outreach program in the coming year. They will continue to use "*don't flush the mush*" mailers, newsletters, public outreach presentations, and plant tours to communicate with the general public on the topic of cat litter and waste disposal. In addition, MBCSD staff will continue to make periodic visits to specific commercial and professional establishments to encourage them to establish and implement appropriate policies and procedures to properly dispose of cat waste.

In addition to cat litter education, the MBCSD's public outreach program also educated consumers and local business about best management practices for the proper disposal techniques for a variety of household wastes, including pharmaceuticals, fats, oils, and grease to include Information was also provided on the household hazardous-waste facility located at the treatment plant, and the availability of high-quality compost as a soil amendment produced by the plant's onsite biosolids composting program.

In August 2000 the MBCSD partnered with the Integrated Waste Management Authority to establish a permanent household hazardous-waste collection facility at the treatment plant. The WWTP offers free waste disposal to all residents of San Luis Obispo County every Saturday from 11:00 AM to 3:00 PM, except holiday weekends.

Over the last decade, the hazardous-waste disposal site has helped make the facility one of the top sites in the county in terms of the volume of material collected. On average, between 20 and 50 individuals dispose of household hazardous waste at the facility each weekend. Between July 2008 and June 2009, the WWTP disposal facility processed more than 107 tons of household hazardous waste; a large portion of that waste was recycled. More than half (118,340 pounds) of the collected material, by weight, was comprised of electronic wastes (e-waste), including video display devices such as television and computer monitors, which the facility started accepting in 2004. Cathode ray tubes (CRT), the picture tubes used in many older computer monitors and television screens, contain large quantities of five known toxic chemicals: cadmium, mercury, chromium, lead, and phosphorous. In fact, the EPA estimates that discarded CRTs contribute at least 40% of the known lead in U.S. landfills. Flat panel monitors, cell phones, digital cameras, and computer hardware also contain hazardous waste elements.

Additional materials collected at the facility during 2009 included more than 5,280 pounds of oil-based paint; 35,750 pounds of latex paint; 2,150 pounds of flammable liquids and solids; 4,875 pounds of aerosol containers; 4,128 pounds of antifreeze; 6,000 pounds of car batteries; 5,610 pounds of motor oil/oil products; 4,800 pounds of poisons; 1,250 pounds of acids and bases; and 8,775 pounds of compressed gas cylinders. Without the permanent hazardous waste facility, some of this material would have gone to a landfill or been discharged into the ocean.

Source Identification

Although measures have been implemented to reduce incompatible contaminants introduced into the wastestream, concentrations are occasionally elevated in the periodic chemical analysis of effluent. When this occurs, MBCSD personnel trace the contaminants to the source and work with the source owner to eliminate the contamination. However, in 2006 the State Water Resources Control Board adopted new statewide waste discharge requirements for sanitary sewer systems. These new requirements transferred responsibility for managing the introduction of fats, oils, grease, and other components from the WWTP to the Collections Department under the City of Morro Bay's Sewage System Management Plan². Although no unusual contaminants were detected within the wastestream during 2009, WWTP personnel identified and tracked occasional excursions of influent properties with the established source-detection program.

Ongoing source identification and resolution efforts conducted by the City in 2009 included a grease-trap inspection program. Originally begun in 2002, this program manages the potentially damaging input of fats, oils, and grease into the WWTP. In 2002, 68 businesses in the City of Morro Bay were subject to grease-trap requirements. This number has fluctuated over the years with approximately 44 to 55 businesses subject to the requirements in 2009. The MBCSD conducted spot checks at many of these establishments during the year; however, they did not find any concerns during these inspections.

2.2 WASTEWATER CHARACTERIZATION

Monthly wastewater characterizations documented a number of different aspects of the treatment plant's performance in 2009 (Table 2.2). Removal rates quantified the plant's ability to reduce major organic constituents within the wastestream. Effluent concentrations characterized the overall quality of effluent discharged through the ocean outfall, while mass emissions quantified the cumulative load of wastewater constituents introduced into the marine environment.

² City of Morro Bay Sewer System Management Plan, approved June, 2009. City of Morro Bay Public Services Department, Wastewater Collections Division

Table 2.2 Monthly Averages of Influent and Effluent Parameters

Month	Flow (MGD)	Suspended Solids				Biochemical Oxygen Demand			
		Influent (mg/L)	Effluent (mg/L)	Removal (percent)	Emission (kg/day)	Influent (mg/L)	Effluent (mg/L)	Removal (percent)	Emission (kg/day)
January	0.983	343	25	91.9	92	369	60	84.0	219
February	1.196	304	26	91.0	120	310	33	89.3	155
March	1.096	333	30	91.3	122	315	38	87.9	156
April	1.128	312	37	88.3	155	305	45	83.6	198
May	1.083	312	28	91.1	111	280	34	87.8	139
June	1.099	350	25	93.3	103	312	37	86.7	151
July	1.277	337	22	92.2	105	315	38	87.1	184
August	1.150	374	27	92.9	116	356	42	88.2	173
September	1.012	334	18	94.8	67	344	26	92.3	102
October	1.011	274	19	93.1	70	222	30	86.2	114
November	1.008	372	23	93.7	87	311	30	88.8	115
December	1.073	293	23	93.5	95	295	41	86.1	144
Average	1.092	328	25	92.3	103	311	38	87.4	154
Monthly Limitation	≤2.36¹		≤70	≥75.0	≤546		≤120	≥30.0	≤936
Annual Total (MT)					38				56
Nominal Annual (MT/year)					≤199				≤342

Table 2.2 (continued) Monthly Averages of Influent and Effluent Parameters

Month	pH		Turbidity (NTU)	Settleable Solids (ml/L)	Median ² Total Coliform (MPN/100ml)	Oil and Grease		
	Influent	Effluent				Influent (mg/L)	Effluent (mg/L)	Emission (kg/day)
January	7.8	7.5	29	<0.1 ³	<2	23	≈3.8 ⁴	18
February	7.8	7.5	29	<0.1	<2	160	≈3.4	16
March	7.8	7.5	31	<0.1	<2	140	7.4	26
April	7.9	7.5	37	<0.1	<2	100	5.3	24
May	7.8	7.5	32	<0.1	<2	57	≈4.6	19
June	7.9	7.5	31	<0.1	<2	80	6.8	27
July	7.9	7.7	31	<0.1	13	60	≈3.8	20
August	7.8	7.5	32	<0.1	4	140	≈4.0	19
September	7.7	7.5	25	<0.1	<2	100	≈4.0	16
October	7.7	7.4	26	<0.1	<2	140	≈4.4	19
November	7.8	7.5	25	<0.1	<2	75	≈3.2	12
December	7.9	7.5	25	<0.1	<2	65	≈4.5	20
Average	7.8	7.5	29	<0.1	<2	93	≈4.5	20
Monthly Limitation		6-9	≤75	≤1.0	≤23		≤25.0	≤195

¹ Peak Seasonal Dry-Weather Flow (PSDWF)

² Computed from samples collected in the 30 days prior to the last day of the month (MBCSD 1997a)

³ The “less-than” symbol (<) indicates that the substance was not detected at a concentration above the method detection limit (MDL), which is listed after the “<” symbol.

⁴ Monthly medians are reported because O&G concentrations in most effluent samples were below the 5-mg/L practical quantification limit (PQL), as shown by the light-gray shading in Figure 2.9c on Page 2-24. COP compliance determination for multiple samples within a sampling period is based on the median value, rather than the average, when one or more concentrations are below minimum reporting level (ML) (SWRCB 2005). The “approximation” symbol (≈) indicates that the median concentration for the month was too low to be reliably quantified, namely, it was below the PQL or ML.

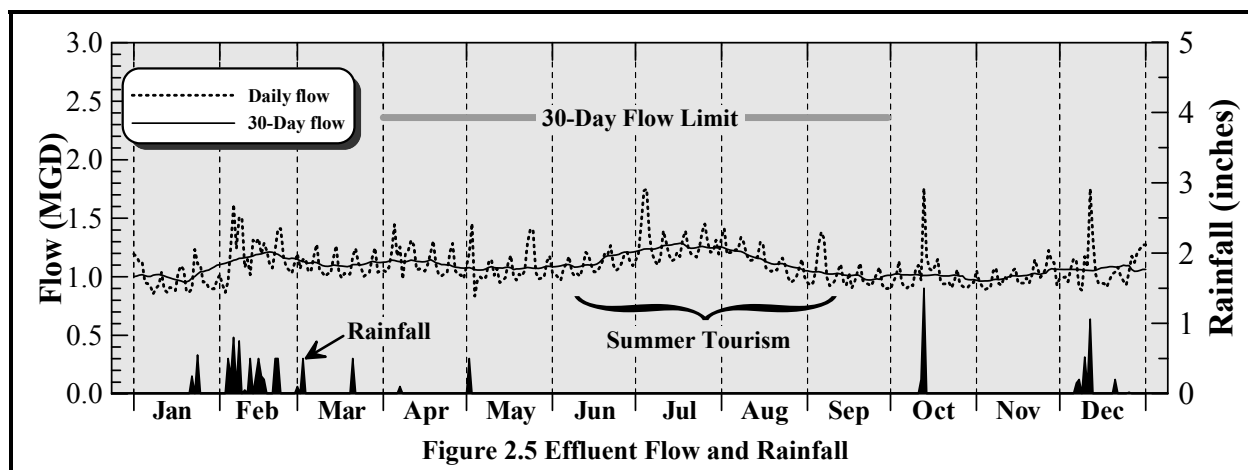
Treatment-plant personnel collected and analyzed samples throughout 2009; those samples were then used to compute the monthly averages of the principal influent and effluent characteristics listed in Table 2.2. WWTP personnel regularly determined the principal physicochemical properties of the effluent, including suspended solids, BOD, pH, total residual chlorine (TRC), turbidity, settleable solids, and total coliform bacteria. The frequency and the duration of individual samples varied among the parameters. For example, average reductions in suspended solids and BOD were determined from 24-hour composite samples of influent and effluent collected and analyzed at least weekly. Analyses for the concentration of most of the remaining constituents were conducted only on effluent samples. Discrete effluent grab samples were analyzed for pH, TRC, temperature, turbidity, and settleable solids on a daily basis. Effluent grab samples were also analyzed for total coliform five times per week, whereas O&G concentrations were determined weekly. Effluent ammonia was determined from monthly grab samples.

Detailed analyses of these measurements has repeatedly concluded that the plant consistently outperformed wastewater treatment expectations based on regulatory standards. Over the long plant history, there has never been an indication of deteriorating plant performance, and effluent quality has consistently exceeded expectations based on the original design criteria. Rare exceptions to standards or criteria have been direct results of brief, unavoidable mechanical failures of a treatment-system component or the external introduction of a contaminant within the influent stream. As a byproduct of a diligent preventative maintenance program, the plant operates at a high level of efficiency with little equipment down time. The primary challenge for plant personnel is to quickly respond to unanticipated failures in system components and to external events that impact the treatment process.

2.2.1 Flow Rate

Flow through the plant in 2009 was far less than the plant's design capacity and the limit in the NPDES discharge permit. The waste discharge requirements (RWQCB-USEPA 2009) state that the "*peak seasonal dry weather flow shall not exceed a monthly average of 2.36 MGD.*" Plant throughput never approached this flow limitation during 2009, not even during winter when the limitation does not apply (Table 2.2).

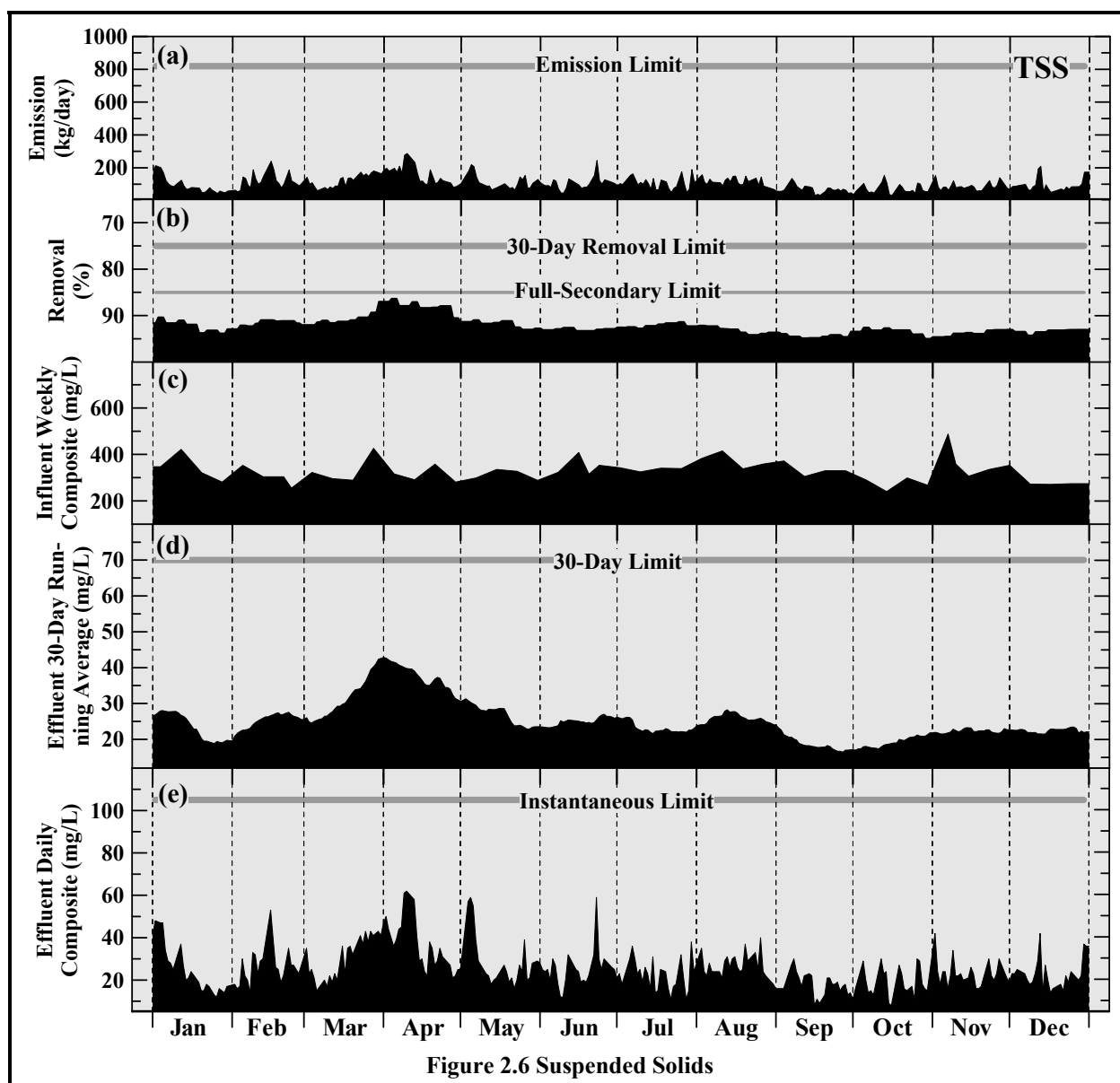
The highest average monthly flow (1.277 MGD) of 2009 occurred in July as a result of increased tourism during the summer months, particularly over the Independence Day holiday when both the third and fourth highest daily flows were recorded. The influence of summer tourism is also apparent as a slight, but distinct increase in the 30-day running average flow between mid-June and mid-August (solid line in Figure 2.5). However, at 1.29 MGD, the mid-July peak of this 30-day running average flow represented



only 54% of the monthly permit limit for peak dry-season flow, which is indicated by the thick shaded line that spans the ‘dry’ season (April through September) in Figure 2.5.

2.2.2 Suspended Solids, Turbidity, and Settleable Solids

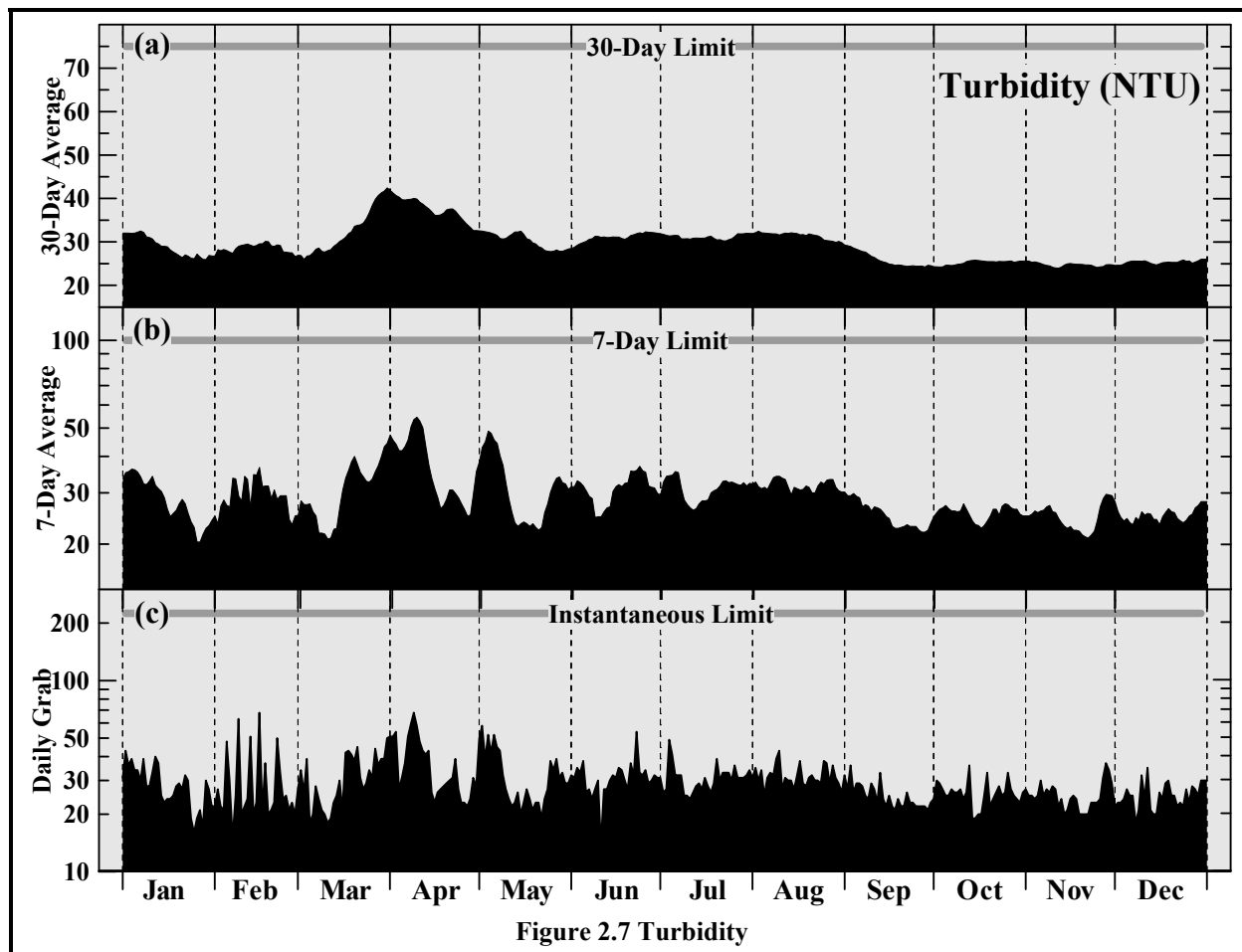
Suspended solids, turbidity, and settleable solids measure the particulate load within the wastewater stream. One of the primary functions of the treatment process is to remove organic particulates from the wastestream. The treatment plant’s removal of nearly all (92%) of solids from influent (Figure 2.6; Table 2.2 on Page 2-18) indicates an exceptionally high overall performance during 2009. As such, the plant’s solids removal rate far exceeded the minimum required by the NPDES permit, which specifies removal of only 75% of the suspended solids on a monthly basis. In fact, during every month in 2009, the plant’s removal rate far exceeded the rate (85%) established for full secondary treatment.



All of the TSS data collected in 2009 demonstrate that the treatment plant's routine performance levels exceed secondary treatment standards. The low average TSS concentration (25 mg/L) within the effluent discharged in 2009 measured just over one-third of the monthly permit limit of 70 mg/L, and was a direct consequence of the plant's high solids removal rate. Benchmark monthly TSS concentrations during eleven months of the year were also at or below the 30-mg/L maximum concentration required to meet full-secondary standards even though the average influent TSS concentration was 328 mg/L.

Regardless of the high influent solids load, the effluent TSS concentrations were so low in 2009 that the permit-required removal rate did not even apply. Regulators recognize that high removal rates are unnecessary when effluent already has low TSS concentrations. Consequently, the NPDES discharge permit imposes the 75% monthly removal rate only when effluent TSS concentrations exceed 60 mg/L (RWQCB-USEPA 2009, SWRCB 2005). Monthly effluent concentrations at the WWTP remained at or below 37 mg/L throughout 2009 and the treatment process exceeded expectations by removing an additional 17% of the influent TSS above the 75% removal rate.

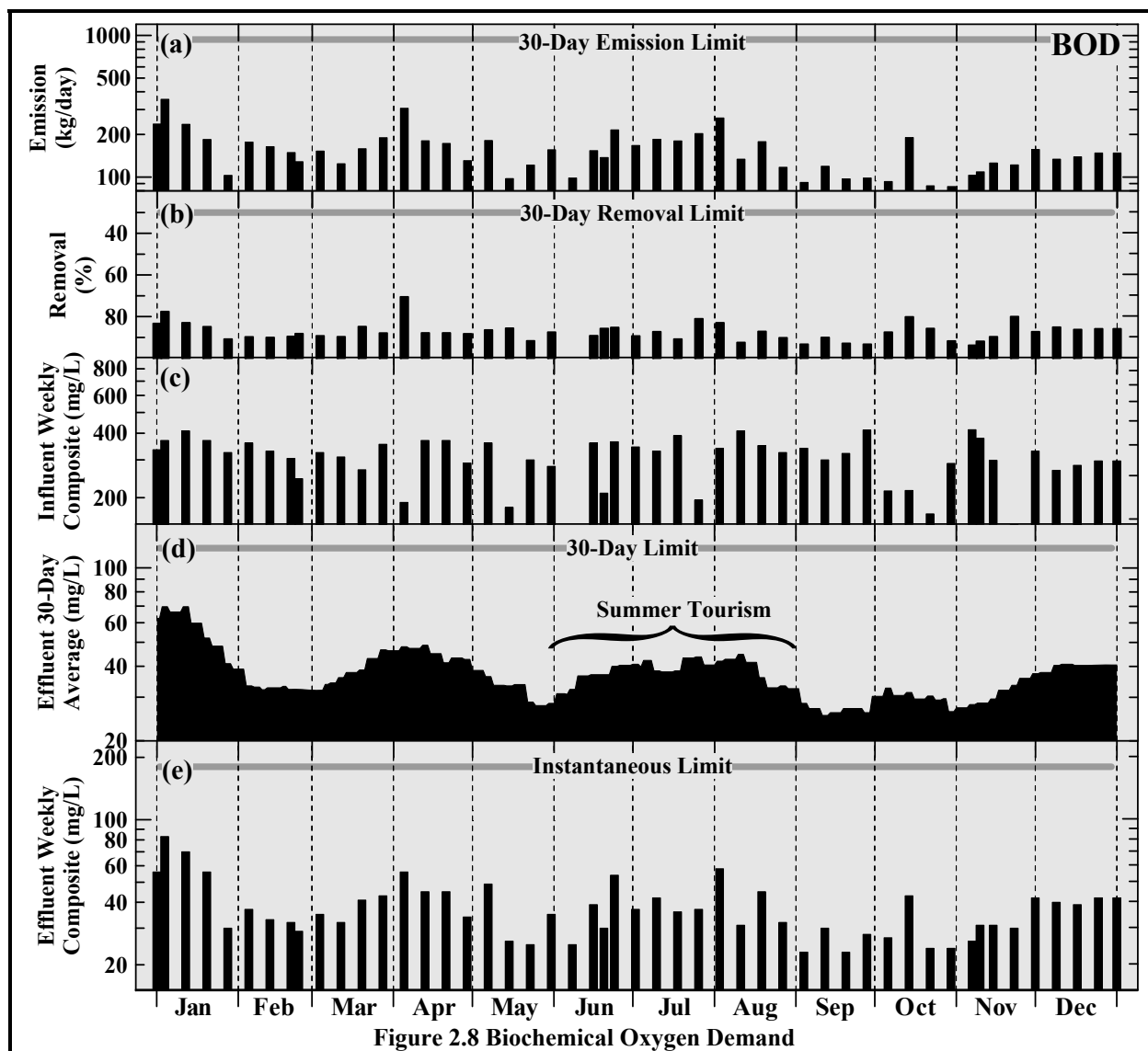
The diffuse particulate cloud in the photograph of the diffuser in Figure 2.2 on Page 2-4 reflects the light sediment loads in discharged wastewater and its low turbidity (Figure 2.7). Over the entire year, the WWTP discharged approximately 38 metric tons of suspended solids to the ocean. This mass emission is only 19% of the projected 199 metric tons that would have been discharged if effluent reached the permitted TSS concentration of 70 mg/L and the nominal average dry-weather flow of 2.06 MGD.



The consistently low monthly averages for TSS, turbidity, and settleable solids demonstrate the overall effectiveness of the treatment plant's screening, grit removal, sedimentation, filtration, and clarifying processes (Table 2.2). None of the monthly averages even approached half of the permitted limits, and despite a low detection limit of 0.1 ml/L, not one of the 365 daily effluent samples contained a detectable amount of settleable solids.

2.2.3 Biochemical Oxygen Demand

BOD measures organic loading within the wastewater stream. Organic loading is indirectly determined from the amount of oxygen required for aerobic bacteria to decompose organic matter in a sample of wastewater. Organic material, which supports bacterial degradation and demands oxygen, can harm the environment if organic decomposition severely depleats DO within receiving waters. However, such occurrences are only of concern in semi-enclosed water bodies such as bays and estuaries. Their environments are vastly different from the highly oxygenated open-coastal marine environment of Estero



Bay, where the MBCSD discharge is located. Because of higher oxygen-replenishment capabilities, an evaluation by the National Academy of Sciences (1993) questioned the environmental benefits of imposing pure technology-based BOD limits on open-ocean dischargers, namely, requiring secondary treatment-treatment standards for BOD.

Nevertheless, during 2009, the treatment process reduced influent organics by more than 87%, as determined by the weekly composite samples analyzed for BOD (Figure 2.8; Table 2.2 on Page 2-18). Thus, the WWTP removed nearly three times as much organic material than required by the NPDES discharge permit, which is only a 30% reduction in BOD for primary treatment (USGPO 1997a). Not only was the annual average BOD removal far higher than the required minimum, monthly removal rates consistently exceeded the 85% removal rate requirement for full secondary treatment. January and April were the only months where average BOD removal fell below 85%, and during those months, the respective rates were only 1% and 1.4% lower than the secondary standard. Because of the high removal rates, the 56 MT of oxygen-demanding organic material discharged during 2009 was only one-sixth of the 342 MT allowed by the discharge permit.

Thus, the treatment plant routinely performed at secondary-treatment levels with respect to its removal of oxygen-demanding organics from the wastestream. Throughout 2009, the treatment process also maintained monthly effluent BOD concentrations at or below 60 mg/L. BOD concentrations in the effluent never exceeded, or even approached, the 30-day limit of 120 mg/L (Figure 2.8d), much less the permitted instantaneous maximum of 180 mg/L (Figure 2.8e). As with TSS removal, regulators recognize that high BOD removal rates are not necessary when effluent has a low BOD concentration. Consequently, the NPDES discharge permit imposes the 30% minimum monthly removal rate only when effluent BOD levels exceed 60 mg/L. Nonetheless, although the plant was not subject to the 30% removal requirement during 2009, it consistently achieved far higher rates of BOD removal.

2.2.4 Oil and Grease

During 2009, the treatment process reduced average O&G concentrations within the influent stream by a factor of over twenty (Table 2.2). As a result, individual weekly effluent O&G concentrations remained low, not exceeding 10 mg/L (Figure 2.9c) at any time during the year. Therefore, all of the measurements were well below the instantaneous limit of 75 mg/L, and the associated emissions were only a fraction of the permitted maximum emission of 585 kg/day.

At the beginning of 2009, MBCSD personnel proactively initiated a source identification and evaluation program for O&G in response to some slightly elevated O&G concentrations observed at the end of 2008 (MRS 2009a). As part of this effort, O&G samples were evaluated for their polar and non-polar hydrocarbon compositions (Table 2.3). Hydrocarbon composition can help indicate whether the source of an O&G sample is industrial in nature, and therefore represents a new or potentially hazardous discharge for the treatment process. For example, polar hydrocarbons are associated with animal and vegetable-based O&G, such as that used in restaurant cooking, while non-polar hydrocarbons are usually associated with more industrial sources, specifically fuels and motor oils. None of the four samples exhibited an

Table 2.3 Influent O&G Compounds

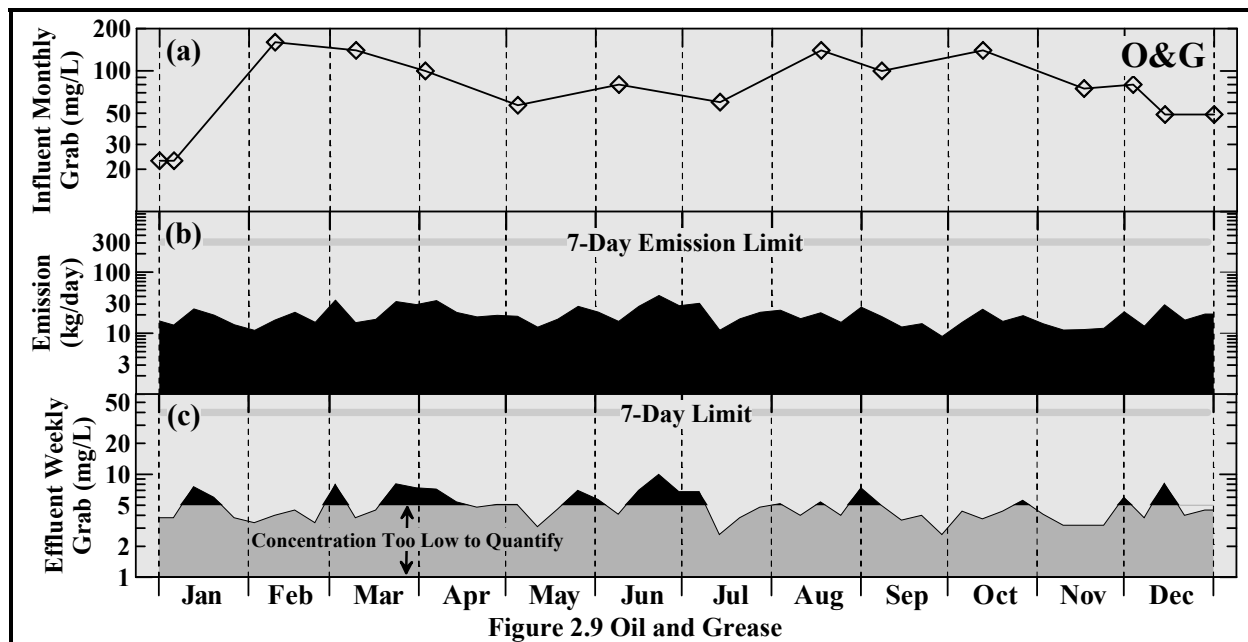
Date ¹	Concentration (mg/L)			Polar Fraction
	Polar ²	TPH ³	Total	
3/10/2009	125.0	15.0	140.0	89%
4/3/2009	92.6	7.4	100.0	93%
5/5/2009	53.8	≈3.2 ⁴	57.0	94%
6/9/2009	73.0	7.0	80.0	91%
Average	86.1	8.2	94.3	91%

¹ Sample Collection Date

² Animal- and Vegetable-based O&G

³ Total Petroleum (Non-Polar) Hydrocarbons

⁴ The “approximation” symbol (≈) indicates an estimated concentration too low to be reliably quantified because it was below the 5 mg/L PQL.

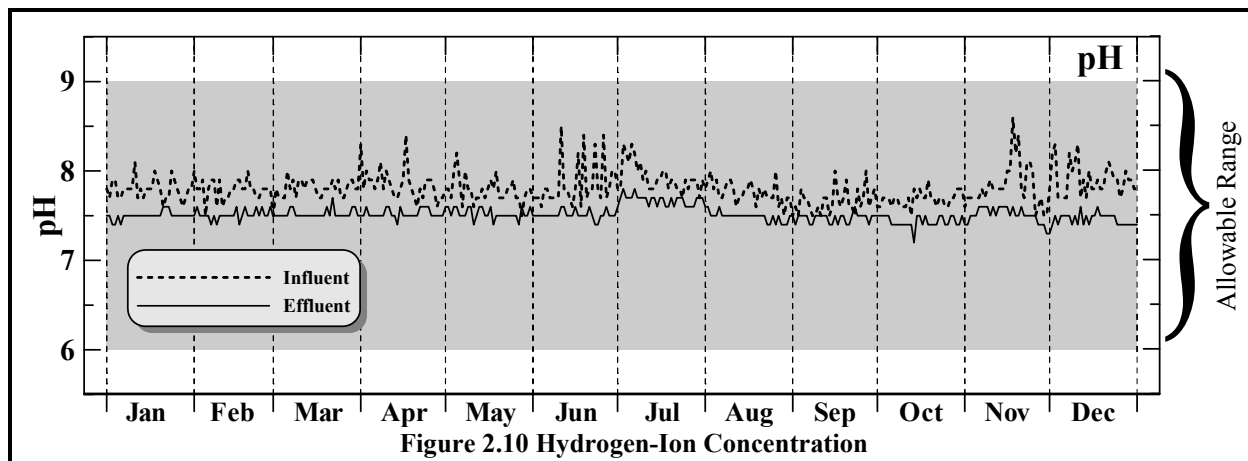


elevated O&G concentration, and they were all comprised primarily (91%) of polar hydrocarbons. Given the tourism-based economy and substantial number of restaurants within the service area, polar hydrocarbons are expected to comprise the majority of O&G in the MBCSD influent.

2.2.5 pH

The MBCSD discharge permit requires that the hydrogen-ion concentration (pH) of the effluent remain within 6 to 9 at all times. Section 301(h) of the Clean Water Act allows an NPDES discharge permit to be issued that exceeds these pH limitations. However, because the plant's partial secondary treatment can routinely treat wastewater to comply with the pH standards for full secondary treatment, the MBCSD discharge permit does not allow this exception. Moreover, the general absence of heavy industrial input into the collection system creates an influent stream with a nominal pH that would meet the discharge requirement even without secondary treatment.

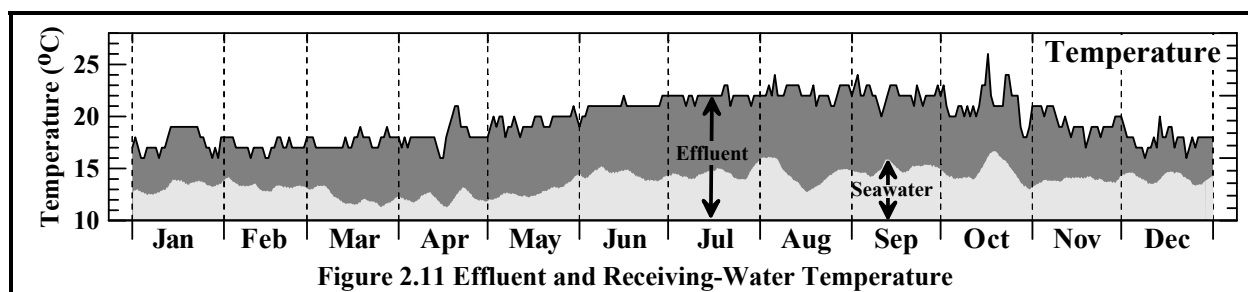
Because influent pH (dashed line in Figure 2.10) remained within the discharge limits (shaded area), effluent pH measurements also remained within the allowable range by default (solid line). Comparison



of the two time histories demonstrates that the treatment process significantly moderated short-term pH fluctuations within the influent.

2.2.6 Temperature

Although the NPDES permit does not limit effluent temperature, it is an important physical property to document because the difference between effluent and receiving-water temperature dictates the amount of mixing that occurs shortly after the wastewater is discharged into the ocean. The warmer the effluent compared to seawater, the greater the buoyancy of the plume and the more turbulence generated by its rise within the water column. Effluent temperature, shown by the dark shading in Figure 2.11, exhibits a distinct semi-annual cycle that tracks seasonal insolation, as does air temperature. Effluent temperatures generally begin increasing in spring (mid-May), peak in mid-to-late summer (July through September), and then decline during the fall (October through December).

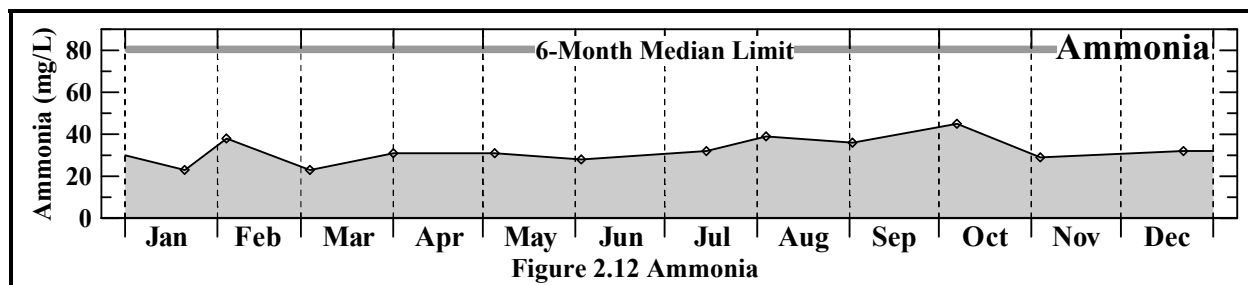


Because of the influence of upwelling in 2009, seawater temperatures, shown by the light shading, did not track trends in effluent that were due to seasonal insolation. In response to intense southeastward winds, a sharp drop in seawater temperature occurred in mid-March and extended into May, (see Chapter 3). The resulting low seawater temperatures in March and April provided a greater thermal contrast with effluent than occurred in late fall and winter. Upwelling winds continued well into summer of 2009, and depressed seawater temperatures relative to the steadily increasing effluent temperatures. As a result, a large thermal contrast between seawater and effluent persisted throughout the period between March and October. Although this large thermal contrast would normally enhance buoyancy-induced dispersion of the effluent plume, the stratification of the water-column caused by upwelling limits vertical motion, largely offsetting the dispersion benefits of the thermal contrast during upwelling season.

Of particular note during 2009, was a late season heat wave that resulted in the highest effluent temperature (26°C on October 17th) recorded at the WWTP in the more than 16 years of monitoring. Immediately following a two-day storm on 13 and 14 October 2009 that brought warm subtropical moisture into the region, Morro Bay experienced a prolonged heat wave. Daytime temperatures over 90 degrees occurred on successive days during the following week, resulting in marked increases in both effluent and seawater temperature (Figure 2.11).

2.2.7 Ammonia

The concentration of ammonia as nitrogen ($\text{NH}_3\text{-N}$) was uniformly low throughout 2009. Grab samples analyzed for ammonia on a monthly basis had concentrations at or below 45 mg/L, which is only slightly more than half of the 6-month median limit of 80.4 mg/L (Figure 2.12). This peak concentration was also approximately 18 times lower than the permitted instantaneous limit of 804 mg/L, which is imposed to protect marine aquatic life.

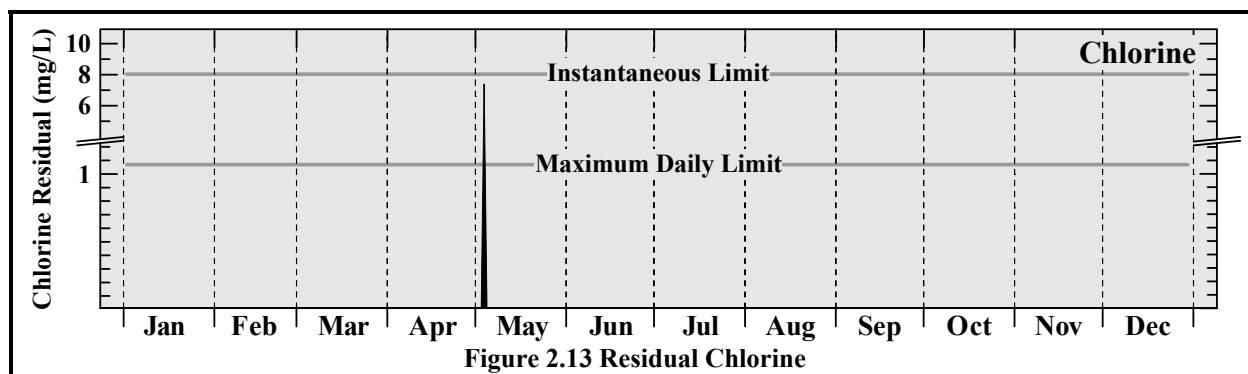


2.2.8 Residual Chlorine

Total residual chlorine (TRC) measures chlorine remaining in the effluent after disinfection with sodium hypochlorite and subsequent dechlorination or buffering with sodium bisulfite. Daily grab samples for residual chlorine were collected when concentrations of effluent constituents are expected to be at their highest levels, during peak flow periods. Balancing chlorination and dechlorination to obtain adequate disinfection (coliform reduction) without dosing the marine environment with high levels of chlorine can be challenging, because the chlorine demand is constantly changing due to continuous variations in flow and organic loading within the wastestream. Consequently, the disinfection process occasionally requires direct operator intervention. If sodium hypochlorite beyond what is needed to meet the coliform demand is added, then dechlorination may be complicated and TRC levels in the effluent may increase.

Throughout 2009, treatment plant personnel maintained careful control over the disinfection and dechlorination processes. Only 1 of the 365 grab samples had detectable concentrations of TRC (Figure 2.13). TRC in the remaining samples never exceeded the 0.05-mg/L detection limit, which is five-times lower than the 6-month median limit of 0.27 mg/L specified in the discharge permit.

The only noteworthy TRC measurement during 2009 occurred on 4 May 2009. On April 30th, MBCSD staff discovered that one of the drive chains for the collector flights in the north chlorine contact chamber was broken, and that the drive unit was inoperable. After notifying RWQCB and the Department of Health Services of the situation, staff drained the chlorine contact chamber and commenced emergency



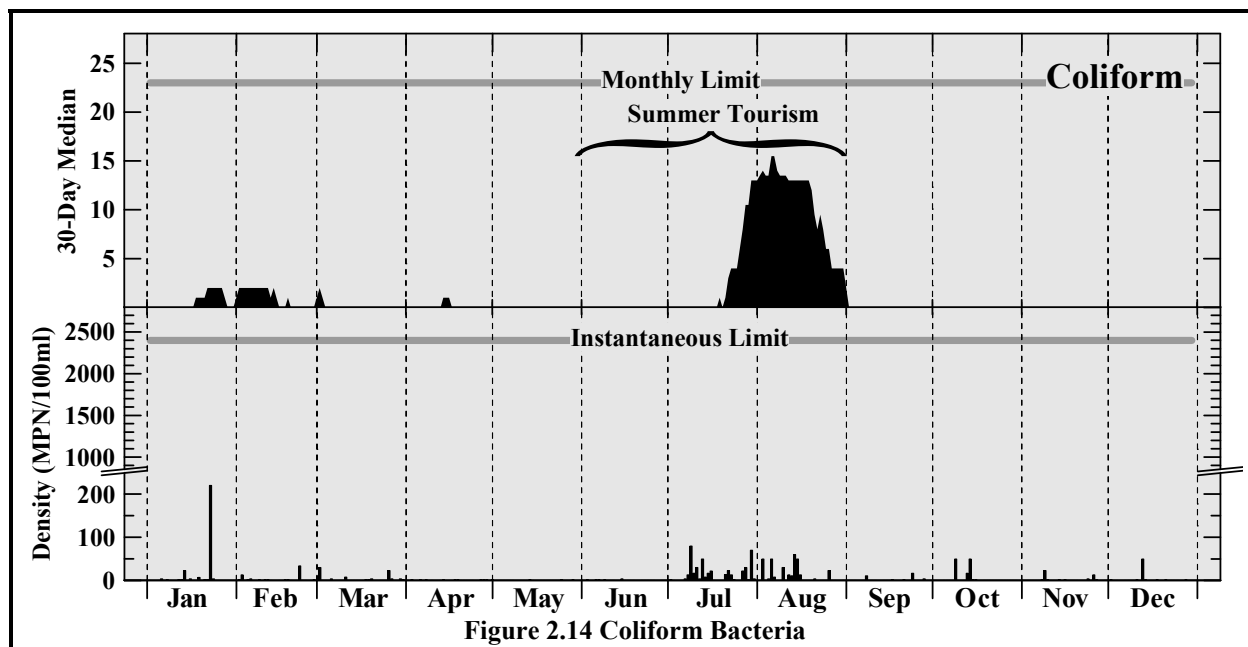
repairs. The chamber was bypassed from 0300 until 1330 hours on May 4 2009 while links were removed from the drive train to allow the flights to contact the support rail as designed.

Unfortunately, without the use of the chlorine contact chamber, full disinfection and dechlorination cannot be conducted. While the chamber was being bypassed, effluent disinfection was accomplished by chlorinating at normal dosing rates, while the detention (travel) time in the outfall provided the necessary contact time to guarantee ample disinfection. Disinfection was verified by analysis of a grab sample for bacteriological populations collected at the air relief structure following chlorination. Therefore, the grab sample used to report the TRC on May 4th reflected an elevated dose of chlorine that exceeded the permit's maximum daily limit of 1.07 mg/L. Nevertheless, this lone measurable concentration remained below the permitted instantaneous limit (8.04 mg/L), and the plant did not exceed the 6-month median specified in the permit.

The chamber repairs and bypass also artificially impacted the recorded flow rates on both 3 and 4 May 2009 resulting in one of the highest flow rates of the year followed by the lowest (Figure 2.5). Because the daily flow rate is normally read in the morning, the final daily flow rate reading on the morning of 4 May was delayed for several hours while the repairs to the contact chamber were completed. Consequently, the daily flow calculations for 3 May essentially included a portion of the flow generated on 4 May, resulting in a very high reported flow rate on 3 May, and an artificially depressed flow rate the next day.

2.2.9 Coliform Bacteria

Effluent samples collected on five consecutive days each week were analyzed for the most probable number of total coliform organisms per 100 ml (MPN/100ml). The highest monthly median coliform density (Table 2.2) was approximately half of the 30-day median limit of 23 MPN/100ml specified in the NPDES permit. Figure 2.14 shows that measured daily coliform densities were also all far less than the permitted instantaneous maximum of 2400 MPN/100ml. In fact, more than half of the 286 effluent samples analyzed in 2009 had no measurable coliform density. Nevertheless, the influence of the summer population increase is apparent in the 30-day running mean shown in the top frame of Figure 2.14. However, for the most part, increased coliform densities were randomly scattered throughout the year.



2.2.10 Toxicity

In 2009, effluent samples were tested semiannually, in January and July (Table 2.4), for toxicity using chronic bioassays of composite effluent samples. The chronic bioassays found consistently low effluent toxicity, with levels much less than the discharge permit limits. Because the current permit did not go into effect until March 2009, the results of final acute toxicity bioassay conducted on effluent grab samples collected in January 2009 under the previous NPDES permit are also reported here (Table 2.4). Acute bioassay testing requirements were eliminated in the current MBCSD discharge permit, in accordance with previous updates to the California Ocean Plan. Nevertheless, the reported TUC of 1.41 for January 2009 was well below the permitted limit of 4.3.

Table 2.4 Comparison of Measured Toxicity Levels with Permit Limitations

Sample Date	Bioassay Test	End Point (%)	Concentration (TU)	Limit (TU)
19 – 22 January	Acute: Fathead Minnow (<i>Pimephales promelas</i>)	70.7	1.41 ¹	4.3
5 January	Chronic: Giant Kelp (<i>Macrocystis pyrifera</i>)			
	Germination	10.0	10.0	134
	Growth	10.0	10.0	134
15 July	Chronic: Giant Kelp (<i>Macrocystis pyrifera</i>)			
	Germination	10.0	10.0	134
	Growth	5.6	17.9	134
15 July	Chronic: Red Abalone (<i>Haliotis rufescens</i>)	3.2	31.2	134

¹ Acute toxicity levels were artificially elevated due to ammonia interference.

The chronic toxicity tests in January and July measured spore germination and growth response in giant kelp (*Macrocystis pyrifera*) after exposure to a range of effluent dilutions.³ The results of the 2009 kelp bioassays confirm the effluent's continued low chronic toxicity. All chronic-toxicity endpoints were more than seven-times lower than the applicable permit limitation of 134 chronic toxic units (TUC) for the daily maximum toxicity. The reported TUC were based on a "No Observable Effects Concentration" (NOEC), which is the highest effluent concentration that does not cause an adverse effect statistically different from a control sample. They indicate that the chronic bioassays did not find adverse effects when kelp was exposed to effluent concentrations as high as 5.6%, whereas the permit allows adverse effects in concentrations as low as 0.75%.

Toxic screening studies conducted in 1993 indicated that giant kelp (*M. pyrifera*) was more sensitive to MBCSD effluent than other species typically used in bioassays at that time, such as the larvae of the inland silverside (*Menidia beryllina*) and the bay mussel (*Mytilus edulis*) (MRS 1994). Chronic bioassays conducted on kelp since that time repeatedly demonstrated that giant kelp was only minimally affected by exposure to treatment plant effluent. As required by current discharge permit, a new screening study was conducted on the July 2009 effluent sample, and included an assessment of the effluent's effect on the development of larval red abalone (*Haliotis rufescens*). Although additional screening bioassays will be conducted in January 2010, the July 2009 bioassay indicated larval abalone were somewhat more sensitive than kelp zoospores to that particular set of effluent samples. Nevertheless, adverse effects in larval abalone were not observed after exposure to effluent that was four times more concentrated than allowed by the discharge permit.

³ The semiannual effluent reports contain raw test data, pertinent quality assurance/quality control (QA/QC) data, and chains of custody for the chronic bioassays (MRS 2009gh).

2.2.11 Nutrients

The current discharge permit's receiving-water limitations on chemical constituents state that *"Wastewater constituents within the discharge shall not cause objectionable aquatic growths or degradation of indigenous biota resulting from the discharge of nutrients."* Measurements collected in 2009 demonstrate that nutrient concentrations within the MBCSD effluent, and mass loading to the marine environment from its discharge, are small compared to other central-coast dischargers, and compared to the contribution from regional streams and rivers. There is no evidence that these other much-larger nutrient sources materially contribute to the harmful or objectionable growth of marine algae along the central coast, so it is highly unlikely that the MBCSD nutrient discharge is of environmental concern.

Nevertheless, this concern was raised during the review process for the current MBCSD discharge permit (USEPA 2007) because the relative contribution of nutrients discharged to the ocean by coastal treatment plants, such as the MBCSD WWTP, was largely unknown, as was their potential role in promoting harmful algal blooms. Therefore, the USEPA proposed a conservation measure for *"Regular monitoring of nutrient loading from the [MBCSD] facility's ocean outfall"* in their biological evaluation and request for concurrence with their finding of *"no likely adverse effects"* from the USFWS.

In response, MRS (2008) designed a nutrient-monitoring requirement for the MBCSD effluent monitoring program that included semiannual analysis of nitrate, urea, ortho-phosphate, and dissolved silica concentrations. Open-ocean dischargers, such as the MBCSD treatment plant, are not normally required to monitor for these bio-stimulatory nutrients because energetic, well-flushed marine environments rapidly dilute and disperse discharged nutrients, preventing their accumulation to deleterious levels. For this reason, there are no numerical objectives for nutrient compounds (except ammonia) within receiving waters that are promulgated in the COP.

Nevertheless, to estimate relative nutrient contribution from the MBCSD WWTP, analyses of these four compounds were added to the monitoring program. These particular compounds were selected because they represent limiting macronutrients for phytoplankton growth within the euphotic zone of the ocean. The ocean bio-stimulatory nutrients, in order of decreasing importance, are nitrogen, phosphorus, and silica. Ammonia [NH_3], nitrate [NO_3^-], and urea [$\text{CO}(\text{NH}_2)_2$] are nitrogen compounds found in measurable concentrations within wastewater, and have been associated with the stimulation of phytoplankton growth (Kudela and Cochlan 2000). Ammonia concentrations have always been regularly measured as part of the compliance evaluation within the MBCSD discharge permit's waste discharge requirements, so the other two nitrogen forms were added to the new monitoring requirement. Similarly, dissolved phosphorus [ortho-phosphate, $(\text{PO}_4)^{3-}$] and dissolved silica [SiO_2] are the principal bioavailable forms of these two nutrients in seawater, and measurement of the concentrations of these analytes within effluent were also included as part of the nutrient-monitoring component.

The first nutrient assay of MBCSD effluent was conducted on a grab sample collected in July 2009 as part of the new annual monitoring requirement. It demonstrates that the contribution of nutrients from the MBCSD WWTP is insignificant compared to that of other central-coast WWTPs, and its loading to the marine environment is miniscule compared to nutrient mass contained within streams and rivers in the region (Table 2.5). Concentrations of all four nutrients with MBCSD effluent were uniformly lower than those of the three large central-coast WWTPs to the north. With a 0.1-mg/L concentration at the detection limit, the MBCSD nitrate levels, in particular, were an order of magnitude lower than those of the other WWTPs within the central-coast region. Although nitrate and silica concentrations within MBCSD effluent were also less than average concentrations with central-coast rivers and streams, urea and phosphate concentrations were higher, as was the case for the other central-coast WWTPs.

Table 2.5 Nutrient Concentrations and Loading from Central-Coast Ocean Discharges

Source	Concentration (mg/L)				Mass Emission (kg)			
	Nitrate	Urea	Phosphate	Silica	Nitrate	Urea	Phosphate	Silica
MBCSD	0.10	0.082	2.3	12.5	151.	124.	3,500.	18,900.
Santa Cruz	9.52	0.087	7.7	30.2	139,000.	1,360.	117,000.	489,000.
Watsonville	10.52	0.110	13.6	35.6	105,000.	1,250.	154,000.	364,000.
Monterey	4.82	0.084	3.4	41.0	85,600.	1,100.	30,300.	488,000.
Stream and River ¹	3.58	0.021	0.14	25.6	1,660,000.	33,500.	340,000.	25,200,000.

¹ Average concentrations and total emissions from fourteen streams and rivers discharging to the northern central coast from July 2005 and June 2006 (CClean 2007)

Notwithstanding the slightly higher urea and phosphate concentrations within effluent, potential environmental effects from nutrient discharge are dictated by the total mass contributed by the various sources (Table 2.5). When the relatively small volume of the MBCSD is considered, its total nutrient loading to the marine environment is one- to three- orders-of-magnitude less than the individual large WWTPs to the north, and up to four-orders-of-magnitude (10,000-times) less than the contribution from runoff from the central-coast region.

While it is unlikely that any of the central-coast WWTPs materially contribute to nutrient levels within the marine environment along the central coast, the occurrence of harmful algal blooms (HABs) within coastal waters throughout the world has become a growing concern. HABs occur when periodic explosions of growth in the naturally occurring algae, which normally form the base of the marine food web, result in extensive monocultures, or blooms, of particular species that are harmful to humans or other life. HABs can cause harm through the production of toxins, or simply by their accumulated biomass. Both types of impacts affect co-occurring marine organisms and can dramatically alter food-web dynamics. Documented impacts from HABs include the devastation of coastal habitats, loss of economically and culturally vital shellfish resources, illness and death in populations of protected marine species, and serious threats to human health posed by exposure or ingestion of algal toxins.

Offshore central California, impacts from HABs are mainly caused by recurring blooms of two genera of algae (*Alexandrium* and *Pseudo-nitzschia*). Both *Alexandrium* and *Pseudo-nitzschia* algae produce potent neurotoxins that accumulate in fish and shellfish, and can cause paralytic shellfish poisoning (PSP) and amnesic shellfish poisoning (ASP), respectively. ASP is also commonly known as domoic acid poisoning. The exceptionally high potency of the saxotoxin produced by *Alexandrium* species means that even low density populations can cause severe problems; thus, these blooms generally do not discolor the water and may not be visible on the water surface.

Pseudo-nitzschia is a genera of naturally occurring diatoms common along the west coast of the United States. *Pseudo-nitzschia* species produce domoic acid, which, when ingested, can cause neurological damage, including dizziness, headache, seizures, disorientation, difficulty breathing, and coma. Domoic acid poisoning has been documented in a wide variety of marine mammals and seabirds.

Considerable research has been conducted in an effort to understand the environmental factors that promote HABs. Through these studies, processes such as coastal upwelling and river runoff have been implicated as factors that may create physical and chemical conditions (e.g., high nutrient concentrations) conducive to the development of phytoplankton blooms (Trainer et al. 2002, Kudela et al. 2004). Upwelling conditions along the central California coastline, which are discussed in Chapter 3 of this report, have been particularly implicated in the generation of HABs within the region that includes the MBCSD discharge (Trainer et al. 2000, Kudela et al. 2005). In addition to these natural processes, increased human activity and pollution are also thought to be contributing factors to the recent observed higher frequency and intensity of HABs.

2.2.12 Chemical Compounds

In addition to the effluent properties and bioassay results described above, there are 79 chemical properties that are regulated by the COP, and whose effluent concentrations are limited in the discharge permit. Effluent composite samples were analyzed in January and July 2009 for the presence of these chemical compounds, which include trace metals, chlorinated and nonchlorinated phenolic compounds, volatile organic compounds, organochlorine pesticides, PCBs, cyanide, base-neutral compounds, and radionuclides. The COP regulates the discharge of these compounds for the protection of marine life and the protection of human health from exposure to both carcinogenic and non-carcinogenic substances.

As has been the case in the historical record of 2,882 chemical assays spanning seventeen years of MBCSD effluent monitoring, the 2009 analyses detected concentrations of only a few ubiquitous compounds at levels well below the regulatory limits (Table 2.6). Those detected compounds are discussed below, while detailed discussion of effluent chemistry, along with the corresponding concentration limits, minimum reporting levels, laboratory data sheets, pertinent QA/QC data, and chains of custody for all the chemical constituents was provided in semiannual self-monitoring reports (MRS 2009gh).

Table 2.6 Chemical Compounds Detected within Effluent Samples

Compound	Concentration (µg/L)			Mass Emission (kg/vr)	
	Limit	January	July	Goal	Measured
Protection of Marine Aquatic Life					
Chromium VI	270.	<2.3 ¹	≈1.1 ²	93.	<2.56
Copper	140.	13.	11.	690.	18.1
Lead	270.	≈0.99	1.1	465.	≈1.58
Nickel	670.	≈3.4	≈5.2	142.	≈6.50
Selenium	2,010.	≈1.4	≈1.5	65.	≈2.19
Zinc	1,620.	53.	52.	244.	79.3
Cyanide	130.	<3.2	≈4.8	71.	<6.05
Phenolics (Non-Cl ₂)	4,020.	≈11.	<0.059	— ³	<8.30
Radionuclides (pCi/L)	α 15.	—	≈0.201	—	—
	β 50.	—	3.1	—	—
Protection of Human Health (Non-Carcinogens)					
Chromium III	25,500,000.	<2.3	≈1.1	—	<2.56
Ethylbenzene	549,000.	<0.063	≈0.09	3.	<0.116
Toluene	11,400,000.	≈0.26	≈0.5	4.	≈0.575
Protection of Human Health (Carcinogens)					
Bis(2-ethylhexyl)phthalate	469.	≈21.	9.2	320.	≈22.7
Dibromochloromethane	1,152.	≈0.16	<0.067	25.	<0.171
Chloroform	17,400.	≈1.1	≈0.81	5.	≈1.44
1,4-Dichlorobenzene	2,410.	≈0.1	<0.058	57.	<0.119
Dichloromethane	60,300.	≈0.35	<0.28	—	<0.475
Halomethanes	17,400.	≈0.16	<0.085	25.	<0.185
Dioxin (pg/L)	0.52	—	0.11	1.48 mg	0.17 mg

¹ The “less-than” symbol (<) indicates that the compound was not detected at a concentration above the method detection limit (MDL), which is listed after the “<” symbol.

² The “approximation” symbol (≈) indicates that the median concentration for the month was too low to be reliably quantified, namely, it was below the PQL or Minimum Reporting Level. Consequently, the number listed after the symbol represents an estimated concentration. Accurately quantifiable concentrations are indicated by bold typeface.

³ The “dash” symbol (—) indicates that analysis of the compound was not required as part of the monitoring program, or a mass-emission goal was not specified in the discharge permit.

The chemical assays found only six of the 79 chemical compounds present in quantifiable amounts within the 2009 effluent samples.⁴ The measured concentrations for all six compounds were well less than the permitted limits. Annual mass emissions of these compounds also met the goals in the discharge permit reporting provisions. The compounds with quantifiable concentrations included three trace metals (copper, lead, and zinc), a radionuclide, a common phthalate compound (bis 2-ethylhexyl phthalate), and low-level congeners of dioxin.

The analyses also detected twelve additional compounds in the semiannual effluent samples, but at concentrations that were too low for reliable quantification. Specifically, the concentrations of these compounds were more than the method detection limit (MDL)⁵ but less than the practical quantification limit (PQL)⁶ or minimum reporting level (ML). Reporting of these detected-but-not-quantified concentrations began in July 2005; analysis of prior samples only reported quantifiable concentrations above the PQL. The current NPDES discharge permit issued to the MBCSD requires reporting of these detected-but-not-quantified concentrations, although they are not compared to effluent limitations for compliance assessments.

Trace Metals

Three of the quantifiable concentrations were associated with commonly occurring metals: copper, lead, and zinc. Unlike synthetic organic compounds, trace metals occur naturally within the mineralogy of sediments along the central California coast and are ubiquitous in the local sedimentary environment. All three of the metals were detected in quantifiable amounts within seafloor sediment samples collected during the benthic survey (see Chapter 4). These metals enter the wastewater collection system through erosion of natural mineral deposits along the central California coast, and through corrosion of household plumbing systems. Regardless of their source, the concentrations of all three metals were more than an order of magnitude below levels deemed deleterious to marine organisms. When combined with volume of effluent discharged in 2009, the metal mass emission was less than one-third of the emission goal recommended in the discharge permit based on historical concentrations and maximum allowed flow rates.

These three metals have been detected at quantifiable levels in over half of the effluent samples collected during the last seventeen years, and therefore, do not represent a new or increased source of contaminants entering the collection system. Moreover, the long monitoring history unequivocally demonstrates that there is no reasonable potential for these metal concentrations to exceed the discharge permit limits in the future (Refer to the recommendation concerning reductions in monitoring frequency in Chapter 5).

Bis(2-ethylhexyl) phthalate (DEHP)

Bis(2-ethylhexyl) phthalate (DEHP) is pervasive in the environment due to the massive scale on which it is produced, its mobility, and high vapor pressure. Consequently, detection of quantifiable concentrations of this organic compound with effluent is not surprising and is not indicative of a new contaminant source within the collection system. It has been routinely detected in over half of the MBCSD effluent samples collected during the last seventeen years. However, all detects have been at concentrations well below the

⁴ Quantifiable concentrations of the six compounds are listed in bold typeface in Table 2.6.

⁵ The method detection limit is the lowest concentration that can be reported under ideal conditions, when the sample contains only the compound of interest in a concentration within an optimal calibration range and within a medium that does not interfere with the performance of the analytical instrument.

⁶ The practical quantification limit is the lowest concentration that can be measured with statistical reliability given the sample size and analytical method.

permit limit established for the protection of human health. As with trace metals and other effluent constituents, the long history of measured DEHP concentrations demonstrates that there is no reasonable potential for continued discharge to exceed the DEHP permit limit. At 22.7 kg, its annual emission in 2009 was fourteen times smaller than the goal recommended in the discharge permit.

Radionuclides

As with the chemical compounds described above, the presence of measurable radioactivity within the 2009 effluent sample was not unusual. Radioactivity has always been measured within MBCSD effluent samples, largely because naturally occurring radioactive material (NORM) is present throughout the earth's crust, and because radioactive decay can be quantified at extraordinarily low levels. Consequently, the permit limits specified for radionuclides are not derived in the same manner as for other chemical constituents, which are based on potential impacts after discharge. Specifically, the maximum radioactivity limits in effluent do not account for 133-fold minimum dilution that occurs immediately after discharge, and instead, are the same as those established for drinking water pursuant to the California Code of Regulations, Title 22, §64441 and §64443. Nevertheless, the radionuclide activities measured within the July 2009 effluent sample were well below those drinking-water standards.

The very low alpha (α) and beta (β) decay levels measured within the July 2009 effluent samples were typical of most prior effluent samples, and of naturally occurring sediments of the region. Alpha particle activity arises from natural mineral deposits that enter the collection system through erosion. Beta particle activity arises from radioactive decay in both natural and man-made materials. Except for an erroneous measurement of a slightly elevated β radioactivity in January 1994, an RPA of radioactivity within effluent samples collected over the past decade and a half demonstrates that there is no potential for exceeding the drinking-water limits.

Dioxin

Dioxin was the only other chemical compound quantified in the 2009 effluent samples. The toxic-equivalent concentration of the combined concentrations of dioxin congeners was only one-fifth of the level considered a potential threat to human health. Similarly, the dioxin mass emission in 2009 was well below the goal identified in the discharge permit. Low concentrations of dioxin congeners have been detected in nearly all of the MBCSD effluent samples collected during the last decade, although the toxic-equivalent rarely approach the permitted limit. Dioxin is currently pervasive in the environment because it was introduced historically by incineration of municipal and chemical wastes, exhaust from automobiles using leaded gasoline, and improper disposal of chlorinated chemical wastes. Dioxins do not readily decompose and once introduced into the environment, they persist for long periods. Although relic dioxin introduced in the past accounts for much of the concentrations currently measured within the environment, extremely small concentrations of various dioxin congeners can also be formed during chlorination of municipal drinking water and wastewater effluent.

2.3 BIOSOLIDS

The monitoring and reporting requirements of the NPDES permit (RWQCB-USEPA 2009) stipulate characterization of biosolids in accordance with 40 CFR 503 (USGPO 1997b). To that end, this section describes the disposition of biosolids generated by the WWTP during 2009. Part of this discussion also addresses the major compounds within the sludge produced by the plant, because they determine the suitability of biosolids for future composting and land application. The complete biosolids report⁷ was submitted to USEPA, RWQCB, and San Luis County Environmental Health Services on February 16, 2010 and is incorporated herein by reference.

In 2009 the WWTP produced approximately 215.7 dry metric tons of biosolids. Approximately 95.8 dry metric tons, 44% of the 2009 production, was transported to McCarthy Family Farm's San Joaquin Composting facility on 9, 10, and 12 October 2009. The treatment plant composted 82.7 dry metric tons. The WWTP was storing 37.2 metric tons of biosolids at the time of this report.

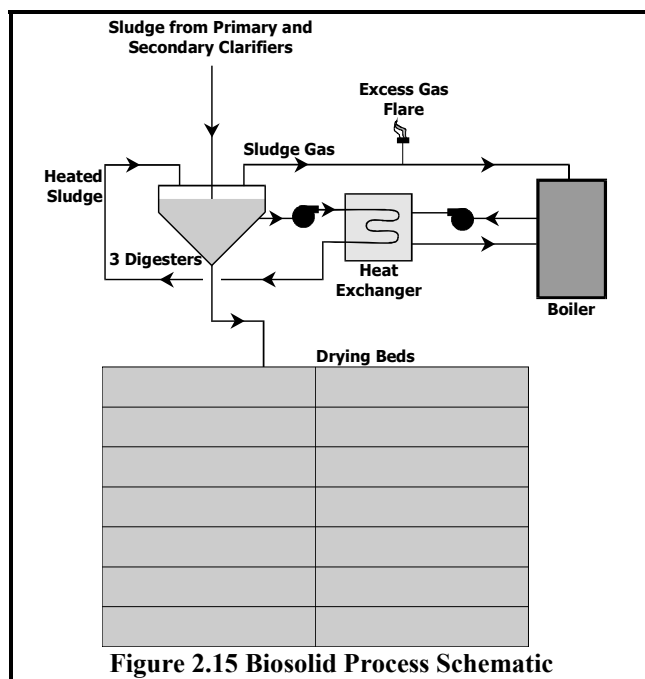


Figure 2.15 Biosolid Process Schematic

Solids removed by the primary clarifiers (Figure 2.3 on Page 2-12) are processed as shown in the schematic of Figure 2.15. Sludge is stabilized using two mixed-primary digesters heated to 97°F (36°C). Heated sludge is transferred to a secondary digester with heat exchange from the primary digesters. Solids settle in the secondary digester and the supernate is returned to the wastewater treatment process. The primary digester's capacities are 192,000 gallons and 170,544 gallons, and the secondary digester's capacity is 166,000 gallons, giving a total capacity of 528,000 gallons (2 megaL). The clarifiers pump an average of 9,250 gallons of sludge per day to the primary digesters. Average detention times are 57 days. Digester temperature and flow are recorded daily.

Stabilized sludge drawn from the secondary digester is transferred to one of 12 sludge-drying beds, each with a capacity of 5,200 ft² (483 m²). Each of these beds has an under-drain and decanting system that recirculates runoff through the treatment process. Twelve to 14 inches (33 cm) of sludge is applied to the beds. Drying times typically range from two to four months depending on the weather conditions. Once dried, the biosolids are removed from the beds and stored in a concrete containment area that also drains rainfall runoff through the treatment system. Biosolids are stored in this area until they are removed from the WWTP for composting and eventual use as a soil amendment. Biosolids storage times are generally less than one year.

In the past six years, treatment-plant personnel developed a beneficial-reuse program for biosolids. The program's goal was to implement a cost-effective technique for producing compost that meets the Federal and State Class-A standards for metals, pathogen reduction, and vector-attraction reduction. As a result of their efforts, the plant regularly produces exceptional-quality (EQ) compost. The EQ compost is now

⁷ Morro Bay/ Cayucos Wastewater Treatment Plant 2009 Annual Sewage Sludge Report, February 2010.

available to the public for use as a high-quality soil amendment. The composting program utilizes windrow composting similar to that of McCarthy Family Farms.

Biosolids removed from the WWTP in October 2009 were composted at the 162-acre San Joaquin Composting Facility (SJCF) owned by McCarthy Family Farms, Inc. The SJCF is located in Kern County, California, and operates under Solid Waste Facility Permit No. 15-AA-0287 (Permit Resolution No. 1999-96 adopted by the California Integrated Waste Management Board). The SJCF uses windrow and aerated static pile composting to further reduce pathogens and limit vector attraction. Windrows are divided into three temperature-recording stations. A windrow passes the high-temperature phase after all three stations maintain a temperature of 55°C for 15 days and the windrow has been turned at least five times. Six temperature stations are monitored for aerated static pile composting. All six stations must maintain a temperature of 55°C for three days before pathogen reduction is considered complete. After maintaining 40°C for 14 days, reduction of vector attraction is also considered complete.

On 9, 10, and 12 October 2009, the treatment plant sent a portion of the stored, dried biosolids to the composting facility. Prior to shipping, the MBCSD provided a Class-B biosolid certification statement based on chemical analyses performed on biosolid samples collected at the treatment plant. Chemical analyses were conducted on a composite sample collected on September 10th from the biosolids that were ready for shipment from the treatment plant at the time. Complying with the Monitoring and Reporting Program, the analyses were conducted on a composite of biosolid samples collected from the drying beds. The full laboratory results, including chains of custody, instrument calibration reports, and analyses of method blanks and spikes, were reported by MRS (2009b). They are compared with regulatory limits in Table 2.7.

The data in the tables show that biosolid contaminant concentrations were significantly less than regulatory criteria that would designate them as hazardous or limit their use for land application or composting. The analyses tested for the presence of more than 150 potential contaminants and measured seven other properties and nutrients within the biosolid sample. Nevertheless, only 20 chemicals were detected and 16 of those were naturally occurring trace metals.

All trace-metal concentrations were below the total threshold limit concentrations (TTLC) that would designate the biosolids as hazardous. One metal, copper, had a bulk wet-weight concentration that exceeded ten-times the soluble threshold limit concentration (STLC). Accordingly, a waste extraction test (WET) assessed its water solubility. This elutriate test demonstrated that the copper within the biosolids sample had very low solubility with a 6.7-mg/L dissolved concentration that was less than one-third of the 25-mg/L STLC level where leaching into groundwater may be of concern. The low solubility shows that the copper was tightly bound into a mineral matrix, with little bioavailability. The insolubility of copper is further confirmed by the low concentrations found in effluent samples (13 µg/L and 11 µg/L in Table 2.6), which are comparable to the biosolids WET concentration. Copper occurs naturally in the mineralogy of ambient sediments in the coast region and, as a result, its presence in biosolids is not unexpected. In any regard, the dry-weight concentrations for all detected metals in the biosolid sample were less than half of the federally mandated limits, including the monthly limit for materials suitable for agricultural land application (three right-most columns of Table 2.7).

Only two synthetic organic contaminants, DEHP and benzoic acid, were detected at quantifiable concentrations within the biosolids sample. As discussed in Section 2.2.12, DEHP has been consistently detected at low levels in effluent and biosolids samples collected throughout the past decade. There is no limit on this compound in State and Federal regulations governing biosolids. Because of its mobility, high vapor pressure, and the massive scale of production, DEHP has become pervasive in the environment.

Table 2.7. Comparison between Measured Biosolid Concentrations and State and Federal Limits

Constituent	Units	Wet Weight				Dry Weight		
		Measured		Limit		Measured	Limit	
		Bulk	WET ¹	STLC ²	TTLC ³	Bulk	Monthly ⁴	Ceiling ⁵
Solids	%	83.4	— ⁶	—	—	—	—	—
Cyanide	ppm	2.9	—	—	—	3.4	—	—
Antimony	ppm	≈4.2 ⁷	—	15.	500.	≈5.0	—	—
Arsenic	ppm	2.5	—	5.	500.	3.0	41.	75.
Barium	ppm	420.	—	100.	10,000.	500.	—	—
Beryllium	ppm	≈0.11	—	0.75	75.	≈0.13	—	—
Boron	ppm	17.	—	—	—	21.	—	—
Cadmium	ppm	3.7	—	1.	100.	4.4	39.	85.
Chromium (Total)	ppm	40.	—	560.	2500.	48.	—	—
Chromium (Hexavalent)	ppm	2.6	<0.07 ⁸	5.	500.	3.2	—	—
Cobalt	ppm	3.5	—	80.	8,000.	4.2	1,500.	4,300.
Copper	ppm	480. ⁹	6.7	25.	2,500.	570.	1,500.	4,300.
Lead	ppm	48.	—	5.	1,000.	58.	300.	840.
Mercury	ppm	1.3	—	0.2	20.	1.5	17.	57.
Molybdenum	ppm	18.	—	350.	3,500.	22.	—	—
Nickel	ppm	32.	—	20.	2,000.	38.	420.	420.
Selenium	ppm	8.7	—	1.	100.	10.	100.	100.
Silver	ppm	3.1	—	5.	500.	3.7	—	—
Thallium	ppm	<0.94	—	7.	700.	<1.1	—	—
Vanadium	ppm	24.	—	24.	2,400.	29.	—	—
Zinc	ppm	1,100.	—	250.	5,000.	1,300.	2,800.	7,500.
Asbestos	%	<0.5	—	—	1.	<0.5	—	—
Bis(2-ethylhexyl) phthalate	ppm	75.	—	—	—	90.	—	—
Benzoic acid	mg/kg	21.	—	—	—	25.	—	—
Hydrogen-Ion	pH	6.46	—	—	—	—	—	—
Phosphate	mg/kg	76,000.	—	—	—	92,000.	—	—
Ammonia	mg/kg	8,900.	—	—	—	11,000.	—	—
TKN	mg/kg	29,000.	—	—	—	35,000.	—	—
Organic Nitrogen	mg/kg	20,100.	—	—	—	24,000.	—	—
Nitrate as NO ₃	mg/kg	820.	—	—	—	980.	—	—
Organic Nitrogen	mg/kg	20,100.	—	—	—	24,000.	—	—
Oil & Grease	ppm	76,000.	—	—	—	91,000.	—	—
Total Dissolve Solids	ppm	—	6,600.	—	—	—	—	—

¹ Waste Extraction Tests (WET) measure the soluble leachate or the extractable amount of a substance contained within a bulk sample of biosolids. A WET is indicated if the bulk wet-weight concentration of a contaminant exceeds ten times the STLC.

² Soluble Threshold Limit Concentrations (STLC) apply to the measured concentration in the liquid extract from a biosolid sample, as determined by a WET. Biosolids with leachate concentrations exceeding the STLC are classified as hazardous in the State of California, as described in the California Code of Regulations (CCR 2003).

³ Total Threshold Limit Concentrations (TTLC) apply to the total wet-weight concentration of a contaminant within a bulk biosolid sample consisting of the entire millable solid matrix, rather than just the leachate. Biosolids are designated as hazardous wastes in the State of California if measured bulk concentrations exceed the TTLC, as described in the CCR (2003).

⁴ Federally mandated dry-weight limits imposed on biosolids suitable for application on agricultural land apply to monthly average concentrations as defined in Table 3 of the Code of Federal Regulations (USGPO 1997b). [40 CFR §503.13(b)(1)].

⁵ Federally mandated dry-weight ceiling concentrations above which biosolids are considered hazardous waste as defined in Table 1 USGPO (1997b).

⁶ Measurement not required or limit not specified

⁷ Concentrations preceded by an “approximation” symbol (≈) were too low to be reliably quantified and represent estimated concentrations because they were reported below the PQL but above the method detection limit (MDL).

⁸ A “less-than” symbol (<) indicates that the substance was not detected at a concentration above the MDL, which is listed after the “<” symbol.

⁹ Bulk concentrations shown in bold were greater than ten times the STLC and a WET was conducted.

The other compounds listed in Table 2.7 further characterize the biosolids, as required in the waste discharge requirements. Although testing for asbestos is no longer required as part of the NPDES permit, it was included for completeness. Additionally, a modified WET test (STLC) for total dissolved solids was conducted in response to a request from the composter.

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CHAPTER 3
Receiving Water Quality

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3.0 RECEIVING WATER QUALITY

This chapter describes environmental conditions within the ocean waters immediately adjacent to the MBCSD wastewater discharge during 2009. The first section presents the details of the monitoring program that assesses compliance with the water-quality objectives of the California Ocean Plan (COP; SWRCB 2005) as embodied in the NPDES permit covering the MBCSD discharge (hereinafter referred to as “*the NPDES permit*,” RWQCB–USEPA 2009). The second section discusses the disposition of the effluent plume within the receiving waters and how it is influenced by the hydraulic design of the outfall and stratification of the receiving waters. The final section of this chapter provides a synopsis of the offshore measurements collected during the four water column surveys conducted in 2009 (MRS 2009cdef) and compares them with the waste discharge requirements specified in the NPDES permit. Quantitative analyses of continuous instrumental measurements and the qualitative visual observations are also described in the last section. All of these observations demonstrate that the diffuser structure was operating as designed by efficiently diluting treated wastewater within the zone of initial dilution (ZID) that surrounds the outfall.

During all four of the 2009 offshore water-quality surveys, dilute wastewater was detected within the receiving waters. The weak discharge-related perturbations in the water-property fields indicated that the treated wastewater was rapidly mixed upon discharge, and all of the observed perturbations were small compared to the natural variability in seawater properties observed along this portion of the central California Coast. Projected contaminant concentrations were far below the receiving-water limitations specified in the NPDES permit, and the discharge fully complied with the objectives of the COP. In summary, the highly localized, transient seawater perturbations associated with the effluent discharge were too small to be of environmental significance.

3.1 MONITORING PROGRAM

Wastewater chemistry (Chapter 2), receiving waters (this chapter), and the biology and physicochemistry of seafloor sediments (Chapter 4) constitute the three major components of the MBCSD monitoring program. During 2009 and for the past 23 years, water-quality monitoring has included quarterly offshore surveys conducted near the wastewater discharge within northern Estero Bay and periodic surfzone coliform sampling along the adjacent shoreline. Measurements collected during the offshore surveys included instrumentally recorded seawater-properties, flow velocity determined from drifter trajectories, qualitative observations of general oceanographic and meteorological conditions, and visual observations of beneficial uses.

3.1.1 Objectives of Sampling

Receiving-water monitoring is required under provisions of a 301(h)-modified NPDES permit to determine compliance with the water-quality objectives of the COP (SWRCB 2005) and the Central Coast Basin Plan (RWQCB 1994). The monitoring program also satisfies the provisions of the Clean Water Act (40 CFR 125.63c) which require a water-quality monitoring program that “*provide[s] adequate data for evaluating compliance with water quality standards or water quality criteria.*” In addition, water column measurements provide background information on the vertical structure of ambient marine waters near the discharge location. This information aids in estimating minimum initial dilution rates, which occur when the receiving waters are strongly stratified, as described in Section 3.2.2.

3.1.2 Scope of Monitoring

One goal of the monitoring program is to assess whether the discharge meets the water-quality objectives of the COP. These objectives are summarized in Table 3.1, and ensure the reasonable protection of beneficial uses and the prevention of nuisance. They apply to samples collected within the discharge's wastefield after initial dilution has been completed. Initial dilution is the rapid, turbulent mixing of wastewater and seawater in the area immediately surrounding the point of discharge.

Ambient seawater is forcibly entrained into the discharge plume by two physical processes. Close to the diffuser ports, the momentum of the wastewater jet induces turbulent shear that rapidly entrains near-bottom seawater, thereby diluting the effluent. Additional turbulent mixing occurs as the warm, buoyant effluent-seawater mixture rises through the water column. This buoyancy-induced entrainment causes the density of the effluent plume to approach that of ambient seawater (neutral buoyancy) at some point in the water column. Depending on ambient stratification at the time of the discharge, the plume either can reach the surface or become trapped at some intermediate depth level. Thus, initial dilution, where a majority of effluent dilution is achieved shortly after discharge, is complete when the diluting wastewater ceases to rise in the water column and begins to spread horizontally.

To better assess compliance with the COP standards, the receiving-water monitoring program was extensively modified when the previous NPDES permit was issued in 1999 (RWQCB–USEPA 1998b). Prior to 1999, the effluent plume was rarely observed in the instrumental measurements and its lateral extent was largely indeterminate when it was observed. This was partially due to the wide spacing of water-sampling stations that, at that time, coincided with the benthic sampling pattern. Additionally, the earlier permit required collection of discrete water samples to be analyzed for suspended solids, coliform, and oil and grease. This water-bottle sampling was time-consuming and compromised the synoptic nature of the instrumental measurements. Beginning with the 1999 surveys, bottle casts were eliminated and the lateral extent of the survey was reduced from 1000 m to 100 m, while the number of sampling stations was doubled from eight to 16. Rapid instrumental sampling within this tighter sampling pattern consistently provided high-resolution synoptic snapshots of the ocean waters immediately surrounding the outfall. As a result, the disposition of the effluent plume has been accurately delineated in all 44 surveys conducted since the beginning of 1999.

Further improvements in the receiving-water monitoring program were implemented in 2009 as part of the current NPDES permit (RWQCB–USEPA 2009). The navigational accuracy of positioning systems has advanced to the point where the location of individual measurements can now be precisely determined relative to the discharge point. While the tightly spaced vertical profiles used in the previous permit's monitoring program successfully identified the presence of dilute wastewater constituents within the water column, they were still incapable of fully delineating the lateral extent of the highly localized effluent plume. Precise determination of the plume's spatial extent is important for assessing compliance with water-quality objectives that only apply beyond the zone of initial dilution. With that in mind, the receiving-water monitoring program in the current permit added a requirement for a tow survey, where the instrumentation package is towed horizontally across and around the diffuser structure at two different depth levels. Collection and analysis of tow data began with the second-quarter receiving-water survey conducted in 2009, when the current permit became effective. Additionally, all four surveys conducted in 2009 included the collection of vertical profiles of seawater properties at six sampling stations aligned along a north-south, alongshore, transect within 100 m of the diffuser structure.

Table 3.1 Water-Quality Objectives of the California Ocean Plan

B. Bacterial Characteristics

1. Water-Contact Standards

Within a zone bounded by the shoreline and a distance of 1,000 feet from the shoreline or the 30-foot depth contour, whichever is further [sic] from the shoreline and in areas outside this zone used for water contact sports, as determined by the Regional Board, but including all kelp beds, the following bacterial objectives shall be maintained throughout the water column:

- a. The 30-day geometric mean of the five most-recent seawater samples from each site shall not exceed a total coliform density of 1,000 per 100 ml; a fecal coliform density of 200 per 100 ml; or an enterococcus density of 35 per 100 ml.
- b. A single seawater sample shall not exceed a total coliform density of 10,000 per 100 ml; a fecal coliform density of 400 per 100 ml; an enterococcus density of 104 per 100 ml, or a total coliform density of 1,000 per 100 ml when the fecal to total coliform ratio exceeds 0.1.

The "Initial Dilution Zone" of wastewater outfalls shall be excluded from designation as "kelp beds" for purposes of bacterial standards and Regional Boards should recommend extension of such exclusion zone where warranted to the State Board. Adventitious assemblages of kelp plants on waste discharge structures (e.g., outfall pipes and diffusers) do not constitute kelp beds for purposes of bacterial standards.

2. Shellfish Harvesting Standards

Throughout the water column in all areas where shellfish may be harvested for human consumption, as determined by the Regional Board, the median total coliform density shall not exceed 70 per 100 ml and not more than 10 percent of the samples shall exceed 230 per 100 ml.

C. Physical Characteristics

1. Floating particulates and grease and oil shall not be visible.
2. The discharge of the waste shall not cause aesthetically undesirable discoloration of the ocean surface.
3. Natural light shall not be significantly reduced at any point outside the initial dilution zone as a result of the discharge of waste.
4. The rate of deposition of inert solids and the characteristics of inert solids in ocean sediments shall not be changed such that benthic communities are degraded.

D. Chemical Characteristics

1. The dissolved oxygen concentration shall not at any time be depressed more than 10 percent from which occurs naturally, as a result of the discharge of oxygen demanding waste materials.
2. The pH shall not be changed at any time more than 0.2 units from that which occurs naturally.
3. The dissolved sulfide concentration of waters in and near sediments shall not be significantly increased above that present under natural conditions.
4. The concentration of substances set forth in Chapter II, Table B in marine sediments shall not be increased to levels which would degrade indigenous biota.
5. The concentration of organic materials in marine sediments shall not be increased to levels which would degrade marine life.
6. Nutrient materials shall not cause objectionable aquatic growths or degrade indigenous biota.
7. Numerical water quality objectives in Table B apply to all discharges within the jurisdiction of this plan.

E. Biological Characteristics

1. Marine communities, including vertebrate, invertebrate and plant species, shall not be degraded.
2. The natural taste, odor and color of fish, shellfish, or other marine resources used for human consumption shall not be altered.
3. The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not be bioaccumulated to levels that are harmful to human health.

F. Radioactivity

1. Discharge of radioactive waste shall not degrade marine life.

An automated probe system was used to collect precise *in situ* measurements of seawater properties during each of the four quarterly receiving-water surveys of 2009. Measured seawater parameters consisted of temperature, salinity, dissolved oxygen (DO), acidity/alkalinity (pH), and light transmittance (water clarity). Qualitative visual observations made during the offshore surveys provided information on any potential wastewater contributions to levels of floating particulates, seawater discoloration, odors,

algal blooms, and surface water clarity. Wildlife and recreational use, as well as general weather and sea conditions, were also noted.

In addition to the quarterly sampling used to delineate the discharge plume offshore, monitoring of the adjacent surfzone along Atascadero State Beach is conducted to assess aesthetic conditions for the beneficial uses described in Section 2.1.2. Bacteriological conditions along the shoreline are of particular interest for shellfish harvesting and for water-contact recreation, namely swimming and surfing. However, disinfection of MBCSD effluent normally reduces bacterial densities below receiving-water standards prior to discharge, and the 100-fold dilution that occurs shortly after discharge renders the plant's bacterial loading imperceptible. Consequently, surfzone bacterial samples are too distant to be materially affected by the discharge, and are instead dominated exclusively by onshore sources and runoff (MRS 1993 – 2009). Because of this, the current permit no longer requires regular monitoring of surfzone bacteria, but triggers monitoring when there is an upset in the WWTP's disinfection process that causes total coliform density in the effluent to exceed 2400 MPN/100 ml. Although near-shore water samples were collected and analyzed for total and fecal coliform densities by WWTP personnel in January and February of 2009 as part of the regular sampling required by the previous permit, surfzone monitoring has not been triggered since implementation of the current permit.

Other beneficial uses, such as fishing and non-water-contact recreation, including beachcombing, boating, and picnicking, were addressed by visual observations of aesthetic conditions noted during the surfzone and offshore surveys conducted in 2009. These auxiliary observations included weather conditions, ocean currents, tides, and any evidence of water discoloration, floating oil and grease, turbidity, odor, or materials of sewage origin on the beach or in the water.

3.1.3 Sampling Station Design

During 2009, water sampling was conducted at eight surfzone stations and six offshore stations (Figure 3.1). The surfzone stations are located at gradient distances upcoast and downcoast relative to Station C, which is positioned at the onshore site closest to the offshore discharge location (Table 3.2). The closest portion of the diffuser structure lies 827 m from the shoreline, while the diffuser structure itself extends an additional 52 m toward the northwest along the seafloor. The beginning of the section of the diffuser structure containing open diffuser ports lies directly offshore of surfzone Station C (Figure 3.1).

Table 3.2 Target Locations of Surfzone Sampling Stations

Station	Description	Along-Shore Distance ¹ (m)	Latitude ²	Longitude
A1	Upcoast Reference	1330 N	35° 23.967' N	120° 52.116' W
A	Upcoast Midfield	912 N	35° 23.750' N	120° 52.067' W
B	Upcoast Nearfield	488 N	35° 23.517' N	120° 52.000' W
C	Onshore of Diffuser	0	35° 23.250' N	120° 51.950' W
D	Downcoast Nearfield	426 S	35° 23.033' N	120° 51.917' W
E	Downcoast Midfield	922 S	35° 22.767' N	120° 51.9005' W
F	Downcoast Reference	1602 S	35° 22.400' N	120° 51.883' W
G	Morro Creek ³	— ⁴	—	—

¹ Along-shore distance and direction from Station C

² As described in the glossary, all coordinates cited in this report are referenced to the WGS84 datum.

³ Immediately before flowing to the ocean

⁴ Location varies with the along-shore migration of the mouth of Morro Creek.

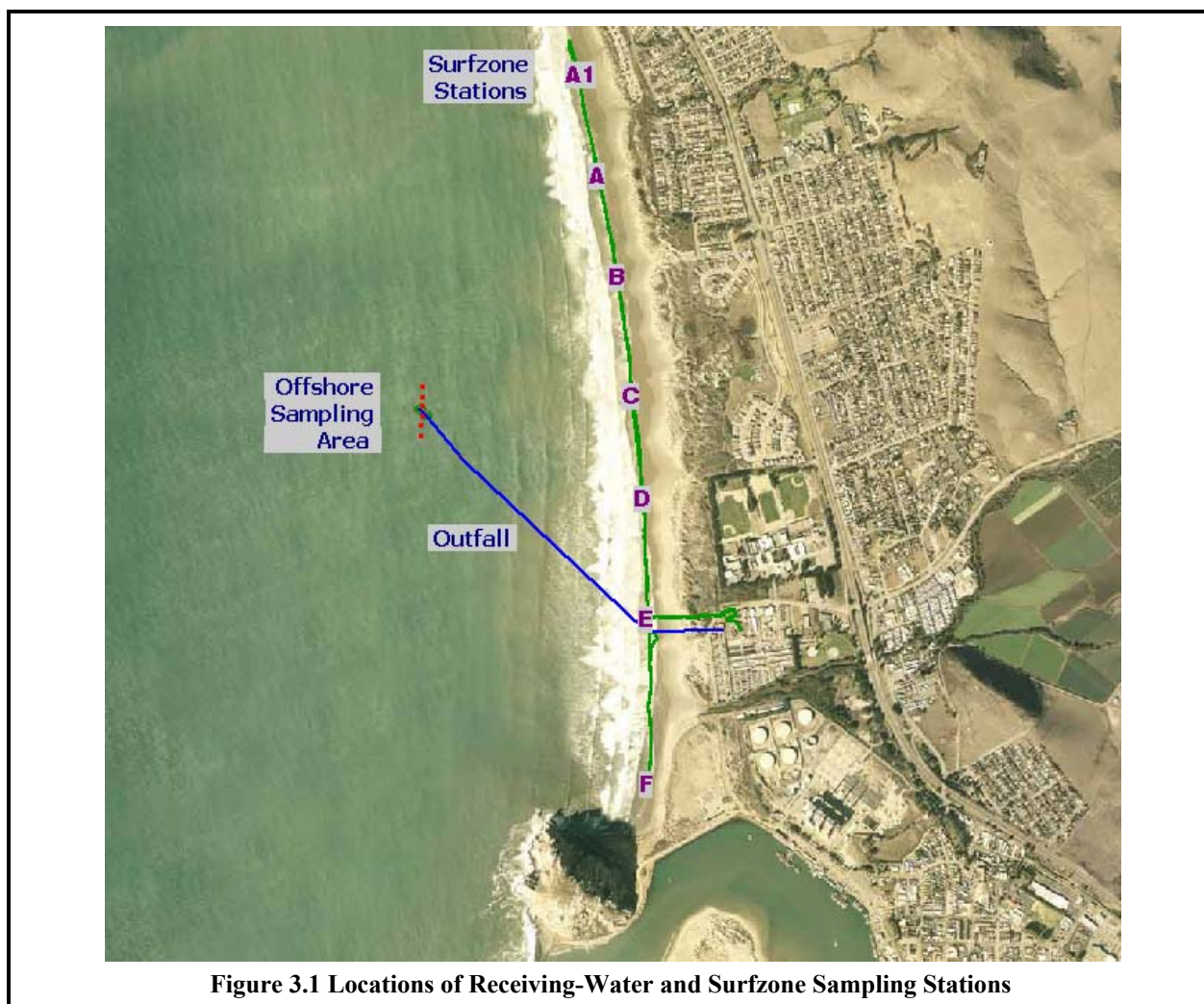


Figure 3.1 Locations of Receiving-Water and Surfzone Sampling Stations

In contrast to the more than 3-km extent covered by the surfzone monitoring, offshore water-quality sampling focused on the water column close to the discharge location (Figure 3.1). The discharge's region of influence was evaluated quarterly using water-quality data collected at six offshore stations (Table 3.3, Figure 3.2). Twenty-eight of the 34 available ports discharge effluent along a 42 m section of the diffuser structure. The diffuser ports were hydraulically designed to rapidly dilute effluent within the receiving

Table 3.3 Target Locations of Receiving-Water Stations

Station	Description	Latitude	Longitude	Closest Approach Distance ¹ (m)	Center Distance ² (m)
RW1	Upcoast Midfield	35° 23.253' N	120° 52.504' W	88.4	100
RW2	Upcoast Nearfield	35° 23.231' N	120° 52.504' W	49.4	60
RW3	Upcoast ZID	35° 23.210' N	120° 52.504' W	15.0	20
RW4	Downcoast ZID	35° 23.188' N	120° 52.504' W	15.0	20
RW5	Downcoast Nearfield	35° 23.167' N	120° 52.504' W	49.4	60
RW6	Downcoast Midfield	35° 23.145' N	120° 52.504' W	88.4	100

¹ Distance from the closest open diffuser port

² Distance to the center of the open diffuser section

seawater immediately upon discharge. Most of this turbulent mixing occurs within a zone of initial dilution (ZID), which extends laterally to a distance of approximately 15 m from the center of the diffuser structure.

Over longer periods, energetic waves, tides, and coastal currents within Estero Bay further disperse the effluent plume within open-ocean receiving waters beyond the ZID. Areas of special concern, such as sanctuaries and estuaries are too distant to be materially affected by the treated wastewater discharge. For example, the southern boundary of the Monterey Bay National Marine Sanctuary is located 38 km to the north, while the entrance to Morro Bay lies 2,800 m to the south of the discharge. In 1995, Morro Bay was included in the National Estuary Program; however, because of its distance from the discharge, incursion of unmixed wastewater into the Bay is highly unlikely. Direct seawater exchange between the discharge point and Morro Bay is restricted by Morro Rock, which lies between the outfall and the south-facing entrance to the Bay. Morro Rock is the largest physiographic feature along the adjacent coastline and extends into Estero Bay approximately 2,000 m south of the point of discharge (Figure 3.1).

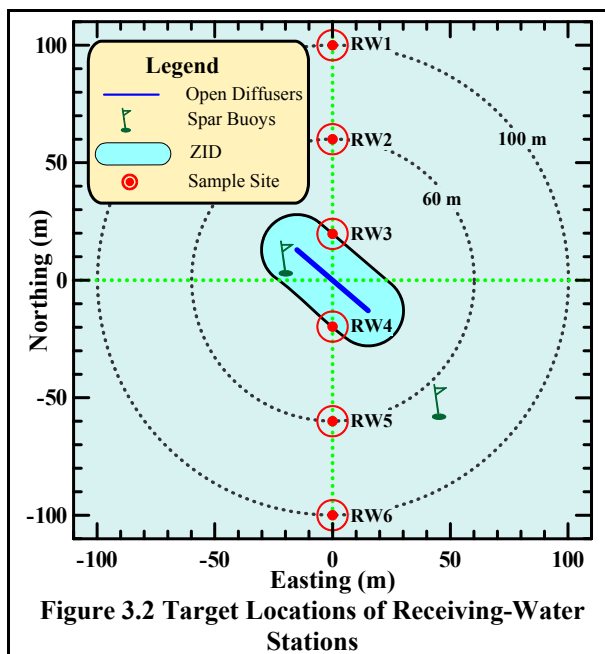


Figure 3.2 Target Locations of Receiving-Water Stations

During 2009, the discharge's region of influence was evaluated quarterly using water-quality data collected at the six offshore stations situated at three gradient distances upcoast and downcoast from the ZID. The two closest stations, which are on the margin of the ZID, were located 15 m from the closest approach of the diffuser rather than from the center point of the diffuser structure. The remaining more-distant stations were located relative to the center point of the diffuser structure.

It is important to consider the “closest-approach” distance when evaluating impacts at stations near the wastewater discharge. Although the discharge has historically been considered a “point source” for most large-scale modeling purposes, it does not occur at a single location of infinitesimal size. Because the discharge is distributed along a 42 m section of the seafloor, its finite size affects assessments of wastewater dispersion at sites close to the discharge. Specifically, the amount of wastewater dispersion at a given point in the water column is determined more by its distance to the closest diffuser port rather than its distance to the center point of the diffuser structure. Near the source, this “closest-approach” distance can be much less than the actual distance to the center of the diffuser structure (Table 3.3, Figure 3.2). As such, it would be unsuitable to design a nearfield sampling pattern based on center-point distances rather than closest-approach distances.

With the closest-approach distances in mind, the six monitoring stations were aligned along a north-south axis at the same isobath (15.2 m) as the diffuser center point. Stations RW3 and RW4 were positioned at the boundary of the ZID at a distance of 15 m upcoast and downcoast of the closest diffuser ports (Table 3.3). Stations RW2 and RW5 were located at nearfield distances (60 m) from the diffuser center point. Midfield Stations RW1 and RW6 represent reference stations situated 100 m upcoast and downcoast of the center point. Depending on the direction of the local oceanic currents at the time of sampling, one or more of these near and midfield stations could conceivably be influenced by wastewater discharge. Under those circumstances, the midfield station on the opposite side of the diffuser acts as a reference station.

Comparisons of water properties at these antipodal stations quantify departures from ambient seawater properties used in the evaluation of compliance with the NPDES discharge permit. Because the January 2009 survey took place before the current permit went into effect in March 2009, it did not involve a tow-survey component, and instead utilized the collection of data at ten additional sampling stations as required under the previous discharge permit.

3.1.4 Navigation

Vessel positioning within the compact offshore sampling pattern has improved with the availability of Differential Global Positioning Systems (DGPS). DGPS, with typical position errors of less than 4 m, significantly enhances the accuracy of traditional GPS navigation systems, which have position errors as large as ± 15 m, a span half the width of the ZID itself. At the beginning of 1998, the survey vessel F/V *Bonnie Marietta* was fitted with a Furuno™ GPS 30 and FBX2 differential beacon receiver. This navigational system was used on 29 July 1998 to precisely locate the position of the open section of the diffuser structure (MRS 1998b). Carson Porter, a diver performing the annual outfall inspection, deployed temporary buoys marking the first and last open diffuser ports. The DGPS locations of these buoys were then used to establish the new target locations for the offshore monitoring stations listed in Table 3.3.

Specifying the precise location of each measurement relative to the diffuser is crucial for accurate interpretation of the water property fields. For example, during vertical profiling, the actual sampling locations do not coincide with the exact target coordinates listed in Table 3.3. The combined influences of winds, waves, and currents induce vessel offsets of tens of meters within the minute or so it takes to complete the water-property profile at each station. Even during quiescent periods, drift is induced by residual vessel momentum remaining after station approach. Prior to the use of DGPS, these offsets could not be resolved by the available navigation, but, during the 2009 surveys, the sampling locations were precisely determined throughout the vertical profiling conducted at each station.

Determination of vessel drift during vertical profiling is an important consideration because it caused some of the measurements in 2009 to be collected within the ZID, where the water-quality objectives in the COP do not apply (see shaded entries in Table 3.4). The average closest-approach distances in Table 3.4 can be compared with the target offsets listed in Table 3.3 to assess the fidelity of the sampling locations with respect to diffuser-structure proximity. From the standpoint of an ideal compliance evaluation, all measurements would be made at or beyond the ZID boundary, namely, at distances of more than 15 m from the diffuser structure. However, measurements unavoidably collected well within the ZID, and close to the diffuser structure, are also valuable because they capture the dynamics of the

Table 3.4 Station Proximity to the Discharge

Station	Description	Closest-Approach Distance ¹ (m)				
		Target	January	May	August	October
RW3	Upcoast ZID	15.0	9.9²	13.3	11.0	12.7
RW4	Downcoast ZID	15.0	16.2	17.3	18.4	15.6
RW2	Upcoast Nearfield	49.4	56.2	55.8	51.1	68.9
RW5	Downcoast Nearfield	49.4	31.9	43.0	47.1	43.2
RW1	Upcoast Midfield	88.4	106.1	78.1	97.3	89.6
RW6	Downcoast Midfield	88.4	75.1	78.9	92.0	93.9

¹ Distance from the closest open diffuser port to the average station position

² All or portions of the profiles highlighted in bold typeface with shading were sampled within the ZID.

plume undergoing rapid initial mixing, and lend timely insight into the dispersive capabilities of the diffuser structure. These close-in measurements have demonstrated that the MBCSD discharge routinely meets the COP receiving-water objectives well within the ZID.

3.1.5 Sampling Equipment and Methodology

The 38-ft F/V *Bonnie Marietta*, owned and operated by Captain Mark Tognazzini of Morro Bay, provided vessel support for the four offshore surveys in 2009. Bonnie Luke and Douglas Coats of Marine Research Specialists (MRS) provided scientific support and Captain Tognazzini supervised vessel and deck-equipment operations, while William Skok served as marine technician.

Standard observations for weather, seas, water clarity/coloration, Secchi depth, and the presence of any odors and floating debris were recorded during the surveys. Wind speeds and air temperatures were measured with a Kestrel® 2000 Thermo-Anemometer. These observations were collected during the vertical profiling conducted at each of the six stations.

Auxiliary Measurements

As vertical profiles were collected at each station, a Secchi disk was lowered through the water column to determine its depth of disappearance. This provided a visual measure of the water clarity within the upper water column. The depth of disappearance is inversely proportional to the average amount of organic and inorganic suspended material along a line of sight immediately below the sea surface. As such, Secchi depth is a measure of ambient light penetration, which can be limited during upwelling when plankton density increases within the near-surface euphotic zone. The depth of the euphotic zone, where most oceanic photosynthesis occurs, extends to approximately twice the Secchi depth. Because Secchi depths are less precise than measurements collected with electronic sensors, these and the other qualitative observations described above were ancillary to the digital measurements of seawater parameters collected throughout the water column.

At the beginning of each survey, a drifter was deployed at the center of the open section of the diffuser structure. The drifter was drogued at mid-depth (7 m) using the curtain shade design of Davis et al. (1982). In this configuration, the drifter trajectory was largely determined by the oceanic flow field rather than surface winds. Satellite navigation onboard the drifter allowed continuous recording of the precise time and position of the drifter trajectory throughout its deployment, and the vessel's locations during deployment and recovery were recorded for navigational intercomparison. These trajectory measurements established the ambient flow velocity throughout each survey, and indicated the path of plume transport for use in the interpretation of seawater property distributions.

Instrumental Measurements

A Sea Bird Electronics SBE-19 Seacat CTD⁸ instrument package was deployed in both a vertical water-profiling mode, as well as a horizontal-tow configuration. It collected measurements of conductivity, temperature, light transmittance, dissolved oxygen (DO), pH, and pressure at a sampling rate of 2 Hz (0.5-s intervals). A submersible pump on the CTD continuously flushed water through the conductivity cell and oxygen plenum at a constant rate, independent of the CTD's motion through the water column.

The CTD instrument package receives regular maintenance and calibration. After the October 2001 survey, the CTD was returned to the factory for comprehensive testing, repair, and calibration. The DO and pH sensors were returned to the factory in May 2003 and June 2006 for testing and calibration.

⁸ Conductivity, temperature, and depth (CTD)

Because of increasing temporal drift associated with aging DO probes, the DO probe was replaced on both occasions. As is the case before all surveys, the CTD system was calibrated at the MRS laboratory prior to the 2009 surveys. The upper-bound DO calibration point at full saturation was established by immersing the CTD in an aerated, temperature-controlled calibration tank. Similarly, a zero-oxygen calibration point was determined by filling the oxygen-sensor plenum with an 8% solution of sodium sulfite (Na_2SO_3). Oxygen calibration coefficients were determined by regression analysis of sensor-membrane current and temperature, as recommended by the manufacturer (SBE 1993). The pre-cruise calibration coefficients determined by MRS closely corresponded with prior factory calibrations.

The six seawater properties used to assess receiving-water quality in this report were derived from the continuously recorded output of the CTD's probes and sensors. Pressure housing limitations on the combination oxygen/pH sensor confine the CTD to depths less than 200 m (Table 3.5), which is well beyond the maximum depth of the deepest station in the

Table 3.5 CTD Specifications

Component	Depth¹	Units	Range	Accuracy	Resolution
Housing	600	—	—	—	—
Pump	3400	—	—	—	—
Pressure	680	psia	0 to 1000	± 5.0	± 0.5
Depth	—	meters	0 to 690	± 3.0	± 0.3
Conductivity	600	Siemens/m	0 to 6.5	± 0.001	± 0.0001
Salinity	600	‰	0 to 38	± 0.006	± 0.0006
Temperature	600	° C	–5 to 35	± 0.01	± 0.001
Transmissivity	2000	%	0 to 100	± 0.1	± 0.025
Dissolved Oxygen	200	mg/L	0 to 21.5	± 0.14	± 0.014
Acidity/Alkalinity	200	pH	0 to 14	± 0.1	± 0.006

¹ Maximum depth limit in meters

outfall survey. The precision and accuracy of the various probes, as reported in manufacturer's specifications are also listed in the Table. Salinity (‰) was calculated from conductivity measurements reported in units of Siemens/m. Density was derived from contemporaneous temperature (°C) and salinity data, and was expressed as 1000 times the specific gravity minus one, which is a unit of sigma-T (σ_t).

All three of the physical parameters (salinity, temperature, and density) helped determine the lateral extent of the effluent plume during the towing phase of the survey. Additionally, during the vertical-profiling phase, they quantified layering, or vertical stratification and stability of the water column, which determines the behavior and dynamics of the effluent as it mixes with seawater within the ZID. Data on the three remaining seawater properties, light transmittance (water clarity), hydrogen-ion concentration (acidity/alkalinity – pH), and dissolved oxygen (DO), further characterized receiving waters and were used to assess compliance with water-quality criteria. Light transmittance was measured as a percentage of the initial intensity of a transmitted beam of light detected at the opposite end of a 0.25-m path. Increased transmittance indicates increased water clarity and decreased turbidity.

During the pre-cruise calibrations, coefficients for the pH sensor were determined from a linear regression of output voltage after immersion in five separate buffered solutions of known pH. Buffering solutions with a pH of 4 ± 0.01 , 6 ± 0.01 , 7 ± 0.01 , and 10 ± 0.02 were used to bracket the range of in situ measurements. The SeaTech transmissometer was air calibrated by fitting the voltages recorded with and without blocking of the light transmission path in air, as recommended by the manufacturer (SBE 1989). Algorithms that converted sensor voltage to engineering units during processing of the field data relied on calibration coefficients determined before the survey.

Comparison with the factory calibration of the entire CTD package conducted in December 2001, and the more recent June 2006 replacement and calibration of the DO probe, confirmed the continued accuracy and stability of the temperature, pressure, and conductivity sensors, as well as the operational integrity of

the oxygen and pH probes. To correct for a slight drift in the pressure strain gauge since its calibration in 2001, a -0.25 Psia offset was incorporated in the conversion to depth measurements. In addition, slight temporal trends in pH, and occasionally DO, arose from the ongoing equilibration of these sensors during some of the surveys. The trends were removed by fitting smooth orthogonal polynomials to the sensor time series. Maximum adjustments were small, and on the order of sensor accuracy.

During its initial deployment for each survey, the CTD was held below the sea surface for an equilibration period. Subsequently, the CTD was raised to within 0.5 m of the sea surface and vertical profiling commenced. The CTD was lowered at a continuous rate of speed to the seafloor. Measurements at all six stations were collected during a single deployment of the CTD package by towing it below the water surface while transiting between adjacent stations. Upon retrieval of the CTD, the data were downloaded to a portable computer and examined for completeness and range acceptability. Data collected during vertical profiling were processed in accordance with standard analysis procedures (SCBFMC 2002), which resulted in bin-averaged data across 0.5-m standard depth intervals. The profile data were collated in individual survey reports (MRS 2009cdef), and digitally archived within the USEPA STORET database.

Following collection of the vertical profiles, the CTD was redeployed and continuously towed around and across the ZID at two separate depths in accordance with the receiving-water monitoring requirements of the current NPDES discharge permit. An example of the tow pattern, from the third-quarter survey, is shown in Figure 3.3. Prior to the tow survey, the CTD instrument package was fitted with a depth-suppressor and horizontal stabilizer to achieve constant-depth tows with forward-looking sensor probes. The appropriate length of towline was deployed, and the reconfigured CTD package was towed near the sea surface, passing close to the diffuser structure at least five times. Subsequently, an additional length of towline was paid-out, and at least five additional passes were made at mid-depth.

