City of Morro Bay and
Cayucos Sanitary District

OFFSHORE MONITORING AND REPORTING PROGRAM

2018 ANNUAL REPORT

Marine Research Specialists

4744 Telephone Rd Ste 3 PMB 315
Ventura, California 93003

Report to the

City of Morro Bay and
Cayucos Sanitary District

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Morro Bay, California 93442
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OFFSHORE MONITORING AND REPORTING PROGRAM

2018 ANNUAL REPORT

Prepared by
Douglas A. Coats

Submitted by
Marine Research Specialists

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14 March 2019

John Gunderlock
Wastewater & Collection Systems Supervisor
City of Morro Bay/Cayucos Sanitary District
955 Shasta Avenue
Morro Bay, CA 93442

Reference: 2018 Annual Monitoring Report

Dear Mr. Gunderlock:

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 permits.

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

Sincerely,

Douglas A. Coats
Vice President
MARINE RESEARCH SPECIALISTS
2019.03.14 07:51:41 -07'00'

Douglas A Coats
Project Manager

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. John Gunderlock
Wastewater/Collections System Supervisor
City of Morro Bay/Cayucos CSD Wastewater Treatment Plant

Date: 3/14/19

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LIST OF ACRONYMS AND DEFINITIONS

AHA	**Activity Hazard Analyses investigate potential facility hazards**
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**
APCD	**San Luis Obispo County Air Pollution Control District**
BMPs	**Best Management Practices**
BOD_5	**Five-day biochemical oxygen demand**
BTEX	**Benzene, toluene, ethyl benzene, and xylene**
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	**Central Coast Long-term Environmental Assessment Network**
CCR	**California Code of Regulations (CCR 2003)**
CDFG	**California Department of Fish and Game**
CIWQS	**California Integrated Water Quality System Project**
CDP	**Coastal Development Permit**
CMAR	**Construction Manager at Risk: A project delivery method wherein the Construction Manager (CM) is required to deliver a project within a guaranteed maximum price**
Coordinate Datum	**All coordinates cited in this report are referenced to the WGS84 datum**
COP	**The California Ocean Plan (SWRCB 2005 2015) is regularly revised. The 2005 edition was in force when the prior NPDES discharge permit was issued to MBCSD and the 2015 edition was the basis for the current permit.**
CSWP	**Cayucos Sustainable Water Project**
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.**
CWSRF	**Clean Water State Revolving Fund (CWSRF) that includes a Water Recycling Funding Program administered by the SWRCB Division of Financial Assistance**
dEIR	**Draft Environmental Impact Report**
DMR	**Discharge Monitoring Report**
DMR-QA	**Discharge Monitoring Report Quality Assurance (DMR-QA) Study**

LIST OF ACRONYMS AND DEFINITIONS
(Continued)

DO	**Dissolved Oxygen**
EIR	**Environmental Impact Report**
ELAP	**California Department of Health Services, Environmental Laboratory Accreditation Program**
ESA	**Endangered Species Act**
FOG	**Fats, Oils, and Greases**
HAB	**Harmful Algal Bloom**
I&I	**Inflow and Infiltration**
ITI	**Infaunal Trophic Index**
JPA	**The Joint Powers Agreement between the City of Morro Bay and the Cayucos Sanitary District (MBCSD) outlines the contractual agreement between the two agencies for the operation of the WWTP**
Leachate	**A solution formed by leaching, especially a solution containing contaminants picked up through the leaching of soil**
MBCSD	**The City of Morro Bay and Cayucos Sanitary District**
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.**
MGD	**Million Gallons per Day**
mg/Kg	**Milligrams per Kilogram = µg/g dry weight = parts per million**
mg/L	**Milligrams per Liter = aqueous parts per million**
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**
MPN	**Most Probable Number**
MRS	**Marine Research Specialists**
MT	**Metric Ton = 1,000 kg**
NEP	**National Estuary Program**
NMFS	**National Marine Fisheries Service**
NOAA	**National Oceanic and Atmospheric Administration**
NOEC	**No Observable Effect Concentration**
NORM	**Naturally Occurring Radioactive Material**

LIST OF ACRONYMS AND DEFINITIONS

(Continued)

NPDES	**National Pollutant Discharge Elimination System**
NRDC	**Natural Resources Defense Council**
NTU	**Nephelometric Turbidity Units**
O&G	**Oil and Grease**
O&M	**Operations and Maintenance**
OIT	**Operator-in-Training**
OSHA	**Occupational Safety and Health Administration**
PAH	**Polynuclear Aromatic Hydrocarbons**
PCB	**Polychlorinated Biphenyl**
pCi/L	**Pico-Curies per liter is a measure of aqueous radioactivity.**
POTW	**Publicly Owned Treatment Works**
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 meaured with statistical reliability given the sample size and analytical method.**
PSDWF	**Peak seasonal dry-weather flow**
PWWF	**Peak wet-weather flow**
QA/QC	**Quality Assurance and Quality Control**
RFP	**Request for Proposal**
RFQ	**Request for Qualifications**
RWQCB	**State of California Regional Water Quality Control Board - Central Coast Region**
SLO EHS	**San Luis Obispo County Environmental Health Services**
SOP	**Standard Operating Procedure**
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 of the California Environmental Protection Agency**
TKN	**Total Kjeldahl Nitrogen**
TRC	**Total Residual Chlorine in effluent is determined from grab samples collected downstream of the chlorine contact chamber.**
TSS	**Total Suspended Solids**

LIST OF ACRONYMS AND DEFINITIONS
(Continued)

TSO	**Time Schedule Order No. R3-2018-0019 dated 27 June 2018**
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.**
TUc	**Chronic Toxicity Units**
TVS	**Total Volatile Solids**
USEPA	**United States Environmental Protection Agency**
USFWS	**United States Fish and Wildlife Service**
USGPO	**United States Government Printing Office**
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.**
WRRF	**Water Resource Recovery Facility**
WRF	**City of Morro Bay Water Reclamation Facility**
WWTP	**City of Morro Bay-Cayucos Sanitary District Waste Water Treatment Plant**
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. During the first two months of 2018, the plant operated under a 301(h)-permit that modified NPDES limits on total suspended solids (TSS) and biochemical oxygen demand (BOD). This allowed the plant to discharge blended primary- and secondary-treated wastewater, although the vast majority of wastewater receives secondary treatment. All other NPDES limits, including restrictions on the discharge of toxic substances, applied to the MBCSD discharge without exception. Regardless, the partial-secondary level of treatment currently performed by the plant routinely achieves reductions in suspended solids and BOD that are close to, and often exceed, secondary treatment removal rates.

The current permit became effective in March 2018. It prescribed full-secondary treatment requirements on suspended solids and BOD, although their implementation was deferred to allow time for a new treatment plant to be built. Both permits require 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 2018 Annual Report partially satisfies those reporting requirements. Companion reports addressing receiving-water and benthic-sediment quality fulfill additional reporting requirements.

This document presents a comprehensive analysis of the extensive monitoring data collected over the last three decades. Virtually every aspect of the treatment process, receiving waters, and seafloor sediments was monitored. An exhaustive quantitative analysis of all measured parameters demonstrates that the effluent discharge consistently meets the permit requirements and has no discernible effect on the ocean environment. A comparison of influent and effluent properties 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 largely restricted to a narrow 15-m zone of initial dilution (ZID) around the outfall. Measurements within the effluent plume collected shortly after discharge quantified the plume's rapid dispersion, and demonstrated that the seafloor diffuser 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.

Effluent monitoring throughout 2018 documented another year of high operational performance by the treatment plant. Major effluent constituents, including TSS, BOD, and oil and grease (O&G), all had much lower concentrations and mass emissions than the permitted maximums, as has consistently been the case throughout the entire operational history of the plant. Although the treatment process efficiently removed major organic wastewater constituents, such as TSS, BOD, O&G, and coliform bacteria, the general lack of other chemical contaminates within effluent was largely due to their absence within the influent stream. Like most publicly owned treatment works, the MBCSD plant is not specifically designed to extract trace metals and synthetic organic compounds from wastewater.

Instead of removal by treatment, the effluent's low toxicity is primarily due to the absence of these contaminants within the influent, largely because of 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 digital database, maintained 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 potential introduction of pollutants into the waste stream.

Throughout more than three decades of operation, the treatment plant has consistently outperformed expectations for wastewater treatment based on regulatory standards. During that 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 when brief exceptions to standards or criteria have occurred, they have been the direct result of unforeseen external events, or the temporary, 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 to unforeseeable external events.

Among the thousands of samples and measurements collected as part of the monitoring program during 2018, there were no exceptions to the waste-discharge limits specified in the two NPDES permits. This 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.

An offshore water-column survey was conducted on 12 March 2018 to evaluate receiving-water quality. The high-precision measurements collected during the survey were capable of resolving minute changes in ambient seawater properties. These measurements detected and delineated effluent as it mixed with the receiving seawater upon discharge from the diffuser structure. Slight anomalies in seawater properties associated with the presence of dilute effluent were only observed close to the diffuser structure and within the ZID. The amplitudes of these highly localized anomalies were still within the limits specified in the NPDES permit, even though they were collected close to the discharge where such limits do not apply.

The physics, chemistry, and biology of benthic sediments around the outfall have been continuously monitored for 33 years. As has been the case throughout this uninterrupted monitoring program, all measurements and samples collected during 2018 fully complied with requirements of the discharge permits and the objectives of the California Ocean Plan. 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 surrounding the diffuser structure during 2018 confirmed that the treatment process successfully removed organic loads from the influent stream and that the diffuser structure efficiently diluted wastewater upon its discharge into receiving waters.

Three sediment-chemistry analyses documented the absence of discharge-related benthic impacts. First, chemical concentrations measured within Estero Bay sediments during 2018, 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 2018 did not exhibit significant gradients of increasing contaminant concentration with increasing proximity to the outfall. Finally, there is no evidence of a buildup of wastewater constituents near the outfall over time, based on a comparison of the long record of measurements collected near and far from the discharge.

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 270,000 infaunal organisms have been collected and examined since the beginning of the benthic monitoring program 33 years ago. Throughout the monitoring program, there has never been an indication of discharge-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.

In the 29 years prior to 2015, analyses demonstrated that the sediments surrounding the outfall supported an extraordinarily healthy marine community dominated by suspension-feeding organisms living in pristine sediments. These observations held true despite widespread and significant temporal variation in the abundance of individual organisms. However, a major change in the benthic environment occurred in 2015, when numerous large sand dollars dominated the benthic environment throughout the survey area. They displaced most of the resident suspension-feeding infauna and introduced opportunistic detritus feeders that also happen to have an affinity to sand-dollar beds. Most measures of the health of the infaunal community declined as a result, including density, diversity, species counts, and richness. The concomitant declines in feeding indices were reminiscent of organic enrichment that had been observed within seafloor sediments surrounding large ocean discharges in other regions prior to improvements in wastewater treatment during the 1980s.

However, the declines in the measures of infaunal wellbeing that have been observed in benthic surveys conducted since 2014 were unrelated to degradation caused by the discharge of organic constituents from the MBCSD outfall. First, organic loading within wastewater discharged from the MBCSD outfall during this period was among the lowest on record, so there is no reason to expect a decline in sediment quality. Second, concentrations of organic constituents measured within sediment samples collected at the infaunal sampling sites were comparable to those of prior years. Third, the declines in diversity occurred uniformly throughout the offshore survey area with no evidence of a spatial gradient related to ZID proximity.

Instead, the observed decline was undeniably associated with the establishment of a mature sand dollar bed. The resulting disturbance of surficial sediments displaced nearly all of the suspension-feeding organisms that had characterized the survey area for the prior 29 years. The small amount of sediment not occupied by the numerous large sand dollars was quickly populated by a few opportunistic organisms directly associated with sand dollars, principally, a sand-dollar parasitic snail and a detritus-feeding lugworm with a strong documented affinity for sand-dollar beds. The presence of these organisms and the absence of other types of infauna resulted in a profound change in the diversity and perceived health of the infaunal community within northern Estero bay; one that was unparalleled in the prior three-decade-long benthic monitoring record.

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. The treatment plant's ocean discharge was regulated by two separate National Pollutant Discharge Elimination System (NPDES) permits covering different periods of 2018. An existing 301(h)-modified[1] NPDES permit was in force during January and February (RWQCB-USEPA[2] 2009). In March, a new permit was issued that changed the monitoring program requirements and promulgated final effluent limits on suspended-solids and oxygen demand consistent with full-secondary-treatment standards (RWQCB 2018a). However, a Time Schedule Order (TSO) was also issued that set interim effluent limits to allow time for the MBCSD's partial-secondary effluent to achieve compliance with the current permit's new effluent limitations (RWQCB 2018b). The TSO also requires the MBCSD to undertake a sequence of specific actions to ensure timely compliance with the final effluent limits.

1.1 REPORT SCOPE

This report examines the MBCSD treatment-plant performance during 2018 in detail. Additionally, it compares the 2018 performance with that of the prior 32 years, and assesses its compliance with the provisions of the two permits that were in force during 2018. Marine Research Specialists (MRS) began conducting the Offshore Monitoring and Reporting Program for the MBCSD in July 1993. Since then, the treatment plant staff, MRS, and various subcontracted laboratories, have collected and analyzed a multitude of samples and measurements as part of the extraordinarily intense monitoring program that is required as part of all 301(h)-modified permits.

This 2018 annual report summarizes results from the four major monitoring components that analyze the treatment plant, receiving waters, marine sediments, and benthic biota. However, the scope of this document departs from that of prior annual reports. Comprehensive reports have previously been submitted that evaluate permit-compliance during 2018 based on the results of the three major offshore-monitoring components conducted during 2018 (MRS 2018a, 2019). The quarterly receiving water-quality monitoring that was required under the prior 301(h)-modified permit was discontinued by the current non-modified permit. Thus, only one offshore water-quality survey was conducted during the first quarter 2018, when the prior permit was still in force. The associated standalone report (MRS 2018a), which contains detailed analyses and results from the survey, is included herein by reference. This annual report only summarizes its findings, and those of 98 prior water-quality surveys conducted since 1993.

Additionally, prior 301(h)-modified permits required reporting the results of offshore-sediment surveys as part of each annual monitoring report. The current permit requires an offshore benthic survey during 2018, and not during subsequent years. However, the current permit stipulates the submission of a detailed standalone report covering the seafloor environment surrounding the outfall during 2018; that report has already been submitted (MRS 2019). The submitted report covers both sediment physicochemistry and benthic biology from the October 2018 survey. Thus, this annual monitoring report only provides a summary of that benthic report's findings. The benthic report itself includes results of extensive hypothesis testing for potential discharge-related impacts that are used in a comprehensive

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[1] A Section 301(h) permit modifies the full-secondary-treatment standards promulgated by general NPDES requirements by relaxing the suspended-solid and oxygen-demand provisions.

[2] Regional Water Quality Control Board (RWQCB) - Central Coast Region
United States Environmental Protection Agency (USEPA) – Region IX

evaluation of compliance with the offshore monitoring provisions in the current permit. It also contains copies of the full laboratory report detailing the results of sediment chemistry analyses, including quality control data.

Lastly, a separate Annual Sewage Sludge Report (MBCSD 2019b) is also incorporated in this report, largely by reference. That report, and its eight attachments of supporting documentation, contains detailed descriptions of the solids stabilization process, transportation offsite, pollutant concentrations, regulatory requirements, the pathogen reduction method, and the vector attraction reduction method. Some of that information is summarized in Chapter 6 of this report; namely, the results of chemical analyses conducted on composited biosolids subsamples, primarily because that data reflects on regulatory compliance, plant performance, and their potential for environmental impacts.

1.2 REPORT ORGANIZATION

In addition to this brief introductory chapter, the major chapters of this annual monitoring report are described below.

- **2.0 Overall Appraisal** Evaluation of the performance of the treatment plant and its compliance record throughout its thirty-three-year history, including the aforementioned summaries of receiving-water and seafloor-sediment conditions surrounding the offshore outfall;
- **3.0 Background** Description of current plant operations, treatment-plant history, regulatory setting of the ocean discharge, the treatment process and outfall system, and the MBCSD pollution prevention program;
- **4.0 Throughput** Examination of the volume of wastewater that passes through the treatment plant, including external factors that affect plant flow, reconciliation of flow measurements by two independent meters, and corrections to flows reported during 2018;
- **5.0 Wastewater Properties** Characterization of the major properties of the influent and effluent during 2018, the influence of the treatment process on those properties, and compliance with the relevant permit provisions;
- **6.0 Chemical Constituents** Summarization of quantifiable concentrations and mass emissions of chemical constituents within effluent, and comparison with numerical limits;
- **7.0 Biosolids** Description of the solids removal process, and the chemical compounds present within biosolids during 2018; and
- **8.0 References** Compilation of full bibliographic references for the documents cited in this report, including hyperlinks to reports available online.

In addition to these chapters, a set of appendices provides supporting documentation for the material in the body of this report. Appendix A lists the design specifications of the wastewater treatment plant. Appendix B contains a report of the annual outfall inspection that was conducted by diver. The March 2018 Monthly Compliance Report is reproduced in Appendix C because it details the technical basis for plant throughput estimates during a data-gap caused by a heavy rainfall event. A copy of the calibration report for the influent flow meter is included as Appendix D to document the incorrect zero-flow set point that was applied for a brief period.

2.0 OVERALL APPRAISAL

The MBCSD monitoring program was designed to appraise the performance of the wastewater treatment plant, to monitor the quality of effluent discharged to the ocean, and to assess potential impacts within receiving waters and seafloor environment. This annual report evaluates compliance with the NPDES discharge permits and gauges the potential for discharge impacts through quantitative analyses of an extensive data set of effluent constituents, receiving-water measurements, sediment chemistry concentrations, and marine biological enumerations. Of the thousands of measurements collected as part of the monitoring program during 2018, none exceeded a discharge limit.

During 2018, the treatment plant removed nearly all organic materials and other solids from the wastewater stream. Analyses of key diagnostic constituents, including total suspended solids (TSS), biochemical oxygen demand (BOD), and oil and grease (O&G), documented 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 (O&M) program eliminated avoidable exceptions to the limits specified in the NPDES discharge permits during 2018. Chapters 4, 5, and 6 use plant data collected during 2018 to evaluate regulatory compliance through a comparison between the measured wastewater characteristics and the limits cited in the three regulatory documents that were issued to the City of Morro Bay and Cayucos Sanitary District during 2018: 1) the prior NPDES discharge permit that was in effect for the first two months of the year (RWQCB-USEPA 2009); 2) the current NPDES discharge permit that was issued in March 2018 (RWQCB 2018a); and 3) a Time Schedule Order (TSO) issued in June 2018 that set interim limits on BOD and TSS (RWQCB 2018b).

Data collected during 2018 augment 32 years of prior monitoring information that chronicle a treatment process that consistently achieves a high level of performance. Despite processing an unusually large fraction of sewage within the wastestream during 2018, the plant discharged only 20% of the allowed solids, while still attaining an annual removal rate of 89.4% that was 19.4% higher than the permitted 75% minimum. Because the treatment plant processed most wastewater through secondary treatment, it removed suspended solids at a rate exceeding the 85% standard for full secondary treatment in all twelve months. Additionally, the average effluent TSS concentrations during six months of the year remained at or below the 30-mg/L criterion for full secondary treatment. The annual average effluent suspended-solids concentration (32 mg/L) was less than half of the permitted maximum (70 mg/L), and the total solids emission for the year (39 MT[1]) was only one-fifth of the allowed solids discharge (199 MT).

During 2018, the treatment plant also removed the vast majority (85.5%) of oxygen-demanding material from the influent stream. Technology-based requirements for BOD are generally unimportant for open-ocean discharges because they are unlikely to result in oxygen depletion (Page 6 in National Academy of Sciences 1993). Nevertheless, the average BOD removal rate met or exceeded the 85% monthly standard for full secondary treatment during seven months of the year, while the lowest monthly removal rate of 81.5% was more than 2½ times greater than the minimum 30% rate required by current permit provisions. Additionally, the annual average effluent BOD concentration (41mg/L) was just one-third of the permitted maximum (120 mg/L), and the total mass emission for the year (51 MT) was 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 commercial and residential sources. Chemical analyses for 78 chemical compounds quantified low-level concentrations of only of only two

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

common wastewater constituents and three naturally occurring trace metals. All measured concentrations were well below permit limits. Chronic bioassays conducted on effluent samples that were collected twice during 2018 determined that the discharge had very low toxicity to marine organisms, a result consistent with the prior 25-year record of toxicity testing.

The 33-year record of effluent and biosolids monitoring data is complemented by an equally long record of offshore monitoring. During that time, 99 quarterly receiving-seawater surveys and 44 benthic surveys have been completed. Comprehensive statistical analyses the enormous amount of data generated by these surveys unequivocally demonstrates the absence of discernible impacts from the MBCSD wastewater discharge. As described below, receiving-water surveys consistently found negligible but perceptible discharge-related excursions in seawater properties that were highly localized around the discharge point. None ever approached levels that would be considered an exception to water-quality objectives promulgated in the California Ocean Plan (COP) and the MBCSD NPDES permits. Similarly, detailed analyses of seafloor sediments, and the organisms within them, revealed a uniformly pristine environment with no evidence of spatial or temporal changes that could conceivably be ascribed to the discharge.

2.1 TREATMENT PROCESS

The MBCSD Wastewater Treatment Plant (WWTP) has been operating under the requirements of a 301(h)-modified NPDES permit since 1986, with 2018 marking the 33rd year of consistently high performance by this treatment facility. As described above, measurements of wastewater characteristics acquired throughout 2018 demonstrate that the treatment process surpassed expectations based on the original plant design, and easily achieved compliance with the applicable NPDES discharge permit requirements and federal regulatory standards.

The uniformly high overall performance of the treatment process during 2018 and throughout the prior 32 years was the direct result of vigilant control by plant personnel, a proactive program of preventative maintenance, and the successful completion of numerous major maintenance and repair projects. Plant personnel actively sought out and corrected potential mechanical problems with plant components before they occurred, and responded quickly to the occasional unforeseen failure.

2.1.1 Historical Record

In fact, many of the best measures of treatment performance have been achieved during the past decade of operation, and 2018 was no exception (Table 2.1). The historical record demonstrates the absence of an age-related decline in process efficiency, even after more than three decades of uninterrupted plant operation. Despite processing influent with uniformly high TSS, BOD, and O&G concentrations throughout the plant's operational history, the treatment process efficiently removed the vast majority of those constituents. Thus, the consistently low effluent concentrations and small emission volumes were the direct result of the treatment plant's exceptional efficiency at removing influent solids.

There is no evidence in the historical record of a decline in removal-rate efficiency, and the 2018 rates equaled or significantly exceeded those of prior years. For example, Table 2.1 shows that the 89.4% TSS removal rate during 2018 was very close to the long-term average (89.8%). More revealing are the BOD and O&G removal rates during 2018. They were among the best ever achieved, and resulted in some of the lowest effluent concentrations and emissions of those constituents on record. For BOD, the 85.5% removal rate during 2018 was well above the average removal rate (81.8%), and exceeded removal rates in all but five of the previous 32 years. Four of those five higher rates were achieved in the last decade of operations. Similarly, the 97.6% O&G removal rate during 2018, was the second highest in the 33-year record, with the 2015 rate (97.9%) only slightly higher.

Table 2.1 Average Annual Wastewater Parameters

		Suspended Solids				**Biochemical Oxygen Demand**			
Year	**Flow (MGD)**	**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	81
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
2010	1.19	383	26.6	92.1	42	350	49.4	85.2	85
2011	1.24	343	26.8	92.4	45	312	52.2	83.2	89
2012	1.10	379	27.1	92.5	41	322	49.9	83.5	77
2013	0.96	351	29.9	90.4	39	327	55.7	82.6	74
2014	0.94	377	29.2	91.3	37	352	51.4	85.3	66
2015	0.93	389	30.8	91.5	39	370	48.9	86.5	63
2016	0.84	358	37.1	90.0	42	384	63.7	82.9	74
2017	1.02	357	37.7	88.1	52	324	52.3	83.8	70
2018	0.90	306	31.7	89.4	39	279	40.6	85.5	51
Average	**1.29**	**341**	**32.1**	**89.8**	**58**	**293**	**50.9**	**81.8**	**90**
Limit	**2.06**		**70.0**	**75.0**	**199**		**120.0**	**30.0**	**342**

Table 5.1 Average Annual Wastewater Parameters (continued)

	Oil and Grease							
Year	**Influent (mg/L)**	**Effluent (mg/L)**	**Removal (percent)**	**Mass Emission (MT)**	**Turbidity (NTU)**	**pH**	**Chronic Toxicity (TUc)**	**Ammonia as NH_3-N (mg/L)**
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[1]	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	95.1	≈7	29	7.5	15.82[2]	32
2010	76	≈4.7	93.8	≈9	31	7.6	10.88[2]	34
2011	75	≈4.0	94.6	≈7	26	7.6	13.95	27
2012	91	5.0	94.5	8	26	7.6	13.95	33
2013	115	≈4.5	96.1	≈6	25	7.5	24.55	40
2014	81	≈4.0	95.1	≈5	28	7.5	17.90	50
2015	81	<1.7	97.9	<2.7	29	7.5	17.90	45
2016	79	≈3.2	95.9	≈4	39	7.5	17.90	44
2017	38	<1.8	95.3	<2.5	35	7.4	17.90	41
2018	50	≈1.2	97.6	≈1.4	32	7.3	12.23[3]	39[4]
Average	**59**	**5.1**	**89.9**	**10**	**35**	**7.5**	**10.23**	**29**
Limit		**25.0**			**75**	**6-9**	**134.00**	**80.4**

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[1] Screening bioassay of three marine species

[2] Screening bioassay of two marine species

[3] The 2018 toxicity tests included bioassays of three marine species to determine the most sensitive marine organism. The TUc listed here is the average of test results in 2018. However, larval abalone was found to be the most sensitive, with a TUc of 17.90. Thus, the 2018 abalone end points were identical to those of the four prior years.

[4] Only three monthly ammonia concentrations were reported during 2018 because the current permit changed the required sampling frequency from monthly to annually.

In contrast to removal rates, which reflect plant performance alone, the concentration and volume of discharged wastewater constituents quantify the effluent's ability to comply with permit limits and ostensibly, its potential for environmental consequences. That compliance capability is demonstrated through comparison with permit limits listed in the last row of Table 2.1. That said, however, the uniformly low effluent concentrations and mass emissions reported in all 33 years of plant operations were the direct result of process efficiency, rather than low influent loads. The influent has always consisted largely of wastewater of domestic origin, and there has been little change in the service-area population, or in the character and volume of influent from commercial sources. Influent concentrations of TSS, BOD, and O&G have been consistently high, with only minor fluctuations from year-to-year. For example, the respective influent concentrations of TSS, BOD, and O&G during 2018 (306 mg/L, 279 mg/L, and 50 mg/L) were comparable to their long-term averages (341 mg/L, 293 mg/L, and 59 mg/L).

Despite processing large volumes of wastewater of sewage origin over the last three decades, the 33-year average effluent concentrations of TSS, BOD, and O&G were all far below their respect allowable limits (compare the two bottom rows in Table 2.1). The long-term average effluent TSS and BOD concentrations were less than half of the permit limits, and the average O&G concentration was one-fifth of the allowable concentration. Even more indicative of the discharge's low historic potential for environmental consequences are the very low annual emissions of TSS and BOD (58 MT and 90 MT), which are less than one-third of the permitted discharge (199 MT and 342 MT). The 2018 emissions of BOD and O&G (51 MT and 1.4 MT) were particularly noteworthy because they were lower than the mass emission in any of the prior 32 years. These unusually low emissions primarily arose because the volume of wastewater processed by the plant during 2018 (0.9 MGD[1]) was the second lowest on record.

Throughout the more-than three decades of modern plant operation, other important effluent constituents were also consistently low. The highest annual average of effluent turbidity and ammonia (56 NTU[2] and 50 mg/L) were all well below their respective permit limits (75 NTU and 80.4 mg/L), and long-term averages (35 NTU and 29 mg/L) were less than half the allowable levels. The highest average toxicity (24.55 TUc[3]), which was reported in 2013, was five-times lower than the allowed maximum (134 TUc). The occasional conspicuous changes in reported chronic toxicities that lasted over extended periods, such as the low toxicities from 1994 through 2008, were due to a change in the test species used in the bioassays.

2.1.2 Plant Throughput

Historically, the most influential factor affecting flow rate was a metering inaccuracy that resulted in flow overtotalization. A study conducted during 2002 found that rates reported by the effluent flow meter were consistently overestimated by as much as 25%. Without this overtotalization, average flow over the 33-year record would be closer to 1.14 MGD rather than the reported 1.29 MGD. Because of overestimated flow prior to 2002, the annual mass emissions were also overestimated. Consequently, the average emissions over the entire plant history, shown in bold in the second to last row of Table 2.1, are slightly inflated. Specifically, over the operational history of the WWTP, the reported average TSS emission of 58 MT was actually closer to 50 MT. Similarly, the average BOD emission reported at 90 MT was, in reality, closer to 80 MT, and the reported 10 MT of discharged O&G was closer to 8 MT. Even after adjusting for past overtotalization in the historical averages, the 2018 emissions of TSS, BOD, and O&G (39 MT,

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[1] Million Gallons per Day
[2] Nephelometric Turbidity Units
[3] Chronic Toxicity Units

51 MT, and ≈1.4 MT) were still well below those of the corrected overall operational record (50 MT, 80 MT, and 8 MT).

During 2002, overtotalization was largely eliminated after a more accurate influent flow meter was commissioned, and flow began to be reported based on its measurements. In contrast to the existing impeller flow meter that was located within the plant's effluent-discharge stream, the new meter determined flow from influent wastewater elevations within a metering flume. However, on occasion, the new meter still overtotalizes flow, for example, when the influent flume becomes temporarily surcharged after water backs up into the influent channel behind the plant headworks. Nevertheless, judicious use of corrected effluent flow totals in place of these obviously aberrant influent flow-meter reports effectively eliminated significant flow overtotalization after 2002. Highly accurate annual flow totals are now regularly achieved by reporting a downward-adjusted effluent-meter flow on those rare occasions that the influent flow data is compromised. The effluent-flow adjustment factor is updated at least annually as described in Section 4.3.3 on Page 4-4.

The 25% correction for flow-meter inaccuracies prior to 2002 still does not fully account for differences in the historical record of annual average flow rates listed in Table 2.1. The uncorrected average flow from 1986 through 2001 (1.53 MGD) was 34% higher than the average flow reported from 2003 through 2012 (1.14 MGD). A detailed review of collection-system activities after 1999 (e.g., MRS 2006) revealed that the additional 9% decline in flow was due to major efforts to reduce rainwater inflow and groundwater infiltration (I&I) into the collection system. These efforts included lining of the existing trunk line entering the plant along Atascadero Road during late 2000, which measurably reduced a known large infiltration source. Additionally, during 2001, a damaged major lateral serving the Morro Bay High School was replaced, and other major laterals were sealed and grouted. These efforts accounted for the additional decline in plant throughput after 2001, when average flow dropped below 1.3 MGD and remained there since. In all fifteen years prior to that time, annual reported flow was always above 1.25 MGD.