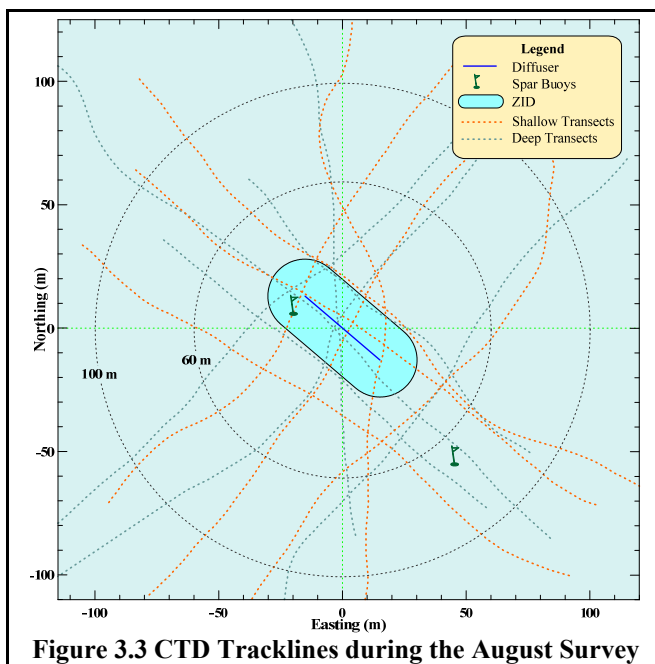


Figure 3.3 CTD Tracklines during the August Survey

3.2 PLUME DISPERSION

Offshore monitoring is conducted to determine whether the wastewater discharge is causing significant impacts on the receiving waters of Estero Bay beyond the ZID. Section 3.3.1 makes this determination by comparing the water quality at the boundary of the ZID, and gradient areas beyond the ZID, with background water quality. However, the complex interaction between physical oceanographic processes and ambient seawater properties near the outfall makes detection of the relatively minor discharge-related changes challenging. The significance of potential water-quality impacts is assessed through a comparison between the amplitude of discharge-related anomalies and the inherent variability in ambient seawater properties. Statistically speaking, if the amplitude of the effluent anomaly is small compared to the inherent variability in ambient seawater properties, then the impact cannot be deemed significant.

The first two subsections of this section describe the nature of wastewater dispersion from the MBCSD diffuser structure. The first subsection discusses the configuration of the multiport diffuser structure and describes how its hydraulic design determines the dimensions of the ZID. The second subsection describes the dynamics of the rapid mixing that occurs within the ZID immediately after discharge from the diffuser.

The last subsection describes oceanographic processes that affect ambient seawater properties within northern Estero Bay, and quantifies ranges in natural variability caused by these processes. The natural-variability ranges are used to establish thresholds for determining whether discharge-induced changes are significant. Regional processes cause major fluctuations in the character of the receiving waters near the diffuser, and large seasonal changes in the vertical structure directly affect the dispersive capability of the outfall.

3.2.1 Zone of Initial Dilution

Treated wastewater from the MBCSD WWTP is discharged into northern Estero Bay through a 1,450-m outfall-diffuser system (Table 3.6). The existing outfall was constructed in 1982 with an upgraded 0.686-m diameter steel pipe lined and coated with cement mortar. The outfall extends to a water depth of about 15.2 m (50 ft), approximately 0.5 nautical miles offshore of Atascadero State Beach. At its terminus is a multiport linear diffuser consisting of 34 ports, each 5.08 cm in diameter. The ports are spaced 1.52 m apart on alternating sides of the pipe. The current level of discharge from the WWTP only requires the use of 28 of the 34 available ports.

For regulatory and modeling purposes, an idealized ZID is envisioned around the diffuser structure, where the most intense turbulent mixing of effluent is thought to take place shortly after discharge. It is assumed to extend beyond the dimensions of the diffuser structure to a horizontal distance equal to the water depth (USEPA 1994). The water depth at the center point of the diffuser structure is 15.24 m (50 ft) measured relative to the MLLW tidal datum. Consequently, the ZID forms a vertical cylinder whose horizontal cross-section is an elongated ellipse as shown in Figure 3.2 on Page 3-6. Based on the diffuser specifications, the dimensions of the ZID are 73.15 m (240 ft) in length, 31.2 m (102.4 ft) in width, and 15.24 m (50 ft) in height. The length is twice the water depth (15.24 m) added to the 42.67 m (140 ft) long diffuser section where ports are open. The width of the ZID is twice the water depth added to the inside diameter (0.68 m) of the diffuser pipe. Coatings, which add 0.2 m to the outside diameter of the pipe, and the angled diffuser ports, which extend beyond the edge of the pipe, were neglected for the purposes of determining ZID dimensions. The ZID covers an ocean surface area of approximately 3000 m².

Table 3.6 Hydraulic Characteristics of the Outfall

Parameter	Measurement
Outfall diameter (m)	0.686
Outfall length (m)	
Land	207
Ocean	1,449
Diffuser diameter (m)	0.686
Diffuser length (m)	51.8
Port orientation (° from horizontal)	0
Port diameter (m)	0.0508
Orifice contraction coefficient	0.89
Center point depth of outfall ports (m MLLW)	15.2
Number of ports open	28 ¹
Port spacing ² (m)	1.52
Design flow rate for each port (m ³ /s)	0.01

¹ 28 of 34 ports available.

² Ports are located on alternating sides of the diffuser. Distance between ports on the same side of the diffuser is 3.04 m.

³ Flow rate assuming 34 ports open in a total flow of 0.340 m³/s (7.76 MGD). The outfall design capacity is 0.358 m³/s (8.17 MGD).

In reality, at any given time the actual initial dilution zone departs markedly from the idealized vertical cylinder described above. On a regular basis, the prevailing current flow carries the effluent plume beyond the boundaries of the ZID, long before it achieves buoyant equilibrium and before initial mixing is complete. Nevertheless, because wastewater is rapidly diluted immediately upon discharge, and well before initial mixing is fully realized, the water-quality objectives of the COP are consistently met, even within the boundary of the ZID.

3.2.2 Critical Initial Dilution Ratio

Shortly after discharge, wastewater dilution is determined by the physical characteristics of the diffuser system and stratification within the receiving waters. The most rapid mixing occurs close to the diffuser structure within the ZID. There, the turbulent processes associated with the high-velocity discharge jet emanating from the diffuser ports, and the buoyant rise of the effluent plume through the water column, result in the rapid dilution of discharged wastewater. Subsequent transport and dispersion by regional oceanographic processes further dissipate the effluent, albeit at a slower rate. The dispersion associated with these oceanographic processes is not considered part of initial dilution.

The limiting concentrations for wastewater constituents specified in the NPDES permit (see Chapter 2) were determined by applying the critical initial dilution ratio for the MBCSD outfall to the open-ocean water-quality objectives specified in the COP for individual contaminants (Table B of SWRCB 2005). The critical initial dilution applicable to the MBCSD outfall was conservatively estimated to be 133:1 based on unrealistically stringent modeling (Tetra Tech 1992). The following example shows how this dilution factor was applied to determine the wastewater limits that were established for cadmium in the NPDES permit. The COP's water-quality objective for cadmium in receiving waters has an instantaneous maximum concentration of 0.01 mg/L or less (SWRCB 2005). Based on modeling under extremely stratified conditions, there will be at least 133 parts of ambient water mixed with each part of wastewater after completion of initial mixing. From the definition of dilution (Fischer et al. 1979), the concentration of a particular contaminant in wastewater is given by:

$$C_e \equiv C_o + D (C_o - C_s) \quad \text{Equation 3.1}$$

where: C_e = the concentration of a constituent in the wastewater effluent,
 C_o = the concentration of the constituent in the ocean after dilution by D ,
 D = the dilution ratio of the volume of seawater mixed with wastewater, and
 C_s = the background concentration of the constituent in ambient seawater.

The background concentration (C_s) for cadmium in seawater is negligible so the wastewater limit is $(D+1)$ times the COP objective (C_o). Thus for cadmium, the instantaneous maximum concentration in wastewater should be no more than 1.34 mg/L, or 134 times the seawater objective of 0.01 mg/L. Thus, under the worst-case scenario, wastewater containing 1.34 mg/L of cadmium will dilute to a concentration of 0.01 mg/L upon reaching the boundary of the ZID, and the receiving water objective will be met. This is how the maximum effluent limit on cadmium concentration (1.34 mg/L) was established in the NPDES discharge permit granted to the MBCSD.

The foregoing calculation demonstrates how strongly the assumed initial dilution influences wastewater limitations that are specified in the discharge permit. Because a low value (133:1) was specified for the critical initial dilution, conservative wastewater limitations have been established for the MBCSD discharge. As discussed in Section 3.3.1, direct observations collected close to the diffuser during the 2009 surveys indicate that dilutions much higher than 133:1 were achieved well within the ZID and below

the assumed plume-trapping depth of 6.4 m. The original plume modeling that established the 133:1 critical dilution (Tetra Tech 1992) applied an especially stringent vertical stratification that is not representative of the receiving waters close to the outfall. In addition, the model included 34 open diffuser ports when only 28 ports have been open since the outfall began operations more than two decades ago.

In addition to underestimating the flow rate from individual diffuser ports, the critical initial dilution computed by the original modeling was conservative because the assumed stratification was unduly strong. The density profile used to establish the MBCSD critical initial dilution was collected at a now-abandoned monitoring station located 1 km south of the diffuser structure. When that particular density profile was measured, the water column at this location was consistently more stratified than the receiving waters close to the diffuser due to the influence of thermal discharge from the Dynegy power plant (formerly owned at various times by Pacific Gas and Electric, Duke Energy, and LS Power Group). At the time the “critical” density profile was measured, the energy plant was discharging heated water to the ocean surface near Station F next to Morro Rock (see Figure 3.1 on Page 3-5).

A decade of monitoring prior to 1999 demonstrated that the thermal outflow from the power plant measurably increased sea-surface temperatures at the old monitoring station relative to ambient conditions near the MBCSD outfall. Because this monitoring station consistently exhibited anomalous water properties, it was discarded when the receiving-water monitoring program was revised in 1999 under the previous discharge permit. Nevertheless, the original plume modeling, which established the critical initial dilution ratio currently applied to the outfall and used to establish present effluent limits, incorporated a heavily stratified profile from this station. The model predicted that the receiving waters would trap the effluent plume 6.4 m below the sea surface. Recent dilution modeling, using more realistic stratification, demonstrates that with the weaker vertical stratification typical of the water column near the diffuser, a critical initial dilution of approximately 200:1 with a plume trapping depth of 1.4 m is more representative of the outfall performance (Lindstrom 1998).

Even with unrealistically low dilutions of 133:1 and highly sensitive instrumentation, the signature of the wastewater discharge would be difficult to detect within receiving waters, except very close to the diffuser ports. Accordingly, most wastewater-induced perturbations in water quality are imperceptible beyond the ZID, particularly in the presence of the large, natural oceanic variability that exists within northern Estero Bay.

3.2.3 Regional Oceanographic Processes

A broad suite of complex oceanographic processes determines the disposition of coastal marine waters within northern Estero Bay. Close to shore, an energetic wave field occasionally dominates the oceanographic conditions along this section of the central California coast. This wave energy increases the turbulence within nearshore waters and causes significant sediment resuspension and sand transport along the outfall corridor. Farther offshore, bands of counter currents move ocean waters in alternating directions along the continental shelf.

This large-scale, along-shore current flow is interrupted by cross-shore tidal currents and by turbulent jets that occasionally form at major promontories such as Point Piedras Blancas, Point Buchon, and Point Arguello. These narrow, energetic jets transport materials far from the coast, and they are repeatedly observed extending from upwelling centers located south of major coastal headlands in satellite imagery (Figure 3.4). In addition to these processes, wind-driven upwelling alters the vertical distribution of water properties within Estero Bay and contributes to the remarkably high productivity of the marine waters there.

The open-ocean flow field largely controls ambient seawater properties within Estero Bay. Beyond the continental slope (>50 miles), the diffuse southward-flowing California Current represents the eastern limb of the clockwise-flowing gyre that covers much of the North Pacific Ocean. Before turning south to form the California Current, subarctic water is carried along at high latitudes where it is exposed to atmospheric cooling, nutrient regeneration, and precipitation. As a result, the waters of the California Current are characterized by a seasonably stable low salinity (32‰ to 34‰), low temperature (13°C to 20°C), and high nutrient concentration. Because of this stabilizing effect, seawater off the central-coast undergoes less seasonal variation than surface waters at similar latitudes along the eastern seaboard.

Immediately shoreward of the California Current, along the continental slope and shelf, is a countercurrent that carries water northward from the Southern California Bight. These southern waters are warmer, more saline, and less oxygenated than waters farther offshore. This northward-flowing Davidson countercurrent exhibits strong seasonal variability in intensity. Nevertheless, it maintains a sustained northward flow near Estero Bay, despite reversals observed elsewhere along the California Coast (Coats et al. 1991). The seasonal variability in the Davidson countercurrent coincides with large-scale changes in coastal winds.

Throughout much of the year, winds along the central coast blow from the northwest, parallel to the coast and in opposition to the northward-flowing Davidson countercurrent. These strong southwestward winds induce upwelling near Points Estero, Buchon, and Sal. During the upwelling season, surface water near the coast is transported offshore and is replaced by deep cool, nutrient-rich seawater as shown in Figure 3.4. When these southwestward winds relax, usually between December and February, the Davidson countercurrent is usually strongest. A spring transition back to strong southwestward winds typically occurs fairly rapidly between March and June.

However, in October 2009, an intense, early season rainstorm reversed the normal fall wind pattern just prior to the fourth-quarter receiving-water survey. The storm dropped 9.25 inches of rain in the Santa Lucia Mountains east of Morro Bay. The associated 976-mb atmospheric low represented one of the most intense weather systems seen during the month of October and even affected the WWTP throughput (see Chapter 2). The strong northwestward winds associated with the storm intensified the Davidson

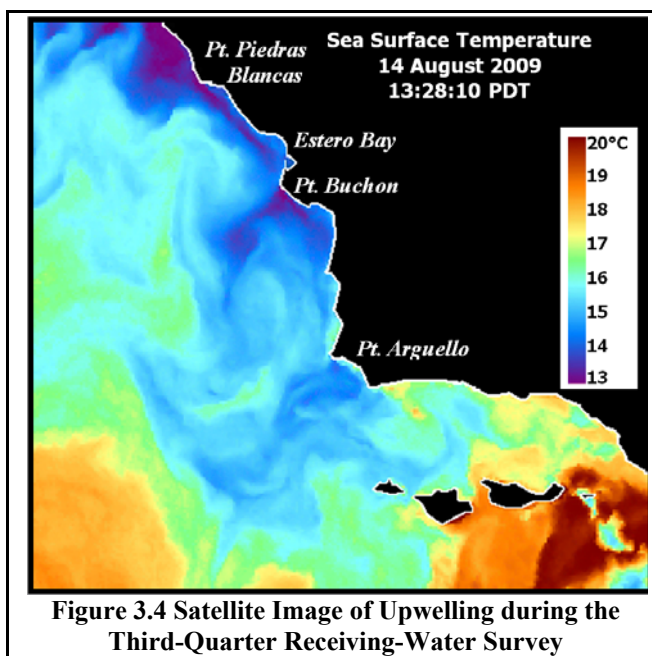


Figure 3.4 Satellite Image of Upwelling during the Third-Quarter Receiving-Water Survey

countercurrent, which carried warmer, more saline, and less oxygenated surface water out of the Santa Barbara Channel and northward along the central coast (Figure 3.5).

Normally, however, the dominant oceanographic force along the central coast is the prevailing southwestward winds. The rapid spring transition to strong southwestward winds occurs between March and June when the Davidson countercurrent weakens. These strong southwestward winds induce upwelling near Points Estero, Buchon, and Sal. During the upwelling season, surface water near the coast is transported offshore and is replaced by deep cool, nutrient-rich seawater as shown in Figure 3.4 on Page 3-14.

Significant inter-annual variations in oceanographic and marine biological properties also occur along the central California coast, and strongly influence the waters of Estero Bay throughout the last half century (Figure 3.6).

These large amplitude variations are associated with the El Niño – Southern Oscillation, which cycles at a period of 3 to 5 years (Graham and White 1988). Each El Niño period lasts approximately 12 months. During El Niño periods, such as between 1982 and 1983, and between 1997 and 1998, basin-wide changes in the dynamic balance of wind-driven currents result in modified flow patterns along the coastline of western North and South America (Chelton et al. 1982).

Changes in the study region include an anomalous strengthening of Davidson countercurrent outflow from the Southern California Bight. It also coincides with increased winter storm activity, reductions in zooplankton biomass, and the introduction of marine organisms typically found far to the south. For example, the relatively strong El Niño condition that was present during the latter half of 1997 and the beginning of 1998 resulted in a substantial increase in rainfall during the early part of 1998, and heavily impacted central-coast ocean waters and associated biota. Another El Niño oscillation began in the summer of 2009, and grew substantially in strength during the fall of 2009. This moderate to strong El Niño (NOAA 2010) may have been responsible for the unusual October storm discussed above, as well as the dramatic increase in sand dollar populations discussed in Chapter 4.

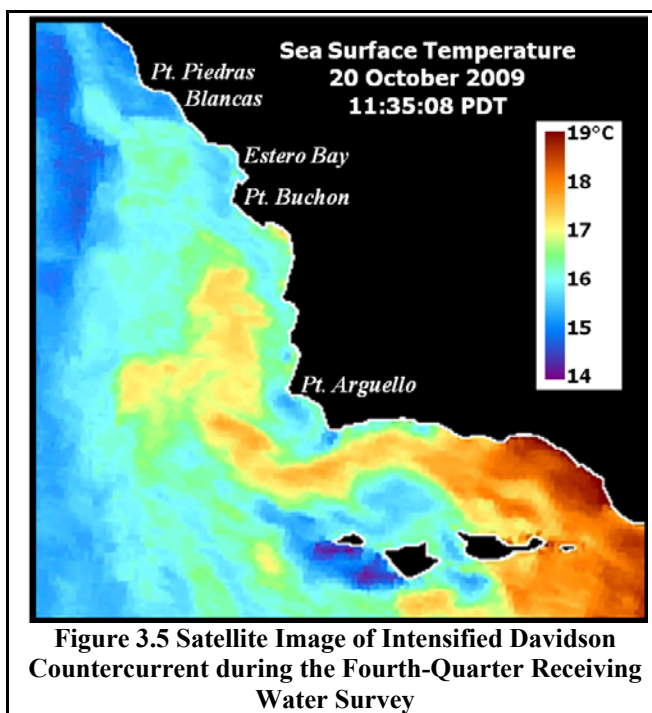


Figure 3.5 Satellite Image of Intensified Davidson Countercurrent during the Fourth-Quarter Receiving Water Survey

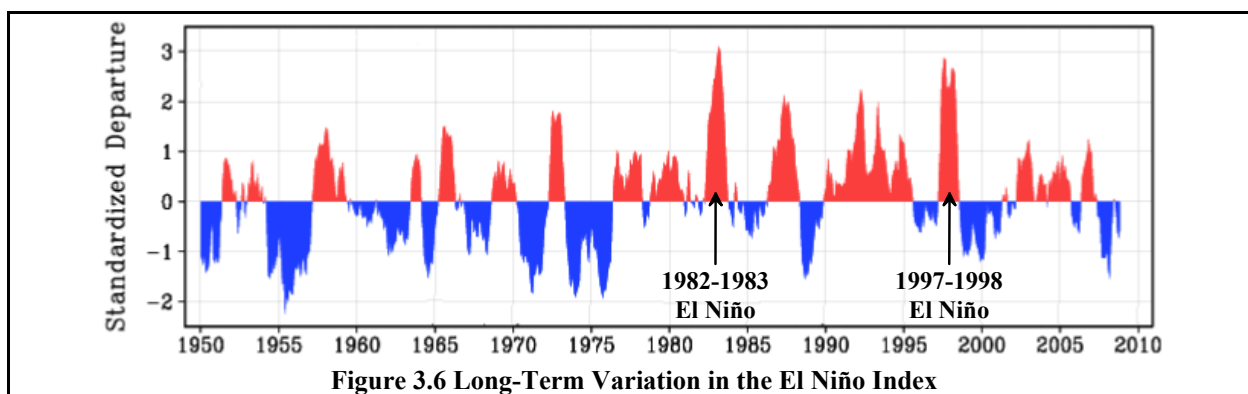


Figure 3.6 Long-Term Variation in the El Niño Index

Superimposed on these large-scale oceanic flows are a variety of transient phenomena including intense eddies, swirls, filaments, meanders, and narrow jets of flow. Many of these cross-shore turbulent features are evident in the complex surface flow pattern depicted in satellite images. For example, in Figure 3.4, a series of upwelling-induced cold-water jets, delineated in shades of purple and dark blue, emanate from major coastal promontories. Some of these jets, such as those near Pt. Arguello, extend far offshore, while others, such as those near Pt. Buchon and Pt. Piedras Blancas, form recirculating eddy-like features closer to shore. Embedded in these large-scale features are smaller filaments of flow that add further complexity to the surface flow pattern. All of these cross-shore flow features are capable of transporting significant quantities of coastal heat, nutrients, and pollutants to offshore waters (Savoie et al. 1991).

Tidal currents provide another mixing mechanism for ocean waters in the study region, although they are not responsible for significant net transport. Estero Bay experiences astronomical tides of diurnal inequality, meaning that the two daily sets of tidal extrema are of unequal amplitude. Tidal fluctuations of as much as 2.1 m can combine with storm surges of up to 0.3 m. Typically, however, the tidal range near the outfall site is approximately 1 m between mean high and low water.

At shorter periods, shoaling internal waves and surface gravity waves also mix coastal water properties in both the horizontal and vertical directions. This region of the central coast is relatively unprotected and experiences a comparatively high flux of wave energy, especially in winter when intense storm events are prevalent. Under certain conditions, this wave energy impinges on Atascadero State Beach at oblique angles, generating substantial alongshore transport within the coastal littoral cell between Point Estero and Morro Rock (Figure 2.1). The wave-generated littoral cell can extend well offshore into Estero Bay, encompassing the MBCSD discharge location. Four primary meteorological sources generate waves in this region: 1) extratropical winter cyclones in the northern hemisphere, 2) southwestward winds after the spring transition to upwelling conditions, 3) tropical disturbances off shore of Mexico, and 4) extratropical storm swells generated in the southern hemisphere during summer. The first two are the dominant influences on the wave climate along this section of the central California coast. The last two generate swells from the south, which are diminished near the outfall site by the sheltering effects of Point Buchon (Figure 2.1).

Winter storm waves generated by extratropical winter cyclones are often accompanied by locally severe weather along the south-central coast. These extratropical storms are associated with low-pressure systems that develop along the polar front in the North Pacific Ocean, and they propagate westward toward the central coast. Thus, major wave events often coincide with an increased discharge from the outfall due to heavy rainfall and increased I&I. These storms occur predominantly in winter (December through March). Less than 5% of all major deepwater wave events ($H_s > 4$ m) occur between the months of May and October (Everts Coastal 1996).

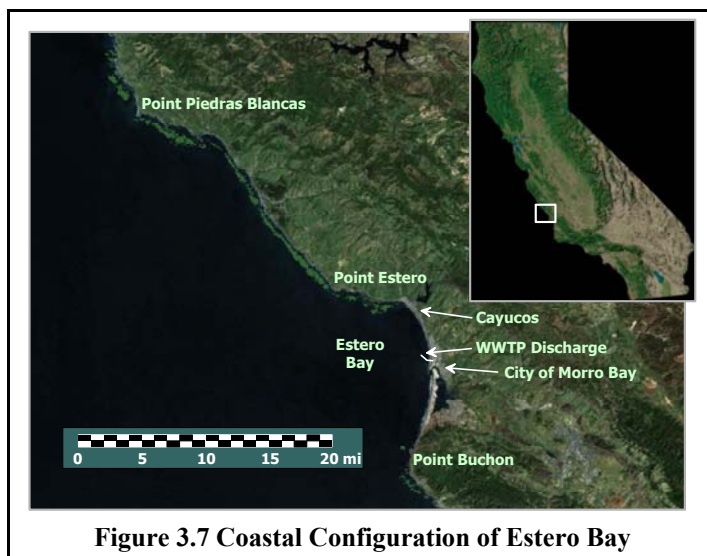


Figure 3.7 Coastal Configuration of Estero Bay

With the exception of major storm events, prevailing southwestward winds are the predominant mechanism for generating waves near the outfall. These winds dominate during the spring and summer when a high-pressure system is established over the eastern North Pacific Ocean. The winds are highly coherent over this section of the central coast and, consequently, can generate wind waves over a large fetch (Chelton et al. 1987). These locally generated waves tend to be of shorter period and smaller significant wave height than those generated by major winter storms.

3.2.4 Ambient Seawater Properties

A detailed understanding of ambient seawater properties, and their natural variability within the region surrounding the outfall, is an integral part of compliance evaluation. The receiving-water limitations in the NPDES permit echo the objectives listed in the COP (Table 3.1 on Page 3-3), and the central coast Basin Plan (RWQCB 1994). The offshore receiving-water surveys are designed to assess compliance with objectives dealing with undesirable alterations to six physical and chemical characteristics of seawater. Other components of the monitoring program address the remaining permit limits.

For the receiving waters, the permit states that wastewater constituents within the discharge shall not cause the limits listed in Table 3.7 to be exceeded (See Sections V.E through V.K of the permit). The first two receiving-water limits, L1 and L2, rely on qualitative visual observations for compliance evaluation. Compliance with the remaining four receiving-water limitations can be quantitatively evaluated through comparison of instrumental measurements and specific numerical limits listed in the NPDES permit. For example, the numeric limits on absolute values of DO (>5 mg/L) and pH (7.0 to 8.3), which reflect Basin Plan objectives, can be directly compared with observed excursions caused by the presence of wastewater constituents. However, the COP narrative limits define unacceptable water-quality impacts in terms of “significant” excursions beyond that which occurs “naturally.” Quantitative evaluation of these limits requires a comparison of any excursion with numerical thresholds that reflect the natural variation in transmissivity, DO, and pH within the receiving waters surrounding the outfall. The historical 23-year record of quarterly receiving-water surveys conducted as part of the MBCSD monitoring program provides the necessary insight into this natural temporal and spatial variation in ambient seawater properties close to the outfall.

Table 3.7 Permit Provisions Addressed by the Offshore Receiving-Water Surveys

Limit#	Provision	Source	Limit
P1	V.E	COP C.1	Floating particles or oil and grease to be visible on the ocean surface
P2	V.F	COP C.2	Aesthetically undesirable discoloration of the ocean surface
P3	V.I	Basin Plan	Temperature of the receiving water to adversely affect beneficial uses
P4	V.G	COP C.3	Significant reduction in the transmittance of natural light at any point outside the initial dilution zone
P5	V.J	COP D.1 Basin Plan	The DO concentration outside the zone of initial dilution to fall below 5.0 mg/L or to be depressed more than 10 percent from that which occurs naturally
P6	V.K	COP D.2 Basin Plan	The pH outside the zone of initial dilution to be depressed below 7.0, raised above 8.3, or changed more than 0.2 units from that which occurs naturally

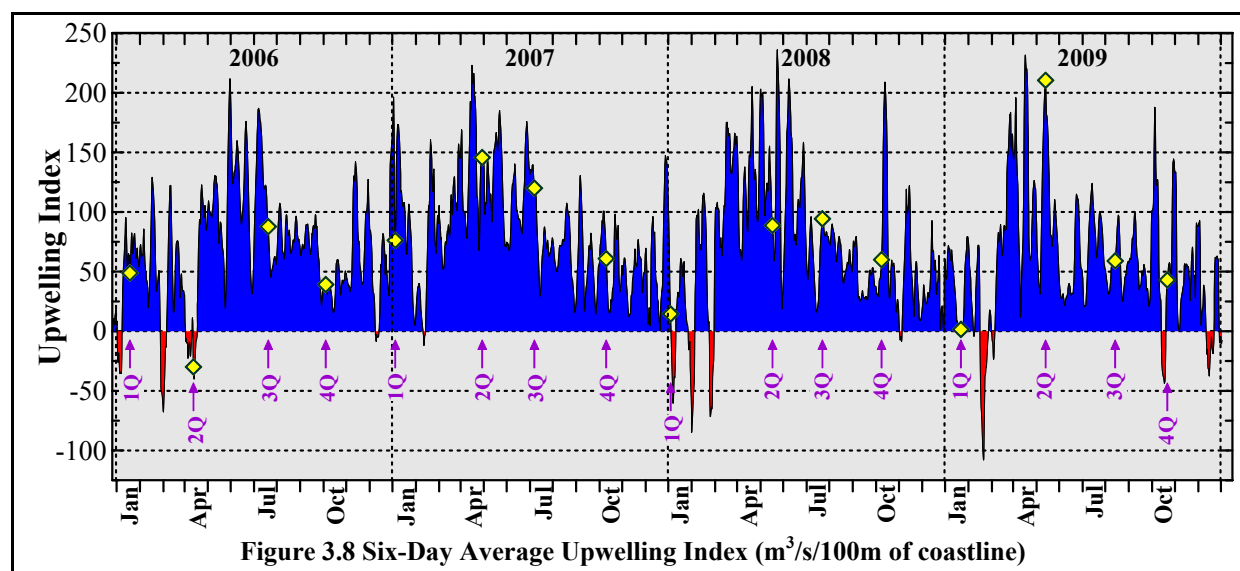
The oceanographic processes described in the previous subsection determine the spatial distribution of ambient seawater properties near the outfall, and how it changes seasonally. Of particular interest are upwelling and downwelling processes that not only determine average properties at a given time, but also the degree of water-column stratification, or spatial variability during any given survey. An accurate characterization of stratification helps distinguish between discharge-related changes that arise from the

presence of wastewater constituents, which are subject to a compliance evaluation, and changes that arise from the upward movement of ambient seawater, which is specifically excluded from the compliance evaluation. For the most part, however, temporal differences in seawater properties among surveys are far larger than spatial differences within individual surveys. For example, when the water column is moderately to highly stratified, vertical differences in seawater properties tend to be much larger than lateral differences.

The influence of seasonal variability on receiving-water properties is reflected in conditions observed during the four offshore surveys (Table 3.8). The strength of upwelling that prevailed at the time of each survey tends to influence the degree of stratification. The blue areas in the Figure represent times when southeastward-directed winds prevail near Estero Bay. These winds drive surface waters offshore, thereby inducing upwelling near the coast. The second- and third-quarter surveys of 2009 were both conducted during periods of upwelling (Figure 3.8). Conversely, the sharp, red spikes in February and October reflect downwelling events caused by passing storms which generate winds in the opposite direction (toward the northwest) creating an onshore surface flow. Downwelling associated with this onshore flow displaces deep watermasses offshore, where they no longer provide a nearshore vertical contrast in seawater properties, producing a uniform water column within the survey area.

Table 3.8 Oceanographic Conditions during the Four Quarterly Receiving-Water Surveys

Conditions	January (winter)	May (spring)	August (summer)	October (fall)
Tide	Ebb	Flood	Flood	Ebb
Wave Height (from)	4 W	5 NW	2 NW	4 NW
Flow Direction (toward)	NW	SE	SW	SE
Stratification	Absent	Strong	Strong	Weak
Water Clarity	High	Low	Very High	Moderate
Upwelling	Absent	Intense	Moderate	Downwelling
Plume Visible	No	No	No	Yes
Plume Signature	Yes	Yes	Yes	Yes



Temperature profiles at Station RW6 reflect the influence of upwelling at the time of the quarterly surveys, both in the degree of stratification and in average temperatures (Figure 3.9). Shallow thermoclines are evident in the May (blue) and August (red) profiles, while stratification is negligible in both the January (black) and October (green) profiles. Additionally, compared to winter (January) temperatures, mid-depth water temperatures were 3°C lower during the strong spring upwelling event in May, and 3°C higher during the fall (October) downwelling event.

For the most part, the other seawater properties reflect the vertical trends exhibited by the thermal structure associated with each survey. This includes the double thermocline of the August (red) profile, where a watermass of cold, dense, saline, turbid, and oxygen-poor was transported onshore at depth to replace surface water transported offshore by upwelling winds.

One important exception to the consistency among water properties was the vertical distribution of water clarity during the October 2009 survey, which exhibited a marked decrease near the seafloor due to the presence of suspended sediments from an onshore dredge discharge (green line in Figure 3.10). During the October survey, the Morro Bay harbor entrance was undergoing maintenance dredging. Spoils from this activity were released on the beach immediately shoreward of the survey area.

The sediment-laden slurry flowed downslope to the surfzone, where it was visually apparent as a turbid plume extending throughout much of the nearshore littoral zone. The data collected during the MBCSD receiving-water survey demonstrated that the dredge-plume formed a density current that flowed downslope, and entered the survey region along the seafloor. As it approached the diffuser structure, turbid dredge material was entrained within the rising effluent plume, creating a visible signature of the plume (Table 3.8). Wastewater-induced anomalies in water clarity during the October survey were exceedingly minute compared to the overwhelming influence of the turbid dredge material. Even so, the observed reductions in water clarity during the October survey still remained well within the range of natural variation. For example, overall water clarity in the region was substantially lower during the May (spring) survey (blue line in Figure 3.10). During that period of intense upwelling, the enhanced

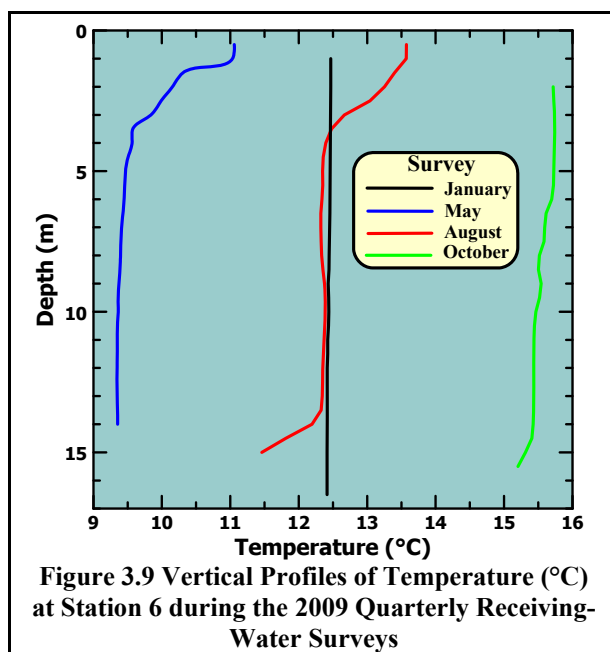


Figure 3.9 Vertical Profiles of Temperature (°C) at Station 6 during the 2009 Quarterly Receiving-Water Surveys

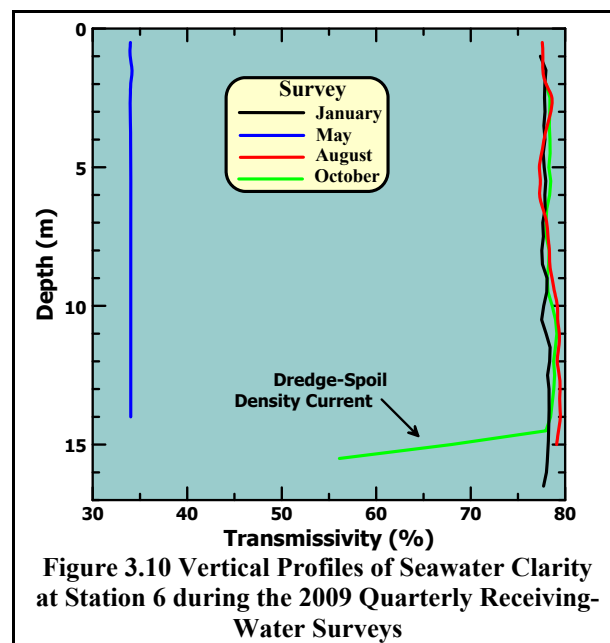


Figure 3.10 Vertical Profiles of Seawater Clarity at Station 6 during the 2009 Quarterly Receiving-Water Surveys

availability of nutrients increased plankton density and reduced transmissivity throughout much of the euphotic zone.

3.3 COMPLIANCE EVALUATION

This section evaluates the compliance of the MBCSD discharge in 2009 with the six permit limits listed in Table 3.7 on Page 3-17. The water-quality limitations are based on criteria in the COP (Table 3.1), the Central-Coast Basin Plan, and other state and federal policies that were designed to protect marine life and beneficial uses of ocean waters. Because the limits only pertain to changes in water properties that are caused by the presence of wastewater constituents beyond the ZID, instrumental measurements undergo a series of screening procedures prior to numeric comparison with the permit thresholds.

The quantitative analyses described in this section focus on water-property excursions caused by the presence of wastewater constituents, their proximity to the ZID, and their amplitude compared to the range in ambient fluctuations. The results of these analyses applied to data collected during 2009 demonstrate that the MBCSD discharge complied with the NPDES discharge permit during 2009, as has been the case for the prior two decades. Moreover, although observations close to the diffuser structure are not subject to compliance evaluations, they often meet the prescribed limits because observed dilution levels exceed the conservative design specifications assumed in the discharge permit. Thus, the quantitative evaluation described in this section documents an outfall and treatment process that was performing at high level during 2009.

3.3.1 Lines of Evidence

Evaluating whether any of the 9,030 receiving-water measurements collected in 2009 exceeds a permit limit is a complex process. For example, apparently significant excursions in an individual seawater property may be unrelated to the presence of wastewater constituents, and may instead be due to any number of confounding factors. These confounding factors include statistical uncertainties, instrumental errors, natural processes, anthropogenic influences unrelated to the discharge, entrainment and upward transport of ambient bottom waters in the rising effluent plume, and ongoing initial mixing within and beyond the ZID.

Because of this complexity, compliance during 2009 was evaluated using a “multiple-lines-of evidence” (LOE) approach similar to that used to implement sediment quality guidelines for California estuaries (SWRCB 2009). Specifically, each receiving-water observation was screened for compliance by evaluating the measurement with a sequence of eleven questions (lines of evidence), identified in Table 3.9. Multiple lines of evidence for the existence of an out-of-compliance event would be indicated by affirmative answers to a number of the questions. As described below, detailed analysis demonstrates that there were no out-of-compliance events associated with receiving-water limitations in 2009.

Completion of Initial Dilution

The COP states that compliance with its receiving-water objectives “*shall be determined from samples collected at stations representative of the area within the waste field where initial dilution is completed.*” Initial dilution includes the mixing that occurs from the turbulence associated with both the ejection jet, and the buoyant plume’s subsequent rise in the water column. During the plume’s rise in the water column, strong currents can transport it a substantial distance from the discharge point. This is evident because the signature of the positively buoyant plume is occasionally observed at mid-depth well beyond the ZID when current flow is strong, indicating that the plume is continuing to undergo initial mixing beyond the boundaries of the ZID.

Table 3.9 Lines of Evidence used to evaluate whether an individual Receiving-Water Measurement exceeded a Permit Limit

LOE#	LOE Question
LOE#01	Was the measurement collected beyond the 15.2-m ZID boundary?
LOE#02	Was the measurement associated with a quantifiable salinity anomaly (550:1 dilution level) indicative of the presence of wastewater constituents?
LOE#03	Was the salinity anomaly (dilution level) unaffected by salinity spiking?
LOE#04	Was the measurement located along the path of expected plume trajectory?
LOE#05	If the measurement was from the tow-survey, was its depth consistent with other measurements from the same tow, or if measured in a vertical profile, was it measured at a depth level other than the sea surface or seafloor and where there were an adequate number of similar measurements for comparison?
LOE#06	Did any of the seawater properties associated with the measurement depart significantly from the natural range in ambient seawater variability at the time of the survey?
LOE#07	Did the measurement exceed its respective numerical permit limit?
LOE#08	Was the direction (sign) of the anomaly consistent with the expected difference between wastewater and seawater properties?
LOE#09	Was the anomaly spatially coincident with anomalies in other seawater properties?
LOE#10	Was anomaly unrelated to non-discharge phenomena such as the presence of dredge spoils, stormwater runoff, or a benthic boundary layer?
LOE#11	Was there an upset in the WWTP process, or were there known problems with the outfall that would account for the anomalous measurement?

However, the COP also states that dilution estimates shall be based on “*the assumption that no currents, of sufficient strength to influence the initial dilution process, flow across the discharge structure.*” Because of this, modeling used to establish the MBCSD critical initial dilution of 133:1 assumed completion of dilution within a standard regulatory mixing distance equal to the 15.2-m water depth of the discharge. For the purposes of screening receiving-water data for compliance, the conservative 15.2-m distance threshold is used to restrict attention to post-dilution observations in LOE#01.

Application of the ZID-distance threshold (LOE#01) to the original 9,030 receiving-water observations eliminates 1,440 receiving-water observations from further consideration because they were collected within the ZID. Although it is likely that some of the remaining 7,590 observations were collected within the buoyant effluent plume as it continued mixing beyond the ZID, for screening purposes these measurements are carried forward in the compliance analysis.

Presence of Wastewater Constituents

The MBCSD discharge permit restricts application of the numerical receiving-water limits to excursions caused by the presence of wastewater constituents. This confines the compliance analysis to changes caused “*as the result of the discharge of waste,*” as specified in the COP, rather than anomalies that arise from the movement of ambient seawater entrained in the effluent plume. Analyses conducted on quarterly receiving-water surveys over the last decade have demonstrated that the direct influence of dilute wastewater is almost never observed in any seawater property other than salinity, except very close (<1 m) to a diffuser port and within its ejection jet.

In fact, negative salinity anomalies are the only consistent indicator of the presence of wastewater constituents within receiving water. Salinity in wastewater is negligible compared to that of the receiving seawater, so the presence of a distinct salinity minimum provides *de facto* evidence of the presence of wastewater constituents. Because of the large difference between the nearly fresh wastewater and the

saltier receiving waters, salinity provides a powerful tracer of dilute wastewater that is unrivaled by other seawater properties. Other properties do not exhibit such a large contrast and, as such, their signatures dissipate rapidly upon discharge with very little mixing. Wastewater's lack of salinity, however, provides a powerful marker that allows the presence of effluent constituents to be identified even after dilution many times greater than the 133-fold critical initial dilution assumed in the discharge permit.

Detection Threshold

Wastewater-induced reductions in salinity can be used to directly determine the amount of dilution achieved by initial mixing. Because wastewater has essentially no salinity, C_e can be neglected in Equation 3.1, and dilution (D) can be computed from the salinity anomaly ($A = C_o - C_s$) as:

$$D = \frac{-C_o}{(C_o - C_s)} \equiv \frac{-C_o}{A} \quad \text{Equation 3.2}$$

where:

- D = the dilution ratio of the volume of seawater mixed with wastewater,
- C_o = the salinity of the wastewater-seawater mixture after dilution by D ,
- C_s = the background seawater salinity, and
- $A = C_o - C_s$ = the salinity anomaly.

The smallest reduction in salinity that can be reliably detected within receiving waters is 0.062‰, which reflects a dilution level of at least 542-fold when substituted into Equation 3.2. The 0.062‰ salinity-reduction threshold was determined from a statistical analysis of the natural variability in salinity readings measured near the outfall over the last five years. Salinity readings potentially affected by the presence of wastewater constituents were excluded from the analysis of more-than 9,200 observations collected during 20 quarterly surveys conducted between 2004 and 2008. Within individual surveys, salinity was found to vary naturally by 0.062‰,⁹ indicating that smaller wastewater-induced salinity reductions cannot be reliably discerned against the backdrop of natural variation. The 33.59‰ mean salinity determined from the ambient database was further substituted into Equation 3.1 to provide a conservative estimate of the 542:1 maximum detectable dilution. The actual maximum dilution is probably smaller than this threshold because C_o , the salinity of the dilute wastewater specified in Equation 3.2 will be far less than the 33.59‰ background salinity (C_s) actually applied in the equation.

As a final level of conservatism, the dilution threshold used in LOE#02 was rounded up to 550-fold. Observations eliminated based on the application of LOE#02 restrict attention to wastewater-induced excursions in temperature, light transmittance, DO, and pH that are related to the presence of wastewater constituents (Table 3.7). Specifically, application of LOE#02 to the 2009 receiving-water database eliminates 7,150 of the 7,590 observations remaining after the application of LOE#01. For these observations, salinity reductions were less than 0.062‰ relative to average levels within each survey, and represent dilutions above 550:1 that are not reliably resolved in the database, and that would be far below discernable changes in other seawater properties. That leaves a total of 440 measurements collected in 2009 that remain of interest from a compliance standpoint.

⁹ Lower 95% one-sided single-sample confidence interval computed in accordance with the COP definition of "significant" as a "statistically significant difference in the means of two distributions of sampling results at the 95 percent confidence level"

Compliance within the ZID

As discussed above, application of the first two LOEs to the instrumental measurements collected during 2009 effectively eliminates approximately 95% of the original 9,030 measurements from consideration. This allowed more careful consideration of the remaining observations by restricting attention to the location and types of measurements that were relevant for the compliance evaluation.

Screening with LOE#01 and LOE#02, eliminated all of the measurements collected during the January survey from further compliance evaluation. This is the case even though strong negative salinity anomalies indicative of the presence of wastewater constituents can be observed in the vertical section collected during the January survey (Figure 3.13a on Page 3-24). The 0.125‰ salinity reduction near 11 m at Station RW3 was excluded because it was located within the ZID, where receiving water limits do not apply. Although the January anomaly's location in the vertical section appears 20 m north of the outfall's centerpoint (Figure 3.13a), it was actually positioned 9.9 m from the northern extent of the diffuser structure (Table 3.4, Figure 3.11), and therefore was subject not to the compliance evaluation.

The anomaly at Station RW3 was located along the expected trajectory of the discharge plume, as delineated by the drogued-drifter path shown in the Figure 3.11. It captured the plume near the seafloor shortly after discharge, and while it was still undergoing intense mixing. Even at that point, the discharge had exceeded the 133:1 predicted dilution well before completion of initial mixing, and was meeting COP water-quality objectives well within the ZID. The observed salinity anomaly corresponded to a dilution of at least 266-fold and was still undergoing intense mixing as it continued to rise through the water column. Its strong buoyancy is indicated by the large negative density anomaly that coincided with the salinity anomaly (Figure 3.12). Even though it had yet to complete initial mixing, wastewater-induced thermal

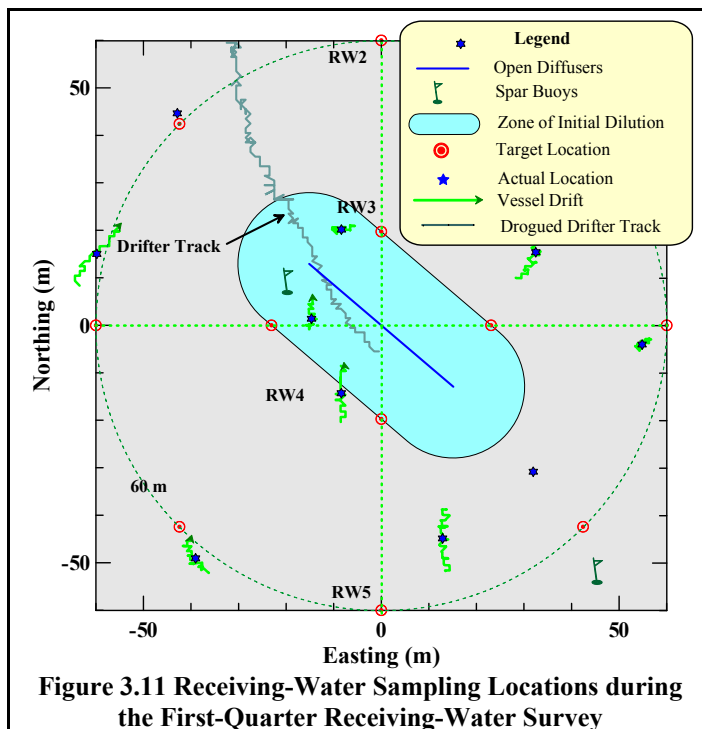


Figure 3.11 Receiving-Water Sampling Locations during the First-Quarter Receiving-Water Survey

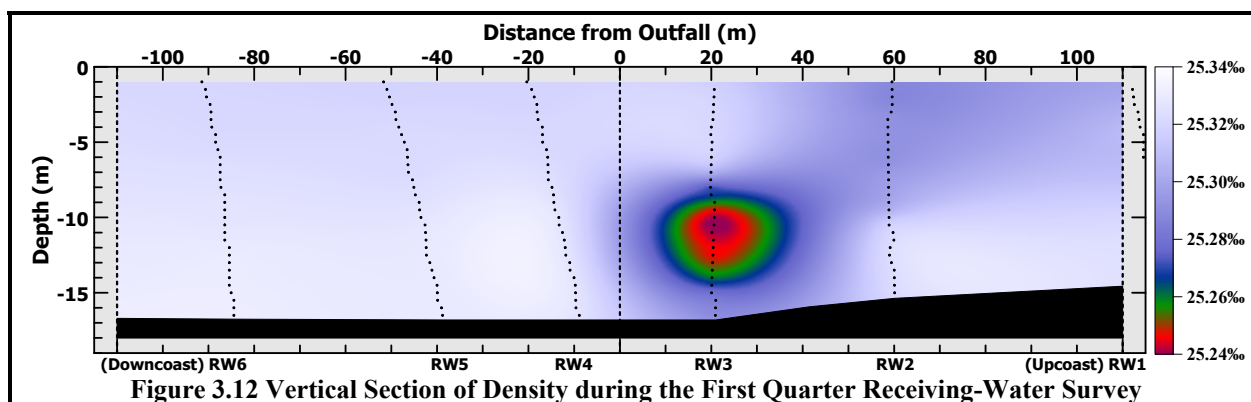


Figure 3.12 Vertical Section of Density during the First Quarter Receiving-Water Survey

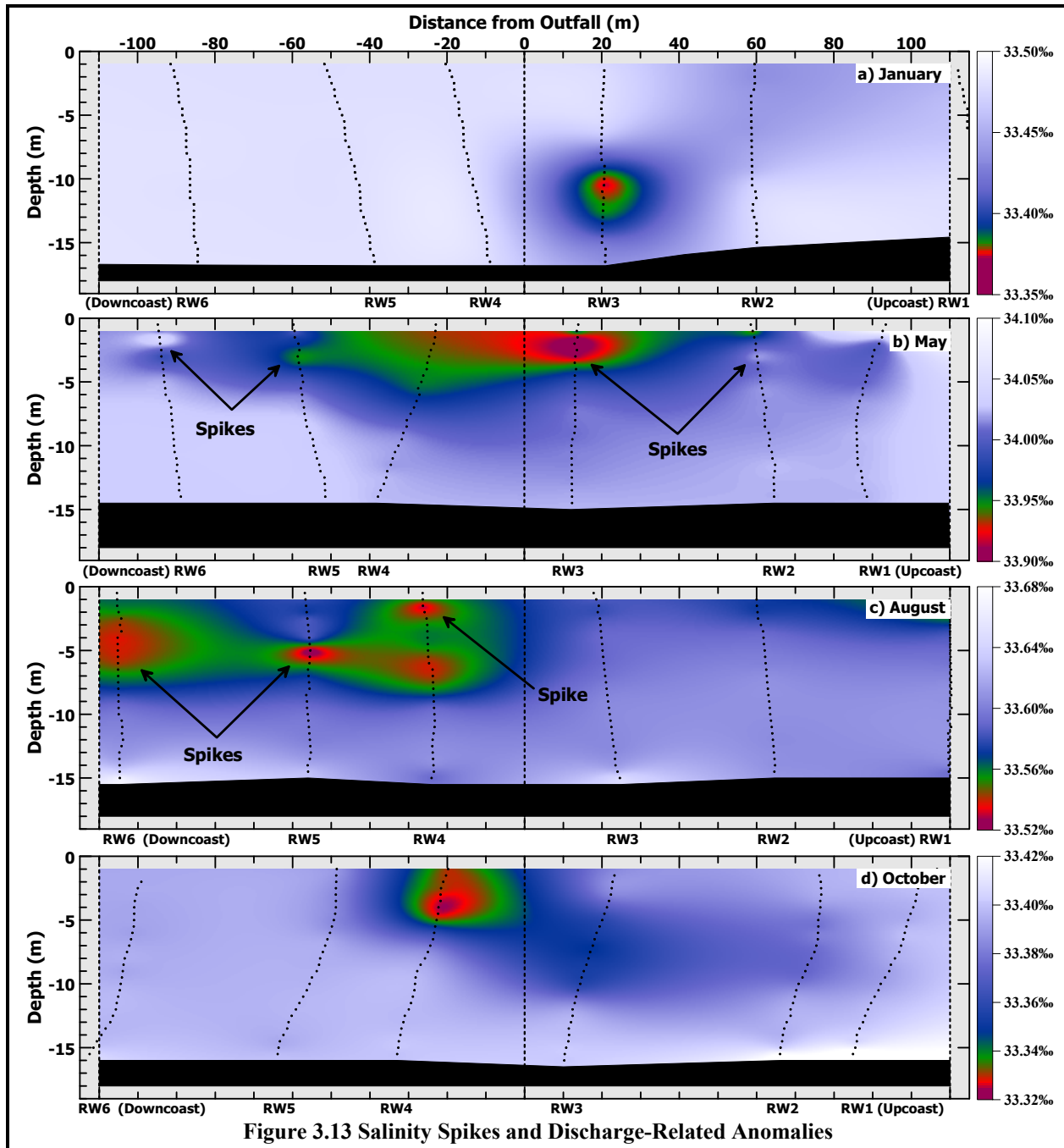


Figure 3.13 Salinity Spikes and Discharge-Related Anomalies

and DO excursions were imperceptible, and the exceedingly small pH and transmissivity reductions were close to the reported accuracy of the CTD sensors, and well within the numerical limits of the permit.

Salinity Spikes

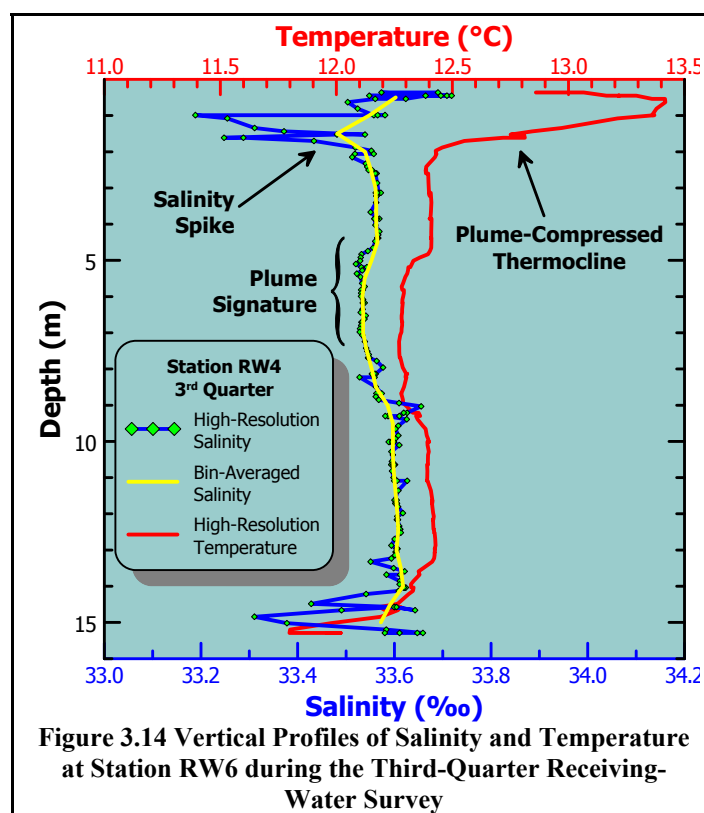
Unlike the January salinity anomaly, not all of the 440 CTD measurements that remained after application of LOE#01 and LOE#02 were associated with the perceptible presence of wastewater constituents. For example, large yet artificial excursions in salinity can result from instrumental errors, known as salinity spikes, that are introduced when the CTD crosses a sharp thermocline. Salinity spikes often appear near

the base of the thermocline, and sometimes coincide with wastewater-induced anomalies, leading to an overestimate of dilution levels. Spikes usually appear as sharp highly localized decreases in salinity, for example, shown by the red shading at Stations RW4, RW5, and R6 in Figure 3.13c. Occasionally, weaker positive salinity spikes occur as shown by the lighter shading at Stations RW2 and RW6 in Figure 3.13b.

Spikes appear because salinity is not measured directly, but is computed from conductivity and temperature readings. These two probes do not measure the same water parcel because the sensors are physically separated within the CTD instrument package. In addition, the sensors do not have the same response times. Consequently, when passing through regions of sharp temperature gradients, the mismatch between the recorded conductivity and temperature measurements results in erroneous spikes in computed salinity. During 2009, salinity spiking was documented during the May and August surveys, when upwelling caused the water column to become well stratified, creating well-defined thermoclines.

Spiking can create, or artificially increase estimated dilution levels, and thus some of the measurements left after screening by LOE#01 and LOE#02, do not reflect the presence of a significant amount wastewater (LOE#03). However, it is difficult to determine from an inspection of vertical sections alone whether a particular salinity anomaly occurred because of, or was enhanced by spiking. That determination requires examination of high-resolution vertical-profile data.

For example, the vertical section from August exhibits pair of stacked salinity anomalies at Station RW4, which is an unrealistic configuration for a plume signature (Figure 3. Figure 3.13c). Not surprisingly, the near-surface salinity anomaly is in fact a salinity spike caused by the rising effluent plume as it compressed the thermocline and created a sharper thermal gradient that was originally present. This is apparent in Figure 3.14 where the vertical extent of the plume is delineated below 5 m as a slight reduction in temperature (red line) and smoothed (bin-averaged) salinity (yellow line). The plume-enhanced thermocline below 1 m resulted in large negative spikes in the raw salinity data (blue), which influenced the bin-averaged salinity (yellow), and resulted in an erroneous salinity anomaly whose amplitude exceeded that of the original plume signature at depth.



Plume Transport

Although the presence of a potential spike-induced salinity anomaly is one of the lines of evidence (LOE#03) used to eliminate data from further compliance evaluation, erroneous spike readings are often found in locations inconsistent with the path of plume transport (LOE#04), adding additional rationale for their exclusion.

More than a decade of receiving-water monitoring around the MBCSD outfall has demonstrated that the plume signature is almost always exclusively located downstream of the diffuser structure. The only exceptions are rare, and occur when flow speeds are negligible (<1 cm/s), or when there is a reversal in flow during the survey. Neither was the case during the surveys conducted in 2009. Although the flow direction was different among surveys, directions were consistent within surveys and speeds were steady, exceeding 4.2 cm/s. At those transport speeds, the plume traverses the ZID in six minutes. Even if the plume became trapped at depth during highly stratified conditions, is unlikely to spread upstream beyond the ZID in the face of such powerful currents.

Of the 440 observations remaining after application of LOE#01 and LOE#02, only one-quarter (112) were found to lie along the path of plume transport (LOE#04). Most of the other observations that were not aligned within a 90° swath of the plume transport direction were also found to be associated with salinity spikes. For example, it is clear that the two salinity spikes located north of the diffuser structure at Stations RW2 and RW3 during the May survey (Figure 3.13b) could not have been caused by the presence of wastewater constituents that were being transported to the south by a strong current. Most of the other off-path data, however, were associated with the tow-surveys conducted in May, when slight variations in the tow depth of the CTD caused lateral salinity anomalies to appear, depending on where within the sharply stratified water column the measurement was collected (LOE#05). The depth fluctuations introduced a large number of apparent lateral differences due to salinity spiking.

Natural Variability

An important part of the compliance analysis is determining whether a particular measurement resulted from the discharge of wastewater constituents. If the measurement does not significantly depart from the natural range in ambient seawater properties at the time of the survey, then it is difficult to ascribe it to the discharge. Thus, quantifying the natural variability around the outfall is necessary for the evaluation of discharge compliance (LOE#06).

With that in mind, a statistical analysis of the large historical database of receiving-water data collected around the outfall was used to establish the range of variability in site-specific natural conditions, and the departures from those conditions that could be indicative of adverse effects on water quality. The same five-year database used to establish the within-survey salinity variation was used to establish one-sided 95% confidence bounds on transmissivity (-10.2%), temperature (+0.82°C), DO (-1.4 mg/L), and pH (± 0.94). These were combined with 95th percentiles for seawater property from each survey, in a manner analogous to COP Appendix VI. The percentiles were determined from vertical profile data excluding measurements potentially affected by the discharge. This resulted in a set of thresholds for water properties that were used to screen data from each survey for a significant departure from natural conditions (Table 3.10).

Table 3.10 Thresholds for Significant Departures from Natural Conditions

Water Property	January	May	August	October
Temperature (°C)	>13.29	>11.12	>14.10	>16.56
Transmissivity (%)	<66.8	<44.3	<67.3	<53.0
DO (mg/L)	<7.55	<2.21	<6.17	<6.48
pH (minimum)	<8.386	<7.902	<7.939	<8.168
pH (maximum)	>8.588	>8.388	>8.211	>8.389

Only five measurements out of the 440 measurements that were potentially related to the presence of wastewater constituents beyond the ZID in 2009 exceeded the thresholds listed in the table. Application of LOE#6 identified the following anomalous measurements for further compliance assessment.

1. Temperature (11.324 °C), and
2. pH (8.407) at 0.5 m in the vertical profile at RW5 in the May survey at a location 50 m from the diffuser structure.
3. pH (8.403) at Scan# 2737 during the deep tow in the May survey at a location 17.1 m southwest of the diffuser structure, out of the path of plume transport and not coincident with anomalies in other seawater properties.
4. pH (8.401) at Scan# 5661, and
5. Scan# 5662 when the CTD slowed and dropped below 6.4 m when turning during the deep-tow-survey in October at a location 15 m due south of the diffuser structure and out the plume trajectory.

Application of other LOEs unequivocally demonstrates that none of these measurements constitute an out-of-compliance event. For example, all of the subject pH values represent slight exceedances of the maximum threshold. Because the pH measured daily in effluent at the treatment effluent never exceeded 7.8 during 2009 (see Section 2.2.5), the presence of wastewater constituents could not have possibly been responsible for any pH increase in the receiving seawater since the lowest pH measured in seawater was 0.2 pH units higher (LOE#08). Besides, the 0.02 increase above ambient pH was an order-of-magnitude less than the 0.2 allowance in the COP (LOE#06), and the readings did not coincide with anomalies in other seawater properties (LOE#09).

Similarly, the elevated temperature measured in the May survey was only 0.2°C higher than the cold ambient seawater brought onshore by upwelling at that time, and much less than the temperatures in other seasons (Table 3.10), so it is unlikely it adversely beneficial uses (LOE#07). Furthermore, the measurement was collected within the thin surface mixed layer, above a sharp thermocline (Figure 3.9 on Page 3-19) where slight depth variations lead to large perceived lateral differences (LOE#05).

3.3.2 Instrumental Measurements

As in prior years, instrumental measurements collected during the 2009 surveys demonstrated that the discharge fully complied with receiving water limitations. Irrespective of the cause of the observed perturbations in seawater properties, or their location, none of the perturbations constituted an exception to the limitations promulgated by the NPDES discharge permit, the COP, or the central-coast Basin Plan.

The addition of tow-surveys to the monitoring program in May of 2009 provided enlightening insight into the limited footprint of the discharge. Prior monitoring, which relied on vertical profiles spaced 30 m apart could not accurately delineate the lateral extent of a plume whose influence was largely restricted to the 15-m-wide ZID (Figure 3.15). The inclusion of the tow survey allows

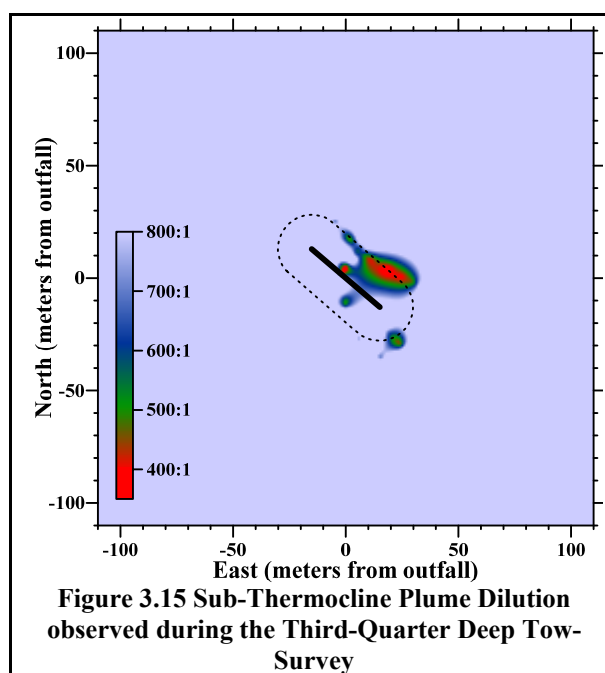


**Figure 3.15 Sub-Thermocline Plume Dilution
observed during the Third-Quarter Deep Tow-
Survey**

precise delineation of the disposition of the effluent plume. This significantly expedites compliance evaluations based on multiple lines of evidence by screening irrelevant (non-discharge-related) observations from consideration (LOE#01 and LOE#02).

The analysis of instrumental measurements collected in 2009 demonstrate that even within the ZID, where exceptions to numeric limitations in the COP are allowed, wastewater is diluted to levels far higher than expectations based on dilution modeling. In general, only slight salinity and density anomalies reveal the presence of very well mixed effluent close to the diffuser structure. Those observations, e.g. the 266-fold dilution in January, demonstrate that discharged wastewater was undergoing rapid dilution immediately after discharge, and that the diffuser structure was operating at a level better than originally designed.

The general absence of perceptible wastewater-induced fluctuations in other water properties, such as turbidity, DO, and pH also demonstrates the efficacy of the onshore treatment process in 2009. The treatment process effectively eliminates the vast majority of suspended solids and oxygen-demanding material from the wastestream. The remaining residual material is rapidly dispersed shortly after discharge into the particularly well-flushed, open-ocean environment of Estero Bay. As a result, wastewater constituents neither accumulate on the seafloor nor impose an oxygen demand on ambient seawater.

3.3.3 Visual Observations

The analysis of instrumental observations described above does not address compliance with the two remaining permit limits addressed by the offshore receiving-water surveys, namely, those dealing with the presence of floating particles, oil and grease, or aesthetically undesirable discoloration of the ocean surface (Permit Limits P1 and P2 in Table 3.7 on Page 3-17). During 2009, there was no visual evidence of discharge-related impacts to the ocean surface. The only time any visual indication of the discharge plume was apparent occurred when increased turbidity was observed within the water column during the October survey. However, as described below, it was unrelated to the presence of wastewater particulates.

In addition to qualitative observations described above, compliance with permit requirement #4 dealing with the transmittance of ambient light was addressed with visual estimates of Secchi disk depth that were collected at each station during 2009 (Table 3.11). The permit places restrictions on impacts to water clarity specifying that the discharge shall not cause a “*significant reduction in the transmittance of natural light at any point outside the initial dilution zone as a result of the discharge of waste.*” This requirement stems from COP Objective C.3 in Table 3.1.

**Table 3.11 Average Secchi Depths (m)
measured near the Diffuser and at Distant
Locations**

Survey	Nearfield ¹	Reference
January	8.2	7.7
May	4.0	3.5
August	8.5	8.6
October	5.7	7.0

¹ Within 30 m of the diffuser structure

Although there were no exceptions to this requirement due to the presence of wastewater constituents during 2009, the entrainment of material from nearby dredging operations led to localized increases in turbidity within the upper water column that were reflected in reduced Secchi depths near the ZID. As described above, dredge spoils released on the beach adjacent to the survey area could be seen suspended in the water column between the shoreline and the shoreward limit of the survey area. The suspended material sank and formed a density current along the seafloor that entered the ZID, where it was entrained

in the rising effluent plume. The increased turbidity was reflected in highly localized reductions in transmissivity during the October tow surveys (Figure 3.16, Figure 3.10), and created a visual signature of the submerged plume's location.

3.3.4 Surfzone Bacteria

The surfzone along Atascadero State Beach was monitored during the first two months of 2009 to assess bacteriological levels, aesthetic conditions, and compliance with the previous NPDES permit. MBCSD WWTP personnel collected water samples from the eight surfzone stations and analyzed them for total and fecal coliform densities (Figure 3.1 on Page 3-5; Table 3.2 on Page 3-4). Coliform densities at all stations were at or below the 2 MPN/100 ml detection limit except at the upcoast midfield station (A), where densities for both fecal and total coliform were 130 MPN/100 ml. Reported densities met the water-contact bacterial standards and were unrelated to the discharge. During this period, and throughout the balance of the year, the low coliform densities reported in effluent samples provided *de facto* evidence that the discharge complied with all receiving-water permit requirements pertaining to bacterial standards (see Chapter 2). There were no instances of elevated effluent coliform that triggered the requirement for surfzone sampling outlined in the current discharge permit.

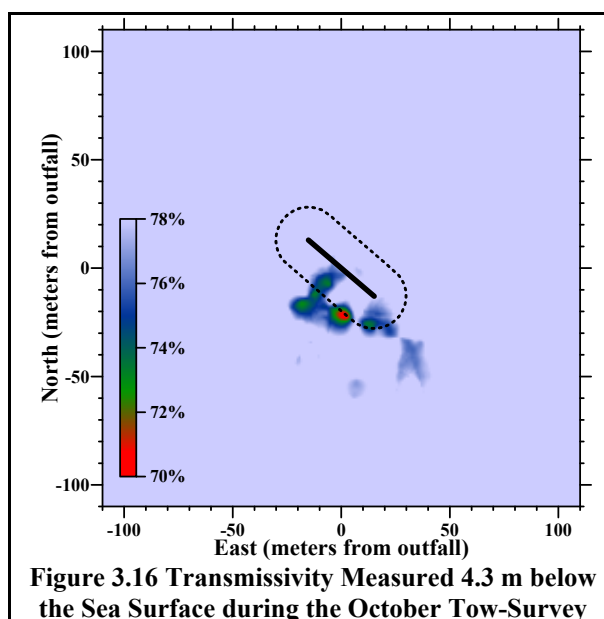


Figure 3.16 Transmissivity Measured 4.3 m below the Sea Surface during the October Tow-Survey

3.4 BENEFICIAL USE

Observations of beneficial use demonstrated that the coastal waters in the outfall vicinity and along adjacent shoreline continued to be utilized by humans and wildlife during the 2009 water-quality surveys. There was no evidence indicating that the discharge detracted from the beneficial uses that were identified for northern Estero Bay in the Basin Plan (see Section 2.1.2). Specifically, fish, marine mammals, and seabirds were observed utilizing the area within and around the ZID area as marine habitat (*viz.*, the MAR beneficial-use identified for the waters of Estero Bay in the Central-Coast Basin Plan outlined in Section 2.1.2). The presence of surfers, kayakers, beachcombers, and commercial and recreational fishing boats attested to the use of the waters for water recreation (*REC-1* and *REC-2*), transportation (*NAV*), and fishing (*COMM*).

A variety of marine organisms were observed during the 2009 water-quality surveys. These included large numbers of California brown pelicans (*Pelecanus occidentalis californicus*), western gulls (*Larus occidentalis*), and Heermann's gulls (*Larus heermanni*) which were generally observed transiting through the survey area during the surveys. Pelagic and Brandt's cormorants (*Phalacrocorax*), which nest on Morro Rock, were also frequently observed. Western grebes (*Aechmophorus occidentalis*) were observed during transit to and from the survey area during the May survey.

In addition to avian fauna, sea lions (*Zalophus californianus*), harbor seals (*Phoca vitulina*), gray whales (*Eschrichtius robustus*), and southern sea otters (*Enhydra lutris nereis*) were observed during several of the surveys (Figure 3.17). Higher numbers of sea lions and otters were typically observed near the Morro Bay harbor entrance and during transit to and from the survey site, than at the survey site itself. For example, during the January 2009 survey, four female southern sea otters and their attendant pups were observed within the confines of the harbor channel. Five additional



Figure 3.17 Southern Sea Otter Photographed within Morro Bay during Survey Demobilization

otters were observed engaged in feeding and play activities within this same area. Similarly, during the August survey six otters were observed inside of the harbor mouth, while two more were observed en route to the survey area. During the survey itself, four otters and several sea lions were observed transiting through the greater survey area. During the May 2009 survey, two gray whales (*Eschrichtius robustus*) were observed just outside the breakwater of the harbor. Pieces of detached bull kelp (*Nereocystis luetkeana*) were noted drifting in the survey area and during transit to the survey area during most surveys.

Recreational (*REC*) beneficial uses were also in evidence during the 2009 surveys. For example, non-contact water recreational activities, designated as *REC-2* in the Basin Plan, were observed along Atascadero Beach during the regularly conducted surfzone surveys. Individuals were documented hiking, jogging, beachcombing, and walking their dogs on the beach. Water-contact recreation, designated *REC-1* in the Basin Plan, also occurs frequently along the beach adjacent to the outfall. This includes activities such as surfing, swimming, body surfing, kayaking, and kite and wind surfing. Commercial and sport-fishing vessels were also regularly observed during the course of the quarterly surveys, demonstrating the area's ocean-fishing (*COMM*) usage.

CHAPTER 4

Marine Sediments and Benthic Biota

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4.0 MARINE SEDIMENTS AND BENTHIC BIOTA

This chapter describes the coastal benthos within Estero Bay where the MBCSD effluent is discharged. The MBCSD Offshore Monitoring Program includes benthic observations to assess potential impacts of wastewater discharge on marine sediments and the infaunal community near the outfall. Benthic environments are important indicators of the presence of marine pollution because they are the major reservoir for most contaminants that enter the ocean. Deleterious changes in the benthic environment, resulting from the deposition of effluent particulates, have been observed around other coastal outfalls (e.g., Stull et al. 1986a); however, no such impacts have been found after 24 years of benthic monitoring around the MBCSD outfall. This includes the October 2009 survey described in this chapter.

In the marine ecosystem, organic and inorganic matter are dynamically interrelated, and the quality of the material deposited on the seafloor directly affects the health of infaunal communities. Therefore, both the physicochemical and biological properties of the benthos are described in this chapter. Infauna residing within sedimentary environments serve as indicators of contaminated sediments because of their limited mobility and well-defined responses to pollution. Numbers of species, abundance, biomass, and other parameters of community composition can indicate contaminant-caused stresses if, for example, gradients are observed extending from a pollutant source to more distant, unaffected areas.

This chapter presents the full results of the benthic survey conducted on 20 October 2009. Physical properties of sediments are tabulated in Appendix C and chemical data from the survey are tabulated in Appendix E of this report, while benthic biological data are provided in Appendix B. BC Laboratories conducted the relevant chemical analyses following methods described by Tetra Tech (1986ab). Marine Research Specialists performed the infaunal community analyses and data synthesis.

The following section describes the benthic-monitoring program, including collection methods and station design. The second section of this chapter presents the findings related to the physicochemical analysis of the sediments. The last section describes the health of the benthic infaunal community residing within Estero Bay during 2009.

4.1 MONITORING PROGRAM

As with the water-quality monitoring described in Chapter 3, sediment samples were collected at reference and outfall stations to investigate any potential discharge-related impacts to the benthos. The samples were analyzed for physicochemical properties and infaunal community composition in order to compare the benthic environment at these two sets of stations, as well as at gradient stations in between.

4.1.1 Scope of Monitoring

On 20 October 2009, offshore sediment samples were collected at seven stations within Estero Bay (Figure 4.1). The field sampling and laboratory procedures adhered to the requirements of the current Monitoring and Reporting Program (RWQCB-USEPA 2009). During the more than two decades of offshore monitoring, the benthic-monitoring program has undergone a number of major modifications. The original permit, issued in 1985, required semiannual sediment collection at six stations with physicochemical analysis of a composite of three replicate grab samples collected at each station. The stations were distributed around the outfall along a north-south isobath. Five of these original stations have continued to be sampled throughout the monitoring program. The sixth station, a “reference” station located 1 km to the south, was dropped when the permit was reissued in 1993 because it was found to be unrepresentative of the benthic environment near the outfall.

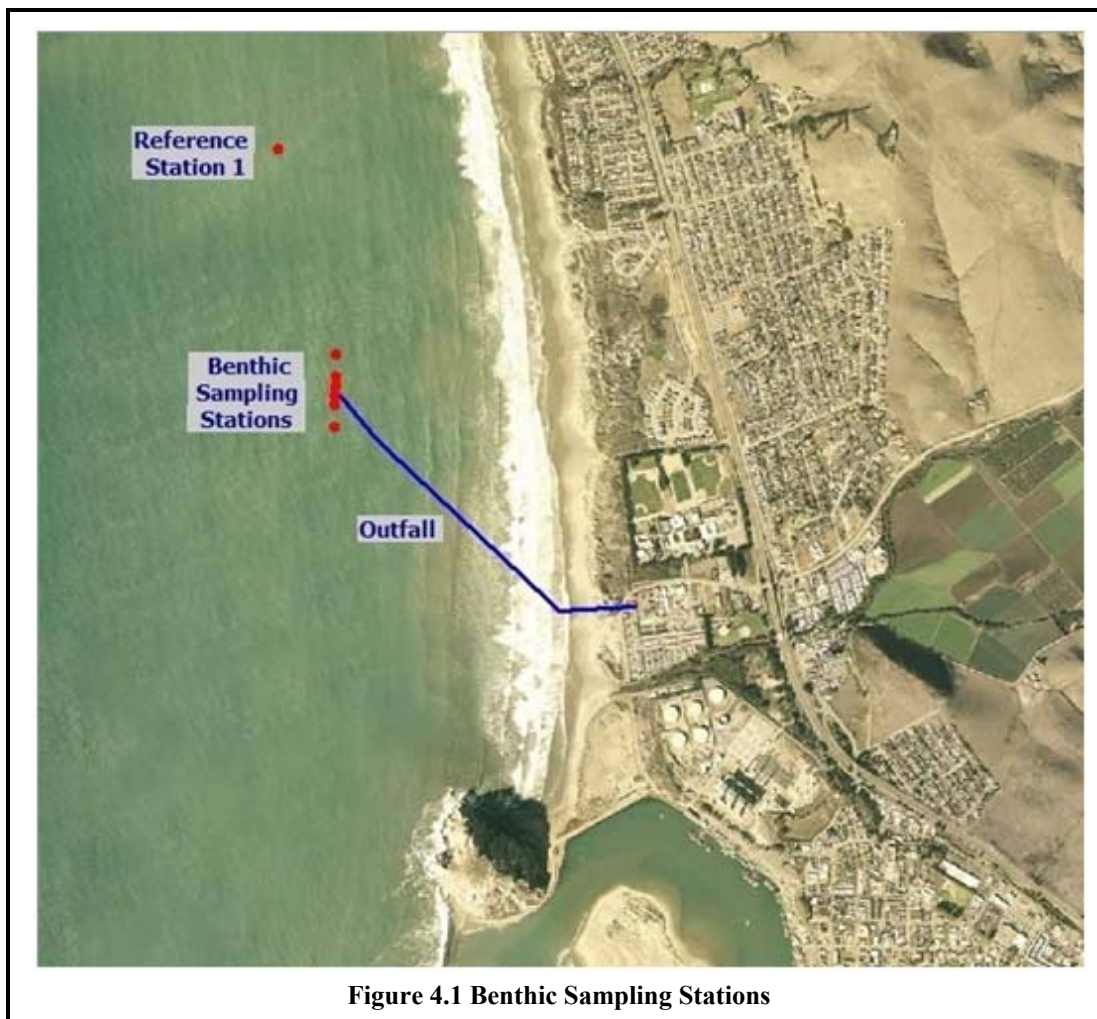


Figure 4.1 Benthic Sampling Stations

The discharge permit that was reissued in 1993 (RWQCB-USEPA 1993ab) also changed laboratory protocols. It required separate chemical analysis of each of the replicate samples collected at the five Stations. Separate analyses of replicate samples quantified the within-station variability and lent insight into the statistical significance of spatial differences among stations. In particular, this report uses the replicate chemical analyses conducted in 1993 and 1994 to establish confidence intervals around concentrations measured at each station. In 1995, chemical analysis reverted to a composite protocol where aliquots from each of the three replicates collected from a station were homogenized into a single composite sample in the laboratory before extraction.

Further modifications were implemented when the NPDES permit was issued in 1998 (RWQCB-EPA 1998ab). After 13 years of monitoring, the amplitude of seasonal fluctuations had been adequately determined, eliminating the need for a post-winter survey. As a result, the focus of monitoring shifted to the determination of interannual changes in spatial patterns. To that end, four additional benthic sampling stations, located 60 m from the outfall, were added to the five historical stations. The cross-shore configuration of two of these new stations (Stations 8 and 9) provided a more spatially balanced sampling pattern capable of detecting potential impacts that might not be restricted to along-shore directions. Finally, chemical analyses were performed on a single grab sample collected at each of the nine stations.

Based on an analysis of the previous 23 years of benthic data, the current permit (RWQCB-EPA 2009), adopted in January 2009, also instituted several changes to the program. First, chemical analysis protocols reverted to those utilized prior to 1998, where aliquots from each of three replicates collected at a station are homogenized into a single composite sample prior to analysis. This reduces uncertainty in the reported station concentrations by reducing within-station variability while not increasing the cost from chemical analysis of individual replicates from each station. Second, the permit eliminated the analyses of sulfides within benthic porewater samples. High-resolution analyses conducted over the previous six years had definitively demonstrated that the Estero Bay sediments do not contain measureable levels of dissolved sulfides. Finally, the cross-shore benthic monitoring stations (Stations 8 and 9) were eliminated from the sampling pattern because the inherent differences in the benthic environments caused by their difference in water depth confounded the interpretation of trends at the remaining stations.

The current permit also eliminated the sampling requirement at the northern reference station (Station B1); however, sampling at this station was still conducted during the 2009 benthic survey to allow for continued comparison of grain size, infaunal, and metals concentrations. Because of its physical separation (1 km) from the outfall, the reference station has a measurably different infaunal community composition (MRS 1998bi), and sediment physicochemistry from the remaining stations. However, it was retained in 2009 for its value as one of the six original sampling stations in the program and for the insight it provides into the larger scale processes working within Estero Bay as a whole.

4.1.2 Sampling Station Design

Benthic sampling in 2009 was conducted at the seven stations shown in Figure 4.1 on Page 4-2 and in Figure 4.2 on Page 4-6. The target positions for sample collection are specified in the current NPDES permit and are summarized in Table 4.1. The stations lie along a north-south isobath (15.2 m) that intersects the center of the diffuser structure. Two stations (B4 and B5) are located within 20m of the center of the diffuser structure, at the edge of the “zone of initial dilution” (ZID). Two additional stations (B3 and B6) are located at nearfield distances (60 m) from the diffuser structure. Finally, the midfield stations (B2 and B7) are separated by three diffuser lengths from the discharge (150 m). The seventh, reference station (B1) is located 1 km north of the outfall, well beyond the discharge’s sphere of influence.

Table 4.1 Target Locations of Benthic-Sediment Sampling Stations

Station	Description	Latitude	Longitude	Distance (m)	
				Closest ^a	Center ^b
B1	Upcoast Reference	35° 23.730' N	120° 52.677' W	1,000	1,016
B2	Upcoast Midfield	35° 23.280' N	120° 52.504' W	138	150
B3	Upcoast Nearfield	35° 23.231' N	120° 52.504' W	49	60
B4	Upcoast ZID	35° 23.210' N	120° 52.504' W	15	20
B5	Downcoast ZID	35° 23.188' N	120° 52.504' W	15	20
B6	Downcoast Nearfield	35° 23.167' N	120° 52.504' W	49	60
B7	Downcoast Midfield	35° 23.118' N	120° 52.504' W	138	150

^a Distance from the closest open diffuser port

^b Distance to the center of the open diffuser section

As described in Section 3.1.3 on Page 3-6, the finite length of the diffuser structure creates ambiguity in the distance measured to the outfall. For discussion purposes, station separations are usually referenced to the center of the diffuser. However, in terms of contaminant dispersion gradients, the closest-approach distance is the controlling parameter.

The upcoast reference station (B1), midfield stations (B2 and B7), and ZID stations (B4 and B5) have all been regularly sampled throughout the more than two decades of benthic monitoring. The two nearfield stations (B3 and B6) were incorporated into the program in 1999, and increased the program's ability to resolve any benthic impacts related to effluent discharge. Although sampling is no longer required at Station B1 under the current permit, samples were voluntarily collected at the station and analyzed for a subset of parameters analyzed at other stations. Station-1 samples were analyzed for grain size, infaunal composition, and trace-metal chemistry, but not organic constituents. Although required for compliance evaluation, organic constituents have not been found to be diagnostic of the seafloor environment, or the effects of the MBCSD discharge. The extraordinarily long record of infauna, grain size, and trace metals, on the other hand, has provided valuable insights into previously unknown trends in Estero Bay's regional benthic conditions, and although those trends are unrelated to the MBCSD discharge, the lengthy time history at Station B1 was deemed of enough scientific value to warrant continued sampling there.

4.1.3 Benthic Sample Collection and Processing

Field sampling and laboratory procedures adhered to the requirements of MBCSD Monitoring and Reporting specified in the permit (RWQCB-USEPA 2009). The 38-ft F/V *Bonnie Marietta*, owned and operated by Mr. Mark M. Tognazzini of Morro Bay, provided vessel support during the offshore survey. Dr. Douglas Coats of Marine Research Specialists (MRS) logged navigation fixes, assisted in benthic grab deployment and retrieval, and collected sediment subsamples for chemical assay. Ms. Bonnie Luke, also of MRS, sieved and processed infaunal samples. Mr. William Skok was the marine-equipment technician responsible for benthic grab operations.

Equipment

Sediment chemistry and benthic infaunal samples were collected using a chain-rigged Young grab whose design was modified from that of a Van Veen sediment sampler. The pair of jaws on the grab acquires sediments from a 0.1-m² area of the seafloor. The stainless-steel grab is coated with Dykor[®] and is equipped with a frame that enhances its penetration, stability, and proficiency in collecting a level, undisturbed sample. Dykor[®] has properties similar to Teflon[®]; it improves the chemical inertness of the grab sampler, limiting contamination of the sediment chemistry samples by the grab itself, particularly from trace metals. The grab was completely refurbished by sandblasting and recoating with Dykor[®] in 1999. At this time, a stainless steel lip was also welded to the mouth of the jaw to improve the seal, which aids in sample retention during ascent.

At each of the seven monitoring stations during the October 2009 survey, three replicate grab samples were collected and composited for analyses of sediment chemistry and bulk properties, and five replicate grab samples were collected for benthic infaunal analyses (Table C.1).

Offshore navigation aboard the survey vessel was supplied by a Furuno[™] GPS 30 coupled to an FBX2 differential beacon receiver. Global positioning satellite (GPS) navigational fixes were recorded digitally at 1-second intervals. Electronic recordings of waypoints were used to mark the trip-time of the grab sampler and other pertinent information. Navigational errors inherent in standard GPS readings were greatly reduced with the use of a Differential GPS (DGPS) system that was first implemented by the U.S. Coast Guard. DGPS incorporates a second signal from a nearby land-based beacon. Because the beacon is fixed at a known location, the position error in the reading from the GPS satellites can be precisely calculated. This correction is continuously transmitted to the DGPS receiver and results in extremely accurate offshore navigation, typically with position errors of less than 2 m.

Physicochemical Samples

Prior to and during the survey, the sampling equipment was thoroughly cleaned to eliminate the introduction of non-sediment contaminants into the samples, and to prevent cross-contamination between stations. Before the survey, the grab sampler and sediment scoops were washed with Alconox®, deionized water, and 10% Hydrochloric Acid (HCl). During the survey, the grab and sampling utensils were washed with Alconox®, rinsed with seawater, and subsequently decontaminated with deionized water, methanol, and 1% HCl prior to sampling at each station.

Surficial sediments were collected from the upper 2 cm of the single grab sample recovered from each of nine benthic stations. Sufficient sample volumes were collected to provide material for QA/QC analyses. Samples were stored in the appropriate glass or plastic containers and refrigerated at approximately 4°C prior to analysis. Chain of custody forms accompanied all sample shipments from the field and between laboratories. Appendix E on the CD ROM included with this report contains the chains of custody, laboratory QA/QC analysis, and the chemical results as reported by the laboratory, while Appendix C includes a physical description of the samples.

The sediments from each of the seven benthic-monitoring stations were separately analyzed for the analytes listed in Table 4.2. A summary of the analytical methods used and their authority is provided in Appendix E.

Table 4.2. List of Analytes in Sediment Samples

• Sediment particle size	• Biochemical oxygen demand	• Total Kjeldahl nitrogen (TKN)
• Moisture content	• Oil and grease	• Total volatile solids (TVS)
• Chlorinated phenolic compounds	• 11 trace metals	• Non-chlorinated phenolic compounds
• Chlordane	• Aldrin	• Dieldrin
• PAHs ¹⁰	• DDT, DDE, DDD	• Endrin
• PCBs ¹¹	• Toxaphene	

Infaunal Samples

In addition to samples collected for sediment chemistry, five replicate grab samples were collected at each of seven benthic-monitoring stations for infaunal analyses. Upon retrieval of the grab, each sample was inspected for acceptability. Acceptance criteria are based on penetration depth, surface condition, and overall sample integrity and are reported in Table C.1 in Appendix C of this report. Sediment samples that met the acceptability criteria were lightly washed, and elutriated onto a 1.0-mm mesh sieve. The extracted material was then washed into a labeled 16-oz. jar and preserved with 10% buffered formalin. After a minimum fixation period of 48 hours, the formalin was rinsed from the samples on a 0.5-mm mesh sieve and the samples were transferred to 70% alcohol for processing, preservation, and storage. After transfer to alcohol, all infaunal samples were stained with a Rose Bengal solution to aid in sorting of the organisms into the following major taxonomic groups: annelida and nemertea, mollusca, crustacea, echinodermata, and miscellaneous phyla.

All individual organisms were enumerated and identified to species level where possible. Voucher collections have aided in the consistent identification of organisms collected throughout the 24-year benthic-monitoring program. The voucher collections contain specimens representative of each species

¹⁰ Polynuclear Aromatic Hydrocarbons

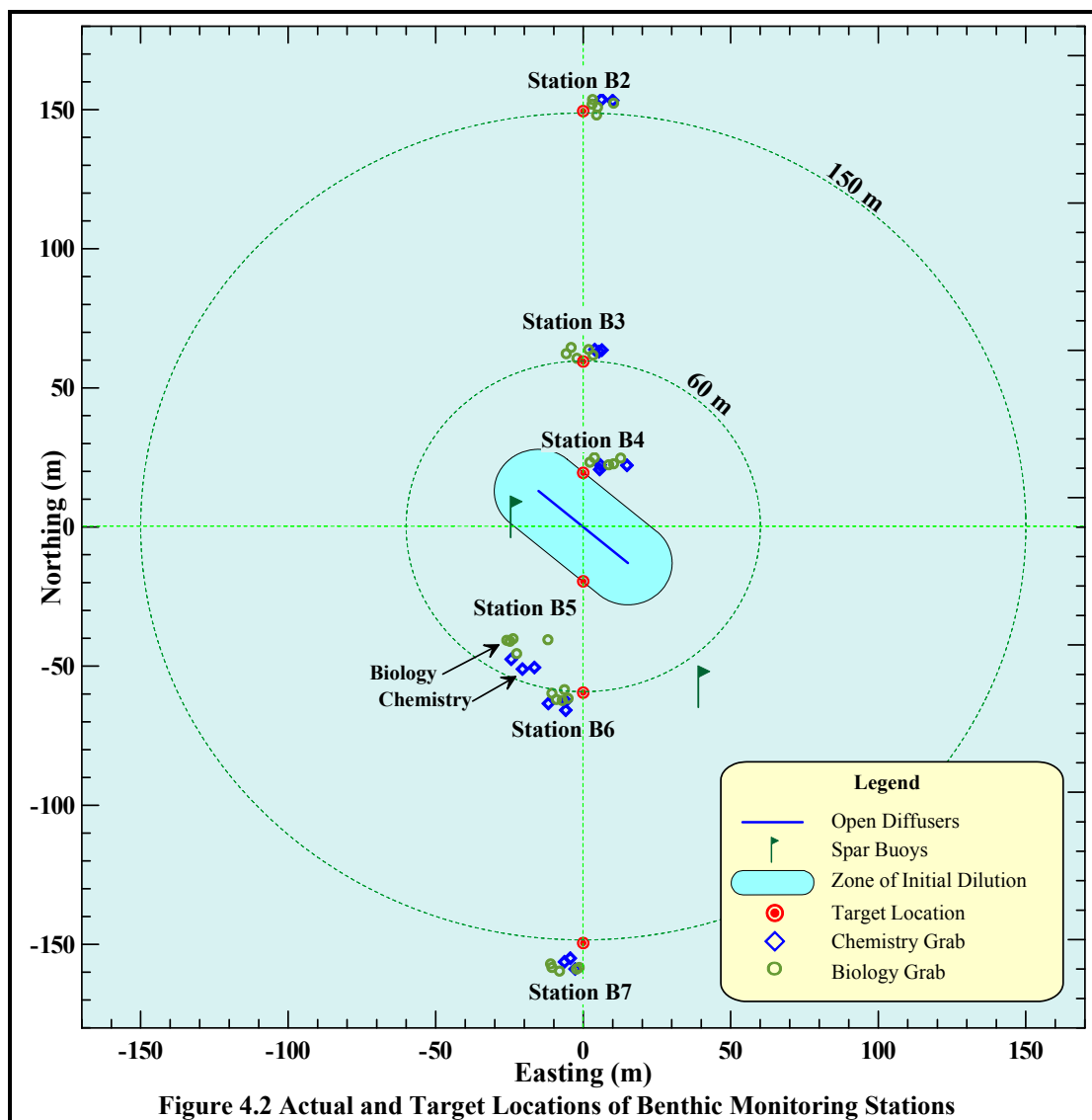
¹¹ Polychlorinated Biphenyl

identified, and are augmented as new taxa are collected. The qualifications and experience of the taxonomic specialists responsible for species identification are presented in Appendix B.

Sampling Location Offsets

As described in Chapter 3, there are a number of unavoidable factors that prevent collection of offshore samples at the exact target locations listed in Table 4.1 on Page 4-3. Figure 4.2 shows the actual position of the chemistry (blue) and infaunal (green) grabs, relative to each target location (red) that were recorded for Stations B2 through B7 during the October survey.

Differences between the sampling and target positions arise because the vessel swings about the anchor location along a scope of approximately 20 m. How the vessel will set relative to its anchor position is difficult to predict based on the constantly changing wind, wave, and current conditions. Changes in position during sampling at an individual station arise because of these changing conditions, and because



of anchor drag. These within-station position changes are most evident as dispersion among the locations of the three sediment-chemistry grab samples and five infaunal grab samples shown in Figure 4.2.

Despite the many unavoidable factors affecting vessel offset, differences between the target position and average grab location were generally far less than the 30-m width of the ZID. Although it was not possible to collect samples at the precise target locations, knowledge of the actual location where samples were collected allowed the spatial offsets to be factored into the gradient analysis. Table 4.3 lists the average position of the eight grabs collected at each station. With the exception of Station B5, the average offset at the outfall monitoring stations was extremely small (≤ 10 m). Without the benefit of differential GPS navigation, most of these offsets would never have been resolved.

Table 4.3 Average Location of Benthic-Sediment Grab Samples at each Station

Station	Description	Latitude	Longitude	Distance (m)		
				Closest ^a	Center ^b	Offset ^c
B1	Upcoast Reference	35° 23.732' N	120° 52.664' W	999	1015	19
B2	Upcoast Midfield	35° 23.281' N	120° 52.500' W	141	152	6
B3	Upcoast Nearfield	35° 23.233' N	120° 52.503' W	52	63	4
B4	Upcoast ZID	35° 23.212' N	120° 52.499' W	23	24	9
B5	Downcoast ZID	35° 23.175' N	120° 52.518' W	47	49	33
B6	Downcoast Nearfield	35° 23.165' N	120° 52.509' W	54	62	8
B7	Downcoast Midfield	35° 23.114' N	120° 52.508' W	146	158	10

^a Distance from the closest open diffuser port

^b Distance to the center of the open diffuser section

^c Average offset from Target Locations listed in Table 4.1

The more substantial 33m average offset that occurred at Station B5 occurred primarily out of a desire to avoid fouling of the anchor on the diffuser structure. In 2008, the survey vessel's anchor was destroyed and the winch was damaged during retrieval because it fouled on the diffuser structure during sampling at Station B5. Therefore, to avoid injury to the sampling equipment and the outfall, the anchor was conservatively set on the station's target location, rather than setting it at an upstream location on the other side of the diffuser. Because the vessel's set at the time was toward the southwest of anchor placement, grab samples were collected close to those of Station B6, and slightly offshore of its target position.

4.1.4 Benthic Analysis

A wide variety of physical, chemical, and biological parameters were determined from the 56 sediment samples collected during the October 2009 survey. This report examines these parameters for any potential discharge-related spatial patterns. They are also compared to historical measurements to reveal any potential temporal trends that could be associated with a buildup of contaminants. Finally, the interrelation between biological and physicochemical parameters is evaluated for possible toxicological effects.

Organic-Loading Properties

Sediment samples collected at the seven benthic-monitoring stations during the October 2009 survey were analyzed for moisture content, oil and grease, and eleven trace metals. Samples from all the stations except Station B1 were also analyzed for the presence of 100 synthetic organic contaminants. The organic-loading parameters, total volatile solids (TVS), total Kjeldahl nitrogen (TKN), and biochemical

oxygen demand (BOD), are also considered relevant for sewage-outfall monitoring. If the volume of organic solids discharged by the outfall is not adequately dispersed, then a buildup of TVS, TKN, and BOD can occur, and impact areas beyond the ZID.

The TVS concentration quantifies the amount of organic matter in the solid fraction of bottom sediments. It is reported as percentage of dry-sample weight. TKN measures the amount of organic nitrogen present as ammonia, as well as that bound into organic compounds in the aqueous phase of the benthic samples. However, natural TKN levels vary widely among seafloor sediment samples, so anthropogenic (human-induced) impacts are difficult to discern from TKN measurements alone. Other properties that indicate organic loading from effluent discharge include sulfides, and oil and grease (O&G).

BOD measures the depletion of dissolved oxygen caused by aerobic microorganisms during decomposition of organic material. Excessive BOD can be deleterious to marine organisms if decomposition significantly depletes dissolved oxygen levels. This can occur when aerobes metabolize excess organic matter deposited by wastewater discharge. However, BOD is difficult to accurately measure in sediment samples, and interference from errant pieces of organic material has resulted in erroneously high levels in several previous surveys, particularly during 2000 and prior to 1992 (Figure 4.9b on Page 4-25). Because of persistent interference during BOD determinations, overall confidence in BOD results for benthic sediment samples remains low.

Synthetic Organic Compounds

The presence of synthetic organic compounds within sediment samples is often indicative of anthropogenic input. In high concentrations, these compounds can be deleterious to the marine ecosystem. Phenolic compounds, which are used in plastics, adhesives, and coatings, are among the most common synthetic organic compounds measured in effluent. As such, benthic sediment samples were analyzed for phenolic compounds as well as for the pesticides aldrin, dieldrin, chlordane, DDT, endrin, and toxaphene. During the October 2009 survey, sediments were also analyzed for the toxic compounds PCB and PAH. As described in Chapter 2, few of these synthetic organic compounds have ever been detected in MBCSD effluent and, when detected, their concentrations are extremely low. Nevertheless, benthic sediments continue to be monitored for organic contaminants because a long-term discharge could conceivably result in a slow buildup in these compounds over time, with sediment concentrations eventually reaching detectable levels. However, none of these synthetic organic compounds was detected in sediment samples collected at any of the stations during 2009, nor have any been detected in the sediment samples collected over the previous 23 years.

Trace Metals

In contrast to synthetic compounds, the presence of trace metals within seafloor sediments is not necessarily indicative of anthropogenic input. Most trace metals are found in detectable concentrations within naturally occurring mineral deposits, some of which are essential minerals needed by marine organisms to survive. However, elevated levels of certain trace metals can be indicative of anthropogenic input, and excessive levels can cause deleterious effects in marine organisms.

Nine trace metals have been measured in seafloor sediments since the inception of the monitoring program. They are arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc. The toxicity of these metals to marine organisms has been examined in numerous laboratory bioassays and field experiments (Long and Morgan 1991, Long et al. 1995). These studies have been summarized in the form of biological effects levels, most notably an effects-range low (ERL), below which toxic effects are not expected, and an effects-range median (ERM), where adverse biological effects can be expected.

In 1998, the analysis of aluminum and iron within benthic sediments was added to the monitoring program. Unlike the other nine metals, aluminum and iron are not particularly toxic to marine organisms, and their naturally occurring concentrations are relatively insensitive to anthropogenic input. This latter attribute makes them ideal tracers of natural variations in all the trace metals. Consequently, they have been used to normalize observed concentrations in the other nine metals so that background variation is reduced and anthropogenic trends can be revealed. In particular, iron has been used as a reference element for determining anthropogenic enrichment of trace metals within the Southern California Bight (Schiff and Weisberg 1997) and in many other offshore regions (Daskalakis and O'Conner 1995).

Physical Properties

Moisture content and grain-size distribution are two important physical properties of marine sediments. Moisture content is a measure of the volume of pore water present in the sediment samples. While not an indicator of discharge effects, it is an important parameter used to convert chemical concentrations measured in a wet sediment sample to a dry-weight basis. Dry-weight concentrations allow a more direct comparison of chemical concentrations associated with bulk sediments by eliminating variations in sample mass that arise from arbitrary differences in water content. Moisture content is also used, along with salinity measurements, to eliminate the bias introduced by salt content in grain-size determinations.

Grain-size distribution is important to quantify because an increase in fine sediments near a municipal ocean outfall can be indicative of excessive effluent-solids deposition. In addition, the amount of fine sediment directly affects the composition of the infaunal community that resides within the sediments; although the precise mechanism for this relationship is rarely clear (Snelgrove and Butman 1994). Finally, natural variation in trace-metal concentrations has been correlated with the fine-sediment (mud) fraction and, like aluminum and iron, has been used to normalize metal concentrations (Dossis and Warren 1980, Ackerman et al. 1983, Horowitz and Elrick 1987).

Accurate measurement of the fine sediment fraction is particularly important for use in the interpretation of the marine biological data. Otherwise, variability in a benthic community's composition could be erroneously ascribed to effluent discharge, when instead it may be the result of natural variation in the distribution of fine particulates. One of the major difficulties in the accurate measurement of the fine fraction in marine sediments is that the standard pipette method described by Plumb (1981) and Folk (1980) overestimates the finest (clay) fraction. This occurs because the procedure incorrectly includes the weight of the dissolved solids (salt) when weighing the dried pipette extraction. This often generates an artificial bimodal grain-size distribution, where the smallest (clay) fraction exceeds the next largest (silt) fraction.

In 1994, the anomalous character of the bimodal size distribution in the MBCSD database led to a number of internal investigations and confirmatory grain-size analyses by outside laboratories (MRS 1995). The refined analysis method that is now in use accounts for the presence of dissolved solids by correcting for the measured salinity in the pipette fractions (MRS 1998i and Coats et al. 1999). This refined particle-size analysis method was instituted in the MBCSD monitoring program beginning in 1998. As a result, the finest size fractions determined in sediment samples collected after October 1997 are far more accurate than those determined in prior surveys. Thus, some, of the long-term trends in the MBCSD grain-size database can be ascribed to improvements in methodology rather than actual changes in the benthic environment.

Biological Parameters

Determining whether the discharge is causing adverse biological effects involves assessing whether a balanced indigenous population (BIP) of shellfish, fish, and wildlife exists in areas potentially affected by the discharge. A BIP is an ecological community, which exhibits characteristics similar to those of nearby, healthy communities existing under comparable environmental conditions beyond the influence of the discharge. Certain biological characteristics of the community are examined in a BIP evaluation, including spatial and temporal distributions of species composition, abundance, biomass, dominance, and diversity. Other overall biological indicators of a BIP include trophic structure and the presence or absence of indicator species. Most marine monitoring programs determine the presence of a BIP using data on the infaunal organisms that live with sediments surrounding a potential pollutant source. In evaluating a BIP, infauna have many advantages over other marine organisms, such as marine mammals or finfish. First, infauna are relatively easy to collect in numbers large enough for reliable statistical testing. Second, they have limited mobility and cannot easily escape exposure to pollutants. Finally, decades of monitoring studies have established well-defined responses of infaunal taxa to pollutant stress.

In the earliest MBCSD monitoring surveys, analysis of biological samples produced two types of data on infaunal organisms: the number of organisms for each taxon, and the biomass of major taxonomic groups within each sample. Biomass is difficult to interpret, however, because the erratic presence of large, undersampled organisms severely skews the results. Also, in practice, the heavy calcareous shells and exoskeletons of mollusks and crustaceans are troublesome to remove, and alcohol evaporation during weighing affects the determination of wet-weight biomass. Because of these problems, the USEPA does not recommend biomass for inclusion in 301(h) monitoring programs (USEPA 1987). Therefore, beginning in 1998, the NPDES permit no longer required this analysis.

Pollution affects marine ecosystems by changing the number and type of benthic organisms found in the sediments. However, subtle changes in community composition are not always readily apparent in the large volume of raw data generated by a long-term monitoring program. Over the 24 years of MBCSD monitoring, more than 229,000 individual organisms representing 374 individual taxa have been collected. To assess whether the infaunal community has been impacted, these data must be summarized into concise parameters that are indicative of pollutant stresses.

Biodiversity is a common indicator of the well-being of ecological systems, and forms the cornerstone of most impact assessment studies. Unfortunately, biodiversity is difficult to define quantitatively, in part because it has two major components: species richness and evenness. Species richness measures the variety (number) of species, while evenness measures the distribution of individuals (abundance) among the species (Magurran 1988). Healthy ecosystems are thought to be both rich in species and have an even distribution of individuals among those species.

Although no single measure can accurately represent changes in both evenness and richness along a pollution gradient, many indices attempt to do so. The Shannon Diversity Index (H') is the most widely used diversity index because it exhibits some degree of sensitivity to both evenness and richness. In addition, most diversity indices only measure the diversity within a local area at a particular time, *viz.*, among replicate samples from a single station (α -diversity). In contrast, pollutant stresses tend to induce marked changes in community composition between samples separated spatially and temporally (β -diversity; Smith et al. 1979). Multivariate analysis techniques are better suited to the evaluation of β -diversity than are individual indices.

Most diversity indices are also poorly suited for describing potential impacts to infaunal communities because they lack biological meaning, show little correlation with environmental quality, and are difficult to interpret ecologically (Goodman 1975, Washington 1984, Green 1979). As a result, ambiguous or

biased estimates of diversity often occur. Therefore, many indices are not recommended for routine inclusion in 301(h) monitoring programs (USEPA 1987). Nevertheless, the current NPDES permit requires that a number of infaunal community indices be reported and examined for temporal trends (RWQCB-USEPA 2009). However, because of limitations associated with the indices, spatial differences with respect to outfall proximity, which are evaluated using standard statistical hypothesis tests, must be interpreted carefully. Table 4.4 lists the infaunal indices computed in this report. The associated algorithms and guidance on how to interpret them are presented in Appendix B.

Table 4.4 List of Infaunal Parameters

• Number of individuals	• Number of species
• Number of individuals per species	• Species richness (S) (Magurran 1988)
• Margalef species richness (d) (Margalef 1951)	• Shannon-Wiener index (H')
• Simpson dominance (C') (Simpson 1949, Wittaker 1965)	• Brillouin index (h)
• Pielou evenness index (J') (Pielou 1977)	• Swartz dominance (S_w)
• Infaunal Trophic Index (ITI)	

4.2 MARINE SEDIMENT QUALITY

The quality of marine sediments surrounding the MBCSD outfall provides a definitive measure of potential marine impacts caused by wastewater discharge. Specifically, discharge-related impacts have been demonstrated in outfall monitoring programs offshore both central and southern California, wherein marked changes in the benthic environment have been observed surrounding the discharge locations (Phillips and Hershelman 1996, Stull et al. 1986b). Discharge-related impacts have also been observed on the continental shelf south of Estero Bay, where sediments were found to exhibit small but statistically significant chemical signatures indicative of drilling mud discharges over widespread areas (Hyland et al. 1994, Coats et al. 1991, Coats 1994). If the MBCSD effluent discharge were causing significant impacts to the marine environment, similar changes in sediment properties would be evident near the diffuser structure. The challenge is to distinguish changes that are caused by naturally occurring processes from changes that result from human activities.

Physicochemical changes in sediments provide a good indication of marine impacts for four main reasons. First, because outfalls are located on the seafloor, sediments are proximal to the source of potential contamination. Second, many contaminants are hydrophobic and tend to preferentially adhere to the fine particulates as they settle out of the effluent plume. Third, contaminants incorporated into seafloor sediments tend to have a long residence time because of the slow dispersive processes that prevail within pore waters. Finally, infaunal organisms that live within seafloor sediments are continuously exposed to contaminants because they cannot easily escape the source of pollution. If seafloor sediments or pore waters become polluted, infaunal organisms can be impacted. Sedentary infaunal organisms provide a food source for other, more mobile organisms, such as finfish and shellfish. These trophic relationships can lead to bioaccumulation of contaminants within the marine food chain.

Despite the sensitivity of the benthos to effluent discharge, there has never been any indication of deleterious impacts to seafloor sediments as a result of the MBCSD discharge. This remained true during 2009, as it has in the previous 23 years of monitoring. The lack of negative benthic impacts is largely due to the comparatively low mass-emission of anthropogenic chemicals from the outfall. There has never been a large industrial contributor to the MBCSD influent stream, and the total discharge volume is small compared to ocean dischargers to the south, where discharge volumes can be over 100-times greater (e.g., SCCWRP 1995).

The lack of benthic impacts is evident from three sets of analyses performed on the chemical properties of sediment samples collected around the MBCSD outfall during the October 2009 survey. Each of these analyses is discussed in the following subsections. First, concentrations of potential contaminants measured in sediment samples were below levels that have been empirically linked to toxicity in marine organisms. Second, sediment concentrations do not exhibit any significant long-term trends that would suggest a buildup of contaminants close to the outfall. Third, the spatial pattern of sediment concentrations near the outfall during 2009 bore no consistent relation to outfall proximity.

4.2.1 Concentrations below Toxic Levels

In keeping with the COP, narrative receiving-water limitations contained within MBCSD's Waste Discharge Requirements (RWQCB-USEPA 2009) state that the discharge should not cause chemical substances in marine sediments "*to be increased above levels which would degrade indigenous biota.*" This requirement was established because contaminants that reside in sediments for long periods have the potential to exert acute and chronic effects on resident marine organisms (NOAA 1991ab, Finney and Huh 1989, Bertine and Goldberg 1977).