Irrespective of these past flow-measurement improvements and I&I reductions, the striking decrease in plant flow over the last six years was largely due to a completely unrelated factor, water conservation. At ≤1.02 MGD, the reported flows were the lowest on record, with 2018 being among the lowest. Some of this recent flow decrease can be attributed to reduced groundwater infiltration into the collection system due to a lowering of the water table during the prolonged drought. However, much of the decrease was undoubtedly related to the successful water-conservation measures implemented by the citizens of Cayucos and Morro Bay. For example, the City of Morro Bay reduced water usage during 2015 by 13.5%, significantly surpassing the 12% mandatory water-restriction goal imposed by statewide limits that went into effect in April of that year.

2.1.3 Wastewater Constituents

The treatment process was designed to remove organic particulates from the wastewater stream and disinfect effluent. As with most municipal treatment plants, the MBCSD WWTP was not designed to eliminate chemical contaminants that may be present within wastewater entering the plant. Instead, a vigorous pollution-prevention program is in place, which aims to limit the introduction of chemical contaminants at the source, before they enter the collection system. The multifaceted pollution-prevention program includes public education efforts, an onsite hazardous waste collection facility, source identification, and inspections of commercial and 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. In the absence of heavy industry within the service area, there is a concomitant lack of industrial pollutants within the MBCSD wastewater.

Because of these pollution-prevention efforts, only a few common metals and ubiquitous chemical compounds have regularly appeared in low concentrations within the effluent and biosolids samples collected over the last 33 years. Of the 78 chemical compounds tested for in the semi-annual effluent samples, only a few have been 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 permits.

As described in Chapter 6, quantifiable compounds within the effluent typically include three commonly occurring trace metals (copper, lead, and zinc), selenium, and radionuclides. The three trace metals all occur naturally within the mineralogy of sediments along the central California coast, but they also enter the collection system through internal corrosion of household plumbing systems. The metalloid selenium, also occurs naturally within the natural mineralogy of the region, but is less likely to arise within plumbing systems. Lastly, some level of radioactivity in effluent samples is expected because of naturally occurring radionuclides. Nonetheless, radiation levels were still well within the limits established for drinking water standards and were similar to historical levels during 2018.

Consistent with the general absence of chemical contaminants, the benign nature of treated wastewater has been repeatedly demonstrated with effluent bioassays conducted over the past quarter century (Table 2.1). The expanded chronic toxicity tests conducted during 2018 again confirmed the MBCSD effluent's low toxicity to a diverse set of sensitive marine organisms.

As with effluent samples, chemical analyses of biosolid samples have quantified only very low concentrations of some commonly occurring wastewater constituents. In addition to the bulk organic compounds, fifteen chemicals with quantifiable concentrations are typically found within biosolid samples (Table 7.1 on Page 7-2). Over the past 33 years, compounds found with the treatment-plant's sludge include ubiquitous metals, metalloids, and cyanide. All measured concentrations have been well below regulatory limits that would make the biosolids hazardous or unsuitable for composting and land application.

2.2 RECEIVING WATERS

Prior to issuance of the current permit, 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 the offshore discharge of wastewater. Comparisons of water quality at the boundary of the zone of initial dilution (ZID[1]) with gradient areas beyond the dilution zone documented compliance with the receiving-water objectives of the California Ocean Plan (COP) as promulgated in the NPDES discharge permits. Extremely sensitive electronic probes provided a detailed picture of seawater quality during each of the four offshore surveys conducted during each year. Precision navigation, in combination with high-resolution data on light transmittance, density, temperature, salinity, pH, and dissolved oxygen delineated the limited spatial extent of the dilute effluent plume within receiving waters.

During all 99 surveys conducted over the past 25 years, 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, were generated by the upward displacement of ambient seawater and not the

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[1] 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 COP do not apply within the ZID.

presence of wastewater constituents, or were insignificant compared to the larger ambient variations resulting from natural oceanographic processes. Many of these plume measurements captured the signature of wastewater deep within the water column while it was undergoing rapid initial mixing as it rose toward the sea surface. Dilution rates determined from these deep measurements were compared with expected critical initial dilution ratios based on modeling used to design the outfall. They demonstrated that the diffuser structure was dispersing the wastewater to a much greater degree than predicted by the modeling.

Because tests for compliance with the receiving-water limitations in the discharge permit only apply outside the ZID, the dilute wastewater measurements recorded shortly after discharge were not subject to COP objectives. Nevertheless, plume observations collected within the ZID were routinely 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 during the 2018 survey confirmed that the diffuser was operating efficiently and that wastewater was diluted 272-fold shortly after discharge from the diffuser ports and well before the completion of the initial-dilution process (MRS 2018a).

Figure 2.1 displays a horizontal map of plume dilution measured 1.5 m below the sea surface during the March-2018 survey. This snapshot of the highly localized plume footprint is typical of that observed during most offshore water-quality surveys. The lowest dilution (272-fold) is delineated in red and is offset 1.5 m south of the diffuser structure. Extremely sensitive instrumentation is incapable of discerning the effluent signature at dilutions exceeding 800-fold. Thus, detectable discharge-related changes to seawater are largely restricted to the 15-m ZID surrounding the outfall. The shoreline is located 827 m east of the discharge (Figure 3.4 on Page 3-12), so impingement of unmixed effluent onto the adjacent coastline implausible.

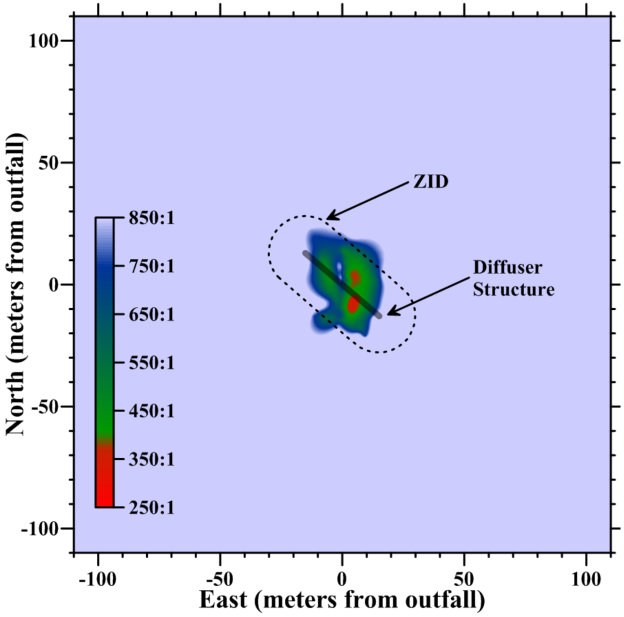

Figure 2.1 Shallow Plume Dilution measured at a depth of 1.5 m during the March-2018 Offshore Water Quality Survey

2.3 SEAFLOOR SEDIMENTS

The monitoring program has evaluated the physical, chemical, and biological conditions within benthic sediments surrounding the MBCSD outfall for more than three decades. Those evaluations provide strong empirical evidence that the quality of the sediments surrounding the outfall have not been perceptibly impacted by the discharge, and that a balanced indigenous population of marine organisms inhabits the benthos throughout the region, including locations along the ZID boundary.

As one component of the benthic assessment, spatiotemporal analyses were applied to the entire physicochemical dataset, which now spans 33 years since benthic monitoring began in 1986. Those analyses demonstrated that there has been no buildup of sediment contaminants surrounding the outfall. In addition, trace-metal and organic concentrations collected both near and far from the outfall during

2018 were tested for consistent spatial trends related to ZID proximity, and none was found. As in prior years, sediment concentrations throughout the survey area remained below thresholds considered harmful to marine biota. In fact, most sediment trace-metal concentrations within Estero Bay were well below concentrations found in the vast majority of samples collected offshore Southern California. This attests to the pristine condition of the ocean environment within northern Estero Bay. Nickel and chromium are the only trace metals that have comparatively elevated concentrations within Estero Bay sediments. However, the concentrations of these particular metals are also naturally elevated in the chromite mineral ores found throughout the region. Thus, the Estero Bay sediment metal concentrations are comparable to those found in nearby benthic environments, such as Port San Luis (NOAA[1] 1991), and the Morro Bay Estuary (Tenera and MRS 1997).

To test for discharge-related biological effects, a large number of population indices and parameters were computed from an enumeration of the 270,000 specimens collected over past 33 years of benthic infaunal 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 within or along the ZID boundary. Not only were spatial differences within individual surveys small compared to inherent sampling variability, but also the differences were generally much smaller than the long-term changes in community structure that arose from natural environmental fluctuations. Specifically, changes in the seafloor biology within the survey area correlate with widespread natural oscillations, the largest of which occur on seasonal and interannual time scales.

The most notable faunal variations within the survey area involve interannual population fluxes of the Pacific sand dollar (*Dendraster excentricus*). Specifically, striking increases in the abundance of juvenile sand dollars were documented in 1989, 1991, 1999, and 2009 in conjunction with major El Niño global climate fluctuations. During, and shortly after these episodic recruitment events, high numbers of juvenile sand dollars dominated infaunal population statistics, but because of their small size, their increased presence did not significantly alter the taxonomic composition of the infaunal community. Because these discrete population changes were related to widespread oceanographic fluctuations, they affected all of the benthic monitoring stations, including the distant reference site, and therefore, were demonstrably unrelated to the MBCSD effluent discharge.

During the first three events, residual sand-dollar populations from the initial successful sand-dollar recruitment only persisted for a year or two following the event due to predation by ochre sea stars (*Pisaster ochraceus*). These sea stars are considered a keystone species, which are organisms that are disproportionately influential in maintaining local biodiversity. Specifically, their predation has been found to be the key to controlling the populations of other species, such as sand dollars, that would otherwise dominate the resident community. However, in recent years, sea-star populations along the Pacific coast of North America suffered widespread losses from an outbreak of the sea-star wasting syndrome. The resulting absence of sea stars within the MBCSD survey area allowed the initial 2009 sand-dollar population to grow unchecked (Figure 2.2 on the following page).

As a result, during the 2018 benthic survey, and in the prior three annual surveys, numerous large sand dollars displaced nearly all of the sediment normally collected within grab samples, and the resident infauna that are normally collected with it. Thus, the overwhelming presence of mature sand dollars within the MBCSD survey area not only dominated infaunal population statistics, as they had briefly after prior El Niño events, but the taxonomic makeup of the infaunal community had now changed dramatically. During the 29 years prior to the 2015 survey, the diverse infaunal community consisted almost exclusively of assemblages of delicate suspension feeding organisms and surface detritus feeders,

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[1] National Oceanic and Atmospheric Administration

whose presence is considered indicative of an extremely pristine undisturbed seafloor habitat. In contrast, after 2014, few infaunal specimens were found within the small amount of available sediment surrounding the many large sand dollars collected in each grab sample. This new low-diversity infaunal community consisted almost entirely of a marine snail, which is a sand-dollar parasite, and an opportunistic lugworm that thrives in disturbed seafloor habitats. This particular lugworm, *A. bioculata*, happens to have a well-known strong affinity for sand-dollar beds.

The enormous taxonomic change associated with the mature sand dollar bed resulted in an abrupt decline in every measure of infaunal community health after 2014, including infaunal density, diversity, species counts, and richness. However, a far more dramatic decline was observed in the infaunal trophic index (*ITI*), which estimates the wellbeing of the infaunal community from the abundance of suspension-feeding infauna, which typically reside in clean sediments, relative to the abundance of pollution-tolerant detritus-feeding organisms, which opportunistically occupy organically contaminated seafloor habitats. Prior to improvements in wastewater treatment during the 1980s, striking *ITI* declines were observed within seafloor sediments immediately surrounding large ocean discharges from low-performance treatment works. However, the sharp *ITI* decline measured within the MBCSD survey area was unrelated to organic loading from effluent discharge. The concentrations of organic constituents measured within both effluent and benthic sediments over the last three years were comparable to those of the prior 29 years. Moreover, the *ITI* declines were clearly unrelated to the MBCSD discharge because they occurred uniformly throughout the survey area, with no evidence of a spatial gradient related to outfall proximity.

Instead of sediment-quality degradation resulting from organic material within MBCSD effluent, the dramatic *ITI* decline after 2014 was an artifact of the sharply increased presence of the *A. bioculata* lugworm within the sand-dollar community. Because this lugworm is a subsurface detritus feeder, it has an inordinately large negative influence on the *ITI* computation. However, regardless of its feeding style, this particular Opheliid lugworm is known to thrive within sand dollar beds irrespective of their organic content. Other field studies have consistently found significantly higher numbers of *A. bioculata* within sand dollar beds than in adjacent sediments with identical concentrations of organic material (Smith 1981).

Figure 2.2 Photographic sequence of the growth of the 2009 Sand Dollar cohort in a) 2009, b) 2010, c) 2011, and d) 2012

Despite recent sand-dollar impacts on benthic infauna, macrofauna living on the sediment surface appear to be unaffected. This is evident from specimens occasionally encountered within grab samples, such as the juvenile East Pacific Red Octopus (*Octopus rubescens*) shown on the cover of this report. That specimen was found within the fourth sediment grab-sample collected at ZID Station B5, which is located 15 m immediately south of the diffuser structure. This benthic predator appeared to be well fed and in good health. When macrofauna like this octopus are encountered in the field, they are quickly identified, enumerated, photodocumented, and then immediately released.

3.0 BACKGROUND

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 3.1). The plant serves the Morro Bay and Cayucos communities, which, according to the 2010 census, have a combined population of approximately 12,835 (10,243 in Morro Bay and 2,592 in Cayucos). The WWTP discharged, on average, 0.903 million gallons per day (MGD) during 2018. 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 even approach, much less surpass, any of these design limits during 2018.