Over the 24 years of continuous benthic monitoring, there has never been any indication of an effluent-related degradation of marine organisms within Estero Bay. In large part, this is due to the consistently low chemical concentrations within the discharged effluent (see Chapter 2). As a result, contaminant concentrations measured within Estero Bay sediments, both near and distant to the outfall, have been below thresholds reliably determined to be harmful to marine biota. In fact, the comparatively pristine marine environment of Estero Bay is reflected in benthic contaminant levels that are well below concentrations measured in sediments offshore southern California.

Thresholds of Biological Effect

Over the years, marine monitoring programs have placed considerable emphasis on benthic contamination. This experience has resulted in a set of thresholds of biological concern that can be used to screen chemical concentrations measured within marine sediment samples at any location. Specifically, these biological benchmarks can be used to assess whether the chemical concentrations measured in sediments have the potential for adverse biological effects. Although the thresholds are not regulatory criteria, they provide toxicological guidelines that help assess the potential environmental significance of specific chemical concentrations measured in the field.

The toxicological benchmarks advanced by NOAA (Long and Morgan 1991) are used in this report to evaluate sediment chemical concentrations measured during 2009. These guidelines are based on a correlation between chemical concentrations and observed biological effects in numerous modeling, laboratory, and field studies (Long et al. 1995). The studies identify two toxicological endpoints, an Effects-Range Low (ERL) and an Effects-Range Median (ERM) concentration. The lower toxicological endpoint (ERL) is associated with the concentration of a particular compound that produced an adverse biological effect in only 10% of the data. Below the ERL, adverse biological effects are unlikely. Above the ERM, which is based on the median of the toxicological data, adverse effects are considered likely to occur. The most conservative benchmark (ERL) was used in this report to determine the potential for marine biological impacts from most of the chemical concentrations that were measured within Estero Bay during 2009. These benchmarks provide a reliable screening tool for most, but not all sediment contaminants. For example, the relationship between nickel concentrations and the incidence of effects in the toxicological database is very weak. Consequently, even the upper (ERM) benchmark for nickel is a poor predictor of levels where biological effects might be expected.

Both trace-metals and organic contaminants are of concern in the benthic environment. However, their natural occurrence differs markedly. Synthetic compounds, such as PAHs, PCBs, and pesticides, are organic constituents that can have the most significant anthropogenic impact if found in sufficient concentrations. However, in this and many other marine sediment studies, their concentrations are less than detection limits. In contrast, trace metals occur naturally in the marine environment and are commonly detected in sediment samples. Because of this, trace metals serve as a powerful surrogate for evaluating the regional transport and fate of a host of other particulate contaminants.

Grain-Size Distribution

Within deep offshore basins, sediment trace metals accurately record the history of contaminant accumulation because they are ubiquitous and long-lived. However, these deep benthic sediments often contain significant fractions of fine-grained sediments, which support an increased number of trace-metal bonding sites per unit of volume. Thus, large differences in trace metal concentrations among sediment samples can be caused by natural differences in mud fractions that are unrelated to human activities. Because of this, many marine benthic studies divide (normalize) trace metal concentrations by the mud fraction. Normalization is intended to reduce inherent natural variability, revealing anthropogenic contaminant patterns normally masked by the natural association between metals and fine particulates (Dossis and Warren 1980).

While this approach works well in deep quiescent basins, it is not as applicable in nearshore environments where energetic oceanographic processes erode fine particles, leaving behind coarser, more transport-resistant sandy sediments. Sandy sediments usually have comparatively low metal concentrations. Also, metals tend to be incorporated into the mineralogy of the sand grains themselves, rather than adsorbed onto their surfaces, as is the case with silts and clays. Therefore, metals are less likely to dissolve and become assimilated by marine organisms residing within sandy sediments. Because of the lower bioavailability of metals in sands, NOAA does not recommend mud fraction normalization of trace-metals for samples with less than 20% fine-grained material (Long and Morgan 1991). As the Estero Bay sediments consist almost entirely of sand (>99%, Table 4.5), iron- and aluminum-normalized concentrations are assessed instead.

Irrespective of trace-metal normalization, grain-size distributions can be indicative of a buildup of effluent particulates within the surficial sediments if, for example, there is an increase in fine fractions close to the discharge point. Although this was not the case around the MBCSD outfall, the overall character of the grain-size distribution is indicative of the dynamics within a particular benthic environment. Higher mud fractions reflect more-quiescent depositional environments, while well-sorted sands result from energetic wave environments that winnow fine particulates as they constantly rework the surficial sediments.

Table 4.5 Grain-Size Distribution (%) within Sea-floor Sediment Samples Collected on 20 October 2009

	Clay (9 to 12φ)	Silt (5 to 8φ)	Fine to Medium Sand (1 to 4φ)	Coarse Sand (1φ)	Very Coarse Sand (0φ)	Gravel (-1φ to -3φ)
Station B1	0.16	0.55	98.75	0.46	0.08	0.00
Station B2	0.12	0.32	98.93	0.42	0.21	0.00
Station B3	0.00	0.27	99.25	0.35	0.13	0.00
Station B4	0.11	0.17	99.20	0.38	0.14	0.00
Station B5	0.13	0.46	98.39	0.73	0.30	0.00
Station B5¹	0.18	0.56	98.89	0.30	0.07	0.00
Station B6	0.13	0.63	98.34	0.59	0.32	0.00
Station B7	0.08	0.63	98.34	0.59	0.32	0.00
Station B7¹	0.08	0.52	98.36	0.84	0.20	0.00
Mean²	0.09	0.42	98.80	0.49	0.17	0.00

¹ Duplicate analysis of sediment sample

² Mean computed after arc-sine transformation

Accordingly, statistical analyses of grain-size distributions within the 2009 sediment samples reflect the high-energy environment near the outfall. The samples consisted of well-sorted fine sands with a distribution skewed slightly toward the finer fractions (Table 4.5; Appendix Table C.4). During 2009, mean particle diameters ranged from 145 to 158 μm , lying in the middle of the fine-sand portion of the grain-size distribution. The high degree of sorting is reflected by low standard deviations ($\sigma < 0.36$). The small, but consistently positive skew to the distribution reflects a slight excess in the finer fractions relative to larger fractions in the tails of the distributions. Together, these properties point to a highly energetic flow regime that tends to winnow fines from the surficial sediments. The contribution of larger-diameter fractions was negligible in that the combined coarse sand and gravel fractions ($\leq 1\phi$) represented less than 1.1% of the total sample weight (Table 4.5). These largest fractions consisted mainly of fragments of shell hash that are randomly distributed on the surface of sediments in many shallow subtidal coastal areas.

Undetected and Nontoxic Metals

In 2009, trace-metal concentrations within sediment samples were either not detected or were below levels that are potentially toxic to marine organisms (*cf.* mean, ERL, and ERM concentrations in Table 4.6). The only exception was nickel, which is described in more detail below. Cadmium and silver were not detected within the 2009 sediment samples, as has been the case in most prior monitoring surveys. Their respective detection levels, 0.05 and 0.08 mg/Kg-dry, were far lower than the lowest toxic-effects level (ERL=1.0 mg/Kg for silver). Thus, even if these two metallic elements were present in Estero Bay sediments at concentrations less than their respective detection limits, they would not be likely to affect

Table 4.6 Metal Concentrations (mg/Kg-dry) within Seafloor Sediment Samples Collected on 20 October 2009

Station	Aluminum	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Silver	Zinc
B1	5,800	2.9	<0.05 ¹	58	2.9	9,100	2.2	≈ 0.03 ²	36	<0.04	17
B2	5,200	3.3	<0.05	44	3.3	8,900	2.1	≈ 0.04	45	<0.05	16
B3	5,900	3.7	<0.05	49	3.4	9,700	2.3	≈ 0.05	47	<0.05	17
B4	5,600	3.7	≈ 0.05	43	3.3	9,100	2.2	≈ 0.04	42	<0.04	16
B5	6,000	3.7	≈ 0.05	55	3.4	10,000	2.6	≈ 0.02	48	<0.04	18
B6	5,600	3.3	≈ 0.05	47	3.2	9,200	2.1	≈ 0.03	43	<0.04	17
B7	5,100	3.1	≈ 0.08	45	2.9	8,700	2.0	≈ 0.04	41	<0.04	17
Mean³	5,600	3.4	<0.05	48	3.2	9,200	2.2	≈ 0.03	43	<0.04	17
ERL	— ⁴	8.2	1.2	81	34.0	—	46.7	0.15	20.9	1.0	150
ERM	—	70.0	9.6	370	270.0	—	218.0	0.71	51.6	3.7	410
SCB⁵	—	6.0	0.2	27	11.3	—	10.1	—	28	0.2	43

¹ “<” indicates that the metal was not detected above the MDL, which is reported after the “<” symbol.

² “ $\approx$ ” indicates that the reported concentration exceeded the method detection limit (MDL) but was not quantified because it was below the PQL.

³ After logarithmic transformation

⁴ Guideline not specified

⁵ Concentration that would be considered enriched (99th percentile) relative to background concentrations in the Southern California Bight after normalization by iron (Schiff and Weisberg 1997).

marine organisms. Similarly, although mercury was detected at all of the stations, it was detected in concentrations too low to be quantified. Regardless, its highest estimated concentration (≤ 0.05 mg/Kg-dry) was still three times lower than the concentration where mercury's biological effects first become noticeable (ERL=0.15 mg/Kg), and far below mercury's ERM (0.71 mg/Kg) where biological impacts are expected.

Two of the remaining eight metals, namely aluminum and iron, are not toxic to marine organisms. As described previously, these two metals were added to the monitoring program in 1998 to track natural variations in concentrations of other trace metals that occur because of inherent differences in mineralogy. The other six metals (arsenic, chromium, copper, nickel, lead, and zinc) have been consistently detected in Estero Bay sediments throughout the history of the benthic-monitoring program. Although they each have the potential for anthropogenic enrichment, their mean concentrations have remained comparable to ambient levels for the region. In 2009, as in previous years, five of these six metals had concentrations well below the ERL where biological effects can begin to become apparent. Only the mean nickel concentration was above the ERL, but below the ERM where biological impacts to marine organisms would be expected to occur. Each of the six detected metals is described below.

Arsenic

Although present in measurable amounts (≤ 3.7 mg/Kg), the mean arsenic concentration in Estero Bay sediments was less than half of the lowest toxicity level (8.2 mg/Kg) where adverse biological impacts would first begin to appear, and an order of magnitude smaller than the ERM (70 mg/Kg) where biological impacts become probable. For comparison, approximately 75% of the area within the Southern California Bight (SCB) has arsenic concentrations exceeding the mean level measured in Estero Bay during 2009 (Schiff and Gossett 1998). After adjustment for the mean iron concentration, average arsenic levels would have to be 2.6 mg/Kg higher to be considered enriched relative to background concentrations in marine sediments to the south (SCB = 6.0 mg/Kg in Table 4.6).

Although arsenic is widely distributed throughout nature, pure arsenic is a highly poisonous metallic element used in insecticides, herbicides, solid-state doping agents, and various alloys. However, these anthropogenic sources of arsenic are not a significant source within the wastewater processed by the MBCSD. Instead, most of the arsenic present in the Estero Bay sediments derives from erosion of enriched onshore mineral deposits. Although arsenic occurs naturally in central-coast sediments, mine tailings may contain higher residual levels due to the increased presence of arsenopyrites in the ore, overburden, and soil. Arsenic from mine tailings may be released into surface and ground waters through erosion, and reach Estero Bay through runoff within the adjacent watershed.

Chromium

Chromium is also enriched within the sediments throughout Estero Bay, and within the entire south central-coast region. This enrichment is reflected in the 48-mg/Kg mean chromium concentration within samples collected near the outfall in 2009, which is almost double the 26-mg/Kg that would be considered impaired for sediments within the SCB (Table 4.6). However, chromium concentrations within all the 2009 sediment samples remained below the lowest toxicity benchmark where biological effects might first be observed. The highest concentration (58 mg/Kg-dry) measured at reference Station B1 was still well below the ERL of 81 mg/Kg. More importantly, the maximum concentration was less than one-sixth of the level where biological effects become probable (ERM=370 mg/Kg). Even at that, the potential for marine effects is probably overstated, given that the incidence of effects in the toxicological studies used to establish the levels for chromium were "*greatly influenced and exaggerated by data from multiple tests conducted in only two field surveys*" (Long et al. 1995).

The presence of hexavalent and metallic oxidation states of chromium generally arises from anthropogenic sources, particularly industrial processes; however, the trivalent form of chromium found within the Estero Bay sediment samples occurs naturally in chromite ore. This is evident from the lack of measurable levels of hexavalent forms in sediment samples collected prior to 1999, when chromium speciation was performed (MRS 1996, 1997c, 1998bi, and 1999b). The elevated chromium levels within Estero Bay sediments originate in naturally occurring chromite minerals that are introduced to the Central Coast's waters by fluvial transport of eroded ultrabasic minerals found in the Franciscan formation. The Franciscan formation outcrops along the headlands north of Point Estero and in the Santa Ynez Mountains. Thus, although chromite ore is a widely distributed mineral deposit, it is more prevalent along the south-central coast of California than in most other areas (SAIC 1986).

Nevertheless, the presence of higher chromium concentrations within central-coast sediments often leads to misinterpretation by regulators and scientists unfamiliar with the local mineralogy. Only around 25% of the SCB had sediments with chromium concentrations higher than those of Estero Bay. Most of this area was within Santa Monica Bay, where a high mass-emission of contaminants from publicly-owned treatment works occurred before 1988. Similarly, elevated chromium levels were observed within the Santa Barbara Basin in the northern reaches of the SBC, which led to speculation that those sediments were impaired as well, even though they can be also be ascribed to the presence of naturally occurring chromite ore in the region (Chow and Earl 1978). The erroneous characterization of an impaired condition in the northern SCB was furthered by an incorrect assertion by Schiff and Gossett (1998) that the elevated chromium concentrations were "*highly predictive of adverse biological effects*" in their review of contaminant concentrations within the SCB. That assertion was in direct conflict with published findings by the developers of the biological-effects levels, who stated that the chromium effect levels were exaggerated (Long et al. 1995).

While erosion of naturally occurring chromite ore along the central coast explains its overall enrichment within the marine sediments of northern Estero Bay, ordinary erosional processes may not be able to account for the trend of increasing chromium concentrations that has been observed over the last two decades. Long-term increases in chromium, arsenic, copper, and nickel are documented in Section 4.2.3. Although these metals are naturally enriched in onshore mineral deposits, nearshore depositional sediments should have reached equilibrium with onshore sediments that have been eroding within the adjacent watershed throughout geologic time. Instead, the increases in marine sediment concentrations that have been observed throughout the monitoring program suggest that the erosion of these mineral deposits has been accelerated by human activities, such as mining. As described by MRS (2000b, 2001), sediment samples collected in conjunction with a supplementary environmental project indicate that erosion around abandoned chromite mines is the likely cause for the accelerated trends observed in the marine sediments of Estero Bay.

Copper

As with arsenic and chromium, copper commonly occurs within the minerals found along the central coast. However, the 3.2-mg/Kg average copper concentration within marine sediments collected at the seven benthic-monitoring stations in 2009 is well below the 11.1-mg/Kg concentration considered enriched relative to background levels within the SCB sediments. Approximately 90% of the SCB sediments have higher copper concentrations than those measured in Estero Bay. All of the sediment samples collected within Estero Bay during 2009 had copper concentrations that were also far below levels that would begin to affect marine organisms (ERL=34 mg/Kg). In contrast to chromium effect levels, the biological effect levels of copper are well defined by toxicological studies. Consequently, biological impacts from the observed copper levels within Estero Bay sediments are highly unlikely given

that the highest measured copper concentration (3.4 mg/Kg) was almost 80-times lower than the ERM level where adverse effects become probable.

Lead and Zinc

Lead and zinc concentrations in Estero Bay sediments are also low compared to ERL levels where adverse biological effects first become noticeable. Additionally, they are low compared to concentrations within the SCB, where approximately 95% of the area has higher concentrations. Most of the elevated lead and zinc concentrations offshore southern California were measured within Santa Monica Bay and on the Palos Verdes Shelf, where large wastewater treatment plants have discharged for many decades. However, most of the metal emissions from these treatment plants occurred prior to the substantial improvements in effluent quality that were realized in 1988. Unfortunately, the historical discharges from these outfalls accumulated within adjacent sediments and have persisted for decades (Stull et al. 1986b). In contrast, the historically low emission of chemicals from the MBCSD treatment plant has had no measurable effect on the high sediment quality within Estero Bay.

Nickel

Although unrelated to wastewater discharge, nickel was the only metal whose concentration in Estero Bay sediments consistently exceeded its ERL level (Table 4.6). In fact, in the more than two decades of benthic monitoring, only one sample has contained nickel in concentrations less than the ERL of 20.9 mg/Kg. However, despite measured nickel concentrations that consistently exceed marine-toxicological benchmarks, no apparent deleterious impacts to infaunal organisms living within northern Estero Bay sediments have been detected. There are two reasons for this.

First, nickel exhibits a very weak relationship between the incidence of effects and concentrations in the database used to establish the toxic-effect ranges (Long et al. 1995). Because of this weak toxicological relationship, specification of bulk nickel concentrations that induce adverse reactions in marine biota is highly uncertain. Much of this uncertainty arises from wide variability in nickel bioavailability. When nickel is in a dissolved form, or adheres to surfaces of fine-grained sediments, it is much more likely to impact organisms that ingest or come into contact with the sediments. Conversely, nickel that is bound into the mineralogy of larger sand grains has less influence on marine organisms. The sandy sediments within the MBCSD benthic monitoring area fall into the latter category.

The second reason for the lack of impacts from elevated nickel concentrations stems from the fact that nickel occurs naturally in the mineralogy of the southern portion of the central California coast (Steinhauer et al. 1994). Because nickel and chromium often co-occur in mineral deposits, it is likely that the increased nickel concentrations found offshore also derive from the Franciscan geologic formation that outcrops at Point Estero. Thus, much of the measured nickel is bound into the mineral matrix of the sand grains themselves, where marine fauna cannot readily metabolize it. Additionally, if there is a slightly higher dissolved-phase nickel concentration within the pore waters of Estero Bay, it has probably been present for epochs and benthic organisms in the region may have adapted accordingly.

Nickel and chromium are the only metals whose measured bulk concentrations in Estero Bay sediments consistently exhibit “*anthropogenic enrichment*” relative to background concentrations in the SCB (Schiff and Weisberg 1997). However, this designation is not correct because much of the regional enrichment arises from natural erosional processes, rather than from accelerated erosion of contaminated mine tailings. In fact, the influence of regional mineralogy is also plainly evident in the SCB database where “*background*” nickel concentrations steadily increase from south to north. As with chromium, Schiff and Gossett (1998) did not account for this natural variability in ore deposits and erroneously ascribed observed nickel trends to anthropogenic contamination within the SCB.

Organic Pollutants

In addition to trace metals, benthic sediments were also analyzed for synthetic organic compounds including chlorinated phenolic compounds, non-chlorinated phenolic compounds, PCBs, PAHs, and pesticides. None of the 100 measured compounds was detected at any of the six outfall stations (See Appendix E). Additionally, PQLs for all the organic compounds were well below ERL guidelines where marine biological impacts become likely for these compounds.

There are no well-established biological effects levels for organic-loading parameters such as TKN, BOD, TVS, and O&G (Table 4.7). However, the moisture content, mud fraction, TKN, BOD, and TVS measured in the sediment samples collected in 2009 were comparable to levels measured over the last decade.

4.2.2 Distribution Unrelated to Outfall Proximity

In 2009, as in previous years, the spatial distribution of sediment chemicals did not exhibit a pattern indicative of a benthic environment impaired by wastewater discharge. Specifically, there was no consistent evidence that sediment chemical concentrations near the diffuser structure were elevated relative to distant sites. A gradient of steadily increasing contaminant concentrations with increasing outfall proximity would provide *prima facie* evidence of discharge-related impacts to the marine environment. This pattern of impairment has been observed around larger outfalls servicing more industrialized locales (Phillips and Hershelman 1996, Stull et al. 1986b, Stull 1995, Diener et al. 1995). The lack of contaminant loading around the MBCSD outfall was confirmed through application of rigorous statistical hypothesis tests, and by qualitative visual comparisons of concentrations ranked by distance from the diffuser structure.

During any given year, a sediment constituent may exhibit an anomalous concentration at one or more stations that results in a spatial trend that appears to be related to outfall proximity. Occasionally, that trend is determined to be statistically “significant” at the 95% confidence level. However, by the very definition of the 95% confidence level, one in twenty tests would be expected to reveal a “significant” gradient when, in fact, none exists. Over the years, many constituents have been tested for spatial gradients, and occasionally the analysis identifies one that may be statistically significant at some particular time. Upon further analysis, however, the gradient has always been found to be unrelated to the discharge. Additionally, approximately half of the time, the statistically “significant” gradients reflect decreasing concentrations with increasing proximity to the outfall, which is opposite the spatial trend expected from impacts associated with effluent discharge.

Table 4.7 Non-metal Concentrations (mg/Kg-dry)¹ within Seafloor Sediment Samples Collected on 20 October 2009

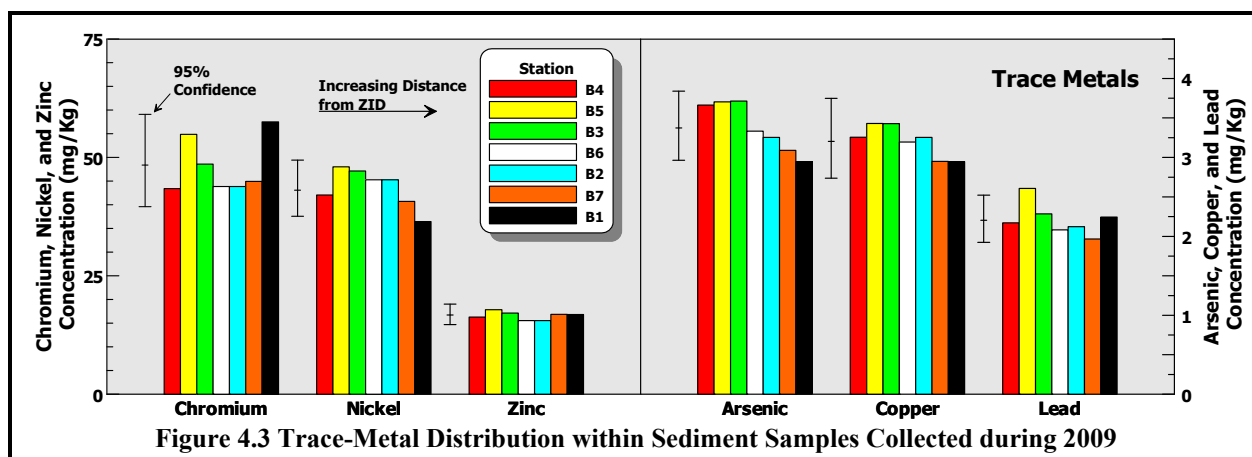
Station	Moisture (%)	BOD	Oil & Grease	TKN	Volatile Solids (%)
B1	28.7	56	— ²	168	1.33
B2	29.3	48	≈40 ³	156	1.46
B3	30.0	44	≈29	157	1.46
B4	26.3	42	<22	130	1.36
B5	27.1	43	≈25	165	1.41
B6	28.0	44	<22	153	1.51
B7	28.8	48	<22	197	1.50
Mean ⁴	28.3	46	<26	160	1.43

¹ Unless otherwise indicated as “%”

² Sample not analyzed for O&G

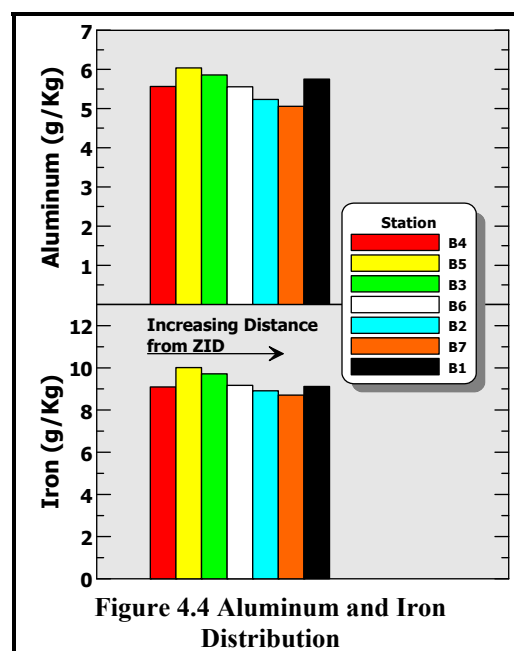
³ Result from reanalysis of sample after initial analysis reported an anomalous concentration (76 mg/Kg-dry)

⁴ Arc-sine transformation for % and logarithmic transformation for mg/Kg



The bar graphs in Figure 4.3 show trace-metal concentrations ranked by distance from the diffuser. Potential outfall-related impacts would appear as bar heights decreasing from left to right in many, if not all of the trace metals. Although several of the bar graphs appear to exhibit a slight decreasing trend from left to right, only the arsenic and copper trends were found to be statistically significant ($p \leq 0.05$). However, the trends are so slight that they are encompassed entirely within the uncertainty in concentrations measured at any given station, as reflected by the 95% confidence intervals shown to the left of each bar graph. The 95% confidence intervals reflect the variability in concentrations found among replicate samples collected at an individual station.¹² Perceived differences between stations that are smaller than this inherent sampling error, have, by definition, a low degree of confidence. Thus, Figure 4.3 shows that, in 2009, most, if not all, of the observed differences among the stations can be ascribed to inherent sampling variability rather than to actual differences in chemical concentrations within the sediments.

Additionally, normalization by iron and aluminum demonstrates that if the apparent spatial trends in raw concentrations were real, they were related to natural processes. As described previously, normalization of raw trace-metal concentrations by aluminum, iron, or mud concentrations is common practice in impact-assessment studies because it can reveal anthropogenic patterns that are otherwise masked by variability in background concentrations. Similarly, they can eliminate spatial differences perceived to be related to an impact when they are in fact due to natural variability. Neither aluminum nor iron is enriched in the MBCSD discharge yet both exhibit a trend of decreasing concentration with distance from the outfall (Figure 4.4).



¹² The confidence intervals were determined from three replicate chemistry samples that were collected and separately analyzed at each station in 1993 and 1994.

Consequently, when used to normalize the raw concentrations in Figure 4.3, many of the perceived trends disappear (Figure 4.5). Regardless of the spatial trends, normalization did not produced concentrations at any station that were elevated compared to the uncertainty in sample concentrations at any given station, as shown by the confidence intervals in Figure 4.5. Normalization even brings the apparently elevated raw lead concentration at Station B5, shown by the yellow bar on the right in Figure 4.3, to within the confidence limits of normalized lead concentrations (Figure 4.5).

Although these spatial bar charts and confidence intervals provide a useful visualization of potential trends, statistical hypothesis tests provide a more rigorous assessment of the significance of any perceived spatial differences. The results of these tests are shown in Table 4.8. The hypothesis tests evaluate whether mean concentrations at the four stations within 60 m of the discharge differ significantly from three distant stations (Stations B1, B2, and B7), which are located more than 140 m away. The tests evaluate whether this difference is large enough to be considered relevant (95% confidence), given the inherent variability in the individual measurements. The ratio of the difference in average concentrations relative to their variability is represented by the “*t*” statistic listed in the fourth column of the table. If “*t*” is large, then the difference in mean concentrations is large compared to the scatter in individual observations, and it is less likely that the perceived difference occurred by chance. The probability that the difference occurred by chance is given by the “*p*” value listed in the fifth column of the table. When

Table 4.8 Tests for Significantly Higher Contaminant Concentrations near the Diffuser

Parameter	Mean (mg/Kg)				Iron-normalized <i>p</i> ⁵	Aluminum-normalized <i>p</i>
	Near ¹	Distant ²	<i>t</i> ³	<i>p</i> ⁴		
Aluminum (g/Kg)	5.75	5.34	1.70	0.09	0.36	NA
Arsenic	3.60	3.09	3.93	0.01	0.06	0.17
Chromium	48.3	48.4	-0.01	[0.5]	[0.25]	[0.16]
Copper	3.33	3.05	2.34	0.05	0.29	0.43
Iron (g/Kg)	9.5	8.9	2.35	0.04	NA	[0.35]
Lead	2.28	2.11	1.26	0.14	0.35	0.44
Nickel	45.0	40.7	1.44	0.12	0.34	0.43
Zinc	17.0	16.4	1.04	0.19	[0.22]	[0.22]
BOD	43.3	50.5	-2.82	[0.05]		
TKN	151	173	-1.60	[0.10]		
TVS (%)	1.43	1.43	0.08	0.47		
Mud (%)	0.45	0.55	-0.70	[0.26]		

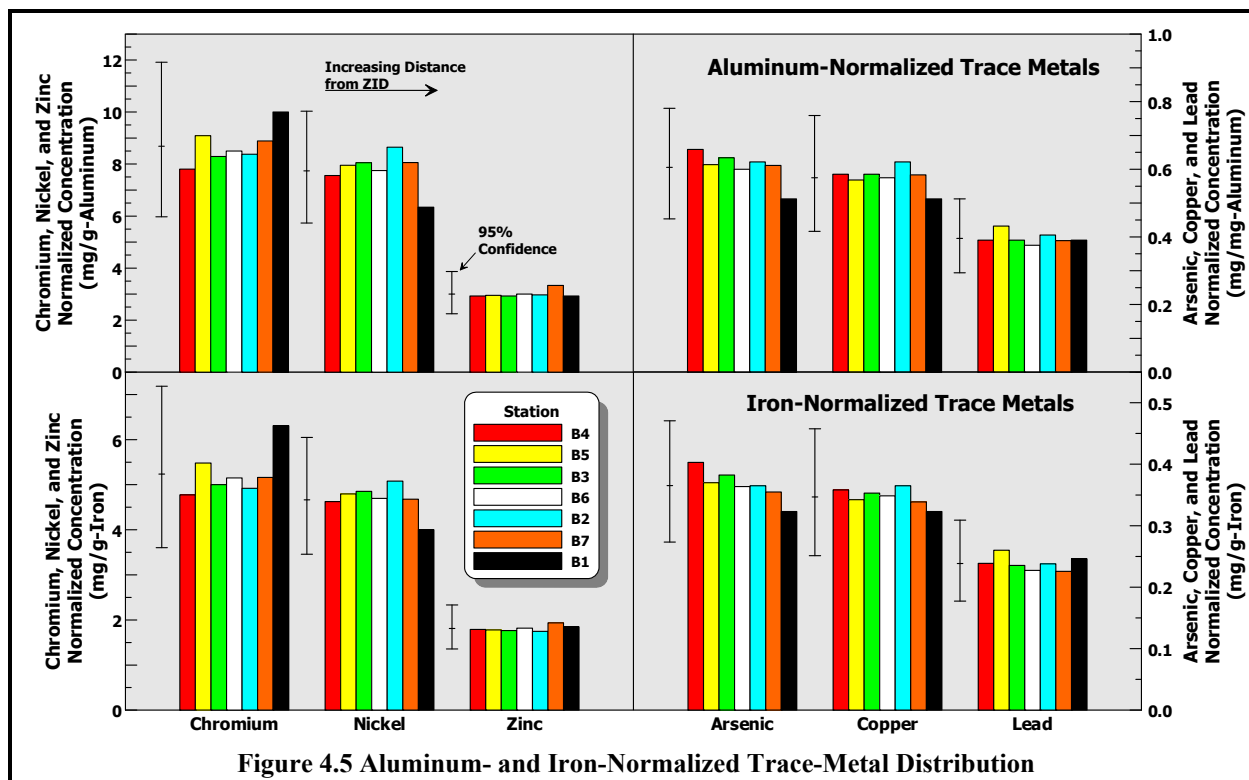
¹ Mean concentration computed among Stations B3, B4, B5, and B6, which lie within 57 m of a diffuser port (the largest closest approach of chemistry grabs in Figure 4.2). For percent concentrations, an arc-sine transform was applied to the concentrations prior to hypothesis testing. For other units, a logarithmic transform was applied.

² Mean concentration computed among Stations B1, B2, and B7, which lie more than 142 m from a diffuser port

³ *t*-value computed from the difference in near and far mean concentrations relative to measurement variability. A negative *t*-value indicates that the computed mean concentration was lower at stations near the diffuser, opposite of that expected in an environment impacted by effluent discharge.

⁴ *p*-value representing the probability that a higher nearfield mean concentration is not significant. In this study, *p*-values less than 0.05 (95% confidence) indicate that nearfield means are significantly higher, and the null hypothesis can be rejected. Note, however, that a “one-sided” *t*-test was performed, in which only higher, rather than lower, nearfield concentrations are meaningful. Consequently, *p*-values for negative *t*-values are not pertinent and are indicated with brackets.

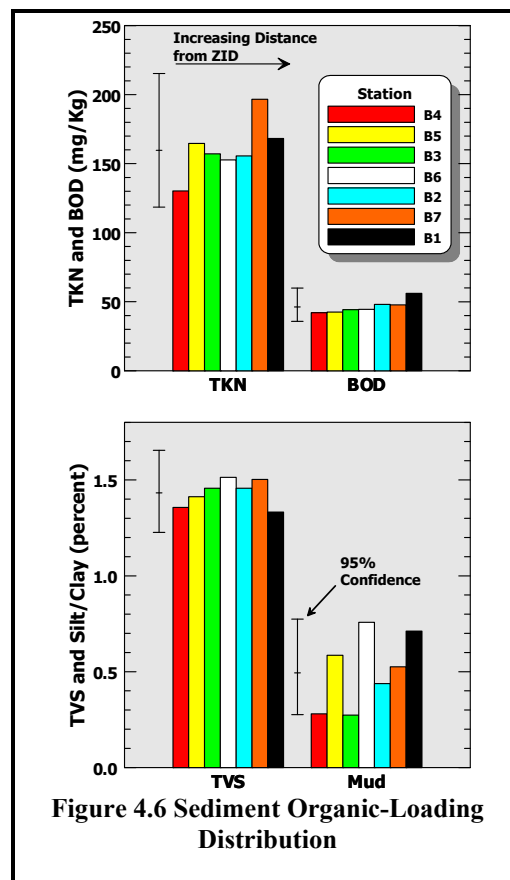
⁵ Results of hypothesis tests performed on trace-metal concentrations normalized by the iron and aluminum concentration to reduce the potential influence of inherent variability in background metal concentrations.



$p < 0.05$, there is less than a 5% risk that the difference was due to random fluctuations, and thus would be deemed significant using the 95%-confidence criterion specified in the COP and used throughout this report.

Not surprisingly, arsenic and copper exhibited significantly higher average raw concentration in the diffuser nearfield, quantifying the spatial trend that was visually apparent in the bar charts describe above (Table 4.8). However, so did iron ($p = 0.04$) and, upon normalization, the significance of the difference was eliminated ($p > 0.05$ in the right two columns of the table).

Table 4.8 also provides hypothesis tests for significant differences in near- and far-field concentrations for the four organic loading parameters. Only TVS had higher average nearfield concentrations relative to distant sites, but the difference was very slight, and far from being statistically significant ($p = 0.47$). Accordingly, Figure 4.6 shows that concentrations reported at individual stations were within the measurement error given by the 95% confidence interval that reflects inherent sampling uncertainty at any given station. Moreover, none of the organic loading parameters exhibits a consistent spatial trend where concentration steadily increases with discharge proximity (a decrease from right to left).



4.2.3 Buildup Unrelated to Wastewater Discharge

The previous section examined the spatial distribution of constituents at a single point in time, namely, during the October 2009 survey. However, the characteristics of ambient sediments at individual stations can be inherently different because of their water depth or the depositional characteristics of their geographic location. These factors complicate the interpretation of any perceived spatial gradients with respect to effluent discharge. Examining changes in spatial distributions over time, however, significantly improves the power to detect potential discharge-related impacts. Specifically, if there were any measurable marine impacts from wastewater discharge, they would be revealed by a long-term buildup of contaminants in sediments surrounding the outfall. Consequently, examining spatial differences in contaminant concentrations over time can reveal discharge-related trends that may be masked in a spatial analysis applied to a single survey.

As revealed by the temporal analyses described in this section, long-term increases in certain chemical concentrations have been observed within the Estero Bay sediments. However, these increases have occurred consistently at all stations suggesting that large-scale processes unrelated to effluent discharge are driving the observed temporal trends in ambient chemical distributions within the sediments of Estero Bay.

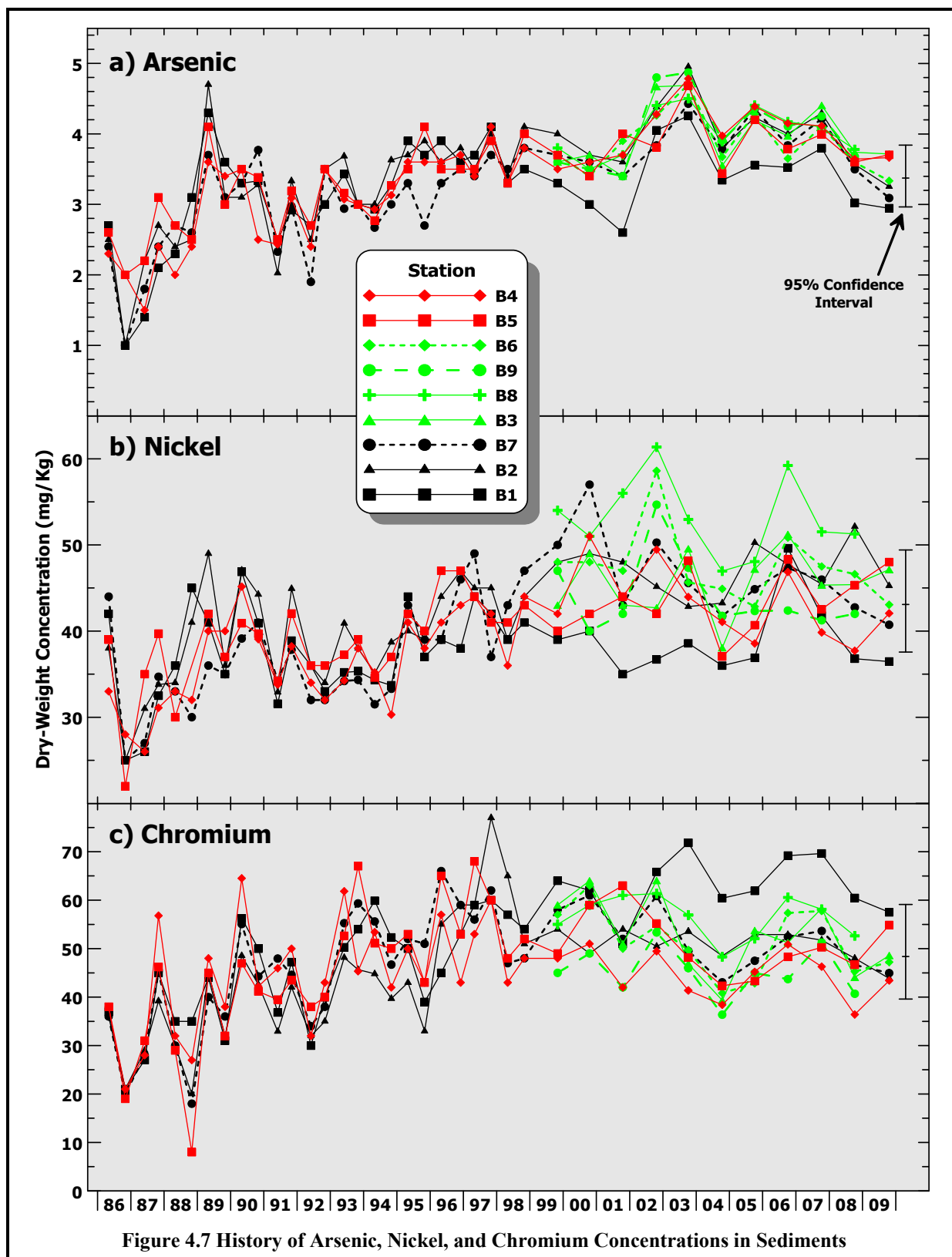
Temporal Trends Independent of Outfall Proximity

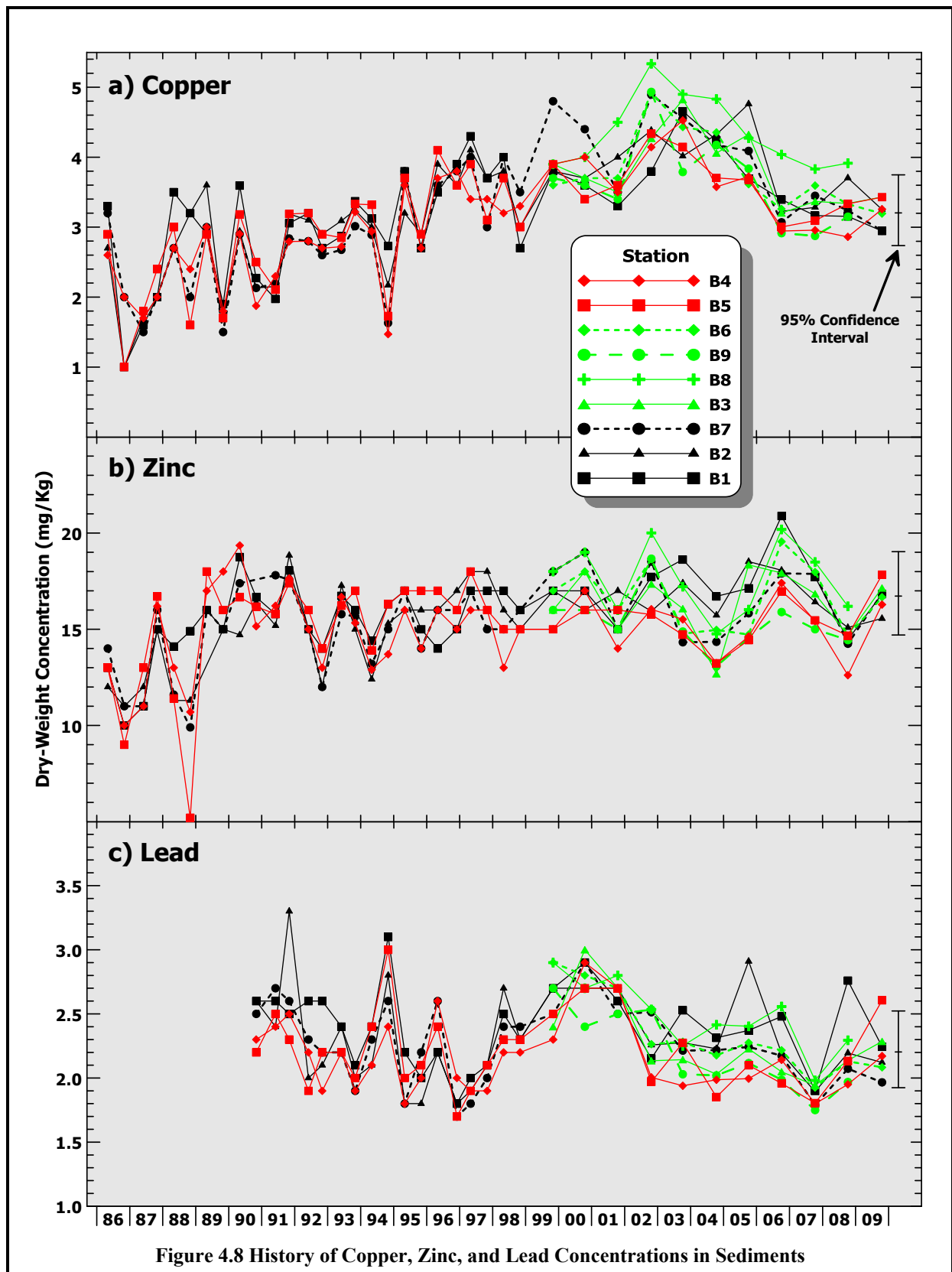
As suggested above, time histories of chemical concentrations within sediments are a powerful tool for discerning the fate of contaminants within the marine environment. A buildup over time indicates that contaminants are accumulating within benthic sediments. Differences in the rate of buildup at various locations can reveal the cause of the contamination, particularly if it is related to a localized point-source discharge, such as a wastewater outfall.

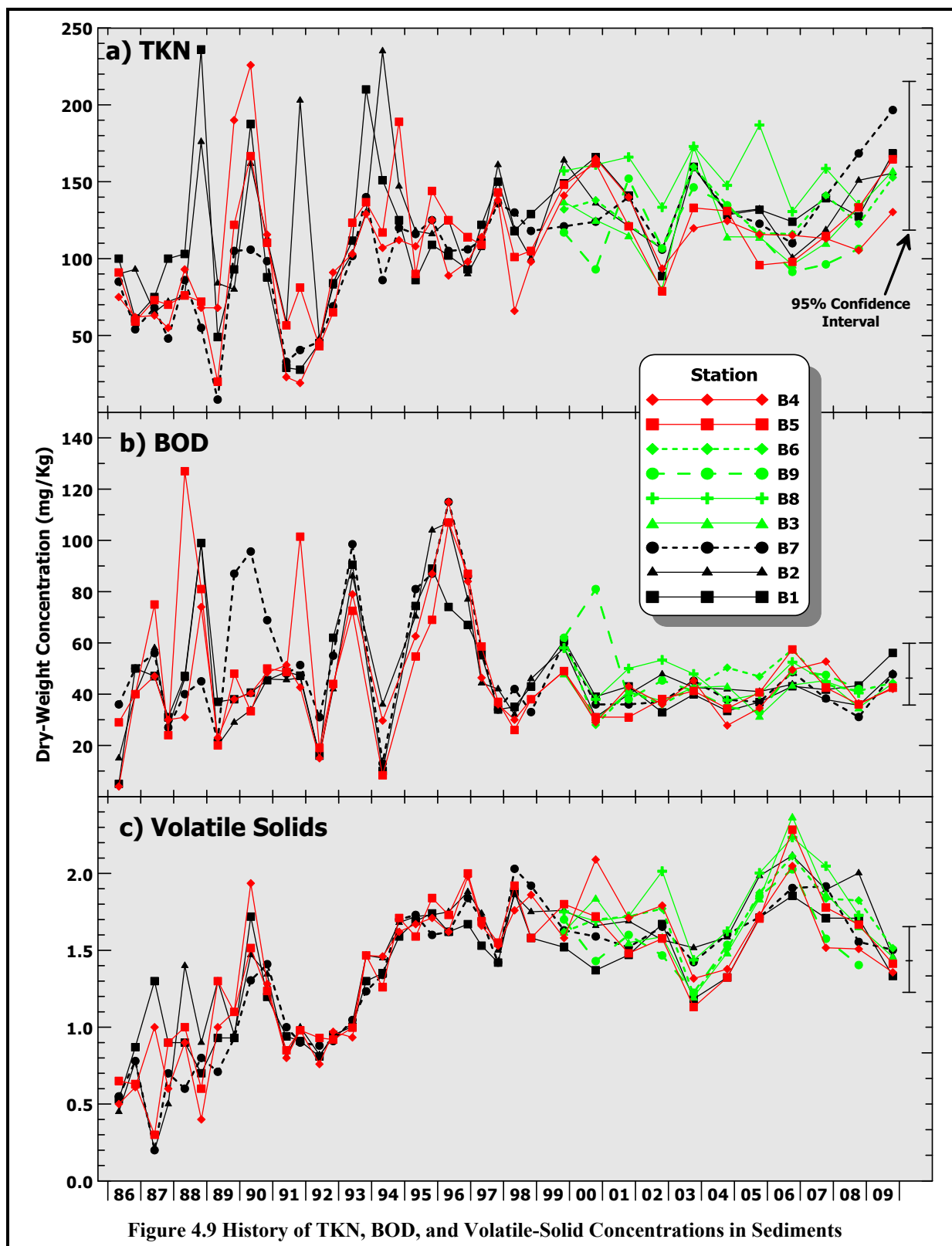
Detailed analyses of sediment time histories spanning the more than two decades of benthic monitoring of the MBCSD discharge continue to demonstrate a lack of benthic impacts from MBCSD discharge. This is largely due to the overall low total emission of chemicals by the MBCSD WWTP. As described in Chapter 2, not only are the chemical concentrations within the effluent itself low, but the plant discharges a comparatively small volume of wastewater overall.

Figure 4.7 and Figure 4.8 show time histories for the six trace metals that have consistently been detected in Estero Bay sediments. Time histories for measurable organic constituents within sediments are shown in Figure 4.9. Concentrations measured in sediment samples collected at the two stations closest to the diffuser, namely ZID Stations B4 and B5, are indicated in red. Concentrations at the nearfield stations (B3 and B6), which are located approximately 60 m from the center of the diffuser, are indicated by green symbols. Similarly, green symbols are also used to indicate the cross-shore Stations B8 and B9, which were discontinued in 2009. These four stations were added to the monitoring program in 1999, so they span only 10 years of the available 24 years. Lastly, the black lines and symbols track sediment concentrations at the midfield stations (B2 and B7), which are 150 m from the diffuser, and the upcoast reference station (B1).

A discharge-related accumulation of contaminants would be evident in these figures as a gradual separation of the colors over time. The red stations would eventually be the highest, followed by green, with black the lowest. However, this temporal signature is not evident in any of the records of trace-metal or organic parameters. On occasion, some metals have exhibited a comparatively consistent offset for several years in a row, particularly chromium at Station B1. For the most part, however, the relative ranking of station concentrations has fluctuated randomly from survey to survey.







In fact, within any given survey, the range in concentrations among stations has often been smaller than the sampling uncertainty associated each station's reported concentration. This within-station sampling variability is reflected in the 95% confidence intervals shown to the right of each constituent's time history. These confidence intervals were discussed in the previous section and are the same as those shown in Figure 4.3 and Figure 4.6. However, Figure 4.7 and Figure 4.8 allow a quick visual comparison between the width of this sampling uncertainty and the scatter in reported concentrations within individual surveys throughout the historical record. The comparison shows that spatial differences at any given time were generally not statistically significant. In contrast, interannual and seasonal fluctuations tend to be much larger in amplitude than the spatial differences among stations that are observed at any particular time. Additionally, they are often larger than the sampling uncertainty reflected in the confidence intervals. Thus, long-term temporal trends, and many shorter-term interannual fluctuations, tend to occur in unison at all stations. This indicates that temporal changes in large-scale processes, such as basin-wide onshore erosion and runoff, dominate sediment metal concentrations at the monitoring stations as a whole.

Despite the overwhelming influence of regional processes, subtle differences in sediment properties at Station B1 are occasionally apparent in the records of chemical concentrations. As with regional processes, these slight differences are due to an inherent variation in depositional processes rather than the influence of the MBCSD discharge. As discussed above, Station B1 is located more than 1 km north from the other monitoring stations, and appears not to be subject to exactly the same oceanographic processes as the rest of the monitoring stations. As a result, slight differences in un-normalized trace-metal concentrations can occasionally be discerned at this station.

For example, in the last decade, offsets have occurred in arsenic, chromium, and nickel concentrations measured at (reference) Station B1 (Figure 4.7abc). Slightly lower arsenic and nickel concentrations are evident as a separation in the solid black line with black squares (■) in the Figures. The relatively increased chromium concentrations reflect a similar scenario, albeit offset in the opposite direction (Figure 4.7c). At various times, the Station-B1 offsets in arsenic and nickel concentrations appear to have re-converged with mean conditions, although elevated chromium concentrations have yet to do likewise. Moreover, elevated chromium concentrations at Station B1 are incongruous with the comparatively depressed arsenic and nickel concentrations at Station B1. This suggests that the trace-metal composition of particulates deposited at Station B1 are slightly different from that of the other monitoring stations, at least over the past decade of sampling conducted under the current NPDES permit.

A requirement for benthic monitoring at Station B1 was discontinued when the discharge permit was re-issued in early 2009. As monitoring results from all facets of offshore monitoring began accumulating over the last two decades, it became increasingly apparent that the footprint of potential discharge impacts from the MBCSD discharge was far smaller than envisioned when the original monitoring program was first designed in 1985. Since that time, both the receiving-water and benthic monitoring locations have moved much closer to the discharge, and monitoring at more distant stations has been eliminated. It is now clear that the large, 1-km separation of Station B1 was unnecessary for ensuring isolation from potential impacts from the discharge. Moreover, because the separation was so large, it exhibited inherent zoogeographic and physicochemical differences that confounded the interpretation data collected at the other stations tightly spaced around the diffuser structure. However, although Station B1 is of little value from a compliance-evaluation standpoint, its unbroken 24-year monitoring record is of immeasurable scientific value. For that reason alone, benthic sediment sample were voluntarily collected at this station in 2009, and continued monitoring is recommended in subsequent years (see Chapter 5).

Table 4.9 Temporal Trends in Sediment Chemical Concentration

Parameter	<i>p</i> -value ¹	Rate ² (mg/Kg/yr)	Concentration (mg/Kg-dry)		Years to Effect ⁴	Emission (Kg/yr) ⁵	
			2009	Effects ³		Actual	Required
Arsenic	<0.001	0.07	3.4	8.2	54	<1.5	6
Chromium	<0.001	0.86	48	81	27	<2.6	76
Copper	<0.001	0.08	3.2	34	393	18.1	7
Nickel	<0.001	0.58	43	51.6 ⁶	7	≈6.5	51
Lead	0.486	-0.01	2.2	46.7	—	—	—
Zinc	0.005	0.13	17	150	1,009	79	12
TKN	<0.001	2.60	160	—	—	—	—
BOD	0.859	-0.10	46	—	—	—	—
TVS	<0.001	0.05	1.43	—	—	—	—

¹ Trend significant if *p*-value less than 0.05

² Rate of concentration increase per year

³ Concentration where biological effects become evident (ERL)

⁴ Predicted number of years (after 2009) to the time when concentrations reach biological effects levels

⁵ Actual mass-emission in 2009 compared to that needed to account for annual concentration increase

⁶ Effects-range median (ERM) for nickel because its concentration currently exceeds the ERL

Chemical Accumulation Rates

This section quantifies long-term increases in chemical concentrations that are apparent in some of the time histories. Because the accumulation occurs at all stations, including stations distant from the outfall, the increase is unrelated to effluent discharge. Nevertheless, the increase in chemical concentrations is of environmental interest, irrespective of an evaluation of discharge impacts. Table 4.9 presents the results of a series of linear regressions applied to the time history of average chemical concentrations.¹³ The “*p*-values” reflect the statistical confidence in the accumulation rates listed in the third column. As with the hypothesis tests conducted on spatial trends, *p*-values less than 0.05 are considered statistically significant, so their corresponding accumulation rates are highlighted in bold font.

Straight-line regressions spanning the entire 24-year time series, and including means from each of the 37 available surveys were performed on the data for each parameter. Visual inspection of the time series plots in Figure 4.7, Figure 4.8, and Figure 4.9 indicates that after 1990, the precision of chemical analyses improved significantly. This is particularly evident in the time series of TKN, BOD, and TVS (Figure 4.9) where large outliers have become less prevalent in recent years.

The regression results reported in Table 4.9 reveal that almost all the chemical parameters have exhibited a statistically significant ($p < 0.05$) increase in concentration over time. The only exceptions are lead and BOD. Lead has only been measured since October 1990 (Figure 4.8c). Although it does not exhibit a long-term trend over the entire record, its concentrations reveal a comparatively brief increase occurred between October 1996 and October 2001. After that, lead concentrations declined, and in 2007, reached the low historical concentrations that were measured in 1996. Despite these large interannual fluctuations, however, there has been no significant trend in lead concentrations over the entirety of the available record ($p = 0.486$). In contrast, zinc concentrations increased slightly between 1986 and 1991, but leveled off in recent years (Figure 4.8b). Consequently, although the zinc depositional rate determined from the entire 24-year time history is statistically significant ($p = 0.005$), it is not in recent years. There were no

¹³ The average contaminant concentration at each point in time is computed as the average of the concentrations reported for all the stations within a given survey.

long-term trends observed in BOD. Even if there were, however, they would be difficult to resolve because of the wide interannual fluctuations that occurred prior to 1998 from interference in the chemical analyses (Figure 4.9b).

The environmental relevance of depositional rates for other sediment constituents is not obvious from a comparison of their magnitudes alone. For example, Table 4.9 indicates that chromium and TKN have much higher rates of increase, with magnitudes at or exceeding 0.86 mg/Kg per annum. However, their overall concentrations in sediments are also proportionally higher, so their percentage increase over time is similar to that of arsenic, copper, and TVS. In actuality, visual comparison of the time series reveals that the relative increase in TKN concentrations has been small, whereas volatile-solid concentrations have nearly tripled since 1986 (Figure 4.9c). In comparison, average arsenic, chromium, and copper concentrations have doubled over the last two decades (Figure 4.7ac; Figure 4.8a).

Biological Implications

The environmental relevance of metal accumulation rates can also be evaluated in terms of their future potential for marine impacts. Estero Bay is one of the more pristine offshore regions along the west coast of the contiguous United States. However, continued accumulation of sediment chemicals at historic rates could eventually degrade the marine environment to levels comparable to some of the more-industrialized regions within Monterey Bay and the Southern California Bight. As described in this section, if the increases continue, some trace-metal concentrations will eventually reach levels where adverse impacts to marine biota might be possible.

The biological implications of the observed chemical accumulations are assessed in the “*Years to Effect*” column of Table 4.9. This column lists the projected number of years that it will take for each of the key chemical concentrations within Estero Bay sediments to reach toxicological benchmarks, assuming they continue to accumulate at historical rates. Five trace metals, arsenic, chromium, copper, nickel, and zinc, are of particular interest because they exhibit highly significant ($p \leq 0.001$) long-term increases in sediment concentration. The trends are visually evident in Figure 4.7a through Figure 4.8b. Although the concentrations of chromium, copper, and zinc, appear to have stabilized in recent years, there is no evidence that concentrations of arsenic or nickel have followed suit.

The “*Years to Effect*” characterizes accumulation rates for these trace metals in terms of their potential relevance to the marine ecosystem. Copper and zinc accumulations are of the least concern. Currently, sediment copper concentrations (near 3.2 mg/Kg) are far below the marine effects level (ERL=34 mg/Kg) and even if they continue to increase at a rate comparable to that of the last two decades, they will remain benign for almost four more centuries. Similarly, current zinc concentrations (17 mg/Kg) are almost nine times lower than the lowest marine toxicological benchmark (ERL=150 mg/Kg), and it will take more than a thousand years at current accumulation rates (0.13 mg/Kg per year) to reach this level. Although current arsenic concentrations (near 3.4 mg/Kg) are only slightly less than half of the lowest marine toxicological benchmark (ERL=8.2 mg/Kg), with annual increases of only 0.07 mg/Kg, it will still be more than five decades before sediment arsenic concentrations might be expected to begin to impact marine biota.

Potential marine impacts resulting from future increases in chromium and nickel are of more immediate concern. Because their concentrations are already naturally high in the marine sediments of northern Estero Bay, even small annual increases will result in a rapid approach toward marine toxicological benchmarks. If chromium concentrations continue to increase at approximately 0.86 mg/Kg each year, contaminant levels could begin to affect marine organisms in as little as 27 years, or by the year 2036.

Over the last two decades, nickel concentrations within the sediments of northern Estero Bay have consistently exceeded the ERL where marine impacts are normally thought to begin to be evident. However, as described in Section 4.2.1, confidence in the effects-levels for nickel is very low. Nevertheless, average nickel concentrations are rapidly approaching the ERM (51.6 mg/Kg) where marine biological impacts are considered probable. At current accumulation rates, average nickel concentrations are predicted to reach toxic levels within Estero Bay sediments by 2016.

Concerns that regional increases in chromium and nickel concentrations could soon reach biological effects levels should be tempered with the knowledge that the predictions are based on bulk metal concentrations rather than on dissolved metal concentrations. Bulk metal concentrations are often not good indicators of biological impacts. This is particularly true when the source of the elevated metal concentrations within Estero Bay is the erosion of naturally occurring mineral deposits. Chromite deposits contain little of the more-toxic hexavalent form of chromium. In contrast, it is likely that the toxicological database that was used to establish the ERL and ERM benchmarks included studies of exposure to industrially derived chromium, which can contain much higher hexavalent fractions. In addition, because of their erosional origin, the elevated trace-metal concentrations within Estero Bay sediments arise from metal that is bound into the mineral matrix of sand grains, where it has less influence on marine organisms. In contrast, the dissolved phases of these metals are far more bioavailable and indicative of potential biological impacts.

Low dissolved-phase concentrations within Estero Bay sediments were confirmed by analyses conducted on pore-water samples collected during the 2003 benthic survey. Pore-water samples were found to contain average concentrations of arsenic (2.3 µg/L), chromium (0.7 µg/L), copper (0.4 µg/L) and nickel (1.5 µg/L) that were all far below the most-stringent saltwater criteria promulgated by the USEPA (36 µg/L, 50 µg/L, 3.1 µg/L, and 8.2 µg/L, respectively). Moreover, the arsenic, chromium, and copper concentrations measured in the pore-water samples were comparable to background concentrations in clean coastal seawater. In contrast, the nickel concentrations that were measured in the pore-water samples were about three times higher than those observed in clean coastal seawater samples. However, it was subsequently determined that the reported dissolved nickel concentrations were artificially elevated due to incomplete filtration of the pore-water samples. Because of the presence of bulk sediment particles, the reported pore-water concentrations overestimated the dissolved-phase concentration. The presence of naturally occurring sediment particulates in the pore-water samples was apparent from the elevated dissolved-aluminum concentrations that were also found in the samples. Even if the dissolved nickel concentrations are slightly elevated within the pore water, it is likely that indigenous infaunal populations have adapted to the higher ambient concentrations over the millennia of exposure.

Low MBCSD Metal Emission

The foregoing discussion identified two trace metals, chromium and nickel, whose projected concentration increases could cause them to approach harmful-effects thresholds within a few decades. However, the observed historical increases in these metal concentrations are unrelated to wastewater discharge from the MBCSD outfall. As described in previous sections, the observed concentration increases are widespread and there are no consistent spatial gradients related to outfall proximity. Moreover, there are no heavy industrial inputs to the MBCSD collection system, and trace-metal concentrations within effluent are uniformly low; so low, in fact, that MBCSD metal emissions could not appreciably contribute to the accretion of these metals in marine sediments. This can be demonstrated with an elementary mass-balance computation.

The two right-hand columns of Table 4.9 compare the actual year-2009 mass-emission of each trace metal (from Chapter 2) with the lowest conceivable emission that could cause the concentration increase

observed within surficial sediments surrounding the outfall. For both metals of concern, actual mass emissions from the MBCSD outfall during 2009 were well below the emissions that would be required to achieve the observed annual increase in sediment concentrations. Specifically, an upper bound mass emission of less than 2.6 Kg of chromium cannot account for the observed 0.86-mg/Kg/yr increase in sediment chromium concentrations. In fact, the emission would have to be nearly 30-times higher. Similarly, the annual increase observed in nickel concentrations could be explained only by a discharge of well more than 51 Kg per annum, while the actual discharge in 2009 was probably closer to 6.5 Kg.

In reality, the differences are much larger given the conservative assumptions incorporated in the mass-balance computation. First, the “*actual*” mass emissions from the outfall represent upper bounds based on the effluent detection limits for the metals. Chromium and nickel concentrations within effluent were too low to be reliably quantified in either of the effluent samples (Table 2.6). In particular, the chromium was not detected in the January effluent sample at the lowest achievable resolution (MDL) of the chemical analyses. Consequently, the actual year-2009 emissions for chromium were probably far less than the upper-bound estimates listed in Table 4.9 because they were largely based on the lowest achievable resolution (MDL) of the chemical analyses, rather than actual concentrations, which could be far lower.

Second, the projected emission rates, namely those required to attain the observed increases in sediment concentrations, were grossly underestimated. The calculation conservatively assumed that the metals were accumulating only within the upper 2 cm of seafloor sediments where subsamples were collected in the field for chemical analysis. However, metal concentrations are probably increasing within a much larger volume of seafloor sediments than was assumed in the mass-balance computation. The area of increase was assumed to cover only the region sampled, namely a radius of approximately 1 km. In reality, the concentration increases are probably occurring over a much wider area, and over a greater depth than that defined by the sampling limits of the monitoring program.

In any regard, the analysis of temporal trends in sediment chemicals demonstrates that contaminants are not preferentially accumulating near the outfall. In addition, upper-bound estimates of emissions from the outfall are too small to have materially contributed to the observed accumulation of trace metals within the sediments of northern Estero Bay.

4.3 BENTHIC INFAUNAL COMMUNITY

The infauna living within the surficial sediments of northern Estero Bay act as sentinels for possible impacts caused by the discharge of MBCSD wastewater. Infauna serve as the best indicators of marine pollution because they have limited mobility and cannot easily escape exposure to contaminants in their immediate environment. Other organisms, such as marine mammals and finfish, range more widely, making it impossible to determine where the organisms were exposed to contaminants.

The diffuser structure lies on the seafloor, where particulate contaminants discharged into marine waters ultimately settle and accumulate. Because infauna reside within seafloor sediments, they are close to the potential source of pollution. Additionally, infaunal species vary in their sensitivity to pollutant stressors. As such, changes in relative abundance among species can signal alterations in their environment. Infauna are also important organisms to monitor because of their low trophic level within the marine food web. They are a major food source for more-mobile epifaunal and pelagic marine organisms, such as crabs, finfish, and marine mammals.

In recognition of infauna’s role as an early detector of marine pollution, the MBCSD discharge permit requires regular monitoring of the overall health of the benthic community within Estero Bay. Infaunal monitoring also addresses the COP requirement that the discharge not degrade indigenous marine biota (see Objective E.1 in Table 3.1 on Page 3-3). The benthic monitoring has now amassed 24 years of

infaunal data. During that time, 229,000 specimens representing more than 374 individual taxa have been examined. Throughout the monitoring program, there has never been any indication of deleterious outfall-related impacts to the benthic community. Instead, the data have revealed a consistently healthy indigenous infaunal community with uniformly high diversity surrounding the outfall. There is no evidence of spatial changes in the infaunal assemblages in relation to diffuser proximity.

These observations hold true despite widespread variations in the abundance of individual organisms. Over the years, the dominance of individual taxa have waxed and waned in response to natural changes in the environment. These natural changes were particularly evident in the 2009 data when faunal density was 100-times higher than average due to a huge explosion in sand-dollar populations. Additionally, for many taxa, distinct differences in abundance are evident between the winter and summer sampling seasons. Other species come and go in response to powerful long-term variations in the oceanographic environment. One such variation is the El Niño – Southern Oscillation, whose impact was evident in benthic sediment samples collected within Estero Bay on at least four occasions during the last two decades of MBCSD monitoring. The first event was in 1988, and the second began at the end of 1997 and extended into 1998. Its influence on benthic organisms was still evident during 1999. Another minor event may have occurred in 1991, but the event with the largest influence on faunal populations around the outfall occurred in 2009 (NOAA 2010).

Almost 72,000 individual organisms were enumerated in the 35 sediment samples that were collected at seven stations during the benthic survey conducted in October 2009. A compendium of the taxonomic identifications and enumerations conducted on year-2009 sediment samples is provided in Tables B.1 through B.8 in Appendix B at the back of this report. Tables B.9 and B.10 list infaunal indices that were computed from infaunal data, as required by the NPDES monitoring and reporting program. This section of the annual report combines these data with biological data collected over the prior 23 years to determine whether there have been discharge-related impacts to the benthic biota.

Three analyses demonstrate that there have been no deleterious impacts to benthic organisms as a result of the discharge. First, the organisms that inhabit the sediments around the outfall are indicative of an indigenous community of filter feeders that thrive only in clean sediments. Second, infaunal data collected during 2009 show no evidence of spatial gradients indicative of biotic degradation attributable to effluent discharge. Third, despite wide fluctuations in community parameters over time, there were no long-term trends indicative of an increasingly degraded benthic environment around the outfall. All the stations tended to respond in unison to large interannual and seasonal influences on the infaunal community. To date, the indigenous benthic community remains healthy, with no perceptible influence from ambient contaminant levels, including the previously discussed long-term increases in trace-metal concentrations that have occurred throughout Estero Bay.

4.3.1 Healthy Indigenous Infaunal Community Surrounding the Outfall

The type and abundance of benthic organisms directly reflect the quality of the marine sediments where they live. Infaunal communities residing in degraded sediments tend to exhibit low species richness and diversity because they are primarily populated by only a few opportunistic taxa that feed on detritus and thrive in sediments that are high in subsurface organics. In contrast, clean sediments are populated by diverse assemblages of organisms that include filter feeders, which extract nutrients from suspended particulates. These suspension feeders are sensitive to excessive particulate loads such as those that can be discharged from low-performance treatment works. The widespread presence of suspension feeders around the MBCSD outfall clearly indicates that the discharge is not adversely affecting them. One such suspension feeder is the club-tipped anemone (*C. californica*). As documented in the diver inspection

report (Appendix D), anemones were found carpeting the diffuser ports in 2009, as they have in prior years (see the photograph in Figure 2.2 on Page 2-4). Their presence is indicative of the benign nature of the suspended sediments discharged by the treatment plant.

Excluded Organisms

The populations of two organisms, *Diopatra ornata* and *Dendroaster excentricus*, have a profound effect on the MBCSD infaunal database. However, these organisms and their attached taxa are not particularly sensitive to changes in sediment quality, and their presence frequently confounds impact assessments. Consequently, their populations were removed from the database prior to the impact assessments described in this section.

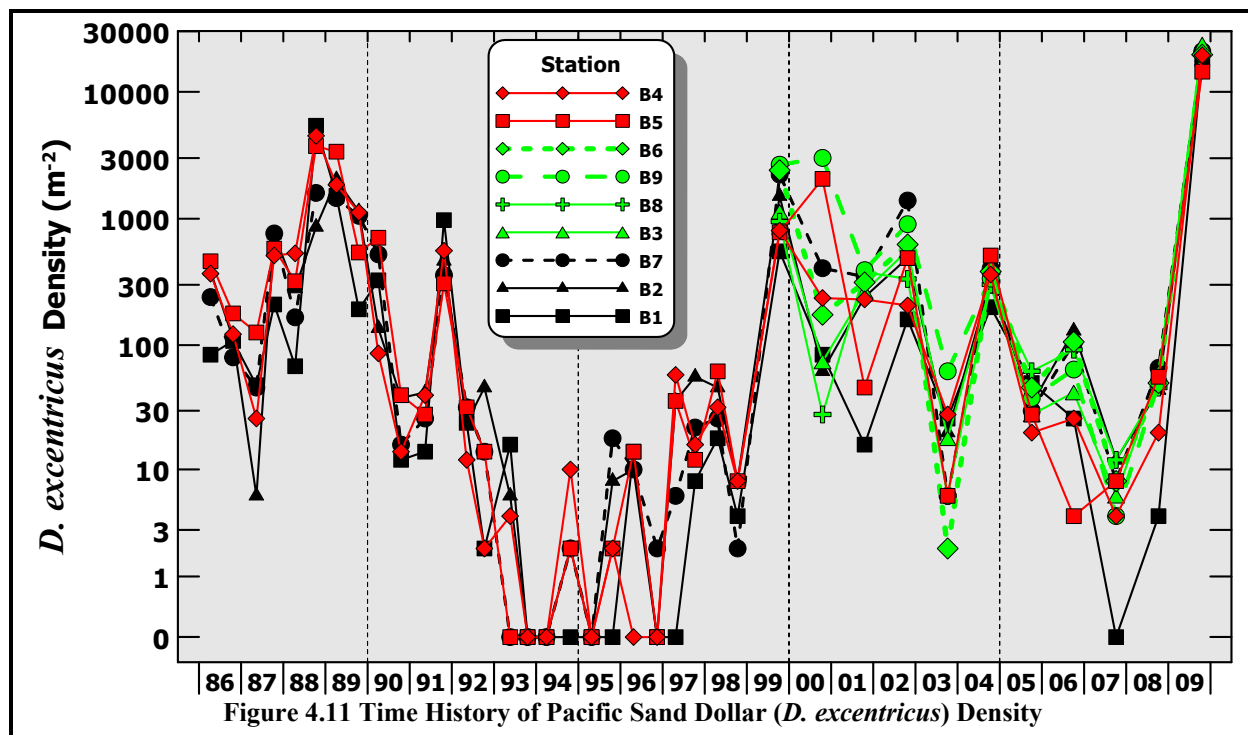
Since 2000, the parchment tubes of the Ornate Tubeworm (*Diopatra ornata*) have routinely been separated in the field prior to sieving of the infauna. Ornate tubeworms are so called for the elaborate layering of pieces of shells, algae, sticks, and other debris onto the outside of their large parchment tubes (Figure 4.10). The inclusion of large numbers of nestling epifauna that reside on the micro-habitats created by these tube casings, particularly small crabs and other crustaceans, can dramatically skew the enumeration of marine infaunal organisms in samples where they are present. Because epifauna live on the surface of marine substrates, they tend to be more mobile and less susceptible to sediment pollutants than infauna, which live in the interstices between sand grains. Removal of the parchment tubes in the field, prior to sieving, avoids the inclusion of large populations of epiphytes. The tubeworms themselves, however, are included in the enumerations because they tend to congregate in higher densities close to both natural reefs and man-made structures, such as outfalls (Davis et al. 1982). During the October 2009 survey, several juvenile *D. ornata* tube casings were separated from samples collected at Stations B4, B6, and B7. Additionally, two adult *D. ornata* were found and separated from samples collected at Station B1.



Figure 4.10 Photograph of a Tubeworm (*Diopatra* sp.)

Statistical analyses performed on the 2009 benthic samples also excluded Pacific sand dollar (*Dendroaster excentricus*) populations. Although sand dollars are filter feeders and can be sensitive to pollution, they are removed from the database prior to statistical analysis because they exhibit extreme population fluctuations from year to year (Figure 4.11) which can potentially mask discharge-related impacts on less-dominant taxa.

Sand dollars form dense beds just seaward of the wave break, which acts as a barrier for predacious sea stars. At that location, predation is limited because sea stars can move over the sand-dollar bed only at significant risk of tumbling into the surf zone with a passing wave (Morin et al. 1985). Consequently, sand-dollar beds migrate shoreward in the summer and seaward in the winter in response to seasonal wave action (Oliver et al. 1980). A winter of strong wave action, usually associated with El Niño, reduces predation, permitting enhanced recruitment of juvenile sand dollars. Specifically, the increased sand dollar recruitment that occurred in late 1988, 1991, 1999, and 2009 was probably associated with high-waves generated by El Niño events in 1988, 1998, 2009 and the weaker one in 1991.



Similarly, the population drop documented in 2003 may have been linked to a predation event in late 2002. On numerous occasions during the October 2002 survey, short-spined sea stars (*Pisaster brevispinus*) became jammed in the jaws of the grab sampler, resulting in an unusually high number of repeated grab sampling attempts at several stations. Accordingly, sand dollar populations in the following year 2003 were markedly diminished, suggesting that predation may have played a significant role in the reduction observed between 2002 and 2003.

Because their large numbers overwhelmingly dominate the population statistics during high-recruitment years, sand dollars have the potential to mask any influence from the discharge on less-dominant taxa whose populations are more consistent and sensitive to potential discharge impacts. For example, historically, average sand dollar densities have ranged from a high of 2600 m⁻² in October of 1988 to less than 50 m⁻² between May 1992 and October 1998. During 1999, recruitment peaked again before engaging in a general decline through 2007 when a total of only 31 sand dollars were collected. During those years, removal of the few *D. excentricus* specimens from the database had little impact on the statistical analyses.

In 2009, however, over 67,000 individual sand dollars were enumerated within the 35 infaunal samples collected at the outfall. This population is the largest ever recorded in course of the monitoring program, with average sand-dollar densities at the seven benthic stations averaging slightly over 19,000 m⁻². In comparison, the amassed total of all other benthic organisms collected during the 2009 sampling came to 4229 individuals. Therefore, community indices computed with (Table B.9) the 2009 *D. excentricus* population were vastly different from indices computed without their inclusion (Table B.10). Most of the indices are measures of the degree of uniformity of abundance among species, such as dominance and diversity. When the overwhelmingly dominant sand-dollar population is included in the indices, trends in the diversity due to population differences in other taxa are completely masked. For example, the Swartz dominance index (*S_w*, see Section B.1.2) is normally a highly diagnostic and stable measure of the

relative health of the infaunal community. However, because sand dollars represent more than 75% of the population in all replicate samples, except in Replicate R4 at Station B5, it remains unchanged from unity (See the *Sw* column in Table B.9) and provides no information about the relative abundances of other taxa. Exclusion of sand dollars from the computation of indices (Table B.10) allows differences in other taxa to be discerned. Note that the infaunal trophic index (*ITI*) is unaffected by the presence of sand dollars because they were not included in the feeding guilds quantified by that index.

Although marked increases in sand dollar populations undoubtedly coincide with the occurrence of El Niño events, the amplitudes of the population increase is not always related to the strength of the event. For example, the 2009 event is only considered a moderate-to-strong event (NOAA 2010), while the 1988 event was very strong; yet, the 2009 sand-dollar population was seven-times greater. Instead, the increased 2009 population may have been due to the timing of the benthic survey, which was conducted shortly after an unusually intense and rainstorm. High waves associated with the storm may have been responsible for repositioning the sand-dollar bed, which tracks the wave-breaking zone, farther offshore and closer to the outfall. See Section 3.2.3 for a discussion of this storm and its effect on regional oceanographic processes.

Exclusion of the highly transient sand-dollar population enhances, but does not detract from the impact evaluation because their distribution is clearly unrelated to effluent discharge. As with the chemical constituent time histories, spatial distributions of sand-dollar populations related to outfall proximity would be evident in Figure 4.11 as a separation between the time histories for the ZID stations (red), for midfield stations (green), and for stations well away from the diffuser structure (black). Instead, the large fluctuations in sand-dollar abundance tend to occur equally at all stations. The consistently low density of fully-grown adult sand dollars, even during the high-population periods, demonstrates that their presence is transient; no permanent sand dollar beds exist in the region (Brown and Caldwell 1989, 1993). It is well established that sand-dollar beds are often dominated by a single age group (cohort) suggesting that recruitment is episodic and only occasionally successful (Cameron 1980, Oliver et al. 1980, Morin et al. 1985, Cameron and Rumrill 1982). Not surprisingly, sand dollars collected during the MBCSD benthic surveys are predominately composed of small juveniles of the same cohort.

Abundance

In this report, the overall health of the benthic community within Estero Bay is reflected by the principal population parameters computed from samples collected at each station over the duration of the monitoring program. For the reasons described above, sand dollars (*D. excentricus*) were excluded from the population statistics to better evaluate the overall health of the benthic community. The community parameters provide a succinct description of the abundance, diversity, richness, and trophic (feeding) structure of benthic biota. Figure 4.12 shows the temporal variability in mean community parameters that were computed for each of the nine benthic monitoring stations, seven of which have been monitored continuously, including in 2009. Each major category of community parameter is discussed in the sections that follow.

Population density, shown in Figure 4.12a, measures the total abundance, or number of organisms, within a 1-m² area of the seafloor. It is the most basic single measure of a community of organisms, but lacks valuable insight as to how the abundance is distributed among the differing taxa. Because of this deficiency, it is not a useful ecological measure by itself. Nonetheless, major declines in organism density can occur after a rapid increase in sediment contamination. This initial decline is often followed by a marked increase in total abundance when opportunistic species repopulate the degraded environment.

Throughout the monitoring program, the number of organisms collected at each station has fluctuated enormously. Although the range in abundance covers almost an order of magnitude, differences in abundance among individual stations within any given survey were much smaller. Namely, all the stations tend to track the temporal fluctuations as a group, and spatial differences among stations within a given survey are generally small compared to the wide temporal fluctuations between surveys.

The largest population changes occur on a seasonal basis. Post-summer populations (those sampled during the October survey) are generally a factor of three higher than the post-winter populations. The reduced winter population, which was only measured prior to 1999, is a response to harsher oceanographic conditions when storms generate intense wave-induced currents that scour the bottom near the 15-m water depth of the outfall. Post-summer populations reflect recruitment of the more delicate annelid worms that can only survive during quiescent benthic-flow regimes. The absence of winter surveys after 1998 accounts for the uniform increase in density that is apparent in the last decade of the monitoring record.

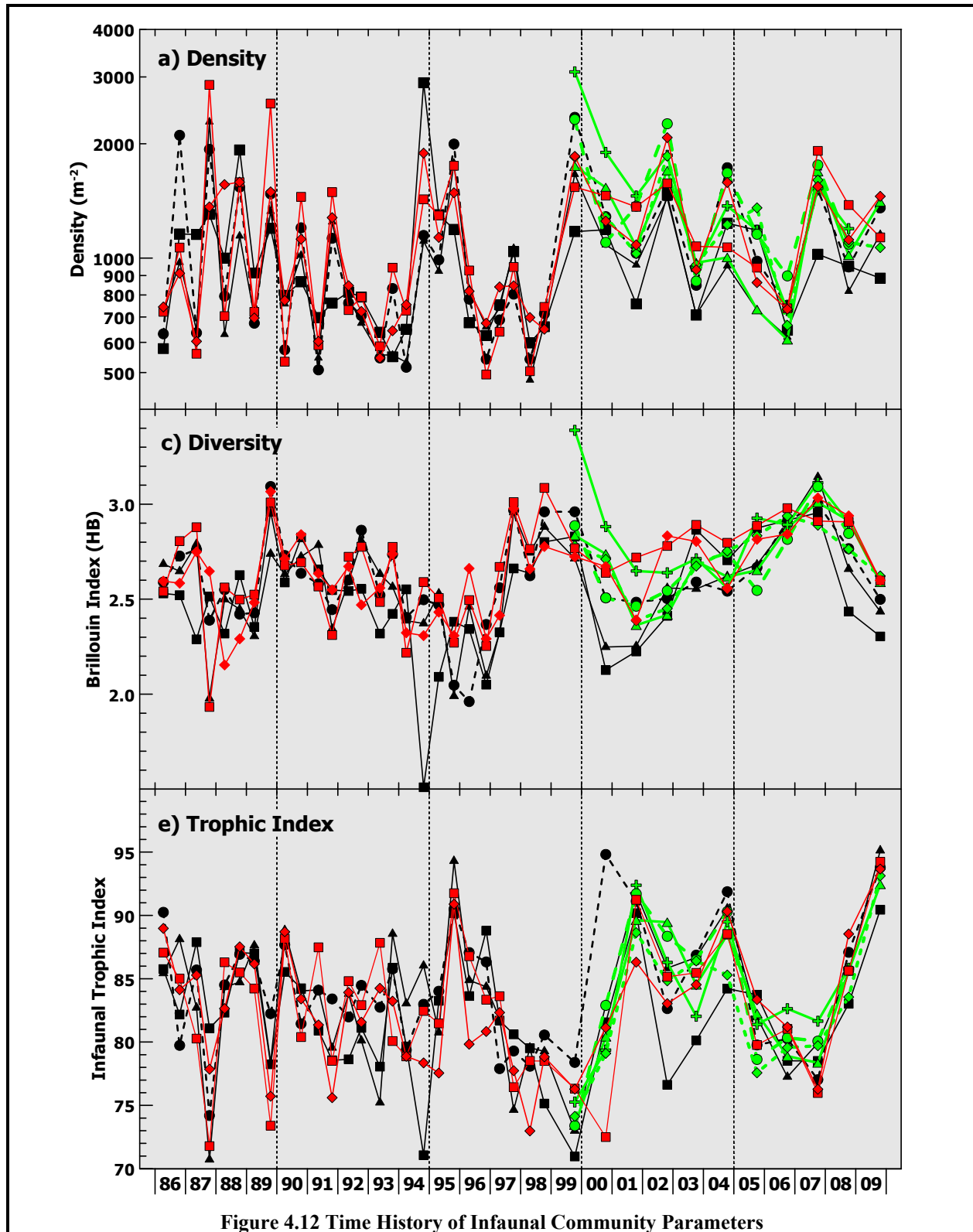
Any spatial gradients in density are completely masked by the large temporal fluctuations. In particular, abundances at stations near the outfall (shown in red) were not consistently lower (or higher) than the density at distant stations (shown in black), and that lack of spatial division has remained constant throughout the monitoring program. This demonstrates that any accumulation of sediment chemicals from the effluent discharge over the last two decades has had no discernable impact on infaunal abundance, particularly when compared to large seasonal and interannual population fluctuations.

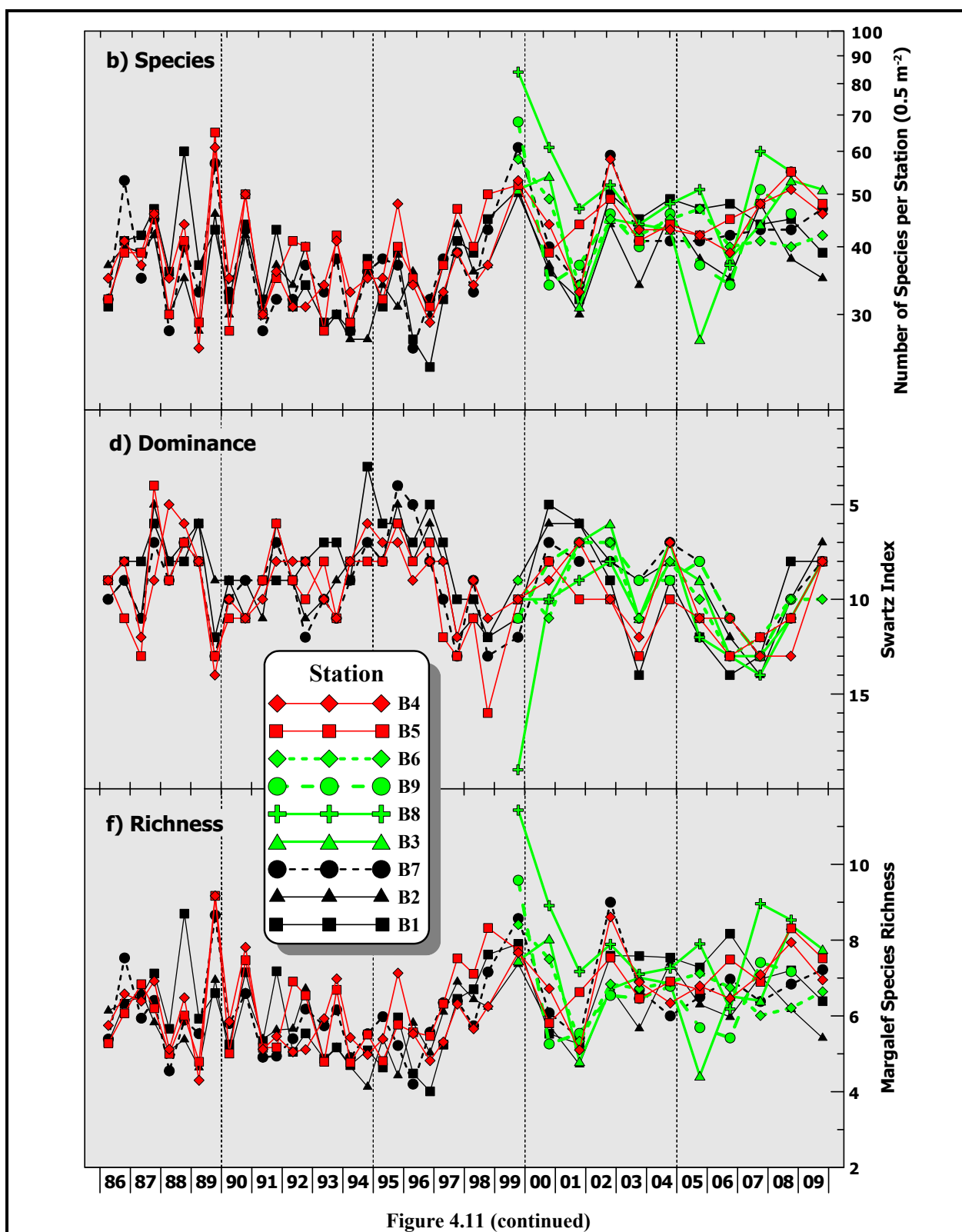
Number of Species

The total number of species is another measure of the overall health of benthic communities (Figure 4.12b). Everything else being equal, infaunal communities respond to environmental stresses by becoming less diverse, as reflected by a substantial reduction in the number of species. However, the number of species encountered in a sample is directly related to the number of organisms in the sample, i.e., it is inherently related to sample abundance. Because rare species are generally undersampled, the number of species automatically increases in samples with more organisms. Thus, it is difficult to tell if a decreased number of species is due to an actual decline in biodiversity, or simply due to decreased sample sizes (abundance). Irrespective of the influence of sample size, reductions in species counts would suggest a decline in diversity and degradation in the marine environment.

There was no obvious temporal trend in numbers of species that would suggest that sedimentary conditions near the outfall were being preferentially degraded (Figure 4.12b). Specifically, there was no divergence in the colors over time, where species counts at stations distant from the outfall, shown in black, steadily increase relative to stations near the outfall. As with abundance, any spatial differences in the 2008 data were minor when compared to seasonal and interannual fluctuations.

Beginning in 1996, there was a steady increase in the number of species encountered in samples. This trend culminated in 1999, when 84 species were collected at Station B8 alone (green line with crosses). However, this increase was largely due to the increased prevalence of ornate tubeworms (*D. ornata*) within some of the samples. Between 1990 and 1996, only one, and usually no *D. ornata* specimens were collected during any given survey. However, in the post-winter surveys of both 1997 and 1998, two ornate tubeworms were encountered. In 1999, four of these tubeworms were found at Station B8 alone. These tubes were not removed prior to sieving, and as discussed previously, the inclusion of numerous epiphytic taxa associated with their tube casings resulted in the unusually large number of species recorded in 1999.





The other temporal fluctuations in species counts tended to track the fluctuations in abundance. Consequently, at least some of the variability in the numbers of species can be an artifact of the sample size (abundance) rather than purely an increase in species richness or diversity. In 2009, the number of species enumerated at each station ranged between 35 and 51, which is comparable to the past several years.

Diversity

A large number of interrelated diversity indices have been developed in an attempt to account for the inherent relationship between the number of species and sample size or abundance. Two common indices are the Shannon Diversity (H') and the Brillouin index (HB) (Appendix B.1.2). Both exhibit nearly identical time histories in the MBCSD database, so only the Brillouin index is shown in Figure 4.12c.

Ostensibly, diversity should decrease in a degraded benthos, although significant reductions can also occur in the absence of anthropogenic stresses. Nevertheless, temporal trends in diversity did not exhibit any evidence of a deteriorating benthic environment near the outfall. On the contrary, in recent years the highest diversity was typically observed at one of the two stations located closest to the outfall (shown in red). Higher diversity at the two ZID stations indicates a healthier infaunal community close to the outfall rather than a community impaired by the discharge of effluent.

Two large historical outliers in diversity warrant some discussion. First, the markedly high diversity (3.39) that was measured at nearfield Station B8 in 1999 was an artifact of the enumeration of additional epiphytes residing on the casings of ornate tubeworms. As discussed previously, the presence of a large number of epiphytic species heavily influenced both the overall abundance, and number of species counted at this station during the 1999 survey (Figure 4.12ab).

The second unusual outlier was the very low diversity (1.51) that was found at Reference Station B1 during the October 1994 survey (black square ■ in Figure 4.12c). As with outlier described above, there were an unusually high number of organisms enumerated in samples collected at this station in 1994 (Figure 4.12a). However, in this case, the increased abundance was associated with a single species, the spioniform polychaete worm *Magelona sacculata*. Nearly 1,000 specimens were collected at Station B1 during the October 1994 survey. As a result of the numeric dominance of this one taxon, the computed diversity at this station was low.

M.sacculata is often one of the numerically dominant taxa found in northern Estero Bay, but on average, only approximately 50 specimens are typically collected at each station. During the 2009 survey, only 21 specimens were collected at all seven stations combined. High populations of this species were recorded in 1994 because the grab encountered a highly localized pocket of densely populated *M. sacculata* in two of the five replicate samples. Although magelonids are common in sandy bottom sediments, their distribution is patchy, so a few replicate samples typically contain most of the specimens, while other grab samples from the same station contain none. The presence of this surface detritus feeder can be considered marginally indicative of degraded sediment conditions. Regardless, its abnormally increased abundance in 1994 occurred at the reference station, and thus bore no relationship to effluent discharge.

Dominance

The Swartz species dominance differs from the other community indices because it does not make an *a priori* assumption concerning how individuals are distributed among species. Because it is non-parametric, it is less sensitive to the limitations that plague other community indices. It is defined as the total number of species accounting for 75% of the individual organisms collected. As such, it represents an inverted measure, in which increased dominance is associated with lower values of the Swartz index. Increased dominance is expected in degraded benthic communities where a few opportunistic, pollution-

tolerant taxa abound in the absence of a wider array of pollution-sensitive organisms. As with the other community parameters, Figure 4.12d shows that differences in dominance among stations in a given survey were generally small compared to temporal fluctuations. Overall dominance was generally low, with five or more species typically sharing numerical superiority. In fact, in most surveys, organisms were more evenly distributed among taxa at the outfall stations (shown in red) than at more distant stations. This is opposite of the pattern expected if effluent discharge had degraded the benthic environment.

By far the lowest historical dominance occurred in samples collected at Station B8 during 1999. During that survey, nineteen species accounted for 75% of the specimens collected. Judging from a Swartz index that normally is near eight species, up to 10 of the 19 dominant species that were found at Station B8 during 1999 were epiphytic organisms associated with the presence of ornate tubeworms. The exclusion of these tubeworms from subsequent surveys has resulted in more representative Swartz indices.

On average, eight species accounted for 75% of the specimens in the benthic samples collected during the October-2009 survey. This indicated that infaunal abundance was evenly distributed among the species. Moreover, uniformly low dominance was found at all the stations in the 2008 survey; with Station B2 have only a slightly higher dominance of seven species.

Clean-Sediment Feeding Guilds

The Infaunal Trophic Index (*ITI*) (Word 1978 and 1980) compares the abundance of four soft-bottom assemblages that are distinguished by their feeding behavior. Because sensitivity or tolerance to organic enrichment differs among the four groups, shifts in the dominance of the individual feeding groups, as reflected by a change in the Trophic Index, can be indicative of degraded environmental conditions. The *ITI* ranges between 0 and 100. When species in Group I (suspension feeders) and Group II (surface-detritus feeders) dominate, index values are above 58, indicating that sediments are relatively clean. Lower infaunal indices occur when populations of species in Group III (surface deposit feeders) and Group IV (sub-surface detritus feeders), which generally dominate when sediments are high in organic contaminants.

The *ITI* has been consistently high throughout the monitoring program, but the 2009 samples supported the highest *ITI* measured in the database (Figure 4.12e). In addition, the increased *ITI* was comparable at all stations, suggesting that the recently increased well-being of the benthic community had occurred throughout northern Estero Bay. Regardless, the exceptionally clean sediments of the Bay have always been reflected in a trophic index well above the critical *ITI* of 58, below which degraded benthic conditions are thought to exist. In fact, trophic indices have always exceeded 70, confirming the consistent dominance of suspension and surface-detritus feeders in the relatively clean sedimentary environment offshore Morro Bay and Cayucos. Moreover, there is no pattern of degradation close to the outfall evident in the *ITI* time series. Effluent-related degradation would appear as a reduced *ITI* at the ZID Stations (4 and 5). Effluent-related degradation would also emerge in Figure 4.12e as a gradual separation in colors over time, with stations closest to the diffuser structure (shown in red) eventually having the lowest *ITI*. This would be followed by a slightly higher *ITI* at nearfield stations, shown in green. Instead, as with the other community indices, and with the chemical concentrations, there is no consistent pattern of color separation from year to year.

The extraordinarily high *ITIs* measured in samples collected during 2009 reflect an especially healthy community where suspension feeders predominate. Specifically, the high trophic indices were a consequence of an infaunal population consisting largely of phoxocephalid amphipods, namely *Majoxiphalus major*, *Rhepoxynius abronius*, and *Rhepoxynius menziesi* (see Table B.1). Together, these three amphipod species alone accounted for one-quarter of all non-*Dendroaster* specimens collected during the survey. In fact, these amphipods were the three most abundant taxa collected during the 2009 survey

behind sand dollars and the nermeritean *Carinoma mutabilis*. Phoxocephalids are active suspension feeders whose presence weighs heavily in the computation of the *ITI* as members of the Group-I feeding guild (see Section B.1.3). The prevalence of these species at all stations during the October-2009 survey lends confidence in the general lack of potential discharge-related impacts.

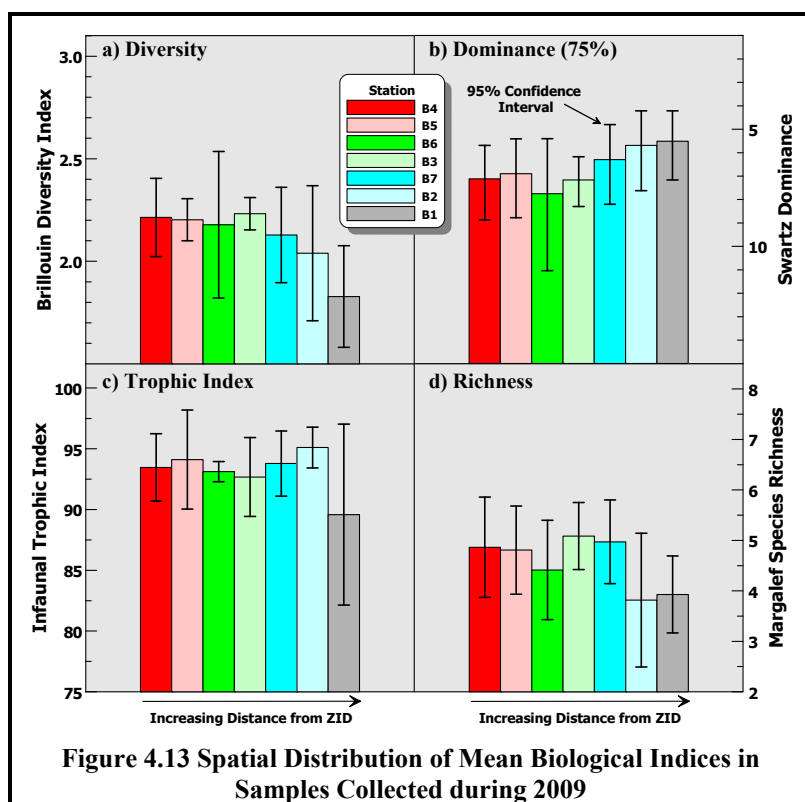
Additionally, *R. abronius* is known to be particularly sensitive to pollution (Pearson and Rosenberg 1978) and is often utilized for bioassay testing of marine sediments (ASTM 1992; USEPA-USACOE 1991, 1993). This taxon is also especially sensitive to increased amounts of fine sediments, and variations in grain-size distribution can often account for variations in its abundance (DeWitt et al. 1988).

In contrast, opportunistic pollution-tolerant species, such as *Polydora ligni*, *Capitella capitata*, *Paraprionospio pinnata*, and oligochaete worms, were almost entirely absent in the samples collected during 2009. Out of the 35 benthic grab samples collected, only one juvenile specimen of an unidentified species of *Polydora* and one *P. pinnata* were enumerated at Station B5 (Table B.6). Thus, it was the combination of the prevalence of sensitive filter-feeding taxa as well as the general absence of pollution-tolerant opportunistic taxa led to overall high levels of the infaunal trophic index in 2009, signifying the presence of a uniformly healthy benthic population consistent with that documented over the last two decades.

4.3.2 Infaunal Distribution in 2009 Unrelated to Outfall Proximity

The previous section documented the overall health of the infaunal community surrounding the outfall using a 24-year record of infaunal community indices. This section investigates whether spatial trends related to outfall proximity exist in the infaunal data collected in 2009. As described in Appendix B.1, four of the biological indices are more informative than the other indices. They include the Brillouin Diversity Index, the Swartz Dominance Index, the Margalef Richness Index, and the Infaunal Trophic Index (*ITI*). The 2009 spatial distribution of average values for these four indices is shown in Figure 4.13.

The bars shown in Figure 4.13 are arranged in order of increasing distance from the diffuser structure. The red-colored bars on the left are associated with the ZID stations located closest to the diffuser, while the two green bars in the middle represent the nearfield stations. Finally, the blue and gray bars that are farthest to the right represent the three distant stations, which lie 152 m or more from the outfall.



Impacts to infaunal communities from the discharge would be reflected in the bar chart as a spatial trend of steadily increasing diversity, ITI, or richness from left to right (Figure 4.13acd). In contrast, dominance would be expected to decrease with increasing distance from the outfall (Figure 4.13b). However, none of these spatial trends is visually apparent in the Figure. If anything, the opposite appears to be the case.

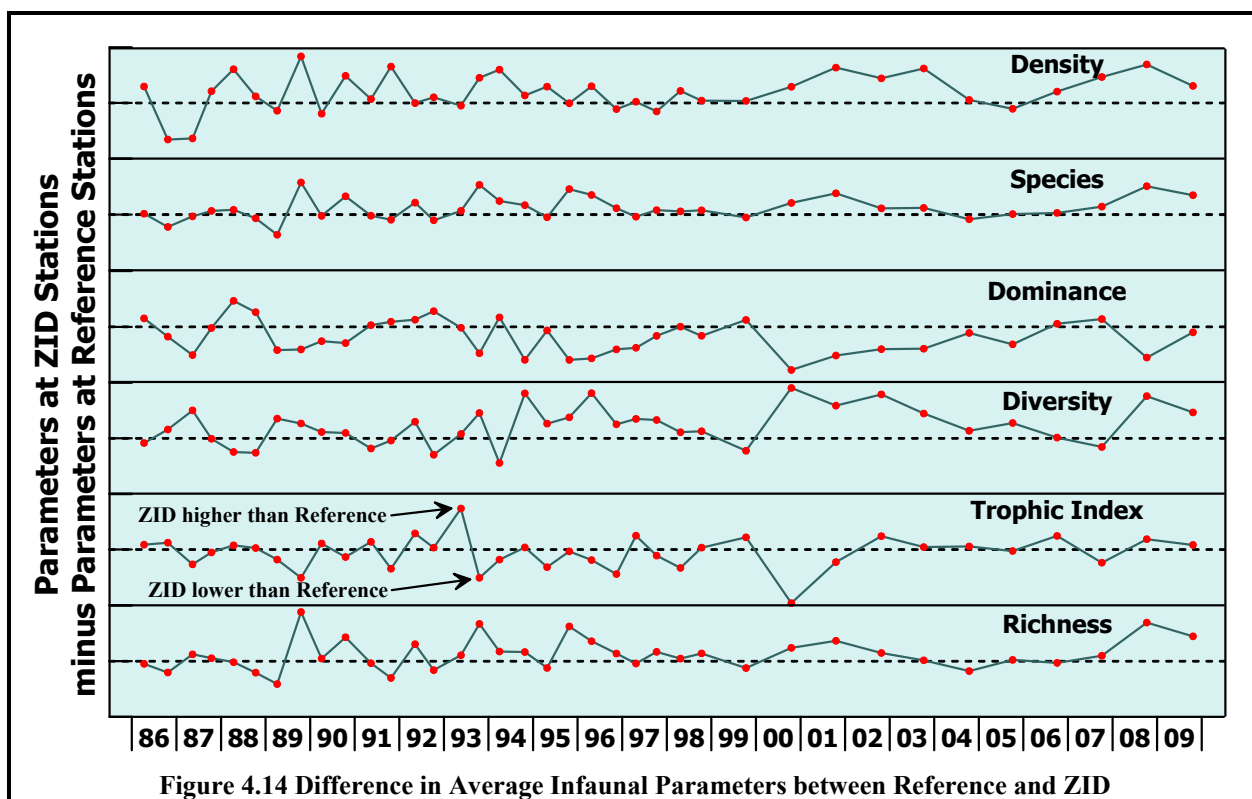
Another way of evaluating whether significant spatial differences exist among the infaunal indices is to test whether any of the average values are significantly different from those of other stations, irrespective of their distance from the outfall. The height of the bars in Figure 4.13 reflects the average index computed from the five replicate samples collected at each station. The 95% confidence intervals surrounding those averages quantify the variability among replicate samples collected at each individual station. As such, the confidence intervals reflect the inherent uncertainty in the determination of average station values. Thus, if the mean at one station is encompassed within the confidence interval at another station (or vice versa), then no statistical significance can be ascribed to any perceived difference between the averages at those two stations, at least with any degree of confidence (viz., a 95% confidence level, $\alpha \leq 0.05$). Visual inspection of Figure 4.13 indicates that the average indices at almost all pairs of stations are encompassed by the associated confidence intervals, except perhaps occasionally at Station B1.

4.3.3 Spatiotemporal Infaunal Trends Unrelated to Outfall Proximity

As with the chemical constituents within northern Estero Bay sediments, subtle spatiotemporal trends in the infaunal community can be difficult to discern in the time series shown in Figure 4.12. The parameters exhibit wide fluctuations between seasons and years. Compared to these large temporal oscillations, the spatial differences among samples collected at a given time (i.e., within a given survey) were comparatively small. In other words, the stations generally tracked one another through time. This indicates that changes in infaunal communities that arise because from regional influences throughout Estero Bay are far larger than those induced by any localized effects. Therefore, within a given survey, spatial differences in infaunal parameters can be difficult to discern when they are confounded by larger natural differences in the sedimentary environment and other zoogeographic influences.

The limitations associated with purely spatial or purely temporal approaches to impact evaluation are largely eliminated through the use of an analysis technique based on tests for nonparallel trends at impact and reference sites (Coats et al. 1999, Skalski et al. 2001). In this application, statistical analyses based on parallelism are capable of discerning subtle temporal trends in the difference between average indices at stations located near the outfall, and those that are distant from the outfall, even though the indices as a whole widely fluctuate from survey to survey. As described previously, discharge-related spatiotemporal changes would appear in Figure 4.12 as a gradual separation of the colors as contaminants accumulate near the outfall and affect the resident organisms. However, because of the large coherent fluctuations that occur over time, subtle spatiotemporal changes may be present but not visually apparent in that kind of presentation. Taking the difference in average values at distant and near sites removes the temporal oscillations that occur on a seasonal and interannual basis. In effect, parallelism assumes that the large temporal excursions in indices occur in unison at all stations and represent a simultaneous response to regional influences. Time series of differences in parameters at ZID and distant stations are presented in Figure 4.14.

If the MBCSD discharge were negatively affecting the benthic community over time, the infaunal properties of populations at stations near the outfall (4 and 5) would slowly diverge from those of the distant stations (1, 2, and 7). This would appear as a trend or slope in the average difference shown in Figure 4.14. A regression test for a statistically significant trend (slope) in the difference is equivalent to a test of the null hypothesis that the population responses at impacted and non-impacted sites are parallel over time.



Parallelism tests applied to the 24-year time series found only one statistically significant linear trend in the infaunal indices. The slight increase in the difference between diversity at ZID and reference stations apparent in Figure 4.14 was found to be marginally significant ($p=0.045$). The trend arose because ZID stations have had higher diversity in all but three of the 22 surveys conducted since 1992. However, the positive diversity differences, and their temporal trend is unrelated to deleterious impacts from the discharge because decreases in diversity would be expected to occur at ZID stations if contaminants were impacting the benthos near the outfall. Higher diversity at stations close to the outfall reflects a healthier infaunal community compared to the distant reference stations. Except for this marginal trend, parallelism was strongly indicated ($p>0.10$) for all other indices.

4.3.4 Influential Taxa

Table B.1 shows that five species accounted for more than half of the non-*Dendroaster* specimens collected in 2009. These influential taxa consisted of a predatory worm, three filter-feeding amphipods, and a marine isopod. The nemertean *Carinoma mutabilis* was by far the most abundant taxon found in 2009, representing approximately 26 percent of all organisms (excluding sand dollars) collected. Nemerteans are soft-bodied, unsegmented worms (Figure 4.15). *C. mutabilis* are carnivorous, eating other small infaunal invertebrates such as annelids and crustaceans.



Figure 4.15 The Nemertean worm *C. mutabilis*

C. mutabilis is normally among the top five most populous organisms in the sediment samples collected as part of the MBCSD monitoring program. However, during both 2008 and 2009, this taxon dramatically increased its prevalence. Whereas in 2007, a total of 395 *C. mutabilis* were collected and comprised approximately five percent of the total infauna, the number of *C. mutabilis* collected during 2008 was more than double that (834), which made it the dominant taxon. The 1117 individuals collected in 2009 represented a 35 percent increase over the 2008 population (Table B.1), but, more importantly, it resulted in a significant increase in the *C. mutabilis* dominance of the non-sand-dollar benthic population.

The second, third, and fourth-most abundant taxa encountered during 2009, *Majoxiphalus major*, *Rhepoxynius abronius*, and *Rhepoxynius menziesi* were discussed previously with respect to their role as indicators of clean sediments. Together they comprised approximately 25 percent of the 2009 benthic assemblage. In the 2009 benthic samples, as well as those collected in past surveys, this phoxocephalid amphipod assemblage has been influential in distinguishing the infaunal communities at the various stations (MRS, 2007a). The assemblage consists of the four amphipods: *Majoxiphalus major*, *Foxiphalus xiximeus*, *Rhepoxynius menziesi*, and the closely-related *Rhepoxynius abronius*. Amphipods, such as the one pictured in Figure 4.17, are small shrimp-like scavengers that eat organic debris. These organisms are laterally composed with small eyes, small heads, and strongly arched backs. They are benthic filter feeders that are generally found burrowing within the top few centimeters of sediment. As such, they are sensitive to contamination, high organic content, and the presence of fine-grained sediments. Because of their narrow habitat specificities, phoxocephalid amphipods are found only at selected depth intervals and locations along the central and southern California coast.

Analyses conducted over the past several years, support the notion that physical characteristics, such as grain-size distribution, are largely responsible for the observed differences in phoxocephalid amphipod community structure among the benthic sampling stations (MRS 2008). Competition for the same ecological niche among closely related phoxocephalid amphipods, may also play a part in their relative distributions, particularly at stations where *R. abronius* is naturally less abundant due to physical sediment characteristics.

The fifth-most abundant organism encountered during the October 2009 benthic survey was the sphaeromatid isopod, *Tecticeps convexus* (Figure 4.16). One of the most distinguishing features of this group of isopods is their ability to roll their compact, convex bodies into a ball. In this ability they resemble certain terrestrial isopods, called pillbugs, a striking example of parallel evolution. *T. convexus* are surface deposit feeders that possess a broad, grinding structure used to chew algae or other plant material, and to scrape diatoms and detritus



Figure 4.17 A Gammarid Amphipod



Figure 4.16 The marine isopod, *Tecticeps convexus*

off sand grains. Like other sphaeromatid isopods, they exhibit marked sexual dimorphism wherein males are substantially larger than females.

As with benthic samples from previous surveys, the infaunal community surrounding the MBCSD outfall in 2009 reflected slight differences in the benthic environment at the various monitoring stations. Historically, the same few species have been found to be influential in differentiating the community structure at specific stations, primarily Stations B1 and B8. The differences in the infauna at these stations can be ascribed to zoogeographic separation in the case of Station B1, and to differences in the water depth at cross-shore Station B8, along with the concomitant differences in orbital wave motion and fine sediment fractions at both stations. Under the current discharge permit, sampling at both of these stations was discontinued, although benthic infaunal sampling was conducted in 2009 at Station B1 in order to maintain continuity of the historical dataset.

Compared to the differences in infaunal communities at these stations, there is little to distinguish the communities at Stations B4 and B5, which are located close to the outfall, from the more distant stations (B2, B3, B6, and B7) that are located farther away along the same isobath. This, along with the analysis of physicochemical measurements described previously in this chapter, provides strong empirical evidence that the sediments surrounding the outfall, along with the organisms that reside within them, have not been perceptibly impacted by the discharge.

CHAPTER 5

Conclusions and Recommendations

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5.0 CONCLUSIONS AND RECOMMENDATIONS

The City of Morro Bay and Cayucos Sanitary District (MBCSD) Monitoring and Reporting Program has been designed to evaluate the performance of the wastewater treatment plant and monitor the quality of the effluent discharged to the ocean. This annual report evaluated compliance with the NPDES discharge permit and documented potential discharge impacts through quantitative analyses of an extensive data set of effluent constituents, receiving water quality, benthic sediment chemistry, and marine biota. Of the thousands of measurements collected as part of the monitoring program during 2009, there was only one that exceeded the discharge limitations. An isolated incidence of elevated residual chlorine was caused on 4 May 2009 when dechlorination was briefly suspended while emergency repairs were made to equipment in the chlorine contact chamber after staff discovered that one of the drive chains for the collector flights broken, and that the drive unit was inoperable.

5.1 TREATMENT PLANT

The MBCSD Wastewater Treatment Plant (WWTP) has been operating under the provisions of a 301(h)-modified NPDES permit since 1986, with 2009 marking the 24th year of consistently high performance by this treatment facility. There is no evidence of a decline in treatment performance in the 24 years of annual averages shown in Table 5.1. In fact, many of the best measures of treatment performance have been achieved during the past six years of operation. For example, the low average effluent Total Suspended Solids (TSS) concentration in 2009 (25.3 mg/L) was the direct result of the exceptional efficiency of the treatment process, which reduced influent TSS concentrations by an average of 92.3%. Additionally, the 2009 solids emission was only 60% of the long-term annual average emission and only 19% of the solids discharge permitted under the NPDES permit. The record low emissions and high effluent quality measurements achieved over the past six years attest to the consistent and exemplary level of recent plant performance.

Reductions in the discharge of oil and grease (O&G) and biochemical oxygen demand (BOD) also attest to the plant's high standard of performance. As with TSS, the discharge of O&G and BOD over the past several years has been exceptionally low, while their corresponding removal rates were high compared to the average rates achieved over the entire 24 years of monitoring (Table 5.1). In fact, the BOD removal rate in 2009 was the second highest on record, while its emission was the lowest on record. Reduced emissions in recent years benefited from more-accurate flow measurements and substantial reductions in inflow and infiltration (I&I) into the collection system due to a comprehensive and pro-active maintenance plan and persistent source-control efforts.

5.1.1 Overall Performance

Irrespective of comparisons with historical performance, the average wastewater characteristics measured in 2009 demonstrated that the treatment process was routinely and substantially exceeding expectations based on the original plant design, the NPDES discharge permit, and federal regulatory standards. For example, in 2009, the average suspended-solids removal rate was 17% above the permitted minimum, and the average BOD removal rate was nearly three times the minimum permitted rate of 30%. The treatment process was so efficient that average effluent TSS and BOD concentrations during every month in 2009 remained at or below the 60-mg/L threshold below which removal rate requirements are not even imposed on the discharge. Moreover, the plant routinely achieved treatment levels that exceeded the requirements for full secondary treatment. For example, monthly solids-removal rates substantially surpassed the 85% full secondary criterion throughout 2009, while BOD removal rates achieved full secondary levels in all but two months, when they were 1.0% and 1.4% below the standard. However,

BOD loading from wastewater discharges to the open ocean is of negligible concern, so the MBCSD discharge effectively met secondary treatment requirements for all of 2009. Other effluent constituents were also correspondingly low during 2009. The discharge of settleable solids was imperceptible, and monthly averages of effluent turbidity, pH, ammonia, and coliform density remained far below the applicable permit limitations.

Flow through the plant during 2009 (1.09 MGD) was one of the lowest on record (Table 5.1). During 2009, approximately 110 million fewer gallons flowed through the plant than the average annual throughput measured over the entire course of the monitoring program. Although portions of this flow reduction were related to improvements in the accuracy of flow measurements instituted in 2002, increased efforts to reduce I&I in recent years also directly impacted the volume of flow processed by the plant.

The high overall performance of the treatment process during 2009 was the direct result of a vigilant and proactive program of preventative maintenance, wherein plant personnel actively seek out and correct potential mechanical impairment of treatment-plant components and respond quickly to the inevitable failures that occasionally occur. For example, unexpected failure of the variable frequency drives used to control the main influent pumps at the end of April 2009 prompted a quick response by plant personnel that limited impacts to the treatment process.

Table 5.1 Average Annual Wastewater Parameters

Year	Flow (MGD)	Suspended Solids				Biochemical Oxygen Demand			
		Influent (mg/L)	Effluent (mg/L)	Removal (percent)	Emission (MT)	Influent (mg/L)	Effluent (mg/L)	Removal (percent)	Emission (MT)
1986	1.42	332	32.8	89.8	64	235	77.0	67.2	151
1987	1.51	274	21.8	92.0	45	257	52.0	79.8	108
1988	1.51	397	29.8	90.0	62	242	43.9	81.9	92
1989	1.46	321	37.3	88.4	75	259	69.8	73.1	141
1990	1.38	345	36.0	89.6	69	261	75.7	71.0	144
1991	1.28	280	30.5	89.1	54	236	66.9	71.6	118
1992	1.41	310	43.0	86.3	84	224	59.3	73.5	116
1993	1.54	339	33.0	89.6	70	222	39.0	81.9	83
1994	1.38	310	32.0	89.4	61	249	33.0	86.4	63
1995	1.55	270	30.6	87.6	69	208	31.4	83.9	67
1996	1.55	344	33.1	89.9	70	241	35.7	85.0	73
1997	1.64	283	36.0	86.6	79	231	38.6	83.0	85
1998	1.95	236	38.8	83.9	101	216	39.1	81.5	99
1999	1.68	386	44.0	86.7	102	287	49.5	82.5	118
2000	1.77	337	37.4	87.5	91	271	50.3	81.1	125
2001	1.48	450	37.6	89.5	74	396	62.7	83.1	127
2002	1.14	374	49.2	86.0	77	386	67.5	82.4	101
2003	1.06	314	39.2	86.7	56	311	56.3	81.3	83
2004	1.09	354	28.9	91.3	44	336	53.3	83.8	81
2005	1.25	373	24.3	93.3	42	303	49.8	83.0	88
2006	1.19	335	20.5	93.2	34	291	45.3	83.8	75
2007	1.09	381	20.9	94.1	31	330	44.4	86.0	68
2008	1.10	337	20.0	94.1	30	331	38.4	88.3	58
2009	1.09	328	25.3	92.3	38	311	37.6	87.4	56
Average	1.39	334	32.6	89.5	63	276	50.7	80.9	97
Limitation	2.06		70.0	75.0	199		120.0	30.0	342

Table 5.1 Average Annual Wastewater Parameters (continued)

Year	Oil and Grease			Mass Emission (MT)	Turbidity (NTU)	pH	Chronic Toxicity (TUC)	Ammonia as NH ₃ -N (mg/L)
	Influent (mg/L)	Effluent (mg/L)	Removal (percent)					
1986	64	13.8	78.4	27	26	7.7		18
1987	44	6.2	85.9	13	23	7.5		
1988	38	6.3	83.4	13	40	7.5		
1989	28	6.1	78.2	12	49	7.4		26
1990	34	8.5	75.0	16	55	7.4		26
1991	73	6.9	90.5	12	50	7.3		18
1992	33	5.3	83.9	10	56	7.3		9
1993	26	6.0	76.9	13	43	7.4	19.42 ²	20
1994	60	4.1	93.2	8	36	7.5	4.37	27
1995	63	5.1	91.9	11	32	7.5	4.35	23
1996	52	7.9	84.8	17	34	7.7	4.83	23
1997	49	5.3	89.2	12	32	7.7	7.80	23
1998	51	5.4	89.4	15	34	7.6	7.80	19
1999	52	6.2	88.1	14	48	7.5	5.00	25
2000	74	5.5	92.6	13	39	7.5	5.60	24
2001	47	4.6	90.2	9	41	7.4	5.60	28
2002	39	4.4	88.7	7	41	7.5	4.98	31
2003	44	5.3	87.9	7	34	7.5	7.80	27
2004	47	3.7	92.0	6	26	7.5	5.60	29
2005	62	4.4	92.9	8	23	7.6	5.60	27
2006	44	4.1	90.6	7	26	7.6	4.36	28
2007	52	4.0	92.4	6	27	7.6	4.36	28
2008	84	4.4	94.8	7	30	7.5	5.56	27
2009	93	4.5	94.6	7	29	7.5	15.82 ³	32
Average	52	5.8	87.7	11	36	7.5	6.99	24
Limitation		25.0			75	6-9	134.00	322

¹ Interference from ammonia artificially increased the reported acute toxicity.

² Screening bioassay of three marine species

³ Screening bioassay of two marine species

5.1.2 Flow Rate

Historically, the most influential factor on flow rate was an artificially increased reported flow that resulted from overttotalization. Overttotalization was particularly significant prior to 2002, when only the effluent flow meter reported flow rates. This meter consistently overestimated flow by as much as 25%. Without overttotalization, average flow over the 24-year record would be closer to 1.19 MGD rather than the reported 1.39 MGD. Because of overestimated flow prior to 2002, the annual mass emissions were also overestimated. Consequently, the average emissions, shown in bold at the bottom of Table 5.1, were slightly inflated. Specifically, the reported average annual TSS emission of 63 MT was actually closer to 54 MT. Similarly, the average annual BOD emission reported at 97 MT was, in reality, closer to 82 MT, and the reported 11 MT of O&G discharged on average was closer to 9 MT.

In 2002, overttotalization was largely eliminated after the more accurate influent flow meter was commissioned, and reported flow began to be based on its measurements. However, flow is still

occasionally overttotalized due to aberrant influent flow readings when the influent flume becomes temporarily surcharged after water backs up from the wetwell at the plant headworks. On these rare occasions, judicious use of corrected effluent flow totals, based on an adjustment determined in the flow-meter study conducted in 2002, effectively eliminates flow overttotalization.

5.1.3 Effluent Constituents

The treatment process was primarily designed to remove organic particulates from the wastewater stream and disinfect effluent. It was not designed to eliminate the majority of chemical contaminants dissolved in wastewater. Instead, a vigorous pollution-prevention program limits introduction of chemical contaminants at the source, before they enter the collection system. The multifaceted pollution-prevention program includes public education, an onsite hazardous waste collection facility, source identification, and inspections of industrial users. Domestic users generate more than 80% of the sewage processed at the WWTP; non-industrial users or light industry, which generate wastewater similar to that of domestic sources but on a larger scale, contribute the remaining portion of the WWTP's influent. Without heavy industry within the service area, there is a concomitant lack of industrial pollutants within the MBCSD wastewater.

As in prior years, a few common metals and ubiquitous chemical compounds appear in low concentrations within effluent and biosolid samples collected during 2009. Of the 79 chemical compounds tested in semi-annual effluent samples, only a few were present in quantifiable amounts. Additionally, the measured concentrations of these compounds were all well below applicable NPDES discharge limits. In most cases, the concentrations were orders of magnitude lower than their respective limits. The associated mass emissions were also well below the limits identified in the discharge permit.

Quantified compounds included three trace metals (copper, lead, and zinc), a common phthalate compound (bis 2-ethylhexyl phthalate), low-level congeners of dioxin, a radionuclide, and ammonia. Because of its sewage origin, ammonia regularly occurs in wastewater. Additionally, some level of radioactivity in effluent samples is expected because of naturally occurring radionuclides. Nonetheless, radiation levels were still well within limits established for drinking water standards and similar to historical levels. Similarly, trace metals also occur naturally within the mineralogy of sediments along the central California coast, although copper, lead, and zinc also enter the collection system through internal corrosion of household plumbing systems. The other two compounds are ubiquitous in the environment, have occasionally been detected within effluent samples, and do not indicate a new or elevated source within the collection system.

As with effluent samples, chemical analyses of biosolid samples quantified only very low concentrations of some commonly occurring wastewater constituents. In addition to the bulk organic compounds, the only constituents with quantifiable concentrations included 17 ubiquitous trace metals, cyanide, benzoic acid, and the same common phthalate found in effluent. All measured concentrations were low and well below regulatory limits that would make the biosolids hazardous or unsuitable for composting and land application. Because of the high quality of the biosolids and implementation of windrow composting allowed the plant to make the final product available to the public for beneficial reuse as a high-quality soil amendment.

Largely because of low contaminant concentrations in effluent, bioassays conducted over the past decade consistently demonstrate the MBCSD effluent's low toxicity to marine organisms. The chronic bioassays conducted in 2009 confirmed the benign nature of MBCSD effluent. All toxicity measurements in 2009 were less than permit limits.

5.2 RECEIVING WATERS

The receiving-water environment was monitored on a quarterly basis to evaluate the oceanographic conditions near the outfall, particularly with respect to any adverse impacts from wastewater discharge. Comparison of water quality at the boundary of the zone of initial dilution (ZID) with gradient areas beyond the dilution zone documented compliance with the receiving-water objectives of the California Ocean Plan (COP) as specified in the NPDES discharge permit. Extremely sensitive electronic probes provided a detailed picture of water quality during the four surveys conducted in 2009. Precise navigation and high-resolution data on light transmittance, density, temperature, salinity, pH, and dissolved oxygen assessed spatial variations within receiving waters.

During all four surveys, small anomalies in water properties associated with the submerged wastewater plume were detected. In all cases, the water-quality fluctuations were restricted to the ZID, generated by the upward displacement of ambient seawater and not the presence of wastewater constituents, or were insignificant compared to the larger ambient variations resulting from natural oceanographic processes. Several of these plume measurements captured the signature of wastewater while it was undergoing rapid initial mixing within the ejection jet emanating from a diffuser port. Dilution rates determined from these close-in measurements were compared with expected critical initial dilution ratios based on modeling during the outfall design. They demonstrated that the diffuser structure had dispersed the wastewater to a much greater extent than predicted by the modeling.

Because tests for compliance with the receiving-water limitations in the discharge permit only apply outside the ZID, these close-in measurements were not subject to the standards in the COP. Nevertheless, most of the plume observations collected within the ZID were below the permit limits applicable to observations collected outside this narrow 15-m mixing zone. None of the observed conditions suggested that unmixed wastewater was tangibly affecting receiving waters within or beyond the ZID. As with prior monitoring, water quality parameters measured in the 2009 surveys confirmed that the diffuser was operating efficiently and that wastewater was diluted by more than 180-fold immediately following discharge from the diffuser ports (MRS 2009d).

5.3 SEAFLOOR SEDIMENTS

The monitoring program has evaluated physical, chemical, and biological conditions within the benthic sediments around the outfall for 24 years. Temporal fluctuations in these factors have been directly related to natural influences, the largest of which occur on seasonal and interannual time scales. The more notable faunal variations have involved interannual population fluxes within individual taxa. For example, the abundance of the Pacific sand dollar (*Dendraster excentricus*) was substantially elevated in 1989, 1991, 1999, and 2009. During these recruitment years, sand dollar populations overwhelmingly dominated the infaunal community. Their marked population increases coincided with the well-recognized global climate fluctuations known as El Niños. These major changes affect all of the benthic monitoring stations, including reference sites, and are related to inherent oceanographic variability rather than the discharge of effluent.

To test for outfall-related effects, a large number of biological indices and parameters were computed from an enumeration of the more than 229,000 specimens collected over 24 years of benthic monitoring. None of these parameters exhibited statistically significant spatial distributions related to the effluent discharge or long-term spatiotemporal trends indicative of an increasingly degraded benthic habitat near the outfall. Not only were the spatial differences in 2009 small compared to inherent sampling variability, but also seasonal and interannual changes in community structure from natural environmental oscillations, such as El Niño, were substantially larger. Despite large temporal fluctuations in the infaunal

community, its health has remained uniformly high throughout the more than two decades of monitoring. The benthic environment surrounding the outfall continues to be populated by an infaunal community dominated by pollution-sensitive suspension-feeding organisms.

Spatiotemporal analyses were also conducted on the large dataset of physicochemical properties determined from sediment samples collected near the outfall since benthic monitoring began in 1986. None of these properties exhibited a significant relationship to the discharge in 2009. Slight but statistically significant increases in some of the bulk sediment trace metal concentrations were apparent; however, these long-term increases are unrelated to effluent discharge. In addition, the annual mass emission of trace metals discharged by the treatment plant is far too small to account for the observed increases in sediment concentrations.

In addition, trace-metal concentrations within Estero Bay sediment samples have been well below the concentrations found in the vast majority of samples collected offshore Southern California. This further attests to the pristine nature of the ocean environment in northern Estero Bay. Nickel and chromium were the only trace metals with comparatively elevated concentrations in Estero Bay sediments. However, these metals occur naturally in the mineralogy of the region. As a result, the Estero Bay sediment metal concentrations were comparable to those in nearby benthic environments, such as Port San Luis (NOAA 1991a), or within the Morro Bay Estuary (Tenera and Marine Research Specialists 1997). Accordingly, contaminant concentrations measured in bulk sediment samples collected within northern Estero Bay, both near and far from the outfall, remained below thresholds considered harmful to marine biota. This, along with the analysis of infaunal community structure, provides strong empirical evidence that the sediments surrounding the outfall, along with the organisms within them, have not been perceptibly impacted by the discharge, even after more than two decades of operation and monitoring.

5.4 RECOMMENDATIONS

This annual report summarizes 24 years of monitoring data. These data consistently demonstrate that the MBCSD WWTP has been operating as was designed and that the discharge of effluent has not adversely impacted the marine environment within Estero Bay. Occasional adjustments made to the monitoring program have substantially increased its capacity to detect minute environmental impacts, and continue to ensure the high quality of the plant effluent.

Many of the monitoring adjustments made to the program in 2009 were based on recommendations in earlier annual reports and were ultimately incorporated in the current NPDES discharge permit that became effective in March 2009. Additionally, most of the recommendations in recent reports dealt with potential improvements to the monitoring program rather than with improvements to plant performance. Similarly, all three of the following recommendations concern proposed adjustments to the monitoring program:

- **Reduce the monitoring frequency for 79 effluent chemical parameters.** Pursuant to the provisions within the current NPDES permit, and the quantitative statistical assessment of historical contaminant measurements based on a Reasonable Potential Analysis outlined by the SWRCB (2005), a reduction in the monitoring frequency of most effluent chemical concentrations measured over the last two decades is warranted (MBCSD 2004; MRS 2004b, 2009i). The MBCSD discharge permit allows a request for a change in monitoring frequency to once-in-the-life of the permit for those compounds that are undetected in the first year of monitoring. During 2009 sampling, there were 73 chemical constituents which met this criterion. Additionally, strong quantitative justification exists for a reduction in the monitoring frequency of an additional six compounds that were detected at concentrations far below their respective permit limits. A reduction in monitoring frequency is

justified by the historically high level of compliance, a proposed monitoring frequency that is consistent with other similar-sized dischargers, and an ongoing bioassay program that provides a more sensitive all-inclusive evaluation of effluent.

- **Reinstate analysis for trace metals, grain size, and infauna at benthic Station B1.** Although the physical environment at Station 1 varies slightly from that at the outfall stations, its 1 km distance from the outfall provides valuable insight into large-scale environmental processes within Estero Bay that are independent of the discharge. Additionally, Station B1 has been continuously sampled throughout the 24-year monitoring program. Even though benthic monitoring at this location is no longer required by the current discharge permit, voluntary collection and analysis of sediment samples would maintain historical consistency with the long-term time series analyses and provide insight into regional processes affecting Estero Bay as whole.
- **Reevaluate the Cat-Litter Public-Outreach Program.** The permit requires an annual reevaluation of the implementation goals of the Cat-Litter Public-Outreach work plan. As part of that outreach program, the public and regulatory agencies should be informed of the latest scientific information available on this topic. The requirement for development and submittal of a work plan was included in the current permit as a conservation measure because concerns were raised that Estero Bay was a “hot-spot” for otter mortality associated with *Toxoplasma gondii* infection. Disposal of cat litter into the MBCSD collection system was thought to be a contributing factor to the purported location of the disease epicenter near Morro Bay. However, two weeks after final approval of the current MBCSD permit, results from a comprehensive field study (Johnson et al. 2009) were published that determined that disease vectors unrelated to WWTP discharge are responsible for *T. gondii* exposure in otters, and that the epicenter for infection was actually located well outside of Estero Bay. As such, there is little scientific rationale for an outreach program specific to cat-litter disposal in the MBCSD collection system. Including the latest scientific findings in the ongoing public-outreach effort will serve to reduce misconceptions about the significance of *T. gondii* potentially discharged in treated wastewater, to otter health within Estero Bay.

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CHAPTER 6
Literature Cited

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6.0 LITERATURE CITED

- Ackerman, R., Bergmann, M. and G. Schleichert. 1983. Monitoring heavy metals in coastal and estuarine sediments – a question of grain size: < 20µm versus < 60 µm. *Environmental Technology Letters*. 4:317-328.
- Agg, A.R., G. Stanfield, and D.J. Gould. 1978: Indicators of pollution. In: Investigations of sewage discharges to some British coastal waters. Water Research Centre Technical Report TR67: 9-96.
- American Public Health Association, American Water Works Association, Water Environment Federation. (APHA) 1998. Standard Methods for the Examination of Water and Wastewater. 20th Edition. Washington, DC. 1200 pp.
- American Society for Testing and Materials (ASTM). 1992. Standard guide for conducting 10-day static sediment toxicity tests with marine and estuarine amphipods, E1367-92. In: Annual Book of ASTM Standards, Vol. 11.04. American Society of Testing and Materials, Philadelphia, PA.
- Aramini, J. J., C. Stephen, and J. P. Dubey. 1998. Toxoplasma gondii in Vancouver Island cougars (Felis concolor vancouverensis): Serology and oocyst shedding. *Journal of Parasitology* 84:438–440.
- Barclays Law Publishers (Barclay). 1997. California Code of Regulations (CCR), Environmental Health. Title 22, §64441 and §64443. Barclays, P. O. Box 3066, South San Francisco, CA 94083.
- Bertine, K. and E. Goldberg. 1977. History of heavy metal pollution in the southern California coastal zone – Reprise. *Environmental Science and Technology*. 11:297-299.
- Bowie, W.R., A.S. King, D.H. Werker, J.L. Isaac-Renton, A. Bell, S. B. Eng, and S. A. Marion. 1997. Outbreak of toxoplasmosis associated with municipal drinking water. *The Lancet* 350:173–177.
- Brown and Caldwell Consulting Engineers. 1989. City of Morro Bay, 301(h) Receiving Water Monitoring Program, 1988 Annual Analysis Report. January 1989.
- Brown and Caldwell Consulting Engineers. 1993. City of Morro Bay and Cayucos Sanitary District, NPDES permit monitoring and reporting program, 1992 annual report (January 1993). Prepared for the City of Morro Bay, Morro Bay.
- California Code of Regulations (CCR). 2003. Title 22, Chapter 11: *Identification and Listing of Hazardous Waste*. California Code of Regulations Updated on February 10, 2004. Current as of Register 2004, No. 5 Dated January 30, 2004.
- California Department of Fish and Game (CDFG). 2003. Proposal: Expanded Monitoring Of Threatened California Sea Otters and Their Prey For Terrestrial-Origin Parasitic And Bacterial Pathogens. Submitted by David A. Jessup and Melissa A. Miller, Marine Wildlife Veterinary Care and Research Center, California Department of Fish and Game, 1451 Shaffer Road, Santa Cruz, CA 95060. Submitted on March 25, 2003.
- Cameron, R.A. 1980. Elements of recruitment in a population of the sand-dollar *Dendraster excentricus*; *Am. Zool.* - 20(4): 928.
- Cameron, R.A. and S.S. Rumrill. 1982. Larval abundance and recruitment of the sand dollar *Dendraster excentricus* in Monterey Bay, California; *Mar. Biol.* - 71(2): 197-202.
- Carignan, R., Rapin, F., and A. Tessier. 1985. A Sediment Porewater Sampling for Metal Analysis - A Comparison of Techniques. *Geochimica Et Cosmochimica Acta* 49 (11): 2493-2497.

- Carollo Engineers. 1999. Cayucos/Morro Bay Comprehensive Recycled Water Study. City of Morro Bay Cayucos Sanitary District. Draft. October 1999.
- Carr, R.S. and D.C. Chapman. 1995. Comparison of methods for conducting marine and estuarine sediment porewater toxicity tests - Extraction, storage, and handling techniques. Arch. Environ. Contam. Toxicol. 28:69-77.
- Central Coast Long-term Environmental Assessment Network (CClean). 2007. 2001–2006 Program Overview: Central Coast Long-term Environmental Assessment Network, Regional Monitoring Program. Submitted to: California Regional Water Quality Control Board, Region 3, 895 Aerovista Place, Suite 101. San Luis Obispo, CA 93401. [Overview.PDF](#) [Accessed 11 February 2010].
- Central Coast Water Authority. 2009. Comprehensive Annual Financial Report. Year Ended June 30, 2009. [Statistical Section.pdf](#) [Accessed 9 February 2010].
- Chelton, D.B., P.A. Bernal, and J.A. McGowan. 1982. Large-scale interannual physical and biological interaction in the California Current. Journal of Marine Research. 40:1095-1125.
- Chelton, D.B., R.L. Bernstein, A. Bratkovich, and P.M. Kosro. 1987. The Central California Coastal Circulation Study, EOS Trans. AGU, 68(1), 12-13.
- Chow, T.J. and J. Earl. 1978. Trace Metal in Sediments. Southern California Baseline Study. Final Report. Volume III. Report 4.1.1 submitted to the Bureau of Land Management, Washington D.C.
- Coats, D.A. 1994. Deposition of Drilling Particulates Offshore Point Conception California, Marine Environmental Research. Vol. 37(1994): 95-127.
- Coats, D.A. 1995. 1994 Annual Soft-Bottom Benthic Monitoring: Massachusetts Bay Outfall Studies. MWRA Enviro. Quality Dept. Tech. Rpt. Series No. 95 20 Massachusetts Water Resources Authority, Boston MA. 174 pp.
- Coats, D.A., M.A. Savoie, and D.D. Hardin. 1991. Poleward flow on the Point Conception Continental Shelf and its relation to the distribution of oil-drilling particulates and biological impacts, EOS Trans. AGU 72(44):254.
- Coats, D.A., Imamura, E., Fukuyama, A.K., Skalski, J.R., Kimura, S., and J. Steinbeck. 1999. Monitoring of Biological Recovery of Prince William Sound Intertidal Sites Impacted by the Exxon Valdez Oil Spill: 1997 Biological Monitoring Survey. Edited By: G. Shigenaka, R. Hoff, and A. Mearns. NOAA Technical Memorandum NOS OR&R 1. NOAA Hazardous Materials Response and Assessment Division, 7600 Sand Point Way NE, Seattle, WA 98115.
- Coats, D.A., Imamura, E., Fukuyama, A.K., Skalski, J.R., Kimura, S., and J. Steinbeck. 2003. Monitoring of Biological Recovery of Prince William Sound Intertidal Sites Impacted by the Exxon Valdez Oil Spill: Sampling Effort in Assessments of Oil-Spill Impacts to Intertidal Organisms Edited By: G. Shigenaka and R. Hoff. NOAA Technical Memorandum Administrative Draft, January 2003. NOAA Hazardous Materials Response and Assessment Division, 7600 Sand Point Way NE, Seattle, WA 98115.
- Cohen, J. 1988. Statistical Power Analysis for the Behavioral Sciences. Second Edition. Lawrence Erlbaum Associates, Publishers. New Jersey.

- Conrad, P.A. 2003. Personal communication via telephone on 4 April 2003 between Mr. Bruce Keogh, MBCSD Wastewater Division Manager, and Dr. P.A. Conrad, Department of Pathology, Microbiology, and Immunology, University of California, Davis.
- Conrad, P.A. 2004a. Letter from Patricia Conrad DVM, Ph.D., Professor of Parasitology, University of California, Davis, to Bruce Keogh, Wastewater Division Manager, City of Morro Bay, dated December 13, 2004.
- Conrad, P.A. 2004b. Subject: Bivalve Results. Personal communication via email on 9 February 2004 at 15:09 from Dr. P.A. Conrad, Department of Pathology, Microbiology, and Immunology, University of California, Davis to Mr. Bruce Keogh, MBCSD Wastewater Division Manager.
- Crecelius, E. and V. Cullinan. 1998. Differences in the Concentrations of Priority Pollutant Metals in Seawater Samples from Puget Sound and the Strait of Georgia. In: Toxic Contaminants Session of the 1998 Conference on Puget Sound Research. http://www.psat.wa.gov/Publications/98_proceedings/sessions/toxic_contaminants.html
- Daskalakis, K. and T. O'Conner. 1995. Normalization and elemental sediment contamination in the coastal United States. *Environmental Science and Technology* 29:470-477.
- Davis, N., G.R. Van Blaricom, and P.K. Dayton. 1982. Man-made structures on marine sediments: effects on adjacent benthic communities. *Marine Biology* 70: 295-303.
- Davis, R.E., J.E. Dufour, G.J. Parks, and M.R. Perkins. 1982. Two Inexpensive Current-Following Drifters. Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California. SIO Reference No. 82-28. December 1982.
- DeWitt, T.H., G.R. Ditsworth, and R.C. Swartz. 1988. Effects of natural sediment features on survival of the phoxocephalid amphipod *Rhepoxynius abronius*. *Mar. Environ. Res.* 25:99-124.
- Diener, D.R. and S.C. Fuller. 1995. Infaunal Patterns in the Vicinity of a Small Coastal Wastewater Outfall and the Lack of Infaunal Community Response to Secondary Treatment. *Bulletin of the Southern California Academy of Sciences*. 94(1):5-20.
- Diener, D., S. Fuller, A. Lissner, C. Haydock, D. Maurer, G. Robertson and T. Gerlinger. 1995. Spatial and temporal patterns of the infaunal community near a major ocean outfall in southern California. *Marine Pollution Bulletin*. 30:861-878.
- Dossis, P. and L.J. Warren. 1980. Distribution of heavy metals between the minerals and organic debris in a contaminated marine sediment. Pages 119-139 In: Baker, R.A. (Ed) *Contaminants and Sediments, Vol. 1: Fate and transport, case studies, modeling toxicity*. Ann Arbor Science, Ann Arbor Michigan. 558 pp.
- Earth-Wise. 2003. Biosolids and Green Waste Compost Project. Final Report Submitted to the City of Morro Bay & Cayucos Sanitary District, San Luis Obispo County, California to the City of Morro Bay & Cayucos; by Tim Bolander and Ted Peterson, Earth-Wise/Spirit of the Earth, P.O.Box 6741, Los Osos, CA 93412, Phone: (805) 534-9605; March 2003.
- Ebert, E.E. 1968. A food-habits study of the southern sea otter, *Enhydra lutris nereis*. *Calif. Fish and Game* 54:33-42.
- Estes, J.A., R.J. Jameson, and A.M. Johnson. 1981. Food selection and some foraging tactics of sea otters. In: D.A. Chapman and D. Pursley (eds.). *Worldwide furbearer conference proceedings*, August 3-11, 1980. Frostburg, MD. Pp. 606-636.

- Everts Coastal. 1996. Evaluation: Artificial Beach Enhancement to Reduce the Potential for Daylighting and Improve Beach Conditions at Avila Beach, California. Appendix C of the Addendum to Alternative Analysis and Proposed Remedial Action Study for the Beach Areas Avila Beach, California, Volume 2. Fluor Daniel GTI Report Prepared for UNOCAL. November 4, 1996. 50pp+appendices.
- Fischer, H.B., E.J. List, R.C.Y. Koh, J. Imberger and N.H. Brooks. 1979. Mixing in Inland and Coastal Waters. Academic Press, New York. 483 pp.
- Finney, B. and C. Huh. 1989. History of metal pollution in the Southern California Bight: An Update.. Environmental Science and Technology. 23:294-303.
- Folk, R.L. 1980. Petrology of Sedimentary Rocks. Herpmill Publishing Co., Austin, Tx.
- Goodman, E. 1975. The theory of diversity-stability relationships in ecology. Q. Rev. Biol. 50:237-266.
- Gotshall, D.W., L.L. Laurent, S.L. Owen, J. Grant, and P. Law. 1984. A Quantitative Ecological Study of Selected Nearshore Marine Plants and Animals at the Diablo Canyon Power Plant Site: A Pre-Operational Baseline, 1973-1978. California Department of Fish and Game, Marine Resources Technical Report No. 48.726 pp.
- Gotshall, D.W., J.R.R. Ally, D.L. Vaughan, B.B. Hatfield, and P. Law. 1986. Pre-Operational Baseline Studies of Selected Nearshore Marine Biota at the Diablo Canyon Power Plant Site: 1979-1982. California Department of Fish and Game, Marine Resources Technical Report No. 50.369-70 pp.
- Graham, N.E. and W.B. White. 1988. The El Niño cycle: a natural oscillator of the Pacific Ocean atmosphere system. Science. 240 1293-1302.
- Grassle, J.F. and W. Smith. 1976. A similarity measure sensitive to the contribution of rare species and its use in investigation of variation in marine benthic communities. Oecologia 25: 13-22.
- Green, R.H. 1979. Sampling design and statistical methods for environmental biologists. John Wiley & Sons, Inc., New York, NY. 257p.
- Green, E.J., and D. Schnitker. 1974. The direct titration of water soluble sulfide in estuarine muds of Montsweag Bay, Maine. Marine Chemistry 2(1974):111-124.
- Hoenig, J.M. and D.M. Heisey. 2001. The Abuse of Power: The Pervasive Fallacy of Power Calculations for Data Analysis. The American Statistician, 55:19-24.
- Horowitz, A. and K. Elick. 1987. The relation of stream sediment surface area, grain size, and trace element chemistry. Applied Geochemistry. 2:437-445.
- Hyland, J., D. Hardin, M. Steinhauer, D. Coats, R. Green, and J. Neff, 1994. Environmental Impact of Offshore Oil Development on the Outer Continental Shelf and Slope off Point Arguello, California, Marine Environmental Research. Vol. 37(1994): 195-229.
- Johnson, C.K., M.T. Tinker, J.A. Estes, P.A. Conrad, M. Staedler, M.A. Miller, D.A. Jessup, and J.A. K. Mazet. 2009. Prey choice and habitat use drive sea otter pathogen exposure in a resource-limited coastal system. PNAS published online before print January 21, 2009. doi:10.1073/pnas.0806449106. [PNAS Otter](https://doi.org/10.1073/pnas.0806449106)
- Keith, J.O., L.A. Woods, Jr., and E.G. Hunt. 1971. Reproductive failure in brown pelicans on the Pacific coast. Trans. N. Amer. Wildl. and Nat. Res. Conf. 35:56-63.

- Khoury, J.; Pang, M.; Young, C.; Pandit, A.; Carr, S.; and D. Fischer. 2005. Cyanide generation during preservation of chlorinated wastewater effluent samples for total cyanide analysis. *Water Environment Research*, Submitted Nov 07, 2005.
- Kopperdahl, F. 1976. Guidelines for Performing Static Acute Toxicity Fish Bioassays in Municipal and Industrial Wastewaters. Calif. Dept. of Fish and Game.
- Kudela, R.M. and W.P. Cochlan. 2000. Nitrogen and Carbon Uptake Kinetics and the Influence of Irradiance for a Red Tide Bloom off Southern California. *Aquat. Microb. Ecol.* 21: 31-47.
- Kudela, R.M., Pitcher, G., Probyn, T., Figueiras, F., Moita, T., Trainer, V.L., 2005. Harmful algae blooms in coastal upwelling systems. *Oceanography* 18, 184–197.
- Kudela, R.W., Chochlan, W., Roberts, A., 2004. Spatial and temporal patterns of *Pseudo-nitzschia* spp. in central California related to regional oceanography. In: Steidinger, K.A., Landsberg, J.H., Tomas, C.R., Vargo, G.A. (Eds.), *Harmful Algae 2002*. Florida and Wildlife Conservation Commission, Florida Institute of Oceanography, and Intergovernmental Oceanographic Commission of UNESCO, pp. 347–349.
- Lenth, R.V. 2001. Some Practical Guidelines for Effective Sample Size Determination. *The American Statistician*, 55:187-193.
- Lindstrom, K. 1998. Report on Evaluation of February 1998 Sampling Results: AERA Energy LLC (Aera) Produced Water Discharge Proposal. K.P. Lindstrom, Inc. P.O. Box 51008, Pacific Grove Ca. In association with Carollo Engineers, 4200 Truxtun Ave, Suite 200, Bakersfield, CA 93309.
- Lindsey, J. 2008. April and May are the coldest seawater months. The San Luis Obispo Tribune. 22 November 2008. <http://www.sanluisobispo.com/news/local/story/537286.html>
- Long, E.R., and Lee G. Morgan. 1991. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. U.S. Dept. Commerce, Nat. Oceanic Atmos. Admin., Off. Oceanogr. Mar. Assess., Rockville, MD. NOAA Tech. Mem. NOS OMA 52 175 pp. plus appendices.
- Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environmental Management* 19(1):81-97.
- Magurran, A.E. 1988. *Ecological diversity and its measurement*. University Press, Cambridge.
- Margalef, R. 1951. Diversidad de especies en las comunidades naturales. *Publ. Inst. Biol. Aplic.* Barcelona 9:5-27.
- Margalef, R. 1972. Homage to Evelyn Hutchinson, or why is there an upper limit to diversity. *Trans. Connect. Acad. Arts Sci.* 44: 211-235. (Non consulté.)
- Marine Research Specialists (MRS). 1994. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 1993 Annual Report. Submitted February 1994 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 1995. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 1994 Annual Report. Submitted February 1995 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.

- Marine Research Specialists (MRS). 1996. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 1995 Annual Report. Submitted February 1996 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 1997a. City of Morro Bay and Cayucos Sanitary District, Supplement to the 1997 Renewal Application for Ocean Discharge under NPDES Permit No. CA0047881. Prepared for the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA. May 1997.
- Marine Research Specialists (MRS). 1997b. Recommended Changes to NPDES Permit No. CA0047881. Letter from Dr. D. A. Coats, Senior Oceanographer at Marine Research Specialists, to Mr. W. T. Boucher, Director, Public Works Department of the City of Morro Bay, dated 25 June 1997.
- Marine Research Specialists (MRS). 1997c. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 1996 Annual Report. Submitted February 1997 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 1998a. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Water Column Sampling, March 1998 Survey. Prepared for the City of Morro Bay, Morro Bay, CA. April 1998.
- Marine Research Specialists (MRS). 1998b. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Semiannual Benthic Sampling Report, April 1998 Survey. Prepared for the City of Morro Bay, Morro Bay, CA. July 1998.
- Marine Research Specialists (MRS). 1998c. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Water Column Sampling, July 1998 Survey. Prepared for the City of Morro Bay, Morro Bay, CA. August 1998.
- Marine Research Specialists (MRS). 1998d. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 1997 Annual Report. Submitted February 1998 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 1998e. Review of USEPA Tentative Decision Document, Regional Board Staff Report, Draft Waste Discharge Requirements, and Draft Monitoring and Reporting Program for Reissuance of a Modified NPDES Permit. Letter from Dr. D. A. Coats, Senior Oceanographer at Marine Research Specialists, to Mr. Bruce Keogh, Wastewater Division Manager, City of Morro Bay, dated 10 September 1998.
- Marine Research Specialists (MRS). 1998f. Modifications to Draft Waste Discharge Requirements and Draft Monitoring and Reporting Program for Reissuance of NPDES Permit CA0047881 Letter from Dr. D. A. Coats, Senior Oceanographer at Marine Research Specialists, to Mr. Bruce Keogh, Wastewater Division Manager, City of Morro Bay, dated 23 October 1998.
- Marine Research Specialists (MRS). 1998g. Further Modifications to Draft Waste Discharge Requirements and Draft Monitoring and Reporting Program for Reissuance of NPDES Permit CA0047881 Letter from Dr. D. A. Coats, Senior Oceanographer at Marine Research Specialists, to Ms. Sorrel Marks, Central Coast Regional Water Quality Control Board, dated 2 November 1998.
- Marine Research Specialists (MRS). 1998h. Additional Benthic Data Supporting the 1997 NPDES Permit Renewal Application for the City of Morro Bay/Cayucos Sanitary District. Letter from Dr. D. A. Coats, Senior Oceanographer at Marine Research Specialists, to Dr. T. Fleming, U.S. Environmental Protection Agency, Region 9; dated 7 April 1998.

- Marine Research Specialists (MRS). 1998i. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Semiannual Benthic Sampling, October 1997. Prepared for the City of Morro Bay, Morro Bay, CA.
- Marine Research Specialists (MRS). 1998h. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 1997 Annual Report. Submitted February 1998 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 1999a. MTBE Analysis Results for Effluent Samples Collected in January and July 1998. Letter from Dr. Douglas A. Coats, Program Manager for Marine Research Specialists, to Mr. Bruce Keogh, Wastewater Division Manager, City of Morro Bay; dated 18 October 1999.
- Marine Research Specialists (MRS). 1999b. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 1998 Annual Report. Submitted March 1999 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 2000a. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 1999 Annual Report. Submitted February 2000 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 2000b. Supplemental Environmental Report: Source of Metal Contamination within the Seafloor Sediments of Northern Estero Bay, October 2000. City of Morro Bay and Cayucos Sanitary District Offshore Monitoring and Reporting Program. December 2000.
- Marine Research Specialists (MRS). 2001. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2000 Annual Report. Submitted February 2001 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 2002. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2001 Annual Report. Submitted February 2002 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 2003a. City of Morro Bay and Cayucos Sanitary District, Supplement to the 2003 Renewal Application For Ocean Discharge Under NPDES Permit No. CA0047881. Prepared for the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA. July 2003.
- Marine Research Specialists (MRS). 2003b. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2002 Annual Report. Submitted February 2003 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 2004a. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2003 Annual Report. Submitted February 2004 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 2004b. Letter report from Dr. Douglas A. Coats, Senior Oceanographer, Marine Research Specialists, to Mr. Bruce Keogh, Wastewater Division Manager, City of Morro Bay, dated 12 July 2004. Reference: Quantitative Analysis in Support of Reduction in Monitoring Frequency.

- Marine Research Specialists (MRS). 2005. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2004 Annual Report. Submitted February 2005 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 2006a. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2005 Annual Report. Submitted February 2006 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 2006b. Response to the Natural Resources Defense Council document, Time is of the Essence: The Legal and Technical Reasons Why EPA and the Regional Board Must Deny the 301(h) Waiver and Require Upgrade of the Morro Bay-Cayucos Sewage Plant “As Fast as Possible.”
- Marine Research Specialists (MRS). 2007. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2006 Annual Report. Submitted February 2007 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 2008a. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2007 Annual Report. Submitted February 2007 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 2008b. Proposed Nutrient Monitoring Requirement for MBCSD’s Draft NPDES Discharge Permit. Letter from Letter from Dr. D. A. Coats, Senior Scientist at Marine Research Specialists, to Mr. B. Keogh, Wastewater Division Manager, City of Morro Bay, dated 7 May 2008.
- Marine Research Specialists (MRS). 2009a. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2008 Annual Report. Submitted February 2008 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.
- Marine Research Specialists (MRS). 2009b. Monitoring and Reporting Program Annual Biosolids Report: Chemical Analysis Results, October 2009. Prepared for the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA. 20 October 2009.
- Marine Research Specialists (MRS). 2009c. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Quarterly Report, Water Column Sampling, January 2009 Survey. Prepared for the City of Morro Bay, Morro Bay, CA. 23 February 2009.
- Marine Research Specialists (MRS). 2009d. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Quarterly Report, Water Column Sampling, May 2009 Survey. Prepared for the City of Morro Bay, Morro Bay, CA. 30 July 2009.
- Marine Research Specialists (MRS). 2009e. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Third Quarter Receiving-Water Survey, August 2009. Prepared for the City of Morro Bay, Morro Bay, CA. 28 October 2009.
- Marine Research Specialists (MRS). 2009f. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Fourth Quarter Receiving-Water Survey, October 2009 Survey. Prepared for the City of Morro Bay, Morro Bay, CA. 25 January 2010.
- Marine Research Specialists (MRS). 2009g. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Semiannual Effluent Sampling, Chemical and Bioassay Analysis Results for Effluent Samples Collected in January 2009. Prepared for the City of Morro Bay, Morro Bay, CA. 7 February 2009.

- Marine Research Specialists (MRS). 2009h. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Semiannual Effluent Sampling, Chemical and Bioassay Analysis Results for Effluent Samples Collected in July 2009. Prepared for the City of Morro Bay, Morro Bay, CA. 8 August 2009.
- Marine Research Specialists (MRS). 2009i. Request for Reduction in the MBCSD WWTP Effluent monitoring Frequency and Correction to Heptachlor Units. Draft Letter from Dr. D. A. Coats, Senior Oceanographer at Marine Research Specialists, to Mr. Bruce Keogh, Wastewater Division Manager, City of Morro Bay, dated 7 December 2009.
- City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Semiannual Effluent Sampling, Chemical and Bioassay Analysis Results for Effluent Samples Collected in July 2009. Prepared for the City of Morro Bay, Morro Bay, CA. 8 August 2009.
- McConnaughey, B.H. and E. McConnaughey. 1985. National Audubon Society Nature Guides: Pacific Coast. Alfred Knopf, New York.
- Meador, J.P., R.C. Clark, Jr., P.A. Robisch, D.W. Ernest, J.T. Landahl, U. Varanasi, S. Chan, and B.B. McCain. 1994. Analyses of Elements in Sediment and Tissue Cycles I to V (1984-88). National Status and Trends Program, National Benthic Surveillance Project: Pacific Coast. National Marine Fisheries Service, Northwest Fisheries Science Center, Coastal Zone and Estuarine Studies Division Technical Memorandum NMFS-NWFSC-16. 2725 Montlake Blvd. E., Seattle WA 98112. August 1994.
- Miller, M.A., I.A. Gardner, C. Kreuder, D.M. Paradies, K.R. Worcester, D.A. Jessup, E. Dodd, M.D. Harris, J.A. Ames, A.E. Packham, and P.A. Conrad. 2002. Coastal freshwater runoff is a risk factor for *Toxoplasma gondii* infection of southern sea otters (*Enhydra lutris nereis*). International Journal for Parasitology 32(2002) 997-1066.
- Morin, J.G., J.E. Kastendiek, A. Harrington, and N. Davis. 1985. Organization and patterns of interaction in a subtidal sand community on an exposed coast. Mar. Ecol. Prog. Ser. 27: 163-185.
- Morris, R., D. Abbott, and E. Haderlie. 1980. Intertidal Invertebrates of California. Stanford University Press. Stanford, California. 690pp.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD). 1997a. Sampling and Analyses of Samples. Letter to Ms. Sorrel Marks of the Regional Water Quality Control Board, Central Coast Region from Mr. B. Keogh, Acting Wastewater Division Manager. 10 June 1997.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD). 1997b. Draft of NPDES Permit for Morro Bay – Cayucos Wastewater Treatment Plant: Permit NO. 92-67. Letter from Mr. B. Keogh, Interim Wastewater Division Manager for the City of Morro Bay, to Mr. R. W. Briggs, Executive Director of the Regional Water Quality Control Board Central Coast Region, dated 24 July 1997.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD). 1998. Letter from Mr. Bruce Keogh, Wastewater Division Manager for the MBCSD, to Ms. Sorrel Marks, Regional Water Quality Control Board, dated 1 October 1998.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD). 2003. Letter from Mr. Bruce Ambo, Public Services Director to Mr. Roger Briggs, Executive Officer, California Regional Water Quality Control Board. Subject: Notice of submittal of application and supplemental documentation for the renewal of National Pollution Discharge Elimination System Permit No. CA0047881, dated July 3, 2003.

- [City of] Morro Bay and Cayucos Sanitary District (MBCSD). 2004. Letter to Mr. Matt Thompson of the Regional Water Quality Control Board, Central Coast Region from Mr. B. Keogh, Wastewater Division Manager, dated 19 July 2004. Reference: Submittal of Quantitative Documentation in Support of Reductions in the Monitoring Frequency for the Morro Bay/Cayucos Sanitary District Effluent.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD).2008a. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Operations Summary, January2008.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD).2008b. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Operations Summary, February2008.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD).2008c. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Operations Summary, March2008.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD).2008d. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Operations Summary, April2008.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD).2008e. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Operations Summary, May2008.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD).2008f. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Operations Summary, June2008.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD).2008g. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Operations Summary, July2008.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD).2008h. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Operations Summary, August2008.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD).2008i. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Operations Summary, September2008.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD).2008j. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Operations Summary, October2008.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD).2008k. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Operations Summary, November2008.
- [City of] Morro Bay and Cayucos Sanitary District (MBCSD).2008l. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Operations Summary, December2008.
- Morro Group, Inc. 1999. MFS Globenet Corp./WorldCom Network Services Fiber Optic Cable Project Draft Environmental Impact Report. SCH No. 98091053. Submitted to: County of San Luis Obispo Department of Planning and Building. Prepared in association with Arthur D. Little, Inc. and Marine Research Specialists. October 1999.
- Musick, Peeler & Garrett, LLP (MP&G). 2004. Response to RWQCB Staff “Findings” dated August 7, 2004. Letter from Mr. Steven J. Elie, Attorney at Law and counsel for the City of Morro Bay, to Mr. Roger Briggs, Executive Officer, California Regional Water Quality Control Board; dated September 5, 2004.
- Natural Resources Defense Council (NRDC). 2006. Time is of the Essence: The Legal and Technical Reasons Why EPA and the Regional Board Must Deny the 301(h) Waiver and Require Upgrade of the Morro Bay-Cayucos Sewage Plant “As Fast as Possible.”

- National Oceanic and Atmospheric Administration (NOAA). 1991a. Progress Report on the National Status and Trends Program. Second summary of data on chemical contaminants in sediments from the National Status and Trends Program. U.S. Dept. Commerce, Nat. Oceanic Atmos. Admin., Off. Oceanogr. Mar. Assess., Rockville, MD. NOAA Tech. Mem. NOS OMA 59 29 pp. plus appendices
- National Oceanic and Atmospheric Administration (NOAA). 1991b. Contaminant trends in the southern California Bight: Inventory and assessment. NOAA Tech, Memo. NOS ORCA 62. Seattle WA.
- National Oceanic and Atmospheric Administration (NOAA). 1998. Letter from Dr. William T. Hogarth, Regional Administrator of the National Marine Fisheries Service to Mr. Bruce Keogh, Wastewater Division Manager for the City of Morro Bay; dated 30 July 1998.
- National Oceanic and Atmospheric Administration (NOAA). 2004. Letter from Ms. Valerie L. Chambers, Assistant Regional Administrator for Habitat Conservation of the National Marine Fisheries Service, to Mr. Bruce Keogh, Wastewater Division Manager for the City of Morro Bay; dated 12 August 2004.
- National Oceanic and Atmospheric Administration (NOAA). 2010. El Nino/Southern Oscillation (ENSO) Diagnostic Discussion. Climate Prediction Center: National Centers for Environmental Protection, National Weather Service, National Oceanic and Atmospheric Administration; Camp Springs MD. Updated March 10, 2010. Available at ensodisc.html. Accessed March 31, 2010.
- National Academy of Sciences. 1993. Managing Wastewater in Coastal Urban Areas. National Research Council Committee on Wastewater Management for Coastal Urban Areas, Water Science and Technology Board, Commission on Engineering and Technical Systems. 477 pp.
- North Carolina Division of Water Quality. 2008. Use of EPA Method 1664, Environmental Testing & Analysis Article. <http://h2o.enr.state.nc.us/lab/files/epa1664.pdf>
- Oliver, J.S., P.N. Slattery, L.W. Hulberg, and J.W. Nybakken. 1980. Relationships between wave disturbance and zonation of benthic invertebrate communities along a subtidal high-energy beach in Monterey Bay, California. Fish. Bull., U.S. 78:437-454.
- Ott, F. S. 1986. Amphipod sediment bioassays: effects on response of methodology, grain size, organic content, and cadmium. Ph.D. Dissertation. University of Washington. Seattle, Washington. 285pp.
- Pearson, T.H., and R. Rosenberg. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanogr. Mar. Biol. Annu. Rev. 16:229-311.
- Phillips, C. and G. Hershelman. 1996. Recent temporal trends in sediment metal concentrations near a large wastewater outfall off Orange County, California. Water Environment Research. 68:105-114.
- Pielou, E.C. 1977. Mathematical ecology. John Wiley and Sons, New York, NY. 384 pp.
- Plumb, R.H., Jr. 1981. Procedures for handling and chemical analysis of sediment and water samples. U.S. Army Corps of Engineer Waterway Experiment Stations, Vicksburg, Miss.
- Puget Sound Estuary Program (PSEP). 1997. Recommended Guidelines For Measuring Metals In Puget Sound Marine Water, Sediment and Tissue Samples. In: Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound. Prepared for U. S. Environmental Protection Agency Region 10, and the Puget Sound Water Quality Action Team, April 1997. <http://www.psat.wa.gov/Publications/protocols/protocol.html>.

- Regional Water Quality Control Board (RWQCB) - Central Coast Region. 1994. Water Quality Control Plan (Basin Plan) Central Coast Region. Available from the RWQCB at 81 Higuera Street, Suite 200, San Luis Obispo, California. 148pp+appendices.
- Regional Water Quality Control Board (RWQCB) - Central Coast Region. 1998. Administrative Extension of Waste Discharge Requirements/National Pollution Discharge Elimination System (NPDES) CA0047881, Order 92-67. Letter to Mr. William Boucher, Director of Public Works, City of Morro Bay from Roger W. Briggs, Executive Officer. 10 April 1998.
- Regional Water Quality Control Board (RWQCB) - Central Coast Region. 1999. Special Request for Methyl Tertiary Butyl Ether (MTBE) Waste Discharge Data. Letter to Mr. Bruce Keogh, Morro Bay/Cayucos WWTP from Roger W. Briggs, Executive Officer. 3 May 1999.
- Regional Water Quality Control Board (RWQCB) - Central Coast Region. 2003a. 2002 Annual Offshore Monitoring Report, City of Morro Bay and Cayucos Sanitary District Wastewater Treatment Plant, San Luis Obispo County. Letter from Roger W. Briggs, Executive Officer of the RWQCB to Mr. Bruce Keogh, City of Morro Bay WWTP; dated 14 March 2003.
- Regional Water Quality Control Board (RWQCB) - Central Coast Region. 2003b. Effluent Toxicity and Toxoplasma Monitoring, City of Morro Bay and Cayucos Sanitary District Wastewater Treatment Plant, San Luis Obispo County. Letter from Mr. Roger Briggs, Executive Officer of the California Regional Water Quality Control Board Central Coast Region, to Mr. Bruce Keogh, City of Morro Bay WWTP; dated 11 June 2003.
- Regional Water Quality Control Board (RWQCB) - Central Coast Region. 2004. Continuance of National Pollutant Discharge Elimination System (NPDES) Permit No. CA 0047881, Morro Bay/Cayucos WWTP. Letter from Mr. Roger Briggs, Executive Officer of the California Regional Water Quality Control Board Central Coast Region, to Mr. Bruce Keogh, City of Morro Bay; dated 4 February 2004.
- Regional Water Quality Control Board (RWQCB) - Central Coast Region and the Environmental Protection Agency (USEPA) – Region IX. 1993a. Waste Discharge Requirements (Order No. 92-67) and Authorization to Discharge under the National Pollutant Discharge Elimination System (Permit No. CA0047881) for City of Morro Bay and Cayucos Sanitary District, San Luis Obispo County.
- Regional Water Quality Control Board (RWQCB) - Central Coast Region and the Environmental Protection Agency (USEPA) – Region IX. 1993b. Monitoring and Reporting Program No. 92-67 for City of Morro Bay and Cayucos Sanitary District, San Luis Obispo County (Permit No. CA0047881).
- Regional Water Quality Control Board (RWQCB) - Central Coast Region and the Environmental Protection Agency (USEPA) – Region IX. 1998a. Waste Discharge Requirements (Order No. 98-15) and National Pollutant Discharge Elimination System (Permit No. CA0047881) for City of Morro Bay and Cayucos Sanitary District, San Luis Obispo County. 11 December 1998.
- Regional Water Quality Control Board (RWQCB) - Central Coast Region and the Environmental Protection Agency (USEPA) – Region IX. 1998b. Monitoring and Reporting Program No. 98-15 for City of Morro Bay and Cayucos Sanitary District, San Luis Obispo County. 11 December 1998.

- Regional Water Quality Control Board (RWQCB) - Central Coast Region and the Environmental Protection Agency (USEPA) – Region IX. 1998c. Staff Report for Regular Meeting of 11 December 1998 (prepared on 2 September 1998). Subject: Reissuance of modified National Pollutant Discharge Elimination System Permit No. CA0047881, Waste Discharge Requirements for the City of Morro Bay and Cayucos Sanitary District Wastewater Treatment Facility, San Luis Obispo County—Order No 98-15.
- Regional Water Quality Control Board (RWQCB) - Central Coast Region and the Environmental Protection Agency (USEPA) – Region IX. 2009. Waste Discharge Requirements (Order No. R3-2008-0065) and National Pollutant Discharge Elimination System (Permit No. CA0047881) for the Morro Bay and Cayucos Wastewater Treatment Plant Discharges to the Pacific Ocean, Morro Bay, San Luis Obispo County. Effective 1 March 2009.
- Riedman, M.L. and J.A. Estes. 1990. The sea otter, *Enhydra lutris*: behavior, ecology and natural history. Biological report 90(14). Washington, DC: USDOI, FWS, 127 pp.
- Roper, D.S. 1990. Benthos associated with an estuarine outfall, Tauranga Harbour, New Zealand. New Zealand Journal of Marine and Freshwater Research. 24: 487-498.
- Roper, D.S., D.G. Smith, and G.B. Read. 1989. Benthos associated with two New Zealand coastal outfalls. New Zealand Journal of Marine and Freshwater Research 23: 295-309.
- Sarda, N. and G.A. Burton. 1995. Ammonia variation in sediments: spatial, temporal and method-related effects. Environ. Toxicol. Chem., 14: 1499-1506.
- Savoie, M.A., D.A. Coats, P. Wilde, and P. Kinney. 1991. “Low-Frequency Flow Variability on the Continental Shelf Offshore Point Conception.” In: Minerals Management Service. 1991. California OCS Phase II Monitoring Program Final Report. U.S. Department of the Interior, Minerals Management Service, Pacific OCS Region, Los Angeles, California. OCS Study MMS 91-0083. 41pp.
- Science Applications International Corporation (SAIC). 1986. Assessment of Long-Term Changes in Biological Communities in the Santa Maria Basin and Western Santa Barbara Channel – Phase I. Volume II Synthesis of Findings. Prepared for the United States Department of the Interior, Minerals Management Service, Pacific OCS Region, Los Angeles, California. OCS Study MMS 86-0012.
- Schiff, K.C. and R.W. Gossett. 1998. Southern California Bight 1994 Pilot Project: III. Sediment chemistry. Southern California Coastal Water Research Project. Westminster, CA.
- Schiff, K. and S. Weisberg. 1997. Iron as a reference element for determining trace metal enrichment in California coastal shelf sediments. pp 68-78 in : S. Weisberg, C. Francisco and D. Hallock (eds.), Southern California Coastal Water Research Project Annual Report 1995-96. Westminster, CA.
- Schreiber, R.W. and R.W. Risebrough. 1972. Studies of the brown pelican. *Wilson Bull.*:84:119-135.
- Sea-Bird Electronics, Inc. (SBE). 1989. Calculation of M and B Coefficients for the Sea-Tech Transmissometer. Application Note No. 7, Revised September 1989.
- Sea-Bird Electronics, Inc. (SBE). 1993. SBE 13/22/23/30 Dissolved Oxygen Sensor Calibration and Deployment. Application Note No. 13-1, rev B, Revised April 1993.
- Shannon, C.H., and W. Weaver. 1949. The mathematical theory of communication. Univ. of Illinois Press, Urbana, IL. 117 pp.

- Simpson, E.H. 1949. Measurement of diversity. *Nature*. 163:688.
- Skalski, J. R., D.A. Coats, and A.K. Fukuyama. 2001. Criteria for oil spill recovery: A case study of the intertidal community of Prince William Sound, Alaska, following the *Exxon Valdez* oil spill. *Environmental Management*, Vol. 28, pp 9-18.
- Skalski, J.R., J.J. Millspaugh, C. Cooper, and D.A. Coats. 2004. A Statistical Test and Sample Size Calculations for Differences in Ecological Community Composition Based on Analysis of Distance (ANODIS). Submitted to: *Journal of Agricultural, Biological and Environmental Statistics*, February 2004.
- Smith, W., V.R. Gibson, L.S. Brown-Leger and J.F. Grassle. 1979. Diversity as an indicator of pollution: cautionary results from microcosm experiments. Pp. 269-277 in J. F. Grassle, G. P. Patil, W. Smith, and C. Tallie, eds, *Ecological diversity in theory and practice*. International Cooperative Publishing House, Fairland, MD.
- Snelgrove, P.V.R. and C.A. Butman. 1994. Animal-Sediment Relationships Revisited: Cause Versus Effect. *Oceanography and Marine Biology: an Annual Review*. UCL Press. 32:111-177.
- Sokal, R.R. and F.J. Rohlf. 1997. *Biometry: the Principals and Practice of Statistics in Biological Research*, 3rd ed. W.H. Freeman and Company, New York. 850 pp.
- Southern California Bight Field Methods Committee (SCBFMC). 2002. Field Operation Manual for Marine Water-Column, Benthic, and Trawl monitoring in Southern California. Technical Report 359. Southern California Coastal Water Research Project. Westminster, CA. March 2002.
- Southern California Coastal Water Research Project (SCCWRP). 1995. Characteristics of effluents from large municipal wastewater treatment facilities in 1993. Pp.9-17, in: Southern California Coastal Water Research Project Annual Report 1993-94. Westminster, CA.
- State Water Resources Control Board (SWRCB). 1972. Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California. Revises and supersedes the policy adopted by the State Board on January 7, 1971, and revised October 13, 1971, and June 5, 1972. California Division of Water Quality, Water Quality Planning Unit.
- State Water Resources Control Board (SWRCB). 1990. California Ocean Plan, Water Quality Control Plan Ocean Waters of California. Corrected Copy (Table B, Radioactivity). October 18, 1990.
- State Water Resources Control Board (SWRCB). 1997. Water quality control plan, ocean waters of California, California Ocean Plan. California Environmental Protection Agency. Effective July 23, 1997.
- State Water Resources Control Board (SWRCB). 2001. Water quality control plan, ocean waters of California, California Ocean Plan. California Environmental Protection Agency. Effective December 3, 2001.
- State Water Resources Control Board (SWRCB). 2005. Water Quality Control Plan, Ocean Waters of California, California Ocean Plan. California Environmental Protection Agency. Effective February 14, 2006.
- State Water Resources Control Board (SWRCB). 2009. Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality. California Environmental Protection Agency. Effective August 23, 2009. [sed_qlty_part1.pdf](#) [Accessed 03/26/10].

- Steinhauer, M., E. Crecelius, and W. Steinhauer. 1994. Temporal and spatial changes in the concentrations of hydrocarbons and trace metals in the vicinity of an offshore production platform. *Mar. Environ. Res.*, 37, 129-163.
- Stull, J. 1995. Two decades of marine biological monitoring, Palos Verdes, California, 1972 to 1992. *Bulletin of the Southern California Academy of Sciences*. 94:21-45.
- Stull, J.K., C.I. Haydock, R.W. Smith, and D.E. Montagne. 1986a. Long-term changes in the benthic community on the coastal shelf of Palos Verdes, Southern California. *Marine Biology* 91: 539-551.
- Stull, J., R. Baird, and T. Heesen. 1986b. Marine sediment core profiles of trace constituents offshore a deep wastewater outfall. *Journal of the Water Pollution Control Federation*. 58:985-991.
- Swartz, R.C., D.W. Schultz, G.R. Ditsworth, W.A. DeBen, and F.A. Cole. 1985. Sediment toxicity, contamination, and macrobenthic communities near a large sewage outfall. Pages 152-75 in *Validation and Predictability of Laboratory Methods for Assessing the Fate and Effects of Contaminants in Aquatic Ecosystems*. T.T. Boyle (ed.). American Society for Testing and Materials. STP 865. Philadelphia, PA.
- Tenera and Marine Research Specialists. 1997. Analysis of sediments from the City of Morro Bay mooring area A-1 maintenance dredging project. Report to the City of Morro Bay, Harbor Department, Morro Bay, CA. 11 pp. plus appendices.
- Tetra Tech. 1986a. Analytical methods for EPA priority pollutants and 301(h) pesticides in estuarine and marine sediments. Final program document prepared for the Marine Operations Division, Office of Marine and Estuarine Protection, U.S. Environmental Protection Agency. EPA Contract No. 68-01-6938. Tetra Tech, Inc., Bellevue, WA.
- Tetra Tech. 1986b. Quality assurance and quality control (QA/QC) for 301(h) monitoring programs: Guidance on field and laboratory methods. Final program document prepared for the Marine Operations Division, Office of Marine and Estuarine Protection, U.S. Environmental Protection Agency. EPA Contract No. 68-01-6938. Tetra Tech, Inc., Bellevue, WA.
- Tetra Tech. 1992. Technical Review City of Morro Bay, CA Section 301(h) Application for Modification of Secondary Treatment Requirements for a Discharge into Marine Waters. Prepared for the U.S. Environmental Protection Agency, Region IX, San Francisco, CA by Tetra Tech, Inc., Lafayette, CA. February 1992.
- Trainer, V.L., Adams, N.G., Bill, B.D., Stehr, C.M., Wekell, J.C., Moeller, P., Busman, M., Woodruff, D., 2000. Domoic acid production near California coastal upwelling zones, June 1998. *Limnol. Oceanogr.* 45, 1818–1833.
- Trainer, V.L., Hickery, B.M., Horner, R.A., 2002. Biological and physical dynamics of domoic acid production off the Washington coast. *Limnol. Oceanogr.* 47, 1438–1446.
- Trueblood, D. D., E. D. Gallagher, and D. M. Gould. 1994. The three stages of seasonal succession on the Savin Hill Cove mudflat, Boston Harbor. *Limnol. Oceanogr.* 39: 1440-1454.
- U.S. Department of the Interior (USDOI). 1998. Morro-Bay Cayucos Wastewater Treatment Plant NPDES Permit Renewal Application. Letter from Ms. Diane K. Noda, Field Supervisor of the Fish and Wildlife Service to Mr. Bruce Keogh, Wastewater Division Manager for the City of Morro Bay; dated 18 September 1998.

- U.S. Environmental Protection Agency (USEPA). 1983. Methods for chemical analysis of water and wastes. EPA 600/4-79-020. Environmental Monitoring and Support Laboratory, Cincinnati, OH.
- U.S. Environmental Protection Agency (USEPA). 1987. Recommended Biological Indices for 301(h) Monitoring Programs. EPA 430/9-86-002. September 1987.
- U.S. Environmental Protection Agency (USEPA). 1993. Technical Information Review. Methyl tertiary Butyl Ether (CAS No. 1634-04-4). Office of Pollution Prevention and Toxics, U.S. EPA, Washington, D.C.
- U.S. Environmental Protection Agency (USEPA). 1994. Amended Section 301(h) Technical Support Document. Oceans and Coastal Protection Division (4504F), Office of Wetlands, Oceans and Watersheds, United States Environmental Protection Agency, Washington DC 20460. EPA 842-B-94-007. September 1994.
- U.S. Environmental Protection Agency (USEPA). 1998. Letter from F. Marcus, Regional Administrator of the USEPA Region IX in regard to the City of Morro Bay/Cayucos Sanitary Districts application for a modified NPDES permit under Section 301(h) of the Clean Water Act. Tentative Decision of the Regional Administrator Pursuant to 40 CFR Part 125, Subpart G; dated 3 September 1998.
- U.S. Environmental Protection Agency (USEPA). 2002. Methods for Measuring the Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms, Fifth Edition. October 2002. U.S. Environmental Protection Agency, Office of Water (4303T). 1200 Pennsylvania Avenue, NW Washington, DC 20460. EPA-821-R-02-012.
- U.S. Environmental Protection Agency (USEPA). 2005. Letter from Wayne Nastri, Regional Administrator of the USEPA Region IX in regard to the City of Morro Bay/Cayucos Sanitary Districts application for a modified NPDES permit under Section 301(h) of the Clean Water Act. Tentative Decision of the Regional Administrator Pursuant to 40 CFR Part 125, Subpart G; dated 10 September 2005.
- U.S. Environmental Protection Agency (USEPA). 2007. Request for Concurrence with EPA Finding of "No Likely Adverse Effect" Pursuant to Section 7 of the Federal Endangered Species Act for the Continued Ocean Discharge from the Morro Bay/Cayucos Wastewater Treatment Plant. Letter dated 6 September 2007 from Ms. Alexis Strauss, Director, USEPA Water Division to Ms. Diane Noda, Field Supervisor, U.S. Fish and Wildlife Service, transmitting an Endangered Species Act Biological Evaluation for the Morro Bay/Cayucos Wastewater Treatment Plant prepared by the U.S. EPA Region IX, September 2007.
- U.S. Environmental Protection Agency (USEPA) and the U.S. Army Corps of Engineers (USACE). 1991. Evaluation of Dredged Material Proposed for Ocean Disposal (Testing Manual). Prepared by the Environmental Protection Agency, Office of Marine and Estuarine Protection, Washington, D.C., and Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. EPA-503/8-91/001, 280 pp.
- U.S. Environmental Protection Agency (USEPA) and the U.S. Army Corps of Engineers (USACE). 1993. Draft Inland Testing Manual. Prepared by the Environmental Protection Agency, Office of Water, Washington, D.C., and Department of the Army, U.S. Army Corps of Engineers, Washington, D.C.
- U.S. Fish and Wildlife Service (USFWS). 1982. California brown pelican recovery plan. Portland, OR.

- U.S. Government Printing Office (USGPO). 1997a. Code of Federal Regulations. Protection of the Environment. Criteria And Standards For The National Pollutant Discharge Elimination System, Criteria for Modifying the Secondary Treatment Requirements Under Section 301(h) of the Clean Water Act, Definitions. Chapter 40, Part 125, Subpart G.
- U.S. Government Printing Office (USGPO). 1997b. Code of Federal Regulations. Environmental Protection. Standards for the use or disposal of Sewage Sludge, Land Application, Pollutant Limits. Chapter 40, Part 503, Subpart B. 1 July 1997 edition.
- U.S. Government Printing Office (USGPO). 1982a. Code of Federal Regulations. Protection of the Environment. Criteria And Standards For The National Pollutant Discharge Elimination System, Criteria for Modifying the Secondary Treatment Requirements Under Section 301(h) of the Clean Water Act, Primary or equivalent treatment requirements. Chapter 40, Part 125, Subpart G.
- U.S. Government Printing Office (USGPO). 1982b. Code of Federal Regulations. Protection of the Environment. Criteria And Standards For The National Pollutant Discharge Elimination System, Criteria for Modifying the Secondary Treatment Requirements Under Section 301(h) of the Clean Water Act, Establishment of a monitoring program. Chapter 40, Part 125, Subpart G.
- U.S. Minerals Management Service (USMMS). 1996. Outer continental shelf oil and gas leasing program: 1997-2002, final environmental impact statement. U.S. Department of the Interior, Minerals Management Service, Herndon, VA. OCS EIS/EA MMS 96-0043.
- Washington, H.G. 1984. Diversity, biotic and similarity indices. A review with special relevance to aquatic ecosystems. *Water Res.* 18:653-694.
- Water Environment Research Foundation (WERF). 2003. Cyanide formation and fate in complex effluents and its relation to water quality criteria. WERF publication No. 98-HHE-5. Water Environment Research Foundation, Alexandria, Va. Co-published by IWA Publishing, London, United Kingdom.
- Winger P.V. and P.J. Lasier. 1991. A Vacuum-Operated Pore Water Extractor for Estuarine and Freshwater Sediments. *Archives of Environmental Contamination and Toxicology*, v.21, p. 321-324; Aug 1991.
- Wittaker, R.H. 1965. Dominance and diversity in land plant communities. *Science* 147:250-260.
- Word, J.Q. 1978. The infaunal trophic index. Pages 19-39 In: Bascom (Ed.) Southern California Coastal Water Research Project, Annual report for the year 1978. El Segundo, CA.
- Word, J.Q. 1980. Classification of Benthic Invertebrates into Infaunal Trophic Index Feeding Groups. Pages 103-121 In: Bascom (Ed.) Southern California Coastal Water Research Project, Annual report for the years 1979-1980. El Segundo, CA.
- Zheng A., Dzombak DA, Luthy, R.G., Kavanaugh, M.C., and R.A. Deeb. 2004a. The occurrence of cyanide formation in six full-scale publicly owned treatment works. *Water Environment Research* 2004 Mar-Apr;76(2):101-12.
- Zheng, A., Dzombak, D.A., and R.G. Zheng, R.G. 2004b. Effects of Nitrosation on the Formation of Cyanide in Publicly Owned Treatment Works Secondary Effluent. *Water Environment Research*, 2004 May-Jun: 76(3): 197-204(8).

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APPENDIX A

Wastewater Treatment Plant Specifications

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Table A.1 WWTP Specifications

Parameter	Quantity	Parameter	Quantity
Waste Loading		Tank 1	2.74
Flow (MGD)		Tank 2	2.74
Average dry-weather flow	2.06	Surface loading rate PSDWF (10 ³ L/m ² /day)	29.74
PSDWF	2.36	Detention time at PWWF (hr.)	2.2
Peak dry-weather flow	6.64	Total Treatment	
PWWF	6.60	Overall treatment efficiencies (%)	
Strength		BOD ₅	57
BOD ₅ (mg/L)	280	Suspended solids	75
Suspended solids (mg/L)	280	Expected effluent quality (mg/L)	
Grit (ft ³ /mg)	10	BOD ₅	120
Waste quantities at PSDWF		Suspended solids	70
BOD ₅ (mt/day)	2.5	Solids stabilization	
Suspended Solids (mt/day)	2.5	Anaerobic digester loading (mt/day)	
Grit (ft ³ /day)	23.6	Primary solids	1.6
Preliminary Treatment		Secondary solids	0.4
Mechanically cleaned bar screen		Assumed sludge volatile content (%)	
Number	1	Primary solids	70
Capacity (MGD)	8.2	Secondary solids	82
Channel Monster		Sludge volume (m ³ /day)	50.7
Number	1	Digester 1 (existing, fixed cover)	
Capacity (MGD)	7.0	Diameter (m)	12.2
Influent pumps (variable speed)		Side water depth (m)	4.9
Number	3	Volume (m ³)	629
Capacity each (MGD)	3.3	Digester 2 (existing, fixed cover)	
Total head (m)	9.6	Diameter (m)	12.2
Aerated grit removal tanks		Side water depth (m)	5.8
Number	1	Volume (m ³)	725
Length (m)	9.1	Digester 3 (new, floating cover)	
Width (m)	4.9	Diameter (m)	10.7
Depth (m)	2.4	Side water depth (m)	6.9
Detention time at PWWF (min)	6.3	Volume (m ³)	646
Grit Pumps		Hydraulic detention time based on net volume of digesters 2 and 3 (days)	23
Number	2	Assumed volatile solids reduction (%)	55
Capacity (gpm)	250	Expected sludge gas production (m ³ /day)	804
Primary Treatment			
Sedimentation tanks			
Number	2		
Diameter (m)			
Tank 1	15.2		
Tank 2	12.2		
Average side water depth (m)			

Parameter	Quantity
Sludge drying beds	
Number	12
Length each (m)	49.4
Width each (m)	9.8
Solids Loadings (kg ft ⁻¹ yr ⁻¹)	78.3
Assumed removal efficiency (%)	
BOD ₅	35
Suspended solids	65
Primary effluent quality (mg/L)	
BOD ₅	182
Suspended solids	98
Secondary treatment	
Biofilters (existing, in partial secondary treatment mode of operation)	
Flow distribution at PSDWF (MGD)	
Biofilter 1	0.39
Biofilter 2	0.58
Diameter (m)	
Biofilter 1	18.3
Biofilter 2	21.3
Net media surface area (m ²)	
Biofilter 1	262
Biofilter 2	350
Average media height (m)	
Biofilter 1	1.4
Biofilter 2	1.5
Media Volume (m ³)	
Biofilter 1	360
Biofilter 2	532
Specific organic loading rate (lbs BOD ₅ /day/1000 ft ³)	47
Circulated flow (MGD)	
Biofilter 1	1.37
Biofilter 2	2.04
Hydraulic loading rate (gpm/ft ² media surface)	
Biofilter 1	0.34
Biofilter 2	0.38
Circulation pumps	
Biofilter 1	
Capacity (gpm)	950
Total head (m)	3.4
Biofilter 2	
Capacity (gpm)	1420
Total head (m)	4.3

Parameter	Quantity
Stand-by (2-speed)	
Capacity (gpm)	960
	1660
Total head (m)	3.4
	4.4
Interstage pumping	
Biofilter effluent pumps (variable speed)	
Number	2
Capacity each (gpm)	2300
Total head (m)	8.2
Secondary sedimentation tanks	
Number	1
Diameter (m)	16.8
Tank surface area (m ²)	221
Tank volume (m ³)	3125
Average water depth (m)	4.6
Overflow rate at PSDWF (10 ³ L/m ² /day)	16.6
Expected secondary treatment effluent quality (mg/L)	
BOD ₅	30
Suspended Solids	30
Chlorination	
Chlorine contact tank (existing)	
Number of passes	2
Length (m)	
Pass 1	16.8
Pass 2	22.9
Width each pass (m)	4.6
Average depth (m)	2.3
Total volume (m ³)	413
Detention time at PDWF (min)	24
Chlorinators	
Pre-chlorinator	
Number	1
Initial capacity (kg/day)	227.3
Ultimate capacity (kg/day)	909.1
RAS chlorinator	
Number	1
Capacity (kg/day)	227.3
Ultimate capacity (kg/day)	90.9
Sodium Hypochlorite Post Chlorinator	
Chemical feed pumps	3
Combined Capacity (kg/day)	5450
Dechlorination	
Sodium Bisulfite System	
Chemical feed pumps	3
Combined Capacity (kg/day)	1226

APPENDIX B
Infaunal Biology

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INFAUNAL INDICES

B.1 SPECIES DIVERSITY

The Shannon diversity index (H') (Shannon and Weaver 1949) is the most common diversity index used in 301(h) programs. It measures the relative distribution of individual organisms among the species present in the sample. H' increases for broader distributions of individuals among species. If all individuals are of one species then H' is 0.00. If each individual organism is a separate species then H' is determined by the logarithm of the total number of organisms collected. For other distributions, the

diversity index is given by: $H' = - \sum_{j=1}^S \left[\left(\frac{n_j}{N} \right) \ln \left(\frac{n_j}{N} \right) \right]$; where: S = total number of species, n_j = number of individuals in the j^{th} species, N = total number of individuals, and $\ln$ = natural logarithm (base e). The value of the Shannon index usually falls between 1.5 and 3.5 and only rarely surpasses 4.5 (Margalef 1972).

Some studies have found a decrease in this index in response to pollutant stress in benthic communities. However, this index is ambiguous because it depends on how evenly the organisms are distributed among the species. Consequently, a statistically significant reduction in this index can occur in the absence of anthropogenic (human-induced) stresses.

When randomness in the sample cannot be guaranteed, then the Brillouin index (h) is a more appropriate

measure of diversity (Pielou 1977). It is calculated using the formula: $h = \frac{\ln(N!) - \sum_{j=1}^S [\ln(n_j!)]}{N}$. It gives a similar measure of diversity although it produces a slightly lower value than the Shannon index when applied to the same data. In contrast to the Shannon index, the Brillouin will vary between samples although the number of species and their proportional abundance remain the same. Because of its dependence on sample size and the increased complexity of its computation, the Brillouin index is more rarely used than the Shannon index.

B.1.1 Evenness

The Pielou evenness index (J') (Pielou 1977) measures how evenly the individual organisms are distributed among the species present in the sample. J' increases for more even distributions of individuals among species. If all individuals belong to a single species, then J' is indeterminate. If each species is represented by a single organism, then J' will be equal to 1.00. For other distributions, the evenness index is given by: $J' = \frac{H'}{\ln S}$; where: S = total number of species, and H' = Shannon-Wiener diversity index.

Because this index is derived from the Shannon-Wiener diversity index (H'), it is subject to the same limitations.

B.1.2 Species Dominance

Dominance indices increase with decreasing diversity and are heavily weighted toward the most common species in a sample. The best known of these measures is Simpson's index (C') (Simpson 1949; Wittaker 1965). It is related to other diversity and evenness indices but increases with increasing proportions of individuals associated with a few species. If all individuals are of one species, then C' is maximum and equal to the maximum dominance of 1.00. If individual organisms are evenly distributed among species

($J'=1.00$), then C' asymptotically approaches 0.00 with increasing numbers of individuals. The Simpson dominance measure is given by: $C' = \sum_{j=1}^S \left(\frac{n_j}{N} \right)^2$ but for finite communities, the unbiased form is:

$$C' = \sum_{j=1}^S \left(\frac{n_j(n_j-1)}{N(N-1)} \right) \text{ (Magurran 1988).}$$

An unrelated measure of dominance has been ascribed to Swartz et al. (1985). The Swartz dominance index (Sw) is defined as the minimum number of species that account for 75% of all individual organisms collected in a sample. In this dominance measure, species are first ranked by the number of individual organisms before establishing the cumulative percent equal to or exceeding 75%. This is an inverse measure because higher dominance is reflected in a lower number of species accounting for 75% of the individual organisms. Despite this, it is not subject to many of the limitations that plague the other univariate indices. It is a non-parametric measure that does not assume an underlying distribution of individuals among species.

B.1.3 Infaunal Trophic Index

The Infaunal Trophic Index (ITI) (Word 1978) compares the abundance of four soft-bottom benthic assemblages distinguished by feeding behavior. Because the sensitivity or tolerance to organic enrichment in particulate matter differs among the four groups, shifts in group dominance, as reflected in a changing infaunal index, can be indicative of changed or degraded environmental conditions. The ITI ranges between 0 and 100. When species in Group I (suspension feeders) and Group II (surface-detritus feeders) dominate, index values are above 58 and sediments are relatively clean. Lower infaunal indices occur when species in Group III (surface deposit feeders) and Group IV (sub-surface detritus feeders) dominate and sediments are high in organics. The ITI is computed from: $ITI = 100 - 33.3 \left[\frac{G_2 + 2G_3 + 3G_4}{G_1 + G_2 + G_3 + G_4} \right]$; where:

G_i = number of individual organisms within the i^{th} trophic group.

B.1.4 Species Richness

The Margalef species richness index (d) (Margalef 1951) measures the number of species in a sample relative to the number of individual organisms. d strongly increases for increasing number of species and increases only logarithmically for decreasing number of individuals. If only one species is present then d is 0.00. For other distributions, the richness index is given by: $d = \frac{S-1}{\ln N}$. Its applicability to biological communities is dependent on whether specimens are log-normally distributed among the species in a given sample. Such an assumption is not globally applicable to benthic marine communities, and without testing each data set, the richness index is of questionable value.

Table B.1 Station Abundance by Taxa during October 2009

Taxonomic Group	Taxon	Station							Station Total	Percent of Total	Cumulative %
		B1	B2	B3	B4	B5	B6	B7			
Echinodermata	<i>Dendraster excentricus</i>	9097	9412	11823	9741	7217	9841	10462	67593	—	—
Nemertea	<i>Carinoma mutabilis</i>	153	149	185	175	131	137	187	1117	26.41	26.41
Crustacea	<i>Majoxiphalus major</i>	17	80	83	113	54	58	92	497	11.75	38.17
Crustacea	<i>Rhepoxynius abronius</i>	42	41	42	36	68	27	43	299	7.07	45.24
Crustacea	<i>Rhepoxynius menziesi</i>	12	38	53	26	59	28	42	258	6.10	51.34
Crustacea	<i>Tecticeps convexus</i>	33	45	14	30	30	14	35	201	4.75	56.09
Bivalvia	<i>Tellina bodegensis</i>	14	33	45	36	29	25	16	198	4.68	60.77
Mollusca	<i>Alvania</i>	30	16	30	54	13	5	47	195	4.61	65.38
Crustacea	<i>Cancer gracilis</i>	4	28	29	50	6	26	11	154	3.64	69.02
Annelida	<i>Scoloplos armiger</i>	12	15	23	20	11	15	16	112	2.65	71.67
Bivalvia	<i>Tellina modesta</i>	16	19	12	18	12	10	12	99	2.34	74.01
Crustacea	<i>Eohaustorius sencillus</i>	6	12	18	17	10	6	15	84	1.99	76.00
Annelida	<i>Sigalion spinosa</i>	11	8	11	6	16	22	5	79	1.87	77.87
Echinodermata	<i>Amphiodia</i>	4	8	9	6	12	8	10	57	1.35	79.21
Bivalvia	<i>Pandora bilirata</i>	2	7	15	6	4	8	3	45	1.06	80.28
Annelida	<i>Lumbrineris californiensis</i>	2	6	4	4	5	14	8	43	1.02	81.30
Mollusca	<i>Odostomia</i>	—	6	6	6	6	8	11	43	1.02	82.31
Annelida	<i>Onuphis iridescens</i>	5	4	8	13	4	6	2	42	0.99	83.31
Phoronida	<i>Phoronis</i>	5	4	4	4	5	9	10	41	0.97	84.28
Annelida	<i>Axiiothella rubrocincta</i>	7	5	8	11	5	1	3	40	0.95	85.22
Nemertea	<i>Carinomella lactea</i>	—	—	—	—	—	20	16	36	0.85	86.07
Bivalvia	<i>Chione</i>	—	6	6	1	3	10	4	30	0.71	86.78
Crustacea	<i>Photis brevipes</i>	—	—	11	5	2	7	3	28	0.66	87.44
Annelida	<i>Glycera convoluta</i>	4	3	4	4	5	1	5	26	0.61	88.06
Annelida	<i>Ampharete labrops</i>	2	1	4	6	6	2	3	24	0.57	88.63
Annelida	<i>Chaetozone setosa</i>	2	4	—	5	4	6	2	23	0.54	89.17
Crustacea	<i>Foxiphalus xiximeus</i>	3	—	1	4	4	6	5	23	0.54	89.71
Bivalvia	<i>Clinocardium nuttallii</i>	—	2	4	7	4	3	3	23	0.54	90.26
Crustacea	<i>Photis macinerneyi</i>	3	4	3	5	—	1	6	22	0.52	90.78
Crustacea	<i>Pacifoculodes spinipes</i>	1	3	1	4	4	2	6	21	0.50	91.27
Annelida	<i>Magelona sacculata</i>	4	2	7	3	3	—	2	21	0.50	91.77
Crustacea	Isaeidae	—	2	5	—	1	8	5	21	0.50	92.27
Crustacea	<i>Isocheles pilosus</i>	3	3	—	2	1	4	3	16	0.38	92.65
Annelida	<i>Phyllodoce</i>	5	2	2	4	—	2	1	16	0.38	93.02
Crustacea	<i>Bathycopea daltonae</i>	5	3	1	1	1	1	3	15	0.35	93.38
Crustacea	<i>Crangon</i>	—	1	3	2	4	—	5	15	0.35	93.73
Annelida	<i>Notomastus lineatus</i>	—	—	4	5	—	1	—	10	0.24	93.97
Crustacea	<i>Callinassa</i>	2	—	1	—	—	2	4	9	0.21	94.18
Annelida	<i>Diopatra ornata</i>	—	—	2	4	—	1	2	9	0.21	94.40
Crustacea	<i>Gibberosus myersi</i>	1	2	1	2	1	—	1	8	0.19	94.59
Annelida	<i>Armandia bioculata</i>	—	—	1	—	4	1	2	8	0.19	94.77
Annelida	<i>Nephtys caecoides</i>	1	1	3	1	—	—	1	7	0.17	94.94
Annelida	<i>Typosyllis farallonensis</i>	4	—	—	—	2	—	1	7	0.17	95.11
Crustacea	<i>Diastylopsis tenuis</i>	—	1	1	—	—	1	4	7	0.17	95.27
Bivalvia	<i>Cooperella subdiaphana</i>	—	1	2	2	—	—	2	7	0.17	95.44

Table B.1 Station Abundance by Taxa during October 2009

Taxonomic Group	Taxon	Station							Station Total	Percent of Total	Cumulative %
		B1	B2	B3	B4	B5	B6	B7			
Annelida	<i>Lumbrineris</i>	–	–	1	1	2	1	2	7	0.17	95.60
Nemertea	<i>Cerebratulus californiensis</i>	–	–	2	–	4	1	–	7	0.17	95.77
Crustacea	<i>Leuroleberis sharpei</i>	–	–	3	1	3	–	–	7	0.17	95.93
Bivalvia	Mytilidae	1	2	2	1	–	–	–	6	0.14	96.07
Crustacea	<i>Americhilidium shoemakeri</i>	1	–	–	2	2	1	–	6	0.14	96.22
Crustacea	<i>Lepidopa californica</i>	–	1	1	–	–	2	2	6	0.14	96.36
Bivalvia	<i>Rochefortia tumida</i>	–	–	2	2	1	1	–	6	0.14	96.50
Crustacea	Aoridae	–	–	2	2	–	1	1	6	0.14	96.64
Nemertea	<i>Amphiporus bimaculatus</i>	1	–	3	1	–	–	–	5	0.12	96.76
Bivalvia	<i>Solen sicarius</i>	–	–	1	–	2	–	2	5	0.12	96.88
Crustacea	<i>Synidotea bicuspidata</i>	–	–	–	–	–	5	–	5	0.12	97.00
Annelida	<i>Syllides</i>	1	1	–	1	1	–	–	4	0.09	97.09
Annelida	<i>Polycirrus</i>	1	–	1	–	–	1	1	4	0.09	97.19
Bivalvia	Bivalvia	1	–	–	1	1	1	–	4	0.09	97.28
Annelida	<i>Arabella iricolor</i>	1	–	–	–	1	–	2	4	0.09	97.38
Mollusca	Naticidae	2	2	–	–	–	–	–	4	0.09	97.47
Crustacea	<i>Caprella californica</i>	2	–	1	–	1	–	–	4	0.09	97.56
Annelida	<i>Spiophanes bombyx</i>	–	–	1	3	–	–	–	4	0.09	97.66
Mollusca	Gastropoda	–	–	2	1	–	1	–	4	0.09	97.75
Annelida	<i>Sthenelais verruculosa</i>	–	–	–	1	1	1	1	4	0.09	97.85
Crustacea	<i>Parasterope barnesi</i>	–	–	–	2	2	–	–	4	0.09	97.94
Annelida	<i>Glycinde armigera</i>	1	–	1	–	1	–	–	3	0.07	98.01
Annelida	<i>Eumida</i>	1	–	1	–	–	1	–	3	0.07	98.08
Mollusca	<i>Nassarius fossatus</i>	1	–	–	2	–	–	–	3	0.07	98.16
Nemertea	Lineidae	1	–	–	–	2	–	–	3	0.07	98.23
Crustacea	<i>Photis</i>	3	–	–	–	–	–	–	3	0.07	98.30
Crustacea	<i>Mesolamprops dillonensis</i>	–	1	1	–	–	–	1	3	0.07	98.37
Echinodermata	<i>Leptosynapta</i>	–	–	–	–	–	–	2	2	0.05	98.42
Annelida	<i>Travisia gigas</i>	1	–	–	–	1	–	–	2	0.05	98.46
Annelida	<i>Eupolymnia heterobranchia</i>	1	–	–	–	–	1	–	2	0.05	98.51
Mollusca	<i>Nassarius perpinguis</i>	2	–	–	–	–	–	–	2	0.05	98.56
Crustacea	<i>Edotia sublittoralis</i>	–	1	–	–	–	–	1	2	0.05	98.60
Annelida	<i>Podarkeopsis glabra</i>	–	–	1	1	–	–	–	2	0.05	98.65
Annelida	<i>Goniada maculata</i>	–	–	1	–	1	–	–	2	0.05	98.70
Crustacea	<i>Anchicolurus occidentalis</i>	–	–	1	–	–	–	1	2	0.05	98.75
Annelida	Nereidae	–	–	2	–	–	–	–	2	0.05	98.79
Annelida	<i>Acmira catherinae</i>	–	–	–	1	1	–	–	2	0.05	98.84
Crustacea	Majidae	–	–	–	1	1	–	–	2	0.05	98.89
Crustacea	Porcellanidae	–	–	–	1	1	–	–	2	0.05	98.94
Crustacea	<i>Gnathopleustes pugettensis</i>	–	–	–	1	–	1	–	2	0.05	98.98
Annelida	<i>Notomastus tenuis</i>	–	–	–	1	–	–	1	2	0.05	99.03
Cnidaria	Actiniaria	–	–	–	–	1	1	–	2	0.05	99.08
Bivalvia	<i>Siliqua lucida</i>	–	–	–	–	1	1	–	2	0.05	99.13
Annelida	<i>Magelona hartmanae</i>	–	–	–	–	–	2	–	2	0.05	99.17
Bivalvia	<i>Nuculana</i>	1	–	–	–	–	–	–	1	0.02	99.20

Table B.1 Station Abundance by Taxa during October 2009

Taxonomic Group	Taxon	Station							Station Total	Percent of Total	Cumulative %
		B1	B2	B3	B4	B5	B6	B7			
Crustacea	<i>Caprella</i>	1	–	–	–	–	–	–	1	0.02	99.22
Annelida	<i>Hesionella mccullochae</i>	1	–	–	–	–	–	–	1	0.02	99.24
Annelida	Polynoidae	1	–	–	–	–	–	–	1	0.02	99.27
Vertebrata	<i>Chilara taylori</i>	1	–	–	–	–	–	–	1	0.02	99.29
Mollusca	<i>Cadulus tolmiei</i>	1	–	–	–	–	–	–	1	0.02	99.31
Annelida	<i>Tenonia priops</i>	–	1	–	–	–	–	–	1	0.02	99.34
Bivalvia	<i>Pandora punctata</i>	–	1	–	–	–	–	–	1	0.02	99.36
Crustacea	<i>Cirolana</i>	–	1	–	–	–	–	–	1	0.02	99.39
Annelida	Capitellidae	–	1	–	–	–	–	–	1	0.02	99.41
Echinodermata	<i>Astropecten verrilli</i>	–	1	–	–	–	–	–	1	0.02	99.43
Annelida	<i>Chone mollis</i>	–	–	1	–	–	–	–	1	0.02	99.46
Annelida	<i>Platynereis bicanaliculata</i>	–	–	1	–	–	–	–	1	0.02	99.48
Bivalvia	<i>Rochefortia grippi</i>	–	–	1	–	–	–	–	1	0.02	99.50
Annelida	<i>Eteone</i>	–	–	1	–	–	–	–	1	0.02	99.53
Crustacea	<i>Euphilomedes carcharodonta</i>	–	–	1	–	–	–	–	1	0.02	99.55
Mollusca	<i>Epitonium sawinae</i>	–	–	1	–	–	–	–	1	0.02	99.57
Crustacea	<i>Cancer magister</i>	–	–	1	–	–	–	–	1	0.02	99.60
Nemertea	<i>Paranemertes sp. A</i>	–	–	–	1	–	–	–	1	0.02	99.62
Annelida	<i>Spiochaetopterus costarum</i>	–	–	–	1	–	–	–	1	0.02	99.65
Annelida	<i>Polydora</i>	–	–	–	–	1	–	–	1	0.02	99.67
Mollusca	<i>Turbonilla</i>	–	–	–	–	1	–	–	1	0.02	99.69
Mollusca	<i>Polinices lewisii</i>	–	–	–	–	1	–	–	1	0.02	99.72
Annelida	<i>Paraprionospio pinnata</i>	–	–	–	–	1	–	–	1	0.02	99.74
Crustacea	<i>Ampelisca cristata</i>	–	–	–	–	1	–	–	1	0.02	99.76
Annelida	<i>Cirriiformia tentaculata</i>	–	–	–	–	1	–	–	1	0.02	99.79
Nemertea	<i>Tubulanus nothus</i>	–	–	–	–	1	–	–	1	0.02	99.81
Annelida	<i>Aphelochaeta</i>	–	–	–	–	–	1	–	1	0.02	99.83
Bivalvia	Nuculanidae	–	–	–	–	–	1	–	1	0.02	99.86
Annelida	<i>Hesionella mccullochae</i>	–	–	–	–	–	1	–	1	0.02	99.88
Annelida	<i>Scalibregma californicum</i>	–	–	–	–	–	1	–	1	0.02	99.91
Annelida	<i>Phylo felix</i>	–	–	–	–	–	–	1	1	0.02	99.93
Mollusca	<i>Olivella pedroana</i>	–	–	–	–	–	–	1	1	0.02	99.95
Crustacea	<i>Crangon alaskensis</i>	–	–	–	–	–	–	1	1	0.02	99.98
Crustacea	<i>Haliophasma geminata</i>	–	–	–	–	–	–	1	1	0.02	100.00
Total Number of Individuals		9540	9990	12526	10468	7784	10374	11140	71822		
Total Number of Individuals Excluding <i>D. Excentricus</i>		443	578	703	727	567	533	678	4229		

Table B.2 Replicate Sample Abundance by Taxa at Station B1 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Echinodermata	<i>Dendraster excentricus</i>	1853	1297	1942	2496	1509	9097	—	—
Nemertea	<i>Carinoma mutabilis</i>	39	26	23	33	32	153	34.54	34.54
Crustacea	<i>Rhepoxynius abronius</i>	3	4	1	19	15	42	9.48	44.02
Crustacea	<i>Tecticeps convexus</i>	21	3	4	1	4	33	7.45	51.47
Mollusca	<i>Alvania</i>	9	—	5	3	13	30	6.77	58.24
Crustacea	<i>Majoxiphalus major</i>	4	4	4	5	—	17	3.84	62.08
Bivalvia	<i>Tellina modesta</i>	2	2	5	4	3	16	3.61	65.69
Bivalvia	<i>Tellina bodegensis</i>	3	4	1	4	2	14	3.16	68.85
Annelida	<i>Scoloplos armiger</i>	3	2	—	2	5	12	2.71	71.56
Crustacea	<i>Rhepoxynius menziesi</i>	—	2	—	7	3	12	2.71	74.27
Annelida	<i>Sigalion spinosa</i>	1	—	2	3	5	11	2.48	76.75
Annelida	<i>Axiiothella rubrocincta</i>	2	—	—	5	—	7	1.58	78.33
Crustacea	<i>Eohaustorius sencillus</i>	1	—	2	2	1	6	1.35	79.68
Phoronida	<i>Phoronis</i>	1	2	—	2	—	5	1.13	80.81
Annelida	<i>Phyllodoce</i>	1	2	—	2	—	5	1.13	81.94
Annelida	<i>Onuphis iridescens</i>	1	—	2	2	—	5	1.13	83.07
Crustacea	<i>Bathycopea daltonae</i>	5	—	—	—	—	5	1.13	84.20
Annelida	<i>Glycera convoluta</i>	1	1	1	1	—	4	0.90	85.10
Annelida	<i>Magelona sacculata</i>	2	—	—	1	1	4	0.90	86.00
Echinodermata	<i>Amphiodia</i>	—	1	—	3	—	4	0.90	86.91
Annelida	<i>Typosyllis farallonensis</i>	—	1	—	3	—	4	0.90	87.81
Crustacea	<i>Cancer gracilis</i>	—	—	—	1	3	4	0.90	88.71
Crustacea	<i>Isocheles pilosus</i>	1	—	1	—	1	3	0.68	89.39
Crustacea	<i>Photis macinerneyi</i>	—	2	—	1	—	3	0.68	90.07
Crustacea	<i>Photis</i>	—	—	—	2	1	3	0.68	90.74
Crustacea	<i>Foxiphalus xiximeus</i>	—	—	—	—	3	3	0.68	91.42
Annelida	<i>Chaetozone setosa</i>	1	—	—	—	1	2	0.45	91.87
Crustacea	<i>Callianassa</i>	1	—	—	—	1	2	0.45	92.33
Bivalvia	<i>Pandora bilirata</i>	—	1	—	1	—	2	0.45	92.78
Mollusca	<i>Nassarius perpinguis</i>	—	1	—	1	—	2	0.45	93.23
Mollusca	Naticidae	—	—	1	1	—	2	0.45	93.68
Annelida	<i>Lumbrineris californiensis</i>	—	—	—	1	1	2	0.45	94.13
Crustacea	<i>Caprella californica</i>	—	—	—	2	—	2	0.45	94.58
Annelida	<i>Ampharete labrops</i>	—	—	—	—	2	2	0.45	95.03
Bivalvia	<i>Nuculana</i>	1	—	—	—	—	1	0.23	95.26
Annelida	<i>Glycinde armigera</i>	1	—	—	—	—	1	0.23	95.49
Crustacea	<i>Pacifoculodes spinipes</i>	1	—	—	—	—	1	0.23	95.71
Mollusca	<i>Nassarius fossatus</i>	—	1	—	—	—	1	0.23	95.94
Annelida	<i>Travisia gigas</i>	—	1	—	—	—	1	0.23	96.16
Annelida	<i>Hesionella mccullochae</i>	—	1	—	—	—	1	0.23	96.39
Crustacea	<i>Americhilidium shoemakeri</i>	—	—	1	—	—	1	0.23	96.61
Bivalvia	Bivalvia	—	—	1	—	—	1	0.23	96.84
Nemertea	<i>Amphiporus bimaculatus</i>	—	—	1	—	—	1	0.23	97.07
Mollusca	<i>Cadulus tolmiei</i>	—	—	1	—	—	1	0.23	97.29
Crustacea	<i>Gibberosus myersi</i>	—	—	—	1	—	1	0.23	97.52
Annelida	<i>Eumida</i>	—	—	—	1	—	1	0.23	97.74

Table B.2 Replicate Sample Abundance by Taxa at Station B1 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Annelida	<i>Syllides</i>	–	–	–	1	–	1	0.23	97.97
Nemertea	Lineidae	–	–	–	1	–	1	0.23	98.19
Annelida	<i>Eupolymnia heterobranchia</i>	–	–	–	1	–	1	0.23	98.42
Bivalvia	Mytilidae	–	–	–	1	–	1	0.23	98.65
Annelida	<i>Polycirrus</i>	–	–	–	1	–	1	0.23	98.87
Annelida	<i>Arabella iricolor</i>	–	–	–	1	–	1	0.23	99.10
Crustacea	<i>Caprella</i>	–	–	–	1	–	1	0.23	99.32
Annelida	Polynoidae	–	–	–	1	–	1	0.23	99.55
Annelida	<i>Nephtys caecoides</i>	–	–	–	–	1	1	0.23	99.77
Vertebrata	<i>Chilara taylori</i>	–	–	–	–	1	1	0.23	100.00
Total Number of Individuals		1958	1358	1998	2618	1608	9540		
Total Number of Individuals Excluding <i>D. Excentricus</i>		105	61	56	122	99	443		

Table B.3 Replicate Sample Abundance by Taxa at Station B2 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Echinodermata	<i>Dendraster excentricus</i>	1085	1927	3006	1271	2123	9412	–	–
Nemertea	<i>Carinoma mutabilis</i>	23	24	26	24	52	149	25.78	25.78
Crustacea	<i>Majoxiphalus major</i>	13	26	21	10	10	80	13.84	39.62
Crustacea	<i>Tecticeps convexus</i>	22	7	2	14	–	45	7.79	47.40
Crustacea	<i>Rhepoxynius abronius</i>	14	5	12	5	5	41	7.09	54.50
Crustacea	<i>Rhepoxynius menziesi</i>	17	3	9	4	5	38	6.57	61.07
Bivalvia	<i>Tellina bodegensis</i>	7	5	9	3	9	33	5.71	66.78
Crustacea	<i>Cancer gracilis</i>	–	–	11	3	14	28	4.84	71.63
Bivalvia	<i>Tellina modesta</i>	3	2	3	2	9	19	3.29	74.91
Mollusca	<i>Alvania</i>	2	6	4	4	–	16	2.77	77.68
Annelida	<i>Scoloplos armiger</i>	4	3	4	2	2	15	2.60	80.28
Crustacea	<i>Eohaustorius sencillus</i>	7	–	3	2	–	12	2.08	82.35
Echinodermata	<i>Amphiodia</i>	2	–	3	–	3	8	1.38	83.74
Annelida	<i>Sigalion spinosa</i>	–	–	1	2	5	8	1.38	85.12
Bivalvia	<i>Pandora bilirata</i>	2	1	2	1	1	7	1.21	86.33
Mollusca	<i>Odostomia</i>	1	3	1	1	–	6	1.04	87.37
Annelida	<i>Lumbrineris californiensis</i>	4	–	1	1	–	6	1.04	88.41
Bivalvia	<i>Chione</i>	–	2	2	1	1	6	1.04	89.45
Annelida	<i>Axiiothella rubrocincta</i>	1	–	–	1	3	5	0.87	90.31
Annelida	<i>Onuphis iridescens</i>	1	–	2	–	1	4	0.69	91.00
Phoronida	<i>Phoronis</i>	2	–	1	–	1	4	0.69	91.70
Crustacea	<i>Photis macinerneyi</i>	2	–	2	–	–	4	0.69	92.39
Annelida	<i>Chaetozone setosa</i>	–	–	1	1	2	4	0.69	93.08
Crustacea	<i>Isocheles pilosus</i>	1	–	2	–	–	3	0.52	93.60
Crustacea	<i>Bathycopoea daltonae</i>	1	–	–	2	–	3	0.52	94.12

Table B.3 Replicate Sample Abundance by Taxa at Station B2 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Crustacea	<i>Pacifoculodes spinipes</i>	1	—	—	2	—	3	0.52	94.64
Annelida	<i>Glycera convoluta</i>	—	—	1	1	1	3	0.52	95.16
Annelida	<i>Magelona sacculata</i>	1	—	1	—	—	2	0.35	95.50
Mollusca	Naticidae	1	—	—	1	—	2	0.35	95.85
Crustacea	Isaeidae	1	—	—	—	1	2	0.35	96.19
Bivalvia	<i>Clinocardium nuttallii</i>	2	—	—	—	—	2	0.35	96.54
Annelida	<i>Phyllodoce</i>	—	1	—	1	—	2	0.35	96.89
Bivalvia	Mytilidae	—	—	—	1	1	2	0.35	97.23
Crustacea	<i>Gibberosus myersi</i>	—	—	—	—	2	2	0.35	97.58
Annelida	<i>Syllides</i>	1	—	—	—	—	1	0.17	97.75
Crustacea	<i>Diastylopsis tenuis</i>	1	—	—	—	—	1	0.17	97.92
Crustacea	<i>Mesolamprops dillonensis</i>	1	—	—	—	—	1	0.17	98.10
Crustacea	<i>Crangon</i>	1	—	—	—	—	1	0.17	98.27
Crustacea	<i>Lepidopa californica</i>	1	—	—	—	—	1	0.17	98.44
Crustacea	<i>Cirolana</i>	1	—	—	—	—	1	0.17	98.62
Annelida	Capitellidae	1	—	—	—	—	1	0.17	98.79
Bivalvia	<i>Pandora punctata</i>	—	1	—	—	—	1	0.17	98.96
Annelida	<i>Tenonia priops</i>	—	—	1	—	—	1	0.17	99.13
Bivalvia	<i>Cooperella subdiaphana</i>	—	—	1	—	—	1	0.17	99.31
Annelida	<i>Ampharete labrops</i>	—	—	—	1	—	1	0.17	99.48
Annelida	<i>Nephtys caecoides</i>	—	—	—	1	—	1	0.17	99.65
Echinodermata	<i>Astropecten verrilli</i>	—	—	—	1	—	1	0.17	99.83
Crustacea	<i>Edotia sublittoralis</i>	—	—	—	—	1	1	0.17	100.00
Total Number of Individuals		1227	2016	3132	1363	2252	9990		
Total Number of Individuals Excluding <i>D. Excentricus</i>		142	89	126	92	129	578		

Table B.4 Replicate Sample Abundance by Taxa at Station B3 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Echinodermata	<i>Dendraster excentricus</i>	2134	2393	2369	2138	2789	11823	—	—
Nemertea	<i>Carinoma mutabilis</i>	36	37	39	42	31	185	26.32	26.32
Crustacea	<i>Majoxiphalus major</i>	19	18	7	23	16	83	11.81	38.12
Crustacea	<i>Rhepoxynius menziesi</i>	13	4	19	9	8	53	7.54	45.66
Bivalvia	<i>Tellina bodegensis</i>	9	10	8	12	6	45	6.40	52.06
Crustacea	<i>Rhepoxynius abronius</i>	5	7	16	2	12	42	5.97	58.04
Mollusca	<i>Alvania</i>	3	11	5	9	2	30	4.27	62.30
Crustacea	<i>Cancer gracilis</i>	10	—	12	5	2	29	4.13	66.43
Annelida	<i>Scoloplos armiger</i>	4	1	8	9	1	23	3.27	69.70
Crustacea	<i>Eohaustorius sencillus</i>	1	1	8	2	6	18	2.56	72.26