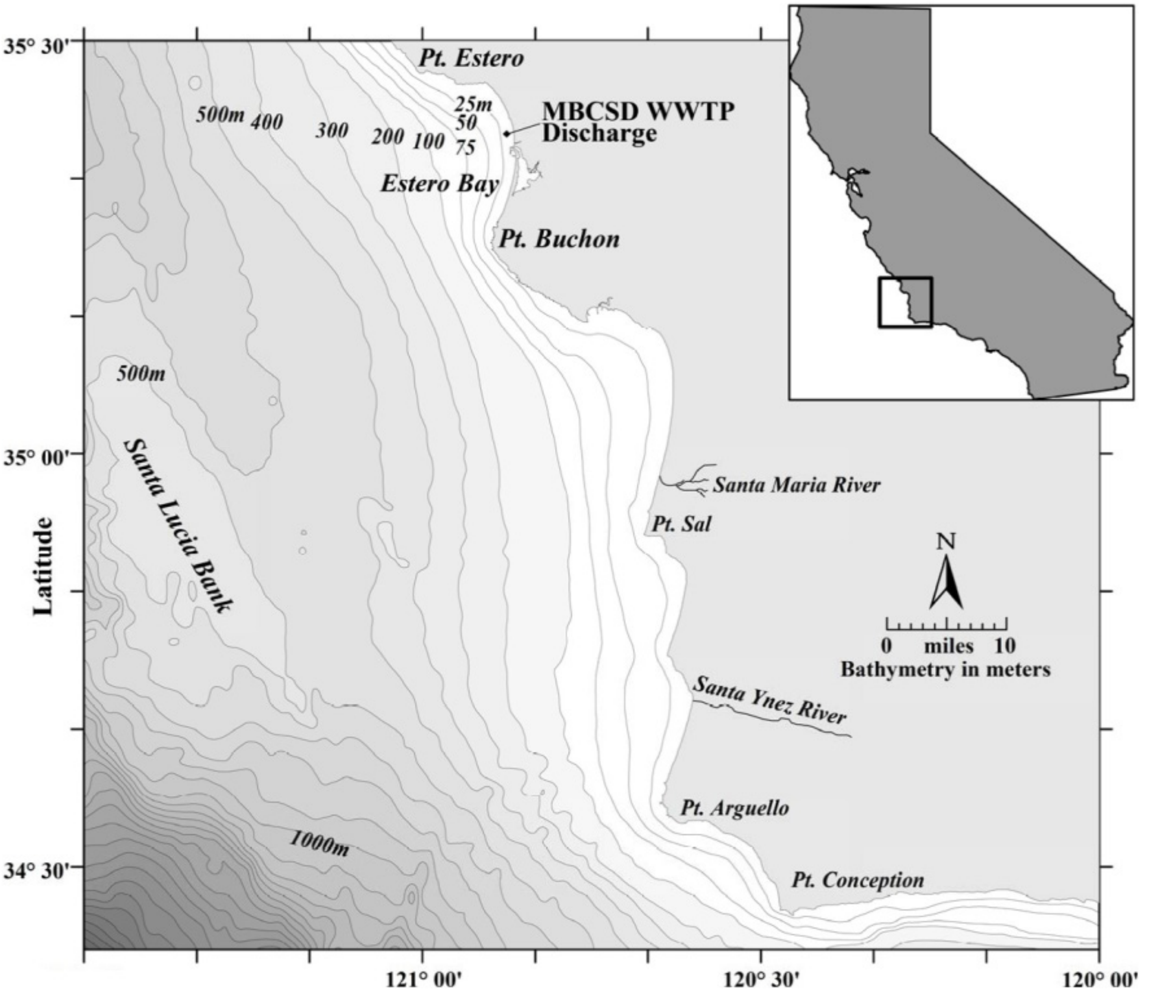

Figure 3.1 Regional Location of the Treatment Plant

3.1 OPERATIONS

Table 3.1 Morro Bay/Cayucos WWTP Personnel During 2018

Name	Grade and Certification No.
Joe Mueller	V-8495
John Gunderlock	V-10500
Dave Zevely	IV-34838
Richard Fernandez	III-41341
Steven Aschenbrener	II-7548
Dane Lundy	II-36547
Landon Mortimer	II-42800
Kyle Quaglino	II-43869
Robert Victor	I-OIT[1]
Chad Rocha	I-OIT
Alex Tapia	I-OIT

Throughout most of 2018, eleven trained personnel operated the WWTP (Table 3.1). John Gunderlock served as both the WWTP and Collections System Supervisor. Joe Mueller provides additional WWTP oversight as the City's Utilities Division Manager. 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 workshops, seminars, and continuing education classes throughout 2018. Training courses and seminars covered topics such as Environmental Safety Training, Confined Space Entry, Trench Shoring Safety, Lockout/Tagout Electrical Hazard Control, and OSHA[2] Construction Safety Training. Laboratory personnel training included refresher coursework in Basic Water Analysis, Laboratory Exam Review, and Distribution System Field Monitoring and Chlorine Testing for Small Systems. Plant personnel also attended a class addressing spill-volume estimation at the City of San Luis Obispo Wastewater Treatment Plant. The Supervisor attended the California Water Environment Association annual seminar in Sacramento. The City's Utilities Division Manager attended The Water Environment Federation Water Leadership Institute and annual seminars in Chicago and New Orleans. The City of Morro Bay Fire Department held a rescue-training event at the WWTP with multiple agencies from around the county.

Throughout 2018, WWTP personnel conducted plant tours for the public, students from local schools, members of various local agencies, staff from other treatment plants, and members of the Water Reclamation Facility Citizen Advisory Committee. During several plant tours, concerned citizens and Morro Bay City Councilpersons learned about treatment-plant processes and the City's plans for the new Water Reclamation Facility. Another tour group consisted of fourteen environmental-science students and two chaperones from Bakersfield High School. A local college student also toured the facility and as part of an environmental studies course report, which compared actual WWTP specifications with calculated treatment-performance metrics. As part of the Plant's annual permit requirements, APCD[3] employees conducted a regulatory-based tour and inspection.

Plant operations during 2018 included ongoing maintenance of an overall health and safety plan. The WWTP passed an annual inspection by SLO EHS[4] in conjunction with the WWTP Hazardous Waste Business Plan on file with that county agency. The WWTP's chemical response plan was reviewed with SLO EHS representative during a tour of the WWTP.

In addition to performing the periodic effluent analyses required by the NPDES Permit during 2018, the laboratories involved in the analyses of the MBCSD WWTP samples participated in laboratory performance evaluations intended to assess the accuracy of effluent measurements and ensure the overall quality of the monitoring reports. In particular, the adequacy of each laboratory's analytical chemistry capabilities was demonstrated during 2018 when acceptable results were achieved in a Water Pollution

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[1] Operator-in-training
[2] Occupational Safety and Health Administration
[3] San Luis Obispo County Air Pollution Control District
[4] San Luis Obispo County Environmental Health Services

Proficiency Testing Study, which is an annual requirement of laboratories certified by the State of California Environmental Lab Accreditation Program (ELAP) and is sponsored by the State Water Resources Control Board and the USEPA. Successful completion of the federally mandated Discharge Monitoring Report Quality Assurance Study 38 (DMR-QA[1] 38) satisfied this state regulatory requirement.

The MBCSD WWTP laboratory analyzed wastewater parameters reported on a daily basis, including residual chlorine, turbidity, and pH. Abalone Coast Analytical performed suspended solids, BOD, and total coliform analyses on samples collected at least weekly. Aquatic Testing Laboratories evaluated the toxicity of effluent to marine organisms with semiannual bioassays. BC Laboratories, Weck Laboratories, Vista Analytical Services, and Monterey Bay Analytical Services determined the concentrations of a wide range of chemical compounds within effluent on a semiannual basis. BC Laboratories also performed the annual chemical analysis of biosolid and benthic-sediment samples, as described in Chapter 7.0 of this report, and in the 2018 Benthic Monitoring Report (MRS[2] 2019).

To assist WWTP personnel in the operations and maintenance (O&M) of major plant components, an O&M Manual (dated November 1987) was completed following the plant upgrade in 1986. The WWTP's O&M Manual has since been reviewed and updated on a regular basis. It is currently complete and valid for the operation and maintenance of the existing facility. The Manual was last reviewed and updated on 6 December 2018. For example, a Standard Operating Procedure (SOP) that specifies morning open-up activities was created to assist operators in performing daily inspections. It included standard operating ranges for all process controls to facilitate rapid evaluation of current conditions. Additionally, laboratory personnel prepared five SOPs covering instrument inspection and data transfer. Lastly, fifteen Activity Hazard Analyses (AHAs) and related SOPs were completed in 2018 by plant personnel. These AHAs investigated potential facility hazards and informed the development of associated SOPs.

Updates also included revisions or additions to SOPs as new major equipment was placed online or when procedures for existing equipment were changed or improved. For example, the SOPs include procedures to archive project records for tasks completed on individual plant components, thereby expediting future reviews of prior actions taken. Additionally, contingency plans are embedded within the O&M Manual that address response to chemical spills, high flow and flood response, fire prevention and suppression, emergency evacuation, and comprehensive hazard communication procedures. Safety updates address procedures for heat illness identification and prevention, equipment lockout-tagout, confined space entry, and emergency notifications.

As part of routine maintenance procedures, divers inspect the ocean outfall's exterior and the diffuser structure for signs of damage annually. The outfall was inspected on November 8th, and the written inspection report is included herein as Appendix B. The outfall and diffuser system was found to be in good condition, with no broken or plugged diffuser ports. The divers provided photodocumentation of the outfall's condition in the form of digital video recorded throughout their inspection.

Figure 3.2 on the following page displays 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 a 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. Quantitative

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[1] Discharge Monitoring Report Quality Assurance (DMR-QA) Study
[2] Marine Research Specialists

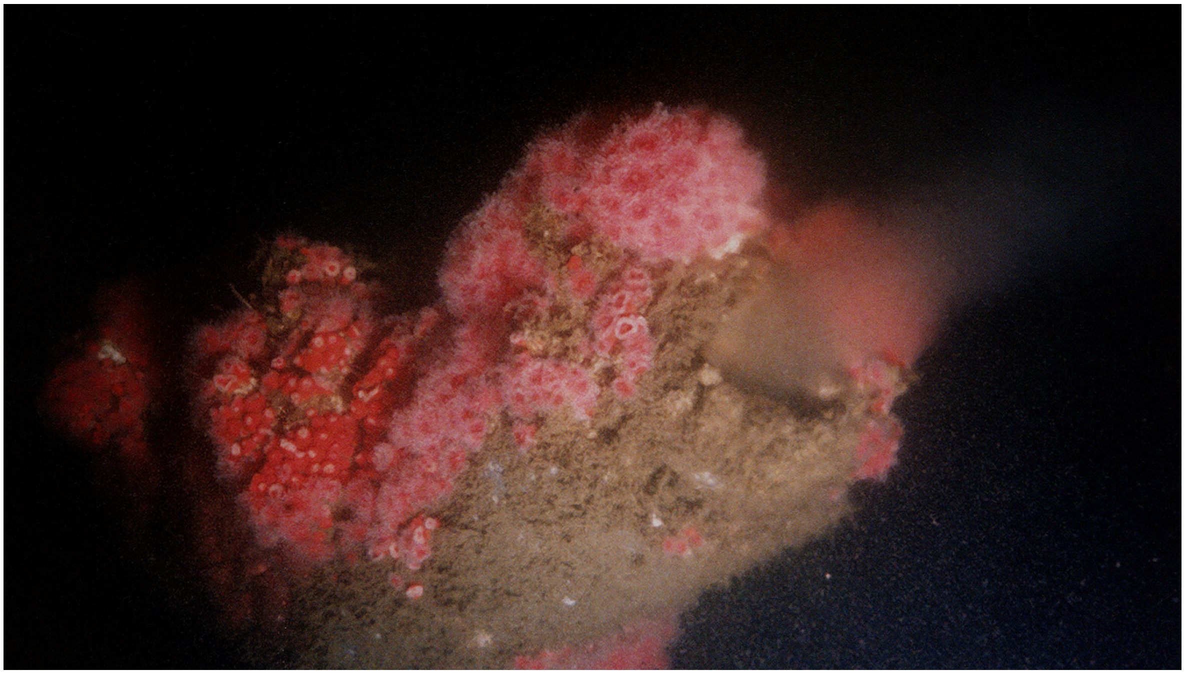

Figure 3.2 Photograph of a Diffuser Port Discharging Effluent

biological surveys conducted within the region found that these anemones are only occasionally observed on high-relief rock surfaces within Estero Bay, and then only in deeper water (>85 m) (Morro Group 1999). Ostensibly, their susceptibility to elevated suspended-sediment loads explains their rarity on nearshore, lower-relief rocky substrates.

3.2 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 process secondary sludge. The existing office building 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 augment the plant's capacity further. In 1980, the City began designing these planned improvements, including the construction of a new outfall to protect the marine environment, and an upgrade of processing equipment to provide full secondary treatment.

Following a yearlong 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 much farther offshore. This deeper discharge significantly increased the effluent mixing rate 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, monetary aid from state or federal agencies to finance the construction of a full-secondary-treatment facility was not available. Since discharge through the new outfall was not causing any apparent adverse environmental impacts, 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 ensure full compliance with the state water-quality standards set forth in the California Ocean Plan (COP) (SWRCB[1] 1990).

State officials concurred with this partial-secondary level of treatment, provided that the USEPA approve a 301(h)-modified NPDES discharge permit that adjusted secondary-treatment requirements on suspended-solid and BOD emissions. In a March 1983 letter, RWQCB personnel formally determined that the proposed discharge would comply with state water-quality standards pursuant to Subsection 301(h) of Title 40 of the Code of Federal Regulations.[2]

Upgrades to the treatment plant, completed between 1983 and 1985, increased the plant's 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. Additionally, depending on the hydraulic conditions within the plant, up to 1 MGD of the flow can be diverted through a secondary-treatment process consisting of trickling filters, clarifiers, and a solids-contact chamber. The secondary-treatment process utilizes two trickling filters, an aerated solids-contact channel, and a secondary sedimentation tank. The original 1954 sedimentation tank was converted into a chlorination system where the primary- and secondary-treated effluents are mixed and disinfected prior to dechlorination and discharge through the ocean outfall.

In March 1985, an NPDES permit, based on the previously approved Section-301(h) modification, codified water-quality standards for the MBCSD WWTP. The permit required treated effluent to achieve a suspended-solids content of no more than 70 mg/L (75% removal) and a maximum BOD of 120 mg/L (30% removal). The permit also required an extensive monitoring program to assure maintenance of environmental quality. The permit was valid for five years and expired in March 1990. After an evaluation process, the permit was reissued in December 1992. During this evaluation period, improvements to the treatment facilities included the installation of a sludge-removal system within 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 10 years of monitoring data (MRS 1997). An administrative extension until 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.

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[1] State Water Resources Control Board of the California Environmental Protection Agency

[2] 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)

Based on discussions between RWQCB, USEPA, and MBCSD personnel 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 program, increasing the number of stations close to the diffuser structure and eliminating seasonal sampling;
- A revised receiving-water sampling program, doubling the number of vertical profiles close to the diffuser structure and eliminating bottle casts; and
- Specification of mass emission goals for toxic chemicals.

Based on the historical absence of perceptible impacts from the discharge, and the projected continuation of consistently high effluent quality, the MBCSD again applied for a renewal of the Section-301(h)-modified discharge permit in July 2003 (MBCSD 2003). As with the previous permits, the application requested continued discharge under the 301(h) provision that allows minor modifications to the BOD and suspended-solids requirements. In February 2004, the RWQCB (2004) administratively extended the existing permit to allow time for further review. In September 2005, the USEPA Region IX (2005) issued a tentative decision concurring with issuance of a permit to the MBCSD in accordance with Section 301(h) of the Clean Water Act. In April 2006, the USEPA and RWQCB personnel issued a joint notice for a proposed action to reissue the 301(h) modified NPDES discharge permit to the MBCSD. However, in May 2006, the RWQCB and the USEPA conducted a joint public hearing addressing the reissuance of the MBCSD permit wherein the RWQCB voted to continue the hearing pursuant to the issuance of a biological evaluation by the USEPA (2007).

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. In December 2007, the USFWS concurred with the USEPA's "*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 be required to monitor nutrient loading from the WWTP on a regular basis. Third, the facility would upgrade to a minimum of full secondary-treatment levels by 2014.

Based on the foregoing findings and the incorporation of conservation measures, the RWQCB unanimously adopted the prior discharge permit in 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. 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;
- Revision of benthic sampling pattern, eliminating cross-shore stations and shifting from grab to composite sediment-chemistry samples; and
- Revision of receiving-water sampling program, reducing the number of vertical profiles and implementing a tow-survey component.

Although this previous 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 USEPA 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 the Cayucos Sanitary District individually adopted revenue programs that identified increases in sewer-rate fees necessary 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, based on the findings of flood hazard analysis, the City and District voted to relocate the treatment plant site to an elevated area adjacent to the existing treatment plant. In October 2009, the MBCSD public noticed a Request for Proposal (RFP) for Engineering Design Services for the upgrade, and the City of Morro Bay released a Revised Notice of Preparation for the project, reflecting changes to the project description involving construction of treatment-plant components adjacent to the current ones. Demolition of the existing plant was to occur after the relocated treatment-plant components were constructed and brought online. The engineering design contract was awarded at the February 2010 Joint Powers (JPA) meeting with a projected completion in 15 months.