Table B.4 Replicate Sample Abundance by Taxa at Station B3 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Bivalvia	<i>Pandora bilirata</i>	—	5	5	1	4	15	2.13	74.40
Crustacea	<i>Tecticeps convexus</i>	1	6	2	2	3	14	1.99	76.39
Bivalvia	<i>Tellina modesta</i>	4	2	1	2	3	12	1.71	78.09
Annelida	<i>Sigalion spinosa</i>	3	3	3	—	2	11	1.56	79.66
Crustacea	<i>Photis brevipes</i>	8	3	—	—	—	11	1.56	81.22
Echinodermata	<i>Amphiodia</i>	3	2	2	1	1	9	1.28	82.50
Annelida	<i>Axiiothella rubrocincta</i>	1	2	1	3	1	8	1.14	83.64
Annelida	<i>Onuphis iridescens</i>	2	2	1	1	2	8	1.14	84.78
Annelida	<i>Magelona sacculata</i>	—	—	3	2	2	7	1.00	85.78
Mollusca	<i>Odostomia</i>	3	—	1	1	1	6	0.85	86.63
Bivalvia	<i>Chione</i>	3	—	—	—	3	6	0.85	87.48
Crustacea	Isaeidae	5	—	—	—	—	5	0.71	88.19
Annelida	<i>Glycera convoluta</i>	1	1	1	1	—	4	0.57	88.76
Phoronida	<i>Phoronis</i>	1	2	—	—	1	4	0.57	89.33
Annelida	<i>Lumbrineris californiensis</i>	1	2	—	—	1	4	0.57	89.90
Annelida	<i>Ampharete labrops</i>	2	—	—	1	1	4	0.57	90.47
Annelida	<i>Notomastus lineatus</i>	—	1	—	1	2	4	0.57	91.04
Bivalvia	<i>Clinocardium nuttallii</i>	—	3	—	1	—	4	0.57	91.61
Crustacea	<i>Leuroleberis sharpei</i>	1	—	1	—	1	3	0.43	92.03
Crustacea	<i>Crangon</i>	1	—	2	—	—	3	0.43	92.46
Nemertea	<i>Amphiporus bimaculatus</i>	3	—	—	—	—	3	0.43	92.89
Crustacea	<i>Photis macinerneyi</i>	—	1	—	1	1	3	0.43	93.31
Annelida	<i>Nephtys caecoides</i>	—	—	2	1	—	3	0.43	93.74
Annelida	Nereidae	1	1	—	—	—	2	0.28	94.03
Crustacea	Aoridae	1	—	—	1	—	2	0.28	94.31
Bivalvia	Mytilidae	1	—	—	—	1	2	0.28	94.59
Annelida	<i>Diopatra ornata</i>	2	—	—	—	—	2	0.28	94.88
Nemertea	<i>Cerebratulus californiensis</i>	—	1	—	1	—	2	0.28	95.16
Bivalvia	<i>Rochefortia tumida</i>	—	1	—	1	—	2	0.28	95.45
Mollusca	Gastropoda	—	1	—	—	1	2	0.28	95.73
Bivalvia	<i>Cooperella subdiaphana</i>	—	—	1	1	—	2	0.28	96.02
Annelida	<i>Phyllodoce</i>	—	—	1	—	1	2	0.28	96.30
Annelida	<i>Platynereis bicanaliculata</i>	1	—	—	—	—	1	0.14	96.44
Crustacea	<i>Diaetylopsis tenuis</i>	1	—	—	—	—	1	0.14	96.59
Annelida	<i>Glycinde armigera</i>	1	—	—	—	—	1	0.14	96.73
Annelida	<i>Podarkeopsis glabra</i>	1	—	—	—	—	1	0.14	96.87
Crustacea	<i>Euphilomedes carcharodonta</i>	1	—	—	—	—	1	0.14	97.01
Annelida	<i>Chone mollis</i>	—	1	—	—	—	1	0.14	97.16
Crustacea	<i>Anchicolurus occidentalis</i>	—	1	—	—	—	1	0.14	97.30
Crustacea	<i>Bathycopea daltonae</i>	—	1	—	—	—	1	0.14	97.44
Crustacea	<i>Mesolamprops dillonensis</i>	—	1	—	—	—	1	0.14	97.58
Annelida	<i>Spiophanes bombyx</i>	—	1	—	—	—	1	0.14	97.72
Annelida	<i>Eteone</i>	—	1	—	—	—	1	0.14	97.87
Annelida	<i>Goniada maculata</i>	—	1	—	—	—	1	0.14	98.01
Annelida	<i>Polycirrus</i>	—	1	—	—	—	1	0.14	98.15

Table B.4 Replicate Sample Abundance by Taxa at Station B3 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Annelida	<i>Armandia bioculata</i>	–	–	1	–	–	1	0.14	98.29
Crustacea	<i>Gibberosus myersi</i>	–	–	1	–	–	1	0.14	98.44
Crustacea	<i>Pacifoculodes spinipes</i>	–	–	1	–	–	1	0.14	98.58
Crustacea	<i>Cancer magister</i>	–	–	1	–	–	1	0.14	98.72
Bivalvia	<i>Solen sicarius</i>	–	–	–	1	–	1	0.14	98.86
Crustacea	<i>Foxiphalus xiximeus</i>	–	–	–	1	–	1	0.14	99.00
Crustacea	<i>Callianassa</i>	–	–	–	1	–	1	0.14	99.15
Crustacea	<i>Caprella californica</i>	–	–	–	1	–	1	0.14	99.29
Bivalvia	<i>Rochefortia grippi</i>	–	–	–	1	–	1	0.14	99.43
Mollusca	<i>Epitonium sawinae</i>	–	–	–	1	–	1	0.14	99.57
Annelida	<i>Eumida</i>	–	–	–	–	1	1	0.14	99.72
Annelida	<i>Lumbrineris</i>	–	–	–	–	1	1	0.14	99.86
Crustacea	<i>Lepidopa californica</i>	–	–	–	–	1	1	0.14	100.00
Total Number of Individuals		2287	2529	2522	2280	2908	12526		
Total Number of Individuals Excluding <i>D. Excentricus</i>		153	136	153	142	119	703		

Table B.5 Replicate Sample Abundance by Taxa at Station B4 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Echinodermata	<i>Dendraster excentricus</i>	1771	2269	1074	1915	2712	9741	–	–
Nemertea	<i>Carinoma mutabilis</i>	29	28	54	29	35	175	24.07	24.07
Crustacea	<i>Majoxiphalus major</i>	29	18	15	19	32	113	15.54	39.61
Mollusca	<i>Alvania</i>	5	30	6	6	7	54	7.43	47.04
Crustacea	<i>Cancer gracilis</i>	16	6	–	25	3	50	6.88	53.92
Bivalvia	<i>Tellina bodegensis</i>	4	5	13	5	9	36	4.95	58.87
Crustacea	<i>Rhepoxynius abronius</i>	7	11	7	6	5	36	4.95	63.82
Crustacea	<i>Tecticeps convexus</i>	1	1	10	12	6	30	4.13	67.95
Crustacea	<i>Rhepoxynius menziesi</i>	1	3	6	5	11	26	3.58	71.53
Annelida	<i>Scoloplos armiger</i>	5	6	5	2	2	20	2.75	74.28
Bivalvia	<i>Tellina modesta</i>	5	3	3	2	5	18	2.48	76.75
Crustacea	<i>Eohaustorius sencillus</i>	–	1	9	6	1	17	2.34	79.09
Annelida	<i>Onuphis iridescens</i>	1	1	1	4	6	13	1.79	80.88
Annelida	<i>Axiothella rubrocincta</i>	–	–	2	6	3	11	1.51	82.39
Bivalvia	<i>Clinocardium nuttallii</i>	2	3	1	–	1	7	0.96	83.36
Annelida	<i>Sigalion spinosa</i>	1	2	3	–	–	6	0.83	84.18
Bivalvia	<i>Pandora bilirata</i>	2	1	–	2	1	6	0.83	85.01
Mollusca	<i>Odostomia</i>	2	4	–	–	–	6	0.83	85.83
Annelida	<i>Ampharete labrops</i>	5	1	–	–	–	6	0.83	86.66
Echinodermata	<i>Amphiodia</i>	–	4	1	1	–	6	0.83	87.48

Table B.5 Replicate Sample Abundance by Taxa at Station B4 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Annelida	<i>Chaetozone setosa</i>	1	1	2	1	—	5	0.69	88.17
Crustacea	<i>Photis macinerneyi</i>	1	1	—	3	—	5	0.69	88.86
Crustacea	<i>Photis brevipes</i>	2	—	—	3	—	5	0.69	89.55
Annelida	<i>Notomastus lineatus</i>	—	—	3	1	1	5	0.69	90.23
Crustacea	<i>Foxiphalus xiximeus</i>	1	1	—	2	—	4	0.55	90.78
Annelida	<i>Glycera convoluta</i>	1	—	1	2	—	4	0.55	91.33
Annelida	<i>Lumbrineris californiensis</i>	2	1	—	—	1	4	0.55	91.88
Annelida	<i>Diopatra ornata</i>	4	—	—	—	—	4	0.55	92.43
Annelida	<i>Phyllodoce</i>	—	—	2	2	—	4	0.55	92.98
Crustacea	<i>Pacifoculodes spinipes</i>	—	—	2	2	—	4	0.55	93.54
Phoronida	<i>Phoronis</i>	—	—	—	3	1	4	0.55	94.09
Annelida	<i>Spiophanes bombyx</i>	—	—	1	2	—	3	0.41	94.50
Annelida	<i>Magelona sacculata</i>	—	—	1	—	2	3	0.41	94.91
Mollusca	<i>Nassarius fossatus</i>	1	1	—	—	—	2	0.28	95.19
Crustacea	<i>Isocheles pilosus</i>	1	1	—	—	—	2	0.28	95.46
Crustacea	<i>Parasterope barnesi</i>	1	—	—	—	1	2	0.28	95.74
Crustacea	Aoridae	2	—	—	—	—	2	0.28	96.01
Bivalvia	<i>Rochefortia tumida</i>	—	1	—	—	1	2	0.28	96.29
Bivalvia	<i>Cooperella subdiaphana</i>	—	—	1	1	—	2	0.28	96.56
Crustacea	<i>Crangon</i>	—	—	1	—	1	2	0.28	96.84
Crustacea	<i>Americhilidium shoemakeri</i>	—	—	—	1	1	2	0.28	97.11
Crustacea	<i>Gibberosus myersi</i>	—	—	—	2	—	2	0.28	97.39
Crustacea	<i>Leuroleberis sharpei</i>	1	—	—	—	—	1	0.14	97.52
Crustacea	<i>Gnathopleustes pugettensis</i>	1	—	—	—	—	1	0.14	97.66
Nemertea	<i>Amphiporus bimaculatus</i>	1	—	—	—	—	1	0.14	97.80
Bivalvia	Mytilidae	1	—	—	—	—	1	0.14	97.94
Nemertea	<i>Paranemertes sp. A</i>	1	—	—	—	—	1	0.14	98.07
Crustacea	Majidae	1	—	—	—	—	1	0.14	98.21
Annelida	<i>Notomastus tenuis</i>	1	—	—	—	—	1	0.14	98.35
Bivalvia	<i>Chione</i>	—	1	—	—	—	1	0.14	98.49
Annelida	<i>Nephtys caecoides</i>	—	1	—	—	—	1	0.14	98.62
Annelida	<i>Sthenelais verruculosa</i>	—	1	—	—	—	1	0.14	98.76
Crustacea	Porcellanidae	—	1	—	—	—	1	0.14	98.90
Annelida	<i>Podarkeopsis glabra</i>	—	—	1	—	—	1	0.14	99.04
Bivalvia	Bivalvia	—	—	—	1	—	1	0.14	99.17
Annelida	<i>Lumbrineris</i>	—	—	—	1	—	1	0.14	99.31
Mollusca	Gastropoda	—	—	—	1	—	1	0.14	99.45
Annelida	<i>Acmira catherinae</i>	—	—	—	1	—	1	0.14	99.59
Annelida	<i>Spiochaetopterus costarum</i>	—	—	—	1	—	1	0.14	99.72
Annelida	<i>Syllides</i>	—	—	—	—	1	1	0.14	99.86
Crustacea	<i>Bathycopea daltonae</i>	—	—	—	—	1	1	0.14	100.00
Total Number of Individuals		1910	2408	1225	2075	2850	10468		
Total Number of Individuals Excluding <i>D. Excentricus</i>		139	139	151	160	138	727		

Table B.6 Replicate Sample Abundance by Taxa at Station B5 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Echinodermata	<i>Dendraster excentricus</i>	1863	404	3204	234	1512	7217	—	—
Nemertea	<i>Carinoma mutabilis</i>	32	17	46	17	19	131	23.10	23.10
Crustacea	<i>Rhepoxynius abronius</i>	24	7	15	15	7	68	11.99	35.10
Crustacea	<i>Rhepoxynius menziesi</i>	23	4	14	14	4	59	10.41	45.50
Crustacea	<i>Majoxiphalus major</i>	10	12	8	8	16	54	9.52	55.03
Crustacea	<i>Tecticeps convexus</i>	3	6	—	14	7	30	5.29	60.32
Bivalvia	<i>Tellina bodegensis</i>	5	7	7	7	3	29	5.11	65.43
Annelida	<i>Sigalion spinosa</i>	6	5	3	1	1	16	2.82	68.25
Mollusca	<i>Alvania</i>	1	—	8	1	3	13	2.29	70.55
Echinodermata	<i>Amphiodia</i>	2	2	5	1	2	12	2.12	72.66
Bivalvia	<i>Tellina modesta</i>	2	3	2	3	2	12	2.12	74.78
Annelida	<i>Scoloplos armiger</i>	2	4	3	—	2	11	1.94	76.72
Crustacea	<i>Eohaustorius sencillus</i>	4	—	—	4	2	10	1.76	78.48
Mollusca	<i>Odostomia</i>	1	4	—	—	1	6	1.06	79.54
Annelida	<i>Ampharete labrops</i>	4	—	1	—	1	6	1.06	80.60
Crustacea	<i>Cancer gracilis</i>	—	—	6	—	—	6	1.06	81.66
Annelida	<i>Glycera convoluta</i>	1	2	1	1	—	5	0.88	82.54
Phoronida	<i>Phoronis</i>	1	—	3	1	—	5	0.88	83.42
Annelida	<i>Lumbrineris californiensis</i>	2	—	1	1	1	5	0.88	84.30
Annelida	<i>Axiothella rubrocincta</i>	—	1	1	3	—	5	0.88	85.19
Bivalvia	<i>Clinocardium nuttallii</i>	1	1	1	—	1	4	0.71	85.89
Annelida	<i>Onuphis iridescentis</i>	1	1	1	—	1	4	0.71	86.60
Crustacea	<i>Crangon</i>	1	1	—	1	1	4	0.71	87.30
Crustacea	<i>Pacifoculodes spinipes</i>	1	2	—	1	—	4	0.71	88.01
Annelida	<i>Chaetozone setosa</i>	1	—	—	3	—	4	0.71	88.71
Bivalvia	<i>Pandora bilirata</i>	3	—	1	—	—	4	0.71	89.42
Nemertea	<i>Cerebratulus californiensis</i>	—	1	1	1	1	4	0.71	90.12
Crustacea	<i>Foxiphalus xiximeus</i>	—	2	—	—	2	4	0.71	90.83
Annelida	<i>Armandia bioculata</i>	—	—	4	—	—	4	0.71	91.53
Crustacea	<i>Leuroleberis sharpei</i>	—	1	—	—	2	3	0.53	92.06
Bivalvia	<i>Chione</i>	—	2	1	—	—	3	0.53	92.59
Annelida	<i>Magelona sacculata</i>	—	—	1	2	—	3	0.53	93.12
Crustacea	<i>Photis brevipes</i>	1	—	1	—	—	2	0.35	93.47
Annelida	<i>Lumbrineris</i>	1	—	—	1	—	2	0.35	93.83
Crustacea	<i>Parasterope barnesi</i>	1	—	—	—	1	2	0.35	94.18
Bivalvia	<i>Solen sicarius</i>	—	1	—	1	—	2	0.35	94.53
Nemertea	Lineidae	—	—	1	1	—	2	0.35	94.89
Annelida	<i>Typosyllis farallonensis</i>	—	—	1	—	1	2	0.35	95.24
Crustacea	<i>Americhilidium shoemakeri</i>	—	—	2	—	—	2	0.35	95.59
Bivalvia	<i>Siliqua lucida</i>	1	—	—	—	—	1	0.18	95.77
Bivalvia	Bivalvia	1	—	—	—	—	1	0.18	95.94
Crustacea	<i>Caprella californica</i>	1	—	—	—	—	1	0.18	96.12
Annelida	<i>Arabella iricolor</i>	1	—	—	—	—	1	0.18	96.30
Mollusca	<i>Turbonilla</i>	—	1	—	—	—	1	0.18	96.47
Annelida	<i>Goniada maculata</i>	—	1	—	—	—	1	0.18	96.65

Table B.6 Replicate Sample Abundance by Taxa at Station B5 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Annelida	<i>Paraprionospio pinnata</i>	–	1	–	–	–	1	0.18	96.83
Annelida	<i>Cirriformia tentaculata</i>	–	1	–	–	–	1	0.18	97.00
Annelida	<i>Polydora</i>	–	–	1	–	–	1	0.18	97.18
Crustacea	<i>Gibberosus myersi</i>	–	–	1	–	–	1	0.18	97.35
Annelida	<i>Acmira catherinae</i>	–	–	1	–	–	1	0.18	97.53
Crustacea	<i>Isocheles pilosus</i>	–	–	1	–	–	1	0.18	97.71
Crustacea	<i>Ampelisca cristata</i>	–	–	1	–	–	1	0.18	97.88
Crustacea	Majidae	–	–	1	–	–	1	0.18	98.06
Nemertea	<i>Tubulanus nothus</i>	–	–	1	–	–	1	0.18	98.24
Cnidaria	Actiniaria	–	–	–	1	–	1	0.18	98.41
Annelida	<i>Syllides</i>	–	–	–	1	–	1	0.18	98.59
Crustacea	<i>Bathycopoea daltonae</i>	–	–	–	1	–	1	0.18	98.77
Crustacea	Isaeidae	–	–	–	–	1	1	0.18	98.94
Annelida	<i>Glycinde armigera</i>	–	–	–	–	1	1	0.18	99.12
Bivalvia	<i>Rocheffortia tumida</i>	–	–	–	–	1	1	0.18	99.29
Mollusca	<i>Polinices lewisii</i>	–	–	–	–	1	1	0.18	99.47
Annelida	<i>Sthenelais verruculosa</i>	–	–	–	–	1	1	0.18	99.65
Annelida	<i>Travisia gigas</i>	–	–	–	–	1	1	0.18	99.82
Crustacea	Porcellanidae	–	–	–	–	1	1	0.18	100.00
Total Number of Individuals		2001	494	3350	339	1600	7784		
Total Number of Individuals Excluding <i>D. Excentricus</i>		138	90	146	105	88	567		

Table B.7 Replicate Sample Abundance by Taxa at Station B6 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Echinodermata	<i>Dendraster excentricus</i>	2204	1101	1976	4086	474	9841	–	–
Nemertea	<i>Carinoma mutabilis</i>	58	10	28	28	13	137	25.70	25.70
Crustacea	<i>Majoxiphalus major</i>	10	7	13	19	9	58	10.88	36.59
Crustacea	<i>Rhepoxynius menziesi</i>	6	8	7	3	4	28	5.25	41.84
Crustacea	<i>Rhepoxynius abronius</i>	6	5	7	6	3	27	5.07	46.90
Crustacea	<i>Cancer gracilis</i>	4	5	10	5	2	26	4.88	51.78
Bivalvia	<i>Tellina bodegensis</i>	5	7	5	5	3	25	4.69	56.47
Annelida	<i>Sigalion spinosa</i>	5	4	8	5	–	22	4.13	60.60
Nemertea	<i>Carinomella lactea</i>	–	18	2	–	–	20	3.75	64.35
Annelida	<i>Scoloplos armiger</i>	2	2	5	5	1	15	2.81	67.17
Crustacea	<i>Tecticeps convexus</i>	1	–	6	1	6	14	2.63	69.79
Annelida	<i>Lumbrineris californiensis</i>	3	5	–	–	6	14	2.63	72.42
Bivalvia	<i>Chione</i>	1	1	1	2	5	10	1.88	74.30
Bivalvia	<i>Tellina modesta</i>	1	6	1	1	1	10	1.88	76.17
Phoronida	<i>Phoronis</i>	2	–	–	6	1	9	1.69	77.86

Table B.7 Replicate Sample Abundance by Taxa at Station B6 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Crustacea	Isaeidae	1	—	4	2	1	8	1.50	79.36
Mollusca	<i>Odostomia</i>	2	1	1	3	1	8	1.50	80.86
Echinodermata	<i>Amphiodia</i>	3	1	2	2	—	8	1.50	82.36
Bivalvia	<i>Pandora bilirata</i>	—	1	4	—	3	8	1.50	83.86
Crustacea	<i>Photis brevipes</i>	3	—	—	1	3	7	1.31	85.18
Annelida	<i>Chaetozone setosa</i>	1	3	1	1	—	6	1.13	86.30
Annelida	<i>Onuphis iridescens</i>	3	1	1	—	1	6	1.13	87.43
Crustacea	<i>Foxiphalus xiximeus</i>	—	3	1	1	1	6	1.13	88.56
Crustacea	<i>Eohaustorius sencillus</i>	—	3	1	—	2	6	1.13	89.68
Mollusca	<i>Alvania</i>	2	1	1	1	—	5	0.94	90.62
Crustacea	<i>Synidotea bicuspidata</i>	—	—	—	—	5	5	0.94	91.56
Crustacea	<i>Isocheles pilosus</i>	—	—	—	2	2	4	0.75	92.31
Bivalvia	<i>Clinocardium nuttallii</i>	—	—	2	1	—	3	0.56	92.87
Crustacea	<i>Callinassa</i>	2	—	—	—	—	2	0.38	93.25
Annelida	<i>Magelona hartmanae</i>	2	—	—	—	—	2	0.38	93.62
Crustacea	<i>Lepidopa californica</i>	2	—	—	—	—	2	0.38	94.00
Annelida	<i>Ampharete labrops</i>	—	1	—	1	—	2	0.38	94.37
Annelida	<i>Phyllodoce</i>	—	—	—	1	1	2	0.38	94.75
Crustacea	<i>Pacifoculodes spinipes</i>	—	—	—	—	2	2	0.38	95.12
Bivalvia	<i>Siliqua lucida</i>	1	—	—	—	—	1	0.19	95.31
Bivalvia	Nuculanidae	1	—	—	—	—	1	0.19	95.50
Annelida	<i>Hesionella maccullochae</i>	1	—	—	—	—	1	0.19	95.68
Cnidaria	Actiniaria	—	1	—	—	—	1	0.19	95.87
Annelida	<i>Armandia bioculata</i>	—	1	—	—	—	1	0.19	96.06
Annelida	<i>Lumbrineris</i>	—	1	—	—	—	1	0.19	96.25
Annelida	<i>Eupolymnia heterobranchia</i>	—	1	—	—	—	1	0.19	96.44
Annelida	<i>Diopatra ornata</i>	—	1	—	—	—	1	0.19	96.62
Annelida	<i>Sthenelais verruculosa</i>	—	1	—	—	—	1	0.19	96.81
Annelida	<i>Scalibregma californicum</i>	—	1	—	—	—	1	0.19	97.00
Annelida	<i>Glycera convoluta</i>	—	—	1	—	—	1	0.19	97.19
Annelida	<i>Notomastus lineatus</i>	—	—	1	—	—	1	0.19	97.37
Annelida	<i>Polycirrus</i>	—	—	1	—	—	1	0.19	97.56
Annelida	<i>Eumida</i>	—	—	—	1	—	1	0.19	97.75
Crustacea	<i>Diastylopsis tenuis</i>	—	—	—	1	—	1	0.19	97.94
Bivalvia	<i>Rochefortia tumida</i>	—	—	—	1	—	1	0.19	98.12
Annelida	<i>Aphelochaeta</i>	—	—	—	1	—	1	0.19	98.31
Mollusca	Gastropoda	—	—	—	1	—	1	0.19	98.50
Crustacea	<i>Photis macinerneyi</i>	—	—	—	—	1	1	0.19	98.69
Crustacea	<i>Americhilidium shoemakeri</i>	—	—	—	—	1	1	0.19	98.87
Crustacea	<i>Bathycopoea daltonae</i>	—	—	—	—	1	1	0.19	99.06

Table B.7 Replicate Sample Abundance by Taxa at Station B6 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Bivalvia	Bivalvia	–	–	–	–	1	1	0.19	99.25
Nemertea	<i>Cerebratulus californiensis</i>	–	–	–	–	1	1	0.19	99.44
Crustacea	<i>Gnathopleustes pugettensis</i>	–	–	–	–	1	1	0.19	99.62
Annelida	<i>Axiothella rubrocincta</i>	–	–	–	–	1	1	0.19	99.81
Crustacea	Aoridae	–	–	–	–	1	1	0.19	100.00
Total Number of Individuals		2332	1201	2090	4193	558	10374		
Total Number of Individuals Excluding <i>D. Excentricus</i>		128	100	114	107	84	533		

Table B.8 Replicate Sample Abundance by Taxa at Station B7 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Echinodermata	<i>Dendraster excentricus</i>	2001	2226	1097	2552	2586	10462	–	–
Nemertea	<i>Carinoma mutabilis</i>	32	52	23	36	44	187	27.58	27.58
Crustacea	<i>Majoxiphalus major</i>	16	20	18	23	15	92	13.57	41.15
Mollusca	<i>Alvania</i>	2	10	5	20	10	47	6.93	48.08
Crustacea	<i>Rhepoxynius abronius</i>	6	9	15	3	10	43	6.34	54.42
Crustacea	<i>Rhepoxynius menziesi</i>	6	19	7	5	5	42	6.19	60.62
Annelida	<i>Scoloplos armiger</i>	5	5	2	–	4	16	2.36	62.98
Bivalvia	<i>Tellina bodegensis</i>	2	9	–	4	1	16	2.36	65.34
Crustacea	<i>Tecticeps convexus</i>	8	16	8	2	1	35	5.16	70.50
Nemertea	<i>Carinomella lactea</i>	8	1	2	2	3	16	2.36	72.86
Crustacea	<i>Eohaustorius sencillus</i>	1	2	11	–	1	15	2.21	75.07
Mollusca	<i>Odostomia</i>	3	1	1	–	6	11	1.62	76.70
Bivalvia	<i>Tellina modesta</i>	1	3	–	5	3	12	1.77	78.47
Phoronida	<i>Phoronis</i>	3	3	3	1	–	10	1.47	79.94
Crustacea	<i>Cancer gracilis</i>	3	2	1	3	2	11	1.62	81.56
Echinodermata	<i>Amphiodia</i>	–	3	–	3	4	10	1.47	83.04
Annelida	<i>Lumbrineris californiensis</i>	1	1	2	1	3	8	1.18	84.22
Crustacea	<i>Pacifoculodes spinipes</i>	1	2	3	–	–	6	0.88	85.10
Annelida	<i>Glycera convoluta</i>	1	1	–	1	2	5	0.74	85.84
Crustacea	<i>Photis macinerneyi</i>	–	–	4	–	2	6	0.88	86.73
Annelida	<i>Sigalion spinosa</i>	1	1	1	1	1	5	0.74	87.46
Crustacea	Isaeidae	1	–	2	–	2	5	0.74	88.20
Crustacea	<i>Foxiphalus xiximeus</i>	2	–	1	–	2	5	0.74	88.94
Crustacea	<i>Crangon</i>	3	2	–	–	–	5	0.74	89.68
Crustacea	<i>Diastylopsis tenuis</i>	1	–	1	–	2	4	0.59	90.27
Bivalvia	<i>Chione</i>	–	1	1	1	1	4	0.59	90.86
Bivalvia	<i>Pandora bilirata</i>	–	–	3	–	–	3	0.44	91.30
Crustacea	<i>Callianassa</i>	–	1	–	2	1	4	0.59	91.89
Crustacea	<i>Bathycopoea daltonae</i>	1	1	1	–	–	3	0.44	92.33
Crustacea	<i>Isocheles pilosus</i>	1	1	–	1	–	3	0.44	92.77

Table B.8 Replicate Sample Abundance by Taxa at Station B7 during October 2009

Taxonomic Group	Taxon	Replicate					Total	Percent of Total	Cumulative Percent
		1	2	3	4	5			
Annelida	<i>Axiothella rubrocincta</i>	—	—	1	2	—	3	0.44	93.22
Bivalvia	<i>Clinocardium nuttallii</i>	1	2	—	—	—	3	0.44	93.66
Crustacea	<i>Photis brevipes</i>	—	—	2	1	—	3	0.44	94.10
Annelida	<i>Ampharete labrops</i>	—	—	—	2	1	3	0.44	94.54
Annelida	<i>Chaetozone setosa</i>	1	1	—	—	—	2	0.29	94.84
Annelida	<i>Diopatra ornata</i>	1	—	1	—	—	2	0.29	95.13
Crustacea	<i>Lepidopa californica</i>	1	—	—	—	1	2	0.29	95.43
Annelida	<i>Onuphis iridescens</i>	2	—	—	—	—	2	0.29	95.72
Annelida	<i>Arabella iricolor</i>	2	—	—	—	—	2	0.29	96.02
Annelida	<i>Lumbrineris</i>	—	1	1	—	—	2	0.29	96.31
Annelida	<i>Magelona sacculata</i>	—	—	1	—	1	2	0.29	96.61
Annelida	<i>Armandia bioculata</i>	—	—	1	1	—	2	0.29	96.90
Bivalvia	<i>Cooperella subdiaphana</i>	—	—	1	1	—	2	0.29	97.20
Echinodermata	<i>Leptosynapta</i>	—	—	1	—	1	2	0.29	97.49
Crustacea	<i>Edotia sublittoralis</i>	1	—	—	—	—	1	0.15	97.64
Crustacea	<i>Mesolamprops dillonensis</i>	1	—	—	—	—	1	0.15	97.79
Crustacea	<i>Aoridae</i>	1	—	—	—	—	1	0.15	97.94
Annelida	<i>Phyllodoce</i>	—	1	—	—	—	1	0.15	98.08
Bivalvia	<i>Solen sicarius</i>	—	1	—	1	—	2	0.29	98.38
Annelida	<i>Nephtys caecoides</i>	1	—	—	—	—	1	0.15	98.53
Annelida	<i>Polycirrus</i>	1	—	—	—	—	1	0.15	98.67
Mollusca	<i>Olivella pedroana</i>	—	1	—	—	—	1	0.15	98.82
Crustacea	<i>Crangon alaskensis</i>	—	1	—	—	—	1	0.15	98.97
Crustacea	<i>Anchicolurus occidentalis</i>	—	—	1	—	—	1	0.15	99.12
Crustacea	<i>Haliophasma geminata</i>	—	—	1	—	—	1	0.15	99.26
Crustacea	<i>Gibberosus myersi</i>	—	—	—	1	—	1	0.15	99.41
Annelida	<i>Notomastus tenuis</i>	—	—	—	1	—	1	0.15	99.56
Annelida	<i>Typosyllis farallonensis</i>	—	—	—	—	1	1	0.15	99.71
Annelida	<i>Phylo felix</i>	—	—	—	—	1	1	0.15	99.85
Annelida	<i>Sthenelais verruculosa</i>	—	—	—	—	1	1	0.15	100.00
Total Number of Individuals		2123	2400	1223	2676	2718	11140		
Total Number of Individuals Excluding <i>D. Excentricus</i>		122	174	126	124	132	678		

Table B.9 Infaunal Indices in Sediment Samples Collected in October 2009

Parameter ^a		Total Organisms	Identified Organisms	Number of Species	Organisms per Species	Diversity (H')	Brillouin Index (h)	Dominance (C')	Dominance (S _n)	Species Richness (d)	Evenness (J')	Infaunal Index (ITI)
Station B1	Replicate 1	1958	1945	19	102	0.28	0.27	0.91	1	2.38	0.10	84
	Replicate 2	1358	1353	17	80	0.26	0.24	0.92	1	2.22	0.09	83
	Replicate 3	1998	1991	15	133	0.16	0.15	0.95	1	1.84	0.06	96
	Replicate 4	2618	2598	25	104	0.26	0.25	0.92	1	3.05	0.08	95
	Replicate 5	1608	1593	19	84	0.32	0.31	0.90	1	2.44	0.11	91
Station B2	Replicate 1	1227	1215	24	51	0.61	0.58	0.80	1	3.24	0.19	95
	Replicate 2	2016	2007	12	167	0.24	0.23	0.92	1	1.45	0.10	97
	Replicate 3	3132	3122	23	136	0.25	0.24	0.93	1	2.73	0.08	95
	Replicate 4	1363	1355	23	59	0.39	0.36	0.88	1	3.05	0.12	94
	Replicate 5	2252	2245	17	132	0.32	0.31	0.90	1	2.07	0.11	95
Station B3	Replicate 1	2287	2268	27	84	0.38	0.36	0.89	1	3.36	0.11	92
	Replicate 2	2529	2510	28	90	0.31	0.29	0.91	1	3.45	0.09	93
	Replicate 3	2522	2512	25	100	0.36	0.35	0.89	1	3.07	0.11	91
	Replicate 4	2280	2268	30	76	0.36	0.34	0.89	1	3.75	0.11	91
	Replicate 5	2908	2896	23	126	0.25	0.24	0.93	1	2.76	0.08	97
Station B4	Replicate 1	1910	1901	31	61	0.43	0.41	0.87	1	3.97	0.12	93
	Replicate 2	2408	2372	26	91	0.29	0.27	0.92	1	3.22	0.09	92
	Replicate 3	1225	1215	22	55	0.62	0.60	0.78	1	2.96	0.20	92
	Replicate 4	2075	2060	27	76	0.44	0.42	0.87	1	3.41	0.13	93
	Replicate 5	2850	2840	22	129	0.29	0.28	0.91	1	2.64	0.09	97
Station B5	Replicate 1	2001	1994	25	80	0.40	0.38	0.87	1	3.16	0.12	98
	Replicate 2	494	488	23	21	0.92	0.86	0.69	1	3.55	0.29	92
	Replicate 3	3350	3330	28	119	0.25	0.24	0.93	1	3.33	0.08	89
	Replicate 4	339	331	19	17	1.31	1.23	0.51	2	3.10	0.45	96
	Replicate 5	1600	1592	26	61	0.33	0.31	0.90	1	3.39	0.10	96
Station B6	Replicate 1	2332	2319	19	122	0.30	0.28	0.90	1	2.32	0.10	93
	Replicate 2	1201	1196	24	50	0.50	0.47	0.85	1	3.25	0.16	92
	Replicate 3	2090	2081	21	99	0.33	0.31	0.90	1	2.62	0.11	94
	Replicate 4	4193	4176	20	209	0.15	0.15	0.96	1	2.28	0.05	93
	Replicate 5	558	548	26	21	0.78	0.72	0.75	1	3.96	0.24	93
Station B7	Replicate 1	2123	2112	30	70	0.34	0.33	0.90	1	3.79	0.10	93
	Replicate 2	2400	2378	24	99	0.38	0.37	0.88	1	2.96	0.12	96
	Replicate 3	1223	1210	27	45	0.55	0.53	0.82	1	3.66	0.17	92
	Replicate 4	2676	2649	22	120	0.24	0.23	0.93	1	2.66	0.08	96
	Replicate 5	2718	2699	25	108	0.27	0.26	0.92	1	3.04	0.08	92
Mean	Station B1	1908	1896	19.0	100.5	0.26	0.24	0.92	1.0	2.39	0.09	90
	Station B2	1998	1989	19.8	108.9	0.36	0.35	0.88	1.0	2.51	0.12	95
	Station B3	2505	2491	26.6	95.1	0.33	0.32	0.90	1.0	3.28	0.10	93
	Station B4	2094	2078	25.6	82.6	0.41	0.39	0.87	1.0	3.24	0.13	93
	Station B5	1557	1547	24.2	59.7	0.64	0.60	0.78	1.2	3.31	0.21	94
	Station B6	2075	2064	22.0	100.2	0.41	0.39	0.87	1.0	2.89	0.13	93
	Station B7	2228	2210	25.6	88.5	0.36	0.34	0.89	1.0	3.22	0.11	94
Standard Deviation	Station B1	476	472	3.7	21.0	0.06	0.06	0.02	0.0	0.44	0.02	6.0
	Station B2	766	767	5.2	51.4	0.15	0.14	0.05	0.0	0.74	0.04	1.3
	Station B3	256	257	2.7	19.4	0.05	0.05	0.02	0.0	0.38	0.01	2.6
	Station B4	604	601	3.8	29.5	0.14	0.13	0.05	0.0	0.50	0.05	2.2
	Station B5	1228	1223	3.4	42.4	0.46	0.43	0.18	0.4	0.18	0.16	3.3
	Station B6	1380	1376	2.9	72.6	0.24	0.22	0.08	0.0	0.71	0.07	0.7
	Station B7	611	606	3.0	30.6	0.12	0.12	0.04	0.0	0.48	0.04	2.2

Table B.9 Infaunal Indices in Sediment Samples Collected in October 2009

Parameter ^a		Total Organisms	Identified Organisms	Number of Species	Organisms per Species	Diversity (H')	Brillouin Index (h)	Dominance (C')	Dominance (S _n)	Species Richness (d)	Evenness (J')	Infaunal Index (ITI)
Station Total	Station B1	9540	9480	40	237	0.27	0.26	0.92	1	4.26	0.07	90
	Station B2	9990	9944	36	276	0.35	0.34	0.90	1	3.80	0.10	95
	Station B3	12526	12454	52	239	0.34	0.33	0.90	1	5.41	0.09	92
	Station B4	10468	10388	47	221	0.40	0.40	0.88	1	4.97	0.10	94
	Station B5	7784	7735	49	158	0.43	0.42	0.87	1	5.36	0.11	94
	Station B6	10374	10320	43	240	0.32	0.31	0.91	1	4.54	0.08	93
	Station B7	11140	11048	48	230	0.35	0.34	0.90	1	5.05	0.09	94
Survey	Total	71822	71369	89	802	0.35	0.35	0.90	1	7.87	0.08	93

Table B.10 Infaunal Indices excluding *D. excentricus* in Sediment Samples Collected in October 2009

Parameter ^a		Total Organisms	Identified Organisms	Number of Species	Organisms per Species	Diversity (H')	Brillouin Index (h)	Dominance (C')	Dominance (S _n)	Species Richness (d)	Evenness (J')	Infaunal Index (ITI)
Station B1	Replicate 1	105	92	18	5.11	1.97	1.74	0.24	4	3.76	0.68	84
	Replicate 2	61	56	16	3.50	2.06	1.73	0.24	6	3.73	0.74	83
	Replicate 3	56	49	14	3.50	1.95	1.63	0.25	5	3.34	0.74	96
	Replicate 4	122	102	24	4.25	2.43	2.14	0.16	7	4.97	0.76	95
	Replicate 5	99	84	18	4.67	2.18	1.91	0.19	6	3.84	0.75	91
Station B2	Replicate 1	142	130	23	5.65	2.53	2.29	0.11	7	4.52	0.81	95
	Replicate 2	89	80	11	7.27	1.86	1.67	0.22	4	2.28	0.78	97
	Replicate 3	126	116	22	5.27	2.48	2.23	0.12	6	4.42	0.80	95
	Replicate 4	92	84	22	3.82	2.47	2.15	0.14	7	4.74	0.80	94
	Replicate 5	129	122	16	7.63	2.05	1.86	0.22	5	3.12	0.74	95
Station B3	Replicate 1	153	134	26	5.15	2.58	2.32	0.12	8	5.10	0.79	92
	Replicate 2	136	117	27	4.33	2.52	2.23	0.14	8	5.46	0.77	93
	Replicate 3	153	143	24	5.96	2.49	2.26	0.13	7	4.63	0.78	91
	Replicate 4	142	130	29	4.48	2.43	2.16	0.16	6	5.75	0.72	91
	Replicate 5	119	107	22	4.86	2.45	2.18	0.14	7	4.49	0.79	97
Station B4	Replicate 1	139	130	30	4.33	2.60	2.31	0.13	8	5.96	0.76	93
	Replicate 2	139	103	25	4.12	2.52	2.22	0.13	7	5.18	0.78	92
	Replicate 3	151	141	21	6.71	2.26	2.06	0.18	6	4.04	0.74	92
	Replicate 4	160	145	26	5.58	2.66	2.41	0.11	9	5.02	0.82	93
	Replicate 5	138	128	21	6.10	2.29	2.07	0.16	6	4.12	0.75	97
Station B5	Replicate 1	138	131	24	5.46	2.41	2.17	0.14	6	4.72	0.76	98
	Replicate 2	90	84	22	3.82	2.67	2.33	0.10	9	4.74	0.86	92
	Replicate 3	146	126	27	4.67	2.38	2.12	0.17	6	5.38	0.72	89
	Replicate 4	105	97	18	5.39	2.41	2.16	0.11	6	3.72	0.84	96
	Replicate 5	88	80	25	3.20	2.59	2.23	0.12	8	5.48	0.81	96
Station B6	Replicate 1	128	115	18	6.39	1.99	1.78	0.28	6	3.58	0.69	93
	Replicate 2	100	95	23	4.13	2.76	2.44	0.08	10	4.83	0.88	92
	Replicate 3	114	105	20	5.25	2.48	2.22	0.12	7	4.08	0.83	94
	Replicate 4	107	90	19	4.74	2.28	2.01	0.16	6	4.00	0.77	93
	Replicate 5	84	74	25	2.96	2.86	2.45	0.08	11	5.58	0.89	93
Station B7	Replicate 1	122	111	29	3.83	2.64	2.32	0.13	8	5.95	0.78	93
	Replicate 2	174	152	23	6.61	2.25	2.05	0.17	5	4.38	0.72	96
	Replicate 3	126	113	26	4.35	2.61	2.32	0.11	7	5.29	0.80	92
	Replicate 4	124	97	21	4.62	2.15	1.89	0.21	5	4.37	0.71	96
	Replicate 5	132	113	24	4.71	2.33	2.06	0.19	7	4.87	0.73	92

Table B.10 Infaunal Indices excluding *D. excentricus* in Sediment Samples Collected in October 2009

Parameter ^a		Total Organisms	Identified Organisms	Number of Species	Organisms per Species	Diversity (H')	Brillouin Index (h)	Dominance (C')	Dominance (S _h)	Species Richness (d)	Evenness (J')	Infaunal Index (ITI)
Mean	Station B1	89	77	18.0	4.2	2.12	1.83	0.22	5.6	3.93	0.74	90
	Station B2	116	106	18.8	5.9	2.28	2.04	0.16	5.8	3.82	0.78	95
	Station B3	141	126	25.6	5.0	2.49	2.23	0.14	7.2	5.09	0.77	93
	Station B4	145	129	24.6	5.4	2.47	2.21	0.14	7.2	4.86	0.77	93
	Station B5	113	104	23.2	4.5	2.49	2.20	0.13	7.0	4.81	0.80	94
	Station B6	107	96	21.0	4.7	2.47	2.18	0.14	8.0	4.41	0.81	93
	Station B7	136	117	24.6	4.8	2.39	2.13	0.16	6.4	4.97	0.75	94
Standard Deviation	Station B1	29	23	3.7	0.71	0.20	0.20	0.04	1.1	0.61	0.03	6.0
	Station B2	24	23	5.2	1.55	0.30	0.27	0.05	1.3	1.07	0.03	1.3
	Station B3	14	14	2.7	0.65	0.06	0.06	0.01	0.8	0.53	0.03	2.6
	Station B4	10	16	3.8	1.12	0.18	0.15	0.03	1.3	0.80	0.03	2.2
	Station B5	27	24	3.4	0.99	0.13	0.08	0.03	1.4	0.70	0.06	3.3
	Station B6	16	16	2.9	1.28	0.36	0.29	0.08	2.3	0.79	0.08	0.7
	Station B7	22	21	3.0	1.06	0.22	0.19	0.04	1.3	0.67	0.04	2.2
Station Total	Station B1	443	383	39	9.8	2.45	2.30	0.19	8	6.39	0.67	90
	Station B2	578	532	35	15.2	2.54	2.44	0.13	7	5.42	0.72	95
	Station B3	703	631	51	12.4	2.71	2.59	0.13	8	7.76	0.69	92
	Station B4	727	647	46	14.1	2.72	2.60	0.12	8	6.95	0.71	94
	Station B5	567	518	48	10.8	2.74	2.60	0.12	8	7.52	0.71	94
	Station B6	533	479	42	11.4	2.76	2.62	0.12	10	6.64	0.74	93
	Station B7	678	586	47	12.5	2.62	2.50	0.15	8	7.22	0.68	94
Survey	Total	4229	3776	88	42.9	2.78	2.74	0.13	8	10.56	0.62	93

SUSAN J. WILLIAMS

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Education

B.S.	Marine Biology, California State University, Long Beach
Certificate	Environmental Studies, California State University, Long Beach
M.S.	Biology, California State University, Long Beach

Credential

Instructor, California Community Colleges
Subjects: Biological Sciences, Marine Sciences, Ecology

Qualifications

Susan Williams is an environmental scientist with over thirty years experience in ecological monitoring and assessment. She has a strong background in natural history and an excellent working knowledge of such varied communities as coastal sage scrub, coastal dunes, wetlands, and marine benthos. Ms. Williams also has training in hazardous materials management, including courses and seminars in CEQA, environmental auditing, and the fate of toxins in the environment. She has an extensive background in biological survey techniques and laboratory methodology.

The postgraduate Environmental Studies Certificate provided interdisciplinary training in economics, public health issues, environmental toxicology, and assessing human impacts on terrestrial and marine environments.

Professional Employment

- 1989-present. Consultant and Contract Employee. Projects include Shoreline Recovery Study of the Exxon Valdez spill, terrestrial ecological survey of a Superfund site, and various benthic surveys, and environmental education.
- 1990-present. Interpretive Specialist, City of Ventura (Community Services). As part of the Interpretive Outreach Program, deliver classroom and field presentations on a variety of natural and cultural history topics; program development.
- 1993 - 1994. Park Ranger (Interpretive Division), Channel Islands National Park. Staff Visitor Center, present programs to school groups and general public, develop public programs (Tidepools, Island Ethnobotany).
- 1989 - 1994. Part-time Instructor, Oxnard College. Topics taught include Microbiology, Marine Biology, Biology, and Environmental Sciences.
- 1986 - 1989. Researcher, Battelle Ocean Sciences, Ventura. Laboratory supervisor, task leader for monitoring program, taxonomist, safety officer.
- 1984 - 1986. Research Scientist, Harbors Environmental Project, University of Southern California. Assessment of the marine environment of Marina Del Rey; monitoring offshore disposal of cannery waste.
- 1980 - 1986. Assistant Curator, Allan Hancock Foundation, University of Southern California. Responsible for maintaining museum collection of marine animals, processing loans, conducting independent research.

- 1979 - 1981. Research Associate, Applied Ecology Program, Institute for Marine and Coastal Studies. Investigated impacts of storms on sandy beaches, monitored benthic impacts of electrical generating stations, supervised laboratory.
- 1975 - 1978. Associate Research Scientist, Department of Biological Sciences, University of Southern California. As part of the Outer Continental Shelf Program, collected and analyzed benthic samples prior to offshore oil exploration.

Miscellaneous

Charter Member, Southern California Association of Marine Invertebrate Taxonomists

Participant, Boys & Girls Club of Ventura Career Fair

Judge, Ventura County Science Fair (2004-present). Assigned categories included Zoology, Botany, and Human Biology, junior division (grades 6-8)

Publications and Technical Reports

Ms. Williams has published 13 papers, ranging from taxonomic works and ecological analyses to articles on environmental issues for the general public.

Detailed list available upon request.

ROY K. KROPP

Senior Research Scientist
Pacific Northwest National Laboratory
Battelle Marine Sciences Laboratory
Sequim, Washington

Education

Ph.D.	Zoology, University of Maryland, 1988
M.S.	Biology, University of Guam, 1982
B.S.	Zoology, San Diego State University, 1978

Qualifications

Dr. Kropp is a specialist in benthic marine ecology, toxicology, and the systematics of crustaceans and mollusks with 21 years of experience. He has served as the principal investigator for or participated in marine environmental surveys in the tropical and boreal Pacific, off California, the Gulf of Mexico, along the Atlantic Coast of the United States, and in the Mediterranean. Currently, Dr. Kropp is the Senior Scientist for Benthic Biology for the Massachusetts Water Resources Authority Monitoring Program. Since matriculating to the Marine Sciences Laboratory from Battelle's Duxbury facility, Dr. Kropp has continued benthic ecological studies, recently completing studies of infaunal communities associated with dredged material disposal sites in Rhode Island Sound and Long Island Sound. He was the technical project manager for the preparation of the Final Environmental Impact Statement being prepared for the Providence River dredging project by the U.S. Army Corps of Engineers and is participating as a benthic ecologist on similar EISs for the designation of disposal sites in Rhode Island Sound and Long Island Sound. Dr. Kropp designed and directed a study to examine the effects of increased summer nutrient loads on nearshore seagrass beds in NW Sardinia by examining changes in plant phenology, motile epifaunal communities, and plant epiphyte loads. Dr. Kropp is a recognized authority on crustacean systematics. He was the crustacean taxonomist for the Sardinian study and served as the crustacean and mollusk taxonomist for studies conducted off California and New England. He was the crustacean taxonomist for the Gulf of Thailand and Sea of Okhotsk programs and has extensive experience in the systematics of Indo-Pacific crustaceans. Dr. Kropp is a Research Associate with the Smithsonian Institution and a Research Affiliate of the University of Guam Marine Laboratory. He has authored or coauthored many journal publications and technical reports.

Project Experience

- **Soft-Bottom Monitoring Study conducted for Massachusetts Water Resources Authority (MWRA).** Senior Scientist responsible for technical oversight of benthic monitoring tasks, including directing data analyses and report preparation for study of the response of the Boston Harbor benthos to the abatement of sludge discharge, and for the eventual diversion of effluent to Massachusetts Bay. Assisted in the design and performance of the rapid assessment technique used in the study. Co-principal Investigator of a study to determine the importance of the new outfall site as a recruitment area for juvenile lobsters.
- **Piscataqua River, New Hampshire 301(h) waiver Water Quality and Benthic Community Study.** Principal investigator for the study performed to fulfill requirements of a 301(h) waiver application. Designed the sampling scheme for the study, analyzed ecological and water-quality data, and prepared the interpretive report.
- **Rhode Island Sound and Long Island Sound Infaunal Community Analyses.** Co-Principal Investigator for two studies of infaunal communities in and near dredged material disposal sites for the U.S. Army Corps of Engineers. Performed benthic data analyses and coauthored the technical reports.
- **Effect of Water-Column Nutrients on Seagrass Epifaunal Communities in NW Sardinia, Italy.** Principle Investigator responsible for study design, staff training, study implementation, data analysis and interpretation, and preparation of interpretive report. Study examining the effects of increased summer nutrient loads (related to increased tourism) on nearshore seagrass beds by examining changes in plant phenology, motile epifaunal communities, and epiphyte loads.
- **Environmental Studies in the Gulf of Thailand, Phase I and II** Biology Task Leader for project that investigated the impacts of drilling activities on the benthos. Performed ecological data analysis, wrote biological characterization chapters of the resulting reports.

Roy K. Kropp (Continued)

Other Experience

Monitoring Studies.

Task Leader for a study to determine the abundance of ocean quahogs (*Arctica islandica*) at proposed dredged material disposal sites in Rhode Island Sound. Designed and directed the study. Analyzed quahog abundance and size-frequency data, and prepared an interpretive report.

Biology Task Leader for the Sediment Survey at the (New York) Mud Dump Site and Environs. Responsible for analysis and interpretation of infaunal data collected during 1994. Prepared sections on the benthic community for the draft final report. Contributed sections on the infaunal community and trophic relationships for the draft SEIS.

Task Leader. Statistical design of field sampling and data analysis, interpretation, and write-up for program involving lead shot remediation at Remington Gun Club site.

Biology Task Leader for Environmental Studies in the Sea of Okhotsk. Analyzed infaunal data collected from proposed drilling platform sites. Prepared an interpretive report on the infaunal communities in the study area.

Biology Task Leader for the Region VI (EPA) contaminated sediment study. Analyzed infaunal data from seven ocean dredged material disposal sites in the Gulf of Mexico. Prepared interpretive reports on the communities at each site and provided recommendations for improving the study design.

Scientist for the New York Bight Rapid Benthic Assessment project that concerned the selection of a new site for the disposal of dredge spoils. Conducted epibenthic trawls and sediment grab sampling. Analyzed trawl catches, fish stomach contents, and infauna collected in sediment grabs.

Assistant Program Manager for California OCS Phase II Monitoring Program (CAMP) that established baseline conditions in the Santa Maria Basin prior to the installation of a drilling platform. Principal Investigator studying the life histories of several key infaunal species. Conducted independent study on the incidence of repaired shell damage to gastropods and scaphopods in the study area.

Beach Replenishment Dredging Studies. Principal Investigator for three USACE sand borrow area studies. Responsible for design and ecological analysis for three projects establishing baseline conditions or investigating the effects of dredging in sand borrow areas at Broadkill Beach in Delaware Bay and off Absecon Inlet and Great Egg Harbor, New Jersey.

Toxicological Studies. Project Manager or Senior Scientist for toxicological testing of sediments from the Providence River, New Haven, and Boston Harbor/Weymouth Fore River. These tests were conducted from the New England Division, Army Corps of Engineers and involved marine species, including *Americamysis bahia* and *Ampelisca abdita*. Responsibilities included overall test planning and supervision, data analyses, and report preparation.

Project Manager for toxicological testing of sediments from Pistol Point Bar, CT. These tests were conducted from the New England Division, Army Corps of Engineers and involved freshwater species including *Hyalella azteca*, *Chironomus tentans*, and *Lumbriculus variegatus*.

Project Manager for toxicological testing of synthetic-based drilling muds from the Gulf of Mexico. These tests were conducted from the American Petroleum Institute and involved a marine species, *Leptocheirus plumulosus*.

Environmental Impact Statements. Project Manager for the preparation of the Final Environmental Impact Statement being prepared for the Providence River dredging project by the US Army Corps of Engineers. Coordinator for activities including response to public comments, re-analysis of fish trawl data to evaluate fishery value of potential disposal sites, directed the development of a statistically valid design of study on lobster populations at disposal sites, directing implementation of the study, designed a dredge survey to sample northern quahog populations in the area to be dredged and wrote the interpretive report, monitored project budgets and tracked deliverable preparation. Information will be used to assist the government in deciding the most appropriate disposal alternative.

Artificial Reef Studies. Benthic Infauna/Epifauna Task Leader for 5-year study for U.S. Army Corps of Engineers (USACE) and Environmental Protection Agency (EPA) Delaware Artificial Reef Study that investigated the feasibility of using artificial reef as compensation for shallow- and deep-water habitat loss. Performed ecological data analysis of epifaunal communities on the reefs and infaunal communities surrounding the reefs, wrote sections

Roy K. Kropp (Continued)

of the report. Designed portions of a study to examine the effects of artificial reef units on the infauna.

NOAA Hydrolab Aquanaut and field assistant for study of artificial reef colonization at Salt River Canyon, St. Croix, U.S. Virgin Islands.

Taxonomist. Crustacean taxonomist for benthic studies conducted in NW Sardinia, Italy.

Identified crustaceans and mollusks collected from Boston Harbor, Massachusetts Bay, and Cape Cod Bay for the MWRA Harbor and Outfall Monitoring Program.

Chief taxonomist for the Environmental Studies in the Gulf of Thailand, Phase I and II project. Identified the crustaceans collected during the study. Directed the establishment of a project-specific voucher collection and edited the documentation for the voucher collection.

Identified crustaceans and mollusks collected from off California for the CAMP program and the Morro Bay/Cayucos Sanitation District 301(h) monitoring program.

Specialist on benthic invertebrates for several baseline monitoring studies conducted in the western Pacific (Micronesia).

Professional Affiliations

Biological Society of Washington
Crustacean Society
Estuarine Research Federation
Pacific Science Association

Technical Reports

Kropp RK, Diaz RJ, Dahlen DT, Boyle JD. 2002. *2001 Harbor Benthic Monitoring Report*. MWRA Environmental Quality Department Technical Report Series 2002-19. Prepared for the Massachusetts Water Resources Authority, Boston, Massachusetts.

Kropp R, Diaz R, Hecker B, Dahlen D, Boyle J, Abramson S, Emsbo-Mattingly S. 2002. *2001 Outfall Benthic Monitoring Report*. MWRA Environmental Quality Department Technical Report Series 2002-15. Prepared for the Massachusetts Water Resources Authority, Boston, Massachusetts.

Kohn NP, and RK Kropp. 2002. *Year 5 Post-Remediation Biomonitoring of Pesticides and other Contaminants in Marine Waters near the United Heckathorn Superfund Site, Richmond, California*. Prepared for the U.S. Environmental Protection Agency, Region 9.

Kropp RK, Diaz RJ, Dahlen DT, Boyle JD, Hunt, CD. 2002. *2000 Harbor Benthic Monitoring Report*. MWRA Environmental Quality Department Technical Report Series 2002-02. Prepared for the Massachusetts Water Resources Authority, Boston, Massachusetts.

Kropp R, Diaz R, Hecker B, Dahlen D, Boyle J, Abramson S, Emsbo-Mattingly S. 2002. *2000 Outfall Benthic Monitoring Report*. MWRA Environmental Quality Department Technical Report Series 2001-11. Prepared for the Massachusetts Water Resources Authority, Boston, Massachusetts.

Kohn, NP, and RK Kropp. 2001. *Year 4 Postremediation Biomonitoring of Pesticides and Other Contaminants in Marine Waters Near the United Heckathorn Superfund Site, Richmond, California*. PNNL-13632. Prepared for the U.S. Environmental Protection Agency, Region 9.

Kropp RK, RJ Diaz, D Dahlen, JD Boyle, CD Hunt. 2001. *1999 Harbor Benthic Monitoring Report*. MWRA Environmental Quality Department Technical Report Series 01-03. Prepared for the Massachusetts Water Resources Authority, Boston, Massachusetts.

Williams, G. D., R. M. Thom, J. E. Starks, J. S. Brennan, J. P. Houghton, D. Woodruff, P. L. Striplin, M. Miller, M. Pedersen, A. Skillman, R. Kropp, A. Borde, C. Freeland, K. McArthur, V. Fagerness, S. Blanton, and L. Blackmore. 2001. *Reconnaissance Assessment of the State of the Nearshore Ecosystem: Eastern Shore of Central Puget Sound, Including Vashon and Maury Islands (WRIAs 8 and 9)*. Ed., J. S. Brennan. PNNL-14055. Report prepared for King County Department of Natural Resources, Seattle, Washington. 353 pp.
<http://dnr.metrokc.gov/wlr/watersheds/puget/nearshore/sonr.htm>.

Roy K. Kropp (Continued)

Williams, GD, RM Thom, DL Woodruff, MC Miller, RK Kropp, AB Borde, AD Skillman, SL Blanton, J Brennan, and L Blackmore. 2001. A Comprehensive Assessment of the Central Puget Sound (King County) Nearshore Ecosystem: Historic Changes, Data Gaps, and Pending Threats. PNNL-SA-34562. In *Puget Sound Research 2001 Proceedings--The Puget Sound/Georgia Basin Ecosystem: Status, Stressors, and the Road to Recovery*. Bellevue, Washington, February 12-14, 2001.

Kohn, NP, and RK Kropp. 2000. *Year 3 Post-Remedial Monitoring of Pesticides and Other Contaminants in Marine Waters Near the United Heckathorn Superfund Site, Richmond, California*. PNNL-13286. (Final Draft Report October 2000. Prepared for the U.S. Environmental Protection Agency, Region 9, San Francisco, California.

Kropp, R.K., V.I. Cullinan, J.D. Boyle, and C.D. Hunt. April 2000. "Stratford Point Benthic Analysis September 1999 Survey." Prepared for Sporting Goods Properties, Inc..

Kropp, R.K., R. Diaz, D. Dahlen, J.D. Boyle, D. Shull, and E.D. Gallagher. 2000. *1998 Boston Harbor Benthic Monitoring Report*. MWRA Environmental Quality Department Technical Report Series 00-06. Prepared for the Massachusetts Water Resources Authority, Boston, Massachusetts.

Kropp RK, RJ Diaz, B Hecker, D Dahlen, JD Boyle, KE Keay, CD Hunt. 2000. *1999 Outfall Benthic Monitoring Report*. MWRA Environmental Quality Department Technical Report Series 00-16. 230 pp. Prepared for the Massachusetts Water Resources Authority, Boston, Massachusetts..

Pinza, M.R., J.Q. Word, J.A. Ward, and R.K. Kropp. 2000. Ecotoxicological Testing to Address Confounding Factors for Hong Kong Contaminated Sediments. PNWD-3020. Prepared for ERM-Hong Kong, Ltd..

Kropp, R.K., R. Diaz, D. Dahlen, J.D. Boyle, D. Shull, and E.D. Gallagher. 2000. 1998 Boston Harbor benthic monitoring report. MWRA Environmental Quality Department Technical Report Series 00-06. Prepared for the Massachusetts Water Resources Authority, Boston, Massachusetts.

Kropp, R.K., D. Dahlen, J.D. Boyle, R. Diaz, B. Hecker, and E.D. Gallagher. 1999. 1998 Outfall benthic monitoring report. MWRA Environmental Quality Department Technical Report Series 99-15.

Lavalli, K. and R.K. Kropp. 1998. Abundance Of Juvenile Lobsters At The New Outfall Site: Comparisons With Inshore Abundances And Discussion of Potential Outfall Impacts On Lobster Populations. MWRA Environmental Quality Department Technical Report Series 98-14. 31 pp.

Battelle [Kropp, R.K.]. 1998. Shellfish sampling and site characterizations: Narragansett Bay and Rhode Island Sound Proposed Disposal Sites. Final Report to U.S. Army Corps of Engineers, North Atlantic Division, New England District. 28 pp.

Battelle. 1996. Region VI contaminated sediment study phase III. Draft Final Report to U.S.E.P.A. Region VI. [wrote sections on infaunal communities at seven ODMDS sites in the Gulf of Mexico].

Battelle. 1996. Sediment survey at the Mud Dump Site and environs. Draft Final Report to U.S.E.P.A. Region II. [wrote sections on infaunal communities].

Kropp, R.K. and R.J. Diaz. 1995. Infaunal community changes in Boston Harbor, 1991-1994: The 1994 annual soft-bottom benthic monitoring report: Boston Harbor studies. MWRA Environmental Quality Department Technical Report Series 95-21. 41 pp.

Kropp, R.K. and R.J. Diaz. 1995. 1993 annual soft-bottom benthic monitoring report: Boston Harbor studies. MWRA Environmental Quality Department Technical Report Series 94-10. 78 pp.

Kropp, R.K. 1995. Environmental post-dredge monitoring, Great Egg Harbor Inlet and Peck Beach Ocean City, New Jersey. Final report to U.S. Army Corps of Engineers, Philadelphia District. 44 pp.

Kropp, R.K. 1995. Brigantine Inlet to Great Egg Harbor Inlet feasibility study, Atlantic County, New Jersey: Benthic animal assessment of potential borrow source. Final report to U.S. Army Corps of Engineers, Philadelphia District. 40 pp.

Foster, K.L., R.K. Kropp, A.M. Spellacy, F. Querzoli, and R. Lordo. 1995. Delaware Bay Artificial Reef Study □ Year 5. Draft Summary Report to [U.S.] EPA and U.S. Army Corps of Engineers. 132 pp.

Kropp, R.K. 1994. Delaware Bay Coastline □ Broadkill Beach interim feasibility study, Sussex County Delaware: Benthic animal assessment of potential borrow source. Final report to U.S. Army Corps of Engineers, Philadelphia

Roy K. Kropp (Continued)

District. 40 pp.

Kropp, R.K. 1994. Piscataqua River, New Hampshire water quality and benthic community study. Final report to U.S. EPA Region I. 30 pp.

Kropp, R.K. (ed.). 1994. Voucher collection documentation sheets. *In*: Battelle, Environmental Studies in the Gulf of Thailand, Phase II. Final Report to Unocal Thailand, Ltd.

Kropp, R.K. 1994. Biological characterization studies. *In*: Battelle, Environmental Studies in the Gulf of Thailand, Phase II: Impact of processing activities and produced water discharges at Platong Central Processing Platform. Final Report to Unocal Thailand, Ltd.

Kropp, R.K. 1994. Biological characterization studies. *In*: Battelle, Environmental Studies in the Gulf of Thailand Phase II: Impact of drilling fluids and cuttings discharges. Final Report to Unocal Thailand, Ltd.

Foster, K.L., R.K. Kropp, A.M. Spellacy, F. Querzoli, and R. Lordo. 1994. Delaware Bay Artificial Reef Study □ Year 4. Final Summary Report to [U.S.] EPA and U.S. Army Corps of Engineers. 89 pp.

Foster, K.L., R.K. Kropp, A.M. Spellacy, F. Querzoli, R. Lordo, and J. Ryther, Jr. 1993. Delaware Bay Artificial Reef Study □ Year 3. Draft Final Report to [U.S.] EPA and U.S. Army Corps of Engineers. 126 pp.

Foster, K.L., R.K. Kropp, J.H. Ryther, and A.M. Spellacy. 1992. Delaware Artificial Reef Study □ Year 2. Final Report to [U.S.] EPA and U.S. Army Corps of Engineers. 92 pp.

Kelly, J.R., and R.K. Kropp. 1992. Benthic recovery following sludge abatement in Boston Harbor: Part I Baseline survey 1991 and Part II Spring 1992 Survey. Final Report to the Massachusetts Water Resources Authority.

Kropp, R.K. 1991. Biological characterization. *In*: Battelle, Funan Field Background Monitoring Study. Final Report to Unocal Thailand, Ltd.

Kropp, R.K. 1991. Biological characterization studies. *In*: Battelle, Environmental Studies in the Gulf of Thailand. Final Report to Unocal Thailand, Ltd.

Foster, K.L., R.K. Kropp, and T.L. Burch. 1991. Delaware Bay Artificial Reef Study □ Year 1. Final Report to [U.S.] EPA and U.S. Army Corps of Engineers. 67 pp.

Hyland, J., E. Baptiste, J. Campbell, J. Kennedy, R. Kropp, C. Robinson, and S. Williams. 1990. Macroinfaunal assemblages in the Santa Maria Basin off the coast of southern California. Chapter 7 *In*: M. Steinhauer and E. Imamura, eds., California OCS Phase II Monitoring Program. Year-Three annual Report. Report to U.S. Department of Interior, Minerals Management Service, Pacific OCS Office, Los Angeles, CA. Contract No. 14-12-0001-30262. Two volumes.

Kropp, R.K., and D.G. Carroll. 1990. Life-history studies of selected macroinfaunal invertebrates from the Santa Maria Basin, California. Chapter 8 *In*: M. Steinhauer and E. Imamura, eds., California OCS Phase II Monitoring Program. Year-Three annual Report. Report to U.S. Department of Interior, Minerals Management Service, Pacific OCS Office, Los Angeles, CA. Contract No. 14-12-0001-30262. Two volumes.

Kropp, R.K., and L.G. Eldredge. 1982. Macroinvertebrates. *In*: R.H. Randall and L.G. Eldredge, eds., Assessment of shoalwater environments in the vicinity of the proposed Ocean Thermal Energy Conversion development at Cabras Island, Guam. University of Guam Marine Lab Technical Report, 79 pp. 107-131.

Amesbury, S.S., M.W. Colgan, R.F. Myers, R.K. Kropp, and F.A. Cushing. 1981. Biological monitoring study of airport runway expansion site, Moen, Truk, eastern Caroline Islands. Part B: Construction phase. University of Guam Marine Lab Technical Report 74:1-125.

Eldredge, L.G., and R.K. Kropp. 1981. Selected bibliography of the physical, chemical, and biological oceanographic literature for the waters surrounding Guam. Lawrence Berkeley Laboratory Earth Sciences Division Report LBL-13443, 22 pp.

Journal Publications

Steimle, F., K. Foster, R. Kropp, and B. Conlin. 2002. Benthic macrofauna productivity enhancement by an artificial reef in Delaware Bay, USA. *ICES Journal of Marine Science* 59:S100-S105.

Roy K. Kropp (Continued)

- Paulay G, R Kropp, PK Ng, and LG Eldredge. In press. "The crustaceans and pycnogonids of the Mariana Islands." *Micronesia* in press.
- Lavalli, K.L., R.K. Kropp, and K.E. Keay. 2000. Anticipated effects of the discharge of secondary effluent on lobster fisheries in Massachusetts Bay: Perception and reality. Submitted to *Environmental Management*.
- Kropp, R.K., K.L. Foster, F.W. Steimle, W.C. Muir, and B.E. Conlin. 1999. A mussel-based epifaunal community on artificial reefs in Delaware Bay, USA: early development and variation. Proceedings of the 7th International Conference on Artificial Reefs and Related Aquatic Habitats, San Remo, Italy, October 1999. Abstract .
- Kelly, J.R., R.K. Kropp, A.D. Uhler, M.B. Zielinski, and S. Tawatchai. 1998. Environmental response and recovery at drilling platforms in the Gulf of Thailand. Proceedings of the 1998 SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production. Caracas, Venezuela. 21 pp.
- Trulli, W.R., R.K. Kropp, H.K. Trulli, D.P. Redford. 1997. Comparison of the results of two EPA marine debris studies. Pp 307-325 In Coe, J.M. and D.B. Rogers (eds) *Marine Debris: Sources, Impacts, and Solutions*. Springer. New York.
- Kropp, R.K. and R.B. Manning. 1996. Two new genera and species of deep-water gall crabs from the Indo-West Pacific (Crustacea: Decapoda: Cryptochiridae). In: A. Crosnier (ed.), *Résultats des Campagnes MUSORSTOM*, Volume 15. *Mémoires Museum National D'Histoire Naturelle* 168:531-539.
- Foster, K.L., R.K. Kropp, F.W. Steimle, W.C. Muir, and B.E. Conlin. 1995. Fish community and feeding habitats at a pre-fabricated concrete artificial reef in Delaware Bay, U.S.A. *Ecoset '95, Proceedings of the International Conference on Ecological System Enhancement Technology for Aquatic Habitats*, Tokyo 1:266-271.
- Steimle, F., W. Muir, K. Foster, R. Kropp, and B. Conlin. 1995. Benthic community enhancement by a prefabricated concrete artificial reef in lower Delaware Bay. *Ecoset '95, Proceedings of the International Conference on Ecological System Enhancement Technology for Aquatic Habitats*, Tokyo, 2:581-586.
- Kropp, R.K. 1995. *Lithoscaptus pardalotus*, a new species of coral-dwelling gall crab (Brachyura, Cryptochiridae) from Belau. *Proceedings of the Biological Society of Washington*, 108(4):637-642.
- Vermeij, G.J. and R.K. Kropp. 1995. A note on the muricid gastropod *Muricodrupa jacobsoni* in the Palau Islands. *The Festivus* 27(7):84-85.
- Foster, K.L., F.W. Steimle, W.C. Muir, R.K. Kropp, and B.E. Conlin. 1994. Mitigation potential of habitat replacement: Concrete artificial reef in Delaware Bay—Preliminary results. *Bulletin of Marine Science* 55:783-795.
- Kropp, R.K. and J. Haig. 1994. *Petrolisthes extremus*, a new porcelain crab (Decapoda: Porcellanidae) from the Indo-West Pacific. *Proceedings of the Biological Society of Washington* 107:312-317.
- Kropp, R.K. 1994. The gall crabs (Decapoda: Cryptochiridae) of the Rumphius Expeditions revisited and the description of three new species. *Raffles Bulletin of Zoology* 42:521-538.
- Kropp, R.K. 1992. Repaired shell damage among soft-bottom mollusks on the continental shelf and upper slope north of Point Conception, California. *The Veliger* 35:36-51.
- Hyland, J., E. Baptiste, J. Campbell, J. Kennedy, R. Kropp, and S. Williams. 1991. The infaunal benthos of the outer continental shelf and slope north of Point Conception, California. *Marine Ecology Progress Series* 78:147-161.
- Kropp, R.K. and J.H. Dominguez. 1990. *Mesacturus dicrurus*, an unusual new stomatopod crustacean from Micronesia. *Proceedings of the Biological Society of Washington* 103:372-375.
- Manning, R.B., R.K. Kropp, and J. Dominguez. 1990. Distribution patterns of deep-sea stomatopod crustaceans, Family Bathysquillidae. *Progress in Oceanography* 24:311-316.
- Kropp, R.K. 1990. Revision of the genera of gall crabs occurring in the Pacific Ocean (Crustacea: Cryptochiridae). *Pacific Science* 44:417-448.
- Kropp, R.K. 1989. A revision of the Pacific species of gall crabs, genus *Opecarcinus* (Crustacea: Cryptochiridae). *Bulletin of Marine Science* 45:98-129.

Roy K. Kropp (Continued)

Haig, J. and R.K. Kropp. 1988. *Petrolisthes eldredgei*, a new porcellanid crab from the Indo-West Pacific, with redescription of two related species. *Micronesica* 20:171-186. [issue date 1987]

Kropp, R.K. 1988. The status of *Cryptochirus hongkongensis* Shen, 1936 (Brachyura: Cryptochiridae). *Proceedings of the Biological Society of Washington* 101:866-871.

Kropp, R.K. 1988. The status of *Cryptochirus corallodytes* Heller and *Lithoscaptus paradoxus* Milne Edwards (Brachyura: Cryptochiridae). *Proceedings of the Biological Society of Washington* 101:872-882.

Kropp, R.K. 1988. Case 2636. *Fizesereneia* Takeda and Tamura, 1908 (Crustacea: Decapoda): proposed confirmation of *Troglocarcinus heimi* Fize and Serène, 1956 as the type species. *Bulletin of Zoological Nomenclature* 45:262-263.

Kropp, R.K. and M. Takeda. 1988. *Utinomiella*, a replacement name for *Utinomia* Takeda and Tamura, 1981 (Crustacea, Decapoda), *non* Tomlinson, 1963 (Crustacea, Acrothoracica). *Bulletin of the Biogeographical Society of Japan* 43:29.

Kropp, R.K. and R.B. Manning. 1987. The Atlantic gall crabs, family Cryptochiridae (Crustacea: Decapoda: Brachyura). *Smithsonian Contributions to Zoology* 462:1-21.

Kropp, R.K. 1987. Descriptions of some endolithic habitats for snapping shrimp (Alpheidae) in Micronesia. *Bulletin of Marine Science* 41:204-213.

Kropp, R.K. 1986. Feeding biology and mouthpart morphology of three species of coral gall crabs (Decapoda: Cryptochiridae). *Journal of Crustacean Biology* 6:377-384.

Kropp, R.K. 1986. A neotype designation for *Petrolisthes tomentosus* (Dana), and the description of two new species of *Petrolisthes* from the Mariana Islands (Anomura, Porcellanidae). *Proceedings of the Biological Society of Washington* 99:452-463.

Nelson, S.G. and R.K. Kropp. 1985. Ammonia excretion and nitrogen assimilation by the tropical freshwater prawn *Macrobrachium lar* (Crustacea, Palaemonidae). *Comparative Biochemistry and Physiology* 81A:699-704.

Kropp, R.K. and R.B. Manning. 1985. Cryptochiridae, the correct name for the family containing the gall crabs (Crustacea, Decapoda, Brachyura). *Proceedings of the Biological Society of Washington* 98:954-955.

Eldredge, L.G. and R.K. Kropp. 1985. Volcanic ashfall effects on intertidal and shallow-water coral reef zones at Pagan, Mariana Islands. *Proceedings of the Fifth Coral Reef Congress, Tahiti* 4:189-194.

Kropp, R.K. 1984. *Tanaocheles stenochilus*, a new genus and species of crab from Guam, Mariana Islands (Brachyura, Xanthidae). *Proceedings of the Biological Society of Washington* 97:744-747.

Kropp, R.K. 1983. Three new species of Porcellanidae (Crustacea, Anomura) from the Mariana Islands and a discussion of Borradaile's *Petrolisthes lamarckii* complex. *Micronesica* 19:91-106.

Kropp, R.K. 1982. Responses of five holothurian species to attacks by a predatory gastropod, *Tonna perdx*. *Pacific Science* 36:445-452.

Eldredge, L.G. and R.K. Kropp. 1981. Crustacean-induced skeletal modification in *Acropora*. *Proceedings of the Fourth International Coral Reef Symposium, Manila* 2:115-119. [published 1982]

Kropp, R.K. and C. Birkeland. 1981. Comparison of crustacean associates of *Pocillopora* from high islands and atolls. *Proceedings of the Fourth International Coral Reef Symposium, Manila* 2:627-632. [published 1982]

Kropp, R.K. 1981. Additional porcelain crab feeding methods (Decapoda, Porcellanidae). *Crustaceana* 40:307-310.

APPENDIX C

Sediment Properties: October 2009 Survey

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APPENDIX C

Properties of Sediment Samples Collected during October 2009 Offshore Survey

Table C.1 Sediment Grab-Sample Collection Record

Station	Sample	Date	¹ Time	Penetration Depth (cm)	Latitude	Longitude	Sediment Type	Sediment ² Color
1	Bio 1	10/20/2009	12:44:06	8.0	35° 23.7288' N	120° 52.6676' W	Sand	Lt. Brown
	Bio 2	10/20/2009	12:46:47	10.0	35° 23.7305' N	120° 52.6661' W	Sand	Lt. Brown
	Bio 3	10/20/2009	12:49:17	8.3	35° 23.7314' N	120° 52.6652' W	Sand	Lt. Brown
	Bio 4	10/20/2009	12:51:51	7.7	35° 23.7327' N	120° 52.6640' W	Sand	Lt. Brown
	Bio 5	10/20/2009	12:54:21	9.0	35° 23.7303' N	120° 52.6665' W	Sand	Lt. Brown
	Chem 1	10/20/2009	12:56:52	N/A	35° 23.7313' N	120° 52.6649' W	Sand	Lt. Brown
	Chem 2	10/20/2009	13:00:34	N/A	35° 23.7364' N	120° 52.6623' W	Sand	Lt. Brown
	Chem 3	10/20/2009	13:04:00	N/A	35° 23.7358' N	120° 52.6598' W	Sand	Lt. Brown
2	Bio 1	10/20/2009	11:52:30	8.0	35° 23.2791' N	120° 52.5010' W	Sand	Lt. Brown
	Bio 2	10/20/2009	11:55:37	7.5	35° 23.2812' N	120° 52.5020' W	Sand	Lt. Brown
	Bio 3	10/20/2009	12:01:14	8.0	35° 23.2806' N	120° 52.5008' W	Sand	Lt. Brown
	Bio 4	10/20/2009	12:04:03	10.0	35° 23.2814' N	120° 52.4972' W	Sand	Lt. Brown
	Bio 5	10/20/2009	12:06:30	8.5	35° 23.2821' N	120° 52.5019' W	Sand	Lt. Brown
	Chem 1	10/20/2009	12:08:47	N/A	35° 23.2821' N	120° 52.4999' W	Sand	Lt. Brown
	Chem 2	10/20/2009	12:12:39	N/A	35° 23.2819' N	120° 52.4974' W	Sand	Lt. Brown
	Chem 3	10/20/2009	12:16:07	N/A	35° 23.2821' N	120° 52.4999' W	Sand	Lt. Brown
3	Bio 1	10/20/2009	11:13:41	8.0	35° 23.2327' N	120° 52.5078' W	Sand	Lt. Brown
	Bio 2	10/20/2009	11:19:17	8.5	35° 23.2335' N	120° 52.5028' W	Sand	Lt. Brown
	Bio 3	10/20/2009	11:21:42	7.0	35° 23.2318' N	120° 52.5054' W	Sand	Lt. Brown
	Bio 4	10/20/2009	11:24:22	10.0	35° 23.2324' N	120° 52.5018' W	Sand	Lt. Brown
	Bio 5	10/20/2009	11:26:58	7.5	35° 23.2339' N	120° 52.5067' W	Sand	Lt. Brown
	Chem 1	10/20/2009	11:29:30	N/A	35° 23.2334' N	120° 52.4998' W	Sand	Lt. Brown
	Chem 2	10/20/2009	11:33:43	N/A	35° 23.2335' N	120° 52.5014' W	Sand	Lt. Brown
	Chem 3	10/20/2009	11:37:54	N/A	35° 23.2331' N	120° 52.5005' W	Sand	Lt. Brown
4	Bio 1	10/20/2009	10:30:43	8.2	35° 23.2116' N	120° 52.5025' W	Sand	Lt. Brown
	Bio 2	10/20/2009	10:33:23	7.5	35° 23.2111' N	120° 52.4983' W	Sand	Lt. Brown
	Bio 3	10/20/2009	10:36:12	8.0	35° 23.2124' N	120° 52.4956' W	Sand	Lt. Brown
	Bio 4	10/20/2009	10:38:48	8.0	35° 23.2125' N	120° 52.5015' W	Sand	Lt. Brown
	Bio 5	10/20/2009	10:41:34	8.0	35° 23.2113' N	120° 52.4972' W	Sand	Lt. Brown
	Chem 1	10/20/2009	10:44:09	N/A	35° 23.2110' N	120° 52.4942' W	Sand	Lt. Brown
	Chem 2	10/20/2009	10:47:41	N/A	35° 23.2111' N	120° 52.5002' W	Sand	Lt. Brown
	Chem 3	10/20/2009	10:51:11	N/A	35° 23.2102' N	120° 52.5003' W	Sand	Lt. Brown
5	Bio 1	10/20/2009	09:32:45	8.8	35° 23.1771' N	120° 52.5119' W	Sand	Lt. Brown
	Bio 2	10/20/2009	09:35:29	8.2	35° 23.1768' N	120° 52.5204' W	Sand	Lt. Brown
	Bio 3	10/20/2009	09:38:16	10.5	35° 23.1773' N	120° 52.5197' W	Sand	Lt. Brown
	Bio 4	10/20/2009	09:43:53	10.5	35° 23.1770' N	120° 52.5211' W	Sand	Lt. Brown
	Bio 5	10/20/2009	09:46:51	8.0	35° 23.1744' N	120° 52.5189' W	Sand	Lt. Brown
	Chem 1	10/20/2009	09:49:26	N/A	35° 23.1717' N	120° 52.5149' W	Sand	Lt. Brown
	Chem 2	10/20/2009	09:53:18	N/A	35° 23.1733' N	120° 52.5201' W	Sand	Lt. Brown
	Chem 3	10/20/2009	09:57:14	N/A	35° 23.1714' N	120° 52.5176' W	Sand	Lt. Brown

¹ Time when the sediment grab was collected (trip time of the grab)

² No odors emanating from the sediment samples were noted at any station

Table C.1 Sediment Grab-Sample Collection Record

Station	Sample	Date	¹ Time	Penetration Depth (cm)	Latitude	Longitude	Sediment Type	Sediment ² Color
6	Bio 1	10/20/2009	08:52:55	9.8	35° 23.1657' N	120° 52.5074' W	Sand	Lt. Brown
	Bio 2	10/20/2009	08:55:34	9.0	35° 23.1674' N	120° 52.5082' W	Sand	Lt. Brown
	Bio 3	10/20/2009	08:58:15	7.0	35° 23.1653' N	120° 52.5087' W	Sand	Lt. Brown
	Bio 4	10/20/2009	09:00:58	8.5	35° 23.1655' N	120° 52.5100' W	Sand	Lt. Brown
	Bio 5	10/20/2009	09:03:57	9.0	35° 23.1667' N	120° 52.5110' W	Sand	Lt. Brown
	Chem 1	10/20/2009	09:06:40	N/A	35° 23.1652' N	120° 52.5079' W	Sand	Lt. Brown
	Chem 2	10/20/2009	09:11:12	N/A	35° 23.1647' N	120° 52.5118' W	Sand	Lt. Brown
	Chem 3	10/20/2009	09:15:33	N/A	35° 23.1634' N	120° 52.5079' W	Sand	Lt. Brown
7	Bio 1	10/20/2009	08:01:35	10.5	35° 23.1127' N	120° 52.5093' W	Sand	Lt. Brown
	Bio 2	10/20/2009	08:04:07	8.5	35° 23.1131' N	120° 52.5055' W	Sand	Lt. Brown
	Bio 3	10/20/2009	08:04:26	8.0	35° 23.1134' N	120° 52.5049' W	Sand	Lt. Brown
	Bio 4	10/20/2009	08:07:00	10.5	35° 23.1134' N	120° 52.5110' W	Sand	Lt. Brown
	Bio 5	10/20/2009	08:09:57	9.5	35° 23.1141' N	120° 52.5113' W	Sand	Lt. Brown
	Chem 1	10/20/2009	08:16:36	N/A	35° 23.1145' N	120° 52.5082' W	Sand	Lt. Brown
	Chem 2	10/20/2009	08:22:23	N/A	35° 23.1131' N	120° 52.5058' W	Sand	Lt. Brown
	Chem 3	10/20/2009	08:26:51	N/A	35° 23.1152' N	120° 52.5069' W	Sand	Lt. Brown

Table C.2 Grain-Size Class Distribution in October 2009 Sediment Samples

Phi	-2 to -1	-1 to 0	0 to 1	1 to 2	2 to 3	3 to 4	4 to 9	>9
Size (µm)	2000	1000	500	250	125	62.5	62.5 to 2	<2
Class	Gravel	Vry Crs Snd	Crs Sand	Med Snd	Fine Snd	Vry Fine Snd	Silt	Clay
Station B1	0.000%	0.075%	0.460%	1.227%	72.783%	24.742%	0.553%	0.159%
Station B2	0.000%	0.208%	0.421%	1.343%	80.125%	17.464%	0.318%	0.120%
Station B3	0.000%	0.127%	0.348%	1.198%	83.760%	14.293%	0.274%	0.000%
Station B4	0.000%	0.142%	0.377%	1.653%	85.226%	12.322%	0.171%	0.109%
Station B5	0.000%	0.297%	0.727%	1.501%	77.424%	19.465%	0.458%	0.128%
Station B5(d)	0.000%	0.069%	0.302%	1.058%	77.250%	20.578%	0.563%	0.179%
Station B6	0.000%	0.316%	0.589%	1.536%	77.891%	18.910%	0.628%	0.129%
Station B7	0.000%	0.143%	0.472%	1.206%	79.766%	17.887%	0.450%	0.075%
Station B7(d)	0.000%	0.199%	0.837%	1.554%	80.900%	15.911%	0.520%	0.078%

Table C.3 Grain-Size Weight Distribution in October 2009 Sediment Samples

Phi Size (µm) Class	Dry Weight (grams)			Percentage Summary		
	<-1 to 4	>4	Total	-2 to -1	-1 to 4	4 to >9
	2000 to 62.5	<62.5		2000	1000 to 62.5	<62.5
	Coarse	Fine		Gravel	Sand	Mud
Station B1	114.942	0.824	115.766	0.000%	99.288%	0.712%
Station B2	112.707	0.496	113.203	0.000%	99.562%	0.438%
Station B3	116.831	0.321	117.152	0.000%	99.726%	0.274%
Station B4	116.802	0.328	117.130	0.000%	99.720%	0.280%
Station B5	112.902	0.665	113.567	0.000%	99.414%	0.586%
Station B5(d)	112.902	0.844	113.746	0.000%	99.258%	0.742%
Station B6	113.716	0.868	114.584	0.000%	99.242%	0.758%
Station B7	114.893	0.607	115.500	0.000%	99.474%	0.526%
Station B7(d)	114.654	0.690	115.344	0.000%	99.402%	0.598%

Table C.4 Grain-Size Statistics for October 2009 Sediment Samples

Station	Percent Coarser than Listed Diameter (µm)								
	Mean (φ)	σ (φ)	Skewness (φ)	Mean (µm)	5%	16%	50%	84%	95%
B1	2.79	0.353	0.11	145	211	181	146	113	91
B2	2.72	0.321	0.10	152	216	186	153	122	99
B3	2.68	0.312	0.09	156	220	189	157	127	102
B4	2.66	0.293	0.09	158	216	191	159	130	107
B5	2.73	0.345	0.09	151	221	187	152	119	95
B5(d)	2.76	0.332	0.13	148	209	182	150	118	93
B6	2.73	0.348	0.11	151	220	188	153	120	94
B7	2.73	0.323	0.11	151	214	185	152	122	97
B7(d)	2.70	0.330	0.10	154	222	190	156	124	99

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APPENDIX D
Outfall Inspection Report

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OUTFALL/DIFFUSOR ANNUAL REPORT

NAME OF DISCHARGER
NPDES PERMIT #

Bruce Keogh
CA0047881

NAME OF DIVER/INSPECTOR
FIRM & ADDRESS

Craig Porter / Porter Diving
15730 Mono Rd. Alameda CA 94522

TELEPHONE #

(805) 466-0566

OUTFALL LENGTH 5160' FT. DEPTH OF WATER 50' FT.

DESIGN OF DIFFUSOR (physical dimensions, shape, include sketch)

OF PORTS 34 # PORTS OPEN 28 DIFFUSOR LEVEL? 1'-6'

END OF DIFFUSOR OPEN? CLOSED? ✓ and of flange uncovered

OUTFALL MARKED BY BOUYS? YES ✓ NO TYPE SPAR (PVC)

DIFFUSORS OPERATING AS DESIGNED? YES ✓ NO

BREAKS IN OUTFALL LINE NOTED? YES NO ✓ IF YES, DESCRIBE

DESCRIBE PROBLEMS NOTED Bolting still ok, Re-check when
Bouys are replaced in Spring

CORRECTIVE ACTION NEEDED Replace SPAR Bouys in Spring

PHYSICAL DESCRIPTION OF ENVIRONMENT AROUND OUTFALL (ie. fish noted, debris, sediments, etc.) Lots of Starfish, Anemones, lots of Kelp and
Debris Due to recent storms. No visible plume @ surface

DIRECTION OF PLUME IN RELATIONSHIP TO SHORELINE North, strong Northward
Current during inspection.

PICTURES TAKEN? YES ✓ VIDEO NO (INCLUDE COPIES IF TAKEN)

SIGNATURE OF DIVER/INSPECTOR

Bruce Keogh
SIGNATURE OF DISCHARGER

12/20/2009
DATE

12/21/2009
TITLE

RHS/DIFF. DISC C

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APPENDIX E

Sediment Chemistry: October 2009 Survey Methods, Results, and QA/QC

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Methods

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**Table E.1 Summary of Analytical Methods Used for
Physicochemical Determinations of Sediment**

Parameter	Method	Description	Reference
Biochemical Oxygen Demand 5-Day	5210B	Dissolved Oxygen Probe	6
Total Kjeldahl Nitrogen (TKN)	351.2	Block Digestion/Colorimetry	1
Dissolved Sulfides	376.2	Spectrophotometric	1
Total Volatile Solids	160.4	Dry ashing/Gravimetry	1
Moisture	160.3	Evaporation/Gravimetry	1
Sediment Grain Size	MRS, 1998	Sieve/Pipette without salt	2,3,4
Aluminum	6010	ICP	5
Arsenic	7060	GFAAS	5
Cadmium	6010	ICP	5
Chromium	6010	ICP	5
Copper	6010	ICP	5
Iron	6010	ICP	5
Lead	7421	CVAAS	5
Mercury	7471	CVAAS	5
Nickel	6010	ICP	5
Silver	272.2	GFAAS	1
Zinc	6010	ICP	5
Organochlorine Pesticides	8080	GC	5
PCBs	8080	GC	5
Phenolic Compounds	8270	GC/MS	5
Oil and Grease	1664	Extraction/Gravimetry	7

CVAAS = Cold Vapor Atomic Absorption Spectrometry

ICP/MS = Inductively Coupled Plasma/Mass Spectrometry

GC = Gas Chromatography

GC/MS = Gas Chromatography/Mass Spectrometry

GFAAS = Graphite Furnace Atomic Absorption Spectrometry

References:

1. U.S. Environmental Protection Agency. 1983. Methods for chemical analysis of water and wastes. EPA-600/4-79-020.
2. Plumb, R.H., Jr. 1981. Procedures for Handling and chemical analysis of sediment and water samples. U.S. Army Corps of Engineer Waterway Experiment Stations, Vicksburg, Miss.
3. Marine Research Specialists. 1998. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Semiannual Benthic Sampling, October 1997. Prepared for the City of Morro Bay, Morro Bay, CA
4. Coats, D.A., Imamura, E., Fukuyama, A.K., Skalski, J.R., Kimura, S., and J. Steinbeck. 1998. Monitoring of Biological Recovery of Prince William Sound Intertidal Sites Impacted by the *Exxon Valdez* Oil Spill. 1997 Biological Monitoring Survey. NOAA Technical Memorandum NOS ORCA NOS OR&R 1.
5. U.S. Environmental Protection Agency. 1986. Test methods for evaluating solid wastes physical/chemical methods. EPA SW-846. 3rd ed., revised.
6. American Public Health Association, American Water Works Association, and Water Pollution Control Federation. 1998. Standard methods for the examination of water and wastewater (20th Ed.). Washington, DC.
7. U.S. Environmental Protection Agency. 1999. Method 1664 Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM; Non-polar Material) by Extraction and Gravimetry. February 1999. EPA-821-R-98-002.

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Analytical Results

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Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Chemical Analysis

BCL Sample ID:	0914065-01	Client Sample Name:	Station B1, 10/20/2009 1:04:00PM											
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru- ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Moisture	0	28.7	%	0.05	0.05	Calc	10/26/09	10/28/09 16:32	TMS	Calc	1	BSJ1631	ND	
Total Kjeldahl Nitrogen	160	120	mg/kg	40	15	EPA-351.2	10/28/09	10/29/09 09:40	JSM	SC-1	0.962	BSJ1799	ND	
Volatile Solids	1.33	0.950	%	0.200	0.200	SM-2540G	11/04/09	11/10/09 21:33	MSA	Inst	1	BSK0632		Z1
Biochemical Oxygen Demand	56	40	mg O/kg	10	10	SM17-521 0B	10/21/09	10/21/09 13:00	HPR	YSI-57	0.333	BSJ1661		
Solids	100	71.3	%	0.05	0.05	SM-2540G	10/23/09	10/23/09 16:15	NW1	MANUAL	1	BSJ1561		

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Total Concentrations (TTLC)

BCL Sample ID: 0914065-01		Client Sample Name: Station B1, 10/20/2009 1:04:00PM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time		Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Arsenic	2.9	2.1	mg/kg	0.50	0.12	EPA-6020	10/23/09	10/30/09	05:59	JDC	PE-EL1	1	BSJ1535	ND	
Cadmium	ND	ND	mg/kg	0.50	0.033	EPA-6010 B	10/23/09	10/26/09	10:08	ARD	PE-OP1	1	BSJ1534	ND	
Chromium	57	41	mg/kg	0.50	0.045	EPA-6010 B	10/23/09	10/26/09	10:08	ARD	PE-OP1	1	BSJ1534	ND	
Copper	2.9	2.1	mg/kg	1.0	0.13	EPA-6010 B	10/23/09	10/26/09	10:08	ARD	PE-OP1	1	BSJ1534	ND	
Lead	2.3	1.6	mg/kg	0.25	0.038	EPA-6020	10/23/09	10/30/09	05:59	JDC	PE-EL1	1	BSJ1535	0.078	
Mercury	0.028	0.020	mg/kg	0.16	0.014	EPA-7471 A	11/03/09	11/03/09	14:20	MEV	CETAC1	0.977	BSK0138	ND	J
Nickel	36	26	mg/kg	0.50	0.12	EPA-6010 B	10/23/09	10/26/09	10:08	ARD	PE-OP1	1	BSJ1534	ND	
Silver	ND	ND	mg/kg	0.25	0.032	EPA-6020	10/23/09	10/30/09	05:59	JDC	PE-EL1	1	BSJ1535	ND	
Zinc	17	12	mg/kg	2.5	0.25	EPA-6010 B	10/23/09	10/26/09	10:08	ARD	PE-OP1	1	BSJ1534	1.0	
Aluminum	5800	4100	mg/kg	5.0	1.9	EPA-6010 B	10/23/09	10/26/09	10:08	ARD	PE-OP1	1	BSJ1534	ND	
Iron	9200	6500	mg/kg	5.0	1.4	EPA-6010 B	10/23/09	10/26/09	10:08	ARD	PE-OP1	1	BSJ1534	3.2	

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Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

BCL Sample ID: 0914065-02		Client Sample Name: Station B2, 10/20/2009 12:13:00PM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Aldrin	ND	ND	mg/kg	0.00050	0.000026	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
alpha-BHC	ND	ND	mg/kg	0.00050	0.00014	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
beta-BHC	ND	ND	mg/kg	0.00050	0.00038	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
delta-BHC	ND	ND	mg/kg	0.00050	0.000076	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
gamma-BHC (Lindane)	ND	ND	mg/kg	0.00050	0.00025	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
Chlordane (Technical)	ND	ND	mg/kg	0.050	0.015	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
4,4'-DDD	ND	ND	mg/kg	0.00050	0.000063	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
4,4'-DDE	ND	ND	mg/kg	0.00050	0.000045	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
4,4'-DDT	ND	ND	mg/kg	0.00050	0.000031	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
Dieldrin	ND	ND	mg/kg	0.00050	0.000032	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
Endosulfan I	ND	ND	mg/kg	0.00050	0.000086	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
Endosulfan II	ND	ND	mg/kg	0.00050	0.000066	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
Endosulfan sulfate	ND	ND	mg/kg	0.00050	0.00013	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
Endrin	ND	ND	mg/kg	0.00050	0.000035	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
Endrin aldehyde	ND	ND	mg/kg	0.00050	0.000061	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
Heptachlor	ND	ND	mg/kg	0.00050	0.00026	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
Heptachlor epoxide	ND	ND	mg/kg	0.00050	0.00015	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
Methoxychlor	ND	ND	mg/kg	0.00050	0.00013	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
Toxaphene	ND	ND	mg/kg	0.050	0.0074	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
PCB-1016	ND	ND	mg/kg	0.010	0.0027	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
PCB-1221	ND	ND	mg/kg	0.010	0.0050	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
PCB-1232	ND	ND	mg/kg	0.010	0.0012	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	

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Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

BCL Sample ID: 0914065-02		Client Sample Name: Station B2, 10/20/2009 12:13:00PM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
PCB-1242	ND	ND	mg/kg	0.010	0.0016	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
PCB-1248	ND	ND	mg/kg	0.010	0.0012	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
PCB-1254	ND	ND	mg/kg	0.010	0.00078	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
PCB-1260	ND	ND	mg/kg	0.010	0.0022	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
Total PCB's (Summation)	ND	ND	mg/kg	0.010	0.0050	EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235	ND	
TCMX (Surrogate)	77.5	77.5	%	65 - 129 (LCL - UCL)		EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235		
Dibutyl chlorendate (Surrogate)	71.7	71.7	%	65 - 173 (LCL - UCL)		EPA-8080	10/31/09	11/03/09 22:58	jst	GC-1	1.010	BSK0235		

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Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-02			Client Sample Name: Station B2, 10/20/2009 12:13:00PM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
Acenaphthene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Acenaphthylene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Aldrin	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Aniline	ND	ND	mg/kg	0.59	0.35	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Anthracene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Benzidine	ND	ND	mg/kg	8.8	0.65	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Benzo[a]anthracene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Benzo[b]fluoranthene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Benzo[k]fluoranthene	ND	ND	mg/kg	0.29	0.053	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Benzo[a]pyrene	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Benzo[g,h,i]perylene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Benzoic acid	ND	ND	mg/kg	1.5	0.091	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Benzyl alcohol	ND	ND	mg/kg	0.29	0.047	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Benzyl butyl phthalate	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
alpha-BHC	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
beta-BHC	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	

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Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-02			Client Sample Name: Station B2, 10/20/2009 12:13:00PM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
delta-BHC	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
gamma-BHC (Lindane)	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
bis(2-Chloroethoxy)methane	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
bis(2-Chloroethyl) ether	ND	ND	mg/kg	0.29	0.026	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
bis(2-Chloroisopropyl)ether	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
bis(2-Ethylhexyl)phthalate	ND	ND	mg/kg	0.59	0.11	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
4-Bromophenyl phenyl ether	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
4-Chloroaniline	ND	ND	mg/kg	0.29	0.25	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2-Chloronaphthalene	ND	ND	mg/kg	0.29	0.024	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
4-Chlorophenyl phenyl ether	ND	ND	mg/kg	0.29	0.027	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Chrysene	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
4,4'-DDD	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
4,4'-DDE	ND	ND	mg/kg	0.29	0.050	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
4,4'-DDT	ND	ND	mg/kg	0.29	0.062	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Dibenzo[a,h]anthracene	ND	ND	mg/kg	0.29	0.050	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Dibenzofuran	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	

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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-02			Client Sample Name: Station B2, 10/20/2009 12:13:00PM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
1,2-Dichlorobenzene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
1,3-Dichlorobenzene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
1,4-Dichlorobenzene	ND	ND	mg/kg	0.29	0.026	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
3,3-Dichlorobenzidine	ND	ND	mg/kg	0.59	0.19	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Dieldrin	ND	ND	mg/kg	0.29	0.071	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Diethyl phthalate	ND	ND	mg/kg	0.29	0.059	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Dimethyl phthalate	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Di-n-butyl phthalate	ND	ND	mg/kg	0.29	0.028	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2,4-Dinitrotoluene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2,6-Dinitrotoluene	ND	ND	mg/kg	0.29	0.050	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Di-n-octyl phthalate	ND	ND	mg/kg	0.29	0.024	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
1,2-Diphenylhydrazine	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Endosulfan I	ND	ND	mg/kg	0.59	0.062	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Endosulfan II	ND	ND	mg/kg	0.59	0.085	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Endosulfan sulfate	ND	ND	mg/kg	0.29	0.11	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Endrin	ND	ND	mg/kg	0.59	0.26	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-02		Client Sample Name: Station B2, 10/20/2009 12:13:00PM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
Endrin aldehyde	ND	ND	mg/kg	1.5	0.35	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Fluoranthene	ND	ND	mg/kg	0.29	0.028	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Fluorene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Heptachlor	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Heptachlor epoxide	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Hexachlorobenzene	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Hexachlorobutadiene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Hexachlorocyclopentadiene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Hexachloroethane	ND	ND	mg/kg	0.29	0.023	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Indeno[1,2,3-cd]pyrene	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Isophorone	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2-Methylnaphthalene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Naphthalene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2-Naphthylamine	ND	ND	mg/kg	8.8	0.091	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2-Nitroaniline	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
3-Nitroaniline	ND	ND	mg/kg	0.59	0.32	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-02			Client Sample Name: Station B2, 10/20/2009 12:13:00PM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
4-Nitroaniline	ND	ND	mg/kg	0.59	0.15	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Nitrobenzene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
N-Nitrosodimethylamine	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
N-Nitrosodi-N-propylamine	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
N-Nitrosodiphenylamine	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Phenanthrene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Pyrene	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
1,2,4-Trichlorobenzene	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
4-Chloro-3-methylphenol	ND	ND	mg/kg	0.59	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2-Chlorophenol	ND	ND	mg/kg	0.29	0.027	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2,4-Dichlorophenol	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2,4-Dimethylphenol	ND	ND	mg/kg	0.29	0.088	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
4,6-Dinitro-2-methylphenol	ND	ND	mg/kg	1.5	0.022	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2,4-Dinitrophenol	ND	ND	mg/kg	1.5	0.16	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2-Methylphenol	ND	ND	mg/kg	0.29	0.068	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
3- & 4-Methylphenol	ND	ND	mg/kg	0.59	0.056	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-02			Client Sample Name: Station B2, 10/20/2009 12:13:00PM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
2-Nitrophenol	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
4-Nitrophenol	ND	ND	mg/kg	0.59	0.028	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Pentachlorophenol	ND	ND	mg/kg	0.59	0.032	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Phenol	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2,4,5-Trichlorophenol	ND	ND	mg/kg	0.59	0.035	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2,4,6-Trichlorophenol	ND	ND	mg/kg	0.59	0.032	EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2-Fluorophenol (Surrogate)	104	104	%	42 - 137 (LCL - UCL)		EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934		A10	
Phenol-d5 (Surrogate)	109	109	%	36 - 137 (LCL - UCL)		EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934		A10	
Nitrobenzene-d5 (Surrogate)	116	116	%	34 - 135 (LCL - UCL)		EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934		A10	
2-Fluorobiphenyl (Surrogate)	110	110	%	40 - 135 (LCL - UCL)		EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934		A10	
2,4,6-Tribromophenol (Surrogate)	130	130	%	54 - 162 (LCL - UCL)		EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934		A10	
p-Terphenyl-d14 (Surrogate)	115	115	%	20 - 176 (LCL - UCL)		EPA-8270 C	10/26/09	10/29/09 22:06	SKC	MS-B1	2.941	BSJ1934		A10	

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EPA Method 1664

BCL Sample ID: 0914065-02		Client Sample Name: Station B2, 10/20/2009 12:13:00PM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Oil and Grease	76	54	mg/kg	50	16	EPA-1664 HEM	10/31/09	10/31/09 10:30	JAK	MAN-SV	1	BSK0037	ND	

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Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Chemical Analysis

BCL Sample ID: 0914065-02		Client Sample Name: Station B2, 10/20/2009 12:13:00PM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru- ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Moisture	0	29.3	%	0.05	0.05	Calc	10/26/09	10/28/09 16:32	TMS	Calc	1	BSJ1631	ND	
Total Kjeldahl Nitrogen	150	110	mg/kg	40	15	EPA-351.2	10/28/09	10/29/09 09:42	JSM	SC-1	1	BSJ1799	ND	
Volatile Solids	1.46	1.03	%	0.200	0.200	SM-2540G	11/04/09	11/10/09 21:33	MSA	Inst	1	BSK0632		Z1
Biochemical Oxygen Demand	48	34	mg O/kg	6.0	6.0	SM17-521 0B	10/21/09	10/21/09 13:00	HPR	YSI-57	0.200	BSJ1661		
Solids	100	70.7	%	0.05	0.05	SM-2540G	10/23/09	10/23/09 16:15	NW1	MANUAL	1	BSJ1561		

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Total Concentrations (TTLC)

BCL Sample ID: 0914065-02		Client Sample Name: Station B2, 10/20/2009 12:13:00PM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Arsenic	3.3	2.3	mg/kg	0.50	0.12	EPA-6020	10/23/09	10/30/09 06:22	JDC	PE-EL1	0.980	BSJ1535	ND	
Cadmium	ND	ND	mg/kg	0.50	0.033	EPA-6010 B	10/23/09	10/26/09 10:20	ARD	PE-OP1	0.980	BSJ1534	ND	
Chromium	44	31	mg/kg	0.50	0.045	EPA-6010 B	10/23/09	10/26/09 10:20	ARD	PE-OP1	0.980	BSJ1534	ND	
Copper	3.3	2.3	mg/kg	1.0	0.13	EPA-6010 B	10/23/09	10/26/09 10:20	ARD	PE-OP1	0.980	BSJ1534	ND	
Lead	2.2	1.5	mg/kg	0.25	0.038	EPA-6020	10/23/09	10/30/09 06:22	JDC	PE-EL1	0.980	BSJ1535	0.077	
Mercury	0.038	0.027	mg/kg	0.16	0.014	EPA-7471 A	11/03/09	11/03/09 14:22	MEV	CETAC1	1.008	BSK0138	ND	J
Nickel	45	32	mg/kg	0.50	0.12	EPA-6010 B	10/23/09	10/26/09 10:20	ARD	PE-OP1	0.980	BSJ1534	ND	
Silver	ND	ND	mg/kg	0.25	0.032	EPA-6020	10/23/09	10/30/09 06:22	JDC	PE-EL1	0.980	BSJ1535	ND	
Zinc	16	11	mg/kg	2.5	0.25	EPA-6010 B	10/23/09	10/26/09 10:20	ARD	PE-OP1	0.980	BSJ1534	0.98	
Aluminum	5200	3700	mg/kg	5.0	1.9	EPA-6010 B	10/23/09	10/26/09 10:20	ARD	PE-OP1	0.980	BSJ1534	ND	
Iron	8900	6300	mg/kg	5.0	1.4	EPA-6010 B	10/23/09	10/26/09 10:20	ARD	PE-OP1	0.980	BSJ1534	3.1	

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Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

BCL Sample ID: 0914065-03		Client Sample Name: Station B3, 10/20/2009 11:34:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Aldrin	ND	ND	mg/kg	0.00050	0.000026	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
alpha-BHC	ND	ND	mg/kg	0.00050	0.00014	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
beta-BHC	ND	ND	mg/kg	0.00050	0.00038	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
delta-BHC	ND	ND	mg/kg	0.00050	0.000076	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
gamma-BHC (Lindane)	ND	ND	mg/kg	0.00050	0.00025	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
Chlordane (Technical)	ND	ND	mg/kg	0.050	0.015	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
4,4'-DDD	ND	ND	mg/kg	0.00050	0.000063	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
4,4'-DDE	ND	ND	mg/kg	0.00050	0.000045	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
4,4'-DDT	ND	ND	mg/kg	0.00050	0.000031	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
Dieldrin	ND	ND	mg/kg	0.00050	0.000032	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
Endosulfan I	ND	ND	mg/kg	0.00050	0.000086	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
Endosulfan II	ND	ND	mg/kg	0.00050	0.000066	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
Endosulfan sulfate	ND	ND	mg/kg	0.00050	0.00013	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
Endrin	ND	ND	mg/kg	0.00050	0.000035	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
Endrin aldehyde	ND	ND	mg/kg	0.00050	0.000061	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
Heptachlor	ND	ND	mg/kg	0.00050	0.00026	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
Heptachlor epoxide	ND	ND	mg/kg	0.00050	0.00015	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
Methoxychlor	ND	ND	mg/kg	0.00050	0.00013	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
Toxaphene	ND	ND	mg/kg	0.050	0.0074	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
PCB-1016	ND	ND	mg/kg	0.010	0.0027	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
PCB-1221	ND	ND	mg/kg	0.010	0.0050	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
PCB-1232	ND	ND	mg/kg	0.010	0.0012	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

BCL Sample ID: 0914065-03		Client Sample Name: Station B3, 10/20/2009 11:34:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
PCB-1242	ND	ND	mg/kg	0.010	0.0016	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
PCB-1248	ND	ND	mg/kg	0.010	0.0012	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
PCB-1254	ND	ND	mg/kg	0.010	0.00078	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
PCB-1260	ND	ND	mg/kg	0.010	0.0022	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
Total PCB's (Summation)	ND	ND	mg/kg	0.010	0.0050	EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235	ND	
TCMX (Surrogate)	78.3	78.3	%	65 - 129 (LCL - UCL)		EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235		
Dibutyl chlorendate (Surrogate)	72.6	72.6	%	65 - 173 (LCL - UCL)		EPA-8080	10/31/09	11/03/09 23:13	jst	GC-1	1.003	BSK0235		

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-03			Client Sample Name: Station B3, 10/20/2009 11:34:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time		Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Acenaphthene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Acenaphthylene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Aldrin	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Aniline	ND	ND	mg/kg	0.59	0.35	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Anthracene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Benzidine	ND	ND	mg/kg	8.8	0.65	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Benzo[a]anthracene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Benzo[b]fluoranthene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Benzo[k]fluoranthene	ND	ND	mg/kg	0.29	0.053	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Benzo[a]pyrene	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Benzo[g,h,i]perylene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Benzoic acid	ND	ND	mg/kg	1.5	0.091	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Benzyl alcohol	ND	ND	mg/kg	0.29	0.047	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Benzyl butyl phthalate	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
alpha-BHC	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
beta-BHC	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-03			Client Sample Name: Station B3, 10/20/2009 11:34:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time		Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
delta-BHC	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
gamma-BHC (Lindane)	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
bis(2-Chloroethoxy)methane	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
bis(2-Chloroethyl) ether	ND	ND	mg/kg	0.29	0.026	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
bis(2-Chloroisopropyl)ether	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
bis(2-Ethylhexyl)phthalate	ND	ND	mg/kg	0.59	0.11	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
4-Bromophenyl phenyl ether	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
4-Chloroaniline	ND	ND	mg/kg	0.29	0.25	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
2-Chloronaphthalene	ND	ND	mg/kg	0.29	0.024	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
4-Chlorophenyl phenyl ether	ND	ND	mg/kg	0.29	0.027	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Chrysene	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
4,4'-DDD	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
4,4'-DDE	ND	ND	mg/kg	0.29	0.050	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
4,4'-DDT	ND	ND	mg/kg	0.29	0.062	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Dibenzo[a,h]anthracene	ND	ND	mg/kg	0.29	0.050	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Dibenzofuran	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-03		Client Sample Name: Station B3, 10/20/2009 11:34:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time		Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
1,2-Dichlorobenzene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
1,3-Dichlorobenzene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
1,4-Dichlorobenzene	ND	ND	mg/kg	0.29	0.026	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
3,3-Dichlorobenzidine	ND	ND	mg/kg	0.59	0.19	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Dieldrin	ND	ND	mg/kg	0.29	0.071	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Diethyl phthalate	ND	ND	mg/kg	0.29	0.059	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Dimethyl phthalate	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Di-n-butyl phthalate	ND	ND	mg/kg	0.29	0.028	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
2,4-Dinitrotoluene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
2,6-Dinitrotoluene	ND	ND	mg/kg	0.29	0.050	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Di-n-octyl phthalate	ND	ND	mg/kg	0.29	0.024	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
1,2-Diphenylhydrazine	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Endosulfan I	ND	ND	mg/kg	0.59	0.062	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Endosulfan II	ND	ND	mg/kg	0.59	0.085	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Endosulfan sulfate	ND	ND	mg/kg	0.29	0.11	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Endrin	ND	ND	mg/kg	0.59	0.26	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10

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Project Number: Offshore Sediment Sampling
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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-03			Client Sample Name: Station B3, 10/20/2009 11:34:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time		Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Endrin aldehyde	ND	ND	mg/kg	1.5	0.35	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Fluoranthene	ND	ND	mg/kg	0.29	0.028	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Fluorene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Heptachlor	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Heptachlor epoxide	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Hexachlorobenzene	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Hexachlorobutadiene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Hexachlorocyclopentadiene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Hexachloroethane	ND	ND	mg/kg	0.29	0.023	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Indeno[1,2,3-cd]pyrene	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Isophorone	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
2-Methylnaphthalene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Naphthalene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
2-Naphthylamine	ND	ND	mg/kg	8.8	0.091	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
2-Nitroaniline	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
3-Nitroaniline	ND	ND	mg/kg	0.59	0.32	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10

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Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-03			Client Sample Name: Station B3, 10/20/2009 11:34:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time		Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
4-Nitroaniline	ND	ND	mg/kg	0.59	0.15	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Nitrobenzene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
N-Nitrosodimethylamine	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
N-Nitrosodi-N-propylamine	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
N-Nitrosodiphenylamine	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Phenanthrene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
Pyrene	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
1,2,4-Trichlorobenzene	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
4-Chloro-3-methylphenol	ND	ND	mg/kg	0.59	0.035	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
2-Chlorophenol	ND	ND	mg/kg	0.29	0.027	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
2,4-Dichlorophenol	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
2,4-Dimethylphenol	ND	ND	mg/kg	0.29	0.088	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
4,6-Dinitro-2-methylphenol	ND	ND	mg/kg	1.5	0.022	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
2,4-Dinitrophenol	ND	ND	mg/kg	1.5	0.16	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
2-Methylphenol	ND	ND	mg/kg	0.29	0.068	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10
3- & 4-Methylphenol	ND	ND	mg/kg	0.59	0.056	EPA-8270 C	10/26/09	10/30/09	21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10

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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-03		Client Sample Name: Station B3, 10/20/2009 11:34:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
2-Nitrophenol	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10	
4-Nitrophenol	ND	ND	mg/kg	0.59	0.028	EPA-8270 C	10/26/09	10/30/09 21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Pentachlorophenol	ND	ND	mg/kg	0.59	0.032	EPA-8270 C	10/26/09	10/30/09 21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10	
Phenol	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2,4,5-Trichlorophenol	ND	ND	mg/kg	0.59	0.035	EPA-8270 C	10/26/09	10/30/09 21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2,4,6-Trichlorophenol	ND	ND	mg/kg	0.59	0.032	EPA-8270 C	10/26/09	10/30/09 21:24	SKC	MS-B1	2.941	BSJ1934	ND	A10	
2-Fluorophenol (Surrogate)	96.6	96.6	%	42 - 137 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:24	SKC	MS-B1	2.941	BSJ1934		A10	
Phenol-d5 (Surrogate)	96.6	96.6	%	36 - 137 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:24	SKC	MS-B1	2.941	BSJ1934		A10	
Nitrobenzene-d5 (Surrogate)	109	109	%	34 - 135 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:24	SKC	MS-B1	2.941	BSJ1934		A10	
2-Fluorobiphenyl (Surrogate)	104	104	%	40 - 135 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:24	SKC	MS-B1	2.941	BSJ1934		A10	
2,4,6-Tribromophenol (Surrogate)	125	125	%	54 - 162 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:24	SKC	MS-B1	2.941	BSJ1934		A10	
p-Terphenyl-d14 (Surrogate)	101	101	%	20 - 176 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:24	SKC	MS-B1	2.941	BSJ1934		A10	

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Reported: 11/12/2009 15:25

EPA Method 1664

BCL Sample ID: 0914065-03			Client Sample Name: Station B3, 10/20/2009 11:34:00AM											
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Oil and Grease	28	20	mg/kg	50	16	EPA-1664 HEM	10/31/09	10/31/09 10:30	JAK	MAN-SV	0.994	BSK0037	ND	J

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Reported: 11/12/2009 15:25

Chemical Analysis

BCL Sample ID: 0914065-03		Client Sample Name: Station B3, 10/20/2009 11:34:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru- ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Moisture	0	30.0	%	0.05	0.05	Calc	10/26/09	10/28/09 16:32	TMS	Calc	1	BSJ1631	ND	
Total Kjeldahl Nitrogen	160	110	mg/kg	40	15	EPA-351.2	10/28/09	10/29/09 09:42	JSM	SC-1	0.962	BSJ1799	ND	
Volatile Solids	1.46	1.02	%	0.200	0.200	SM-2540G	11/04/09	11/10/09 21:33	MSA	Inst	1	BSK0632		Z1
Biochemical Oxygen Demand	44	31	mg O/kg	10	10	SM17-521 0B	10/21/09	10/21/09 13:00	HPR	YSI-57	0.333	BSJ1661		
Solids	100	70.0	%	0.05	0.05	SM-2540G	10/23/09	10/23/09 16:15	NW1	MANUAL	1	BSJ1561		

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Total Concentrations (TTLC)

BCL Sample ID: 0914065-03		Client Sample Name: Station B3, 10/20/2009 11:34:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time		Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Arsenic	3.8	2.6	mg/kg	0.50	0.12	EPA-6020	10/23/09	10/30/09	06:25	JDC	PE-EL1	1	BSJ1535	ND	
Cadmium	ND	ND	mg/kg	0.50	0.033	EPA-6010 B	10/23/09	10/26/09	10:22	ARD	PE-OP1	1	BSJ1534	ND	
Chromium	49	34	mg/kg	0.50	0.045	EPA-6010 B	10/23/09	10/26/09	10:22	ARD	PE-OP1	1	BSJ1534	ND	
Copper	3.4	2.4	mg/kg	1.0	0.13	EPA-6010 B	10/23/09	10/26/09	10:22	ARD	PE-OP1	1	BSJ1534	ND	
Lead	2.3	1.6	mg/kg	0.25	0.038	EPA-6020	10/23/09	10/30/09	06:25	JDC	PE-EL1	1	BSJ1535	0.078	
Mercury	0.046	0.032	mg/kg	0.16	0.014	EPA-7471 A	11/03/09	11/03/09	14:24	MEV	CETAC1	0.962	BSK0138	ND	J
Nickel	47	33	mg/kg	0.50	0.12	EPA-6010 B	10/23/09	10/26/09	10:22	ARD	PE-OP1	1	BSJ1534	ND	
Silver	ND	ND	mg/kg	0.25	0.032	EPA-6020	10/23/09	10/30/09	06:25	JDC	PE-EL1	1	BSJ1535	ND	
Zinc	18	12	mg/kg	2.5	0.25	EPA-6010 B	10/23/09	10/26/09	10:22	ARD	PE-OP1	1	BSJ1534	1.0	
Aluminum	5900	4100	mg/kg	5.0	1.9	EPA-6010 B	10/23/09	10/26/09	10:22	ARD	PE-OP1	1	BSJ1534	ND	
Iron	9800	6800	mg/kg	5.0	1.4	EPA-6010 B	10/23/09	10/26/09	10:22	ARD	PE-OP1	1	BSJ1534	3.2	

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Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

BCL Sample ID: 0914065-04		Client Sample Name: Station B4, 10/20/2009 10:48:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Aldrin	ND	ND	mg/kg	0.00050	0.000026	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
alpha-BHC	ND	ND	mg/kg	0.00050	0.00014	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
beta-BHC	ND	ND	mg/kg	0.00050	0.00038	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
delta-BHC	ND	ND	mg/kg	0.00050	0.000076	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
gamma-BHC (Lindane)	ND	ND	mg/kg	0.00050	0.00025	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
Chlordane (Technical)	ND	ND	mg/kg	0.050	0.015	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
4,4'-DDD	ND	ND	mg/kg	0.00050	0.000063	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
4,4'-DDE	ND	ND	mg/kg	0.00050	0.000045	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
4,4'-DDT	ND	ND	mg/kg	0.00050	0.000031	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
Dieldrin	ND	ND	mg/kg	0.00050	0.000032	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
Endosulfan I	ND	ND	mg/kg	0.00050	0.000086	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
Endosulfan II	ND	ND	mg/kg	0.00050	0.000066	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
Endosulfan sulfate	ND	ND	mg/kg	0.00050	0.00013	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
Endrin	ND	ND	mg/kg	0.00050	0.000035	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
Endrin aldehyde	ND	ND	mg/kg	0.00050	0.000061	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
Heptachlor	ND	ND	mg/kg	0.00050	0.00026	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
Heptachlor epoxide	ND	ND	mg/kg	0.00050	0.00015	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
Methoxychlor	ND	ND	mg/kg	0.00050	0.00013	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
Toxaphene	ND	ND	mg/kg	0.050	0.0074	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
PCB-1016	ND	ND	mg/kg	0.010	0.0027	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
PCB-1221	ND	ND	mg/kg	0.010	0.0050	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
PCB-1232	ND	ND	mg/kg	0.010	0.0012	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

BCL Sample ID: 0914065-04		Client Sample Name: Station B4, 10/20/2009 10:48:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
PCB-1242	ND	ND	mg/kg	0.010	0.0016	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
PCB-1248	ND	ND	mg/kg	0.010	0.0012	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
PCB-1254	ND	ND	mg/kg	0.010	0.00078	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
PCB-1260	ND	ND	mg/kg	0.010	0.0022	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
Total PCB's (Summation)	ND	ND	mg/kg	0.010	0.0050	EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235	ND	
TCMX (Surrogate)	69.9	69.9	%	65 - 129 (LCL - UCL)		EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235		
Dibutyl chlorendate (Surrogate)	62.9	62.9	%	65 - 173 (LCL - UCL)		EPA-8080	10/31/09	11/03/09 23:29	jst	GC-1	1.007	BSK0235		S09

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-04			Client Sample Name: Station B4, 10/20/2009 10:48:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time		Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Acenaphthene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Acenaphthylene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Aldrin	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Aniline	ND	ND	mg/kg	0.59	0.35	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Anthracene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Benzidine	ND	ND	mg/kg	8.8	0.65	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Benzo[a]anthracene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Benzo[b]fluoranthene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Benzo[k]fluoranthene	ND	ND	mg/kg	0.29	0.053	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Benzo[a]pyrene	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Benzo[g,h,i]perylene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Benzoic acid	ND	ND	mg/kg	1.5	0.091	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Benzyl alcohol	ND	ND	mg/kg	0.29	0.047	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Benzyl butyl phthalate	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
alpha-BHC	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
beta-BHC	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-04			Client Sample Name: Station B4, 10/20/2009 10:48:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
delta-BHC	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
gamma-BHC (Lindane)	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
bis(2-Chloroethoxy)methane	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
bis(2-Chloroethyl) ether	ND	ND	mg/kg	0.29	0.026	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
bis(2-Chloroisopropyl)ether	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
bis(2-Ethylhexyl)phthalate	ND	ND	mg/kg	0.59	0.11	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
4-Bromophenyl phenyl ether	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
4-Chloroaniline	ND	ND	mg/kg	0.29	0.25	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
2-Chloronaphthalene	ND	ND	mg/kg	0.29	0.024	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
4-Chlorophenyl phenyl ether	ND	ND	mg/kg	0.29	0.027	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Chrysene	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
4,4'-DDD	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
4,4'-DDE	ND	ND	mg/kg	0.29	0.050	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
4,4'-DDT	ND	ND	mg/kg	0.29	0.062	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Dibenzo[a,h]anthracene	ND	ND	mg/kg	0.29	0.050	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Dibenzofuran	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-04		Client Sample Name: Station B4, 10/20/2009 10:48:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
1,2-Dichlorobenzene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
1,3-Dichlorobenzene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
1,4-Dichlorobenzene	ND	ND	mg/kg	0.29	0.026	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
3,3-Dichlorobenzidine	ND	ND	mg/kg	0.59	0.19	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Dieldrin	ND	ND	mg/kg	0.29	0.071	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Diethyl phthalate	ND	ND	mg/kg	0.29	0.059	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Dimethyl phthalate	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Di-n-butyl phthalate	ND	ND	mg/kg	0.29	0.028	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
2,4-Dinitrotoluene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
2,6-Dinitrotoluene	ND	ND	mg/kg	0.29	0.050	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Di-n-octyl phthalate	ND	ND	mg/kg	0.29	0.024	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
1,2-Diphenylhydrazine	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Endosulfan I	ND	ND	mg/kg	0.59	0.062	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Endosulfan II	ND	ND	mg/kg	0.59	0.085	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Endosulfan sulfate	ND	ND	mg/kg	0.29	0.11	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Endrin	ND	ND	mg/kg	0.59	0.26	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-04		Client Sample Name: Station B4, 10/20/2009 10:48:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
Endrin aldehyde	ND	ND	mg/kg	1.5	0.35	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Fluoranthene	ND	ND	mg/kg	0.29	0.028	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Fluorene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Heptachlor	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Heptachlor epoxide	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Hexachlorobenzene	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Hexachlorobutadiene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Hexachlorocyclopentadiene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Hexachloroethane	ND	ND	mg/kg	0.29	0.023	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Indeno[1,2,3-cd]pyrene	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Isophorone	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
2-Methylnaphthalene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Naphthalene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
2-Naphthylamine	ND	ND	mg/kg	8.8	0.091	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
2-Nitroaniline	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
3-Nitroaniline	ND	ND	mg/kg	0.59	0.32	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-04			Client Sample Name: Station B4, 10/20/2009 10:48:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time		Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
4-Nitroaniline	ND	ND	mg/kg	0.59	0.15	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Nitrobenzene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
N-Nitrosodimethylamine	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
N-Nitrosodi-N-propylamine	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
N-Nitrosodiphenylamine	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Phenanthrene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
Pyrene	ND	ND	mg/kg	0.29	0.044	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
1,2,4-Trichlorobenzene	ND	ND	mg/kg	0.29	0.041	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
4-Chloro-3-methylphenol	ND	ND	mg/kg	0.59	0.035	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
2-Chlorophenol	ND	ND	mg/kg	0.29	0.027	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
2,4-Dichlorophenol	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
2,4-Dimethylphenol	ND	ND	mg/kg	0.29	0.088	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
4,6-Dinitro-2-methylphenol	ND	ND	mg/kg	1.5	0.022	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
2,4-Dinitrophenol	ND	ND	mg/kg	1.5	0.16	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
2-Methylphenol	ND	ND	mg/kg	0.29	0.068	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10
3- & 4-Methylphenol	ND	ND	mg/kg	0.59	0.056	EPA-8270 C	10/26/09	10/30/09	20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-04		Client Sample Name: Station B4, 10/20/2009 10:48:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
2-Nitrophenol	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
4-Nitrophenol	ND	ND	mg/kg	0.59	0.028	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Pentachlorophenol	ND	ND	mg/kg	0.59	0.032	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
Phenol	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
2,4,5-Trichlorophenol	ND	ND	mg/kg	0.59	0.035	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
2,4,6-Trichlorophenol	ND	ND	mg/kg	0.59	0.032	EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934	ND	A10	
2-Fluorophenol (Surrogate)	98.0	98.0	%	42 - 137 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934		A10	
Phenol-d5 (Surrogate)	102	102	%	36 - 137 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934		A10	
Nitrobenzene-d5 (Surrogate)	89.7	89.7	%	34 - 135 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934		A10	
2-Fluorobiphenyl (Surrogate)	81.4	81.4	%	40 - 135 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934		A10	
2,4,6-Tribromophenol (Surrogate)	98.0	98.0	%	54 - 162 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934		A10	
p-Terphenyl-d14 (Surrogate)	85.9	85.9	%	20 - 176 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 20:21	SKC	MS-B2	2.941	BSJ1934		A10	

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Reported: 11/12/2009 15:25

EPA Method 1664

BCL Sample ID: 0914065-04		Client Sample Name: Station B4, 10/20/2009 10:48:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Oil and Grease	ND	ND	mg/kg	50	16	EPA-1664 HEM	10/31/09	10/31/09 10:30	JAK	MAN-SV	1	BSK0037	ND	

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Reported: 11/12/2009 15:25

Chemical Analysis

BCL Sample ID: 0914065-04		Client Sample Name: Station B4, 10/20/2009 10:48:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Moisture	0	26.3	%	0.05	0.05	Calc	10/26/09	10/28/09 16:32	TMS	Calc	1	BSJ1631	ND	
Total Kjeldahl Nitrogen	130	96	mg/kg	40	15	EPA-351.2	10/28/09	10/29/09 09:45	JSM	SC-1	0.962	BSJ1799	ND	
Volatile Solids	1.36	1.00	%	0.200	0.200	SM-2540G	11/04/09	11/10/09 21:33	MSA	Inst	1	BSK0632		Z1
Biochemical Oxygen Demand	42	31	mg O/kg	6.0	6.0	SM17-521 0B	10/21/09	10/21/09 13:00	HPR	YSI-57	0.200	BSJ1661		
Solids	100	73.7	%	0.05	0.05	SM-2540G	10/23/09	10/23/09 16:15	NW1	MANUAL	1	BSJ1561		

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Reported: 11/12/2009 15:25

Total Concentrations (TTLC)

BCL Sample ID: 0914065-04		Client Sample Name: Station B4, 10/20/2009 10:48:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
Arsenic	3.7	2.7	mg/kg	0.50	0.12	EPA-6020	10/23/09	10/30/09 06:28	JDC	PE-EL1	0.971	BSJ1535	ND		
Cadmium	0.052	0.039	mg/kg	0.50	0.033	EPA-6010 B	10/23/09	10/27/09 08:09	ARD	PE-OP1	0.971	BSJ1534	ND	J	
Chromium	44	32	mg/kg	0.50	0.045	EPA-6010 B	10/23/09	10/27/09 08:09	ARD	PE-OP1	0.971	BSJ1534	ND		
Copper	3.2	2.4	mg/kg	1.0	0.13	EPA-6010 B	10/23/09	10/27/09 08:09	ARD	PE-OP1	0.971	BSJ1534	ND		
Lead	2.1	1.6	mg/kg	0.25	0.038	EPA-6020	10/23/09	10/30/09 06:28	JDC	PE-EL1	0.971	BSJ1535	0.076		
Mercury	0.037	0.027	mg/kg	0.16	0.014	EPA-7471 A	11/03/09	11/03/09 14:26	MEV	CETAC1	0.947	BSK0138	ND	J	
Nickel	42	31	mg/kg	0.50	0.12	EPA-6010 B	10/23/09	10/27/09 08:09	ARD	PE-OP1	0.971	BSJ1534	ND		
Silver	ND	ND	mg/kg	0.25	0.032	EPA-6020	10/23/09	10/30/09 06:28	JDC	PE-EL1	0.971	BSJ1535	ND		
Zinc	16	12	mg/kg	2.5	0.25	EPA-6010 B	10/23/09	10/27/09 08:09	ARD	PE-OP1	0.971	BSJ1534	0.97		
Aluminum	5600	4100	mg/kg	5.0	1.9	EPA-6010 B	10/23/09	10/27/09 08:09	ARD	PE-OP1	0.971	BSJ1534	ND		
Iron	9100	6700	mg/kg	5.0	1.4	EPA-6010 B	10/23/09	10/27/09 08:09	ARD	PE-OP1	0.971	BSJ1534	3.1		

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
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Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

BCL Sample ID: 0914065-05		Client Sample Name: Station B5, 10/20/2009 9:53:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Aldrin	ND	ND	mg/kg	0.00050	0.000026	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
alpha-BHC	ND	ND	mg/kg	0.00050	0.00014	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
beta-BHC	ND	ND	mg/kg	0.00050	0.00038	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
delta-BHC	ND	ND	mg/kg	0.00050	0.000076	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
gamma-BHC (Lindane)	ND	ND	mg/kg	0.00050	0.00025	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
Chlordane (Technical)	ND	ND	mg/kg	0.050	0.015	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
4,4'-DDD	ND	ND	mg/kg	0.00050	0.000063	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
4,4'-DDE	ND	ND	mg/kg	0.00050	0.000045	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
4,4'-DDT	ND	ND	mg/kg	0.00050	0.000031	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
Dieldrin	ND	ND	mg/kg	0.00050	0.000032	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
Endosulfan I	ND	ND	mg/kg	0.00050	0.000086	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
Endosulfan II	ND	ND	mg/kg	0.00050	0.000066	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
Endosulfan sulfate	ND	ND	mg/kg	0.00050	0.00013	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
Endrin	ND	ND	mg/kg	0.00050	0.000035	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
Endrin aldehyde	ND	ND	mg/kg	0.00050	0.000061	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
Heptachlor	ND	ND	mg/kg	0.00050	0.00026	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
Heptachlor epoxide	ND	ND	mg/kg	0.00050	0.00015	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
Methoxychlor	ND	ND	mg/kg	0.00050	0.00013	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
Toxaphene	ND	ND	mg/kg	0.050	0.0074	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
PCB-1016	ND	ND	mg/kg	0.010	0.0027	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
PCB-1221	ND	ND	mg/kg	0.010	0.0050	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
PCB-1232	ND	ND	mg/kg	0.010	0.0012	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

BCL Sample ID: 0914065-05			Client Sample Name: Station B5, 10/20/2009 9:53:00AM											
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
PCB-1242	ND	ND	mg/kg	0.010	0.0016	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
PCB-1248	ND	ND	mg/kg	0.010	0.0012	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
PCB-1254	ND	ND	mg/kg	0.010	0.00078	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
PCB-1260	ND	ND	mg/kg	0.010	0.0022	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
Total PCB's (Summation)	ND	ND	mg/kg	0.010	0.0050	EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235	ND	
TCMX (Surrogate)	42.9	42.9	%	65 - 129 (LCL - UCL)		EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235		S09
Dibutyl chlorendate (Surrogate)	43.2	43.2	%	65 - 173 (LCL - UCL)		EPA-8080	10/31/09	11/03/09 23:44	jst	GC-1	0.993	BSK0235		S09

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-05			Client Sample Name: Station B5, 10/20/2009 9:53:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time		Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Acenaphthene	ND	ND	mg/kg	0.30	0.033	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Acenaphthylene	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Aldrin	ND	ND	mg/kg	0.30	0.045	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Aniline	ND	ND	mg/kg	0.59	0.36	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Anthracene	ND	ND	mg/kg	0.30	0.029	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Benzidine	ND	ND	mg/kg	8.9	0.65	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Benzo[a]anthracene	ND	ND	mg/kg	0.30	0.033	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Benzo[b]fluoranthene	ND	ND	mg/kg	0.30	0.029	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Benzo[k]fluoranthene	ND	ND	mg/kg	0.30	0.053	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Benzo[a]pyrene	ND	ND	mg/kg	0.30	0.042	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Benzo[g,h,i]perylene	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Benzoic acid	ND	ND	mg/kg	1.5	0.092	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Benzyl alcohol	ND	ND	mg/kg	0.30	0.048	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
Benzyl butyl phthalate	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
alpha-BHC	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10
beta-BHC	ND	ND	mg/kg	0.30	0.045	EPA-8270 C	10/26/09	10/30/09	20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-05		Client Sample Name: Station B5, 10/20/2009 9:53:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
delta-BHC	ND	ND	mg/kg	0.30	0.033	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
gamma-BHC (Lindane)	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
bis(2-Chloroethoxy)methane	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
bis(2-Chloroethyl) ether	ND	ND	mg/kg	0.30	0.026	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
bis(2-Chloroisopropyl)ether	ND	ND	mg/kg	0.30	0.039	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
bis(2-Ethylhexyl)phthalate	ND	ND	mg/kg	0.59	0.11	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
4-Bromophenyl phenyl ether	ND	ND	mg/kg	0.30	0.042	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
4-Chloroaniline	ND	ND	mg/kg	0.30	0.26	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2-Chloronaphthalene	ND	ND	mg/kg	0.30	0.024	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
4-Chlorophenyl phenyl ether	ND	ND	mg/kg	0.30	0.027	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Chrysene	ND	ND	mg/kg	0.30	0.042	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
4,4'-DDD	ND	ND	mg/kg	0.30	0.045	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
4,4'-DDE	ND	ND	mg/kg	0.30	0.050	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
4,4'-DDT	ND	ND	mg/kg	0.30	0.062	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Dibenzo[a,h]anthracene	ND	ND	mg/kg	0.30	0.050	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Dibenzofuran	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-05		Client Sample Name: Station B5, 10/20/2009 9:53:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
1,2-Dichlorobenzene	ND	ND	mg/kg	0.30	0.030	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
1,3-Dichlorobenzene	ND	ND	mg/kg	0.30	0.033	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
1,4-Dichlorobenzene	ND	ND	mg/kg	0.30	0.026	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
3,3-Dichlorobenzidine	ND	ND	mg/kg	0.59	0.19	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Dieldrin	ND	ND	mg/kg	0.30	0.071	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Diethyl phthalate	ND	ND	mg/kg	0.30	0.059	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Dimethyl phthalate	ND	ND	mg/kg	0.30	0.029	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Di-n-butyl phthalate	ND	ND	mg/kg	0.30	0.028	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2,4-Dinitrotoluene	ND	ND	mg/kg	0.30	0.039	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2,6-Dinitrotoluene	ND	ND	mg/kg	0.30	0.050	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Di-n-octyl phthalate	ND	ND	mg/kg	0.30	0.024	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
1,2-Diphenylhydrazine	ND	ND	mg/kg	0.30	0.042	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Endosulfan I	ND	ND	mg/kg	0.59	0.062	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Endosulfan II	ND	ND	mg/kg	0.59	0.086	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Endosulfan sulfate	ND	ND	mg/kg	0.30	0.11	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Endrin	ND	ND	mg/kg	0.59	0.26	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-05		Client Sample Name: Station B5, 10/20/2009 9:53:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
Endrin aldehyde	ND	ND	mg/kg	1.5	0.36	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Fluoranthene	ND	ND	mg/kg	0.30	0.029	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Fluorene	ND	ND	mg/kg	0.30	0.039	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Heptachlor	ND	ND	mg/kg	0.30	0.039	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Heptachlor epoxide	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Hexachlorobenzene	ND	ND	mg/kg	0.30	0.042	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Hexachlorobutadiene	ND	ND	mg/kg	0.30	0.029	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Hexachlorocyclopentadiene	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Hexachloroethane	ND	ND	mg/kg	0.30	0.023	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Indeno[1,2,3-cd]pyrene	ND	ND	mg/kg	0.30	0.045	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Isophorone	ND	ND	mg/kg	0.30	0.033	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2-Methylnaphthalene	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Naphthalene	ND	ND	mg/kg	0.30	0.033	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2-Naphthylamine	ND	ND	mg/kg	8.9	0.092	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2-Nitroaniline	ND	ND	mg/kg	0.30	0.045	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
3-Nitroaniline	ND	ND	mg/kg	0.59	0.33	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-05		Client Sample Name: Station B5, 10/20/2009 9:53:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
4-Nitroaniline	ND	ND	mg/kg	0.59	0.15	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Nitrobenzene	ND	ND	mg/kg	0.30	0.039	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
N-Nitrosodimethylamine	ND	ND	mg/kg	0.30	0.039	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
N-Nitrosodi-N-propylamine	ND	ND	mg/kg	0.30	0.039	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
N-Nitrosodiphenylamine	ND	ND	mg/kg	0.30	0.029	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Phenanthrene	ND	ND	mg/kg	0.30	0.039	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Pyrene	ND	ND	mg/kg	0.30	0.045	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
1,2,4-Trichlorobenzene	ND	ND	mg/kg	0.30	0.042	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
4-Chloro-3-methylphenol	ND	ND	mg/kg	0.59	0.036	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2-Chlorophenol	ND	ND	mg/kg	0.30	0.027	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2,4-Dichlorophenol	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2,4-Dimethylphenol	ND	ND	mg/kg	0.30	0.089	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
4,6-Dinitro-2-methylphenol	ND	ND	mg/kg	1.5	0.022	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2,4-Dinitrophenol	ND	ND	mg/kg	1.5	0.16	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2-Methylphenol	ND	ND	mg/kg	0.30	0.068	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
3- & 4-Methylphenol	ND	ND	mg/kg	0.59	0.056	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	

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Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-05		Client Sample Name: Station B5, 10/20/2009 9:53:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
2-Nitrophenol	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
4-Nitrophenol	ND	ND	mg/kg	0.59	0.028	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Pentachlorophenol	ND	ND	mg/kg	0.59	0.033	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
Phenol	ND	ND	mg/kg	0.30	0.036	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2,4,5-Trichlorophenol	ND	ND	mg/kg	0.59	0.036	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2,4,6-Trichlorophenol	ND	ND	mg/kg	0.59	0.033	EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934	ND	A10	
2-Fluorophenol (Surrogate)	85.4	85.4	%	42 - 137 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934		A10	
Phenol-d5 (Surrogate)	84.4	84.4	%	36 - 137 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934		A10	
Nitrobenzene-d5 (Surrogate)	82.1	82.1	%	34 - 135 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934		A10	
2-Fluorobiphenyl (Surrogate)	78.1	78.1	%	40 - 135 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934		A10	
2,4,6-Tribromophenol (Surrogate)	95.4	95.4	%	54 - 162 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934		A10	
p-Terphenyl-d14 (Surrogate)	83.0	83.0	%	20 - 176 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 20:48	SKC	MS-B2	2.970	BSJ1934		A10	

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Project: Annual Benthic Sediment Sampling for MBTP
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Reported: 11/12/2009 15:25

EPA Method 1664

BCL Sample ID: 0914065-05			Client Sample Name: Station B5, 10/20/2009 9:53:00AM											
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Oil and Grease	25	18	mg/kg	50	16	EPA-1664 HEM	10/31/09	10/31/09 10:30	JAK	MAN-SV	1	BSK0037	ND	J

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Project: Annual Benthic Sediment Sampling for MBTP
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Reported: 11/12/2009 15:25

Chemical Analysis

BCL Sample ID: 0914065-05		Client Sample Name: Station B5, 10/20/2009 9:53:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Moisture	0	27.1	%	0.05	0.05	Calc	10/26/09	10/28/09 16:32	TMS	Calc	1	BSJ1631	ND	
Total Kjeldahl Nitrogen	160	120	mg/kg	40	15	EPA-351.2	10/28/09	10/29/09 09:46	JSM	SC-1	1	BSJ1799	ND	
Volatile Solids	1.41	1.03	%	0.200	0.200	SM-2540G	11/04/09	11/10/09 21:33	MSA	Inst	1	BSK0632		Z1
Biochemical Oxygen Demand	43	31	mg O/kg	7.5	7.5	SM17-521 0B	10/21/09	10/21/09 13:00	HPR	YSI-57	0.250	BSJ1661		
Solids	100	72.9	%	0.05	0.05	SM-2540G	10/23/09	10/23/09 16:15	NW1	MANUAL	1	BSJ1561		

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Total Concentrations (TTLC)

BCL Sample ID: 0914065-05		Client Sample Name: Station B5, 10/20/2009 9:53:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
Arsenic	3.7	2.7	mg/kg	0.50	0.12	EPA-6020	10/23/09	10/30/09 06:31	JDC	PE-EL1	0.962	BSJ1535	ND		
Cadmium	0.053	0.039	mg/kg	0.50	0.033	EPA-6010 B	10/23/09	10/27/09 08:11	ARD	PE-OP1	0.962	BSJ1534	ND	J	
Chromium	54	40	mg/kg	0.50	0.045	EPA-6010 B	10/23/09	10/27/09 08:11	ARD	PE-OP1	0.962	BSJ1534	ND		
Copper	3.5	2.5	mg/kg	1.0	0.13	EPA-6010 B	10/23/09	10/27/09 08:11	ARD	PE-OP1	0.962	BSJ1534	ND		
Lead	2.7	1.9	mg/kg	0.25	0.038	EPA-6020	10/23/09	10/30/09 06:31	JDC	PE-EL1	0.962	BSJ1535	0.075		
Mercury	0.024	0.017	mg/kg	0.16	0.014	EPA-7471 A	11/03/09	11/03/09 14:29	MEV	CETAC1	0.947	BSK0138	ND	J	
Nickel	48	35	mg/kg	0.50	0.12	EPA-6010 B	10/23/09	10/27/09 08:11	ARD	PE-OP1	0.962	BSJ1534	ND		
Silver	ND	ND	mg/kg	0.25	0.032	EPA-6020	10/23/09	10/30/09 06:31	JDC	PE-EL1	0.962	BSJ1535	ND		
Zinc	18	13	mg/kg	2.5	0.25	EPA-6010 B	10/23/09	10/27/09 08:11	ARD	PE-OP1	0.962	BSJ1534	0.96		
Aluminum	6100	4400	mg/kg	5.0	1.9	EPA-6010 B	10/23/09	10/27/09 08:11	ARD	PE-OP1	0.962	BSJ1534	ND		
Iron	10000	7300	mg/kg	5.0	1.4	EPA-6010 B	10/23/09	10/27/09 08:11	ARD	PE-OP1	0.962	BSJ1534	3.1		

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

BCL Sample ID: 0914065-06		Client Sample Name: Station B6, 10/20/2009 9:11:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Aldrin	ND	ND	mg/kg	0.00050	0.000026	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
alpha-BHC	ND	ND	mg/kg	0.00050	0.00014	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
beta-BHC	ND	ND	mg/kg	0.00050	0.00038	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
delta-BHC	ND	ND	mg/kg	0.00050	0.000076	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
gamma-BHC (Lindane)	ND	ND	mg/kg	0.00050	0.00025	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
Chlordane (Technical)	ND	ND	mg/kg	0.050	0.015	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
4,4'-DDD	ND	ND	mg/kg	0.00050	0.000063	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
4,4'-DDE	ND	ND	mg/kg	0.00050	0.000045	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
4,4'-DDT	ND	ND	mg/kg	0.00050	0.000031	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
Dieldrin	ND	ND	mg/kg	0.00050	0.000032	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
Endosulfan I	ND	ND	mg/kg	0.00050	0.000086	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
Endosulfan II	ND	ND	mg/kg	0.00050	0.000066	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
Endosulfan sulfate	ND	ND	mg/kg	0.00050	0.00013	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
Endrin	ND	ND	mg/kg	0.00050	0.000035	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
Endrin aldehyde	ND	ND	mg/kg	0.00050	0.000061	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
Heptachlor	ND	ND	mg/kg	0.00050	0.00026	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
Heptachlor epoxide	ND	ND	mg/kg	0.00050	0.00015	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
Methoxychlor	ND	ND	mg/kg	0.00050	0.00013	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
Toxaphene	ND	ND	mg/kg	0.050	0.0074	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
PCB-1016	ND	ND	mg/kg	0.010	0.0027	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
PCB-1221	ND	ND	mg/kg	0.010	0.0050	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
PCB-1232	ND	ND	mg/kg	0.010	0.0012	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

BCL Sample ID: 0914065-06		Client Sample Name: Station B6, 10/20/2009 9:11:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
PCB-1242	ND	ND	mg/kg	0.010	0.0016	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
PCB-1248	ND	ND	mg/kg	0.010	0.0012	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
PCB-1254	ND	ND	mg/kg	0.010	0.00078	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
PCB-1260	ND	ND	mg/kg	0.010	0.0022	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
Total PCB's (Summation)	ND	ND	mg/kg	0.010	0.0050	EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235	ND	
TCMX (Surrogate)	67.7	67.7	%	65 - 129 (LCL - UCL)		EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235		
Dibutyl chlorendate (Surrogate)	58.4	58.4	%	65 - 173 (LCL - UCL)		EPA-8080	10/31/09	11/04/09 00:32	jst	GC-1	1.007	BSK0235		S09

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-06			Client Sample Name: Station B6, 10/20/2009 9:11:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
Acenaphthene	ND	ND	mg/kg	0.28	0.031	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Acenaphthylene	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Aldrin	ND	ND	mg/kg	0.28	0.042	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Aniline	ND	ND	mg/kg	0.56	0.33	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Anthracene	ND	ND	mg/kg	0.28	0.027	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Benzidine	ND	ND	mg/kg	8.3	0.61	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Benzo[a]anthracene	ND	ND	mg/kg	0.28	0.031	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Benzo[b]fluoranthene	ND	ND	mg/kg	0.28	0.027	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Benzo[k]fluoranthene	ND	ND	mg/kg	0.28	0.050	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Benzo[a]pyrene	ND	ND	mg/kg	0.28	0.039	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Benzo[g,h,i]perylene	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Benzoic acid	ND	ND	mg/kg	1.4	0.086	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Benzyl alcohol	ND	ND	mg/kg	0.28	0.044	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Benzyl butyl phthalate	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
alpha-BHC	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
beta-BHC	ND	ND	mg/kg	0.28	0.042	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-06		Client Sample Name: Station B6, 10/20/2009 9:11:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
delta-BHC	ND	ND	mg/kg	0.28	0.031	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
gamma-BHC (Lindane)	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
bis(2-Chloroethoxy)methane	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
bis(2-Chloroethyl) ether	ND	ND	mg/kg	0.28	0.024	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
bis(2-Chloroisopropyl)ether	ND	ND	mg/kg	0.28	0.036	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
bis(2-Ethylhexyl)phthalate	ND	ND	mg/kg	0.56	0.11	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
4-Bromophenyl phenyl ether	ND	ND	mg/kg	0.28	0.039	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
4-Chloroaniline	ND	ND	mg/kg	0.28	0.24	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2-Chloronaphthalene	ND	ND	mg/kg	0.28	0.022	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
4-Chlorophenyl phenyl ether	ND	ND	mg/kg	0.28	0.026	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Chrysene	ND	ND	mg/kg	0.28	0.039	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
4,4'-DDD	ND	ND	mg/kg	0.28	0.042	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
4,4'-DDE	ND	ND	mg/kg	0.28	0.047	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
4,4'-DDT	ND	ND	mg/kg	0.28	0.058	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Dibenzo[a,h]anthracene	ND	ND	mg/kg	0.28	0.047	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Dibenzofuran	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-06		Client Sample Name: Station B6, 10/20/2009 9:11:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
1,2-Dichlorobenzene	ND	ND	mg/kg	0.28	0.028	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
1,3-Dichlorobenzene	ND	ND	mg/kg	0.28	0.031	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
1,4-Dichlorobenzene	ND	ND	mg/kg	0.28	0.025	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
3,3-Dichlorobenzidine	ND	ND	mg/kg	0.56	0.18	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Dieldrin	ND	ND	mg/kg	0.28	0.067	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Diethyl phthalate	ND	ND	mg/kg	0.28	0.056	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Dimethyl phthalate	ND	ND	mg/kg	0.28	0.027	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Di-n-butyl phthalate	ND	ND	mg/kg	0.28	0.026	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2,4-Dinitrotoluene	ND	ND	mg/kg	0.28	0.036	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2,6-Dinitrotoluene	ND	ND	mg/kg	0.28	0.047	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Di-n-octyl phthalate	ND	ND	mg/kg	0.28	0.022	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
1,2-Diphenylhydrazine	ND	ND	mg/kg	0.28	0.039	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Endosulfan I	ND	ND	mg/kg	0.56	0.058	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Endosulfan II	ND	ND	mg/kg	0.56	0.081	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Endosulfan sulfate	ND	ND	mg/kg	0.28	0.11	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Endrin	ND	ND	mg/kg	0.56	0.24	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-06			Client Sample Name: Station B6, 10/20/2009 9:11:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
Endrin aldehyde	ND	ND	mg/kg	1.4	0.33	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Fluoranthene	ND	ND	mg/kg	0.28	0.027	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Fluorene	ND	ND	mg/kg	0.28	0.036	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Heptachlor	ND	ND	mg/kg	0.28	0.036	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Heptachlor epoxide	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Hexachlorobenzene	ND	ND	mg/kg	0.28	0.039	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Hexachlorobutadiene	ND	ND	mg/kg	0.28	0.028	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Hexachlorocyclopentadiene	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Hexachloroethane	ND	ND	mg/kg	0.28	0.021	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Indeno[1,2,3-cd]pyrene	ND	ND	mg/kg	0.28	0.042	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Isophorone	ND	ND	mg/kg	0.28	0.031	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2-Methylnaphthalene	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Naphthalene	ND	ND	mg/kg	0.28	0.031	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2-Naphthylamine	ND	ND	mg/kg	8.3	0.086	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2-Nitroaniline	ND	ND	mg/kg	0.28	0.042	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
3-Nitroaniline	ND	ND	mg/kg	0.56	0.31	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-06		Client Sample Name: Station B6, 10/20/2009 9:11:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
4-Nitroaniline	ND	ND	mg/kg	0.56	0.14	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Nitrobenzene	ND	ND	mg/kg	0.28	0.036	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
N-Nitrosodimethylamine	ND	ND	mg/kg	0.28	0.036	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
N-Nitrosodi-N-propylamine	ND	ND	mg/kg	0.28	0.036	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
N-Nitrosodiphenylamine	ND	ND	mg/kg	0.28	0.027	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Phenanthrene	ND	ND	mg/kg	0.28	0.036	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Pyrene	ND	ND	mg/kg	0.28	0.042	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
1,2,4-Trichlorobenzene	ND	ND	mg/kg	0.28	0.039	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
4-Chloro-3-methylphenol	ND	ND	mg/kg	0.56	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2-Chlorophenol	ND	ND	mg/kg	0.28	0.025	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2,4-Dichlorophenol	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2,4-Dimethylphenol	ND	ND	mg/kg	0.28	0.083	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
4,6-Dinitro-2-methylphenol	ND	ND	mg/kg	1.4	0.021	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2,4-Dinitrophenol	ND	ND	mg/kg	1.4	0.15	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2-Methylphenol	ND	ND	mg/kg	0.28	0.064	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
3- & 4-Methylphenol	ND	ND	mg/kg	0.56	0.053	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.
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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-06		Client Sample Name: Station B6, 10/20/2009 9:11:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
2-Nitrophenol	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
4-Nitrophenol	ND	ND	mg/kg	0.56	0.026	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Pentachlorophenol	ND	ND	mg/kg	0.56	0.031	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
Phenol	ND	ND	mg/kg	0.28	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2,4,5-Trichlorophenol	ND	ND	mg/kg	0.56	0.033	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2,4,6-Trichlorophenol	ND	ND	mg/kg	0.56	0.031	EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934	ND	A10	
2-Fluorophenol (Surrogate)	102	102	%	42 - 137 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934		A10	
Phenol-d5 (Surrogate)	103	103	%	36 - 137 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934		A10	
Nitrobenzene-d5 (Surrogate)	98.8	98.8	%	34 - 135 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934		A10	
2-Fluorobiphenyl (Surrogate)	94.2	94.2	%	40 - 135 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934		A10	
2,4,6-Tribromophenol (Surrogate)	108	108	%	54 - 162 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934		A10	
p-Terphenyl-d14 (Surrogate)	83.4	83.4	%	20 - 176 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:15	SKC	MS-B2	2.778	BSJ1934		A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
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Reported: 11/12/2009 15:25

EPA Method 1664

BCL Sample ID: 0914065-06			Client Sample Name: Station B6, 10/20/2009 9:11:00AM											
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Oil and Grease	ND	ND	mg/kg	50	16	EPA-1664 HEM	10/31/09	10/31/09 10:30	JAK	MAN-SV	0.990	BSK0037	ND	

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Reported: 11/12/2009 15:25

Chemical Analysis

BCL Sample ID: 0914065-06		Client Sample Name: Station B6, 10/20/2009 9:11:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru- ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Moisture	0	28.0	%	0.05	0.05	Calc	10/26/09	10/28/09 16:32	TMS	Calc	1	BSJ1631	ND	
Total Kjeldahl Nitrogen	160	110	mg/kg	40	15	EPA-351.2	10/28/09	10/29/09 09:47	JSM	SC-1	0.962	BSJ1799	ND	
Volatile Solids	1.51	1.09	%	0.200	0.200	SM-2540G	11/04/09	11/10/09 21:33	MSA	Inst	1	BSK0632		Z1
Biochemical Oxygen Demand	44	32	mg O/kg	6.0	6.0	SM17-521 0B	10/21/09	10/21/09 13:00	HPR	YSI-57	0.200	BSJ1661		
Solids	100	72.0	%	0.05	0.05	SM-2540G	10/23/09	10/23/09 16:15	NW1	MANUAL	1	BSJ1561		

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Reported: 11/12/2009 15:25

Total Concentrations (TTLC)

BCL Sample ID: 0914065-06		Client Sample Name: Station B6, 10/20/2009 9:11:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
Arsenic	3.3	2.4	mg/kg	0.50	0.12	EPA-6020	10/23/09	10/30/09 06:34	JDC	PE-EL1	1	BSJ1535	ND		
Cadmium	0.054	0.039	mg/kg	0.50	0.033	EPA-6010 B	10/23/09	10/27/09 08:13	ARD	PE-OP1	1	BSJ1534	ND	J	
Chromium	47	34	mg/kg	0.50	0.045	EPA-6010 B	10/23/09	10/27/09 08:13	ARD	PE-OP1	1	BSJ1534	ND		
Copper	3.2	2.3	mg/kg	1.0	0.13	EPA-6010 B	10/23/09	10/27/09 08:13	ARD	PE-OP1	1	BSJ1534	ND		
Lead	2.1	1.5	mg/kg	0.25	0.038	EPA-6020	10/23/09	10/30/09 06:34	JDC	PE-EL1	1	BSJ1535	0.078		
Mercury	0.033	0.024	mg/kg	0.16	0.014	EPA-7471 A	11/03/09	11/03/09 14:31	MEV	CETAC1	0.933	BSK0138	ND	J	
Nickel	43	31	mg/kg	0.50	0.12	EPA-6010 B	10/23/09	10/27/09 08:13	ARD	PE-OP1	1	BSJ1534	ND		
Silver	ND	ND	mg/kg	0.25	0.032	EPA-6020	10/23/09	10/30/09 06:34	JDC	PE-EL1	1	BSJ1535	ND		
Zinc	17	12	mg/kg	2.5	0.25	EPA-6010 B	10/23/09	10/27/09 08:13	ARD	PE-OP1	1	BSJ1534	1.0		
Aluminum	5500	4000	mg/kg	5.0	1.9	EPA-6010 B	10/23/09	10/27/09 08:13	ARD	PE-OP1	1	BSJ1534	ND		
Iron	9200	6600	mg/kg	5.0	1.4	EPA-6010 B	10/23/09	10/27/09 08:13	ARD	PE-OP1	1	BSJ1534	3.2		

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

BCL Sample ID: 0914065-07		Client Sample Name: Station B7, 10/20/2009 8:22:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Aldrin	ND	ND	mg/kg	0.00050	0.000026	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
alpha-BHC	ND	ND	mg/kg	0.00050	0.00014	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
beta-BHC	ND	ND	mg/kg	0.00050	0.00038	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
delta-BHC	ND	ND	mg/kg	0.00050	0.000076	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
gamma-BHC (Lindane)	ND	ND	mg/kg	0.00050	0.00025	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
Chlordane (Technical)	ND	ND	mg/kg	0.050	0.015	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
4,4'-DDD	ND	ND	mg/kg	0.00050	0.000063	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
4,4'-DDE	ND	ND	mg/kg	0.00050	0.000045	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
4,4'-DDT	ND	ND	mg/kg	0.00050	0.000031	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
Dieldrin	ND	ND	mg/kg	0.00050	0.000032	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
Endosulfan I	ND	ND	mg/kg	0.00050	0.000086	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
Endosulfan II	ND	ND	mg/kg	0.00050	0.000066	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
Endosulfan sulfate	ND	ND	mg/kg	0.00050	0.00013	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
Endrin	ND	ND	mg/kg	0.00050	0.000035	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
Endrin aldehyde	ND	ND	mg/kg	0.00050	0.000061	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
Heptachlor	ND	ND	mg/kg	0.00050	0.00026	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
Heptachlor epoxide	ND	ND	mg/kg	0.00050	0.00015	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
Methoxychlor	ND	ND	mg/kg	0.00050	0.00013	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
Toxaphene	ND	ND	mg/kg	0.050	0.0074	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
PCB-1016	ND	ND	mg/kg	0.010	0.0027	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
PCB-1221	ND	ND	mg/kg	0.010	0.0050	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
PCB-1232	ND	ND	mg/kg	0.010	0.0012	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

BCL Sample ID: 0914065-07		Client Sample Name: Station B7, 10/20/2009 8:22:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
PCB-1242	ND	ND	mg/kg	0.010	0.0016	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
PCB-1248	ND	ND	mg/kg	0.010	0.0012	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
PCB-1254	ND	ND	mg/kg	0.010	0.00078	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
PCB-1260	ND	ND	mg/kg	0.010	0.0022	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
Total PCB's (Summation)	ND	ND	mg/kg	0.010	0.0050	EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235	ND	
TCMX (Surrogate)	59.1	59.1	%	65 - 129 (LCL - UCL)		EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235		S09
Dibutyl chlorendate (Surrogate)	53.5	53.5	%	65 - 173 (LCL - UCL)		EPA-8080	10/31/09	11/04/09 00:47	jst	GC-1	1.014	BSK0235		S09

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-07			Client Sample Name: Station B7, 10/20/2009 8:22:00AM												
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time		Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Acenaphthene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Acenaphthylene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Aldrin	ND	ND	mg/kg	0.29	0.043	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Aniline	ND	ND	mg/kg	0.58	0.35	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Anthracene	ND	ND	mg/kg	0.29	0.028	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Benzidine	ND	ND	mg/kg	8.7	0.63	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Benzo[a]anthracene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Benzo[b]fluoranthene	ND	ND	mg/kg	0.29	0.028	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Benzo[k]fluoranthene	ND	ND	mg/kg	0.29	0.052	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Benzo[a]pyrene	ND	ND	mg/kg	0.29	0.040	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Benzo[g,h,i]perylene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Benzoic acid	ND	ND	mg/kg	1.4	0.089	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Benzyl alcohol	ND	ND	mg/kg	0.29	0.046	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Benzyl butyl phthalate	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
alpha-BHC	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
beta-BHC	ND	ND	mg/kg	0.29	0.043	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-07		Client Sample Name: Station B7, 10/20/2009 8:22:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
delta-BHC	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
gamma-BHC (Lindane)	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
bis(2-Chloroethoxy)methane	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
bis(2-Chloroethyl) ether	ND	ND	mg/kg	0.29	0.025	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
bis(2-Chloroisopropyl)ether	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
bis(2-Ethylhexyl)phthalate	ND	ND	mg/kg	0.58	0.11	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
4-Bromophenyl phenyl ether	ND	ND	mg/kg	0.29	0.040	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
4-Chloroaniline	ND	ND	mg/kg	0.29	0.25	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
2-Chloronaphthalene	ND	ND	mg/kg	0.29	0.023	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
4-Chlorophenyl phenyl ether	ND	ND	mg/kg	0.29	0.027	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Chrysene	ND	ND	mg/kg	0.29	0.040	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
4,4'-DDD	ND	ND	mg/kg	0.29	0.043	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
4,4'-DDE	ND	ND	mg/kg	0.29	0.049	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
4,4'-DDT	ND	ND	mg/kg	0.29	0.061	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Dibenzo[a,h]anthracene	ND	ND	mg/kg	0.29	0.049	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Dibenzofuran	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-07		Client Sample Name: Station B7, 10/20/2009 8:22:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
1,2-Dichlorobenzene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
1,3-Dichlorobenzene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
1,4-Dichlorobenzene	ND	ND	mg/kg	0.29	0.026	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
3,3-Dichlorobenzidine	ND	ND	mg/kg	0.58	0.18	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Dieldrin	ND	ND	mg/kg	0.29	0.069	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Diethyl phthalate	ND	ND	mg/kg	0.29	0.058	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Dimethyl phthalate	ND	ND	mg/kg	0.29	0.028	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Di-n-butyl phthalate	ND	ND	mg/kg	0.29	0.027	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
2,4-Dinitrotoluene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
2,6-Dinitrotoluene	ND	ND	mg/kg	0.29	0.049	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Di-n-octyl phthalate	ND	ND	mg/kg	0.29	0.023	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
1,2-Diphenylhydrazine	ND	ND	mg/kg	0.29	0.040	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Endosulfan I	ND	ND	mg/kg	0.58	0.061	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Endosulfan II	ND	ND	mg/kg	0.58	0.084	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Endosulfan sulfate	ND	ND	mg/kg	0.29	0.11	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Endrin	ND	ND	mg/kg	0.58	0.25	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-07		Client Sample Name: Station B7, 10/20/2009 8:22:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
Endrin aldehyde	ND	ND	mg/kg	1.4	0.35	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Fluoranthene	ND	ND	mg/kg	0.29	0.028	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Fluorene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Heptachlor	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Heptachlor epoxide	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Hexachlorobenzene	ND	ND	mg/kg	0.29	0.040	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Hexachlorobutadiene	ND	ND	mg/kg	0.29	0.029	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Hexachlorocyclopentadiene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Hexachloroethane	ND	ND	mg/kg	0.29	0.022	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Indeno[1,2,3-cd]pyrene	ND	ND	mg/kg	0.29	0.043	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Isophorone	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
2-Methylnaphthalene	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Naphthalene	ND	ND	mg/kg	0.29	0.032	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
2-Naphthylamine	ND	ND	mg/kg	8.7	0.089	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
2-Nitroaniline	ND	ND	mg/kg	0.29	0.043	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
3-Nitroaniline	ND	ND	mg/kg	0.58	0.32	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	

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Project: Annual Benthic Sediment Sampling for MBTP
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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-07		Client Sample Name: Station B7, 10/20/2009 8:22:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time		Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
4-Nitroaniline	ND	ND	mg/kg	0.58	0.15	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Nitrobenzene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
N-Nitrosodimethylamine	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
N-Nitrosodi-N-propylamine	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
N-Nitrosodiphenylamine	ND	ND	mg/kg	0.29	0.028	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Phenanthrene	ND	ND	mg/kg	0.29	0.038	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
Pyrene	ND	ND	mg/kg	0.29	0.043	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
1,2,4-Trichlorobenzene	ND	ND	mg/kg	0.29	0.040	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
4-Chloro-3-methylphenol	ND	ND	mg/kg	0.58	0.035	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
2-Chlorophenol	ND	ND	mg/kg	0.29	0.026	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
2,4-Dichlorophenol	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
2,4-Dimethylphenol	ND	ND	mg/kg	0.29	0.087	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
4,6-Dinitro-2-methylphenol	ND	ND	mg/kg	1.4	0.022	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
2,4-Dinitrophenol	ND	ND	mg/kg	1.4	0.16	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
2-Methylphenol	ND	ND	mg/kg	0.29	0.066	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10
3- & 4-Methylphenol	ND	ND	mg/kg	0.58	0.055	EPA-8270 C	10/26/09	10/30/09	21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10

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Project: Annual Benthic Sediment Sampling for MBTP
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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

BCL Sample ID: 0914065-07		Client Sample Name: Station B7, 10/20/2009 8:22:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
2-Nitrophenol	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
4-Nitrophenol	ND	ND	mg/kg	0.58	0.027	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Pentachlorophenol	ND	ND	mg/kg	0.58	0.032	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
Phenol	ND	ND	mg/kg	0.29	0.035	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
2,4,5-Trichlorophenol	ND	ND	mg/kg	0.58	0.035	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
2,4,6-Trichlorophenol	ND	ND	mg/kg	0.58	0.032	EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934	ND	A10	
2-Fluorophenol (Surrogate)	90.7	90.7	%	42 - 137 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934		A10	
Phenol-d5 (Surrogate)	85.4	85.4	%	36 - 137 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934		A10	
Nitrobenzene-d5 (Surrogate)	86.7	86.7	%	34 - 135 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934		A10	
2-Fluorobiphenyl (Surrogate)	84.2	84.2	%	40 - 135 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934		A10	
2,4,6-Tribromophenol (Surrogate)	104	104	%	54 - 162 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934		A10	
p-Terphenyl-d14 (Surrogate)	83.6	83.6	%	20 - 176 (LCL - UCL)		EPA-8270 C	10/26/09	10/30/09 21:42	SKC	MS-B2	2.885	BSJ1934		A10	

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Reported: 11/12/2009 15:25

EPA Method 1664

BCL Sample ID: 0914065-07			Client Sample Name: Station B7, 10/20/2009 8:22:00AM											
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Oil and Grease	ND	ND	mg/kg	50	16	EPA-1664 HEM	10/31/09	10/31/09 10:30	JAK	MAN-SV	1	BSK0037	ND	

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Project Number: Offshore Sediment Sampling
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Reported: 11/12/2009 15:25

Chemical Analysis

BCL Sample ID:	0914065-07	Client Sample Name:	Station B7, 10/20/2009 8:22:00AM											
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru- ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Moisture	0	28.8	%	0.05	0.05	Calc	10/26/09	10/28/09 16:32	TMS	Calc	1	BSJ1631	ND	
Total Kjeldahl Nitrogen	200	140	mg/kg	40	15	EPA-351.2	10/28/09	10/29/09 09:47	JSM	SC-1	0.962	BSJ1799	ND	
Volatile Solids	1.50	1.07	%	0.200	0.200	SM-2540G	11/04/09	11/10/09 21:33	MSA	Inst	1	BSK0632		Z1
Biochemical Oxygen Demand	48	34	mg O/kg	7.5	7.5	SM17-521 0B	10/21/09	10/21/09 13:00	HPR	YSI-57	0.250	BSJ1661		
Solids	100	71.2	%	0.05	0.05	SM-2540G	10/23/09	10/23/09 16:15	NW1	MANUAL	1	BSJ1561		

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Reported: 11/12/2009 15:25

Total Concentrations (TTLC)

BCL Sample ID: 0914065-07		Client Sample Name: Station B7, 10/20/2009 8:22:00AM													
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals	
Arsenic	3.1	2.2	mg/kg	0.50	0.12	EPA-6020	10/23/09	10/30/09 06:37	JDC	PE-EL1	0.962	BSJ1535	ND		
Cadmium	0.076	0.054	mg/kg	0.50	0.033	EPA-6010 B	10/23/09	10/27/09 08:15	ARD	PE-OP1	0.962	BSJ1534	ND	J	
Chromium	45	32	mg/kg	0.50	0.045	EPA-6010 B	10/23/09	10/27/09 08:15	ARD	PE-OP1	0.962	BSJ1534	ND		
Copper	3.0	2.1	mg/kg	1.0	0.13	EPA-6010 B	10/23/09	10/27/09 08:15	ARD	PE-OP1	0.962	BSJ1534	ND		
Lead	2.0	1.4	mg/kg	0.25	0.038	EPA-6020	10/23/09	10/30/09 06:37	JDC	PE-EL1	0.962	BSJ1535	0.075		
Mercury	0.044	0.031	mg/kg	0.16	0.014	EPA-7471 A	11/03/09	11/03/09 14:33	MEV	CETAC1	0.933	BSK0138	ND	J	
Nickel	41	29	mg/kg	0.50	0.12	EPA-6010 B	10/23/09	10/27/09 08:15	ARD	PE-OP1	0.962	BSJ1534	ND		
Silver	ND	ND	mg/kg	0.25	0.032	EPA-6020	10/23/09	10/30/09 06:37	JDC	PE-EL1	0.962	BSJ1535	ND		
Zinc	16	12	mg/kg	2.5	0.25	EPA-6010 B	10/23/09	10/27/09 08:15	ARD	PE-OP1	0.962	BSJ1534	0.96		
Aluminum	5100	3600	mg/kg	5.0	1.9	EPA-6010 B	10/23/09	10/27/09 08:15	ARD	PE-OP1	0.962	BSJ1534	ND		
Iron	8700	6200	mg/kg	5.0	1.4	EPA-6010 B	10/23/09	10/27/09 08:15	ARD	PE-OP1	0.962	BSJ1534	3.1		

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Project: Annual Benthic Sediment Sampling for MBTP
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Reported: 11/12/2009 15:25

EPA Method 1664

BCL Sample ID: 0914065-08			Client Sample Name: Station B2 (Recheck), 10/20/2009 12:13:00PM											
Constituent	Dry Basis Result	As Recvd Result	Units	PQL	MDL	Method	Prep Date	Run Date/Time	Analyst	Instru-ment ID	Dilution	QC Batch ID	MB Bias	Lab Quals
Oil and Grease		28	mg/kg	50	16	EPA-1664 HEM	11/11/09	11/11/09 13:00	JAK	MAN-SV	0.996	BSK0746	ND	J

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Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

Quality Control Report - Precision & Accuracy

Constituent	Batch ID	QC Sample Type	Source Sample ID	Source Result	Result	Spike Added	Units	RPD	Percent Recovery	Control Limits		Lab Quals
										RPD	Percent Recovery	
Aldrin	BSK0235	Matrix Spike	0911528-98	ND	0.0080320	0.0084175	mg/kg		95.4		67 - 133	
		Matrix Spike Duplicate	0911528-98	ND	0.0064123	0.0084459	mg/kg	22.8	75.9	30	67 - 133	
gamma-BHC (Lindane)	BSK0235	Matrix Spike	0911528-98	ND	0.0060144	0.0084175	mg/kg		71.5		58 - 117	
		Matrix Spike Duplicate	0911528-98	ND	0.0049320	0.0084459	mg/kg	20.1	58.4	30	58 - 117	
4,4'-DDT	BSK0235	Matrix Spike	0911528-98	ND	0.0066959	0.0084175	mg/kg		79.5		43 - 129	
		Matrix Spike Duplicate	0911528-98	ND	0.0053283	0.0084459	mg/kg	23.1	63.1	30	43 - 129	
Dieldrin	BSK0235	Matrix Spike	0911528-98	ND	0.0078590	0.0084175	mg/kg		93.4		74 - 121	
		Matrix Spike Duplicate	0911528-98	ND	0.0060779	0.0084459	mg/kg	25.9	72.0	30	74 - 121	Q03
Endrin	BSK0235	Matrix Spike	0911528-98	ND	0.0082317	0.0084175	mg/kg		97.8		46 - 144	
		Matrix Spike Duplicate	0911528-98	ND	0.0062463	0.0084459	mg/kg	27.8	74.0	30	46 - 144	
Heptachlor	BSK0235	Matrix Spike	0911528-98	ND	0.0083440	0.0084175	mg/kg		99.1		72 - 132	
		Matrix Spike Duplicate	0911528-98	ND	0.0064095	0.0084459	mg/kg	26.6	75.9	30	72 - 132	
TCMX (Surrogate)	BSK0235	Matrix Spike	0911528-98	ND	0.0098608	0.010101	mg/kg		97.6		65 - 129	
		Matrix Spike Duplicate	0911528-98	ND	0.0085734	0.010135	mg/kg		84.6		65 - 129	
Dibutyl chlorendate (Surrogate)	BSK0235	Matrix Spike	0911528-98	ND	0.022642	0.025253	mg/kg		89.7		65 - 173	
		Matrix Spike Duplicate	0911528-98	ND	0.018125	0.025338	mg/kg		71.5		65 - 173	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

Quality Control Report - Precision & Accuracy

Constituent	Batch ID	QC Sample Type	Source Sample ID	Source Result	Result	Spike Added	Units	RPD	Percent Recovery	Control Limits		Lab Quals
										RPD	Percent Recovery	
Acenaphthene	BSJ1934	Matrix Spike	0909743-91	ND	1.7634	1.6556	mg/kg		107		36 - 158	
		Matrix Spike Duplicate	0909743-91	ND	1.6792	1.6667	mg/kg	5.6	101	29	36 - 158	
1,4-Dichlorobenzene	BSJ1934	Matrix Spike	0909743-91	ND	1.6187	1.6556	mg/kg		97.8		33 - 135	
		Matrix Spike Duplicate	0909743-91	ND	1.5550	1.6667	mg/kg	4.7	93.3	26	33 - 135	
2,4-Dinitrotoluene	BSJ1934	Matrix Spike	0909743-91	ND	1.5954	1.6556	mg/kg		96.4		52 - 137	
		Matrix Spike Duplicate	0909743-91	ND	1.5885	1.6667	mg/kg	1.1	95.3	26	52 - 137	
Hexachlorobenzene	BSJ1934	Matrix Spike	0909743-91	ND	1.8524	1.6556	mg/kg		112		44 - 152	
		Matrix Spike Duplicate	0909743-91	ND	1.7074	1.6667	mg/kg	8.8	102	20	44 - 152	
Hexachlorobutadiene	BSJ1934	Matrix Spike	0909743-91	ND	1.6600	1.6556	mg/kg		100		33 - 127	
		Matrix Spike Duplicate	0909743-91	ND	1.5140	1.6667	mg/kg	9.9	90.8	27	33 - 127	
Hexachloroethane	BSJ1934	Matrix Spike	0909743-91	ND	1.5674	1.6556	mg/kg		94.7		29 - 129	
		Matrix Spike Duplicate	0909743-91	ND	1.5183	1.6667	mg/kg	3.8	91.1	27	29 - 129	
Nitrobenzene	BSJ1934	Matrix Spike	0909743-91	ND	1.5341	1.6556	mg/kg		92.7		39 - 137	
		Matrix Spike Duplicate	0909743-91	ND	1.4833	1.6667	mg/kg	4.0	89.0	23	39 - 137	
N-Nitrosodi-N-propylamine	BSJ1934	Matrix Spike	0909743-91	ND	1.5359	1.6556	mg/kg		92.8		35 - 123	
		Matrix Spike Duplicate	0909743-91	ND	1.4366	1.6667	mg/kg	7.3	86.2	30	35 - 123	
Pyrene	BSJ1934	Matrix Spike	0909743-91	ND	1.9594	1.6556	mg/kg		118		36 - 161	
		Matrix Spike Duplicate	0909743-91	ND	1.7622	1.6667	mg/kg	11.3	106	25	36 - 161	
1,2,4-Trichlorobenzene	BSJ1934	Matrix Spike	0909743-91	ND	1.6977	1.6556	mg/kg		103		41 - 135	
		Matrix Spike Duplicate	0909743-91	ND	1.6021	1.6667	mg/kg	6.5	96.1	28	41 - 135	
4-Chloro-3-methylphenol	BSJ1934	Matrix Spike	0909743-91	ND	1.5720	1.6556	mg/kg		94.9		54 - 144	
		Matrix Spike Duplicate	0909743-91	ND	1.4922	1.6667	mg/kg	5.9	89.5	21	54 - 144	
2-Chlorophenol	BSJ1934	Matrix Spike	0909743-91	ND	1.3591	1.6556	mg/kg		82.1		43 - 126	
		Matrix Spike Duplicate	0909743-91	ND	1.3097	1.6667	mg/kg	4.4	78.6	21	43 - 126	
2-Methylphenol	BSJ1934	Matrix Spike	0909743-91	ND	1.4508	1.6556	mg/kg		87.6		40 - 133	
		Matrix Spike Duplicate	0909743-91	ND	1.3776	1.6667	mg/kg	5.8	82.7	19	40 - 133	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.
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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

Quality Control Report - Precision & Accuracy

Constituent	Batch ID	QC Sample Type	Source Sample ID	Source Result	Result	Spike Added	Units	RPD	Percent Recovery	Control Limits		Lab Quals
										RPD	Percent Recovery	
3- & 4-Methylphenol	BSJ1934	Matrix Spike	0909743-91	ND	2.7365	3.3113	mg/kg		82.6		10 - 216	
		Matrix Spike Duplicate	0909743-91	ND	2.5921	3.3333	mg/kg	6.1	77.8	17	10 - 216	
4-Nitrophenol	BSJ1934	Matrix Spike	0909743-91	ND	1.0932	1.6556	mg/kg		66.0		10 - 154	
		Matrix Spike Duplicate	0909743-91	ND	1.1001	1.6667	mg/kg	0.0	66.0	26	10 - 154	
Pentachlorophenol	BSJ1934	Matrix Spike	0909743-91	ND	1.1067	1.6556	mg/kg		66.8		26 - 183	
		Matrix Spike Duplicate	0909743-91	ND	1.0443	1.6667	mg/kg	6.5	62.7	26	26 - 183	
Phenol	BSJ1934	Matrix Spike	0909743-91	ND	1.3415	1.6556	mg/kg		81.0		39 - 123	
		Matrix Spike Duplicate	0909743-91	ND	1.2948	1.6667	mg/kg	4.2	77.7	21	39 - 123	
2,4,6-Trichlorophenol	BSJ1934	Matrix Spike	0909743-91	ND	1.6494	1.6556	mg/kg		99.6		50 - 140	
		Matrix Spike Duplicate	0909743-91	ND	1.5510	1.6667	mg/kg	6.8	93.1	19	50 - 140	
2-Fluorophenol (Surrogate)	BSJ1934	Matrix Spike	0909743-91	ND	2.5640	2.6490	mg/kg		96.8		42 - 137	
		Matrix Spike Duplicate	0909743-91	ND	2.4347	2.6667	mg/kg		91.3		42 - 137	
Phenol-d5 (Surrogate)	BSJ1934	Matrix Spike	0909743-91	ND	2.6105	2.6490	mg/kg		98.5		36 - 137	
		Matrix Spike Duplicate	0909743-91	ND	2.5005	2.6667	mg/kg		93.8		36 - 137	
Nitrobenzene-d5 (Surrogate)	BSJ1934	Matrix Spike	0909743-91	ND	2.8172	2.6490	mg/kg		106		34 - 135	
		Matrix Spike Duplicate	0909743-91	ND	2.6928	2.6667	mg/kg		101		34 - 135	
2-Fluorobiphenyl (Surrogate)	BSJ1934	Matrix Spike	0909743-91	ND	3.1837	2.6490	mg/kg		120		40 - 135	
		Matrix Spike Duplicate	0909743-91	ND	2.9006	2.6667	mg/kg		109		40 - 135	
2,4,6-Tribromophenol (Surrogate)	BSJ1934	Matrix Spike	0909743-91	ND	3.6228	2.6490	mg/kg		137		54 - 162	
		Matrix Spike Duplicate	0909743-91	ND	3.1784	2.6667	mg/kg		119		54 - 162	
p-Terphenyl-d14 (Surrogate)	BSJ1934	Matrix Spike	0909743-91	ND	1.7010	1.3245	mg/kg		128		20 - 176	
		Matrix Spike Duplicate	0909743-91	ND	1.5403	1.3333	mg/kg		116		20 - 176	

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Reported: 11/12/2009 15:25

EPA Method 1664

Quality Control Report - Precision & Accuracy

Constituent	Batch ID	QC Sample Type	Source Sample ID	Source Result	Result	Spike Added	Units	RPD	Percent Recovery	Control Limits		Lab Quals
										RPD	Percent Recovery	
Oil and Grease	BSK0037	Duplicate	0913999-09	ND	ND		mg/kg			30		
		Matrix Spike	0913999-09	ND	619.00	818.00	mg/kg		75.7		56 - 111	
		Matrix Spike Duplicate	0913999-09	ND	704.00	818.00	mg/kg	12.8	86.1	30	56 - 111	
Oil and Grease	BSK0746	Duplicate	0914970-03	723.00	479.04		mg/kg	40.6		30		Q01
		Matrix Spike	0914970-03	723.00	1385.0	794.00	mg/kg		83.4		56 - 111	
		Matrix Spike Duplicate	0914970-03	723.00	1018.0	794.00	mg/kg	76.7	37.2	30	56 - 111	Q02

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Chemical Analysis

Quality Control Report - Precision & Accuracy

Constituent	Batch ID	QC Sample Type	Source Sample ID	Source Result	Result	Spike Added	Units	RPD	Control Limits		
									Percent Recovery	RPD	Percent Recovery Lab Quals
Solids	BSJ1561	Duplicate	0914065-01	71.330	71.030		%	0.4		20	
Biochemical Oxygen Demand	BSJ1661	Duplicate	0914065-01	39.650	38.125		mg O/kg	3.9		20	
Total Kjeldahl Nitrogen	BSJ1799	Duplicate	0914034-01	328.20	398.98		mg/kg	19.5		20	
		Matrix Spike	0914034-01	328.20	793.38	400.00	mg/kg		116		80 - 120
		Matrix Spike Duplicate	0914034-01	328.20	761.24	400.00	mg/kg	7.2	108	20	80 - 120
Volatile Solids	BSK0632	Duplicate			1.0300		%			20	

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Total Concentrations (TTLC)

Quality Control Report - Precision & Accuracy

Constituent	Batch ID	QC Sample Type	Source Sample ID	Source Result	Result	Spike Added	Units	RPD	Percent Recovery	Control Limits		Lab Quals
										RPD	Percent Recovery	
Cadmium	BSJ1534	Duplicate	0914065-01	ND	ND		mg/kg			20		
		Matrix Spike	0914065-01	ND	9.4280	10.000	mg/kg		94.3		75 - 125	
		Matrix Spike Duplicate	0914065-01	ND	9.5276	10.000	mg/kg	1.1	95.3	20	75 - 125	
Chromium	BSJ1534	Duplicate	0914065-01	40.536	41.052		mg/kg	1.3		20		
		Matrix Spike	0914065-01	40.536	137.07	100.00	mg/kg		96.5		75 - 125	
		Matrix Spike Duplicate	0914065-01	40.536	133.72	100.00	mg/kg	3.5	93.2	20	75 - 125	
Copper	BSJ1534	Duplicate	0914065-01	2.0559	2.0178		mg/kg	1.9		20		
		Matrix Spike	0914065-01	2.0559	98.532	100.00	mg/kg		96.5		75 - 125	
		Matrix Spike Duplicate	0914065-01	2.0559	99.653	100.00	mg/kg	1.2	97.6	20	75 - 125	
Nickel	BSJ1534	Duplicate	0914065-01	25.955	26.169		mg/kg	0.8		20		
		Matrix Spike	0914065-01	25.955	124.34	100.00	mg/kg		98.4		75 - 125	
		Matrix Spike Duplicate	0914065-01	25.955	122.35	100.00	mg/kg	2.0	96.4	20	75 - 125	
Zinc	BSJ1534	Duplicate	0914065-01	12.304	12.432		mg/kg	1.0		20		
		Matrix Spike	0914065-01	12.304	107.94	100.00	mg/kg		95.6		75 - 125	
		Matrix Spike Duplicate	0914065-01	12.304	106.65	100.00	mg/kg	1.4	94.3	20	75 - 125	
Aluminum	BSJ1534	Duplicate	0914065-01	4129.8	4159.3		mg/kg	0.7		20		
		Matrix Spike	0914065-01	4129.8	5146.7	500.00	mg/kg		203		75 - 125	A03
		Matrix Spike Duplicate	0914065-01	4129.8	4685.9	500.00	mg/kg	58.6	111	20	75 - 125	A03,Q02
Iron	BSJ1534	Duplicate	0914065-01	6533.1	6582.7		mg/kg	0.8		20		
		Matrix Spike	0914065-01	6533.1	7637.6	500.00	mg/kg		221		75 - 125	A03
		Matrix Spike Duplicate	0914065-01	6533.1	6907.9	500.00	mg/kg	98.7	75.0	20	75 - 125	A03,Q02
Arsenic	BSJ1535	Duplicate	0914065-01	2.0562	2.0865		mg/kg	1.5		20		
		Matrix Spike	0914065-01	2.0562	12.078	10.000	mg/kg		100		75 - 125	
		Matrix Spike Duplicate	0914065-01	2.0562	12.086	10.000	mg/kg	0.1	100	20	75 - 125	
Lead	BSJ1535	Duplicate	0914065-01	1.6382	1.6022		mg/kg	2.2		20		
		Matrix Spike	0914065-01	1.6382	94.737	100.00	mg/kg		93.1		75 - 125	
		Matrix Spike Duplicate	0914065-01	1.6382	96.488	100.00	mg/kg	1.9	94.8	20	75 - 125	

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Total Concentrations (TTLC)

Quality Control Report - Precision & Accuracy

Constituent	Batch ID	QC Sample Type	Source Sample ID	Source Result	Result	Spike Added	Units	RPD	Percent Recovery	Control Limits		Lab Quals
										RPD	Percent Recovery	
Silver	BSJ1535	Duplicate	0914065-01	ND	ND		mg/kg			20		
		Matrix Spike	0914065-01	ND	9.6165	10.000	mg/kg		96.2		75 - 125	
		Matrix Spike Duplicate	0914065-01	ND	9.9045	10.000	mg/kg	3.0	99.0	20	75 - 125	
Mercury	BSK0138	Duplicate	0914044-25RE1	0.039688	0.029688		mg/kg	28.8		20		J,A02
		Matrix Spike	0914044-25RE1	0.039688	0.74688	0.78125	mg/kg		90.5		85 - 115	
		Matrix Spike Duplicate	0914044-25RE1	0.039688	0.75641	0.78125	mg/kg	1.3	91.7	20	85 - 115	

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Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

Quality Control Report - Laboratory Control Sample

Constituent	Batch ID	QC Sample ID	QC Type	Result	Spike Level	PQL	Units	Percent Recovery	RPD	Control Limits		Lab Quals
										Percent Recovery	RPD	
Aldrin	BSK0235	BSK0235-BS1	LCS	0.0083712	0.0084175	0.00050	mg/kg	99.5		76 - 127		
gamma-BHC (Lindane)	BSK0235	BSK0235-BS1	LCS	0.0059922	0.0084175	0.00050	mg/kg	71.2		62 - 119		
4,4'-DDT	BSK0235	BSK0235-BS1	LCS	0.0070340	0.0084175	0.00050	mg/kg	83.6		46 - 118		
Dieldrin	BSK0235	BSK0235-BS1	LCS	0.0081026	0.0084175	0.00050	mg/kg	96.3		71 - 122		
Endrin	BSK0235	BSK0235-BS1	LCS	0.0086325	0.0084175	0.00050	mg/kg	103		67 - 126		
Heptachlor	BSK0235	BSK0235-BS1	LCS	0.0084575	0.0084175	0.00050	mg/kg	100		75 - 133		
TCMX (Surrogate)	BSK0235	BSK0235-BS1	LCS	0.010084	0.010101		mg/kg	99.8		65 - 129		
Dibutyl chlorendate (Surrogate)	BSK0235	BSK0235-BS1	LCS	0.024113	0.025253		mg/kg	95.5		65 - 173		

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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

Quality Control Report - Laboratory Control Sample

Constituent	Batch ID	QC Sample ID	QC Type	Result	Spike Level	PQL	Units	Percent Recovery	RPD	Control Limits		Lab Quals
										Percent Recovery	RPD	
Acenaphthene	BSJ1934	BSJ1934-BS1	LCS	1.5870	1.6667	0.10	mg/kg	95.2		39 - 167		
1,4-Dichlorobenzene	BSJ1934	BSJ1934-BS1	LCS	1.4398	1.6667	0.10	mg/kg	86.4		46 - 131		
2,4-Dinitrotoluene	BSJ1934	BSJ1934-BS1	LCS	1.5037	1.6667	0.10	mg/kg	90.2		58 - 139		
Hexachlorobenzene	BSJ1934	BSJ1934-BS1	LCS	1.7677	1.6667	0.10	mg/kg	106		53 - 151		
Hexachlorobutadiene	BSJ1934	BSJ1934-BS1	LCS	1.4520	1.6667	0.10	mg/kg	87.1		48 - 120		
Hexachloroethane	BSJ1934	BSJ1934-BS1	LCS	1.4088	1.6667	0.10	mg/kg	84.5		44 - 124		
Nitrobenzene	BSJ1934	BSJ1934-BS1	LCS	1.4079	1.6667	0.10	mg/kg	84.5		39 - 143		
N-Nitrosodi-N-propylamine	BSJ1934	BSJ1934-BS1	LCS	1.3598	1.6667	0.10	mg/kg	81.6		36 - 128		
Pyrene	BSJ1934	BSJ1934-BS1	LCS	1.8247	1.6667	0.10	mg/kg	109		45 - 170		
1,2,4-Trichlorobenzene	BSJ1934	BSJ1934-BS1	LCS	1.5264	1.6667	0.10	mg/kg	91.6		55 - 128		
4-Chloro-3-methylphenol	BSJ1934	BSJ1934-BS1	LCS	1.4273	1.6667	0.20	mg/kg	85.6		49 - 153		
2-Chlorophenol	BSJ1934	BSJ1934-BS1	LCS	1.2310	1.6667	0.10	mg/kg	73.9		46 - 128		
2-Methylphenol	BSJ1934	BSJ1934-BS1	LCS	1.3158	1.6667	0.10	mg/kg	78.9		40 - 138		
3- & 4-Methylphenol	BSJ1934	BSJ1934-BS1	LCS	2.5050	3.3333	0.20	mg/kg	75.1		10 - 230		
4-Nitrophenol	BSJ1934	BSJ1934-BS1	LCS	1.0227	1.6667	0.20	mg/kg	61.4		13 - 145		
Pentachlorophenol	BSJ1934	BSJ1934-BS1	LCS	1.0425	1.6667	0.20	mg/kg	62.5		50 - 170		
Phenol	BSJ1934	BSJ1934-BS1	LCS	1.2426	1.6667	0.10	mg/kg	74.6		41 - 126		
2,4,6-Trichlorophenol	BSJ1934	BSJ1934-BS1	LCS	1.4740	1.6667	0.20	mg/kg	88.4		53 - 144		
2-Fluorophenol (Surrogate)	BSJ1934	BSJ1934-BS1	LCS	2.3699	2.6667		mg/kg	88.9		42 - 137		
Phenol-d5 (Surrogate)	BSJ1934	BSJ1934-BS1	LCS	2.3636	2.6667		mg/kg	88.6		36 - 137		
Nitrobenzene-d5 (Surrogate)	BSJ1934	BSJ1934-BS1	LCS	2.5652	2.6667		mg/kg	96.2		34 - 135		
2-Fluorobiphenyl (Surrogate)	BSJ1934	BSJ1934-BS1	LCS	2.7518	2.6667		mg/kg	103		40 - 135		
2,4,6-Tribromophenol (Surrogate)	BSJ1934	BSJ1934-BS1	LCS	3.3271	2.6667		mg/kg	125		54 - 162		

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Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

Quality Control Report - Laboratory Control Sample

Constituent	Batch ID	QC Sample ID	QC Type	Result	Spike Level	PQL	Units	Percent Recovery	RPD	<u>Control Limits</u>		Lab Quals
										Percent Recovery	RPD	
p-Terphenyl-d14 (Surrogate)	BSJ1934	BSJ1934-BS1	LCS	1.6021	1.3333		mg/kg	120		20 - 176		

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Reported: 11/12/2009 15:25

EPA Method 1664

Quality Control Report - Laboratory Control Sample

Constituent	Batch ID	QC Sample ID	QC Type	Result	Spike Level	PQL	Units	Percent Recovery	RPD	<u>Control Limits</u>		Lab Quals
										Percent Recovery	RPD	
Oil and Grease	BSK0037	BSK0037-BS1	LCS	674.00	818.00	50	mg/kg	82.4		59 - 117		
Oil and Grease	BSK0746	BSK0746-BS1	LCS	629.00	794.00	50	mg/kg	79.2		59 - 117		

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Chemical Analysis

Quality Control Report - Laboratory Control Sample

Constituent	Batch ID	QC Sample ID	QC Type	Result	Spike Level	PQL	Units	Percent Recovery	RPD	<u>Control Limits</u>		Lab Quals
										Percent Recovery	RPD	
Biochemical Oxygen Demand	BSJ1661	BSJ1661-BS1	LCS	208.42	198.00	50	mg O/kg	105		85 - 115		
Total Kjeldahl Nitrogen	BSJ1799	BSJ1799-BS1	LCS	389.52	400.00	40	mg/kg	97.4		85 - 115		

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Total Concentrations (TTLC)

Quality Control Report - Laboratory Control Sample

Constituent	Batch ID	QC Sample ID	QC Type	Result	Spike Level	PQL	Units	Percent Recovery	RPD	Control Limits		Lab Quals
										Percent Recovery	RPD	
Cadmium	BSJ1534	BSJ1534-BS1	LCS	9.8653	10.000	0.50	mg/kg	98.7		75 - 125		
Chromium	BSJ1534	BSJ1534-BS1	LCS	98.490	100.00	0.50	mg/kg	98.5		75 - 125		
Copper	BSJ1534	BSJ1534-BS1	LCS	98.758	100.00	1.0	mg/kg	98.8		75 - 125		
Nickel	BSJ1534	BSJ1534-BS1	LCS	107.19	100.00	0.50	mg/kg	107		75 - 125		
Zinc	BSJ1534	BSJ1534-BS1	LCS	103.80	100.00	2.5	mg/kg	104		75 - 125		
Aluminum	BSJ1534	BSJ1534-BS1	LCS	514.54	500.00	5.0	mg/kg	103		75 - 125		
Iron	BSJ1534	BSJ1534-BS1	LCS	514.96	500.00	5.0	mg/kg	103		75 - 125		
Arsenic	BSJ1535	BSJ1535-BS1	LCS	10.113	10.000	0.50	mg/kg	101		75 - 125		
Lead	BSJ1535	BSJ1535-BS1	LCS	98.196	100.00	0.25	mg/kg	98.2		75 - 125		
Silver	BSJ1535	BSJ1535-BS1	LCS	9.9150	10.000	0.25	mg/kg	99.2		75 - 125		
Mercury	BSK0138	BSK0138-BS1	LCS	1.6231	1.5000	0.16	mg/kg	108		75 - 125		

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

Quality Control Report - Method Blank Analysis

Constituent	Batch ID	QC Sample ID	MB Result	Units	PQL	MDL	Lab Quals
Aldrin	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.000026	
alpha-BHC	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.00014	
beta-BHC	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.00038	
delta-BHC	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.000076	
gamma-BHC (Lindane)	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.00025	
Chlordane (Technical)	BSK0235	BSK0235-BLK1	ND	mg/kg	0.050	0.015	
4,4'-DDD	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.000063	
4,4'-DDE	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.000045	
4,4'-DDT	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.000031	
Dieldrin	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.000032	
Endosulfan I	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.000086	
Endosulfan II	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.000066	
Endosulfan sulfate	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.00013	
Endrin	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.000035	
Endrin aldehyde	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.000061	
Heptachlor	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.00026	
Heptachlor epoxide	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.00015	
Methoxychlor	BSK0235	BSK0235-BLK1	ND	mg/kg	0.00050	0.00013	
Toxaphene	BSK0235	BSK0235-BLK1	ND	mg/kg	0.050	0.0074	
PCB-1016	BSK0235	BSK0235-BLK1	ND	mg/kg	0.010	0.0027	
PCB-1221	BSK0235	BSK0235-BLK1	ND	mg/kg	0.010	0.0050	
PCB-1232	BSK0235	BSK0235-BLK1	ND	mg/kg	0.010	0.0012	
PCB-1242	BSK0235	BSK0235-BLK1	ND	mg/kg	0.010	0.0016	
PCB-1248	BSK0235	BSK0235-BLK1	ND	mg/kg	0.010	0.0012	

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Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Organochlorine Pesticides and PCB's (EPA Method 8080)

Quality Control Report - Method Blank Analysis

Constituent	Batch ID	QC Sample ID	MB Result	Units	PQL	MDL	Lab Quals
PCB-1254	BSK0235	BSK0235-BLK1	ND	mg/kg	0.010	0.00078	
PCB-1260	BSK0235	BSK0235-BLK1	ND	mg/kg	0.010	0.0022	
Total PCB's (Summation)	BSK0235	BSK0235-BLK1	ND	mg/kg	0.010	0.0050	
TCMX (Surrogate)	BSK0235	BSK0235-BLK1	97.1	%	65 - 129 (LCL - UCL)		
Dibutyl chlorendate (Surrogate)	BSK0235	BSK0235-BLK1	92.8	%	65 - 173 (LCL - UCL)		

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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

Quality Control Report - Method Blank Analysis

Constituent	Batch ID	QC Sample ID	MB Result	Units	PQL	MDL	Lab Quals
Acenaphthene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.011	
Acenaphthylene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
Aldrin	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.015	
Aniline	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.12	
Anthracene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0098	
Benzidine	BSJ1934	BSJ1934-BLK1	ND	mg/kg	3.0	0.22	
Benzo[a]anthracene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.011	
Benzo[b]fluoranthene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0098	
Benzo[k]fluoranthene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.018	
Benzo[a]pyrene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.014	
Benzo[g,h,i]perylene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
Benzoic acid	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.50	0.031	
Benzyl alcohol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.016	
Benzyl butyl phthalate	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
alpha-BHC	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
beta-BHC	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.015	
delta-BHC	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.011	
gamma-BHC (Lindane)	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
bis(2-Chloroethoxy)methane	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
bis(2-Chloroethyl) ether	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0087	
bis(2-Chloroisopropyl)ether	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.013	
bis(2-Ethylhexyl)phthalate	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.038	
4-Bromophenyl phenyl ether	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.014	
4-Chloroaniline	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.086	

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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

Quality Control Report - Method Blank Analysis

Constituent	Batch ID	QC Sample ID	MB Result	Units	PQL	MDL	Lab Quals
2-Chloronaphthalene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0080	
4-Chlorophenyl phenyl ether	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0092	
Chrysene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.014	
4,4'-DDD	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.015	
4,4'-DDE	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.017	
4,4'-DDT	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.021	
Dibenzo[a,h]anthracene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.017	
Dibenzofuran	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
1,2-Dichlorobenzene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.010	
1,3-Dichlorobenzene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.011	
1,4-Dichlorobenzene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0089	
3,3-Dichlorobenzidine	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.064	
Dieldrin	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.024	
Diethyl phthalate	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.020	
Dimethyl phthalate	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0097	
Di-n-butyl phthalate	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0094	
2,4-Dinitrotoluene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.013	
2,6-Dinitrotoluene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.017	
Di-n-octyl phthalate	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0081	
1,2-Diphenylhydrazine	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.014	
Endosulfan I	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.021	
Endosulfan II	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.029	
Endosulfan sulfate	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.038	
Endrin	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.088	

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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

Quality Control Report - Method Blank Analysis

Constituent	Batch ID	QC Sample ID	MB Result	Units	PQL	MDL	Lab Quals
Endrin aldehyde	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.50	0.12	
Fluoranthene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0096	
Fluorene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.013	
Heptachlor	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.013	
Heptachlor epoxide	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
Hexachlorobenzene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.014	
Hexachlorobutadiene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0099	
Hexachlorocyclopentadiene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
Hexachloroethane	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0077	
Indeno[1,2,3-cd]pyrene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.015	
Isophorone	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.011	
2-Methylnaphthalene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
Naphthalene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.011	
2-Naphthylamine	BSJ1934	BSJ1934-BLK1	ND	mg/kg	3.0	0.031	
2-Nitroaniline	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.015	
3-Nitroaniline	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.11	
4-Nitroaniline	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.051	
Nitrobenzene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.013	
N-Nitrosodimethylamine	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.013	
N-Nitrosodi-N-propylamine	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.013	
N-Nitrosodiphenylamine	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0097	
Phenanthrene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.013	
Pyrene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.015	
1,2,4-Trichlorobenzene	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.014	

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Reported: 11/12/2009 15:25

Base Neutral and Acid Extractables Organic Analysis (EPA Method 8270C)

Quality Control Report - Method Blank Analysis

Constituent	Batch ID	QC Sample ID	MB Result	Units	PQL	MDL	Lab Quals
4-Chloro-3-methylphenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.012	
2-Chlorophenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.0091	
2,4-Dichlorophenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
2,4-Dimethylphenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.030	
4,6-Dinitro-2-methylphenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.50	0.0075	
2,4-Dinitrophenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.50	0.055	
2-Methylphenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.023	
3- & 4-Methylphenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.019	
2-Nitrophenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
4-Nitrophenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.0094	
Pentachlorophenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.011	
Phenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.10	0.012	
2,4,5-Trichlorophenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.012	
2,4,6-Trichlorophenol	BSJ1934	BSJ1934-BLK1	ND	mg/kg	0.20	0.011	
2-Fluorophenol (Surrogate)	BSJ1934	BSJ1934-BLK1	108	%	42 - 137 (LCL - UCL)		
Phenol-d5 (Surrogate)	BSJ1934	BSJ1934-BLK1	111	%	36 - 137 (LCL - UCL)		
Nitrobenzene-d5 (Surrogate)	BSJ1934	BSJ1934-BLK1	120	%	34 - 135 (LCL - UCL)		
2-Fluorobiphenyl (Surrogate)	BSJ1934	BSJ1934-BLK1	123	%	40 - 135 (LCL - UCL)		
2,4,6-Tribromophenol (Surrogate)	BSJ1934	BSJ1934-BLK1	136	%	54 - 162 (LCL - UCL)		
p-Terphenyl-d14 (Surrogate)	BSJ1934	BSJ1934-BLK1	122	%	20 - 176 (LCL - UCL)		

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Reported: 11/12/2009 15:25

EPA Method 1664

Quality Control Report - Method Blank Analysis

Constituent	Batch ID	QC Sample ID	MB Result	Units	PQL	MDL	Lab Quals
Oil and Grease	BSK0037	BSK0037-BLK1	ND	mg/kg	50	16	
Oil and Grease	BSK0746	BSK0746-BLK1	ND	mg/kg	50	16	

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Reported: 11/12/2009 15:25

Chemical Analysis

Quality Control Report - Method Blank Analysis

Constituent	Batch ID	QC Sample ID	MB Result	Units	PQL	MDL	Lab Quals
Moisture	BSJ1631	BSJ1631-BLK1	ND	%	0.05	0.05	
Biochemical Oxygen Demand	BSJ1661	BSJ1661-BLK1	1.0000	mg O/kg	0.98	0.98	
Total Kjeldahl Nitrogen	BSJ1799	BSJ1799-BLK1	ND	mg/kg	40	15	

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Reported: 11/12/2009 15:25

Total Concentrations (TTLC)

Quality Control Report - Method Blank Analysis

Constituent	Batch ID	QC Sample ID	MB Result	Units	PQL	MDL	Lab Quals
Cadmium	BSJ1534	BSJ1534-BLK1	ND	mg/kg	0.50	0.033	
Chromium	BSJ1534	BSJ1534-BLK1	ND	mg/kg	0.50	0.045	
Copper	BSJ1534	BSJ1534-BLK1	ND	mg/kg	1.0	0.13	
Nickel	BSJ1534	BSJ1534-BLK1	ND	mg/kg	0.50	0.12	
Zinc	BSJ1534	BSJ1534-BLK1	0.99745	mg/kg	2.5	0.25	J
Aluminum	BSJ1534	BSJ1534-BLK1	ND	mg/kg	5.0	1.9	
Iron	BSJ1534	BSJ1534-BLK1	3.1988	mg/kg	5.0	1.4	J
Arsenic	BSJ1535	BSJ1535-BLK1	ND	mg/kg	0.50	0.12	
Lead	BSJ1535	BSJ1535-BLK1	0.078250	mg/kg	0.25	0.038	J
Silver	BSJ1535	BSJ1535-BLK1	ND	mg/kg	0.25	0.032	
Mercury	BSK0138	BSK0138-BLK1	ND	mg/kg	0.050	0.014	

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Reported: 11/12/2009 15:25

Notes And Definitions

J	Estimated Value (CLP Flag)
MDL	Method Detection Limit
ND	Analyte Not Detected at or above the reporting limit
PQL	Practical Quantitation Limit
RPD	Relative Percent Difference
A02	The difference between duplicate readings is less than the PQL.
A03	The sample concentration is more than 4 times the spike level.
A10	PQL's and MDL's were raised due to matrix interference.
Q01	Sample precision is not within the control limits.
Q02	Matrix spike precision is not within the control limits.
Q03	Matrix spike recovery(s) is(are) not within the control limits.
S09	The surrogate recovery on the sample for this compound was not within the control limits.
Z1	Due to laboratory miscommunication, volatile solids were analyzed past the holding time.

Chain of Custody Form

CHK BY

DISTRIBUTION

SUB-OUT

Report To: Client: Marine Research Specialists		Project #: Morro Bay Benthic																			
Attn: Bonnie Luke		Project Name: Offshore Sediment Sampling																			
Street Address: 3140 Telegraph Rd STE A		Global ID #:																			
City, State, Zip: Ventura CA 93003		Sampler(s): Doug Coats																			
Telephone: (805) 289-3926																					
Email: Bonnie.Luke@MRSEnv.com																					
Work Order #: 09-14065																					
Sample #		Description	Date Sampled	Time Sampled	Moisture 160.3 or BC	Total Volatile Solids 160.4 or 2540G	Biochemical Oxygen Demand 405	Total Kjeldahl Nitrogen 351.2	Oil and Grease 413.2 or 1664/HEM	Al, Fe, As, Cd, Cr (total), Cu, Pb, Hg, Ni	Ag, Zn	Pesticides and PCBs 8080	Base Neutral and Extractables 8270	Soil	Sludge	Drinking Water	Ground Water	Waste Water	Other	TAT Days	Notes
-1	Station B1	10/20/09	1304 ~~0822~~	X X X X	X X								X							X	No O&G, 8080, or 8270 at Station B1
-2	Station B2	10/20/09	1213	X X X X X X X X X X									X							X	
-3	Station B3	10/20/09	1134	X X X X X X X X X X									X							X	
-4	Station B4	10/20/09	1048	X X X X X X X X X X									X							X	
-5	Station B5	10/20/09	0953	X X X X X X X X X X									X							X	
-6	Station B6	10/20/09	0911	X X X X X X X X X X									X							X	
-7	Station B7	10/20/09	0822	X X X X X X X X X X									X							X	
Billing		☒ Same as Above		EDF Required?		☐ Yes ☒ No		Send Copy to State of CA?		☐ Yes ☒ No		Sample Disposal		☐ Return to Client ☒ Disposal by lab ☐ Archive Months		Special Reporting		☐ QC ☐ EDF ☐ Raw Data			
Client: _____		Address: _____		City: _____ State: _____ Zip: _____		Attn: _____		PO#: _____		1. Relinquish By: _____ Date: _____ Time: _____		2. Received by: _____ Date: _____ Time: _____		3. Relinquish by: _____ Date: _____ Time: _____		4. Received by: _____ Date: _____ Time: _____					

09-14065

marine research specialists

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**Attachment (Page 2 of 2) to Chain of Custody Form
Morro Bay Benthic Sediment Sampling at 7 Stations on
Wednesday, 20 October 2009**

The following analyses should be conducted on the **composited** soil matrix using procedures and a QC Level similar to the analyses conducted in 2008 on BC Laboratory Sample Number **08-13326** (with the exception of the dissolved sulfides analysis, which is no longer required). Prior to analysis, macrofauna and large remnants greater than 0.25 inches should be removed, taking care to avoid contamination. **Additionally, prior to analysis, homogenize the composite sample in the laboratory to ensure uniform distribution of multiple subsamples in sample container(s).** All results should be reported on an as-received (raw) basis and where appropriate, on a **dry-weight basis**. The required analyses are:

Constituent		Samples	Method
Moisture		7	160.3 or BC
Total Volatile Solids		7	160.4 or SM-2540G
Biochemical Oxygen Demand		7	405.1 or SM17-5210B
Total Kjeldahl Nitrogen		7	351.2
Oil and Grease		6	413.2 or EPA-1664/HEM
Metals (11)			
	Aluminum	7	SW-6010
	Iron	7	SW-6010
	Arsenic	7	SW-7060
	Cadmium	7	SW-6010
	Total Chromium	7	SW-6010
	Copper	7	SW-6010
	Lead	7	SW-7421
	Mercury	7	SW-7471
	Nickel	7	SW-6010
	Silver	7	EPA-272.2
	Zinc	7	SW-6010
Pesticides and PCBs		6	8080
Base Neutral and Acid Extractables		6	8270

Questions can be directed to Bonnie Luke at Marine Research Specialists at (805) 289-3926.

Submission #: 09-14065

SHIPPING INFORMATION

Federal Express ☐ UPS ☐ Hand Delivery ☐
BC Lab Field Service ☒ Other ☐ (Specify) _____

SHIPPING CONTAINER

Ice Chest ☒
Box ☐None ☐
Other ☐ (Specify) _____Refrigerant: Ice ☒ Blue Ice ☐ None ☐ Other ☐ Comments: _____Custody Seals Ice Chest ☐ Containers ☐ None ☒ Comments: _____Intact? Yes ☐ No ☐Intact? Yes ☐ No ☐All samples received? Yes ☒ No ☐All samples containers intact? Yes ☒ No ☐Description(s) match COC? Yes ☐ No ☒

COC Received

☒ YES ☐ NO

Emissivity: 0.98 Container: 16 oz jar Thermometer ID: T1080

Temperature: A 0.4 °C / C 0.3 °C

Date/Time 11/20/09 2045

Analyst Init JNW

SAMPLE CONTAINERS	SAMPLE NUMBERS									
	1	2	3	4	5	6	7	8	9	10
QT GENERAL MINERAL/ GENERAL PHYSICAL										
PT PE UNPRESERVED										
QT INORGANIC CHEMICAL METALS										
PT INORGANIC CHEMICAL METALS										
PT CYANIDE										
PT NITROGEN FORMS										
PT TOTAL SULFIDE										
2oz NITRATE / NITRITE										
PT TOTAL ORGANIC CARBON										
PT TOX										
PT CHEMICAL OXYGEN DEMAND										
PTA PHENOLICS										
40ml VOA VIAL TRAVEL BLANK										
40ml VOA VIAL	(	(	(	(	(	(	(	(	(	(
QT EPA 413.1, 413.2, 418.1										
PT ODOR										
RADIOLOGICAL										
BACTERIOLOGICAL										
40 ml VOA VIAL- 504										
QT EPA 508/608/8080										
QT EPA 515.1/8150										
QT EPA 525										
QT EPA 525 TRAVEL BLANK										
100ml EPA 547										
100ml EPA 531.1										
QT EPA 548										
QT EPA 549										
QT EPA 632										
QT EPA 8015M										
QT AMBER										
8 OZ. JAR										
32 OZ. JAR	A	A	A	A	A	A	A			
SOIL SLEEVE										
PCB VIAL										
PLASTIC BAG										
FERROUS IRON										
ENCORE										

Comments: NO time on Sample

Sample Numbering Completed By: CLM

Date/Time: 10/21/09 0750

A = Actual / C = Corrected

Date of Report: 11/12/2009

Doug Coats

Marine Research Specialists

3140 Telegraph Road, Suite A

Suite A

Ventura, CA 93003-3238

RE: Annual Benthic Sediment Sampling for M

BC Work Order: 0914065

Invoice ID: B071062

Enclosed are the results of analyses for samples received by the laboratory on 10/20/2009. If you have any questions concerning this report, please feel free to contact me.

Sincerely,



Contact Person: Tina Green
Client Services Manager



Authorized Signature

Marine Research Specialists
3140 Telegraph Road, Suite A
Suite A
Ventura, CA 93003-3238

Project: Annual Benthic Sediment Sampling for MBTP
Project Number: Offshore Sediment Sampling
Project Manager: Doug Coats

Reported: 11/12/2009 15:25

Laboratory / Client Sample Cross Reference

Laboratory	Client Sample Information			
0914065-01	COC Number:	---	Receive Date:	10/20/2009 20:55
	Project Number:	---	Sampling Date:	10/20/2009 13:04
	Sampling Location:	---	Sample Depth:	---
	Sampling Point:	Station B1	Sample Matrix:	Solids
	Sampled By:	---		
0914065-02	COC Number:	---	Receive Date:	10/20/2009 20:55
	Project Number:	---	Sampling Date:	10/20/2009 12:13
	Sampling Location:	---	Sample Depth:	---
	Sampling Point:	Station B2	Sample Matrix:	Solids
	Sampled By:	---		
0914065-03	COC Number:	---	Receive Date:	10/20/2009 20:55
	Project Number:	---	Sampling Date:	10/20/2009 11:34
	Sampling Location:	---	Sample Depth:	---
	Sampling Point:	Station B3	Sample Matrix:	Solids
	Sampled By:	---		
0914065-04	COC Number:	---	Receive Date:	10/20/2009 20:55
	Project Number:	---	Sampling Date:	10/20/2009 10:48
	Sampling Location:	---	Sample Depth:	---
	Sampling Point:	Station B4	Sample Matrix:	Solids
	Sampled By:	---		
0914065-05	COC Number:	---	Receive Date:	10/20/2009 20:55
	Project Number:	---	Sampling Date:	10/20/2009 09:53
	Sampling Location:	---	Sample Depth:	---
	Sampling Point:	Station B5	Sample Matrix:	Solids
	Sampled By:	---		

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APPENDIX F

Laboratory Quality Assurance and Quality Control Plans

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APPENDIX F

Quality Assurance/Quality Control

Government organizations and respected contract research facilities now require specific Quality Assurance Programs and Plans for all scientific research efforts. Marine Research Specialists (MRS), without exception, abides by these requirements and has integrated Quality Assurance procedures in their normal course of scientific investigations. We pride ourselves on excellence and objectivity in research, and we support that pride with Quality Assurance and Quality Control procedures, which are documented by SOP's. These procedures have been developed through the years in support of major environmental programs for clients such as the U.S. Environmental Protection Agency, U.S. Department of Commerce (NOAA), and the U.S. Department of the Interior (Minerals Management Service).

The quality assurance procedures for work undertaken in this program meet all MRS requirements for assuring the reliability of monitoring and measurement data. This level of QA/QC is also applicable to all subcontractors working on this monitoring program under the direction of MRS. The procedures form an integrated program for assuring complete, accurate, precise, and representative data under defined requirements. Our general quality assurance requirements are discussed below.

Program Management. The basis of any sound QA/QC program resides with the Program Manager. She ensures that monitoring program activities, client-approved changes in scope, and progress are well documented throughout the duration of the monitoring program. She also ensures that specific QA/QC documentation such as field observation logs, sampling logs (separate logs are maintained for water, sediment and infauna samples), and sample transfer forms are properly and accurately recorded and maintained. It is important to note that each and all samples maintain unique sample codes throughout the sample collection, analyses, and reporting phases of the monitoring program.

The Program Manager, Ms. Bonnie Luke, also conducts QA/QC reviews of our subcontractors, BC Laboratories and Aquatic Testing Laboratories, to ensure that their QA/QC procedures, described on the following pages are adhered to. They are promptly notified of any deviation and the need for corrective action.

Field Sampling. All field sampling equipment is calibrated according to manufacturer's specifications. Logs are maintained for the Sea-Bird SBE-19 Seacat CTD Profiler with the number of casts and cast locations recorded. Calibration results are also recorded into the log. Periodically, the CTD is returned to the manufacturer for a complete bench testing and calibration. The CTD was factory calibrated and fully tested at the Sea Bird Testing Facility in November 1999 and again in October 2001.

The Van Veen sediment grab sampler and subsamplers are cleaned with noncontaminating solvents between all collections of sediment chemistry samples. The solvents include methanol for the removal of organics and de-ionized water and HCl for the removal of metals. The grab sampler and sediment subsamplers such as scoops, are coated with noncontaminating Dykor® to limit contamination of chemistry samples from the sampling equipment. Similarly, all sediment sample containers are pre-cleaned and acid washed accorded to USEPA specifications. The grab sampler was recoated with Dykor® in September 1999.

Laboratory Analysis. QA/QC procedures are also used in the laboratory for grain-size analysis and sorting benthic infauna samples. A minimum of 10 percent of all samples sorted by any one technician are resorted by another technician. The level of sorting error must not exceed five percent (i.e. the sample residue that is resorted by another technician must not contain more than five percent of the total number of organisms contained in the original sample). Additionally, all samples sorted by a technician who is in

the process of being trained are subject to quality control inspection. A technician is considered a trained sorter if they pass quality control inspection in five consecutive samples. Ms. Bonnie Luke is currently the lead technician for MRS for both grain-size analysis and benthic sample sorting.

Independent QA/QC Audit. In addition to the QA/QC auditing performed by the Program Manager, an independent semi-random audit on project performance is conducted by Dr. Douglas A. Coats. Dr. Coats reviews all reports for completeness, thoroughness, accurateness, and errors. He also performs periodic unannounced audits on monitoring program status and additionally, calls or meets independently with the Public Works Department's project officer for an evaluation of our performance.

Subcontracted Laboratories. The following Quality Assurance guidelines and methods for subcontractor laboratories are excerpts from the full Quality Assurance Manuals of BC Laboratories and Aquatic Testing Laboratories. The full QA documents are too voluminous to provide in complete form in this annual report but are on file at MRS. BC Laboratories of Bakersfield California, performed the chemical analyses for treatment plant effluent and sludge and the offshore sediments. Aquatic Testing Laboratories of Ventura analyzed the effluent for acute and chronic toxicity levels.

2009

Morro Bay / Cayucos Wastewater Treatment Plant

LABORATORY QUALITY ASSURANCE MANUAL Updated 3-16-09

Bruce Keogh, Lab Director_____ **Date:**_____
Mydocuments/LabQCdocs/LabQCtitlepage.doc

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INTRODUCTION

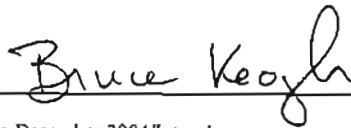
The Morro Bay – Cayucos Wastewater Treatment Plant Laboratory provides analytical services for the Morro Bay – Cayucos Wastewater Treatment Plant located at 160 Atascadero Road, the mailing address is 955 Shasta, Morro Bay, CA.