The final Environmental Impact Report for the upgrade project was released in December 2010. The Morro Bay City Council certified the EIR[1] and approved the Conditional Use Permit and Coastal Development Permit (CDP) for the upgrade project in January 2011; however, the decision to issue the CDP was subsequently appealed to the California Coastal Commission. A *de novo* hearing was held in January 2013 at which the proposed upgrade project at its current location was terminated.

Subsequently, at the February 2013 JPA meeting, the MBCSD approved development of a Major Maintenance and Repair Plan. The Plan was instituted to ensure uninterrupted operation of the existing WWTP in compliance with regulatory requirements during the extended operational period required for the development and construction of a new treatment facility at a different site. In August 2013, the MBCSD submitted an application to the RWQCB for a new discharge permit to replace the current 301(h) modified permit due to expire on 28 February 2014. Based on direction from the MBCSD and RWQCB personnel, an application was submitted for a full secondary discharge permit.

During 2013 and 2014, the MBCSD explored various sites and treatment alternatives for a new facility to process wastewater currently treated by the existing WWTP. In early 2015, the City of Morro Bay identified a Water Reclamation Facility (WRF) as the preferred design, and initially selected a location east of the City and north of Highway 41. On April 30, the Cayucos Sanitary District suspended

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[1] Environmental Impact Report

participation with the City in their WRF and began planning a separate Water Resource Recovery Facility (WRRF). The District began independently evaluating wastewater treatment alternatives, characterizing flow rates and mass loadings specific to the District's collection system, identifying beneficial uses for recycled water, evaluating potential facility locations, and developing a funding and financing strategy.

The WRRF is now encompassed in the Cayucos Sustainable Water Project (CSWP), which also incorporates the necessary conveyance infrastructure. During 2016, the Cayucos Sanitary District selected a membrane bioreactor as the WRRF treatment process, identified a CMAR[1] as the construction delivery method for the CSWP, selected the CMAR contractor, began preparing a dEIR,[2] and purchased a property for the WRRF site along Toro Creek Road. During early 2017, the District published the dEIR and subsequently completed a final EIR, consisting of response to comments on the dEIR. Groundbreaking for construction of the WRRF occurred in August 2018.

At the same time, the City of Morro Bay personnel and their consultants made significant progress on developing the new WRF to replace the existing WWTP. A Memorandum of Understanding was executed for the future purchase of a property near the South Bay Boulevard exit from Highway 1, after site-selection studies were performed to identify a preferred location for the new WRF. A draft Facility Master Plan, Master Water Reclamation Plan, and Draft Rate Study were also completed. Based on recommendations in the Master Water Reclamation Plan, full advanced treatment, a recycled water pipeline, and injection wells to facilitate indirect potable reuse are anticipated as part of the project. The City of Morro Bay received approval for a $10.3M loan from the SWRCB CWSRF[3] for the design and planning of a recycled water project. During October and November 2017, an RFQ[4] was issued for the design and construction of WRF onsite improvements, and the design of WRF offsite improvements, including a lift station and pipelines.

On 7 December 2017, the RWQCB adopted a new permit for the MBCSD discharge with an effective date of 1 March 2018 (RWQCB 2018a). In contrast to prior permits, the current permit is not Section-301(h) modified, but a TSO promulgated interim TSS and BOD effluent limits identical to those of a 301(h)-modified permit to allow the MBCSD time to bring the CSWP and WRF online. This accompanying Time Schedule Order (RWQCB 2018b) requires full compliance with the current permit's final effluent requirements by 23 February 2023. In satisfaction of the TSO requirements, the City of Morro Bay personnel and their consultants completed a number of major WRF-project milestones during 2018, including certification of the Final EIR, adoption of new rates to support the project, and notification to proceed with the design of onsite WRF improvements. The MBCSD also submitted a request to the RWQCB for acceptance of the upcoming Enhanced Source Control Program report, which is required under Title 22 Regulations for indirect potable reuse by the WRF, in lieu of the required submission of a Pollution Prevention Plan for BOD and TSS pursuant to the Clean Water Act (MBCSD 2019a).

The new permit also implemented the following revisions to the monitoring program:

- Decreased the sampling frequency to once-in-the-life of the permit for benthic sediment chemistry and biota, and all effluent chemical constituents except for metals and nutrients, which are to be analyzed on an annual basis;

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[1] A Construction Manager at Risk (CMAR) is a project delivery method wherein the Construction Manager (CM) is required to deliver a project within a guaranteed maximum price.

[2] Draft Environmental Impact Report. The CSWP dEIR was completed in January 2017 and is available at: http://www.cayucossd.org/cswp-draft-eir. The final EIR is also available on the website link, and was certified in April 2017.

[3] The Clean Water State Revolving Fund (CWSRF) includes a Water Recycling Funding Program administered by the SWRCB Division of Financial Assistance.

[4] Request for Qualifications

- Instituted a three-species chronic-toxicity screening study to be conducted annually for three years, followed by annual tests on the most-sensitive species; and
- Eliminated offshore receiving-water monitoring and the cat-litter public-outreach program.

3.3 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 of 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 ("The Basin Plan" RWQCB 1994). The Plan's standards incorporate the applicable portions of the COP, and promulgate water-quality objectives and toxic material limitations that are designed to protect the beneficial uses of receiving waters within individual basins. The Basin Plan identified the following the beneficial uses specific to the marine waters of Estero Bay, including those adjacent to the MBCSD outfall site.

- **Water Contact Recreation (REC-1)** water uses include recreational activities involving body contact with water, where ingestion of water is reasonably possible. Specific uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, and fishing.
- **Noncontact Water Recreation (REC-2)** water uses include recreational activities involving proximity to water but not normally involving body contact with water, where ingestion of water is reasonably possible. Specific uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life studies, hunting, sightseeing, and aesthetic enjoyment in conjunction with the above activities.
- **Industrial Service Supply (IND)** water uses include industrial activities that do not depend primarily on water quality, such as, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.
- **Navigation (NAV)** water uses include those 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 that has sufficient capacity to float watercraft for the purposes of commerce, trade, transportation, and pleasure.
- **Marine Habitat (MAR)** water uses support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, fish, shellfish, and vegetation, such as kelp, or wildlife, such as marine mammals and shorebirds.
- **Shellfish Harvesting (SHELL)** water uses support habitats suitable for the collection of filter-feeding shellfish such as clams, oysters, and mussels, for human consumption, commercial, or sport purposes. Specific uses include waters that have in the past, or may in the future, contain significant shellfisheries.
- **Ocean Commercial and Sport Fishing (COMM)** water uses encompass 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)** water uses 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)** water uses 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 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.

These limits were based on the treatment capabilities of the best technology available at the time, rather than an evaluation of the treatment necessary to reduce potential environmental impacts to an acceptable level within receiving waters. Recognizing that this level of treatment may not be necessary within ocean waters, Section 301(h) was added to the Act to allow an NPDES discharge 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 operated under a Section 301(h)-modified NPDES permit (number CA0047881) from March 1985 to March 2018. The modifications only applied to the TSS and BOD requirements, so all other NPDES limitations remained in force without exception, including those for wastewater pH and toxic compounds. The modification was issued only after the MBCSD satisfied the following additional requirements:

- 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 dissolved-oxygen (DO) depression, thereby establishing the relevant standards (SWRCB 2005). In January 2009, the California Coastal Commission determined that the last 301(h)-modified discharge permit issued to the MBCSD complied 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). Both the USFWS and the NMFS determined that the discharge would 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 comprehensive monitoring program described in this and prior annual reports 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 highly localized footprint of the MBCSD discharge does not overlap that of other discharges.

- Determine whether the WWTP is subject to pretreatment requirements. Since there are no known sources of toxic pollutants or pesticides within the collection area, the WWTP is exempt from general pretreatment requirements in lieu of a pollution prevention program. In addition, because the discharge is considered small, it is 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 introduction 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, the limited projected growth in population and industry within the service area, and the analyses provided in this and prior annual reports 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 the plant's low flow volume. A typical Class IV facility treats more than 20 MGD in the primary process, while the MBCSD plant processes a total flow of less than 2 MGD and carries out partial-secondary treatment on a large portion of that flow.

During 2015, the California Department of Public Health developed a Management Plan for Commercial Shell Fishing within Morro Bay. The Plan provides reporting guidelines in the event of a sewage spill to the Bay or adjacent ocean. WWTP personnel provided comments on the Plan, and signed a Statement of Agreement concerning its implementation.

3.4 TREATMENT PROCESS 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 3.3. Typically, a portion of the flow is diverted for an additional secondary-treatment process using biofilters, a solids-contact chamber, and a secondary clarifier. The secondary

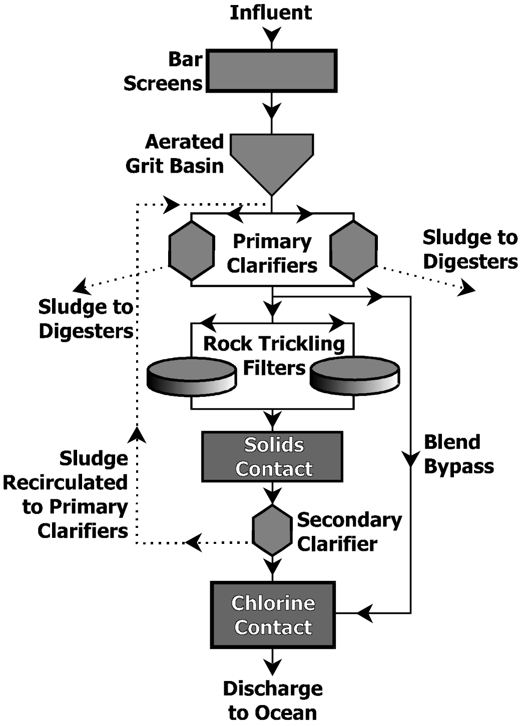

Figure 3.3 Schematic of the Wastewater Treatment Process

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 4,400-ft (1,341-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 biosolids process is shown in Figure 7.1 on Page 7-1.

Figure 3.4 Locations of the MBCSD Outfall and Monitoring Stations within Estero Bay

The location of the Morro Bay-Cayucos WWTP and outfall within Estero Bay is shown in Figure 3.4. The treated wastewater is released into unstressed, open-ocean waters at 35°23'11"N latitude and 120°52'29"W longitude. The 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 at a water depth of 50 ft (15.2 m), measured relative to the mean lower low water (MLLW) datum. 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 the maintenance of water quality and beneficial uses designated for Estero Bay (listed in Section 3.3 on Page 3-8). 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 Morro Bay desalinization plant is from saltwater wells and not from the open ocean where the MBCSD discharge occurs. Similarly, surface discharge of water from the desalination plant, when it does occur, is far south of the MBCSD discharge point and does not add chemical loads to the ocean environment.

3.5 POLLUTION PREVENTION PROGRAM

The MBCSD's Pollution Prevention Program aims to minimize the introduction of incompatible contaminants, such as 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.

Note, however, the City of Morro Bay has now contracted Carollo Engineers to revise the Pollution Prevention Program that will subsequently be submitted to the RWQCB for approval. The program revisions will update the industrial waste survey, provide the city with a public education plan, evaluate sources of residential, industrial and commercial discharges, and develop enforcement response plans for non-compliance and other emergency procedures.

As in previous years, three aspects of pollution prevention were emphasized during 2018: public outreach, industrial-waste source control and identification, and monitoring of influent and effluent for industrial contaminants.

3.5.1 Industrial Waste Survey

During 2018, as in previous years, elevated levels of industrial pollutants were not found within the MBCSD wastewater stream. Instead, three decades of comprehensive monitoring demonstrates that effluent discharged from the MBCSD treatment plant consists of benign constituents typical of wastewater generated from domestic sources. In fact, based on analyses of past water usage, domestic sources contributed approximately 80% of the wastewater processed by the plant, with commercial businesses and government agencies contributing the remaining amount.

However, this usage-based approach overestimates the influence of nondomestic sources on the treatment process. For example, a substantial portion of the water-use attributed to the government agencies is utilized for the irrigation of landscaping, sports fields, and agricultural uses and thus, would not be expected to flow into the collection system. These agencies include the City of Morro Bay, Morro Bay High School, the San Luis Coastal School District, Morro Elementary School, and the State Department of Parks (Morro Bay State Park). Additionally, the compounds added to the wastestream by both large commercial and government users are not particularly toxic to humans or aquatic organisms, and do not generally interfere with the treatment process.

This general lack of chemical contaminates within the wastestream arises because the local economy within the MBCSD service area relies largely on tourism and commercial fishing, with no heavy industry or manufacturing of environmental significance. Nevertheless, beginning in 1999, a digital database has been used to catalogue business names, addresses, and contact information for all of the potential industrial users within the service area. This database has been used to quantify the comparatively low volume of influent derived from light industrial sources within the service area. For example, slightly more than 50 restaurants and an approximately equal number of hotels are found in the service area during any given year.

The list of businesses in the database is adapted and updated regularly based on business license applications filed with the City of Morro Bay and input provided by the Cayucos Sanitary District. Businesses with no potential for industrial discharges, such as offices and retail stores, are classified separately from those with the potential for light-industrial discharge. Businesses that either do not generate wastewater at all, or discharge only domestic wastewater (e.g., theaters, beauty shops, and barbershops), are excluded from the industrial-discharge classification.

The City of Morro Bay's Source Control Program divides facility inspections into two classes: Class I light-industrial facilities and Class II food-service establishments, which constitute the majority of commercial businesses discharging to the collection system. During 2018, twelve Class I and fifty-seven

Class II facilities were inspected. Class I inspections emphasized compliance with the discharge requirements set out in the City's Municipal Code, such as pre-treatment to maintain an acceptable pH range. Class II inspections emphasized the Best Management Practices (BMPs) for the disposal of fats, oils, and greases (FOG). During the Class II inspections, a FOG BMP handout was distributed along with "*No Grease*" stickers to be displayed above kitchen sinks to raise awareness and serve as a reminder of proper FOG disposal methods. The inspections themselves focused on determining the presence of grease traps or interceptors, and if present, whether they were properly cleaned and maintained. For establishments with fryers, the method and frequency of oil disposal was documented.

Class I facilities consist of light industrial businesses such as commercial laundries, car washes, dry cleaners, print shops, and the oil-water separator maintained by the City of Morro Bay. Collections personnel perform scheduled visits, surprise onsite inspections, and formal tours of these facilities. Car-wash discharges are considered industrial in nature because of the volume of solids, oils, and grease that are washed from vehicles. As with restaurants, the sewer-use ordinance within the City of Morro Bay municipal code requires self-service car washes to install and maintain grease traps within their sewer line connections. The municipal code also prohibits smaller contributors, like gas stations and repair garages, from disposing known contaminants into the collection system.

As part of the City's pretreatment program, samples from a commercial laundry's discharge are occasionally collected and analyzed. Inspections during 2018 found that the discharge pH had extended beyond the 5.5-to-9.0 range allowed in the municipal code. Throughout 2018, City personnel discussed strategies with the launderer's staff to improve pH stability within the launderer's discharge and to achieve uninterrupted compliance municipal discharge requirements. In mid-October, laundry staff installed a large mixing equalization tank and new boiler. Subsequent pH monitoring by City personnel demonstrated compliance with municipal code's allowable range.

In addition to chemical input from light industry, the WWTP itself intentionally introduces three chemicals (ferrous chloride, sodium hypochlorite, and sodium bisulfite) into the treatment process. Ferrous chloride is used primarily to control hydrogen sulfide emissions during flaring of digester gas and heating of the digesters at the WWTP, as required by the APCD. Wastewater facilities commonly disinfect effluent prior to discharge with some form of chlorine; the WWTP uses sodium hypochlorite. However, because even low concentrations of residual chlorine can be hazardous to aquatic life, the MBCSD treatment plant adds sodium bisulfite to the wastestream to remove excess total chlorine residual once disinfection is complete.