The laboratory analyzes samples of wastewater effluent, influent, and sludges on a daily, weekly, or monthly basis for physical parameters. Microbiological samples are analyzed daily, weekly, and monthly.

The laboratory only analyzes samples from the Morro Bay – Cayucos Wastewater Treatment Plant. The laboratory does not accept samples for analysis from outside sources.

There are currently two positions in the laboratory, the Laboratory Director and the laboratory analyst.

Bruce Keogh, Lab Director



Date: 1-31-05

MONITORING AND REPORTING PROGRAM NO. 98-15
FOR
CITY OF MORRO BAY AND CAYUCOS SANITARY DISTRICT
WASTEWATER TREATMENT PLANT
SAN LUIS OBISPO COUNTY

The monitoring program for a discharger receiving a 301(h) modified National Pollutant Discharge Elimination System (NPDES) permit is intended to: a) document short and long-term effects of the discharge on receiving waters, sediments, biota, and on beneficial uses of the receiving water; b) determine compliance with NPDES permit items and conditions; and c) assess the effectiveness of industrial pretreatment and toxics control programs.

The Regional Water Quality Control Board (Regional Board) and U.S. Environmental Protection Agency, Region IX (EPA) may revise the monitoring program presented herein, within the specified order and permit period. The program will be reviewed at annual intervals to assess its effectiveness at meeting the objectives stated above. If predictable relationships among effluent, water quality and biological monitoring variables can be clearly demonstrated, it may be appropriate to decrease certain elements of the monitoring program. Conversely, the monitoring program may be intensified if it appears that the above objectives cannot be achieved through the existing monitoring program.

INFLUENT MONITORING

Representative samples of influent to the treatment plant shall be collected (upstream of any in-plant return flows) and analyzed as follows:

<u>Constituent</u>	<u>Units</u>	<u>Sample Type</u>	<u>Minimum Frequency</u> <u>Sampling/Analysis</u>
BOD ₅ (20°C)	mg/l	24-hr Composite	Weekly
Suspended Solids	mg/l	24-hr Composite	Weekly

Influent flow metering shall be required if the Executive Officer determines such monitoring is necessary to identify sources of noncompliance with this Order.

EFFLUENT MONITORING

Representative effluent samples shall be collected (downstream of any inplant return flows or disinfection units) and analyzed as follows:

<u>Constituent</u>	<u>Units</u>	<u>Sample Type</u>	<u>Minimum Frequency</u> <u>Sampling/Analysis</u>
Daily Flow	MG	Metered	Daily
Maximum Daily Flow	MGD	Metered	Daily
Mean Daily Flow	MGD	Calculated	Monthly
Total Chlorine Residual	mg/l	Grab	Daily
Chlorine Used	lbs/day	Recorded	Daily
Total Coliform	MPN	Grab	5 days/week ¹
Temperature	°C	Grab	5 days/week)
Turbidity	NTU	Grab	5 days/week)
BOD ₅ (20°C)	mg/l	24-hr Composite	Weekly ¹
Suspended Solids	mg/l	24-hr Composite	Weekly ¹
pH	pH units	Grab	Weekly ¹
Settleable Solids	ml/l	Grab	Weekly
Grease and Oil	mg/l	Grab	Weekly
Acute Toxicity	TUa	Grab	Quarterly (Jan/Apr/July/Oct)
Chronic toxicity	TUc	24-hr Composite	Semi-annually (Jan/July)
Ammonia (as N)	mg/l	Grab	Monthly
Phenolic Compounds (non-chlorinated)	mg/l	Grab	Semi-annually
Chlorinated Phenolics	mg/l	Grab	Semi-annually

If results of monitoring a constituent appear to violate effluent limitations based on a weekly, monthly, 30-day, or six-month period, but compliance or non-compliance cannot be validated because sampling is too infrequent, the frequency of sampling shall be increased to validate the test within the next monitoring period. The increased frequency shall be maintained until the Executive Officer agrees the original monitoring frequency may be resumed, as stated in B.2 of the Standard Provisions and Reporting Requirements.

FOOTNOTES:

1. Sampling shall be arranged so that each day of the 7-day week is represented, at least once, each month, or every two (2) months for weekly sampling. For samples collected 5 times per month, at least one (1) sample shall be taken weekly, and sampling should be arranged so that each day of the 7-day week is represented, at least once, every two (2) months.
2. Dischargers may at their option meet this limitation as total chromium limitation.
3. ENDOSULFAN shall mean the sum of endosulfan-alpha and -beta and endosulfan sulfate.
4. HCH shall mean the sum of the alpha, beta, gamma (lindane), and delta isomers of hexachlorocyclohexane.
5. DICHLOOROBENZENES shall mean the sum of 1,2- and 1,3-dichlorobenzene.
6. CHLORDANE shall mean the sum of chlordane-alpha, chlordane-gamma, chlordene-alpha, chlordene-gamma, nonachlor-alpha, nonachlor-gamma, and oxychlordane.
7. DDT shall mean the sum of 4,4-DDT, 2,4-DDT, 2,4-DDE, 4,4-DDD, and 2,4-DDD.
8. HALOMETHANES shall mean the sum of bromoform, bromomethane (methyl bromide), chloromethane (methyl chloride), chlorodibromomethane, and dichlorobromomethane.
9. HEPTACHLOR shall mean the sum of heptachlor and heptachlor epoxide.
10. PAHs (polynuclear aromatic hydrocarbons) shall mean the sum of acenaphthylene, anthracene, 1,2-benzanthracene, 3,4-benzofluoranthene, benzo[k]fluoranthene, 1,12-benzoperylene, benzo[a]pyrene, chrysene, dibenzo[ah]anthracene, fluorene, indeno[1,2,3-cd]pyrene, phenanthrene, and pyrene.
11. PCBs (polychlorinated biphenyls) shall mean the sum of chlorinated biphenyls whose analytical characteristics resemble those of Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254 and Aroclor-1260.
12. TCDD EQUIVALENTS shall mean the sum of the concentrations of chlorinated dibenzodioxins (2,3,7,8-CDDs) and chlorinated dibenzofurans (2,3,7,8-CDFs) multiplied by their respective toxicity factors, as shown below:

Isomer Group	Toxicity Equivalent Factor
2,3,7,8-tetra CDD	1.0
2,3,7,8-penta CDD	0.5
2,3,7,8-hexa CDDs	0.1
2,3,7,8-hepta CDD	0.01
octa CDD	0.001
2,3,7,8-tetra CDF	0.1

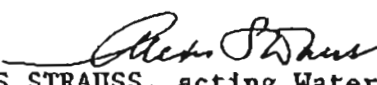
Isomer Group	Toxicity Equivalent Factor
1,2,3,7,8-penta CDF	0.05
2,3,4,7,8-penta CDF	0.5
2,3,7,8-hexa CDFs	0.1
2,3,7,8-hepta CDFs	0.01
octa CDF	0.001

13. Mass emission based on detectable concentrations.
14. Mass emission based on Table B effluent limit concentrations listed in the Order No. 98-15.

This certifies that the foregoing is a full, true and correct copy of an order adopted by the California Regional Water Quality Control Board, Central Coast Region, on December 11, 1998, and of a NPDES permit issued by the U.S. Environmental Protection Agency, Region IX, on 26 January, 1999



ROGER W. BRIGGS, Executive Officer
California Regional Water Quality Control Board
Central Coast Region



ALEXIS STRAUSS, acting Water Division Director for
FELICIA MARCUS, Regional Administrator
U.S. Environmental Protection Agency
Region IX

Quality Assurance Objectives

The role of the analytical laboratory is to provide qualitative and quantitative data to be used in decision making. To be valuable, the data must accurately describe the characteristics or the concentration of constituents in the sample submitted to the laboratory. In many cases, an approximate answer or incorrect result is worse than no answer at all, because it will lead to faulty interpretations.

Decisions made using data from water and wastewater are far reaching. Water quality standards are set to establish satisfactory conditions for a given water use. The laboratory data define whether that condition is being met, and whether the water can be used for its intended purpose. If the laboratory results indicate a violation of the standard, action is required on the part of pollution control authorities. With the present emphasis on legal action and social pressures to abate pollution, the analyst should be aware of his or her responsibility to provide laboratory results that are a reliable description of the sample. Furthermore, the analyst must be aware of his or her professional competence, the procedures he or she has used, and the reported values may be used and challenged in court. To satisfactorily meet this challenge, the laboratory data must be backed up by an adequate program to document the proper control and application of all of the factors which affect the result.

In wastewater analyses, the laboratory data define the treatment plant influent, the status of the steps in the treatment process, and the final load imposed upon the water resources. Decisions on process changes, plant modification, and even the construction of a new facility is based upon the results of laboratory analysis.

Research investigations in water pollution control rest upon a firm base of laboratory data. The final result sought can usually be described in numerical terms. The progress of the research and the alternative pathways available are generally evaluated on the basis of laboratory data. The value of the research effort will depend on the validity of laboratory results.

Because of the importance of laboratory analyses and the resulting actions that they produce, a program to ensure the reliability of the data is essential. It is recognized that all analysts practice quality control to varying degrees, depending somewhat upon their training, professional pride, and awareness of the importance of the work they are doing. An established, routine control program applied to every analytical test is important in assuring the reliability of the final results.

The Quality Control Program in the laboratory has two primary functions. First, the program should monitor the reliability or truth of the results reported. It should continually provide an answer to "How good or true are the results submitted?" This phase may be a "measurement of quality." The second function is the control of the quality in order to meet the program requirements for reliability. For example, the processing of spiked samples is the measurement of quality, while the use of analytical grade reagents is a control measure. Just as each analytical method has a rigid protocol, so the quality control associated with that test must also involve definite required steps to monitor and assure that the result is correct. Ideally, all of the variables, which can affect the final answer should be considered, evaluated, and controlled.

Bruce Keogh, Lab Director

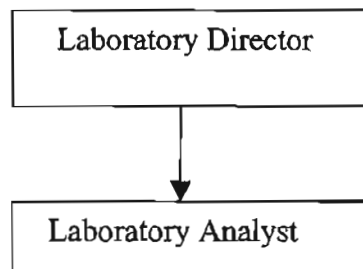
Bruce Keogh Date: 1-31-05

Lab/C/MyDocuments/Lab QC Docs/Lab QA Updates December 2004/qualityassuranceobjectives.doc

PROGRAM ORGANIZATION AND RESPONSIBILITY

The responsibility for the Quality Control Program lies with the Laboratory Director who collects, interprets, and reviews all the data from various quality control measures taken in the laboratory. It is the responsibility of this Quality Control official to make sure that each analyst in the laboratory is performing their duties of quality control measures and proper documentation of sample collection, preservation and analyses. It is therefore requested that all laboratory employees read this Quality Assurance Manual and become familiar with all the quality control terminology, methodology, and procedures. Without exception, the final responsibility for the reliability of the analytical results rest with the Laboratory Director.

The Morro Bay – Cayucos Wastewater Treatment Plant Laboratory is organized as follows:



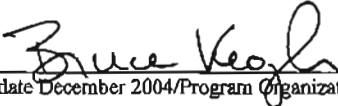
Responsibilities for each position in the Morro Bay – Cayucos Wastewater Treatment Plant Laboratory are as follows:

Laboratory Director

The managerial, administrative, and supervisory level position for the laboratory is responsible for the planning, implementation, and supervision of the laboratory testing and water quality control programs to comply with local, State, and Federal standards. Supervisory duties include making assignments of work, setting priorities, training and inspecting work, selection of employees, preparing performance evaluations and recommending recognition and disciplining of subordinates.

Laboratory Analyst

The chemist level position for the laboratory is responsible for the physical, chemical, and biological testing of water, wastewater, and sludges. Additional responsibilities include sampling and cleaning and preparing laboratory glassware. Analyses include pH, turbidity, total chlorine residual, suspended solids, BOD, oil & grease, volatile acids, alkalinity, and total and fecal coliforms. Assisting in the training and supervision of other laboratory analysts, assigning, instructing, monitoring, and correcting work.

Bruce Keogh, Lab Director  Date: 1-31-05
Lab/C/My Documents/Lab QC Docs/Lab QA Update December 2004/Program Organization and Responsibility

LABORATORY GENERAL PROCEDURES

There are some standard operating procedures that all laboratories have to ensure that procedures are performed the same way by each analyst and are a form of Quality Control.

Glassware

1. After dumping sample, rinse with water and apply FL70 detergent located at sink. Scrub or brush unit until all of sample has been removed from glassware. Glassware should then be rinsed at least three times with hot water. After rinsing with tap water, rinse again with DI water. Dry glassware is ready for use. **Note:** If there is a change in the formulation used, or a change in the method of washing a glassware inhibitory residue test must be performed.
2. Broken, cracked, or chipped glassware is to be discarded.

Sample Custody

1. Sample bottles are labeled either prior to sampling by the lab or during sampling by the sampler.
2. Chain of Custody sheets, filled out completely, must accompany all samples sent to other laboratories for analysis.
3. A copy of Chain of Custody sheets are kept in a separate file in the laboratory file cabinet.

Quality Control

1. Use volumetric glassware and pipettes for all analyses.
2. Label all reagents with name, date, and expiration.
3. Record all temperatures of lab equipment on a daily basis.
4. Keep the laboratory benchtops, floors, and instruments neat and clean.
5. Double check your calculations or have them checked by another analyst.
6. Standards should reflect a high and low value, with the sample close to the middle standard.
7. Rerun any questionable sample results to verify your analyses.

Safety Practices

1. Be familiar with the Material Safety Data Sheets (MSDS) for any chemical you are working with.
2. Do not pipette liquids by mouth.
3. Wear safety glasses when working with strong acids or bases.
4. Wear a lab coat or apron when working in the lab.
5. Use the fume hood to vent hazardous materials.
6. Wipe up any spills on the floors or counter tops immediately.
7. If a large chemical spill occurs use the chemical spill kit.
8. Know where the fire blanket, extinguishers, and showers are located.
9. No eating, drinking, or smoking is allowed in the lab.

10. Wear gloves and then wash hands after working with sewage, sludge, coliform bacteria, or any chemical.
11. Clean up your glassware from your work area when done & wipe counters.
12. Return any chemicals used to the chemical storage area.
13. Try to predict any safety hazards you will encounter before performing a task.
14. Inform the supervisor of any accident or injury immediately.

Bruce Keogh, Lab Director Bruce Keogh Date: 1-31-05
Lab/C/My Documents/Lab QC Docs/Lab QA update December 2004/Laboratory General Procedures

PREVENTATIVE MAINTENANCE

Since instrumentation is heavily relied upon in the laboratory it must be kept clean and well maintained. A computerized work order program, Datastream MP2 Access, is used to schedule and record all preventative maintenance procedures performed on turbidimeters, dissolved oxygen meters, composite samplers, ovens, autoclave, waterbaths, analytical balances, and pH meters. Calibration records of all instruments are also kept in the appropriate folders in the laboratory file cabinet.

Distilled Water: Distilled water is used in the laboratory for dilutions and final rinsing of glassware. We currently use bottled, distilled water from Arrowhead. The water quality is tested and assured from the distributor, a copy of the results are located in the laboratory file cabinet.

Analytical Balances: The laboratory balances are cleaned and serviced annually by a balance technician.

Temperature Logs: Temperature logs are kept on all ovens, incubators, refrigerators, and water baths. Temperatures are recorded twice daily or when in use. Thermometers are compared annually against a certified National Bureau of Standards thermometer and recorded on the temperature logs. Thermometers are also labeled with any corrective factor.

Composite Samplers: Composite samplers have tubing for the sample line and the peristaltic pump. This tubing needs to be cleaned every two weeks due to algae growth. The tubing must be replaced when cracked or worn. Dessicant, inside the control box of the sampler needs to be changed whenever indicator turns pink.

Turbidimeter: The Hach 2100N Turbidimeter needs to be cleaned and serviced per the manufacturers recommendations.

Bruce Keogh, Lab Director Bruce Keogh **Date:** 1-31-05

SYSTEM AUDITS

The laboratory participates annually in the National Pollutant Discharge Elimination System (NPDES) DMR-QA Laboratory Performance Evaluation sponsored by the U.S. Environmental Protection Agency. The samples are purchased from a list of accredited providers and the samples are analyzed along with the lab's regular samples and the results are reported. The accredited provider submits a report to the laboratory and the USEPA that notes whether sample results were acceptable or unacceptable. Any sample result receiving a not acceptable report requires a letter of corrective action be submitted to the State coordinator for USEPA within the specified time period.

The laboratory applies for certification with the California State Department of Health Services every two years as part of their Environmental Laboratory Accreditation Program (ELAP). The laboratory participates in Water Pollution Laboratory Performance Evaluation Studies (WP) for chemistry and microbiological samples on an annual basis. The samples are purchased from a list of accredited providers and the samples are analyzed along with the lab's regular samples and the results are reported. The accredited provider submits a report to the laboratory and to ELAP that notes whether sample results were acceptable or unacceptable. Any sample result receiving a not acceptable report requires a letter of corrective action be submitted to ELAP within the specified time period.

An additional requirement for the State Department of Health Services ELAP certification is a site visit and inspection of the laboratory every two years. The results of the visit and any deficiencies noted are sent back to the lab to be corrected.

Bruce Keogh, Lab Director Bruce Keogh Date: 1-31-05

Lab/C/My Documents/Lab QC Docs/ Lab QA Updates December 2004/System Audits

SAMPLING POINTS AND TECHNIQUES

Sampling is a very important part of analysis. It should always be done with great consistency at the same point and the same technique should always be employed to insure a representative sample. Because of the importance of this subject sample, it is necessary to have outlined procedure and set points for obtaining various samples for analysis.

Sample containers can greatly affect the constituent to be determined. Cations can absorb readily on some plastics and glassware. Metal or aluminum foil cap liners can interfere with metals analyses. How the sample containers are washed and cleaned are also a significant factor in quality control.

All samples should be refrigerated while they are being transported to the laboratory. If the samples cannot be analyzed immediately they should be refrigerated and analyzed as soon as possible. The following page contains our guidelines for sample containers, preservative used and the holding times for most of the samples we pull for analysis by the Morro Bay – Cayucos Wastewater Treatment Plant laboratory or a contract laboratory.

It is essential to ensure sample integrity from collection to data reporting. This includes the ability to trace possession and handling of the sample from the time of collection through analysis and final disposition. This is referred to as chain of custody and is important in the event of litigation involving the analytical results. Where litigation is not involved, chain of custody procedures are useful for routine control of sample flow. Samples that come into the laboratory on a daily basis do not need a chain of custody, but are logged into the laboratory workbook.

A sample is considered to be under a person's custody if it is in the individual's physical possession, in the individual's sight, secured in a tamper proof way by that individual, or is secured in an area restricted to authorized personnel.

All composite samples of final effluent should be collected from the Sigma 900 refrigerated automatic composite sampler currently located on top of the chlorine contact chamber. The sampler should be pre-set according to manufacturer instructions located in the filing cabinet in the laboratory. The effluent grab samples are obtained from the air relief structure, located downstream from the chlorine contact chamber.

If bacteriological samples are needed from the plant final effluent then samples should be collected at the discharge end of the chlorine contact chamber, using sterile sample bottles containing sodium thiosulfate which de-chlorinates the sample.

Influent samples are taken at the headworks and again a Sigma 900 refrigerated automatic composite sampler is employed for obtaining composite samples.

Digester sludge samples are obtained at the valve manifold for each digester. They are all marked and samples can be obtained from any elevation desired. Close

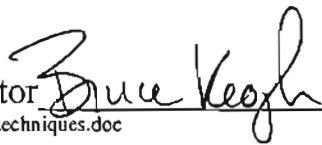
attention should be given to flushing the line by opening the valve and letting the old sludge in the line to run for at least two minutes. Then grab the sample.

Grab samples of mixed liquor suspended solids and return activated sludge are obtained at the south end of the solids contact channel and in the return sludge box respectively on the top of the secondary clarifier.

Samples of primary clarifiers are obtained by holding a beaker or container close to the weirs, where the primary process water is being discharged over the weirs. Samples of trickling filters are collected at the wet well next to them.

Bruce Keogh, Lab Director

Mydocuments/LabQCdocs/samplepoints&techniques.doc

 Date: 1-31-05

Sludge Monitoring

- Maintain a record of the volume of solids generated and disposal sites used.

A. SURF ZONE MONITORING

Station Locations

(see attached Station Location Map)

Shore Stations

Description

A1	Surf, 1700 meters (5600') upcoast of Station C
A	Surf, 610 meters (2000') upcoast of Station C
B	Surf, 305 meters (1000') upcoast of Station C
C	Surf, at point closest to outfall diffuser
D	Surf, 305 meters (1000') downcoast of Station C
E	Surf, 610 meters (2000') downcoast of Station C
F	Surf, 1520 meters (5000') downcoast of Station C

Grab samples shall be taken at all shore stations weekly during summer months (May-October) and monthly during winter months (November-April). Samples shall be analyzed for fecal and total coliform organisms.

Monitoring shall include observations of wind (direction and speed), weather (e.g., cloudy, sunny, rainy), waves, longshore currents (e.g., direction), and tidal conditions (e.g., high, slack, or low tide). Observations of water discoloration, floating oil and grease, turbidity, odor and materials of sewage origin in the water or on the beach shall be recorded. The water temperature (°C) shall also be recorded. The sample shall be collected as far seaward within the surf zone as possible.

CITY OF MORRO BAY WWTP
CHAIN OF CUSTODY

Project Name:	Date:
Project Mngr:	Page _____ Of _____
City of Morro Bay	Special Instruction's:
160 Atascadero Rd.	
Morro Bay, Ca. 93442	
Phone # 805-772-6273	

Sample I.D.	Date	Time	Analysis Requested	Remark's

Relinquished/ Received By:	Date	Time	Firm/City	Signature:

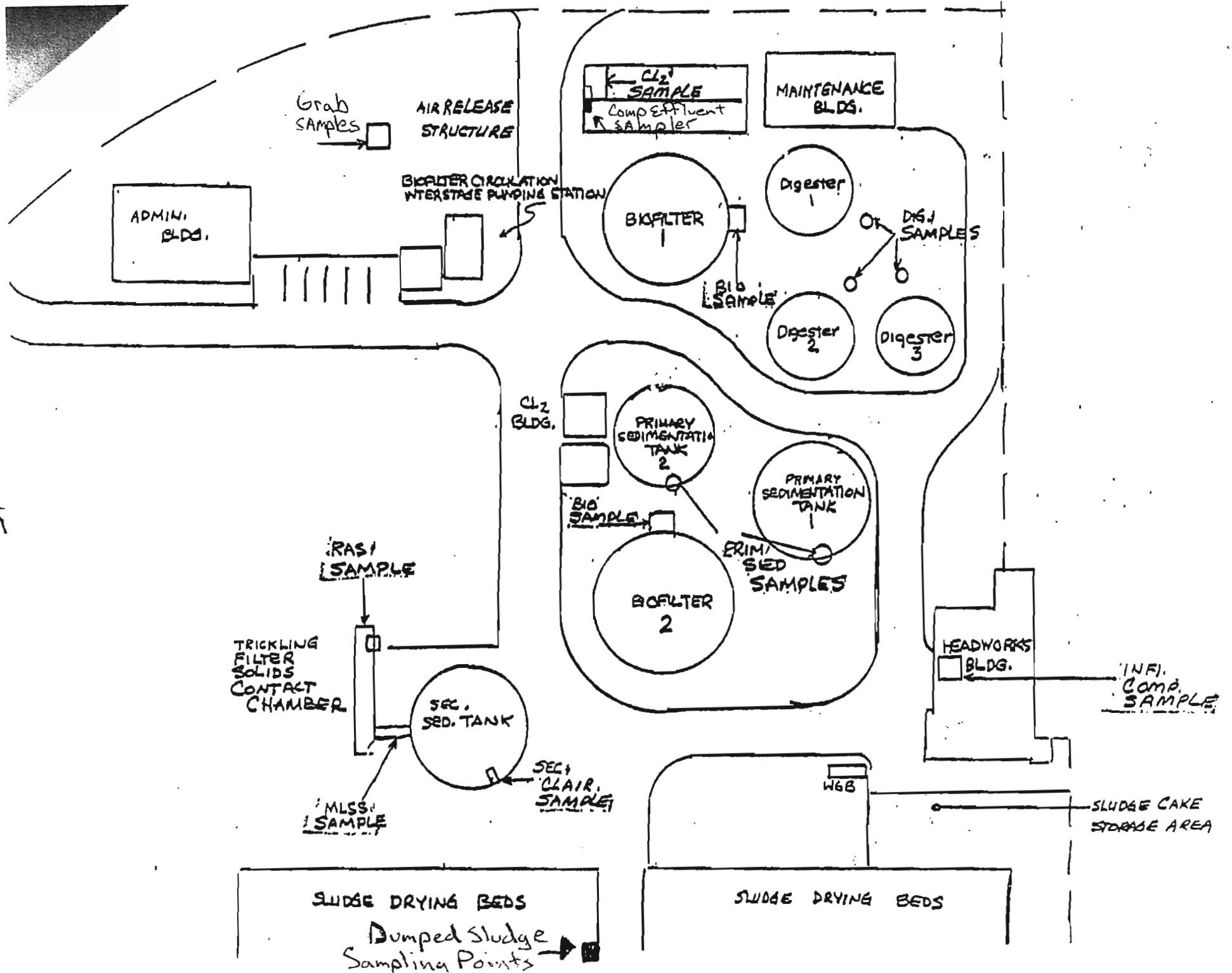
SAMPLING AND PRESERVATION
OF SAMPLES ACCORDING TO MEASUREMENT (1)

4A

Measurement	Container	Preservative	Holding Time (6)
Acidity	P,G (2)	Cool, 4°C	24 Hours
Alkalinity	P,G	Cool, 4°C	24 Hours
BOD	P,G	Cool, 4°C	6 Hours (3)
COD	P,G	H ₂ SO ₄ to pH 2	7 Days
Chloride	P,G	None Req.	7 Days
Chlorine Resid.	P,G	Det. on site	No Holding
Color	P,G	Cool, 4°C	24 Hours
Dissolved Oxygen			
Probe	G only	Det. on site	No Holding
Winkler	G only	Fix on site	No Holding
Hardness	P,G	Cool, 4°C	7 Days
MBAS	P,G	Cool, 4°C	24 Hours
Nitrogen			
Ammonia	P,G	Cool, 4°C H ₂ SO ₄ to pH 2	24 Hours (4)
Kjeldahl	P,G	Cool, 4°C H ₂ SO ₄ to pH 2	24 Hours (4)
Nitrate	P,G	Cool, 4°C H ₂ SO ₄ to pH 2	24 Hours (4)
Nitrite	P,G	Cool, 4°C H ₂ SO ₄ to pH 2	24 Hours (4)
Oil & Grease	G only	Cool, 4°C H ₂ SO ₄ to pH 2	24 Hours
Organic Carbon	P,G	Cool, 4°C H ₂ SO ₄ to pH 2	24 Hours
pH	P,G	Cool, 4°C Det. on site	6 Hours (3)

Measurement	Container	Preservative	Holding Time (6)
Residue			
Filterable	P,G	Cool, 4°C	7 Days
Non-filterable	P,G	Cool, 4°C	7 Days
Total	P,G	Cool, 4°C	7 Days
Volatile	P,G	Cool, 4°C	7 Days
Settleable-Matter	P,G	None Req.	24 Hours
Specific-Conductance	P,G	Cool, 4°C	24 Hours (5)
Sulfide	P,G	2 ml. zinc acetate	24 Hours
Temperature	P,G	Det. on site	No Holding
Threshold Odor	G only	Cool, 4°C	24 Hours
Turbidity	P,G	Cool, 4°C	7 Days

1. A general discussion on sampling water and industrial wastewater may be found in ASTM, part 23, p. 72-91 (1973)
2. Plastic or Glass
3. If samples cannot be returned to the laboratory in less than 6 hours and holding time exceeds this limit, the final reported data should indicate the actual holding time.
4. Mercuric chloride may be used as an alternate preservative at a concentration of 40 mg/l, especially if a longer holding time is required.
5. If the sample is stabilized by cooling, it should be warmed to 25°C for reading, or temperature correction made and result reported at 25°C.
6. It has been shown that samples properly preserved may be held for extended periods beyond the recommended holding time.

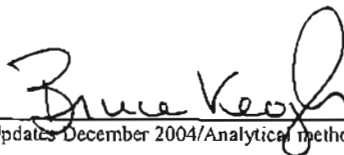


ANALYTICAL METHODS

The following methods are used by the Morro Bay – Cayucos Wastewater Treatment Plant Laboratory and taken from Standard Methods for the Examination of Water and Wastewater, 18th Edition.

<u>Analysis</u>	<u>Method No.</u>
pH.....	SM4500-H+B
Turbidity.....	SM2130B
Total Chlorine Residual.....	SM4500-Cl G
Total Suspended Solids.....	SMSM2540D
BOD.....	SMSM5210B
Oil & Grease.....	SM5520B
Total Coliform.....	SM9221B
Fecal Coliform.....	SM9221E
Volatile Acid	SM5560C
Alkalinity	SM2320A
Settleable Solids	SM2540F

Bruce Keogh, Lab Director



Date: 1-31-05

Lab/C/My Documents/Lab QC Docs/Lab QA Updates December 2004/Analytical methods

CALIBRATION PROCEDURES AND FREQUENCY

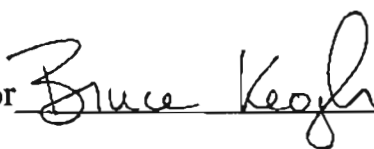
All laboratory instruments are to be calibrated prior to or during use. Instruments require calibration, standardization and informed observation to work accurately.

The pH meter is calibrated daily during lab open up using pH 4, 7, and 10 buffers. Refer to the standard operating procedures (SOP) for pH.

The turbidimeter is checked daily against secondary standards, and calibrated quarterly using primary standards. Refer to the standard operating procedures (SOP) for the turbidimeter.

The analytical balances are calibrated annually by an independent company (Wine Country Balance, Sonoma, CA). Refer to the standard operating procedures (SOP) for the balances.

Bruce Keogh, Lab Director



Date: 1-31-05

Lab/C/My Documents/Lab QC Docs/ Lab QA Updates December 2004/Calibration Procedures and Frequency

Data Reduction, Validation, and Reporting

Significant Figures:

A significant figure is a digit that denotes the amount of the quantity in the particular decimal place in which it stands. Reported analytical values should contain only significant figures. A value is made up of significant figures when it contains all digits known to be true and on the last digit in doubt. For example, if a value is reported as 18.8 mg/L, the 18 must be firm while the 0.8 is somewhat uncertain, but presumably better than one of the values 0.7 or 0.9 would be.

The number zero may or may not be a significant figure depending on the situation. Final zeros after a decimal point are always meant to be significant figures. Zeros before a decimal point with non-zero digits preceding them are significant. With no preceding non-zero digit, a zero before the decimal point is not significant. If there are no non-zero digits preceding a decimal point, the zeros after the decimal point but preceding other non-zero digits are not significant. These zeros only indicate the position of the decimal point.

Rounding Off:

Round off by dropping digits that are not significant. If the digit 6, 7, 8, or 9 is dropped, increase the preceding digit by one unit. If the digit 1, 2, 3, or 4 is dropped, do not alter the preceding digit. If the digit 5 is dropped, increase the preceding digit by one if it is an odd number, or keep it unchanged if it is an even number.

Calculations:

As a practical operating rule, round off the result of a calculation in which several numbers are multiplied or divided to as few significant figures as are present in the factor with the fewest significant figures. When numbers are added or subtracted, the number that has the fewest decimal places, not necessarily the fewest significant figures, puts the limit on the number of places that justifiably may be carried in the sum or difference.

Data Reduction, Validation, and Reporting Cont

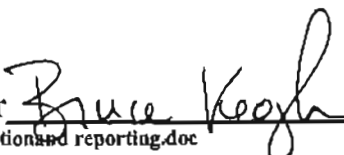
Data Validation:

The data is reviewed and checked by the analyst. The analyst will review all raw data and calculations to insure that the QC criteria has been met. The raw data, sample run sheet, and all other paperwork associated with the job are kept in the individual analyses notebooks for supervisor review. If the data is acceptable, then a report will be generated by the Laboratory supervisor.

The review of the data will include the following checks.

- a. Were the correct samples analyzed for the correct analyses as documented on the chain of custody form?
- b. Was the instrument properly calibrated?
- c. Was the holding time of the samples prior to analysis within acceptable limits?
- d. Are results calculated correctly after dilutions?

If there is a question to the validity of the analyses, then the sample is re-run by the analyst to verify. If the results are still in question after the second analyses, then they are declared invalid and the sampler is contacted to provide a second sample to the laboratory. All final reports are reviewed and signed by the Laboratory supervisor. All NPDES and EPA reports to the Regional Water Quality Control Board are also reviewed and signed by the Lab Manager. All lab data sheets and recorder charts are kept and stored at the wastewater treatment plant.

Bruce Keogh, Lab Director  Date: 1-31-05
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Maintenance of Laboratory Supplies

Standard Methods 18th Edition, Page 9-3 to 9-5 section 9020 B

Monitoring Pure Water Quality:

At this time, laboratory distilled water (DI water) is purchased from an independent company (Arrowhead). Copies of analysis of purchased water are requested from the company. Copies of the monthly and annual analytical results are on file in the laboratory file cabinet. To perform analysis for quality of purified water used in bacteriological testing, refer to Standard Methods 18th Edition, Page 1-32,33 section 1080 A, B, & C.

Bruce Keogh, Lab Director

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Date: 1-31-05



ARROWHEAD DISTILLED WATER

QUALITY OF PURIFIED WATER USED IN MICROBIOLOGY TESTING

The Arrowhead distilled water described below meets all reagent grade water requirements by the California Department of Health Services as listed in Standard Methods for the Examination of Water and Wastewater, 19th Edition, 1995.

ANNUAL SUITABILITY - 2003

Production Location: Los Angeles

Production Date: March 11, 2003

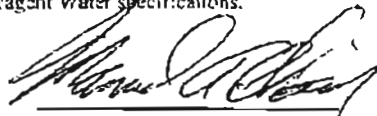
<u>TEST DESCRIPTION</u>	<u>TEST RESULT</u>
Conductivity	1.4 μ mhos/cm
pH	5.60
Total Organic Carbon	< 0.5 mg/L
Heavy Metals:	
Cadmium, Cd	< 0.001 mg/L
Chromium, Cr	< 0.002 mg/L
Copper, Cu	< 0.005 mg/L
Nickel, Ni	< 0.002 mg/L
Lead, Pb	< 0.001 mg/L
Zinc, Zn	< 0.025 mg/L
Ammonia/Organic Nitrogen	Passes USP Standard
Total Chlorine Residual	< 0.01 mg/L
Total Dissolved Solids	< 1.0 mg/L
Heterotrophic Plate Count (HPC)	< 1 cfu/ml
Water Bacteriological Quality Test	Growth ratio = 0.96
Oxidizable Substances	Passes USP Standard
Carbon Dioxide	Passes USP Standard

Arrowhead Distilled Water Specifications:

Total dissolved solids (TDS): < 2 mg/L; Total residual chlorine: ND (< 0.01 mg/L); Ammonia, N: ND (< 0.1 mg/L); pH: 5.0 - 7.0; Heterotrophic Plate Count (HPC): < 100 cfu/ml; Conductivity: < 4.0 μ mhos/cm; Bacterial growth ratio: 0.8-3.0; Heavy metals: < 0.050 mg/L; Total organic carbon: < 1.0 mg/L.

ND = None Detected.

Arrowhead Distilled Water also meets all USP Purified Water and ASTM Type IV Reagent Water specifications.


Quality Assurance Manager

Quality Assurance Laboratory, Los Angeles, CA 90021. Phone (213) 763-1350. Fax (213) 749-3777

Glassware Cleaning
Standard Methods 18th Edition, Page 9-3 Section B-3

Procedure:

1. After dumping sample, rinse with water and apply FL70 detergent located at sink.
2. Scrub or brush unit until all of sample has been removed from glassware.
3. Glassware should then be rinsed three times with hot water.
4. After rinsing with tap water, rinse again with DI water.
5. Dry glassware is ready for use.

Note: A **glassware inhibitory residue test** will be performed on initial use of washing compound, when there is a change in formulation used, or a change in the method of washing of reusable culture tubes, pipettes, flasks, graduated cylinders, beakers, blenders, funnels, etc.

A glassware inhibitory residue test was last performed on _____;
by _____
Lab name

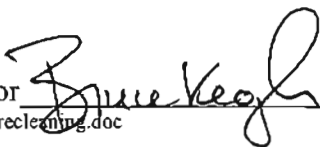
pH Spot Check:

Because some cleaning solutions are difficult to remove completely, spot check batches of clean glassware for pH reaction, especially if soaked in alkali or acid.

Procedure:

On a monthly basis, test clean glassware by adding a few drops of 0.04% bromthymol blue (BTB) or other pH indicator and observe the color reaction. BTB should be blue – green (in the neutral range). Record results on pH check form.

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/glasswarecleaning.doc



Date: 1-31-05

PH Spot Check

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Lab Equipment and Instrumentation

Standard Methods 18th Edition, Page 9 -3, Section 9020 B

Analytical Balance & Top Load Balance

1. Balance must have a readability of 0.1g
2. Balance must be checked daily for accuracy using ASTM class I weights. Note: a minimum of 3 traceable weights that bracket our lab's weighing needs are to be used.
3. Data recording on daily scale record sheet located on the refrigerator.
4. All reference weights will be re-certified if damaged or corroded.
5. Service contract for internal maintenance control on the analytical and top load balance is completed annually by Wine Country Balance, Sonoma, CA.

Portable Balance

The portable top load balance (Sartorius 500.0g) will be checked at least monthly and before use, using ASTM 1, 10 and 100g weights (minimum of three traceable weights that bracket our labs weighing needs) and recorded on the portable balance calibration sheet.

Incubators

1. Our incubator is of sufficient size for our workload.
2. Our incubator unit has an internal temperature monitoring device and maintains a temperature of $35^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$.
3. Any temperature corrections must be noted on the daily incubator record sheet located on the side of our unit and on the thermometers.
4. Temperatures must be recorded twice each day of use, with readings at least 4 hours apart.

Scale Calibration (s)

Class I Weights Used #1____#2____#3____#4____

Scale off in g. (s)

Date

#1

#2

#3

#4

1.

Operator

Scale off in g. (s)

Date _____

#1

#2

#3

1#4

Operator

EQUIPMENT TEMPERATURE RECORD
(C)

Month . Year .

Equipment_____. Certified Thermometer_____. +/-_____.

[illegible]

Autoclave

Standard Methods 18th Edition, Page 9-4, Section 9020 b

1. Our autoclave is sufficient for our workload and pressure cookers are not being used.
2. Our autoclave has an internal heat source, temperature gauge with sensor in exhaust, pressure gauges, and an operational safety valve.
3. Our autoclave maintains sterilization temperature during cycle and completes the entire cycle within 45 minutes when 12 to 15 minute sterilization period is used.
4. For quality control, the automatic timing device is checked quarterly for accuracy with another accurate timing device. Results are recorded on the Control Test Data sheet in the lab data book and corrections are to be noted on log sheet and autoclave time temperature sheet.
5. For quality control, a maximum temperature registering device is used weekly to check the sterilization temperature of $121^{\circ} \pm 2^{\circ} \text{C}$. Results are recorded on the Control Test data sheet in the lab data book.
6. A heat indicating tape is used to identify items that have been sterilized.
7. Routine maintenance of the autoclave includes cleaning of drain screen and visual inspection of the door seals on a weekly basis.
8. Spore ampules are used monthly as bioindicators to confirm sterilization. Results are recorded on the Control Test data sheet in the lab data book.
9. Contaminated test materials must be autoclaved at 121°C for at least 30 minutes.

Autoclave records must include:

- Date
- Contents
- Time in and out
- Total exposure/cycle time
- Sterilization time
- Sterilization temperature
- Initial of technician

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/autoclave.doc

Bruce Keogh Date: 1-31-05

AUTOCLAVE RECORD SHEET

[illegible]

MYDOCUMENTS/LAB/AUTOCLAVESHEET.DOC

LAB OPEN UP

I. Procedures to open Lab:

- A. Check Temp of Bac T Incubator. ($35^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$)
- B. Check Oven Temp. ($103-105^{\circ}\text{C}$)
- C. Check BOD Incubator Temp. ($20^{\circ}\text{C} \pm 1.0^{\circ}\text{C}$)
- D. Check Refrigerator Temp. ($< 5.0^{\circ}\text{C}$)
- E. Check the Calibration of Turbidimeter. (see chart)
- F. Calibrate the PH. meter. (see Instructions)
- G. Check the H₂O Bath Temp. ($44.5^{\circ}\text{C} \pm 0.2^{\circ}\text{C}$)

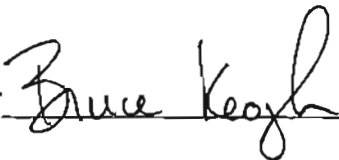
II. Other Open-up Duties:

- A. Read Plant Bac T Test.
 - 1. Monday ~ Friday
 - 2. Saturday – Sunday (Once a month sliding schedule)
- B. Set-up daily glassware
 - 1. Two 250 ml. Graduated cylinders. (Comp Eff Susp Solids Test)
 - 2. One 25 ml. Graduated cylinder. (MLSS)
 - 3. One 250 ml. Graduated cylinder. (Secondary Susp Solids Test.)
 - 4. One 250 ml. Beaker. (Inf PH. Test)
 - 5. One 250 ml. Beaker. (Eff PH. Test)
 - 6. One Imhoff Cone. (Settleable Solids Test)
 - 7. Turbidity Tube. (NTU Test)
 - 8. Glass Vial. (CL₂ Test)

III. Weigh Suspended Solids Filters:

- 1. Two Comp EFF.
- 2. One MLSS.
- 3. One secondary Effluent
- 4. One RAS

Bruce Keogh, Lab Director
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Date: 1-31-05

General scheme of laboratory testing
for detection of COLIFORM group in water
 Standard Methods 18th Edition, Page 9-45 to 9-53 Section 9221 A – E

Presumptive Test

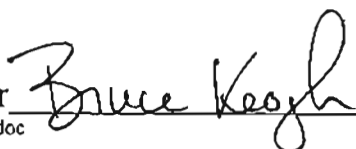
Inoculation of lactose broth

Gas produced = presumed evidence of coliforms Examination continued	No Gas = coliform not present
CONFIRMED TEST – Transfer made from lactose broth tubes to the following:	
BGLB or Brilliant green lactose broth (this medium inhibits the growth of lactose fermenters other than coliforms; thus gas formation in the BGLB medium constitutes a confirmed test: i.e. coliforms present.	Eosin-methylene agar (EMB). Coli-aerogenes organisms produce characteristic colonies; <u>Escherichia</u> : small colonies, dark, almost black centers, with greenish metallic sheen. <u>Enterobacter</u> : large, pinkish colonies, dark centers, rarely show metallic sheen. Presence of typical colonies constitutes a confirmed test: i.e. coliforms present.
Completed Test	
The most typical colonies are selected from EMB plate. (if BGLB used in confirm test, it is first streaked to EMB) and inoculated into :	
Lactose broth (coliforms produce gas).	Agar slant (gram stain prepared from growth; coliforms are gram-negative, nonsporulating bacilli (rod shaped).

Fermentation of lactose broth and demonstration of gram-negative, nonsporulating bacilli constitutes a positive completed test demonstrating the presence of some member of coliform group in the volume of sample examined.

Note: Completed test must be run quarterly, and results are to be logged in Lab log sheet.

Bruce Keogh, Lab Director
 Mydocuments/LabQCdocs/coliformgroupstest.doc



Date: 1-31-05

Coliform

Standard Methods 18th Edition, Page 9-45 to 9-53 Section 9221 A – E

Equipment

Pipettes – 10ml, 5ml, and 1ml
Durham tube (glass vials)
Test tubes with aluminum caps
Wire loop
35° C incubator
44.5° C incubator
Broths (LTB, BGB, EC)

Procedure

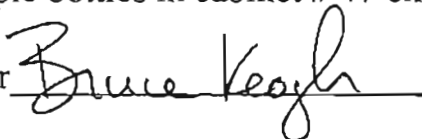
1. Make up and sterilize as on label of broth. Note: make up 1 liter of broth for approx. 80 tubes.
2. Put 10ml of broth in a test tube containing inverted durham tube using the automatic dispenser.
3. Put aluminum caps on.
4. Sterilize using autoclave.

Sterilize capped test tubes containing the media for not more than 15 minutes. The autoclave is preset to maintain a temperature of 121° C at 15 lbs. of pressure. All that is required to operate the autoclave is to fill the chamber with DI water to the marked point, close the door and set the timer for the desired length of time. Make sure that when sterilizing the test tube containing broth media, the exhaust selector switch is in slow (liquid mode). To sterilize pipettes, after rinsing with DI water and drying, place them in the stainless steel cylindrical storage case by the oven. Close the top and place them in the autoclave. Sterilize for 30 minutes at 121°C and 15lbs of pressure.

The sample bottles are also sterilized in the same manner as for pipettes except for samples containing residual chlorine. 1ml = 2 drops of 1% sodium thiosulfate is placed in the jar prior to sterilization. At least one bottle from each batch or lot of bottles shall be tested for sterility with TSB media incubated at 35°C for 24 hours and checked for growth. The results will be recorded on a bottle sterility data sheet.

Store sterilized sample bottles in cabinet # 47 on the east wall.

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/coliformgroup1est

 Date: 1-31-05

Confirmed Test and EC
Brilliant Green Bile (BGB)

Standard Methods 18th Edition, Page 9-45 to 9-53 Section 9221 A – E

LTB broths plus the sample with dilution indicated are positioned in the tray (in the big incubator) as shown below:

10.0 ml LTB II	O	O	O	O	O
1.0 ml LTB	O	O	O	O	O
0.1 ml LTB	O	O	O	O	O

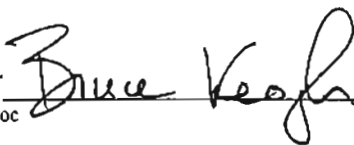
Any positive (gas production) LTB tube either at 24 hrs or 48 hrs is transferred to BGB. The BGB tubes replace the LTB tubes in the same spot.

Example:

1. Burn loop in bunsen burner flame till glowing orange.
2. Air cool 10-15 seconds.
3. Dip loop in a positive LTB tube about 3mls under surface and rotate tube. Pull out loop full of culture and transfer to BGB or BGLB. (try not to pick up scum off the surface of culture).
4. Repeat 1, 2, & 3.
5. Repeat 4 but transfer to EC broth for ocean sampling.

For technique please refer to Standard Methods 18th edition page 9 – 45 sections 9221 a – e.

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/coliformgroup1cst.doc



Date: 1-31-05

Media QC Positive/Negative Control

Standard Methods 18th Edition Page 9-3 Section 9020-9050 C

Rehydrate Culti – Loops: *E-coli*, *Enterobacter aerogenes*, *Staphylococcus aureus* using blood agar (TSA with sheep blood).

Procedure:

The film in each loop is made of a gelatin formulation. To rehydrate the film, the loop must come in contact with both warmth and moisture. To open: cut open the end of the foil packet as indicated on the label.

A: DIRECT STREAK METHOD

1. Warm appropriate plated media to 35° C.
2. Remove red sheath from the loop (*E-coli*, *E-aerogenes*, *staph*).
3. Lay the loop flat on the warm agar surface for 10 – 15 seconds, pressing gently onto the surface of the media. Rehydration of the loop will appear as a clear “bead of moisture” upon lifting the loop from the agar surface. Note: The black film does not have to completely dissolve from the loop for growth of the organism to occur.

After Incubation of 24 to 48 hours at 35°C the *E-aerogenes*, *S.Aureus*, *E-Coli* plates will be ready for use as positive/negative controls.

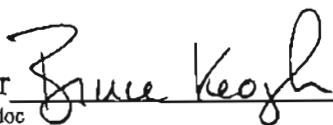
Using a steril inoculation loop transfer the appropriate bacteria to the prepared broths.

LTB/BGB: *E-Aerogenes* as a positive control
Staph aureus as a negative control

EC: *E-Coli* as a positive control
E-Aerogenes as a negative control

Once the bacteria are transferred, LTB and BGB broth will be incubated at 35° C $\pm$ 0.5°C for 24 to 48 hours. Log results in lab book. EC broth will be incubated at 44.5° C $\pm$ 0.2° C for 24 hours only. Log results in lab book.

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/MediaQCPosNeg.doc



Date: 1-31-05

Morro Bay / Cayucos Wastewater Treatment Plant
Quality Controls

AutoClave Bacillus Stearothermophilus			Bact-T Bottle/Pipette Steril Check Media Type (TSB)			
Date	Pos Control	Neg Control	Date	Bottles by numbers	Pipettes Pos/Neg	Bottles Pos/Neg

Completed Test					Autoclave Timer/Temp		
Date	Growth Yes/No	LTB Pos/Neg	BGB Pos/Neg	EC Pos/Neg	Date	Temp	Time Corrections

Mydocuments/lab/controlchecks.doc

Water Bath Quality Control (EC Broth)

[illegible]

Ocean samples are examined as follows:

Standard Methods 18th Edition, Page 9-45 to 9-53 Section 9221 A – E

1. 5 double strength tubes of broth inoculated with 10.0ml of sample.
(double strength = double in concentration).
2. 5 single strength tubes of broth inoculated with 1.0ml of sample.
3. 5 single strength tubes of broth inoculated with .1ml of sample.

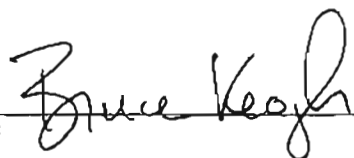
These tubes are then incubated in 35° C incubator by the east wall and checked at the end of 24 hours and 48 hours. The results are entered in the laboratory log book. At the end of 24 hours, transfer with transfer loop the positive tubes (gas production constitutes a positive result) to BLGB broth and E.C. broth at the same time. Incubate BGLB medium in 35° C.

Production of gas at the end of 24 hrs or 48 hrs constitutes a confirmed test, i.e. coliforms are present. Incubate the E.C. broth in water bath at 45° C for 24 hrs. Gas production constitutes a positive test, i.e. fecal coliform is present. If, at the end of 24 hrs, the E.C. broth yields a negative result (no gas production), it constitutes a negative test, i.e fecal coliform is not present. The E.C. tubes are then discarded.

Positive (*Escherichia Coli*) and negative (*Enterobacter aerogenes*) controls must be run whenever sample tubes are placed in the water bath for determination of fecal Coliform. Results are to be recorded on the water bath positive / negative control data sheet and beach survey form.

Please note that the transfer loop is sterilized by heat (a bunsen burner); it is placed in the flame and needs to glow bright orange then taken out and air cooled before using it for transfer. If a sizzling sound is produced when dipping the loop in the medium, that is an indication that the loop has not been given enough time to cool.

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/coliformgroupstest.doc

 Date: 1-31-05

CITY OF MORRO BAY BEACH SURVEY

PLACE: Morro Strand Beach

DATE:

SAMPLER:

WEATHER:

☐

CLEAR

☐

CLOUDY

☐

FOG

☐

RAIN

INCH: _____

TEMPERATURE:

AIR _____

WATER _____

TIDE:

☐

Ebb

☐

Flood

☐

Slack

WIND: Direction _____

Intensity _____

BEACH USE: Swimmers _____

Spectators _____

STATION NUMBER:

A1

A

B

C

D

E

F

M/CRK

TIME SAMPLE COLLECTED:

R E C F I V I N G	N o n S D e e w b a r g i e s	Marine Growth							
		Storm\Shipping							
		Garbage\Refuse							
		Tars\Oils							
		TOTAL COLIFORM							
W A T E R S	S e D w e a b g r e i s	Soap\Grease balls							
		Rubber Goods							
		Fecal Material							
		FECAL COLIFORM							
B E A C H A R E A	N o n D S e b w r a i g s e	Marine Growth							
		Storm\Shipping							
		Garbage\Refuse							
		Tars\Oils							
	S e D w e a b g r e i s								
		Soap\Grease balls							
		Rubber Goods							
		Fecal Material							

PLANT OPERATION:

☐

Good

☐

Fair

☐

Poor

☐

Unknown

BYPASSING WHEN SAMPLING:

☐

Yes

☐

No

☐

Unknown

PREVIOUS DAY

AT TIME OF SAMPLING

Flow _____ MGD Gal NaOCL used _____

Flow _____ MGD Dosage Lbs \ day _____

Calculated NaOCL Dosage _____ mg/L

Residual NaOCL in effluent _____ mg/I

Suspended Solids

Standard Methods 18th Edition Page 2-56, Section 2540 D

Background:

Total suspended solid (nonfilterable residue) is the material retained on a standard glass fiber filter after filtration of a well-mixed sample.

Equipment:

Vacuum source (on the bench top).

- Buchner Funnel and 1000 ml. vacuum flask (by the north sink).
- Filter paper (glass microfibril) 9 cm (located in drawer).
- Oven 103°-105° C (north wall).
- Analytical Balance (north wall).
- Desicator (by oven).

Procedure:

The filtration is achieved by vacuum. The filter paper (located in drawer) is first washed with distilled water (three 20 ml. portions) and place in the 103°-105°C oven for one hour to dry, and then transferred to the desicator to cool for 15-30 mins. (Use forceps for handling the filter paper). Weigh the filter paper and record in the lab log book. Measure the desired volume of sample with a graduated cylinder and pass through the filter (vacuum filtration). This is achieved with the use of a Hirsh Funnel. When washing the filter paper, a Buchner Funnel is employed.

Dry the filter paper in the oven (103°-105° C) for one hour or more and cool in the desicator for 30 mins. Weigh as before and record the values in the lab log book. Composite influent and effluent samples must be averaged between the two samples (of the same kind) when weighed. A second weighing should be done on all samples tested. If a deviation of 5% or more from the previous weight is noted, than a third weighing is necessary. The weight measurements are done by the analytical balance and weights are recorded to the nearest .1 mg. i.e. 1.2345 gr.

Calculation:

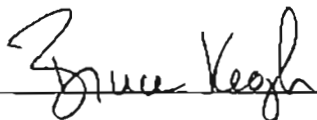
Mg. total nonfilterable residue $PPM = \frac{(a-b) \times 1000}{\text{Sample volume, ml.}}$

A= weight of filter paper + residue in mg. and

B= weight of filter paper, mg.

Note: 1.00 gr. = 1000mg

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/suspendedsolids.doc

 Date: 1-31-05

Suspended Solids Record

40

Biochemical Oxygen Demand (BOD)

Standard Methods 18th Edition, Page 5-1 to 5-6, Sections 5010 ABC, 5020, and 5210 A-B

Background:

Biochemical Oxygen Demand (BOD) is an empirical test that is used to determine the relative oxygen requirements of wastewater effluents and polluted waters. The test measures the oxygen required for the biochemical degradation (degradation by living organisms) of organic materials (pollutants that can be used as food for living organisms).

There are also some inorganic materials that would oxidize and therefore increase the oxygen consumption. These materials are mostly sulfides (S^{2-}) and ferrous iron (Fe^{+2}). A reduced form of nitrogen, like ammonia, would also use the oxygen to become oxidized (nitrogenous demand).

Nitrogenous demand can be prevented by the use of an inhibitor such as 2-chloro-6 (trichloromethyl) pyridine (TCMP).

Equipment:

Dissolved oxygen meter YSI 5100 (on the bench top)

BOD bottles (cabinet under incubator)

Plastic caps (located in drawer)

Glass bottle caps (cabinet under incubator)

Reagents:

BOD nutrient buffer pillows (Hach, BOD nutrient buffer pillows)

Locations:

Compositor at headworks (influent) and upper chlorine contact chamber area (effluent).

Procedure:

Please note that these procedures are only applicable at Morro Bay/Cayucos WWTP lab.

A) Preparations of dilution water:

Use one BOD nutrient buffer pillow for three liters of water, usually six liters of dilution water is made. Aerate the dilution water by shaking the bottle for about five minutes or use filtered air.

Mydocuments/labQCdocs/BOD&DOMeter.doc

BOD Cont.

Standard Methods 18th Edition, Page 5-1 to 5-6, Sections 5010 ABC, 5020, and 5210 A-B

B) Dilution Techniques:

Note: Composite influent and effluent samples both need to be at a pH range between 6.5 and 7.5. This is accomplished by placing the samples on our pH meter and titrating the sample with either sulfuric acid concentrate to reduce the pH to 7.5, if pH is lower than 6.5, titrate with sodium hydroxide to increase pH to proper range.

Use two dilutions for each sample in duplicate (two of each) and a blank for each set of analyses. Composite final effluent samples usually require 20 and 10 ml. of sample per BOD bottle. Raw samples require 3 and 1 ml. per BOD bottle. Use a pipette for all measurements.

After all the samples are measured and put in BOD bottles fill the bottles with dilution water to the top and make sure that there are no air bubbles trapped in the bottles. The air bubbles can be withdrawn by tapping the side of the bottle with a glass or metal rod.

Bruce Keogh, Lab Director
Mydocuments/labQCdocs/BOD&DOmeter.doc



Date: 1-31-05

YSI Dissolved Oxygen Electrode:

BOD TEST

How to Run

1. First you'll need to calibrate the BOD unit.
2. Turn the unit on (see the diagram).
3. Let the unit warm up at least 15 minutes.
4. The meter will have four choices at the bottom.
5. After the 15 minutes warm up choose the Calibrate button (see the diagram).
6. Four new choices will appear (see diagram).
7. Choose the AUTO CAL. Button (D.O. Calibration Saved will appear briefly).
8. Next push the mode button. This will change the screen to the operation ready mode (see the diagram).
9. Now you're ready to start your reads. Place the probe into Blank bottle # 122, wait 45 sec. Then read. Log the reading on BOD sheet.
10. Now do the rest of the BOD bottles the same way. In this order. Bottles # 137, # 130, # 110, # 127, # 123, # 104, # 126, # 135, # 98.
11. After your last bottle. Turn the unit off then rinse the probe CAREFULLY no higher the 1" from the bottom. Replace probe into holder.

Note: The oxygen content of all samples bottles (other than the blanks) should be at least 1 mg/L. Furthermore, a depletion of 2 mg/L of DO is desirable and the DO uptake in the blanks should not be more than 0.2 mg/L and preferably not more than 0.1 mg/L.

To prevent loss of oxygen during incubation, the DO must be reduced to saturation at 20° C by bringing the sample to about 20° C in partially filled bottle while agitating by vigorous shaking or by aerating with clean, filtered compressed air. During the BOD setup, initial DO should not be over 9.0mg/L.

Calculations:

By subtracting final DO from initial DO, the depletion of oxygen is obtained, and since there are duplicate bottles, this depletion is averaged.

$$\text{BOD mg/L} = \frac{\text{In} - \text{Out} \times 300\text{ml}}{\text{Ml of sample}}$$

Bruce Keogh, Lab Director

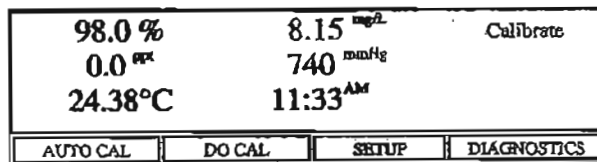
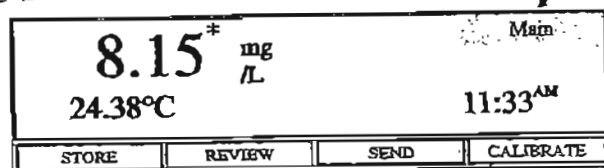
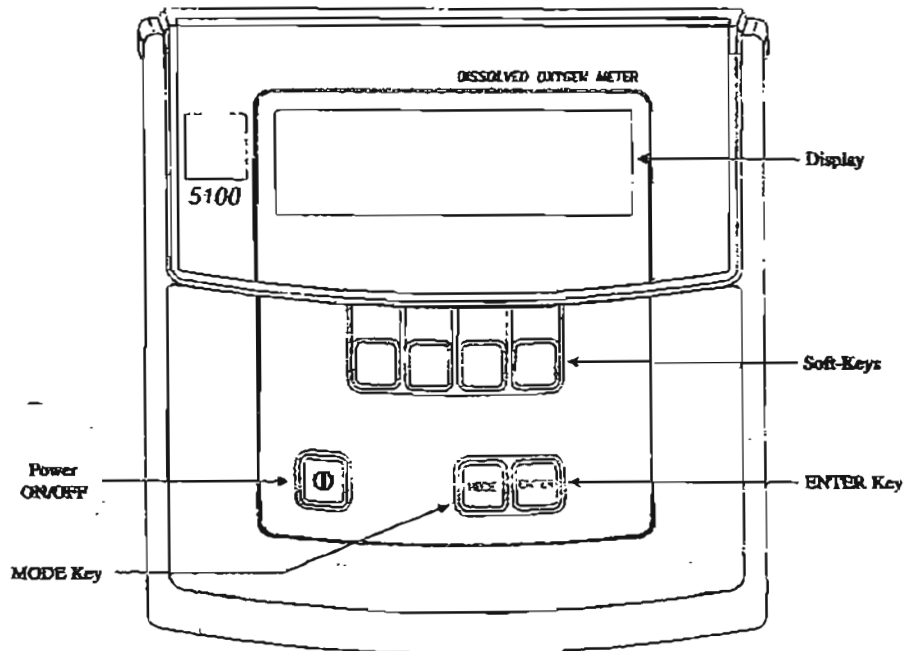
Mydocuments/LabQCdocs/BOD&Dometer.doc

Date 1-31-05

4. Controls

4.1 Front Panel

The front panel of the instrument contains the display and keypad as shown below. The front panel display and controls of the 5000 and 5100 are identical.



MORRO BAY / CAYUCOS WASTEWATER TREATMENT PLANT

BOD Record (mg/L, 5 Day, 20 °C)

[illegible]¹Time at start of incubation

²Include Time Sampler
On and period of
collection

5/5

pH

Please refer to Standard Methods 18th Edition Page 4-65 section 4500 A-B

Equipment: Orion model 310 pH meter

Procedure:

Before making measurements with a pH meter, one must make sure that the meter is calibrated. Each day of use, the pH will be calibrated with 2 buffers (4&7 or 7&10). The buffers must be dated and buffer type documented on our daily logs each time a calibration is made or changed. Accuracy and scale graduations must be within ± 0.1 units and the electrode must be maintained as per manufacturer's instructions. The calibration procedure is in the LAB TEST PROCEDURES BOOK located on shelf above computers.

In general, three types of buffer are used (pH 7.00, pH 4.00, and pH 10 buffer, located in chemical cabinet). Fill one 50 ml beaker with pH 7.00 buffer and one with 10.0 pH buffer. Place the 7.00 buffer on the stirrer and stir. Insert the pH probe into the beaker then press the mode button to turn unit on. Next press the CAL. Button to start the calibration process. The meter will flash SLP (at this point the up arrow may need to be pressed to bring the slope to 7-10 range) then briefly a percentage number. After the slope is seen on the meter push the YES button to accept this range. The meter will show a reading *at or near 7.00*. Log this reading on pH Calibration sheet located on BOD incubator. The meter will then lock onto the 7.00 reading and the ready light will be displayed. At this point, press the YES button locking in the 7.00 pH part of the CAL. Remove probe from 7.00 pH buffer beaker and replace with 10.0 pH buffer (on stirrer). Be sure to wipe the electrode with a clean Kim Wipe to remove 7.00 pH buffer. Insert probe into pH 10.00 and stir. Leave electrode in 10.0 pH buffer until the unit reads exactly 10.01 and the ready light is visible. Hit the Yes button, and a new SLP percentage will show (approx. 98%). The pH meter is now ready for use.

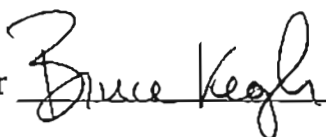
pH meter Cont.

Please refer to Standard Methods 18th Edition Page 4-65 section 4500 A-B

NOTES:

1. Make sure the electrode is thoroughly rinsed with DI water after each use or between measurements of different samples.
2. Do not touch or damage the electrode tip. It is very sensitive and great care should be taken when analysis is performed.
3. Record all reading in lab log book and initial the entries.
4. When testing a lower pH range, for instance, during a grease and oil test, the pH meter must be recalibrated to the 4-7 range by simply pressing the down arrow during initial calibration.
5. Always stir the sample during use of the pH meter.
6. For additional info refer to pH instruction handbook located above the computer desk. Also refer to Standard Method Handbook 18th ed.
Page # 4 – 65 section 4500 A-B.

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/PH.doc

 Date: 1-31-05

PH. CALIBRATION

[illegible]

Determination of Residual Chlorine in Wastewater
(Simplified Field Test)

Refer to Standard Methods 18th Edition, page 4-45 section: 4500-ci

Equipment:

1. LaMotte 1200 Colorimeter
2. 10ml graduated cylinder
3. Sample bottle
4. DI water
5. DPD pillows (reagents)

Procedure:

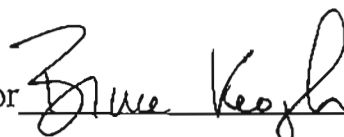
To get an accurate reading a dilution may be necessary for this test. Collect a sample of the wastewater or water to be tested in a clean sample bottle. Add 2.5 ml of sample to your 10ml grad. cylinder. Then fill the rest of the cylinder with DI water up to 10ml.

NOTE: This is your diluted sample used for the test at a ratio of 4:1. In general, this dilution factor will change depending on the strength of CL₂ in your sample as the residual meter does not exceed 9.9mg/l.

In the next step, pour your 10ml sample into the 10m. cylinder designed to fit into the meter. Upon insertion, close the hatch and turn the meter on. Then, hold the "zero" button down until "BLA" appears. The meter is now zeroed. Remove sample and pour reagent (currently using DPD pillow) into sample. Allow reagent to dissolve completely, insert the sample into the machine and press read. The resulting display will show the CL₂ concentration. This number would then be multiplied by 4 to counteract the dilution factor. Example: Meter reads .80mg/l so times by 4 = 3.2mg/l. Log all results in lab book.

For further information please look in the Lamonte 1200 colorimeter handbook located in the meter storage box or for more general info, Standard Methods 18th edition may be utilized page 4-45 section: 4500-ci.

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/chlorineresid.doc

 Date: 1-31-05

Turbidimeter

Standard Methods 18th edition page 2-8,9 sections 2130a-b.

Calibrating:

When data is used is used for USEPA reporting, recalibrate at least every 90 days or as stipulated by the regulating authority. Refer to section 3.2 “calibration” in the Hach 2100N Turbidimeter instrument manual. Furthermore, the turbidimeter will be calibrated using a primary or secondary standard before each use. A quarterly crosscheck should be made using a primary standard. Also, our turbidimeter is on a quarterly work order for calibration and we are using primaries for this check.

Calibration Procedure for the The Hach 2100N Turbidimeter:

1. Fill a clean sample cell to the line (approx 30 ml) with dilution water.
2. Wipe the cell clean and apply a thin film of silicone oil.
3. Place the sample cell into the cell holder and close the cell cover.
4. Press the CAL key. The SO annunciator lights. The NTU value of the dilution water used in the previous water used in the pervious calibration is displayed.
5. Press ENTER key. The instrument display counts down from 60 to 0, and then makes a measurement. This result is stored and used to compensate for the turbidity of the dilution water.
6. The instrument automatically increments to the next standard, displays the expected NTU value, and the S1 annunciator lights. Remove the sample cell from the cell holder.
7. Fill a clean sample cell to the line with well mixed, 20 NTU Formazin standard. Wipe the cell clean and apply a thin film of silicone oil to the surface. Place it into the cell holder, and close the cell cover. Press ENTER key. The instrument display counts down from 60 to 0, and then makes a measurement. The display automatically increments to the next standard, the display shows 200.0 NTU, and the S2 annunciator lights. Remove the sample cell from the instrument.
8. Fill a clean sample cell to the line with well mixed 200 NTU Formazin standard, and complete the same steps used in # 7. This time the S3 light will show.
9. Fill a clean sample cell to the line with well mixed 1000 NTU Formazin standard, and complete the same steps used in # 7. This time the S4 light will show.

Turbidimeter Calibration Cont.

10. Fill a clean sample cell to the line with well mixed 4000 NTU Formazin standard, and complete the same steps used in # 7. This time the S0 light will show, and the previously measured value of the dilution water is displayed.
11. Press the CAL key. The instrument makes calculations based on the new calibration data, stores the new calibration and returns the instrument to the measurement mode.

Reviewing the calibration sequence

Press the CAL key and then use the UP ARROW key to scroll through the standard to review calibration data currently in effect. Press the UNITS/EXIT key to return to the operating mode without altering the current calibration data.

Note: Reassign new values to the Gelex standards each time the instrument is calibrated with Formazin. Formazin is the primary standard and Gelex is the secondary standard. Formazin is known to cause cancer so use extreme caution when handling.

Error Codes are located on the Hach 2100N Turbidimeter Quick reference guide located in the drawer under the meter itself.

Hach 2100N Turbidimeter Test Procedure:

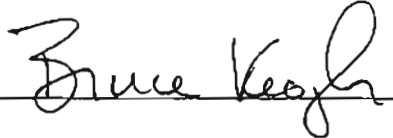
1. Collect a representative sample in a clean container. Fill the sample cell to the line. Take care to handle the sample cell by the top. Cap the sample cell. Our turbidimeter is designed to stay on 24hrs a day. If machine is ever turned off refer to Quick Reference Guide, step 1 in procedures.

Turbidimeter sample procedures cont.

2. Hold the sample by the cap, and wipe to remove water spots and finger prints with a clean Kim Wipe.
3. Apply a thin bead of silicone oil from the top to the bottom of the cell, just enough to coat the cell with a thin layer of oil. Using the oiling cloth provided, spread the oil uniformly. Then, wipe off the excess. The cell should appear nearly dry with little or no visible oil.
4. Place the sample cell in the instrument cell compartment and close the cell cover.
5. Select manual or automatic ranging by pressing the RANGE key.
6. Select the appropriate SIGNAL AVERAGING setting (on or off) by pressing the SIGNAL AVERAGE key.
7. Select the appropriate RATIO setting (on or off) by pressing RATIO key. NOTE: Values greater than 40 NTU require ratio on.
8. Select the appropriate measurement unit by pressing the UNITS/EXIT key (NTU is our standard).
9. Read and record the results in the lab book.

For any other references please look in the HACH 2100N Turbidimeter manual or Quick reference guide or Standard Methods 18th edition page 2-8,9 sections 2130a-b.

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/turbidimeter.doc

 Date: 1-31-05

Turbidity Meter Calibration

Standards Used #1_____, #2_____.

#3 _____, #4 _____.

[illegible]

Settleable Solids

Refer to Standard Methods 18th Edition, Page 2-57 section 2540 – F.

Description:

Settleable solids of sewage is the volume of suspended matter that settles to the bottom of a tank or compartment designed for the collection of the settleable material. The determination for settleable solids is made by allowing one liter of the sewage to stand for one hour in an Imhoff cone, and reading directly from the graduations of the cone the volume of the suspended matter that settled to the bottom. The result represents the settleable solids, in milliliters per liter.

Purpose:

The determination of settleable solids in sewage is valuable as showing how much suspended matter can be or has been removed by sedimentation. To measure visibly the efficiency of a sedimentation process, tests for settleable solids are made on the influent and effluent of the settling basin or compartment. The difference between the settleable solids of the influent and effluent gives the settleable solids removed. The percent of the solids removed may now be calculated by dividing the volume of the solids removed by the volume of the settleable solids of the influent and multiplying by 100.

Equipment:

Imhoff Cones.

Rack for holding Imhoff cones.

Glass stirring rod or wire.

Settleable Solids Cont.

Test Procedure:

1. Thoroughly mix the sewage sample by shaking and immediately fill an Imhoff cone to the Liter mark.
2. Record the time that the cone is filled. Time = _____.
3. Allow the waste sample to settle for 45 minutes.
4. Gently spin the cone to facilitate settling of material adhering to the side of the cone.
5. After one hour, record the number of milliliters of settleable solids in the Imhoff cone. Make allowance for voids among the settled material.
6. Record the settleable solids as ml/L or milliliters per Liter

	Sample
Settleable solids, Influent = _____ ml/L	10.0
Settleable solids, Effluent= _____ ml/L	0.5
Settleable solids, Removal= _____ ml/L	9.5

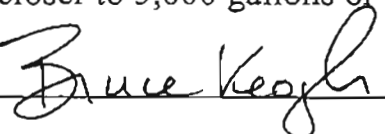
Example:

If one liter of raw sewage or influent contains 10.0 ml of settleable solids, it should be possible to remove most of this in the primary settling system. If the effluent contains 0.5 ml per liter, it is possible to calculate the efficiency of removal by using this formula:

$$\begin{aligned}\% \text{ Efficiency} &= \frac{(\text{ml influent}) - (\text{ml effluent})}{(\text{ml influent})} \times 100 \\ &= \frac{10.0 - 0.5}{10.0} \times 100 = 95\% \text{ removal}\end{aligned}$$

It should also be possible to check the maximum volume of sludge to be pumped out of settling tanks. For example, if one liter, equaling 1,000 ml of sewage, contains 10.0 ml of settleable solids, 1,000,000 gallons of sewage should not contain over 10,000 gallons of sludge. Generally, sludge compacts by a factor of two or three and therefore this volume will be smaller by half or more. Instead of pumping 10,000 gallons, then, the volume would probably be closer to 5,000 gallons or less.

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/settleablesolids.doc

 Date: 1-31-05

Grease and Oil

Refer to Standard Methods 18th Edition, page 2-51 section 2530 –c

Background:

“Grease and Oil” is any material recovered as a substance soluble in trichlorotrifluoroethane (freon). Thus, in the determination of oil and grease on absolute quantity of a specific substance is not measured. The significance of this test arises from the fact that certain constituents measured by the oil and grease analysis may influence wastewater treatment systems. If present in excessive amounts, they may interfere with aerobic and anaerobic biological processes (digester and trickling filter) and can lead to decreased wastewater treatment efficiency. When discharged in wastewater or treated effluents, they may cause surface films and shoreline deposits leading to environmental degradations.

NOTE: The effluent grab sample should be collected in a glass beaker (2000ml) at the air relief structure. Sample volume should be exactly 1000ml. The influent grab sample is taken directly from the main influent channel located in the lower headworks.

Method:

Partition-Gravimetric Method

Apparatus:

1. Separatory funnel, 1 Liter with teflon stoplock
2. Distilling flask
3. Water bath
4. Filter paper, 11cm diameter, Whatman # 40

Reagents:

1. Hydrochloric acid, Hcl 1+1
2. Trichlorotrifluoroethane
3. Sodium sulfate

Procedure:

Collect exactly 1 Liter (1000ml) of sample in your 2000ml beaker. Mark the sample level for later determination of sample volume. Acidify to pH 2.0 or lower (about 5ml of Hcl 1+1). Transfer to separatory funnel. Carefully rinse sample container with 30ml of trichlorotrifluoroethane and add solvent washing to separatory funnel. Shake vigorously for 2 minutes venting immediately and frequently to allow gas build up to be released. Place funnel in holder and allow the layers to separate for 10 mins.

Grease and Oil Cont.

Refer to Standard Methods 18th Edition, page 2-51 section 2530 -c

Procedure continued:

Adding two scoops of sodium sulfate to the filter paper assists in filter efficiency. Then, drain solvent layer through a funnel containing solvent-moistened filter paper into a clean, tared (pre weighed) distilling flask.

As mentioned above, if a clear solvent layer cannot be obtained (which is the case at this treatment plant), add 2 scoops of sodium sulfate to the filter paper cone and slowly drain emulsified solvent onto the crystals. Add more sodium sulfate if necessary.

Extract twice more with 30 ml of solvent each time, but first rinse sample container with each solvent portion. Combine extracts in tarred distilling flask and wash filter paper with an additional 10 to 20 ml solvent.

Evaporate freon from distilling flask in a water bath at 70° C for 15 minutes. Draw air through it with an applied vacuum for the final minute. Cool in a desicator for 30 minutes and weigh.

A blank shall be run on 90ml of trichlorotrifluoroethane (FREON) for each new bottle of trichlorotrifluoroethane opened. The results will be recorded, and a corrective factor will be used for each test conducted.

Calculations:

$$\text{Mg oil and grease/L} = \frac{(A-B) \text{ in mg} \times 1000}{\text{Ml sample}}$$

A = total gain in weight for the sample

B = total gain in weight for the blank

Enter all data collected and calculations in lab log book.

Grease and Oil Cont.

Refer to Standard Methods 18th Edition, page 2-51 section 2530 -c

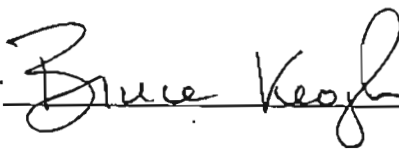
CAUTION !!!

Trichlorotrifluoroethane (FREON) is extremely flammable so handle with care and keep fire or sparks away from are while performing the analysis.

NOTES:

1. DO NOT use a bunsen burner for water bath.
2. Vent the seperatory funnel properly.
3. Avoid breathing the vapor of the solvent (freon).
4. Avoid getting solvent on the skin.
5. For additional information please refer to Standard Methods 18th edition book page 5-25.

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/grease&oil.doc

 Date: 1-31-05

CAUTION:

Trichlorotrifluoroethane (freon) is extremely flammable handle with great care and keep fire or sparks away from work area while performing the analysis.

DO NOT Use a bunsen burner for water bath.

—Vent the separatory funnel properly.

—Avoid breathing the vapor of the solvent.

—Avoid getting the solvent on the skin.

—For additional information, refer to Standard Method 15th. edition, page 460.

Top open
for draining

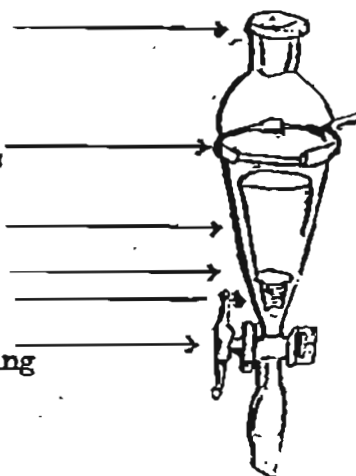
ring with
rubber cushions

top layer

interface

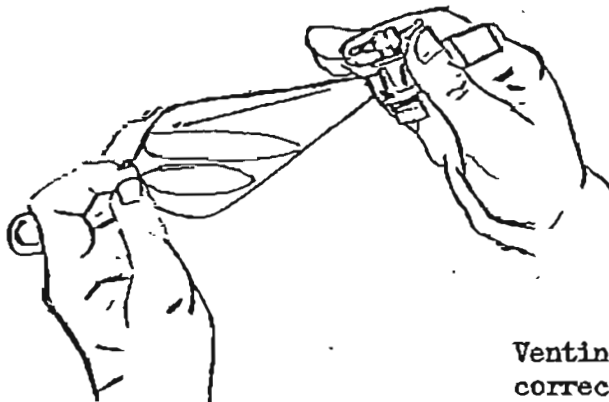
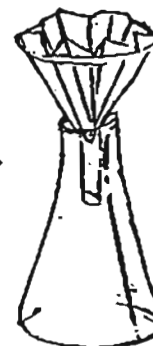
bottom layer

stopcock
open for draining



fluted filter
paper

Erlenmeyer
flask
(other kind of flask
can also be used)



Venting position, showing correct way of holding funnel for shaking and venting.

GREASE & OIL

NAME	DATE	TIME	SAMPLE DESCRIBE LOCATION	ANALYTICAL DATA	REMARK
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	
				FLASK EXTRACT _____ GRMS FLASK TARE WT _____ GRMS NET WEIGHT _____ GRMS	

COMMENTS:

VOLATILE ACIDS TEST

DISTILLATION METHOD

Standard Methods 18th Edition, Page 5-42 Sections 5560 A-C

General Discussion:

Digestion is the process wherein anaerobic organisms, concentrated in a digester tank, decompose the waste organic materials in sludge into simple more stable and non-offensive compounds.

The groups of bacteria work to digest sludge. First, saprophytic bacteria will break down the large organic molecules present in the form of proteins, fats and carbohydrates into simpler organic acids, containing six atoms of carbon or less. Second, methane producing bacteria will further break down these acids, called volatile acids, into methane and carbon dioxide. When the rate of the acids produced equals the rate of acid breakdown with methane production, alkaline digestion progresses satisfactorily. When the process of digestion is upset, the volatile acid level rises rapidly. This condition is usually caused by the sudden inactivity of the methane producing bacteria and the continued production of volatile acids by the saprophytic bacteria. When this occurs, the volatile acid level tends to climb by accumulation. Methane bacteria are much more sensitive to environmental changes in a digester. Sudden variations in digester temperature, pH, feed rate, or the introduction of undesirable waste material easily affect them, curtailing their normal functions.

Purpose:

The volatile acids test measures the acid content in sludge. This test measures the organic fatty acids produced during digestion which are water soluble and can be distilled, such as formic, acetic, propionic, butyric, valeric, and caproic acids. This information is valuable in maintaining digester control. Volatile acid levels below 300 ppm are desirable. Values greater than 1000 ppm are probably indicative of a serious problem. If the acids increase and continue to build up, this test will usually correct this condition, although other factor such as digester temperature, gas production and raw sludge solids concentration should also be checked.

Volatile Acids Test Cont.

Standard Methods 18th Edition, Page 5-42 Sections 5560 A-C

The straight distillation method will be described. This method is simple and requires little equipment. However, because of the continuously changing conditions in the distillation flask it may give slightly high results. Digested sludge liquor is separated from the solids by centrifugation; a measured volume of the supernatant liquor is then acidified to convert the buffered acids into an acid form. These acids are then distilled and titrated with 0.1 normal sodium hydroxide from which the acid content may be determined. If a centrifuge is not available, the liquor may be separated from the solids by filtering the sludge through coarse paper, such as a paper towel place in a funnel.

Equipment:

Glassware needed:

Graduated Cylinder 100 ml. (2)

Erlenmeyer flask 1000 ml.

Pipette 1 ml. 1/100

Flask 225 ml.

Filter w/ 90mm SS filter

Filter Flask w/ hose

Glass beads

Chemicals needed:

H₂SO₄ Sulfuric Acid Conc.

Phenol Indicator

Sodium Hydroxide

Celite Filter Aid

Procedure:

1. Place about 200 ml of sludge into a centrifuge bottle and centrifuge for about 15 minutes, or filter sample through coarse paper.
2. Measure 100 ml of the supernatant sludge liquor or filtrate into the distillation flask.
3. Add 5 ml concentrated sulfuric acid.
4. Add 150ml DI water to make a total volume of 250ml
5. Connect the flask to distillation apparatus.
6. Collect 100 ml of the distilled material in an Erlenmeyer flask which has been previously marked at the 100 ml level.
7. Titrate distillate with 0.1 N Sodium Hydroxide (NaOH).
 - a) Add several drops of phenolphthalein indicator.
 - b) While stirring, add from a buret standard (0.1 N) sodium hydroxide until the pink color of the indicator solution first appears.

Volatile acid test Cont.

Standard Methods 18th Edition, Page 5-42 Sections 5560 A-C

Note: This color should disappear on standing for several mins.

ml of NaOH used = _____

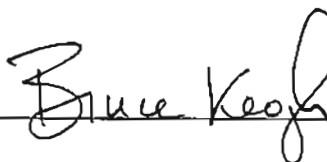
8. Calculation of the volatile acids = If 100 ml of sludge sample is taken, then Volatile acid in mg/L = (ml of standard NaOH used) x 86.5.
9. Record results of test. Volatile acids = _____ mg/L.
10. Sample calculation:
ml of Standard NaOH used = 2.0ml
Volatile acids, mg/L = (ml Std. NaOH used) x 86.5
Volatile acids, mg/L = 2.0 x 86.5 = 173 ppm

Precautions:

1. The sludge sample must be representative of the digester. The sample line should be allowed to run for a few minutes before the sample is taken. The sample temperature should be as warm as the digester itself.
2. The sample for the volatile acids test should not be taken immediately after charging the digester with raw sludge. Should this be done, the raw sludge may short circuit to the withdrawal point and result in the withdrawal of raw sludge rather than digested sludge. Therefore, after the raw sludge has been fed into the tank, the tank should be well mixed by re-circulation or other means before a sample is taken.
3. If a digester is performing well with low volatile acids and then if one sample should unexpectedly and suddenly give a high value, say over 1000 ppm of volatile acids, do not become alarmed. The high result may be caused by a poor, non-representative sample of raw sludge instead of digested sludge. Resample and retest. The second test will probably give a more normal value.
However, continued high values of volatile acids will usually mean that corrective measures should be taken, such as reducing the feed rate, reseedling from another digester, maintaining optimum temperatures, or cleaning the tank of grit and scum.
4. Be sure that the cooling water is running through the condenser.
5. Be sure that the H₂SO₄ has been added before distillation begins. If the solution is alkaline, the volatile acids exist as ammonium salts and will not distill over.

6. Be certain to distill only 200 ml of condensate. Additional distilling beyond 200ml may cause serious errors and very high results, instead of correct answers, for the excess sulfuric acid may start to fume and distill over.

Bruce Keogh, Lab Director
Mydocuments/LabQCdocs/volatile acid.doc

 Date: 1-31-05

Alkalinity

Standard Methods 18th Edition, Page 2-25 Sections 2320 A-B

Equipment:

Graduated cylinder 50ml

Beaker 80ml

5ml Pipette

H₂SO₄ solution

PH meter

D.I water

For sampling points and techniques please refer to page _____.

Procedure:

Note: The pH meter must be recalibrated to the proper range of 4-7 for this particular test. Refer to pH page for step by step instructions.

1. Take the 50ml graduated cylinder and add 45ml D.I. water.
2. Pour the 45ml D.I. water into 80ml beaker.
3. Take 5ml pipette and add 5ml of digester supernatant which has been separated from the sludge sample during the volatile acid test (both tests are run at the same time). This will bring the total amount of sample in the beaker to 50ml (5ml of supernatant and 45ml D.I. water).
4. Grab another clean 5 ml pipette and fill with sulfuric acid solution to 5 ml. Place sample on stirrer and insert pH probe. While stirring, titrate the sample using your sulfuric acid solution until the pH meter reaches 4.30 pH, which usually requires multiple fillings of the pipette.
5. When 4.30 PH is reached, add up the total ml of sulfuric acid solution applied to reach 4.30 pH. Multiply the sulfuric acid used in ml by 200 and this is the alkalinity.
6. Log results in laboratory log sheet.

Bruce Keogh, Lab Director



Date: 1-31-08

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VOLATILE ACID & ALKALINITY

DATE	PH.	VA.	ALK.	RATIO.
DIGESTER #	TEMP.			
DATE	PH.	VA.	ALK.	RATIO.
DIGESTER #	TEMP.			
DATE	PH.	VA.	ALK.	RATIO.
DIGESTER #	TEMP.			
DATE	PH.	VA.	ALK.	RATIO.
DIGESTER #	TEMP.			
DATE	PH.	VA.	ALK.	RATIO.
DIGESTER #	TEMP.			
DATE	PH.	VA.	ALK.	RATIO.
DIGESTER #	TEMP.			
DATE	PH.	VA.	ALK.	RATIO.
DIGESTER #	TEMP.			
DATE	PH.	VA.	ALK.	RATIO.
DIGESTER #	TEMP.			
DATE	PH.	VA.	ALK.	RATIO.
DIGESTER #	TEMP.			
DATE	PH.	VA.	ALK.	RATIO.
DIGESTER #	TEMP.			

COMMENTS:

Volatile Matter / Moisture

Refer to Standard Methods 18th Edition Page 2-57 Section 2540 B,E

General Discussion:

A well mixed sample is evaporated in a weighed dish and dried to a constant weight in an oven at 103° to 105° C. The increase in weight over that of the empty dish represents the total solids. The results may not represent the weight of actual dissolved and suspended solids in wastewater samples.

Equipment:

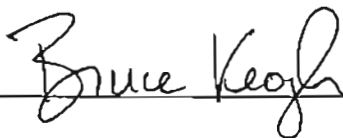
Porcelain dish
Furnace
Desiccator
Drying oven
Analytical balance

Procedure:

Remove a crucible from the oven and allow it to cool to scale temperature in desiccator. Weigh the empty crucible to establish a tare weight and log on sheet. Pour a representative sample into pre weighed, fully cooled crucible approximately one third full and weigh immediately. Log weight on Sludge Moisture / Volatile Solids log sheet and place the crucible in the oven (103°-105°C). Allow crucible to stay in the oven overnight, thus removing any moisture from the sample. Remove and cool to scale temperature in desiccator. Sample is now ready to be placed in the muffle furnace at 500° ±50°C for 15 to 20 minutes thus burning off all volatile matter leaving only inorganic material. Remove carefully (HOT) and place in desiccator until it is cooled to scale temperature. Weigh and record results in log sheet. Perform calculations on log sheet to determine percent moisture and percent volatile solids.

Refer to Standard Methods 18th Edition Page 2-57 Section 2540 B,E

Bruce Keogh, Lab Director
Mydocument/labQCdocs/volatilematter.doc

 Date: 1-31-05

SLUDGE MOISTURE

DATE/ DIGESTER #			
WT OF DISH & WET SLDG			
WEIGHT OF DISH			
WT OF WET SLUDGE			
WT OF DISH & WET SLDG			
WT OF DISH & DRY SLDG			
LOSS IN WEIGHT			
MOISTURE (LOSS IN - WT MULTIPLIED BY 100 / WT OF WET SLUDGE			
SOLIDS (100- MOISTURE)			

VOLATILE CONTENT

WT OF DISH & DRY SOLIDS			
WT OF DISH			
WT OF DRY SOLIDS			
WT OF DISH & DRY SOLIDS			
WT OF DISH & ASH			
LOSS IN WEIGHT			
VOLATILE MATTER (LOSS- N WT MULTIPLIED BY 100 WT OF DRY SOLIDS			

COMMENTS:

1 OBJECTIVES

The primary objectives of the BC Laboratories, Inc. (BCL) Quality Assurance Program Plan (QAPP) are to provide QA/QC guidelines to 1) assure the data produced is of known quality, 2) ensure our organization is capable of providing results which are of value to our customers, 3) ensure the system can consistently perform under adverse conditions, and to 4) comply with quality goals and objectives as set forth in government and industry standards.

1.1 POLICY STATEMENT

B C Laboratories Inc. is an organization committed to providing legally defensible data that is technically valid and in accordance with professional standards, project goals, and government regulations. The management and staff at B C Laboratories, Inc. are committed to use all available resources to supply accurate, precise, timely and fully documented results. BCL's goal is to provide analytical results and services which are of value to our customers.

1.2 COMPONENTS OF THE QUALITY PROGRAM

Our overall program can be broken down into five essential parts: 1) *Preclusion*, 2) *Assessment*, 3) *Validation*, 4) *Corrective Action*, and 5) *Improvement*.

PRECLUSION: This is comprised of an orderly program of positive actions taken before and during analyses to ensure that analytical systems are functioning properly. Components include quality control planning, training, documented and approved methodologies, calibration of instrumentation, instrument maintenance, comprehensive standardization, control charting, internal and external monitoring.

ASSESSMENT: This includes all components of determining analytical performance. Components include matrix duplicates, matrix spikes, matrix spike duplicates, post spikes, blank spikes, blank spike duplicates, laboratory control samples, calibration checks, calibration blanks, method blanks and surrogate additions. Inclusion of all or some of these components and their frequencies are method dependent. B C Laboratories' standard operating procedures (SOP's) contain all pertinent information concerning respective QC criteria needed for assessment and approval of data. The adequacy of the QC program is measured through internal and external auditing and client feedback on customer surveys.

VALIDATION: This consists of all the steps taken to ensure that generated analytical data is complete and correct. Steps include maintenance of sample tracking and data processing systems, technical review of raw data and final results review and approval by management staff.

CORRECTIVE ACTION: The actions rendered to determine the causes of quality defects and restore proper function of the analytical system. This includes troubleshooting techniques, re-evaluations of analyses and/or methodologies, dilution, calculation checks and continued training of analysts.

IMPROVEMENT: Actions taken to improve standard quality baselines. Steps include assessing windows of improved performance, total quality management training of personnel, and research / development.

1.3 OTHER SOURCES FOR QUALITY GUIDELINES

Since BCL's scope of work is very diversified, pertinent Standard Operating Procedures (SOP's) are used at the bench level to provide guidance and direction. Specific project plans are developed to narrow the scope of work, and thus provide QA/QC protocols on a limited scale and provide for possible modifications to standard practice.

1.4 REVISION PRACTICES

The QA Officer is responsible for the maintenance of the QAPP. Review of this plan should take place by each department supervisor and President before the end of each calendar year. All revisions and additions are submitted to the word processing specialist for entry, then each revision is reviewed by pertinent personnel. Once final approval is granted, the revision number is sequentially increased by one and the date of approval is recorded. All revised sections are distributed to persons who have controlled copies of the QAPP.

QUALITY OBJECTIVES

3.0 QUALITY OBJECTIVES

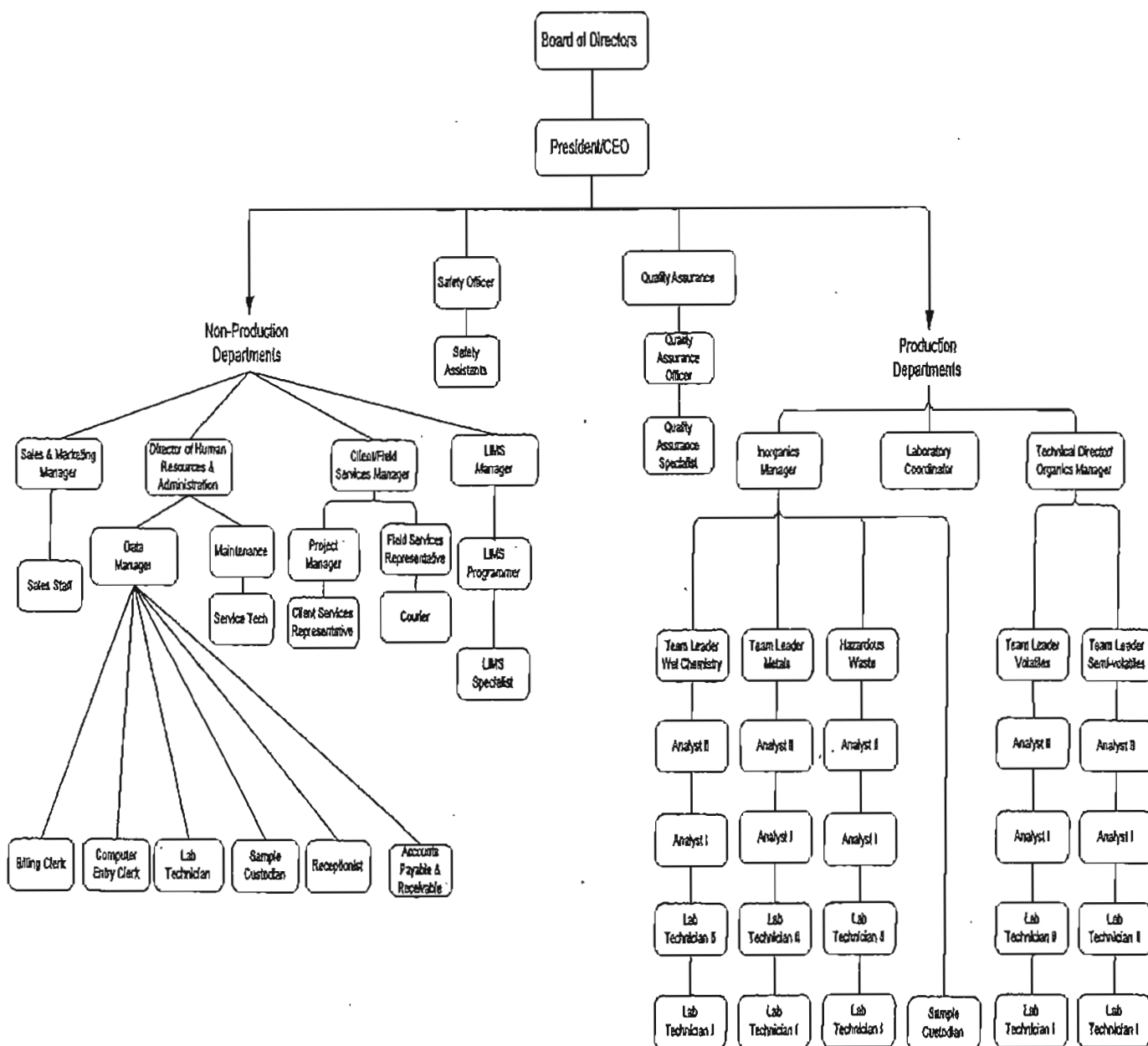
Quality assurance objectives are set to provide the metrics necessary to assess and ensure the quality of generated data. Laboratory QA objectives will be accomplished by applying EPA method acceptance criteria and laboratory internal controls for QC parameters including preparation blanks, surrogates, spikes, duplicates and laboratory control samples. Participation in various audit studies, internal and external will be used to verify the adequacy of the quality objectives. Laboratory data quality will be quantitatively assessed through accuracy, precision and respective method limitations. Qualitative assessment will be conducted through comparability, representativeness and completeness studies.

Specific Parameters:

- ❖ Accuracy - Defined as the degree to which the analytical measurement reflects the true value present. Surrogate, ICV, CCV, RLS, LCS and matrix spike recoveries will be used to measure accuracy. See section 13.4 for the algorithm used to measure accuracy.
- ❖ Precision - Defined as the measure of mutual agreement among individual measurements of the same pollutant in a sample, secured under the same analytical protocols. Laboratory precision will be expressed as relative percent difference (RPD). The goals for precision are related to the proximity of the sample to the detection limit. At or less than five (5) times the PQL, the precision goal will be expressed in absolute concentration (quantitation limit) terms. See section 13.4 for the algorithm used to compute the relative percent difference.
- ❖ Representativeness - Dependent upon the sampling plan. Assessment of site and collection representativeness is done by subcontracted or laboratory field service personnel. Procedures to ensure representativeness will be determined prior to the initiation of individual projects.
- ❖ Comparability - Defined as the extent to which samples can be verified or duplicated by another independent laboratory or compared against results previously found. Comparability will be assessed through parallel studies, round robin programs and internal and external audit results. Acceptable levels of comparability will be addressed in specific project plans.
- ❖ Completeness - Defined as the percentage of valid data obtained, as judged by objectives, compared to the total amount of data collected. QC parameters that shall be assessed for quantitative determinations of completeness shall include initial calibrations, continuing calibrations, surrogate percent recovery, RPD's of duplicates, percent recovery and RPD for matrix spike recoveries, percent recovery for laboratory control samples, and holding times. The requirement for the quantitative assessment of completeness is 90%.
- ❖ Sensitivity - Established practical quantitation limits (PQL's) and method detection limits based on procedures outlined in Appendix B of 40 CFR Part 136, have been documented for analytes of interest. (See Appendix B). Please note that these detection limits are established under ideal conditions, i.e., matrices used for detection limit studies are "clean" soils and deionized laboratory water. MDL studies must be performed annually for each matrix type - water and soil. MDL's and PQL's must meet standards set in SW-846, EPA 500 series methods, EPA 600 series methods and standard methods 18th edition. Special provisions may be necessary in cases of project specific goals, which exceed the aforementioned standards. MDL/PQL derivation procedures are addressed in the QA Protocols Manual.

FIGURE 2

BC Laboratories, Inc.
Laboratory Organizational Chart
Company Structure



SAMPLING PROCEDURES

4.0 SAMPLING PROCEDURES

Proper collection, preservation and storage of samples is needed to ensure sample integrity and representativeness. Samples are collected by trained, experienced field personnel according to guidelines established by Standard Methods for the Examination of Water and Wastewater, Test Methods for Evaluating Solid Waste (SW-846), and 40 CFR Part 136. The Field Services Standard Operating Procedures (SOP) Index, displays the scope of capabilities of our Field Services Department. All protocols for proper sample collection and handling are addressed in respective Field Service SOP's.

4.1 DOCUMENTATION

Proper documentation, including use of Sampling Logs, Field Logs and Chain-of-Custody forms are maintained throughout sampling procedures. Field measurements are recorded in Ink in bound Field Logs with entries signed by respective field service personnel. Field sample information is entered directly into the LIMS upon receipt by a representative of the Sample Control Department. A chain of custody form must be properly completed to track samples in from the field.

4.2 SAMPLE CONTAINERS

All samples collected have proper containers and preservatives with which they are associated. Containers are monitored for artifacts on a quarterly basis or whenever new containers are used.

Table 1 displays Information on proper containers, preservatives and holding times.

4.2.1 SAMPLE BOTTLE / CONTAINER PROCESSING

Preservatives are routinely analyzed before usage. Documentation exists to trace the preservative used for each sample submitted in a laboratory supplied containers.

1. Containers are prepared.
2. Preservatives are made as needed.
 - A. Reagent - grade chemicals are used.
 - B. Once the preservative is made, it is given a batch ID.
 - C. The preservative is tested before use by testing an aliquot brought up to volume in a proper sample container.
 - D. The preservative test is logged into the LIMS.
 - E. The preservative is analyzed for constituents of concern.
 - F. If all constituents of concern are not detected, the preservative can be used. If detections are found, the process must be reinitiated.
3. A reagent log is kept on file to record chemicals used.
4. Analytical records are kept by the Sample / Data Control Supervisor.

4.2.2 TRIP BLANKS

Trip blanks are used to identify the presence of volatile compound contamination attributable to transfer across a sample container septum during shipping and storage of samples. A trip blank is a sample of analyte-free matrix that is transported from the laboratory to the field with sample containers, then stored during sampling and finally transported back to the laboratory with the samples. The trip blank is then treated as an environmental sample in the laboratory with the following exceptions:

1. Analyze trip blanks only when detections are found in associated samples.
2. Analyze according to specific project protocols.

4.2.1.1 Trip blank Preparation

Trip blank matrix is prepared in the laboratory by purifying deionized water. Deionization of laboratory water can be broken into two major steps, macro and micro polishing. Tap water is passed through large resin beds then polished by being passed through a second set of micro resin beds and a carbon cartridge. After purification, the water is collected into a large glass bottle, which is fitted with a carbon filter. A sample, labeled with the batch

SAMPLING PROCEDURES

number and date, is then taken in a 40 ml VOA and analyzed for volatiles by GC/MS. If any analyte concentrations are found above 1 $\mu\text{g/L}$, the process is re-initiated.

4.2.1.2 Monitoring

Every week the stored trip blank water must be analyzed to assure integrity. A sample is taken and labeled with the date and the batch number followed with a letter from the alphabet, which corresponds to the number of samplings after the initial sampling.

Example: Batch 215 initialized and sampled on 06/23/97.
The following weeks' sample is labeled - Batch 215A 05/30/97.

If any target analytes are quantified above 2.0 $\mu\text{g/L}$, a new trip blank batch should be processed.

4.2.3 EQUIPMENT BLANK

A sample of deionized water, which is poured over or through field sampling equipment. This water is processed as an environmental sample in the laboratory for the use of verifying whether or not the decontamination of field equipment was adequate.

4.3 HOLDING TIMES

Samples should be analyzed as soon as possible after collection. The times listed in Table 1 are the maximum time limits that the samples may be held before requested analyses are initiated. Analyses conducted beyond proper sample holding times are to be considered minimum values. Samples may be held for longer periods if the permittee, or monitoring laboratory has data on file to show that the specific types of samples under study are stable for a longer time, and has received a variance from the person in authority. A permittee, or monitoring laboratory is obligated to hold samples for shorter times if knowledge exists showing necessity of maintenance of sample stability. Our goal is to meet every holding time.

4.4 SAMPLE / CONTAINER ORDERING

Completing a bottle order is the responsibility of Client Service personnel. An order is completed by entering all pertinent information from the client into the LIMS. The bottle order form is generated and submitted to the bottle preparation technician. The bottle preparation technician completes the tasks listed on the bottle preparation form and acknowledges completion with the ordering party. Sample containers are now available for client pick up, shipping or courier submittal. A copy of the bottle order form is included for each respective bottle order and should be submitted back to the laboratory after field activities. An example of a Bottle Order Form is given in Figure 3. The bottle ordering process flow chart is located in Appendix E.

SAMPLE CUSTODIAN**5.0 SAMPLE CUSTODY**

All samples must remain under custody from the time of sample collection to the time of sample disposal. A sample is considered under custody if:

- 1) It is in one's or a team's possession verified by some form of documentation, or
- 2) it was in one's possession and he/she locked it or placed it in a sealed container to prevent tampering, or
- 3) It is within the laboratory grounds.

5.1 CHAIN-OF-CUSTODY PROCEDURES

- 5.1.1 Samples will be collected, transported, and received under Chain-Of-Custody (COC) protocols consistent with procedures established by the EPA for litigation-related practices. The Chain-of-Custody record will validate the transfer of samples among client personnel, BCL Field Personnel, and/or BCL Sample Control Personnel.
- 5.1.2 Upon receipt at the laboratory, the Sample Custodian is the primary person who will assume sample custody. If the Sample Custodian is not available, any person from the Sample Control Department will be able to handle initial or secondary custody procedures.
- 5.1.3 The COC record is the documentation supporting the integrity of a sample from data collection to data reporting. COC procedures must be followed for all samples from which analytical results may be obtained and introduced as evidence in litigation.

5.2 COOLER RECEIPT FORM

- 5.2.1 Cooler Receipt Forms will be used to document the condition and availability of samples on arrival at the laboratory. The temperature of the air inside sample coolers and/or the temperature of samples is recorded on the Cooler Receipt Form. Sample shipping, type numbers, condition, and containment is also recorded on this form.

5.3 SAMPLE LABELS AND CUSTODY SEALS

- 5.3.1 If sample containers originated from the laboratory, the sample labels will include fields for the following information:
 - 5.3.1.1 Laboratory Name (defaulted)
 - 5.3.1.2 Sample ID
 - 5.3.1.3 Sampler ID
 - 5.3.1.4 Date and Time of sampling
 - 5.3.1.5 Method (defaulted)
 - 5.3.1.6 Preservative if applicable (defaulted)
 - 5.3.1.7 Preservative batch number if applicable (entered by lab personnel prior to shipping to client)
- 5.3.2 Some sample labels are color coded to indicate preservative types:
 - 5.3.2.1 Yellow - Sulfuric acid
 - 5.3.2.2 Red - Nitric acid
 - 5.3.2.3 Green - Sodium Hydroxide
 - 5.3.2.4 Blue - HCl
 - 5.3.2.5 Brown - Zinc Acetate

[illegible]

SAMPLING PROCEDURES

TABLE 1

GENERAL/INORGANIC CHEMISTRY

ANALYSIS	CONTAINER	PRESERVATIVE	CONTAINER	HOLDING TIME (FROM SAMPLING DATE)	
	WATER	WATER (2-8°C)	SOIL	WATER	SOIL
ALKALINITY	PT. PE	UNPRESERVED	N/A	14 DAYS	N/A
AMMONIA (NH ₃)	PT. PE	H ₂ SO ₄	8 OZ. JAR	28 DAYS	28 DAYS
BOD	QT. PE (HEADSPACE FREE)	UNPRESERVED	N/A	24 HR./ 48 HR.	N/A
BORON	PT. PE	UNPRESERVED	8 OZ. JAR	28 DAYS	28 DAYS
BROMIDE	PT. PE	UNPRESERVED	8 OZ. JAR	28 DAYS	28 DAYS
CHLORIDE	PT. PE	UNPRESERVED	8 OZ. JAR	28 DAYS	28 DAYS
COD	PT. PE	H ₂ SO ₄	8 OZ. JAR	28 DAYS	28 DAYS
COLOR	PT. AMBER GLASS	UNPRESERVED	N/A	48 HR.	N/A
CYANIDE (TOTAL AND/OR REACTIVE)	PT. PE	NaOH	8 OZ. JAR	14 DAYS	NO SPECIFIED TIME
EC (ELECTRICAL CONDUCTIVITY)	PT. PE	UNPRESERVED	8 OZ. JAR	28 DAYS	28 DAYS
FLASHPOINT	PT. AMBER GLASS (GLASS ONLY)	UNPRESERVED	8 OZ. JAR	28 DAYS	28 DAYS
FLUORIDE	PT. PE	UNPRESERVED	8 OZ. JAR	28 DAYS	28 DAYS
GROSS ALPHA/BETA	1 L. PLASTIC	UNPRESERVED	8 OZ. JAR	6 MOS.	6 MOS.
URANIUM	1 L. PLASTIC	UNPRESERVED	8 OZ. JAR	6 MOS.	6 MOS.
HARDNESS	PT. PE	UNPRESERVED	N/A	28 DAYS	N/A
HEXAVALENT CHROMIUM (Cr + 6)	PT. PE	UNPRESERVED	8 OZ. JAR	24 HR.	30 DAYS TIL EXT/24 HR IN EXTRACT FORM
IODIDE	PT. PE	UNPRESERVED	8 OZ. JAR	24 HR.	28 DAYS
NITRATE/NITRITE (NO ₃ /NO ₂)	2 OZ. PE	H ₂ SO ₄	8 OZ. JAR	28 DAYS	28 DAYS
NITRITE/NO ₂	PT. PE	UNPRESERVED	8 OZ. JAR	48 HR.	28 DAYS
NO ₂ AS NO ₃	2 OZ. PE	UNPRESERVED	8 OZ. JAR	48 HR.	28 DAYS
ODOR	PT. AMBER	UNPRESERVED	N/A	24 HR.	N/A
OIL & GREASE	1 L. AMBER GLASS (GLASS ONLY)	HCl	8 OZ. JAR	28 DAYS	28 DAYS
418.1 (TPH BY IR)	1 L. AMBER GLASS (GLASS ONLY)	HCl	8 OZ. JAR	28 DAYS	28 DAYS
PH	PT. PE	UNPRESERVED	8 OZ. JAR	IMMEDIATELY	IMMEDIATELY
PHENOLICS	4 OZ. AMBER GLASS (GLASS ONLY)	H ₂ SO ₄	8 OZ. JAR	28 DAYS	28 DAYS
PHOSPHORUS • TOTAL (P)	PT. PE	H ₂ SO ₄	8 OZ. JAR	28 DAYS	28 DAYS
PHOSPHORUS • ORTHO (PO ₄)	PT. PE	UNPRESERVED	8 OZ. JAR	48 HR.	28 DAYS
SILICA	PT. PE (PLASTIC ONLY)	UNPRESERVED	8 OZ. JAR	28 DAYS	28 DAYS
TDS	QT. PE	UNPRESERVED	N/A	7 DAYS	N/A
TSS	QT. PE	UNPRESERVED	N/A	7 DAYS	N/A
SS	QT. PE	UNPRESERVED	N/A	48 HR.	N/A
TOTAL SOLIDS	QT. PE	UNPRESERVED	N/A	7 DAYS	N/A
SPECIFIC GRAVITY	PT. PE	UNPRESERVED	8 OZ. JAR	28 DAYS	28 DAYS
SULFATE	PT. PE	UNPRESERVED	8 OZ. JAR	28 DAYS	28 DAYS
SULFIDE, TOTAL	PT. PE	Zn ACETATE	8 OZ. JAR	7 DAYS	N/A
SURFACTANTS (MBAS)	QT. PE	UNPRESERVED	N/A	48 HR.	N/A
TOTAL COLIFORM	8 OZ. GLASS OR MARGENE	SODIUM THIOSULFATE	N/A	24 HR.	N/A
TKN (KJELDAHL NITROGEN)	PT. PE	H ₂ SO ₄	8 OZ. JAR	28 DAYS	28 DAYS
TOTAL ORGANIC CARBON (TOC)	4 OZ. AMBER GLASS (GLASS ONLY)	H ₂ SO ₄	8 OZ. JAR	28 DAYS	28 DAYS
TOTAL ORGANIC HALIDE (TOX)	PT. AMBER	H ₂ SO ₄	8 OZ. JAR	7 DAYS	NO SPECIFIED TIME
TURBIDITY	PT. AMBER GLASS	UNPRESERVED	N/A	48 HR.	N/A

SAMPLING PROCEDURES

TABLE 1 (CONTINUED)

ORGANIC CHEMISTRY

ANALYSIS	CONTAINER	PRESERVATIVE	CONTAINER	HOLDING TIME		HOLDING TIME	
	WATER	WATER	SOIL	WATER		SOIL	
				EXTRACT	ANALYSIS	EXTRACT	ANALYSIS
• 601	2X VOA (HEADSPACE FREE)	HCl	8 OZ. JAR	14 DAYS	14 DAYS	N/A	14 DAYS
• 602, 8021	2X VOA (HEADSPACE FREE)	HCl	8 OZ. JAR	14 DAYS	14 DAYS	N/A	14 DAYS
• BTEX	2X VOA (HEADSPACE FREE)	HCl	8 OZ. JAR	14 DAYS	14 DAYS	N/A	14 DAYS
• GASOLINE RANGE	2X VOA (HEADSPACE FREE)	HCl	8 OZ. JAR	14 DAYS	14 DAYS	N/A	14 DAYS
• DIESEL RANGE	1 L. AMBER GLASS W/TEFLON	UNPRESERVED	8 OZ. JAR	14 DAYS	40 DAYS	14 DAYS	40 DAYS
8240, 824.2/824/8260	2X VOA (HEADSPACE FREE)	HCl	8 OZ. JAR	14 DAYS	14 DAYS	N/A	14 DAYS
504	3X VOA	UNPRESERVED	3X VOA	28 DAYS	1 DAY	N/A	N/A
531.1	4 OZ. AMBER GLASS	MONOCHLOROACETIC	8 OZ. JAR	FROZEN IN LAB, 28	N/A	N/A	N/A
547	4 OZ. AMBER GLASS	SODIUM THIOSULFATE	8 OZ. JAR	14 DAY	N/A	N/A	N/A
548	QT. AMBER GLASS	NONE	8 OZ. JAR	7 DAYS	14 DAYS	N/A	N/A
549	QT. AMBER PLASTIC	NONE	8 OZ. JAR	7 DAYS	21 DAYS	N/A	N/A
8080A, 608, 608, 8081, 8082	1 L GLASS AMBER W/TEFLON	UNPRESERVED	8 OZ. JAR	7 DAYS	40 DAYS/14**	14 DAYS	40 DAYS
8140/ 8141	1 L GLASS AMBER W/TEFLON	UNPRESERVED	8 OZ. JAR	7 DAYS	40 DAYS	14 DAYS	40 DAYS
8150, 616, 616.1, 8161	1 L GLASS AMBER W/TEFLON	UNPRESERVED	8 OZ. JAR	7 DAYS	40 DAYS	14 DAYS	40 DAYS
525.2/ 507	2X 1 L GLASS AMBER	SODIUM SULFITE & HCl	8 OZ. JAR	*** 14 DAYS	30 DAYS	14 DAYS	N/A
525, 8270C	2X 1 L GLASS AMBER	UNPRESERVED	8 OZ. JAR	7 DAYS	40 DAYS	14 DAYS	40 DAYS
MODIFIED 632, 832	1 L GLASS AMBER W/TEFLON	UNPRESERVED	8 OZ. JAR	7 DAYS	40 DAYS	14 DAYS	40 DAYS
TCLP • VOLATILES	2X VOA (HEADSPACE FREE)	HCl	8 OZ. JAR			14 DAYS	7 DAYS
• SEMI-VOLATILES	1 L AMBER GLASS (EACH TEST)	NONE	8 OZ. JAR			14 DAYS UNTIL TCLP LEACHING	

METALS

ANALYSIS	CONTAINER	PRESERVATIVE	HOLDING TIME (FROM SAMPLING DATE)
WATER			
METALS (1 OR MORE METALS) • TOTAL	QT. PE	HNO ₃	6 MO. (28 DAYS-Hg)
• DISSOLVED • FILTERED IN FIELD	PT. PE	HNO ₃	8 MO. (28 DAYS-Hg)
• NOT FILTERED	QT. PE	UNPRESERVED	6 MO. (28 DAYS-Hg)
• ORGANIC LEAD	QT. AMBER GLASS	CHILL TO 2-8° C	14 DAYS UNTIL ANALYSIS
• HEXAVALENT CHROMIUM (Cr + 6)	PT. PE	UNPRESERVED	24 HOURS

SOIL

METALS (1 OR MORE METALS) • TOTAL	8 OZ. JAR	CHILL TO 2-6° C	6 MO. (28 DAYS-Hg)
• SOLUBLE	8 OZ. JAR	CHILL TO 2-6° C	8 MO. (28 DAYS-Hg)
• EP TOXICITY	8 OZ. JAR	CHILL TO 2-8° C	8 MO. (28 DAYS-Hg)
• WET	8 OZ. JAR	CHILL TO 2-8° C	8 MO. (28 DAYS-Hg)
• TCLP (SEE ALSO ORGANIC CHEMISTRY)	8 OZ. JAR	CHILL TO 2-8° C	8 MO. (28 DAYS-Hg)
• SPLP	8 OZ. JAR	CHILL TO 2-8° C	6 MO. (28 DAYS-Hg)
• HEXAVALENT CHROMIUM (Cr + 6)	8 OZ. JAR	CHILL TO 2-8° C	30 DAYS UNTIL EXTRACTION/24 HR. IN EXTRACT FORM
• ORGANIC LEAD	8 OZ. JAR	CHILL TO 2-8° C	14 DAYS UNTIL ANALYSIS

6.0 FACILITY

The facility was specially designed to alleviate those undesirable factors, which would affect quality in a detrimental way. Emphasis was placed on 1) minimizing cross contamination potentials, 2) providing extensive bench space and considerable refrigerated sample storage areas to ensure effective sample handling processes, 3) maximizing sample and data flow processes, and 4) ensuring a safe working environment.

Laboratory features:

- 1) (2) Walk-in and (4) large wall reach-in refrigerators
- 2) (6) Fire proof data storage rooms
- 3) chemical storage rooms
- 4) Two-story storage area
- 5) Hazardous Waste drum storage facility
- 6) (8) safety shower/eye stations
- 7) (3) hood rooms (24 hoods)
- 8) Conference room with reference library
- 9) Bottle preparation room
- 10) Automated sample submission doors
- 11) Sample split room
- 12) (3) Compressed Gas storage rooms
- 13) Kern Securities fire and security systems
- 14) On site maintenance department
- 15) Separate volatiles rooms: GC, GC/MS
- 16) (6) RAD Lab

The laboratory was built on a large lot which is company owned to accommodate expansion. Figure 6 displays the laboratory floor plan.

6.1 ORGANICS LABORATORY

6.1.1 Separate semi-volatiles and volatiles laboratories.

6.1.2 Semi-Volatiles

6.1.2.1 Separate HPLC, and GC/MS Laboratories

6.1.2.2 Gases piped in from gas storage room.

6.1.2.3 1,600 sq. ft. of working area.

6.1.3 Volatiles

6.1.3.1 Located in the NW corner of the facility (Extractions located in the SE corner).

6.1.3.2 Two separate laboratories, GC-GC/MS.

6.1.3.3 Maintained under positive pressure.

6.1.3.4 Special carbon filters are integrated into the ventilation systems.

6.1.3.5 2,500 sq. ft. of working space.

6.1.4 Extractions

6.1.4.1 Laboratory equipped with 10 ventilated hoods.

6.1.4.2 400 cubic ft. refrigerator.

6.1.4.3 750 sq. ft. of working space.

6.2 WET CHEMISTRY LABORATORY

- 6.2.1 3,200 sq. ft. of laboratory space.
- 6.2.2 560 cubic ft. of refrigerator space.
- 6.2.3 Preparation area segregated from analytical laboratory.
- 6.2.4 Six (6) laboratory hoods.

6.3 METALS LABORATORY

- 6.3.1 Separate preparation areas (soil / water).
- 6.3.2 Two analytical laboratories (ICP, ICP-MS / GFAA-AA, CV)
- 6.3.3 Gases piped in from gas storage room.
- 6.3.4 2,200 sq. ft. of working space.
- 6.3.5 500 cubic ft. refrigerator.
- 6.3.6 Seven (7) laboratory hoods.

6.4 LOG-IN DEPARTMENT

- 6.4.1 1,000 sq. ft. of working space.
- 6.4.2 100 cubic ft. of refrigerator space.
- 6.4.3 One (1) laboratory hood.

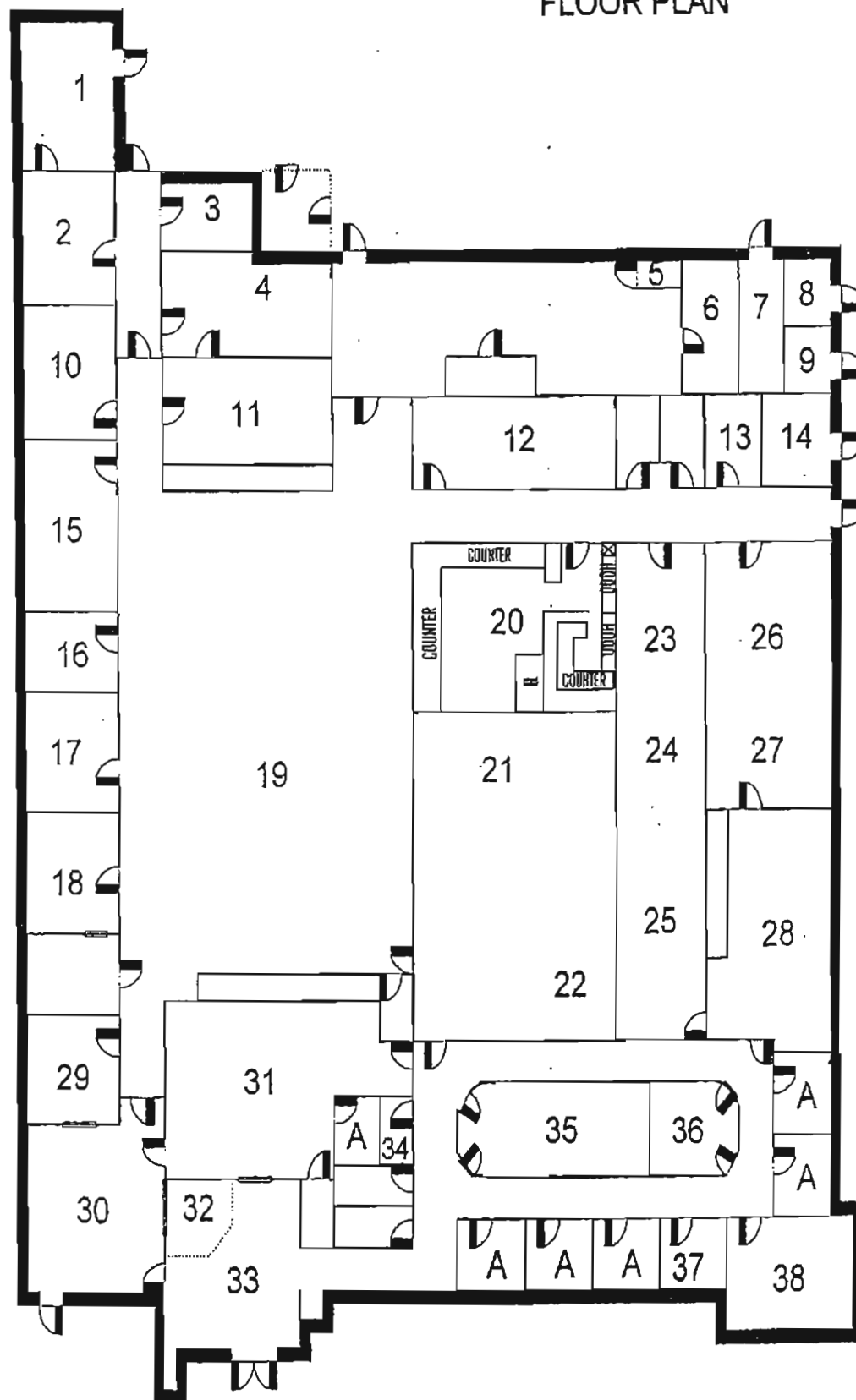
6.5 RECORD KEEPING

- 6.5.1 Five (5) Sea - Trains for data and equipment storage.
- 6.5.2 Fireproofed data storage room for temporary storage of data.

6.6 WASTE DISPOSAL AREA

- 6.6.1 Built from the ground up to be a waste disposal storage unit.
- 6.6.2 Secondary containment for individual waste containers.

BC LABORATORIES, INC.
4100 Atlas Court
Bakersfield, CA 93308
FLOOR PLAN



KEY

- 1 GC Volatiles
- 2 GC/MS Volatiles
- 3 Sample Splitting
- 4 GC/MS Volatiles
- 5 Compressed Air Dryer
- 6 Maintenance Office
- 7 Gas Storage
- 8 Gas Storage
- 9 Gas Storage
- 10 ICP Lab
- 11 GC/MS Volatiles
- 12 Metals Digestion (Solids)
- 13 Solvent Storage
- 14 Electrical Room
- 15 Atomic Absorption Lab
- 16 Bottle Prep
- 17 Metals Digestion (Water)
- 18 Bacteriology
- 19 Wet Chemistry Department
- 20 RAD LAB
- 21 Metals / Misc. Department
- 22 QA/QC Department
- 23 GC/MS Semi-Volatiles Lab
- 24 TPH Lab
- 25 Pesticides / PCB's Lab
- 26 GC Lab
- 27 HPLC Lab
- 28 Organic Extraction
- 29 Data Control Department
- 30 Sample Receiving Dept
- 31 Client Services/Log-In Dept
- 32 Reception
- 33 Lobby
- 34 Computer Room
- 35 Break Room
- 36 Conference Room
- 37 President's Office
- 38 Chairman of the Board
- A Administrative Office
- H Hazardous Waste Storage

Figure 8

PERSONNEL / TRAINING

7.0 PERSONNEL

BC Laboratories, Inc. is staffed by qualified, experienced and well-educated personnel. Brief résumés on key personnel are located in our Statement of Qualifications manual. Job descriptions have been finalized for all laboratory positions. Please refer to the Job Description manual for further details. Each position requires specific qualifications to be met. The training program is structured to ensure that curricula addresses specific needs of employees and the organization.

7.1 QUALIFICATIONS

Technical positions require minimum educational standards and experience to be met. These minimum requirements are documented in BC Laboratories, Inc. Job Description Manual. Each analyst must perform an initial demonstration of competency (IDC) before analyses solely generated by the concerned analyst can be reported to clients. These IDC's will follow guidance as listed in SW-846, Method for the Determination of Metals in Environmental Samples, Methods for the Determination of Organic Compounds in Drinking Water, and Standard Methods, 19th edition.

Training is conducted by persons with a solid background in respective subject matter. Module training is presented by individuals who are technically competent and qualified in instructional techniques.

7.2 INTERNAL TRAINING PROGRAM

Basic skills and training knowledge are conducted through in-house programs and/or subcontract programs. The in-house program includes an initial orientation, on the job training and a training module program, which covers various aspects of laboratory operations.

In House Training Modules (offered as needed and/or every other year). See the QAPM.

Module	Topics	Duration	Trainers
1 SECONDARY	Basic Laboratory Operations Math and Science Basics Introduction to Quality Control Introduction to Laboratory Analyses Physical Properties	To Be Determined	Danette Bohm Marna Atencio
2 PRIMARY	Laboratory Math I Units of Measurement Significant Figures and Rounding Percents Exponential Numbers	13,21-I, 22-I, 23-I 21-O, 22-O, 23-O, 24-O	Danette Bohm Richard Penner
3 SECONDARY	Laboratory Math II Dilutions Percent Solutions Molar Solutions Normal Solutions	To Be Determined	Danette Bohm Richard Penner
4 PRIMARY	Laboratory Math III Basic Statistical Concepts SPC and Normal Distribution Control Charts	13,20-I, 21-I, 22-I, 23-I, 24-I, 20-O, 21-O, 22-O, 23-O, 24-O	Danette Bohm Richard Penner
5 PRIMARY	Sample Containers, Preservation, Holding Times Container types per respective analyses Preservatives Holding Times Restrictions References	9,10,13,14,17,21-I,22-I, 32	Karen Bonanno
6 SECONDARY	Quality Assurance, Quality Control Concepts Parameters Basic Tasks Measurement and Assessment Documentation and Audits Corrective Logic	7, 8, 9, 12, 13, 14, 21-I, 21-O, 29, 30, 32	Danette Bohm

7.3 ON THE JOB TRAINING

After the orientation is completed, the trainee will be directed to his/her respective department supervisor. The department supervisor will initiate on the job training procedures. (See the Training Procedures in the QAPM).

7.4 INITIAL DEMONSTRATION OF COMPETENCY

Each analyst must perform an initial demonstration of competency (IDC) before analyses solely generated by the concerned analyst can be reported to clients. These IDC's will follow guidance as listed in SW-846, Methods for the Determination of Metals in Environment Samples, Methods for the Determination of Organic Compounds in Drinking Water, and Standard Methods, 19th edition.

7.5 EXTERNAL TRAINING PROGRAM

External training is conducted through manufacturer's instrument training programs, various independent seminars, California State University at Bakersfield (CSUB), and Bakersfield College. External training is addressed under the Educational Assistance section of the Employee Policy Manual.

Each supervisor is encouraged to attend at least one outside services seminar or training session, which would enhance his/her job performance or knowledge. In order to attend, supervisors must be granted an approval by the General Manager.

7.6 SAFETY

Safety training begins with the new employee orientation. Quarterly safety meetings are held to provide for continuing training regarding safety-related updates and to ensure safe working conditions by providing reiterated safety practice and policy information. All employees,

unless absence is approved by the Safety Officer, are required to attend quarterly meetings. Meeting schedules can be found posted in the lunchroom or in the Injury and Illness Prevention Plan.

7.7 PERFORMANCE EVALUATIONS

To monitor employee progress and efficiency, department supervisors evaluate each specialist annually. These annual screenings are conducted on a one-on-one basis with supervisors rating employee performance on various job-related subjects. During these interviews, goals are set to provide for deficiencies, or to help employees further their training and skills. Evaluation forms used are exclusive for each laboratory department. (See Appendix C to see an example of an evaluation form.)

7.8 EMPLOYMENT

BC Laboratories, Inc. offers a comprehensive benefit package for each employee to ensure a productive and efficient work force. All agreements and particulars are addressed in the BC Laboratories, Inc. Employee Policy Manual.

8.0 RECORDS

Documentation is the heart of every viable QA/QC Program. Without adequate documentation the ability to defend generated data is impossible. The purpose of documentation for viable QA/QC programs is to provide the ability to defend and recreate steps taken associated with each sample from sampling to final submittal and disposal. Documentation falls into two categories: 1) documents providing assurance of data quality objectives, and 2) documents providing information pertaining to contingent processes to support activities concerning sample and sample data handling. Necessary documentation includes:

8.1 SAMPLE CONTROL RECORDS

- 8.1.1 Chain of Custody - A record verifying the custody of samples and requested and associated analyses. The COC will be generated by the person(s) in the field. Completion of this record is addressed in the LOG-IN SOP.
- 8.1.2 Internal Sample Tracking Records
 - 8.1.2.1 Refrigerator Logs - Logs which track internal sample custody used in the Organics's, Wet Chemistry, and Metals Departments.
 - 8.1.2.2 Sample Split Log - Record of sample preparation of solid matrices prior to analytical manipulations.
 - 8.1.2.3 Water Tracking Log - Used to track internal sample custody in the Metals Department.
 - 8.1.2.4 Disposal Log - Tracks sample route from temporary storage to disposal.
 - 8.1.2.5 Archive Refrigerator Log - Record of internal sample tracking for archived samples.
 - 8.1.2.6 Internal Chain of Custody Ledger - Record of initial sample tracking record.
- 8.1.3 Sample Receipt Form - Record of samples submitted and their disposition, condition, and number.
- 8.1.4 Sample Control Approval Form - Provides a review of the log-in process on a submission basis. Also used to verify sample condition.
- 8.1.5 Preservative Reagent Log - Record of preservative preparation.

8.2 ANALYTICAL / INSTRUMENT RECORDS

- 8.2.1 Bench Worksheets (Analytical Data Forms) - Used to record analytical results and support information.
- 8.2.2 Extraction Log - Record of sample extraction.
- 8.2.3 Digestion Log - Record of sample digestion.
- 8.2.4 Filtration Log - Used to document sample filtration.
- 8.2.5 Analysis Logs (Run Log) - Record of the sample analytical sequence on respective instrumentation. Can include other QC information.
- 8.2.6 Maintenance Log - Used to document routine maintenance and subcontract repair of instrumentation.
- 8.2.7 Standards Log - Record of standards preparation.
- 8.2.8 Reagent Log - Record of reagent preparation and use.
- 8.2.9 Raw data - Printouts, charts, and chromatograms produced by instrumentation. Also will include handwritten records for instrumentation without printing capabilities.
- 8.2.10 LIMS printouts - Records of instrument processing and laboratory corrective activities.
- 8.2.11 QC Sheets - Used to document QC and batching capability.

8.3 QA/QC RECORDS

- 8.3.1 Technical Review Sheets - Formatted sheets which guide reviewers to parameters of interest. Record of technical review.
- 8.3.2 Balance Monitoring Log - Used to document analytical and top-loading balance calibration on a daily basis.
- 8.3.3 Refrigerator Monitoring Log - Used to document refrigerator temperatures on a daily basis.
- 8.3.4 Oven Monitoring Log - Used to monitor oven temperatures on a work basis.
- 8.3.5 Thermometer Calibration Check Log - Record of thermometer external checks against a NIST reference thermometer.
- 8.3.6 Waterbath Logs - Record of waterbath temperature during analysis.
- 8.3.7 Auto-diluter Calibration Record - Gravimetric checks of auto-diluter volume deliveries.
- 8.3.8 Data Custody Ledger - Record of custody of data.
- 8.3.9 Spreadsheets - Used to track
 - 8.3.9.1 SIF's
 - 8.3.9.2 Altered Completed Forms
 - 8.3.9.3 Logbooks
 - 8.3.9.4 Instruments
 - 8.3.9.5 Support Instruments
 - 8.3.9.6 Audits
 - 8.3.9.7 Sample Custody
 - 8.3.9.8 Capacity
 - 8.3.9.9 Data Custody
 - 8.3.9.10 IDC - Initial Demonstration of Competency Forms

8.4 SUPPORT DOCUMENTATION

- 8.4.1 Phone Records - Record of phone correspondence between laboratory personnel and clients.
- 8.4.2 Sample Tracking Logs - Record of sample tracking via project coordinators.
- 8.4.3 Archived Files Request Log - Used to document requests for archived files.
- 8.4.4 Subcontract COC Log - Record of sample tracking of submissions to a subcontractor.
- 8.4.5 Shipping Logs (Federal Express / UPS / DHL) - Used to track shipping of samples and/or data supplies.
- 8.4.6 Requisition Form - Procurement record.
- 8.4.7 Altered Completed Files Form - Record of modifications made to records which have been filed.
- 8.4.8 Maintenance Request Form - Record of scheduled maintenance.

INSTRUMENTATION

9.0 INSTRUMENTATION

9.1 Wet Chemistry

9.1.1 Ion Chromatographs

Instrument	ID	Analysis	Year in Service	Method
Dionex Model 2000i AI450 Data Station GPM Pump CDM-1A Conductivity Detector	IC1	Chloride, Nitrate, Sulfate Bromide, Fluoride	1991	EPA-300.0
Dionex Model 2000i AI450 Data Station GPM Pump CDM-2 Conductivity Detector	IC2	Chloride, Nitrate, Sulfate Bromide, Fluoride	1994	EPA-300.0
Dionex Model DX500 A550 Autosampler LC20 CE CD20 Conductivity Detector IP25 Isocratic Pump Peak Net Software	IC1A/IC2A	Chloride, Nitrate, Sulfate Bromide, Fluoride	2000	EPA-300.0

9.1.2 Auto Analyzer Systems

Instrument	ID	Analysis	Year in Service	Method
Alpkem Rapid Flow Analyzer Total Kjeldahl Nitrogen Semi-automated, block digester	RFA-1	Total Kjeldahl Nitrogen	1989	EPA-351.2
Alpkem Rapid Flow Analyzer Nitrate/Nitrite, Cadmium reduction	RFA-3	Nitrate/Nitrite	1989	EPA-353.2
Technicon AAI Auto Analyzer Cyanide Automated Distillation/Colorimetric	AAII-1	Cyanide	1985-current	EPA-335.3 EPA-335.4
Technicon AAI Auto Analyzer Hexavalent Chromium Diphenylcarbazide	AAII-2	Hexavalent Chromium	1985-current	SW-7196
Technicon AAI Auto Analyzer Phenol Automated distillation/Colorimetric	AAII-3	Phenol	1985-current	EPA-420.2
Technicon AAI Auto Analyzer ortho-Phosphate Molybdenum blue	AAII-4	ortho-Phosphate	1985-current	EPA-365.1 EPA-365.2
Technicon AAI-5 Auto Analyzer NH ₃ -N Automated Colorimetric	AAII-5	NH ₃ -N	1977-current	EPA-350.1

INSTRUMENTATION

9.1.3 Other Instruments

Instrument	ID	Analysis	Year in Service	Method
Spectronic 20 Genesys	Spec 05	COD MBAS Sulfide	2001	EPA-410.4 EPA-425.1 EPA-376.2
Altex 70	APH-70	pH in soil samples	1990	SW-9040
Beckman 360 pH/Temp/mv Meter	pH08	pH in water samples	2000	EPA-150.1
Orion Research 420A pH Meter	04202	pH in soil samples	1991	SW-9040 SW-9045
YSI Model 3100 Conductivity Meter	CND-3	Electrical Conductivity	1985	EPA-120.1 SW-9050
Hach Model 2100N Turbidimeter	T2100	Turbidity	1991	EPA-180.1
YSI Model 57 Oxygen Meter	YSI-57	BOD Dissolved O ₂	1990	EPA-405.1 EPA-360.1
Brinkman Digital Buret	BDB	Alkalinity (HCO ₃ , CO ₃ , OH)	1995	EPA-310.1
Dohrmann Model DC80	DCA-1	TOC Analysis	1988	EPA-415.1 SW-9060

9.2 Metals

9.2.1 Inductively Coupled Argon Plasma / Mass Spectrometer

Instrument	ID	Analysis	Year in Service	Method
Perkin Elmer Elan 6100	PE-EL 1	16 Routine metals; Additional metals available upon request	2001	EPA-200.8

9.2.2 Inductively Coupled Argon Plasma

Instrument	ID	Analysis	Year in Service	Method
TJA Model 61E Trace Simultaneous Instrument	TJA61E	28 metals	1995	EPA-200.7 SW-6010A
TJA Model 36 Simultaneous Instrument	TJA36E	28 metals	1990	EPA-200.7 SW-6010A
Perkin Elmer Optima 4300	PE-OP1	30 Metals	2001	EPA-200.7 SW-6010A

9.2.3 Graphite Furnace Atomic Absorption Spectrophotometers

INSTRUMENTATION

Instrument	ID	Analysis	Year in Service	Method
Varian SpectrAA 40Z Zeeman Background	V802	Antimony Arsenic Beryllium Cadmium Copper Chromium Lead Nickel Selenium Silver Tin Thallium	1989, 1990	EPA-200.9/7000A EPA-200.9/7000A EPA-200.9/7000A EPA-200.9/7000A EPA-220.2/7000 EPA-218.2/7000 EPA-200.9/7000A EPA-249.2/7000 EPA-200.9/7000A EPA-200.9/7000A EPA-282.2/7000 EPA-200.9/7000A
Varian Spectra 300/400Z Zeeman Background	V005	Beryllium Cadmium Copper Chromium Nickel Silver Tin Thallium	1996	EPA-200.9/7000A EPA-200.9/7000A EPA-220.2/7000 EPA-218.2/7000 EPA-249.2/7000 EPA-200.9/7000A EPA-282.2/7000 EPA-200.9/7000A
Perkin Elmer SIMAA 600 Zeeman Background AA Winlab Software	PE-1	Arsenic Selenium Lead Antimony Silver	2000	EPA-200.9/7000A

9.2.4 Mercury Analyzers

Instrument	ID	Analysis	Year in Service	Method
Leeman LDC Mercury Analyzer	LDC1	Mercury	1993, 1995	SW-7470/245.1 & 245.5 SW-7471
Thermo Separation Products Mercury Monitor 3200	TSP1	Mercury	1995	SW-7470/245.1 & 245.5 SW-7471

9.3 ORGANICS

9.3.1 GC/MS - Semi Volatiles

Instrument	ID	Analysis	Year in Service	Method
HP 5972 HP 5673 Autosampler HP Chemstation with Enviroquant	MS-B1	Semi-Volatiles	1994	EPA-625 EPA-8270C
HP 5972 HP 7673 Autosampler HP Chemstation with Enviroquant	MS-B2	Semi-Volatiles	1994	EPA-625 EPA-8270C

BC LABORATORIES, INC.
INSTRUMENTATION

Varian Saturn Varian 8100 Autosampler Varian Enviropro	MS-B3	Synthetic Organic Compounds EPA-507	1995	EPA-525.5 EPA-507

9.3.2 GC/MS - Volatiles

Instrument	ID	Analysis	Varian Service	Method
HP 5970 Tekmar 3000 Concentrator Tekmar Precept II HP Chemstation with Enviroquant	MS-V1	Volatiles	1991	EPA-524.2 EPA-601 EPA-624 EPA-8240B EPA-8260B
HP 5970 Tekmar 3000 Concentrator Tekmar Precept II HP Chemstation with Enviroquant Tekmar Sample Heater	MS-V2	Volatiles	1991	EPA-524.2 EPA-601 EPA-624 EPA-8240B EPA-8260B
HP 5971 Takmar 3000 Concentrator Tekmar Precept II HP Chemstation with Enviroquant	MS-V3	Volatiles	1993	EPA-524.2 EPA-624 EPA-8240B EPA-8260B
HP 5971 Tekmar 3000 Concentrator Tekmar Precept II HP Chemstation with Enviroquant	MS-V4	Volatiles	1993	EPA-524.2 EPA-624 EPA-8240B EPA-8260B
HP 5973 Tekmar 3000 Concentrator Precept II Autosampler HP Chemstation with Enviroquant	MS-V5	Volatiles	2000	EPA-524.2 EPA-601 EPA-624 EPA-8240B EPA-8260B
HP 5972 Tekmar Precept II Tekmar 3000 Concentrator HP Chemstation with Enviroquant	MS-V6	Volatiles	2000	EPA-524.2 EPA-601 EPA-624 EPA-8240B EPA-8260B

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HP 5971 Tekmar 3000 Concentrator Tekmar Solatek 72 HP Chemstation with Enviroquant	MS-V7	Volatiles	2001	EPA-524.2 EPA-601 EPA-624 EPA-8240B EPA-8260B
HP 5971 Tekmar 3000 Concentrator Tekmar Precept II HP Chemstation with Enviroquant	MS-V8	Volatiles	2001	EPA-524.2 EPA-601 EPA-624 EPA-8240B EPA-8260B
HP 5972 Tekmar 3000 Concentrator Tekmar Solatek 72 HP Chemstation with Enviroquant	MS-V9	Volatiles	2001	EPA-524.2 EPA-601 EPA-624 EPA-8240B EPA-8260B

9.3.3 Gas Chromatography

Instrument	ID	Analyte	Year in Service	Method
Varian 3400 HP 3100 Autosampler HP Chemstation with GC-Enviroquant	GC-1	Organochlorine pesticides and PCB's	1994	EPA-508 EPA-608 EPA-8080 EPA-8081
Perkin Elmer Autosystem Autosystem Autosampler HP Chemstation with GC-Enviroquant	GC-2	Diesel Fuel Fingerprint Carbon Ranges	1991	8015M
Varian 3400 Dual ECD Varian 8100 Autosampler HP Chemstation with GC-Enviroquant	GC-3	Organochlorine Pesticides and PCB's	1989	EPA-508 EPA-608 EPA-8080 EPA-8081
Varian 3400 Dual ECD Varian 8100 Autosampler HP Chemstation with GC-Enviroquant	GC-4	DBCP and EDB	1989	EPA-504.1
Tekmar 2000 and 2032	MS-D1	DOE Room	2001	8260
Tekmar 2000 and 2032	MS-D2	DOE Room	2001	8260

INSTRUMENTATION

HP 5890 Series II Dual FID Tekmar 2000 and 2016 HP Chemstation with GC-Enviroquant	GC-5	Gas	1992	8015M
HP 5890 Series II HP 7673 Autosampler HP Chemstation with GC-Enviroquant	GC-6	PCB's only	1989	EPA-8082
Dual TSD HP 5890 Series II HP 7673 Autosampler HP Chemstation with GC-Enviroquant	GC-7	Organophosphorus pesticides	1990	EPA-614 EPA-8140 EPA-8141
Varian 3400 Dual ECD Varian 8100 Autosampler HP Chemstation with GC-Enviroquant	GC-8	Chlorinated herbicides	1990	EPA-515.1 EPA-615 EPA-8150 EPA-8151
HP 5890 Series II Dual FID HP 7673 Dual Tower Autosampler HP Chemstation with GC-Enviroquant	GC-12	Diesel	1992	8015M
Perkin Elmer Autosystem Autosystem Autosampler HP Chemstation with GC-Enviroquant	GC-13	Diesel Fuel Fingerprint Carbon Ranges	1993	8015M

9.3.4 Gas Chromatography - Volatiles

Instrument	ID	Analysis	Year in Service	Method
Varian 3400 with PID and FID Tekmar 2000 Concentrator Tekmar 2016 Autosampler HP Chemstation with GC-Enviroquant	GC-V1	BTEX, MTBE, TPH (gas)	1989	EPA-8020, 8021 8015M
Varian 3400 with PID and FID Tekmar 2000 Concentrator Tekmar 2016 Autosampler Tekmar 2032 Autosampler HP Chemstation with GC-Enviroquant	GC-V2	BTEX, MTBE, TPH (gas)	1992	EPA-8020, 8021 8015M
Varian 3400 with PID and FID Tekmar Precept II Tekmar 3000 HP Chemstation with GC-Enviroquant	GC-V4	BTEX, MTBE, TPH (gas)	1992	EPA-8020, 8021 8015M

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Varian 3400 with PID and FID Tekmar 2000 Concentrator Tekmar 2016 Autosampler HP Chemstation with GC-Enviroquant	GC-V5	BTEX, MTBE, TPH (gas)	1991	EPA-8020, 8021 8015M
Varian 3400 with PID and FID Tekmar 2000 Concentrator Tekmar 2016 Autosampler Tekmar 2032 Autosampler HP Chemstation with GC-Enviroquant	GC-V6	BTEX, MTBE, TPH (gas)	1991	EPA-8020, 8021 8015M
HP 5890 Series II with PID and FID Tekmar 3000 Concentrator Tekmar 2016 Autosampler Tekmar 2032 Autosampler HP Chemstation with GC-Enviroquant	GC-V7	BTEX, MTBE, TPH (gas)	1998	EPA-8020, 8021 8015M
HP 5890 Series II with PID and FID Tekmar 3000 Concentrator Tekmar Precept II Autosampler HP Chemstation with GC-Enviroquant	GC-V8	BTEX, MTBE, TPH (gas)	1998	EPA-8020, 8021 8015M 5035

9.3.5 HPLCs

Instrument	ID	Analyte	Year in Service	Method
HP 1050 Model 79856A Quaternary Eluent Pump Autosampler Multiwavelength UV Detector HP Chemstation with GC-Enviroquant	LC-14	Polynuclear Aromatic Hydrocarbons Carbamate and Urea-containing Pesticides	1994	EPA-610 EPA-8310 EPA-632

9.3.6 Other Instruments

Instrument	ID	Analyte	Year in Service	Method
Foxboro Miran IFF (IR)	IR-1	TPH	1992	EPA-413.2 EPA-418.1
Foxboro Miran IFF (IR)	IR-2	TPH	1992	EPA-413.2 EPA-418.1

9.4 Microbiology

INSTRUMENTATION

Instrument	ID	Analysis	Year In Service
Incubator - ASP Model	IS-81	5.5.5 or 10 Tube	1989-1995
Incubator - VWR Model	1565	5.5.5 or 10 Tube	1989-1995
Incubator - ASP Model	IS-41	Autoclave QC only	1989-1995
Autoclave Marketforge Sterilmatic (2)		1600 Tubes of media (3200)	1990
Waterbath - PS Coliform Incubator Bath		10 (10 tubes/samples)	1992
Waterbath - Precision Scientific Large		20 (10 tubes/samples)	1990
Waterbath - Precision Scientific Small	#1, #2, #3	10 (10 tubes/samples)	1990
Quebec Colony Counter Capacity/100 Potential Capacity/200			1980
Dissection Microscope	Bausch & Lomb		1986
IDEX Spectrolina	EA-160		1996

9.5 Sampling Equipment

9.5.1 Well Sampling

Instrument	ID	Year In Service
ISCO	2700	1994
Grundfos Rediflo	BMI	1992
Grundfos Rediflo	MPI	1992
Solinst Water Depth Finder		1994
Generac 3500 XL Generator	3500	1994
Generac G1600 Generator	G1600	1994
Lamotte Turbidity Meter	2008	1994

9.5.2 Air Sampling

Instrument	ID	Year In Service
SKC Air Sampling Pump	Model 224-PCXR7	1992
Air Test Meters S-275 STD with Pressure Pot (2)		1992
Sensidyne pump	Gastec No. 800	1993

INSTRUMENTATION

9.5.3 Instrumentation

Instrument	Model	Year in Service
Omega pH H60 and pH Conductivity Meter		1994
Myron Company pH & Conductivity Meter		1994
HNU Photolionizer	Model HW - 101	1994

9.6 Support Equipment and Supplies

9.6.1 Laboratory Information & Management System (LIMS)

Instrument	Year in Service
Novell Network Using Advanced Revelations	1990-1998
Pentium 60 40 GB hard drive 32 MB RAM Compaq DLT 15/30 GB Tape backup	1990-1998
Pentium 200 W/9.1 GC hard drive 128 MB RAM Mountain File Safe 1400 8 GB Tape backup	1990-1998
HP Laser Jet Printers (7)	1990-1998
PC's - 386 (13)	1990-1998
PC's - 486 (41)	1990-1998
PC's - Pentium (28)	1990-2000

9.6.2 Laboratory Water System

Instrument	Year in Service
Ionics Deionized Water System	1990-2000
Ionics Nanopure Water System	1990-2000

9.6.3 Glassware

Instrument	Year in Service
Class A for Reagent and Standard Preparation	1990-2000
Various Calibrated Units	1990-2000

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Instrument	Year in Service
Northstar Walk-In	1987
Rancho Reach-In (4)	1990
Traulsen Reach-In (2)	1987-1995
GE Cold Spot: Nor lake (1), Whirlpool (1), Baxter (1)	1987-1995
GE Freezer (1) Montgomery Ward	

9.6.5 Ovens

Instrument	Year in Service
Precision Scientific (2)	1987-1994
Fisher (4)	1987-1994
VWR (3)	1987-1994
Manitowoc VWR (4)	

9.6.6 Misc Equipment

Instrument	Year in Service
Balance Analytical - Mettler H6 (2)	1987-1993
Balance Analytical - Mettler B5	1987-1993
Top-Loading OHAUS 1500, E4000d, TS400D, E120	1988-1994
Top-Loading DTL 4100S	1988-1994
Top-Loading Mettler PE3600, PL300	1988-1994
Top-Loading Mettler PB 3002-5, BD202	2000
Top-Loading Denver Model A160	2000

9.7 Safety

BC LABORATORIES, INC.

INSTRUMENTATION

Instrument	Qty
Laboratory Hoods	26
Fire Extinguishers	35
Halon	
Combined Class ABC	
Eye/Safety Showers	7
Spill Stations	3
First Aid Kits	5
Fire Blanket	1

11.0 ANALYTICAL PROCEDURES

BC Laboratories, Inc. conducts approved methodologies which have been promulgated by Federal and State legislators, and ASTM and in-house methods for non-regulated analyses.

References

Drinking Waters - 40 CFR Parts 131, 143 Methods for the Determination of Metals in Environmental Samples (EPA/600/R-94/111, May 1994, Methods for the Determination of Inorganic Substances in Environmental Samples (EPA/600/R-93/August 1993), Methods for the Determination of Organic Compounds in Drinking Water (EPA/600/4-88/039, EPA/600/4-90/020), Methods for the Chemical Analyses of Water and Wastewater (EPA-600 4-79-020), and Standard Methods for the Examination of Water and Wastewater, 18th Edition (1992), Standard Methods for the Examination of Water and Wastewater, 19th Edition.

Waste waters - 40 CFR Part 136, Standard Methods for the Examination of Water and Wastewater, Methods for the Chemical Analyses of Water and Wastewater, Methods for the Determination of Metals in Environmental Samples (EPA/600/R-94/111, May 1994), Methods for the Organic Chemical Analysis of Municipal and Industrial Wastewater.

Soils, sludges, wastewater, hazardous waste, and solids - SW-846 Federal Register Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Third Edition, Update I, II, & III.

Fuels - LUFT Manual, State Water Resources Control Board and the SB 1764 (1994) Advisory Committee.

Each method has been outlined in respective laboratory standard operating procedures (SOP's). Information such as procedural steps for conducting analysis, standard and reagent preparation, documentation, safety, and quality control are included in each analytical SOP. Refer to Appendix A for listing of SOP's, Table 5-7 list methods conducted on-site.

11.1 SOP CREATION

Department Supervisor's, the Technical Director, and/or the QA Officer will determine the person(s) responsible for SOP creation, and then delegate the task. The template below will be used as guidance for analytical SOP's:

SOP TEMPLATE

- 1.0 SCOPE AND APPLICATION
- 2.0 SUMMARY OF METHOD
- 3.0 INTERFERENCE AND THEIR CORRECTIVE ACTION
- 4.0 APPARATUS AND MATERIALS
 - 4.1 APPARATUS
 - 4.2 INSTRUMENT PARAMETERS
- 5.0 REAGENTS AND STANDARD SOLUTIONS
 - 5.1 REAGENTS - NAME AND SOURCE
 - 5.2 SOLUTIONS - DILUTION SCHEMES
 - 5.3 WORKING STANDARDS
 - 5.4 SPIKES
- 6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING
- 7.0 PROCEDURE

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- 8.0 QUALITY CONTROL
 - 8.1 DETERMINATION OF IDL, MDL, AND PQL
 - 8.2 METHOD BLANKS
 - 8.3 QC SETS - DUPLICATES & SPIKES
 - 8.4 CONTROL CHARTS
 - 8.5 LOG BOOKS
- 9.0 CALCULATIONS
- 10.0 FORMS
 - 10.1 QC SHEET
 - 10.2 OTHER FORMS
- 11.0 METHOD PERFORMANCE
- 12.0 GENERAL MAINTENANCE
- 13.0 WASTE MANAGEMENT
- 14.0 POLLUTION PREVENTION
- 15.0 SAFETY
- 16.0 REFERENCES

Non-analytical SOP's do not follow a standard format, however these documents should contain sufficient detail to ensure processes can be carried out completely and competently. When completed by the responsible party, the SOP is entered into the LIMS via the word processor. SOP identification will be by method number, technique, and a laboratory/department sequential numbering identification (i.e., BCMET01, BCMET02 ...etc.). The word processing specialist will return the SOP to the author for corrections. When corrections are completed, the SOP will be reviewed by the Department Supervisor. When the supervisor review and correction phase is complete, the QA Officer will conduct a final review and approval. Further details of SOP creation can be found in the SOP QA/QC Protocols.

11.2 CONTROL OF SOP'S AND LOGBOOKS

In order to receive a copy of an SOP, a request must be made to the QA officer, Department Supervisor, or General Manager. One of these persons will inform the word processor specialist to generate the requested SOP. Records pertaining to SOP retrieval will be kept by the word processor.

Record: SOP Number.
 Date of regeneration.
 Person receiving the document.
 Purpose.
 Number of Copies.
 Total Number of copies (History).

The SOP will be generated with an approval by the word processing specialist. Logbooks requests are honored by the Word Processing Specialist. Logbook request sheets are located on a clip near the word processing station. Once a logbook is created, the Word Processing Specialists records the following information:

Logbook ID

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Logbook number
Number of copies
Person receiving the logbook
Date of generation

The Word Processing Specialist will then review the logbook and acknowledge final approval by initialing and dating the logbook cover.

11.3 DEPARTURE FROM SOP

In cases where it is necessary to depart from standard practice, approval must be granted by the department supervisor and the Quality Assurance Officer. Departures for standard procedures must be documented on all affecting final reports.

11.3.1 Documentation - Document nonstandard practice on affecting worksheet(s). Client notification must be made and documented before departure can be granted. Affected final reports must have a comment which alludes to the modification of method.

11.3.2 Approvals from the client must be verified in order to close the deviation of standard practice.

11.4 ASSESSMENT AND HANDLING OF NEW/ADDITIONAL WORK

11.4.1 Summary

Project information must be legible and obtained in a timely fashion to allow necessary modifications to be made prior to projects initiation. Information is obtained from QAPPs, SAPs, CDAPs, or subsets of the aforementioned formats, or from projects initiation forms completed by laboratory interviewers. The information is translated into the appropriate language then discussed through supervisor meetings.

Discussion topics:

- * Confirmation of amount of new/additional work
- * Baseline capacities
- * Potential capacities
- * Labor
- * Instrumentation
- * Certification/Methods
- * Materials
- * Implementation
- * Monitoring
- * Responsibilities
- * Deliverables

Once discussed, accommodations addressing pertinent concerns are made in each department. The Project Manager verifies that all project specific work requirements are secured; especially all non-routine tasks. Project Initiation Forms are then completed and distributed to affecting department supervisors, and if possible, to pertinent clients before initiation of sampling. Performance monitoring will be conducted by the QA/QC Department to measure compliance with project specifications and customer satisfaction.

The LIMS will act as the tool used to confirm analytical capabilities.

11.4.2 Responsibilities

Sales and Marketing

1. Obtain project deliverables information
2. Confirm the amount of work and compare to the capability/capacity of the laboratory
3. Confirm type of work (DOD, DOE, RCRA, CERLA, etc)
4. Monitor project quotes
5. Establish probabilities of project awards

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6. Identify project initiation date
7. Obtain project method specifications
8. Obtain quality goals
9. Act as liaison between laboratory and client until award is granted
10. Submit all pertinent information to Client Services Department

Project Coordinator

1. Obtain project information from Sales and Marketing or client.
2. Translate project information.
3. Assign projects to project managers.
4. Provide guidance in project handling.
5. Provide guidance on completing Project Checklist Form.

Project Manager

1. Gather project information into a Project Initiation Form.
2. Distribute project initiation forms.
3. Modify project initiation forms as needed.

President

1. Facilitate brainstorm sessions.
2. Allocate resources.
3. Approve laboratory system modifications.
4. Approve instrumentation purchases.
5. Approve labor allowances.
6. Secure and allocate resources.
7. Approve purchases of materials and instruments.

Department Manager

1. Assess department capacities.
2. Review and approve prospective work.
3. Coordinate with project coordinator.
4. Initiate IDCs or IDPs for new analysts and/or methods.

QA Officer

1. Monitor performance.
2. Provide method guidance.

LIMS Manager

1. Write programs to handle project specific requirements.
2. Update, increase, and modify LIMS capabilities.

11.4.3 Procedure

Sales and Marketing representative produces bid packages then rates the probability of an award by obtaining information through contracts and/or correspondence with bid proprietors. When awards are confirmed, a request for project information is made, if not already available in RFPs or RFQs, by a representative of Sales and Marketing or the Project Coordinator. The Project Coordinator gathers all project information then translates this information into BC Laboratories' language. Translation will be discussed during weekly supervisor meetings and on a one-to-one basis. A project Quotation Form, which is completed through the LIMS or by hand, is created then distributed to all pertinent personnel.

11.5 CAPACITY

Capacities are functions based by method, # of instruments, # of analysts, # of work shifts, potential # of samples analyzed per 8 hour shifts, sample matrix, and baseline levels of continuous work.

Daily capacity is figured by finding the number of samples which can be analyzed (excluding CCV's, Curve Stds, blanks, LCS's and MS's) on one instrument by one analyst during an eight hour work shift. Actual capacity will vary based on

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time of year, workload, analyst vacations, instrument configuration for multiple analyte analysis, instrument performance, and analyst performance. To adjust this daily capacity, take the average amount of samples analyzed per year and divide by the number of work days in a year, then subtract this number from the daily capacity. This will give us available capacity.

Quarterly capacity will be assessed more accurately detail available capacity during high workload periods. This can be found by finding the average daily workload during quarterly monitoring periods.

Projected workload is based on number of analyses and turnaround time.

$$\text{Projected workload} = \frac{\text{Number of analyses}}{\text{Turnaround Time (days)}}$$

In order to verify if additional workload can be handled, find the daily capacity and/or the quarterly capacity, projected workload (analyses per day) and place in the following algorithm:

Available capacity - projected workload

If this number is positive, the additional workload can be approved. If negative, available capacity must be increased through more instrumentation, more labor, and/or modified system changes.

11.6 METHOD QUALIFICATION

Each new method must be pre-qualified prior to use. Prequalification entails meeting reporting and performance criteria outlined in the ELAP manual "Data Package Guidelines". Further details can be found in the QA Protocols Manual.

11.7 USE OF NON-STANDARD METHODS

In order to utilize methods which are non-referenceable or deviate significantly from referenced methods, we are required to obtain client and/or regulatory agency approval. If regulatory approval is needed, the QA Officer will initiate the process of obtaining method exceptions. Approvals by our clients must be documented in writing on a record which is recognized by our system. All data associated with non-standard methods should be flagged on affected final reports.

11.8 USE OF DIFFERENT METHOD VERSIONS

In cases of combined analytical methods, the most stringent requirements for each of the various calibration and quality control steps must be incorporated in the merged procedure. All instruments are set up to accommodate the most stringent QC requirements for like methods so reporting can be a function of sample matrix or project method reporting protocol. Sample results reported under particular methods must be referenced correctly on final reports either in the heading or in a comments section.

TABLE 5 METAL METHODOLOGIES

Aluminum	EPA 200.7, 6010B		EPA 200.8
Antimony	EPA 200.7, 6010B	EPA 204.2, SW7041, 200.9	EPA 200.8
Arsenic	EPA 200.7, 6010B	EPA 206.2, SW7060, 200.9	EPA 200.8
Barium	EPA 200.7, 6010B		EPA 200.8
Beryllium	EPA 200.7, 6010B	EPA 210.2, SW7091, 200.9	EPA 200.8
Boron	EPA 200.7, 6010B		EPA 200.8
Cadmium	EPA 200.7, 6010B	EPA 213.2, SW7131, 200.9	EPA 200.8
Calcium	EPA 200.7, 6010B		EPA 200.8
Cobalt	EPA 200.7, 6010B	EPA 219.2, 200.9	EPA 200.8
Copper	EPA 200.7, 6010B	EPA 220.2, 200.9	EPA 200.8
Chromium	EPA 200.7, 6010B	EPA 218.2, SW7191, 200.9	EPA 200.8
Iron	EPA 200.7, 6010B		EPA 200.8
Lead	EPA 200.7, 6010B	EPA 239.2, SW7421, 200.9	EPA 200.8
Lithium	EPA 200.7, 6010B		EPA 200.8
Magnesium	EPA 200.7, 6010B		EPA 200.8
Manganese	EPA 200.7, 6010B		EPA 200.8
Mercury		EPA 245.1, O, SW7471	EPA 200.8
Molybdenum	EPA 200.7, 6010B		EPA 200.8
Nickel	EPA 200.7, 6010B	EPA 249.2, EPA 200.9	EPA 200.8
Potassium	EPA 200.7, 6010B		EPA 200.8
Selenium	EPA 200.7, 6010B	EPA 270.2, SW7740, EPA 200.9	EPA 200.8
Silica	EPA 200.7, 6010B		EPA 200.8
Silver	EPA 200.7, 6010B	EPA 272.2, EPA 200.9	EPA 200.8
Sodium	EPA 200.7, 6010B		EPA 200.8
Strontium	EPA 200.7, 6010B		EPA 200.8
Tin	EPA 200.7, 6010B	EPA 282.2	EPA 200.8
Titanium	EPA 200.7, 6010B		EPA 200.8
Thallium	EPA 200.7, 6010B	EPA 279.2, SW7841, EPA 200.9	EPA 200.8
Vanadium	EPA 200.7, 6010B		EPA 200.8
Zinc	EPA 200.7, 6010B		EPA 200.8

TABLE 6 ORGANIC METHODOLOGIES

Purgeables (GC)	EPA 601, EPA 602	EPA 8020, EPA 8021A, EPA 8021B
Purgeables (GC / MS)	EPA 524.2, EPA 624, EPA 8240B, EPA 8260B, EPA 601/602 by GC/MS	EPA 8240B, EPA 8260B
EOB / DBCP	EPA 504	EPA 504M
Pesticides, Herbicides (GC)	EPA 608, EPA 614, EPA 619 EPA 515, EPA 508	EPA 8080A, EPA 8081A, EPA 8082, EPA 8141A, EPA 8140, EPA 525.2, EPA 8150B, EPA 8151A, 8081A
Gasoline Residue	LUFT Manual 8015M	LUFT Manual 8015M
Diesel Residue	LUFT Manual 8015M	LUFT Manual 8015M
PCB's	Modified 608, State Method	Modified 8080, State Method
Phenols	EPA 525.2	EPA 8270C
Title 22	State Method	
Priority Pollutants (GC/MS)	EPA 625, EPA 525.2, EPA 548.1	EPA 8270C
Oil and Grease	EPA 413.1, EPA 413.2, 1664	EPA 413.1, EPA 413.2, EPA 9071M
TPH	EPA 418.1	EPA 418.1
Pesticides, Herbicides (HPLC), Carbamates	EPA 632, EPA 531, EPA 547, EPA 549	632M
PAH's	EPA610	EPA 8310
Explosives	EPA8330	EPA8330

TABLE 7 INORGANIC METHODOLOGIES

Alkalinity	EPA 310.1, SM2320B	EPA AVAC, 1.005
Chloride	SM407C, EPA 300.0, SM 4500 CLC	SM 4500CL D, EPA 300.0
Chromium VI	SW 7196A, SM 3500Cr D	SW7196A
Corrosivity	EPA 150.1	SW9040
Conductivity	EPA 120.1	SW9050
Cyanide	EPA 335.3, EPA 335.2, EPA 335.4	SW9012, SW9010
Flashpoint	SW1010	SW1010
Fluoride	EPA 340.2	EPA 340.2
Nitrogen Forms	EPA 350.1, EPA 353.2, EPA 300.0, EPA 351.2	EPA 350.1, EPA 353.2, EPA 300.0, EPA 351.2
Bacteriologicals	SM 9221B, 9221E, 9223B	SM 9221B, 9221E
D.O.	EPA 360.1	N/A
Bromide	EPA 300.0	N/A
Chlorate	EPA 300.0	N/A
Chlorine Residue	SM 4500 CL-B, F	
Color	EPA 110.2, 9215B (Hpc)	N/A
Organic Lead	LUFT Manual	LUFT Manual
pH	EPA 150.1, SW9040	SW9045, SW9040
Phenols	EPA 420.2, 5530D	SW9066
Phosphorous	EPA 365.1, EPA 365.4	SM424G, SM424C
Sulfur Forms	EPA 376.1, EPA 376.2, SW 9030	SW9030, SW 7.3.4.2
Sulfate	EPA 300.0	
BOD	EPA 405.1	
COD	EPA 410.2, EPA 410.4	
TOC	EPA 415.1	SW 9060
Residue	EPA 160.1 - EPA 160.5	
MBAS	EPA 425.1	
Odor	EPA 140.1	
Turbidity	EPA 180.1	

2.0 SUMMARY

It is the responsibility of the analyst to conduct initial data reduction procedures by using calculations referenced in State and Federally recognized methodologies and within respective SOP's. The tools used to reduce data include Excel spreadsheets, Dionex AI-450 software, HP Chemstation software, calculators, Enable database software, LIMS processing programs and instrument programs.

Validation and verification processes include analyst reviews, technical reviews, supervisor reviews, project management reviews, QA department reviews, data processing checks, and final approvals. See the appropriate flowcharts in Appendix D.

Results are entered onto laboratory bench worksheets, then introduced into the LIMS via data entry specialists. At present, a parallel data processing system is in place for QA/QC purposes only. The incorporation of this new reporting system will eventually replace the hand entry process.

12.1 REDUCTION

12.1.1 Organics Department

12.1.1.1 GC/HPLC

Data is processed via HP Chem software reduced by hand if necessary and recorded onto worksheets. The reduced data is electronically transferred to the LIMS. The LIMS performs statistical calculations (% recoveries % RPD, % found, etc) and sample calculations in test solutions sample weights, extract volume and sample dilution.

12.1.1.2 GC/MS

All data is processed and reduced on manufacturer's software. Sample analyses are processed via data systems enviroquant and Varian's enviropro. Results are then recorded onto worksheets. The reduced data is electronically transferred to the LIMS. The LIMS performs statistical calculations (% recoveries % RPD, % found, etc) and sample calculations in test solutions sample weights, extract volume and sample dilution.

12.1.1.3 TRPH

Data is recorded onto QC bench sheets, reduced by hand, then recorded onto worksheets. Calibration factors are used in the linear regression model which is used to reduce data. The reduced data is electronically transferred to the LIMS. The LIMS performs statistical calculations (% recoveries % RPD, % found, etc) and sample calculations in test solutions sample weights, extract volume and sample dilution.

12.1.2 Metals Department

12.1.2.1 ICP, ICP/MS, GFAA, AA

Instrument data is reduced on manufacturer's software. All dilutions are accounted for on laboratory worksheets. The reduced data is electronically transferred to the LIMS. The LIMS performs statistical calculations (% recoveries % RPD, % found, etc) and sample calculations in test solutions sample weights, extract volume and sample dilution.

12.1.2.2 Hg by cold vapor

The method of least squares, using chart line versus concentration, is used as the linear regression model. Results are reduced onto a QC bench sheet then entered onto worksheet. The reduced data is electronically transferred to the LIMS. The LIMS performs statistical calculations (% recoveries % RPD, % found, etc) and sample calculations in test solutions sample weights, extract volume and sample dilution.

12.1.3 General Chemistries

12.1.3.1 IC

Data is reduced via the use of manufacturer's software. Values are recorded onto a QC bench sheet then transferred to worksheets. The reduced data is electronically transferred to the LIMS.

DATA REDUCTION, VALIDATION, AND REPORTING

The LIMS performs statistical calculations (% recoveries % RPD, % found, etc) and sample calculations in test solutions sample weights, extract volume and sample dilution.

12.1.3.2

Meters, titrimetric and gravimetric tests.

Data is recorded onto QC benchsheets then transferred to worksheet. The reduced data is electronically transferred to the LIMS. The LIMS performs statistical calculations (% recoveries % RPD, % found, etc) and sample calculations in test solutions sample weights, extract volume and sample dilution.

12.1.3.3

Optical Analyses

The method of least squares, using chart line versus concentration, is used as the linear regression model. Results are reduced on QC log sheets then transferred onto worksheets. The reduced data is electronically transferred to the LIMS. The LIMS performs statistical calculations (% recoveries % RPD, % found, etc) and sample calculations in test solutions sample weights, extract volume and sample dilution.

BC LABORATORIES, INC.

PQL/MDL DETERMINATIONS

Analyst:
 Analyte:
 Method:
 Run Date:
 Instrument ID:
 Matrix:
 Units:
 Prep Date:
 MDL Study No:

Analyst:
 Analyte:
 Method:
 Run Date:
 Instrument ID:
 Matrix:
 Units:
 Prep Date:
 MDL Study No:

Analyst:
 Analyte:
 Method:
 Run Date:
 Instrument ID:
 Matrix:
 Units:
 Prep Date:
 MDL Study No:

/ / - - -
 DATE INSTR ID SEQ MATRIX
 NO (W,S)

/ / - - -
 DATE INSTR ID SEQ MATRIX
 NO (W,S)

/ / - - -
 DATE INSTR ID SEQ MATRIX
 NO (W,S)

MDL Std. ID	Response	Conc.	MDL Std. ID	Response	Conc.	MDL Std. ID	Response	Conc.
1			1			1		
2			2			2		
3			3			3		
4			4			4		
5			5			5		
6			6			6		
7			7			7		

MDL Std Concentration:

 $\bar{x} =$ $s =$ $3.29(s) =$
 $t_{(n-1, .99)s} =$ MDL =

 $10s =$ PQL =

MDL Std Concentration:

 $\bar{x} =$ $s =$ $3.29(s) =$
 $t_{(n-1, .99)s} =$ MDL =

 $10s =$ PQL =

MDL Std Concentration:

 $\bar{x} =$ $s =$ $3.29(s) =$
 $t_{(n-1, .99)s} =$ MDL =

 $10s =$ PQL =
Standard Curve $r =$ $r^2 =$ Standard Curve $r =$ $r^2 =$ Standard Curve $r =$ $r^2 =$

1st Order	2nd Order	3rd Order	1st Order	2nd Order	3rd Order	1st Order	2nd Order	3rd Order
Stand. ID	Conc.	Response	Stand. ID	Conc.	Response	Stand. ID	Conc.	Response

MDL/PQL DETERMINATIONS

Analyte:	Study No:	Std Concentration Used:	
Dates: Run No. 1		$\bar{x} =$	$s =$ 3.29(s) =
Run No. 2		$t_{(n-1, .99)} =$	$t_{(n-1, .99)} =$
Run No. 3		10s =	
Analyst:		Blank Response Data:	
Instrument:		$\bar{x} =$	$s =$ 3.29(s) =
Method:		3s =	
Matrix:		10s =	
Units:		STANDARD CURVE	
		Standard ID	Conc.
Instrument Parameters:			Response
Standard Calibration Setting:			
Flowcell Length:		1st Order	2nd Order
Program Method ID:			3rd Order
Date of Preparation:		Correlation Coefficient:	
		PQL:	MDL:

Run No. 1			Run No. 2		
MDL STD. ID	RESPONSE	CONC.	MDL STD. ID	RESPONSE	CONC.
1.			1.		
2.			2.		
3.			3.		
4.			4.		
5.			5.		
6.			6.		
7.			7.		
8.			8.		
Run No. 3			Blank Determination		
MDL STD. ID	RESPONSE	CONC.	BLANK ID	RESPONSE	CONC.
1.			1.		
2.			2.		
3.			3.		
4.			4.		
5.			5.		
6.			6.		
7.			7.		
8.			8.		

PERFORMANCE AND SYSTEMS AUDITS

TABLE 8
LEVEL OF QC EFFORT

TEST	MATRIX	FREQUENCY	CRITERIA	CHEMISTRY
Duplicate	Water	10% or 1 per batch, whichever is greater	<10% RPD above 5 times PQL, If <5 times PQL, $\leq$ PQL.	Inorganic
	Soil/ Wastewater	5% for solid and wastewater matrices	<20% RPD above 5 times PQL, If <5 times PQL, $\leq 2 \times$ PQL.	
Matrix Spike, Matrix Spike Dupl.	Water	10% or 1 per batch, whichever is greater	Within defaulted Control Limits	Inorganic except TSS, TDS, Color, Odor, Turbidity, pH, Conductivity
	Soil/other	5% or 1 per batch, whichever is greater	Within defaulted Control Limits	Solid Matrix Metals, Solid Matrix Inorganics
		5% or 1 per batch, whichever is greater	Within Control Limits	Organic
LCS	NA	1 per batch	90 - 110% Recovery or Within Control Limits	Wet Chemistry
		1 per batch	85 - 115% Recovery or Within Control Limits	Metals, Wet Chemistry (Prepared Samples)
		1 per batch	Within Control Limits	Organic
ICV / CCV	NA	10%	90 - 110% Recovery, for CCV 95 - 105% Recovery, for ICV (See SOPs)	Inorganic, except Hg on solids 200.7, 7470, GFAA for waters
		Every 12 hours	See SOP	GC/MS
		10%	$\pm 15\%$ diff	8000 Series except for GC/MS and 500/600 series
CCB	NA	Run after ICV and each CCV	<PQL	Inorganic, Organic
Preparation Blank	NA	1 per batch or 20 (whichever more frequent)	<PQL	Inorganic, Organic
Initial Calibration	NA	Before each sample run and/or when CCV unacceptable	>0.995 Corr. Coeff.	Inorganic
		When CCV unacceptable, when target compounds out	<20% RSD or regression model	Organic except GC/MS
			<15% RSD/If >15% RSD-use linear regression	GC/MS

PERFORMANCE AND SYSTEMS AUDITS

14.0 PERFORMANCE AUDITS

In order to validate BC Laboratories, Inc. method performance accuracy and comparability to standards of the environmental laboratory industry, a program of external and internal performance evaluations must be incorporated into the Quality Program. Comparability studies are through external PE sample analyses, while internal assessments are conducted to validate and maintain control of the analytical system.

14.1 EXTERNAL PERFORMANCE EVALUATION SAMPLES

BC Laboratories, Inc. is involved in 1) the ERA Water Supply and Water Pollution performance evaluation studies, 2) the NPDES DMR PE studies, 3) a program of PE samples for soil matrices through ERA, 4) an internal PE sample assessment through purchased standards from ERA, 5) SLAP, the Shell Laboratory Audit Program, and 6) ELAP Microbiology Evaluation Study.

All performance sample studies are completed (i.e., we participate in every WS, WP and DMR PE Study). This is not a necessity since one compliant analyte result per PE study will validate that parameter for one year. Each PE sample is analyzed to validate continuous control of the analytical system.

14.1.1 Scope of Analytical Parameters

- 14.1.1.1 Water Supply - TAL metals, minerals, Anions, Cations, EPA 507/8140, EPA 508/8080, EPA 525/8270, EPA 531.1, EPA 515.1/8150, EPA 8010/8020, EPA 8240/8260, EPA 300.0, Physical testing, residue EPA 160.1, EPA 335.3/9012, EPA 9040, alkalinity.
- 14.1.1.2 Water Pollution - TAL metals, alkalinity, EPA 9040, Cations, Anions, Demand, PCB's, EPA 8080, EPA 8010/8020, EPA 8240/8260, EPA 413.1, EPA 335.3/9012, EPA 420.2, Residue EPA 160.1, residual chlorine.
- 14.1.1.3 DMR - TAL metals, EPA 9040, EPA 160.2, EPA 413.1, nitrogen forms (350.1, 353.2, 300.0, 351.1), EPA 365.4, EPA 365.1, Demand, EPA 335.3/9012, EPA 420.2, residual chlorine.
- 14.1.1.4 SLAP - EPA 8020, EPA 8270, TAL metals, EPA 415.1, Demand, EPA 351.1, EPA 413.1
- 14.1.1.5 ELAP Microbiology Study - Bacteriological Analyses
- 14.1.1.6 Internal Performance Evaluation - Parameters under investigation
- 14.1.1.7 Soil Series - 8015M purgeable and extractable, 8080, 8150, 8260, 8270, TRPH, metals.

14.2 SYSTEMS AUDIT

14.2.1 Internal

Systems audits will be conducted on a annual basis and will cover 1) parameters outlined on the Internal Assessment Schedule (Figure 7), 2) clerical procedures, 3) invoicing, 4) conformance to methodology and SOP procedural outline, and 5) other tasks with performance objectives. A completed Systems Audit Report will be submitted to the General Manager annually. Topics of concern which arise during the year will be addressed at the weekly Supervisor's Meetings.

14.2.2 External

External based audits are conducted by representatives of the state of California, and other private or government entities.

14.3 ACTION

The QA Officer is responsible for completing annual systems audits and initiating subsequent corrective actions as needed. If corrective action is required, the QA Officer has the authority to delegate responsibilities and to initiate progressive discipline if tasks are not completed sufficiently to restore acceptable performance of the analytical system. Corrective action documentation will illustrate tasks, responsibilities, time frames, and will validate restoration of the process to a controlled status. Corrective action documentation and Quality Improvement Forms are stored in the QA/QC Department and in pertinent files.

ANALYTICAL QUALITY CONTROL REQUIREMENTS

13.0 QC PARAMETERS

Required QC parameters will vary according to method, specific project requirements, and/or sample matrices encountered. Table 5 illustrates generalized criteria. QC parameter requirements in specific SOP's supercede those listed in Table 5.

QC Parameters for Wet Chemistry testing

Sample/Sample Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample-Water or Solid
Method Blank

Exceptions:

pH, EC, TDS, Flashpoint

Sample/Sample Duplicate
Laboratory Control Sample

TSS, Settleable Solids

Sample/Sample Duplicate

QC Parameters for Metals testing

Sample/Sample Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample-Water or Solid
Method Blank
Post Spike

QC Parameters for Organics testing

Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample
Method Blank
Surrogate

Exceptions:

Oil and Grease, Total Recoverable Petroleum Hydrocarbons
Soil

Sample/Sample Duplicate
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample
Method Blank

Water
Matrix Spike/Matrix Spike Duplicate
Laboratory Control Sample
Method Blank

13.1 BATCHING

A group of samples of similar matrix that behave similarly with respect to the procedures being employed. The number of samples in a batch may never exceed 20, (consult SOP to verify maximum batch size). All samples in a batch must be processed as a unit with the same method sequence and the same lots of reagents and standards. The manipulations common to each sample in a batch must be performed simultaneously or in a continuous sequence without significant interruption. If an analytical sequence contains more than one distinct step, such as a preparation procedure, quality control samples required by the method for the batch must be assigned and prepared in the initial step. This group of samples is called a preparation batch, and must contain all quality control

ANALYTICAL QUALITY CONTROL REQUIREMENTS

samples required by the method, including (PB/MB, Dup, MS, MSD, LCS, other). A preparation batch must not contain more than twenty field samples. Laboratory QC samples processed in the preparation batch are not counted in the maximum batch size of 20. If the instrumental analysis of the samples in one preparation batch is not performed in a continuous sequence, the method blank from the preparation batch must be analyzed with each set of samples from the same preparation batch. If re-analyses are required (e.g. to perform dilutions) it is not necessary to include the method blank in the reanalysis.

13.2 LABELING CONVENTIONS

Unique batch identifiers are needed to properly coordinate referencing of QC parameters to associated samples. Preparation sets which are processed into the LIMS are labeled by preparation code, date and set number. All prepared samples within the batch are associated automatically by the LIMS. If preparation tasks are not processed into the LIMS, preparation batches are labeled on individual preparation logs. QC parameters are labeled by a combination of 1) QC parameters type, 2) Method code, 3) Sample number, 4) date and 5) extension.

13.3 QC PARAMETER CONTROL LIMITS

Control limits are calculated from recoveries of laboratory control samples and/or matrix spikes. A minimum of twenty observations should be used to calculate control limits. 500 and 600 series methods mandate calculation of control limits with the statistical use of the word "control" in mind.

Control Limits = Mean Recovery $\pm 3 s$
 s is the standard deviation of the recoveries

The SW-846 series calculation for control limits are as follows:

Control Limits (Matrix Spikes) = Mean Recovery $\pm 3 s$
 s is the standard deviation of the recoveries

Control Limit (for surrogates) = Mean Recovery $\pm 3 s$
 s is the standard deviation of the recoveries

In order to monitor trends in the analytical process, the latest thirty to forty observations are used to calculate laboratory control sample control limits. New control limits are compared to previously calculated limits to track possible trends. Comparisons are made on the means, UCL, LCL and numbers of outliers.

When calculating control limits for matrix spikes, the database will be continually added to until major modifications occur to a method.

There exists many variables that would cause new control limits to be initiated.

Variables:	1.	New Analyst
	2.	New Preparation Tech
	3.	Method Modification
	4.	Instrument Modification
	5.	Reagent and/or standard vendor change

Control limits are calculated by QA Department personnel and analysts using statistical software packages NWA Quality Analyst, Statistica and Excel.

13.4 CALCULATIONS

Precision

Precision is defined as the measure of mutual agreement among individual measurements of the same pollutant in a sample secured under the same analytical protocols. Field and lab precision will be expressed as relative percent difference where:

$$RPD = \frac{|x1 - x2|}{\bar{X}} \times 100$$

ANALYTICAL QUALITY CONTROL REQUIREMENTS

- $|d|$ = Absolute value of the difference between duplicates X1 and X2
X = Mean value of duplicate results, X1 and X2

The goals for precision are related to the proximity of the sample value to the detection limit. At or less than five times the practical quantitation limit, the precision goal will be expressed in absolute concentration (quantitation limit terms).

Accuracy

Accuracy is defined as the degree to which the analytical measurement reflects the true value present. Overall accuracy will be estimated by recovery performance of spiking events, internal standards and control samples. Accuracy will be measured as percent recovery where:

$$\% \text{ RECOVERY} = \frac{X - B}{T} \times 100$$

- X = measured concentration in sample after spiking
B = background concentration in sample
T = concentration of spike added to sample

If the sample concentration is below the MDL, zero(0) will be used in the calculation. In all other cases, the sample concentration must be used to calculate percent recovery. When the sample concentration is greater than four(4) times the spike level, the percent recovery result will be expressed as "High Mean". Percent recovery for selected inorganic method soil matrix samples may use the average of the sample and sample duplicate in the percent recovery equation.

13.5 COMPLETENESS

Completeness shall be evaluated qualitatively and quantitatively if necessary to meet specific project requirements. The qualitative evaluation of completeness shall be determined as a function of all events contributing to the sampling event including items such as correct handling of chain of custody forms, etc. The quantitative description of completeness shall be defined as the percentage of Contract controlled QC parameters that are acceptable.

QC parameters that shall be assessed for quantitative determinations of completeness shall include Initial calibrations, continuing calibrations, surrogate percent recovery for organics analyses, analysis of laboratory duplicates for Relative Percent Difference (RPD), analysis of Matrix Spike/Matrix Spike Duplicate analyses for percent recovery and RPD, and analysis of Laboratory Control Samples for percent recovery, and holding times. The requirement for the quantitative assessment of completeness shall be 90%. The 90% standard shall be applied to the entire list of parameters described above such that a minimum of 90% of the data for each analytical method is associated with acceptable quality control criteria as described above and in other sections of this document. The quantitative assessment of completeness shall be calculated for each analytical method as the ratio of acceptable sample results to all sample results. For multi-analyte methods (organics analyses) each analysis of the aggregate of analytes shall be considered a single sample result. The requirement for holding times shall be 100%. If any sample exceeds the holding time specified by EPA SW 846 (or other guidance documents for other analyses), that sample should be resampled and reanalyzed, unless redirected by the client.

13.6 CORRECTIVE ACTION

Corrective Action will be initiated for instances of QC parameter noncompliance. The extent and steps of corrective action procedures will vary according to project requirements or individual client protocols.

PREVENTATIVE MAINTENANCE

16.0 SCOPE

Preventive maintenance is an orderly program of positive actions (equipment cleaning, lubricating, reconditioning, adjustment and/or testing) done to prevent the failure of measurement systems or support equipment. The goal is to ensure the analytical system is in control and to prevent any nonconformance from occurring before tasks are initiated. Use of preventive maintenance schedules for each analytical measurement system and support equipment type aids in the foretelling of possible problems. Documentation of preventive procedures is through Preventive Maintenance Logs.

Preventive Maintenance Logs are maintained for all instrumentation and equipment. These logs are stored near respective instrumentation and are maintained by responsible analysts or technicians. Figure 8 displays an example of a preventive maintenance schedule.

Service contracts are maintained for all major instrumentation including:

- Varian AAs and GFAAs
- TJA36
- Dionex ICs
- Varian GC/MS
- Varian GCs
- Perkin Elmer GCs

All service calls will be documented in respective Preventive Maintenance Logs.

16.1 GENERAL PROCEDURES

Preventive maintenance will be performed by qualified personnel. Records of repairs, adjustments, and calibrations will be maintained and available for inspection. Periodic checks of Preventive Maintenance Logs and schedules will be performed by department supervisors. Documentation of these checks will consist of approval initials on pertinent logs.

If an instrument is not working properly and cannot be restored by laboratory personnel, a service call to the manufacturer will be made. Approval of a service call must be made by the concerned department supervisor or General Manager before initiation. Documentation of each service call will be maintained in respective Preventive Maintenance Logs.

16.2 TAGGING OUT

In cases when instrumentation or equipment is not operational, they must be labeled out of service, do not use. A sign with the aforementioned label will be affixed to non-operational instruments or equipment by department supervisors or the QA Officer. Responsibility of the removal of warning signs is designated to either department supervisors or the QA Officer.

16.3 GENERAL PREVENTIVE MAINTENANCE CHECKS

EQUIPMENT MONITORING			
Equipment	Check	Frequency	Frequency
Top-loading balances	Verify accuracy with weights calibrated against certified class-S weights	± 0.02 g	Daily or with each use
Analytical balances	Verify accuracy with certified class-S weight using different weight each day over range of weights routinely determined. Calibration by outside source quarterly.	± 0.0005 g	Daily or with each use
Thermometers	Verify accuracy against NIST-certified thermometer, or if purchased with certificate of traceability, check for mercury separation daily.	$\pm 1.0^{\circ}\text{C}$	Annually
Temporary storage refrigerators	Verify temperature within range.	$4^{\circ}\text{C} \pm 2^{\circ}\text{C}$	Daily
Long-term storage refrigerators	Verify temperature within range.	$4^{\circ}\text{C} \pm 2^{\circ}\text{C}$	Daily
Freezers	Verify temperature within range.	$< -10^{\circ}\text{C}$	Daily

17.0 DEFINITIONS

17.0.1 Corrective Action (CA)

A process by which a critical error is corrected in such a way as to prevent future errors of the same nature or type. Some examples of when to initiate corrective action:

- Calculation errors.
- Client Request.
- Out of control trend
- Significant QA/QC anomalies
- Unacceptable PE results.
- Poor curve linearity.
- Dilution error (if sample is diluted).
- Equipment malfunction.
- Improper methodology for sample matrix.
- Contamination.
- Incorrect report formatting.
- Clerical discrepancies.
- Invoicing problems.
- Field service problems.
- Inherent or chronic problems with methodology.

17.0.2 Quality Improvement (QI)

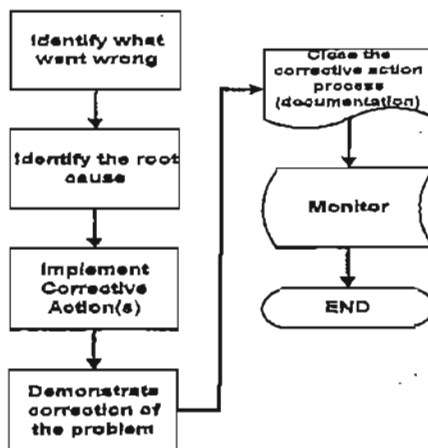
A term used to describe a preemptive positive action or process modification, which increases the level of quality and customer satisfaction.

17.1 PROCESS

Corrective steps for reporting and correcting problems for non-conforming measurements, equipment, or instruments:

1. Assign responsibility for investigating the problem
2. Determine the cause of the problem
3. Determine corrective action to eliminate the problem
4. Assign responsibility for implementing the corrective action
5. Verify that the corrective action has eliminated the problem
6. Create a historical file for future problem solvers
7. Document the corrective action process.
8. Trend corrective action.

PROCESS



Please refer to Appendix D for background on initiation of analytically based corrective action.

PREVENTATIVE MAINTENANCE

Figure 8

MAINTENANCE LOG

MONTH _____
YEAR _____

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
INITIALS																															
DAILY																															
Clean Platens																															
Empty Waste Containers																															
Wipe Spills																															
Dispose of Sample Cups																															
WEEKLY																															
Wipe Pump Rollers																															
Clean Manifolds - KemWash																															
MONTHLY																															
Clean Wash Reservoir																															
160-200 HRS																															
Change Pump Tubing																															
400 HRS																															
Clean Pump Roller Cage																															
Clean Pump Fan																															
Lubricate Pump Gears																															
6 MONTHS																															
Replace Wash Res. Tubing																															
Replace Cart. Drain Tubing																															
Replace Transmission Tubing																															

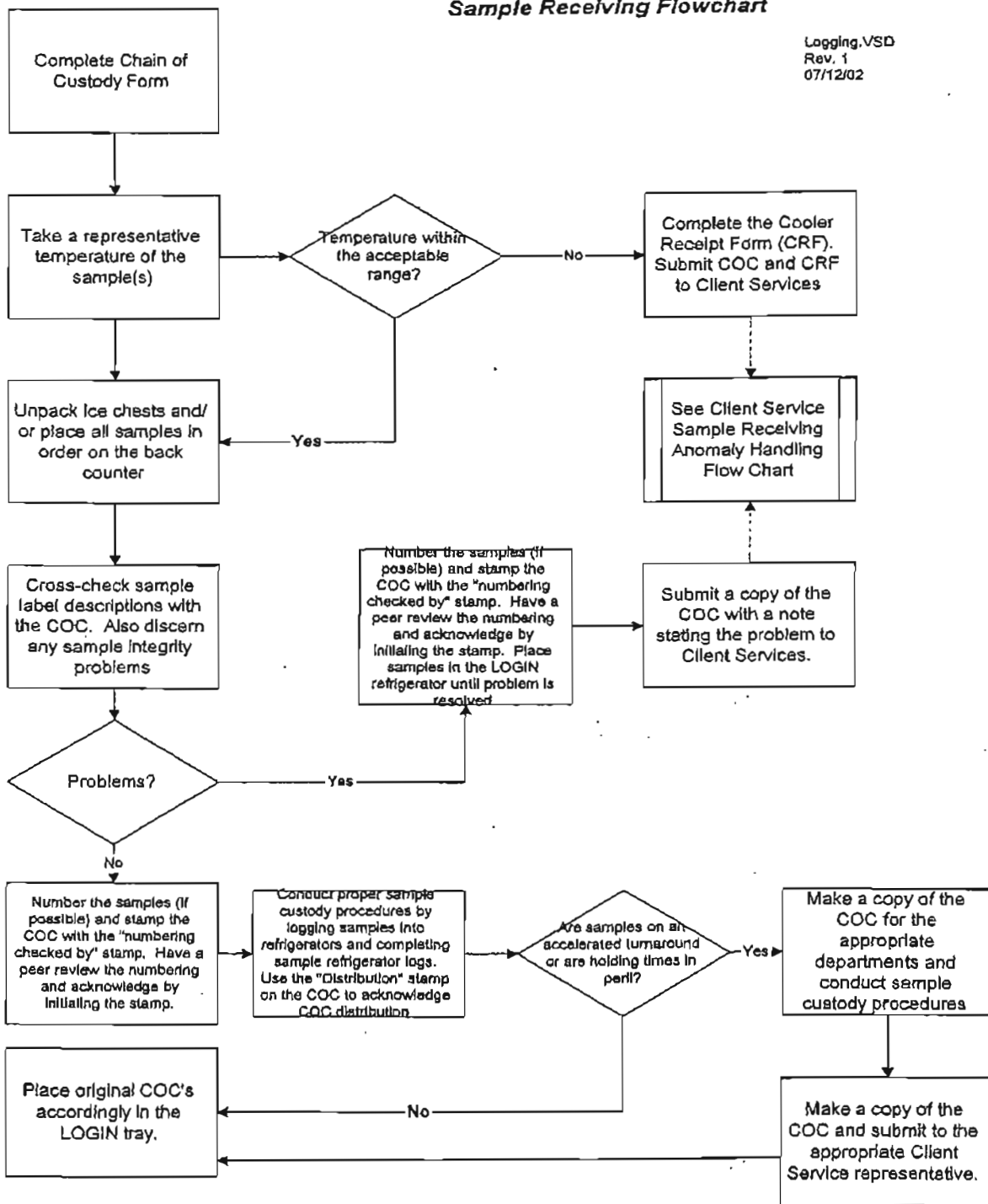
18.0 QUALITY ASSURANCE REPORTS

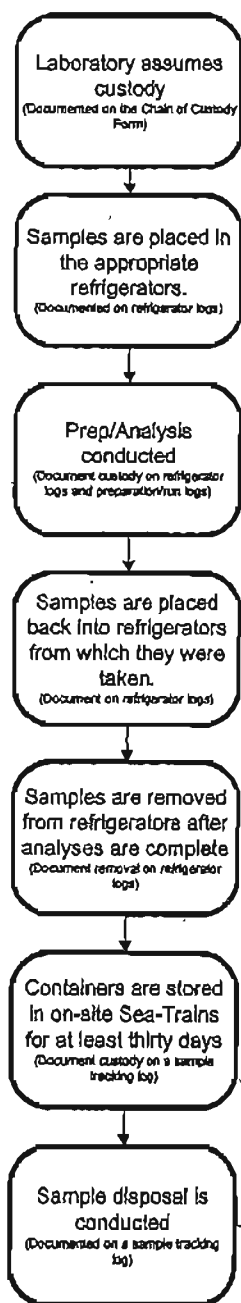
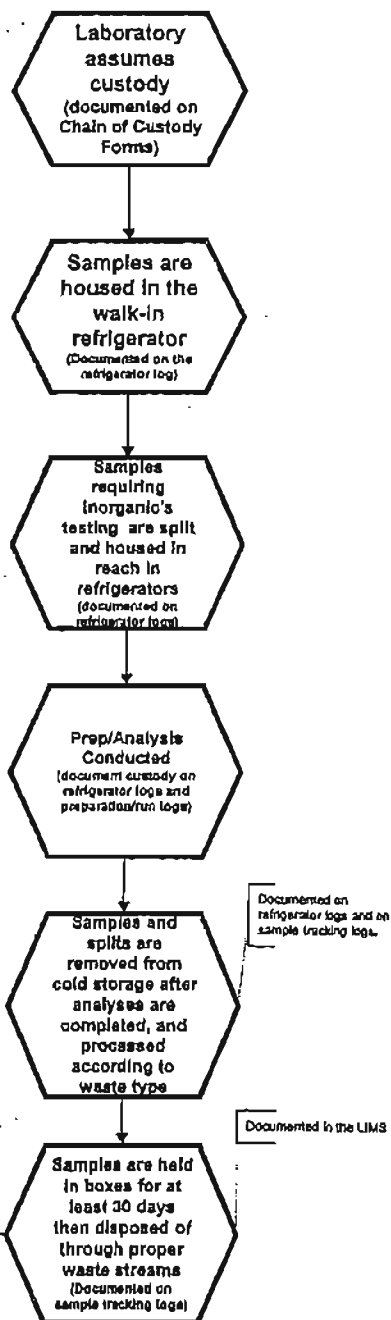
Quality Assurance reports, prepared by the Quality Assurance Officer, are issued on a quarterly basis. The purpose of these quarterly updates is to give an indication of overall laboratory performance and quality of work. These reports contain information pertaining to the overall performance of the laboratory. Annual internal audit reports are also completed to measure laboratory performance during the previous three month spans.

Information is gathered from internal and external audit results, control charts, monitoring programs and supervisor/analyst interviews. Situations such as equipment malfunctions, new or updated QC techniques, revised analytical procedures, corrective action activities, and any significant QC or performance evaluations will also be addressed in the report. Copies of these reports are available upon request.

The QA Officer maintains a direct line of communication with upper management to relay quality related information, therefore eliminating conflict of interest influence from concerned parties.

Sample Receiving Flowchart

Logging.VSD
Rev. 1
07/12/02

Sample Tracking
Aqueous Matrices**Sample Tracking**
Non-Aqueous Matrices

14.6 Working Standards

Internal audit standards are purchased from: ERA, 5540 Marshall Street, Arvada, CO 80002, 303-431-8454, 1-800-ERA-0122.

Catalog descriptions: WW-11: Wastewater, PP-41: PP/CLP Organic-water PW-31: Potablewater.

Optional purchases are made from: Ultra Scientific, 250 Smith Street, North Kingstown, RI 02852, 401-294-9400, Fax: 401-295-2330.

14.7 Sample Collection, Preservation and Handling

Audit samples should be prepared as soon as possible. If this is not practical, store samples or ampuls according to specifications included in respective preparation method instructions.

Preserve audit solutions according to method preparation instructions, and/or laboratory guidelines.

Handle concentrated ampul solutions with care. Read associated MSDS sheets for more information on safe handling of each material.

When analyses are completed, discard samples and remaining ampul contents according to laboratory waste disposal protocols.

14.8 Procedure

14.8.1 Internal Audits (conducted by the QA/QC Dept.)

Purchase audit samples from ERA on an as needed basis. When the audit samples arrive, prepare and process them immediately. If this cannot be done, store the samples inside the walk-in refrigerator. Follow preparation procedures and fill out chain-of-custody forms under fictitious client identifications. Document these sample identifications and notify the billing department of the audit samples so they are not billed. The most anonymous method of submitting samples is to pack the sample batch into an ice chest. Then leave it overnight in the walk-in refrigerator. The samples will be logged in the following morning. When analyses are completed, retrieve data from the billing department or client services. Process the results in report form as part of the quarterly report to upper management. List sample IDs, methods used, results, units, control limits and analytes. Process an unacceptable results section that includes: sample IDs, methods, analytes, reasons for discrepancies, and corrective action.

14.8.2 External Audits

Examine all aspects of sample condition when the audit arrives. If any discrepancies are found, contact the responsible parties for further instruction or action. After examination of samples and instructions, initiate the analytical process. Review all pertinent raw data after respective supervisor validations. If any discrepancies are found, allow the responsible supervisor to correct the problem. When all data is acceptable and complete, hand in the data package to the Data Control Department. Review of data

transferal is conducted by the Data Control Supervisor. When this checkpoint is cleared, the QA Officer reviews the results and clears the audit.

14.9 Forms

- Preparation Forms
- Sample Constituency Forms
- Analyte Concentrations Reports
- Chain-of-Custody

14.10 Safety

Follow any precautions listed in the MSDS associated for each sample. Always wear a labcoat, gloves and safety glasses.

AQUATIC TESTING LABORATORIES

1. INTRODUCTION

Aquatic Testing Laboratories (ATL) is dedicated to providing the highest quality aquatic toxicity testing available to its clients. This document describes ATL's Quality Assurance policies and procedures as they relate to biological monitoring for environmental pollutants.

Purpose of Document

This Quality Assurance Program Plan (QAPP) is intended to ensure that precision, accuracy, completeness, comparability, and representativeness of data are known and documented.

The QAPP presents an overview of the essential elements of ATL's QA program. This plan has been modeled along EPA guidelines as outlined in "Interim Guideline and Specifications for Preparing Quality Assurance Program Plans," QAMS-004/80, December 29, 1980; "Interim Guideline and Specifications for Preparing Quality Assurance Project Plans," QAMS-005/80, February 1983; "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms," EPA/600/4-89/001; and "Manual for the Evaluation of Laboratories Performing Aquatic Toxicity Tests," EPA/600/4-90/031. All of these documents have been issued by the Office of Monitoring Systems and Quality Assurance, Office of Research and Development, U.S. Environmental Protection Agency (U.S. EPA). Primary guidance was obtained from "Enseco Incorporate Quality Assurance Program Plan for Environmental Biology," Revision 3.1, July, 1988, written by Enseco Inc. with additional guidance provided from the Environmental Laboratory Accreditation Program, (State of California Department of Health Services and Department of Fish and Game).

QA Objectives

This QA Program Plan is designed to control and monitor the quality of data generated at MRS and by subcontractors. The described QA program is geared toward generating data that comply with federal regulatory requirements specified under the National Pollutant Discharge Elimination System (NPDES) as well as the State of California Department of Health Services Environmental Laboratory Accreditation Program (DOHS ELAP) and other state equivalents. Although the QC requirements of these various programs are not completely consistent, each of the programs base data quality judgements on two types of information:

- 1) Data that indicate the overall qualifications of the laboratory to perform environmental analyses;
- 2) Data that measure the laboratory's daily performance using a specific method.

The operational elements that are involved in making each of these assessments are described in TABLE 2.1 along with the pertinent section number from this document in which each is discussed.

TABLE 2.1
DATA QUALITY ASSESSMENT

Evaluation Criteria	Operational Elements	QA Plan
LABORATORY QUALIFICATION	Facilities/Equipment/Staff	SOQ*
	Written SOP's for all laboratory procedures	27
	Sample custody	8
	Calibration procedures	10
	Testing procedures	11
	Data validation	15
	Documented QA program	1-28
	Laboratory certifications	21
LABORATORY PERFORMANCE	Calibration data	10
	Check samples	21
	Reference toxicant data	19
	Control charts	19

* SOQ (Statement Of Qualifications) described in a separate document.

2. DEFINITIONS

Definition of Terms

Protocol: the actual plan for scientific testing. A protocol may refer to several SOP's to complete the plan.

Quality Assurance (QA): the total integrated program for assuring the reliability of data generated in the laboratory.

Quality Assurance Program Plan (QAPP): an assemblage of management policies, objectives, principles, and general procedures outlining the techniques by which the laboratory produces data of known and accepted quality.

Quality Assurance Project Plan (QAPjP): an assemblage of detailed SOP's describing how the laboratory will generate data that meet the data quality objective of a specific project.

Quality Control (QC): the routine application of specific, well documented procedures to ensure the generation of data of known and accepted quality, thus fulfilling the objectives of the QA program.

Quality Control Manual: an assemblage of detailed SOP's describing the laboratory implementation of the QAPP.

Standard Operating Procedure (SOP): a detailed, written description of a procedure designed to systematize and standardize the performance of the procedure.

3. ORGANIZATION, RESPONSIBILITIES AND AUTHORITIES

Executing an effective QA program demands the commitment and attention of both management and staff. The QA effort at ATL is managed by the Laboratory Director who serves as the QA Officer and as such, has the responsibility of overseeing and regulating all laboratory functions. The QA program operates independently of all areas, generating analytical data to ensure complete objectivity in the evaluation of laboratory operations.

QA Officer Responsibilities

The QA officer is responsible for:

- * Developing and implementing a QA program that ensures that all data generated are scientifically sound, legally defensible, and of known precision and accuracy;
- * Monitoring the QA Plan to ensure compliance with QA objectives;
- * Ensuring that all employees are complying with the QA Plan;
- * Developing and implementing new QA procedures to improve data quality;
- * Conducting in-house audits and inspections of all laboratories on a regular basis and applying corrective actions as needed to ensure compliance with the QA Plan;
- * Maintaining copies of all SOP'S;
- * Assist in the writing of SOP's;
- * Distributing current SOP's to the laboratory staff;
- * Monitoring laboratory performance in the areas of holding times, turn-around times, and meeting contractual obligations;
- * Performing statistical analyses of QC data and establishing data bases that accurately reflect the performance of the laboratory;
- * Maintaining reference toxicant control charts on all testing done at ATL;

- * Maintain records and archives of all QA/QC data, PE results, audit comments, and client inquiries concerning data quality;
- * Conducting seminars on QA issues for both clients and laboratory staff; and
- * Promoting sound QA practices within the environmental regulatory and analytical communities.

QA Officer Authority

The QA officer has the final authority on all issues dealing with data quality and has the authority to require that procedures be amended or discontinued, or analyses suspended or repeated. He also has the authority to suspend or terminate employees on the grounds of dishonesty, incompetence, or repeated non-compliance with QA procedures.

Laboratory Personnel Responsibilities

All laboratory personnel involved in the generation and reporting of data have a responsibility to understand and follow the ATL QA Plan. Laboratory personnel are responsible for:

- * Have a working knowledge of the ATL QA Plan;
- * Ensuring that all work is generated in compliance with the QA Plan;
- * Performing all work according to written SOP's;
- * Ensuring that all documentation related to their work is complete and accurate; and
- * Providing management with immediate notification of quality problems.

Laboratory Personnel Authority

Laboratory personnel have the authority to accept or reject data based on compliance with well-defined QC acceptance criteria. The acceptance of data that fall outside QC criteria must be approved by laboratory management. The authority of the laboratory personnel flows from the Laboratory Director.

4. SAMPLING PROCEDURES

The generation of quality data begins with the collection of the effluent, water or sediment sample. Therefore the integrity of the sample collection process is of concern to the laboratory. Samples must be collected in such a way that no foreign material is introduced into the sample and no material of interest escapes from the sample prior to analysis. To ensure sample integrity, the following must be considered:

- * Samples must be collected in appropriate containers. In general, glass containers are used for soils and solids, while plastic "cubitainers" are used for effluents and surface waters;
- * The sample containers must be properly cleaned to ensure that the sample is not contaminated during the collection process;
- * Appropriate volumes of sample must be collected to ensure that the required testing may be completed and QC samples may be analyzed;
- * Samples must be cooled to the appropriate holding temperature (4°C) prior to shipping;
- * Samples must be properly shipped to the laboratory, in the appropriate time frame, to ensure that holding times can be met.

ATL can assist in the sample collection process by providing consultation and assistance to clients designing sampling programs and also by making available to the client a set of appropriate sample containers that are properly cleaned for use in sample collection.

The maximum holding times recommended by ATL, appropriate containers, and minimum sample volumes required for routine testing are given in Appendix I. These holding times are in general agreement with EPA and the State of California recommended holding times, as stated in the National Pollutant Discharge Elimination System (NPDES) and the California Environmental Laboratory Accreditation Program (ELAP) programs. Other holding times can be honored if special arrangements are made with the laboratory.

5. SAMPLE CUSTODY

Upon receipt by ATL, samples proceed through an orderly processing sequence specifically designed to ensure continuous integrity of both the sample and its documentation.

All samples are received by ATL's sample control personnel and are carefully checked for label identification, and completed, accurate chain-of-custody records. Photographs may be used to document the condition of samples. Each sample is then assigned a unique laboratory identification number. The date received, the condition upon receipt, the new laboratory identification number, as well as the client and the client's sample identification are recorded in the sample control log book. A sample file is then generated in which all documentation, including testing results, are kept. The sample itself is labeled with the laboratory identification number and stored in a secured refrigerated storage facility with temperature maintained at 4°C until analysis. Any unused sample is returned to refrigerated storage until all analyses are complete. Samples are then either returned to the client, properly disposed of, or at the request of the client, stored for an extended length of time.

An example of ATL's chain-of-custody record form is given in Figure 5.1.

CHAIN OF CUSTODY

Client: _____

Address: _____

Project Manager: _____

Phone: _____

Purchase Order/Quote No.: _____

Aquatic
Testing
Laboratories*"dedicated to providing quality aquatic toxicity testing"*2810 Bunsen Ave., Unit A
Ventura, CA 93003
(805) 650-0546 FAX (805) 650-0756

SAMPLE ID/DESCRIPTION	SAMPLE DATE	SAMPLE TIME	SAMPLE TYPE*	NUMBER OF CONTAINERS	TESTING REQUESTED	REMARKS

Special Instructions: _____

* L - Liquid, S - Solid, SS - Semi-Solid, WW - Waste Water, RW - Receiving Water

CUSTODY TRANSFERS

RELINQUISHED BY (SIGNED)	RECEIVED BY (SIGNED)	DATE	TIME
Sampler:			

Shipping Company:	Airbill No.:
Received for Laboratory by:	Date: Time:
Received Chilled: Yes No	Seals Intact: Yes No None

Figure 5.1 Sample Chain Of Custody Form

6. CALIBRATION PROCEDURES AND FREQUENCY

Standard/Reagent Preparation

A critical element in the generation of quality data is the purity/quality and traceability of the standard solutions and reagents used in the analytical and/or biological operations. ATL continually monitors the quality of reagents and standard solutions through a series of well-documented procedures.

To ensure the highest purity possible, all primary reference standards and standard solutions are obtained from the EPA laboratory in Cincinnati, Ohio, or other reliable commercial sources. All standards and standard solutions are recorded into a log book that identifies the supplier, lot number, purity/concentration, receipt/preparation date, preparer's name, method of preparation, expiration date, and all other pertinent information.

Care is exercised in the proper storage and handling of standard solutions, and all containers are labeled as to compound, concentration, solvent, expiration date, and preparation data (initials of preparer/date of preparation).

Instrument Calibration and Tuning

Calibration of instrumentation is required to ensure that the analytical system is operating correctly and functioning at the proper sensitivity. Instruments used for routine measurements of chemical and physical parameters such as pH, DO, temperature, conductivity, salinity, alkalinity, and hardness, must be calibrated and standardized according to the instrument manufacturer's procedures prior to any uninterrupted use.

Dissolved oxygen probes can be calibrated daily by use of the moist air technique, however, comparison to the Winkler titrimetric method must be performed at least once per week.

Wet chemical methods used to measure hardness and alkalinity must be standardized according to EPA Methods 130.2 and 310.1.

7. TESTING PROCEDURES

Test Organisms

The fish and invertebrates used in toxicity testing should appear healthy, behave normally, feed well, and have low mortality in cultures, holding tanks, and test controls. Test organisms should be disease-free and should be positively identified to species.

The sensitivity (quality) of test organisms obtained from an outside of the laboratory source is to be tested by conducting a reference toxicant test on organisms from each batch received by the laboratory. The sensitivity of test organisms obtained from an in-lab breeding culture is to be tested by conducting a reference toxicant test on the cultured organisms on a monthly basis. Reference toxicant tests may be performed concurrently with an effluent toxicity test.

Facilities, Equipment, and Test Chambers

Laboratory and bioassay temperature control equipment must be adequate to maintain recommended test water temperatures. Surfaces that come in contact with the sample, such as test chambers, must be made of recommended materials. See individual testing SOP's and protocols for recommended materials and testing regimes.

Dilution Water

The dilution water used in toxicity tests will depend on the objectives of the study and client requirements. Hazardous waste testing utilize synthetic, soft (hardness: 40-48 mg/l CaCO_3) water. EPA NPDES toxicity test utilizes synthetic, moderately hard water or 20% diluted mineral water (DMW). Some tests will required the use of client-supplied dilution water.

The dilution water used for internal quality assurance tests with organisms, food, and reference toxicants should be water routinely used with success in the laboratory.

Testing Conditions

Water temperature must be maintained within the limits specified for each test. Dissolved oxygen (DO) concentration and pH in fish and invertebrate test chambers should be checked daily throughout the test period, as described in the test SOP.

Food Quality

The quality of the food for fish and invertebrates is an important factor in toxicity tests. Suitable fish food flakes, brine shrimp cysts, and other foods must be obtained as described in the test SOP's and protocols. The suitability of each new supply of food must be determined in a side-by-side test, using two treatments with four replicates per treatment. In this test, the response of control test organisms fed with the new food is compared with the response of organisms fed a reference food or a previously used, satisfactory food.

Test Methods

Most tests performed by ATL are driven by regulatory concerns. Therefore, methods used at ATL predominately originate from regulatory agencies. Generally the methods used are those specified by the U.S. EPA and other federal agencies, state agencies, and professional organizations, as provided in the following references:

- * American Society for Testing Materials (ASTM). 1989. Standard Guide for Conducting Static Acute Toxicity Tests Starting with Embryos of Four Species of Saltwater Bivalve Molluscs. Procedure E 724-89. ASTM, Philadelphia, PA.
- * California Department of Health Services. 1988. Static Acute Bioassay Procedures for Hazardous Waste Samples. Prepared by J.M. Polisini and R.G. Miller. California Department of Fish and Game Water Pollution Control Laboratory.
- * California State Water Resources Control Board (CSWRCB). 1989. Experimental Evaluation of Effluent Toxicity Testing Protocols with Giant Kelp, Mysids, Red Abalone, and Topsmelt. CSWRCB, Sacramento, CA.

- * Dinnel, P., J.M. Link and Q.J. Stober. 1987. Improved Methodology for a Sea Urchin Sperm Cell Bioassay for Marine Waters. Arch. Environ. Contam. Toxicol. 16:23-32.
- * Kopperdahl, F. 1976. Guidelines for Performing Static Acute Toxicity Fish Bioassays in Municipal and Industrial Wastes. Calif. Dept. of Fish and Game.
- * Machuzak, M.J. and T.K. Mikel, Jr. 1988. Drilling Fluid Bioassays Using Pacific Ocean Mysid Shrimp, *Acanthomysis sculpta*, a Preliminary Introduction. ASTM STP 971. ASTM, Philadelphia, PA.
- * U.S.ACE/HD. 1990. Dredged Material Bioassay/Bioaccumulation Testing Manual for Hawaii. U.S. Army Corps of Engineers, Honolulu District, Fort Shafter, Hawaii.
- * U.S.ACE/NYD. 1984. Guidance for Performing Tests on Dredged Material to be Disposed of in Ocean Waters. U.S. Army Corps of Engineers, Regulatory Branch, Water Compliance Section, New York, NY.
- * U.S.EPA. 1985. Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms. EPA/600/4-85/013.
- * U.S.EPA. 1985. Proposed Regulations for Offshore, Oil and Gas Extraction Point Source Category. Appendix 3. Drilling Fluids Toxicity Tests. Federal Register, Vol. 50, No. 165. Washington DC.
- * U.S.EPA. 1988. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms. EPA/600/4-87/028.
- * U.S.EPA. 1989. Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. EPA/600/4-89/001.
- * U.S.EPA/CE. 1977. Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters. Environmental Effects Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.
- * U.S.EPA/CE. 1990. Draft Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters. EPA-503-8-90/002. Office of Marine and Estuarine Protection, Washington, DC 20460.

9. INTERNAL QC CHECKS

The QA/QC program monitors data quality with internal QC checks which are used to determine if all laboratory operations are "in control," (i.e., operating within acceptable QC guidelines), during data generation.

Responsibility for internal QC checks rests with the QA Officer and with the individual analyst. These QC checks include instrument calibration checks, chemical monitoring of dilution waters, specific test validity requirements, and a reference toxicant monitoring program which includes the generation of test control charts.

Instrument QC Checks

All analytical instruments will be calibrated prior to use as set forth in ATL SOP's. Whenever calibration cannot be achieved or measurement of a calibration standard is not within specified limits, the instrument will be considered malfunctioning and will be reported to the Laboratory Director. Any malfunctioning instrument will not be used until appropriate maintenance or repairs are performed and documented.

Chemical Monitoring Of Dilution Waters

In order to establish and continuously monitor the acceptability of the dilution waters utilized in toxicity tests, the dilution waters will be monitored continuously, for deionized water, or at least twice per year for field collected seawater. Dilution waters are to be analyzed to the parameters listed in the appropriate SOP. Results of such analyses are to be maintained in appropriate dilution log books.

Test Validity Requirements

Due to the wide range of test guidelines utilized in toxicity testing, the requirements to determine the validity of any test conducted will be stated in the appropriate SOP. Generally, all acute toxicity tests will be required to meet the following criteria for acceptability:

- * No more than a total of 10 percent of the control organisms may appear to be diseased, stressed, or die in a test.

- * Appropriate testing conditions, (i.e., temperature, light/dark cycles), are maintained during the course of testing.

Reference Toxicant Monitoring Program

The QA Officer will obtain reference toxicants from the EPA Environmental Monitoring and Support Laboratory in Cincinnati, Ohio, (Telephone No.: (513) 569-7325), or from another reputable commercial supplier. Generally, sodium dodecylsulfate (SDS) will be the reference toxicant of choice, however, in some instances or for certain species other reference toxicants may be utilized.

Reference toxicant tests will be performed on each new batch of test organisms received at the laboratory or on a monthly basis for organisms cultured in-house. Appropriate reference toxicant testing will be conducted concurrently with sample testing when required by test methodology or by the client.

Control Charts

Control charts are to be established and continuously maintained for each organism and test conducted at ATL. Control charts should monitor appropriate test endpoints such as LC50 and NOEC values obtained from the reference toxicant testing program. The control chart is used to evaluate the cumulative trend of the statistics from a series of tests. For point estimation techniques, the mean and upper and lower control limits (± 2 times the mean toxicity value standard deviation) are re-calculated with each successive point, until the statistics stabilize. Outliers, which are values which fall outside the upper and lower control limits, and trends of increasing or decreasing sensitivity are readily identified. Note: at the 0.05 probability level, one in 20 tests would be expected to fall outside of the control limits by chance alone. For hypothesis testing results, the same concentrations of reference toxicants are used for each toxicity test. The NOEC from each successive test is entered on the control chart, and the values should fall within one concentration interval above or below the central tendency.

Control charts are to be established based on five successfully completed reference toxicant tests with control limits recalculated with each successive valid reference toxicant test data endpoint. Control charts are used to monitor test organism sensitivity for both commercially obtained and in-house cultured test organisms. If a control chart data point falls outside the established control limits, corrective action must be taken to determine the cause of the discrepancy.

Laboratory Performance QC Program

Laboratory Performance QC is provided as a standard part of every analysis. The main elements of Laboratory Performance QC are:

- * Organism survival and reproduction;
- * The analysis of reference toxicants
- * The generation of daily calibration data.

Satisfactory laboratory performance is demonstrated by performing at least one acceptable reference toxicant test per month for each of the toxicity test methods commonly used in the laboratory. Reference toxicant tests are to be conducted concurrently with less frequently performed tests. If the toxicity value from a given test with the reference toxicant does not fall in the expected range for the test organisms when using the standard dilution water, the sensitivity of the organisms and the overall credibility of the test system are suspect. In this case, the test procedure should be examined for defects and should be repeated with a different batch of test organisms.

Please refer to section 6 of this manual for a discussion of calibration procedures.

10. PERFORMANCE AND SYSTEM AUDITS

ATL participates in a variety of federal and state certification programs, (i.e., EPA's DMR study and California's ELAP program), that subject the laboratory to stringent system and performance audits on a regular basis. A system audit is a review of laboratory operations conducted to verify that the laboratory has the necessary facilities, equipment, staff and procedures in place to generate acceptable data. A performance audit verifies the ability of the laboratory to correctly identify toxicity in blind check samples submitted by the auditing agency. The purpose of these audits is to identify those laboratories that are capable of generating scientifically sound data. A list of current ATL certifications is available upon request.

In addition to external audits conducted by certifying agencies or by clients, the QA Officer periodically conducts system and performance audits of the laboratory to verify that only quality, scientifically sound, data are being generated.