3.5.2 Public Outreach

The MBCSD utilizes online and written literature as well as direct communication through multiple workshops, presentations, talks, and plant tours in order to educate consumers and local businesses about the organization and operation of the treatment plant; sewer-system BMPs; and techniques for the proper disposal of a variety of household wastes.

The Cayucos Sanitary District maintains a website[1] with status updates and other information relating to the CSWP, along with Town Hall Meeting notices, responses to FAQs,[2] and links to other resources. The City's website[3] includes a series of pages devoted to an overview of the wastewater treatment plant and collection-system operations. The web pages contain pertinent information on current topics of interest.

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[1] http://www.cayucossd.org/

[2] Frequently Asked Questions

[3] http://www.morro-bay.ca.us/342/Wastewater-Treatment-Plant-Operations

These include the status and history of the pending transition to an offsite WRF, the availability of an onsite Household Hazardous Waste Facility, and Collection System Do's & Don'ts. In addition, digital copies of the treatment plant's self-monitoring reports from 2005 onward, including, for example, this annual monitoring report are also available online.

The Collection System Do's & Don'ts section of the City's website also provides current BMPs for cat-litter disposal and the importance of avoiding its introduction into the collection system.[1] This outreach program was one of the conservation measures recommended in the USEPA's (2007) biological evaluation that was conducted in preparation for issuance of the prior NPDES discharge permit. During the permit-renewal process, USEPA personnel postulated that minimizing the input of cat-litter-box wastes into the municipal sewer system could limit the number of *Toxoplasma gondii* parasites introduced into the marine environment, thereby mitigating a known disease vector affecting southern sea otters. RWQCB personnel incorporated the USEPA's concerns into a special provision within the plant's final NPDES permit requiring the creation of a cat-litter public-outreach program.

However, immediately following the finalization of that prior permit, on 21 January 2009, Johnson et al. (2009) published the results of a detailed field study of southern sea otter exposure to *T. gondii*. That study unequivocally demonstrated that the incidental disposal of cat litter into the MBCSD collection system was not the cause of the observed impacts on otter morbidity from *T. gondii* infection. The authors of the 2009 study confirmed that the epicenter of *T. gondii* exposure in otters was not located within Estero Bay, as erroneously asserted by NRDC[2] (2006) and Miller et al. (2002). More importantly, Johnson et al. (2009) also hypothesized that, based in part on the new epicenter location, "*a more important source of infection might be bobcats and mountain lions*" instead of housecats. 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). Based on these recent findings, the requirement for a cat-litter outreach program was eliminated when the current MBCSD discharge permit became effective on 1 March 2018 (RWQCB 2018a).

Other public-outreach endeavors by the MBCSD include its involvement in the collection of household hazardous wastes. Beginning in August 2000, the MBCSD collaborated with the Integrated Waste Management Authority to establish a permanent household hazardous-waste collection facility located at the WWTP. The collection facility offers free waste disposal to all residents of San Luis Obispo County every Saturday from 11:00 a.m. to 3:00 p.m., except holiday weekends. The facility remains one of the top waste-disposal sites in the county in terms of the volume of material collected. Between 20 and 50 individuals utilize the facility each weekend. During 2018, the disposal facility processed nearly 57 tons of household hazardous waste, a large portion of which was recycled. Collected material is sorted, packaged, and labeled before transport to the appropriate offsite recycling and disposal facilities.

3.5.3 Source Identification

Past and ongoing efforts to eliminate or reduce contaminants entering the WWTP's wastestream have been successful, and as evidence of that success, elevated contaminant concentrations within effluent samples are rarely detected during the periodic chemical assays. Although nothing unusual was detected within the wastestream during 2018, anomalous concentrations of individual chemicals have been sporadically reported in the past. On those occasions, MBCSD personnel successfully traced the contaminants to the source and worked with the source owner to eliminate the contamination.

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[1] http://www.morro-bay.ca.us/documentcenter/view/1201

[2] Natural Resources Defense Council

In 2006, the State Water Resources Control Board adopted new statewide waste-discharge requirements for sanitary sewer systems, which transferred responsibility for managing the introduction of FOG, and other components from the WWTP to the Collections Department under the City of Morro Bay's Sewer System Management Plan[1] and the Cayucos Sanitary District.[2] Ongoing source identification and resolution efforts conducted by the City and District include a grease-trap inspection program for businesses subject to the requirements. Collections personnel regularly conduct scheduled inspections as well as spot checks as described in the *Industrial Waste Survey* subsection above. During inspections, personnel discuss BMPs with restaurant staff, provided educational materials such as a BMP handbook and make recommendations for grease trap maintenance as necessary.

Known light-industrial dischargers were also inspected for compliance with source control processes and procedures. One of the most important of the Class I facilities is the commercial laundry that operates within the City of Morro Bay. Although this facility only contributes approximately 1.6% to plant flow, commercial laundries use industrial-grade detergents, bleaches, surfactants, and brighteners that can potentially harm the bacteria within the WWTP's secondary-treatment system. In addition, solvents, oils, and other substances removed from soiled laundry have the potential to release contaminates into the wastestream. To minimize this potential, the laundry installed a pretreatment system during 2002 that included pH buffering with acid to neutralize excessive increases in wastewater alkalinity that can potentially interfere with the plant's treatment process.

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[1] City of Morro Bay Sewer System Management Plan, originally approved June, 2009, reapproved June, 2014. City of Morro Bay Public Services Department, Wastewater Collections Division

[2] CSD Ordinances.pdf

4.0 THROUGHPUT

Flow through the plant during 2018 remained far below both the plant's design capacity and the limits established in the NPDES discharge permit. The waste discharge requirements (RWQCB 2018a) state that the "*peak seasonal dry weather flow shall not exceed a monthly average of 2.36* [*MGD*]." Plant throughput never approached this flow limit during 2018 (Table 5.1 on Page 5-1 later in this report), not even during winter (October through March) when the limit does not apply because increased I&I[1] from precipitation events is expected. Even so, the highest average monthly flow, 1.118 MGD in March, was only 47% of peak dry weather limit.

4.1 INFLOW AND INFILTRATION

Rainfall is an external factor that perceptibly affects plant throughput in two ways: via direct inflow of rainwater into the collection system, and via increased infiltration of groundwater resulting from a longer-term increase in the water-table elevation. During 2018, the most obvious rainfall-related increase in plant flow occurred when an intense two-day winter storm event in mid-March deposited a record 4.8 inches of rainfall at the treatment plant (solid black spikes at the bottom of Figure 4.1). Approximately 6 MG of rainwater flowed into the collection system during this event and resulted in throughput that was among the highest ever processed by the treatment plant. An estimated plant flow of 3.5 MGD on March 21st was followed by 2.5 MGD of flow on March 22nd. The severity of this inflow event is apparent from the amplitude of the sharp upward excursion in the dashed line that coincided with the mid-March rainfall event. Other rainfall events were much less intense, and the resulting inflows to the collection system were proportionally smaller. For example, the 2.1 inches of rainfall that fell during the January 8th event resulted in a more modest inflow that only increased plant throughput to 1.25 MGD; the November 28th rainstorm, which had a similar rainfall amount, produced approximately about the same inflow.

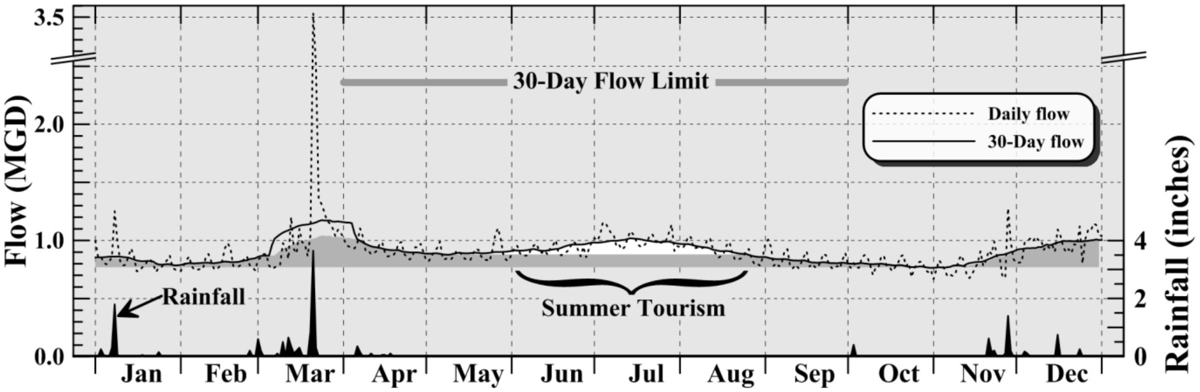

Figure 4.1 Plant Flow and Rainfall

Although rainfall events during 2018 were infrequent and brief, they also contributed to plant flow by increasing the infiltration of groundwater. This longer-term effect on plant throughput is highlighted with dark shading below the solid line in Figure 4.1. The solid line shows the 30-day moving-average plant throughput. The sharply-defined month-long bump in the moving average that extends into early April arose because the intensity of the March 21st rainfall event heavily influenced the computation during the 30 days it was encompassed within the averaging window. To obtain an upper-bound estimate of infiltration (shown by dark shading), the three brief, but major rainfall events were excluded from the

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[1] Inflow (of rainwater) and Infiltration (of groundwater)

moving average. In addition, a lower-bound estimate of increased flow from tourism, shown in white and described below, was also excluded from the 30-day moving mean.

Based on the area of the shaded portion of the flow time series, at least 37 MG flowed into the collection system as a result of increased infiltration from rainstorms.[1] Although this only represents 11% of total plant throughput, the long-term influence of rainstorms contributed more to plant throughput during 2018 than the brief but intense inflows during storms. Episodic large inflows are, however, more challenging for the treatment plant to accommodate.

4.2 TOURISM

Population increases related to summer tourism also resulted in a perceptible increase in the 30-day moving average flow (upward bow in the solid line from June through August in Figure 4.1). However, the additional 6.8 MG of plant throughput that resulted from population increases during the dry season was probably much less than that of infiltration.[2] Moreover, at its 1.02 MGD peak in mid-July, the 30-day flow was only 43% of the monthly allowance for peak dry-season flow shown by the thick shaded line that spans the '*dry*' season (April through September) in Figure 4.1. Short-term increases in flow due to tourism are also apparent around the Memorial, Independence, and Labor Day holidays at the end of May, and the beginning of July and September.

4.3 FLOW CORRECTIONS

Daily plant throughput is normally determined by totaling high-sampling-frequency data from the influent flow meter. The influent flow-meter readings are used because the meter measures the volume of wastewater processed by the treatment plant based on a precision water-level transducer, and thus are more accurate than the effluent meter's mechanical impeller, which is known to overtotalize the actual flow. On rare occasions, however, the influent flow meter also reports erroneously high values. Typically, these outliers are obvious in the flow record and result from easily identifiable causes such as surcharging of the influent trunk line during major rain events or during periods when inflow at the headworks is intentionally reduced to facilitate equipment repair. On those occasions, the original, potentially erroneous daily flow is still reported on the monitoring form using measurements from the influent flow meter. However, when plant personnel suspect, or have direct knowledge that the influent flow reading is inaccurate or compromised, they provide a narrative about the event in the monthly monitoring form, and include an estimate of the actual flow along with the computational rationale for the estimate. Often, this corrected value is based upon effluent flow readings adjusted downward to account for that meter's overtotalization.

In this report's analyses, fifteen daily flows reported during 2018 were corrected to provide a more accurate representation of actual plant throughput (Table 4.1 on the following page). These corrected values, as opposed to the reported values, are used throughout this report to assess plant performance. In addition to providing a more reliable determination of actual plant throughput capacity, they affect mass-emission computations for various parameters considered diagnostic of plant performance, and that are limited by the discharge permit. In addition, the corrected flow values are used in conjunction with

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[1] The actual contribution from groundwater inflow into the collection system is undoubtedly larger, but by assuming a baseline near the minimum 30-day flow for the year (0.77 MGD), at least 37 MG of flow can be unambiguously ascribed to the influence of water-table fluctuations resulting from rainfall during the year.

[2] The white area beneath the 30-day flow (solid line) accounts for 6.8 MG of wastewater throughput. At least this much of the flow is attributable to the increased population within the service area during the summer tourist season. It represents 2% of the 329.7 MG processed by the treatment plant during 2018. However, it accounted for 8.4% of the flow over the shorter span of the summer tourist season.

Table 4.1 Corrections to Reported Daily Flow (MGD)

Date	Reported	Corrected	Reduction	Reason
21-Mar	5.018	3.536	1.482	Output from both flow meters compromised by heavy rain event
22-Mar	3.104	2.503	0.601	Output from both flow meters compromised by heavy rain event
3-Dec	1.103	0.815	0.288	Incorrect transducer elevation during initial influent-meter calibration
4-Dec	1.268	0.980	0.288	Incorrect transducer elevation during initial influent-meter calibration
5-Dec	1.281	0.993	0.288	Incorrect transducer elevation during initial influent-meter calibration
6-Dec	1.305	1.017	0.288	Incorrect transducer elevation during initial influent-meter calibration
7-Dec	1.278	0.990	0.288	Incorrect transducer elevation during initial influent-meter calibration
8-Dec	1.320	1.032	0.288	Incorrect transducer elevation during initial influent-meter calibration
9-Dec	1.292	1.004	0.288	Incorrect transducer elevation during initial influent-meter calibration
10-Dec	1.292	1.004	0.288	Incorrect transducer elevation during initial influent-meter calibration
11-Dec	1.209	0.921	0.288	Incorrect transducer elevation during initial influent-meter calibration
12-Dec	1.244	0.956	0.288	Incorrect transducer elevation during initial influent-meter calibration
13-Dec	1.224	0.936	0.288	Incorrect transducer elevation during initial influent-meter calibration
14-Dec	1.250	0.962	0.288	Incorrect transducer elevation during initial influent-meter calibration
30-Dec	1.530	1.134	0.396	Typographical error on CIWQS data entry

chemical concentrations to establish their mass loading to the marine environment. These chemical mass-emissions are compared to goals that were established from historical measurements to determine whether there has been a significant increase in pollutant loading. The combined 5.95 MG flow correction for the year amounts to a 0.16 MGD reduction in the annual average flow.[1]

4.3.1 Data Gap

The most significant correction was applied to reported daily flows on March 21st and 22nd. The abnormally high reported flows were partially an artifact of gaps in the instrumental flow readings that were available during this extremely heavy rain event. As described in the March Monthly Compliance Report (Appendix C), a high rate of rainwater inflow surcharged the influent metering flume and caused the water-level-based influent flow meter to overtotalize the flow significantly. In accordance with current practice, the influent flow-meter data was reported in the CIWQS[2] database for compliance-evaluation purposes. Normally, when the influent-meter data is compromised by flume surcharging, a corrected estimate of the flow can be determined from effluent flow-meter data. However, for 18 hours, flow through the WWTP was so high that it pegged the impeller-based effluent flow meter at its maximum reading, thereby underestimating daily plant throughput. In contrast to flow reported by direct meter readings, the more-realistic daily flows listed in the first two rows of Table 4.1 were determined from a combination of data as described in the Monthly Compliance Report. Review of high-sample-frequency data from both meters found that they were consistent for 30 hours of the two-day period. Plant flow within the remaining 18-hour data gap was determined using past inflow analyses that found 0.63 MG of rainwater enters the WWTP for each inch of rain that falls within the collection-system's watershed. The rainfall-based estimated flow within the meter data gap was combined with reliable flow totals determined from the high-sampling-rate data to establish the corrected March flow values in Table 4.1.

4.3.2 Influent Meter Calibration

The next set of flow corrections in Table 4.1, which span a 12-day period, arose after the influent flow meter was recalibrated on December 3rd (Appendix D). This water-level-based meter measures influent flow based on the height of water within a specialized flume. That flume is designed to produce laminar

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[1] All of the flows reported herein, including the annual average flow of 0.903 MGD, are based on the corrected readings.

[2] California Integrated Water Quality System Project

flow with little downstream surcharging. The water height within the flume is measured using an ultrasonic transducer. However, during calibration, a default zero-flow offset was incorrectly applied, which resulted in the overtotalization of flow by 0.288 MGD. The offset was corrected 12 days later on December 15th. Corrections to the artificially elevated flow data that were reported to CIWQS during that period resulted in the removal of a total of 3.5 MG of plant throughput.

4.3.3 Effluent Meter Overtotalization

The remaining correction was applied to the influent meter's reported flow on December 30th. The flow entered into the CIWQS database (1.530 MGD) for that day contained a typographical error. That reported flow differed from the flow (1.353 MGD) determined by totalizing influent flow-meter data and listed in the flow meter's database. Additionally, both values were significantly higher than flows reported by that meter on the preceding (1.14 MGD) and following (1.04 MGD) days. Lastly, the reported December 30th flow was noticeably higher than the adjusted effluent meter flow (1.134 MGD). There was no clear reason for the influent meter's high reported flow on that day, such as flume surcharging from rainwater inflow or changes to equipment at the headworks.

As shown in Table 4.1, the suspect influent data was replaced with flow reported by the effluent meter but adjusted downward to account for that meter's current level of overtotalization. Although the effluent meter overtotalizes the flow, the amount of overtotalization can be precisely determined. As a result, the effluent meter's flow history, adjusted for overtotalization, closely matches the influent meter's readings, indicating that the flow data is interchangeable when both meters are functioning properly.

This close correspondence is visually apparent from the comparison of each meter's flows since the beginning of 2018 (Figure 4.2). It justifies the use of an adjusted effluent-meter reading when the influent meter's output is clearly compromised. This results in a continuous time series of flow data that is much more reliable than data from either meter alone. Daily flow reported by the influent meter is shown by the blue time series in Figure 4.2. A few data points were excluded from this "Target Flow" time series because influent meter's readings were known to be compromised, and therefore unsuitable for comparison. The red time series was determined from effluent-meter readings that were adjusted to account for overtotalization. The adjustment equation was determined from a linear regression of past flow data from both meters.

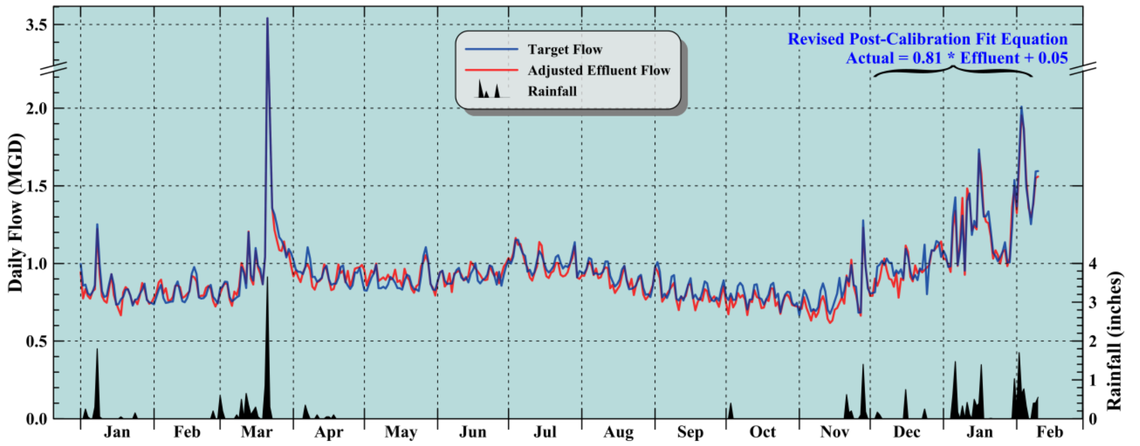

Figure 4.2 Adjusted Effluent Flow from 1 January 2018 through 10 February 2019

The availability of precise and closely matching measurements from both the influent meter and the adjusted effluent meter provides valuable redundancy in the event that one of the meters is taken offline for repairs or calibration. However, to ensure that the adjustments to effluent flow readings continue to be as accurate and timely as possible, the coefficients in the adjustment equation are recomputed at least annually, or when major modifications are made to the meters or flow system. Prior to calibration of the influent meter on December 3rd, the adjustment was determined from a regression on data collected during 2017 (refer to Equation 5.1 on Page 5-9 of the 2017 Annual Report; MRS 2018b). The adjustment equation determined from 2017 data changed little from that determined from data collected in the two prior years (MRS 2016 2017).

The excellent agreement between the adjusted-effluent and target flow data during the first eleven months of 2018 demonstrates that the 2017 adjustment equation remained valid during that time. However, calibration of the influent meter on December 3rd changed the relationship between the two meters. Comparison of post-calibration daily flow totals that were reported by the influent and effluent meters (Figure 4.3) demonstrated that the formula for adjusting the effluent flow-meter readings requires updating:

$$A = 0.81\ X\ E + 0.05 \qquad \text{Equation 4.1}$$

where: A = the actual plant flow in MGD, and
E = the flow measured by the effluent meter.

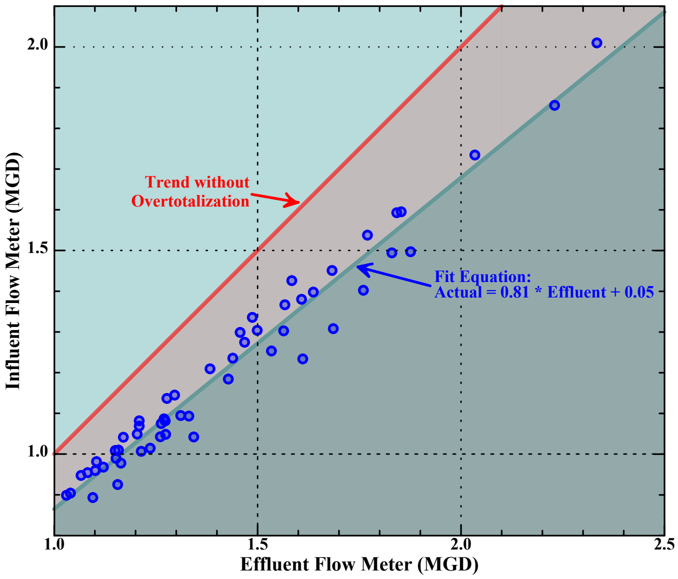

Figure 4.3 Relationship between Flow Reported by the Influent and Effluent Meters between 15 December 2018 and 10 February 2019

Equation 4.1 was determined from a linear regression on 54 pairs of daily flow observations that were measured by the influent and effluent meters after December 15th when both meters were known to be functioning correctly (blue dots in Figure 4.3). Two suspect influent measurements recorded in late December were excluded from the regression analysis. The Figure shows that the effluent meter's overtotalization remains significant and that an adjustment of its readings remains necessary. For comparison, the red line in Figure 4.3 displays the relationship between the influent and effluent meters that would be expected in the absence of overtotalization by the effluent meter, namely, exactly the same readings from each meter. That relationship departs significantly from the scatter among the cloud of dark-blue points surrounding the green regression line in the Figure, which represents the actual post-calibration measurements made by each meter. Although at low flows the effluent meter overtotalizes by only a little over 0.1 MGD, at higher flow, the adjustment can be three times that much.

Equation 4.1 is now recommended for use in adjusting effluent meter data when influent-meter data are compromised or absent. It departs perceptibly from the equation that was applied over the last three years, and future application of the new equation will ensure continued close correspondence with influent data.

Applying the new equation to post-calibration data results in time series that closely track one another (after mid-December in Figure 4.2). This is the case even in the presence of large fluctuations in flow that arose during the major rainfall events experienced in early 2019. Nevertheless, the relationship between the two meters should be revisited annually, or when there are major changes to either meter.

5.0 WASTEWATER PROPERTIES

Monthly characterizations of wastewater properties documented a number of different aspects of the treatment plant's performance during 2018 (Table 5.1). 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.

Table 5.1 Monthly Averages of Influent and Effluent Parameters

		Suspended Solids				Biochemical Oxygen Demand			
Month	**Flow (MGD)**	**Influent (mg/L)**	**Effluent (mg/L)**	**Removal (percent)**	**Emission (kg/day)**	**Influent (mg/L)**	**Effluent (mg/L)**	**Removal (percent)**	**Emission (kg/day)**
January	0.833	297	39	86.5	124	290	46	84.3	138
February	0.808	320	28	91.4	83	267	40	85.2	113
March	1.118	277	27	90.8	122	242	37	84.9	214
April	0.931	290	31	89.1	105	238	39	83.5	131
May	0.887	244	31	87.0	101	221	41	81.5	129
June	0.919	398	34	92.1	116	270	36	86.8	122
July	1.015	346	44	88.4	166	325	49	85.0	185
August	0.908	317	30	90.0	100	331	39	88.3	130
September	0.829	252	28	89.1	85	275	32	88.4	95
October	0.790	377	32	90.4	92	319	50	84.4	138
November	0.809	295	25	91.4	77	316	43	86.4	145
December	0.977	253	30	85.1	110	249	35	86.0	127
Average	**0.903**	**306**	**32**	**89.4**	**107**	**279**	**41**	**85.5**	**139**
Monthly Limit[1]	**≤2.36[2]**		**≤70**	**≥75.0**	**≤546**		**≤120**	**≥30.0**	**≤936**
Annual Total (MT)					**39**				**51**
Nominal Annual (MT/year)					**≤199**				**≤342**

Table 5.1 (continued) Monthly Averages of Influent and Effluent Parameters

	pH					Oil and Grease		
Month	**Influent**	**Effluent**	**Turbidity (NTU)**	**Settleable Solids (ml/L)**	**Median[3] Total Coliform (MPN[4]/100ml)**	**Influent (mg/L)**	**Effluent (mg/L)**	**Emission (kg/day)**
January	7.6	7.2	33	<0.1	2	14	≈1.2	≈3.9
February	7.6	7.3	27	<0.1	<2	75	<0.86	<2.6
March	7.6	7.3	29	<0.1	13	22	<0.86	≈3.6
April	7.7	7.3	29	<0.1	<2	27	<0.86	≈3.2
May	7.6	7.3	35	<0.1	<2	40	≈2.0	<6.3
June	7.6	7.3	28	<0.1	<2	50	≈1.1	≈3.8
July	7.6	7.3	43	<0.1	6	74	≈1.6	≈5.8
August	7.6	7.3	38	<0.1	5	56	≈0.85	<5.4

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[1] Interim limits are listed for TSS and BOD as specified in the TSO

[2] Peak Seasonal Dry-Weather Flow (PSDWF)

[3] The current NPDES discharge permit requires reporting of the 30-Day Geometric Mean except when one or more values are censored, namely, below the quantification limit. In that case, the median is reported. Non-quantifiable coliform densities were present in every month of 2018.

[4] Most Probable Number

Table 5.1 (continued) Monthly Averages of Influent and Effluent Parameters

	pH					Oil and Grease		
Month	**Influent**	**Effluent**	**Turbidity (NTU)**	**Settleable Solids (ml/L)**	**Median[3] Total Coliform (MPN[4]/100ml)**	**Influent (mg/L)**	**Effluent (mg/L)**	**Emission (kg/day)**
September	7.6	7.3	30	<0.1	2	36	<0.82	<3.1
October	7.6	7.3	29	<0.1	13	45	<0.82	≈4.9
November	7.8	7.5	31	<0.1	<1	25	<0.82	<4.5
December	7.9	7.5	36	<0.1	1	130	≈0.85	<4.7
Average	**7.6**	**7.3**	**32**	**<0.1**	**<2**	**50**	**≈1.2**	**≈3.7**
Monthly Limit		**6-9**	**≤75**	**≤1.0**	**≤23**		**≤25.0**	**≤195**

Treatment-plant personnel periodically collected wastewater samples throughout 2018. Results from the analyses of those samples were used to compute the monthly averages of the principal influent and effluent characteristics listed in Table 5.1. Laboratory analyses of influent and effluent samples quantified the principal physicochemical properties of the wastewater stream by determining concentrations of TSS, BOD, settleable solids, O&G, total residual chlorine (TRC), ammonia, and nutrients. Other analyses measured wastewater temperature, scattered light (turbidity), coliform density, acidity (pH), and toxicity.

The frequency and the duration of individual sampling and testing events varied among the parameters. For example, average reductions in suspended solids and BOD were determined from 24-hour composite samples of both influent and effluent that were collected and analyzed at least weekly. For the remaining properties, the permit requires analyses of effluent samples alone, although the treatment plant personnel continued monthly O&G analyses and daily pH determinations of influent during 2018. Discrete effluent grab samples were analyzed for turbidity, settleable solids, TRC, temperature, and pH on a daily basis throughout most of 2018. Lastly, analyses of effluent TSS were conducted five-times per week.

Detailed analyses of these measurements confirm that, during 2018, the plant regularly exceeded wastewater treatment expectations established in regulatory standards and the original WWTP design criteria. Moreover, the plant has consistently discharged exceptionally high quality effluent over its long history, and there has never been an indication of deteriorating plant performance. Rare exceptions to standards or criteria have been brief, and have often resulted from unavoidable repairs to, or mechanical failures of a treatment-system component. However, as a byproduct of a diligent preventative maintenance program, the plant has consistently operated at a high level of efficiency with little equipment down time.

5.1 PARTICULATE LOAD

Suspended solids, turbidity, and settleable solids measure the particulate load within wastewater. One of the principal functions of the treatment process is to remove organic particulates from the wastestream. As in the past, all of the measures of particulate-removal capability unequivocally demonstrate that the treatment process was operating at peak performance throughout 2018, and that all complied with the interim limits specified in the TSO.

5.1.1 Suspended Solids

The treatment plant's removal of nearly all (89%) of the solids from influent (Figure 5.1b; Table 5.1) documents the plant's high overall performance during 2018. In particular, the plant's annual solids removal rate exceeded the minimum required by the interim effluent limits in the TSO, which specifies removal of only 75% of the suspended solids on a monthly basis. This minimum removal rate is also promulgated in COP Table 2 (SWRCB 2015).[1]

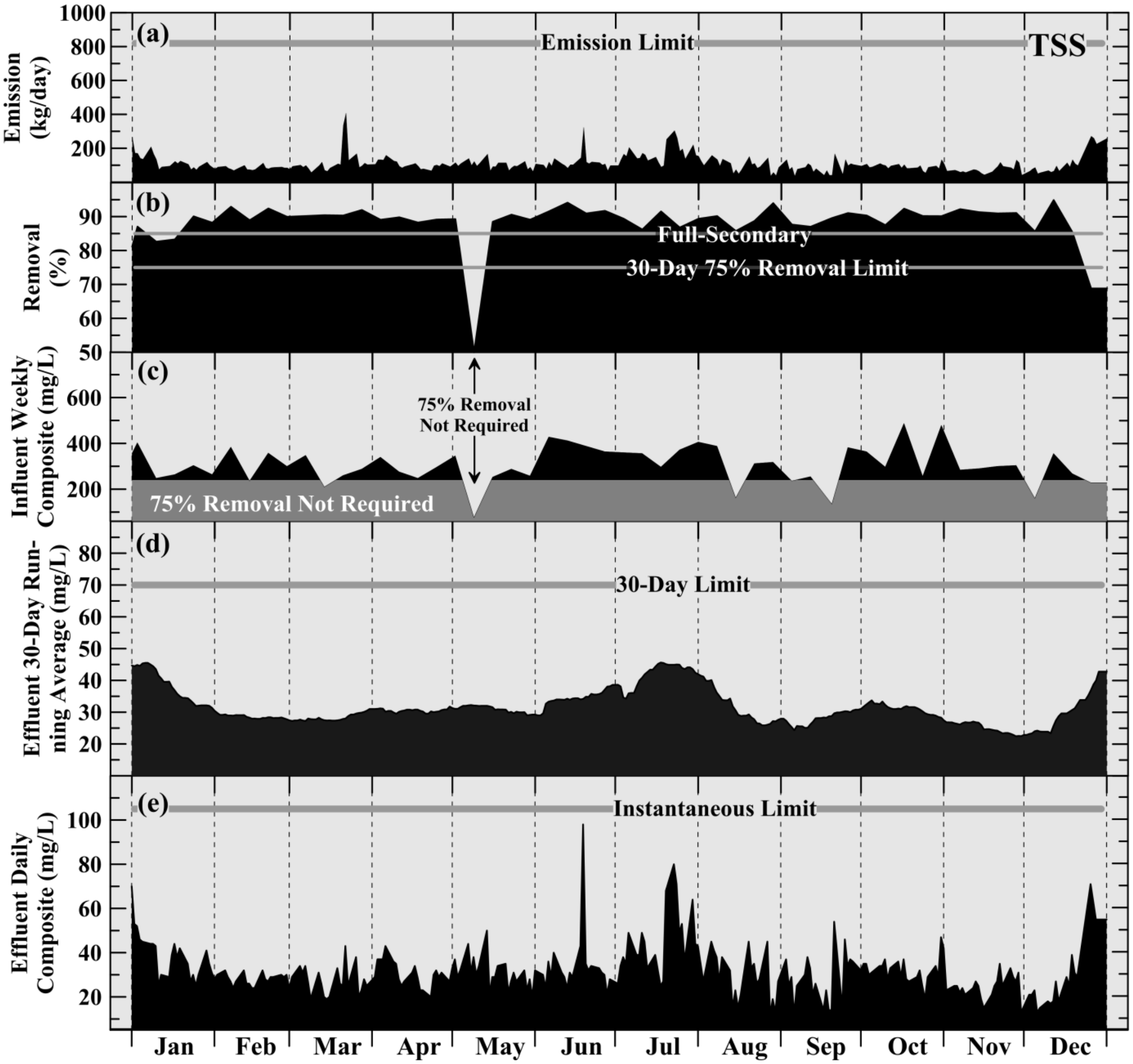

Figure 5.1 Suspended Solids

In fact, the plant's 89% annual removal rate exceeded the 85% monthly removal rate established for full-secondary treatment. This level of treatment is specified the TSO's final effluent limits that will apply in 2023 when the WRF is scheduled to be completed. Moreover, the WWTP achieved removal rates

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[1] COP Table 2 Effluent Limitations only apply to dischargers for which Effluent Limitations Guidelines have not been established under the Federal Clean Water Act.

equivalent to full secondary treatment consistently throughout the year, with monthly averages exceeding the secondary standard in every month. This includes May, when an abnormally low influent TSS concentration (76 mg/L) was reported (refer to the co-occurring downward excursions in Figure 5.1bc). The low TSS concentration in the influent sample possibly resulted from the presence of rags in the composite sampler's intake diffuser (MBCSD 2018). Regardless of the cause, the unrealistically low TSS removal rate reported for May 9th (50%) was exclusively the result of the errant influent TSS concentration, rather than a lapse in plant performance, which would have been reflected in an elevated effluent TSS concentration.

Sharp reductions in influent TSS concentration, such as the one shown in Figure 5.1c, arise from external events unrelated to the treatment process. In the absence of issues related to sample collection, they occasionally occur when rainwater inflow from intense winter storms dilute the suspended solids load within the collection system. Although these low-influent-TSS events are clearly unrelated to the efficacy of the treatment process, they weigh heavily in computation of removal rate. Because of this, removal rates are a somewhat irrelevant measure of plant performance when influent TSS concentrations are low. From a process standpoint, the same fraction of suspended solids cannot be removed from the influent stream when there is less material available to remove. From an environmental standpoint, only the solids loading within the discharged wastestream is of concern, not the influent loading or the fraction of material removed.

Moreover, the removal-rate limits specified in the COP, NPDES discharge permit, and TSO are technology-based requirements rather than ones that reflect the actual potential for environmental impacts within receiving waters. Regulators recognize that requiring a high removal rate is unnecessary when effluent TSS concentrations are low to begin with. Consequently, the applicability of the 75% monthly removal-rate limit specified in COP Table 2 is abrogated when the requirement would result in an effluent TSS concentration of less than 60 mg/L (COP Table 2 Notes in SWRCB 2015). Thus, application of the 75% removal-rate is questionable when influent TSS concentrations fall below 240 mg/L,[1] which occurred on May 9th when the 76 mg/L concentration was reported. Irrespective of this anomaly, the average May influent concentration (244 mg/L) remained slightly above this removal-rate applicability threshold, yet the treatment process still achieved an 87% removal rate, far exceeding the required minimum 75% removal.

In contrast to removal rate, the overall solids load released to the ocean directly reflects the discharge's potential for environmental effects. In that regard, daily mass emissions of solids were uniformly low throughout 2018, and never reached even half of the TSO's allowed amount (thick shaded gray line labeled "*Emission Limit*" in Figure 5.1a). Low overall effluent TSS concentrations, combined with low flow rate during 2018, resulted in an annual total solids emission that was well below the allowable solids emission (Table 5.1). Over the entire year, the WWTP only discharged 39 MT of suspended solids into the ocean. That solids emission was only 20% of the projected 199 MT that would have been discharged if effluent had contained the permitted TSS concentration of 70 mg/L and throughput reached the average dry-weather design flow of 2.06 MGD.

Aside from regulatory compliance, the record of consistently low effluent TSS concentrations also provided a good indication of the high overall plant performance for any given period during 2018 (Figure 5.1d). Month-end averages for each calendar month were well below the monthly limit of 70

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[1] 240 mg/L is four-times the 60-mg/L threshold on effluent concentration that restricts the applicability of removal rate for compliance evaluations. This applicability threshold derives from the first note to Table 2 of the COP (SWRCB 2015), which states: "*... the discharger shall remove 75% of suspended solids from the influent stream at any time the influent concentration exceeds four times* [the effluent concentration limit]."

mg/L (Table 5.1), as was the 30-day moving average (Figure 5.1d). This was the case even though TSS concentrations measured in samples collected on any given day, fluctuated widely (Figure 5.1e). Nevertheless, the TSS concentration within all but one of the 258[1] daily effluent samples were less than 76% of the 105 mg/L instantaneous maximum specified in the TSO. There was no identifiable cause for the abnormally high 98-mg/L TSS concentration reported on June 19th.

5.1.2 Turbidity

Turbidity measures the optical clarity of an effluent sample and as such, it is a somewhat independent measure of solids content. Nevertheless, turbidity levels measured within individual daily grab samples were uniformly low, and they all comfortably complied with the effluent limits specified in the NPDES permits. Month-end (Table 5.1) and moving 30-day averages (Figure 5.2a) never exceeded 70% of the 75-NTU monthly limit. Over shorter periods, all but three of the weekly averages were less than 70% of the 100-NTU limit. Those three excursions occurred when the plant was processing a higher amount of wastewater of sewage origin during July and on December 31st (Figure 5.2b).

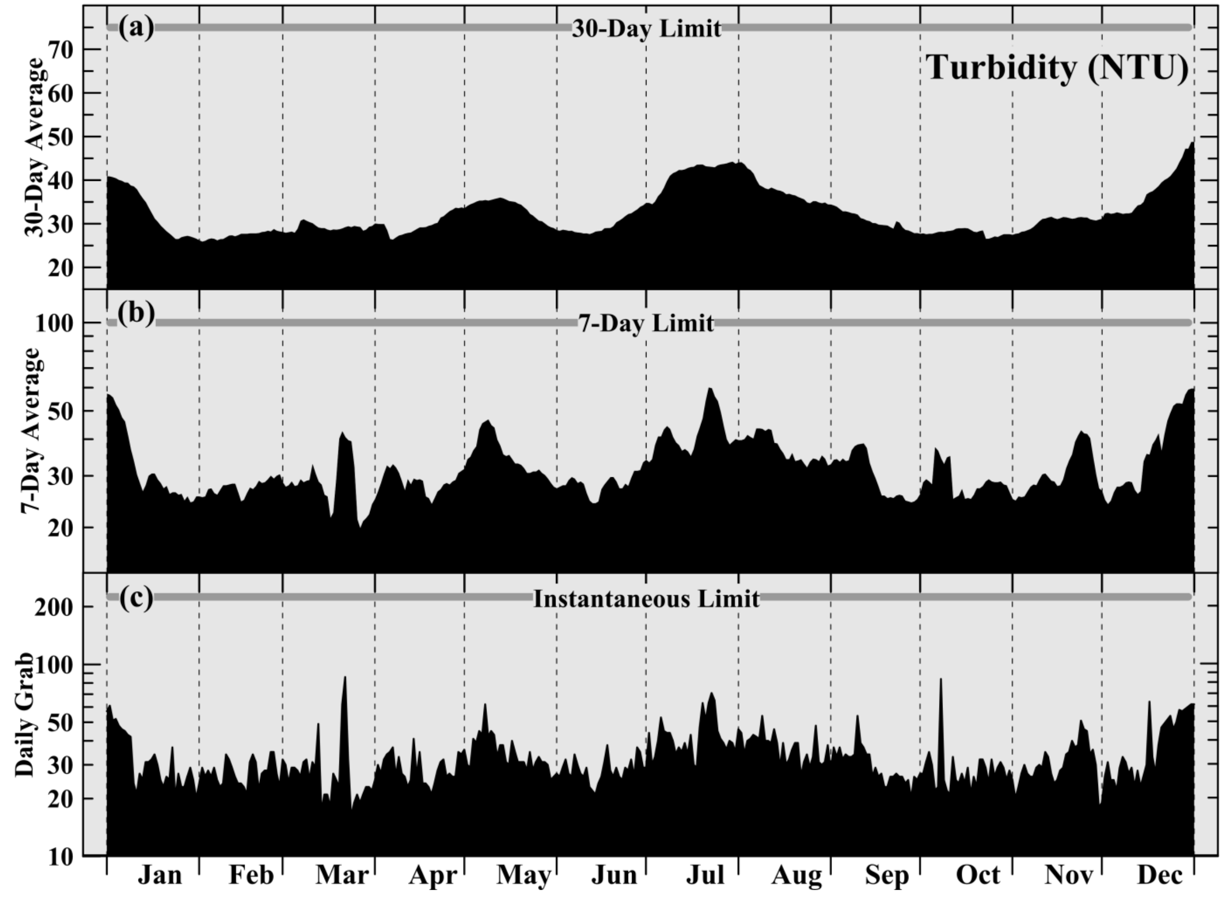

Figure 5.2 Turbidity

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[1] For the most part, TSS concentrations were determined within effluent composite samples five times per week even though the current permit only requires an analysis frequency of once per week.

This suggests that their occurrence was related to an increase in influent loading rather than an upset in the process. Similarly, the 360[1] daily turbidity measurements (Figure 5.2c) were uniformly low and only reached approximately one-fourth of the allowed instantaneous limit (225 NTU).

Effluent turbidity explicitly reflects the discharge's potential to impact receiving seawater clarity offshore. Accordingly, offshore water-quality monitoring that was required in prior permits included measurements of seawater clarity within the water column surrounding the outfall. Over the past 25 years, 99 receiving-water surveys have been conducted using a precision instrument package that included high-resolution measurements of seawater transmissivity. The last survey was conducted in March 2018 (MRS 2018a), and is summarized in Section 2.2 on Page 2-7, while the four quarterly surveys conducted in 2017 are described in last year's annual report (MRS 2018b). Analyses of transmissivity measurements collected during these recent surveys, and during the other 94 surveys, repeatedly demonstrate that turbidity associated with effluent discharge dissipates rapidly upon discharge. Perceptible changes in water clarity associated with effluent particulate loading were rarely found, and only when the transmissometer passed extremely close to a discharge port near the seafloor. Very little sunlight reaches that depth, demonstrating that the discharge has no impact on the penetration of ambient light. The highly localized and diffuse character of wastewater turbidity upon discharge is visually apparent in the wispy cloud emanating from the diffuser port shown in Figure 3.2 on Page 3-4. In fact, some of the distortion apparent in the photograph is an artifact of differences in the refractive index at the seawater-wastewater interface rather than particulate loading.

5.1.3 Settleable Solids

Settleable solids concentrations, which are the only remaining solids-related measure of effluent quality, echo the above findings that particulate loads of all types were low during 2018. Specifically, all monthly averages were below the 0.1-ml/L detection limit (Table 5.1), which is an order-magnitude less than the permit limit of 1.0 ml/L. In fact, only four of the 357[2] daily effluent samples collected during 2018 contained a detectable amount of settleable solids. The highest of those measurable concentrations (0.6 ml/L) remained below the monthly average limit of 1 ml/L, as well as the weekly and instantaneous limits of 1.5 ml/L and 3.0 ml/L.

Thus, during 2018 as in prior years, all measures of effluent solids demonstrated that the treatment process exceeded performance expectations by regularly removing a greater amount of solids from the influent stream, and by discharging a small fraction of the maximum anticipated load to the marine environment. The consistently low monthly averages for effluent TSS, turbidity, and settleable solids attest to the overall effectiveness of the treatment plant's screening, grit removal, sedimentation, filtration, and clarifying processes.

5.2 BIOCHEMICAL OXYGEN DEMAND

In combination with solids removal, a primary function of the treatment process is to reduce organic material within the wastewater stream. The effectiveness of the organic removal process is closely linked to solids removal because the majority of organic constituents are associated with wastewater particulates. However, the measure of organic loading, namely BOD, differs from the direct physicochemical measurements of turbidity and solids concentrations. Instead, BOD indirectly measures organic loading within the wastewater stream by determining the amount of oxygen required for aerobic bacteria to decompose organic matter in a sample of wastewater. Organic material, which supports bacterial

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[1] Five of the daily effluent grab samples collected in last half of December 2018 were not analyzed for turbidity. This reduced analysis-frequency still complied with the current permit's requirement for turbidity determinations five times per week.

[2] Eight of the daily effluent grab samples collected in last half of December 2018 were not analyzed for settleable solids. This reduced analysis-frequency still complied with the current permit's requirement for weekly analysis.

degradation and demands oxygen, can harm the environment if its decomposition severely depletes DO within receiving waters. Specifically, prolonged oxygen depletion can disrupt benthic and demersal communities and cause mass mortalities of aquatic life (Diaz and Rosenberg, 1995).

However, DO depletion is only of concern in semi-enclosed water bodies, such as bays and estuaries, which are environments that fundamentally differ from the highly oxygenated open-coastal marine environment of Estero Bay. In fact, because of the ocean's higher oxygen-replenishment capabilities, an evaluation by the National Academy of Sciences (1993) questioned the environmental benefits of imposing a technology-based BOD limit on open-ocean dischargers, namely, requiring secondary-treatment standards for BOD.

Nevertheless, the NPDES discharge permit sets limits on the discharge of BOD, and independent of potential environmental influence, BOD constitutes an important measure of the overall performance of the treatment process. However, because of the complexity and duration of BOD determinations, its evaluation is only required on a weekly basis (Figure 5.3).

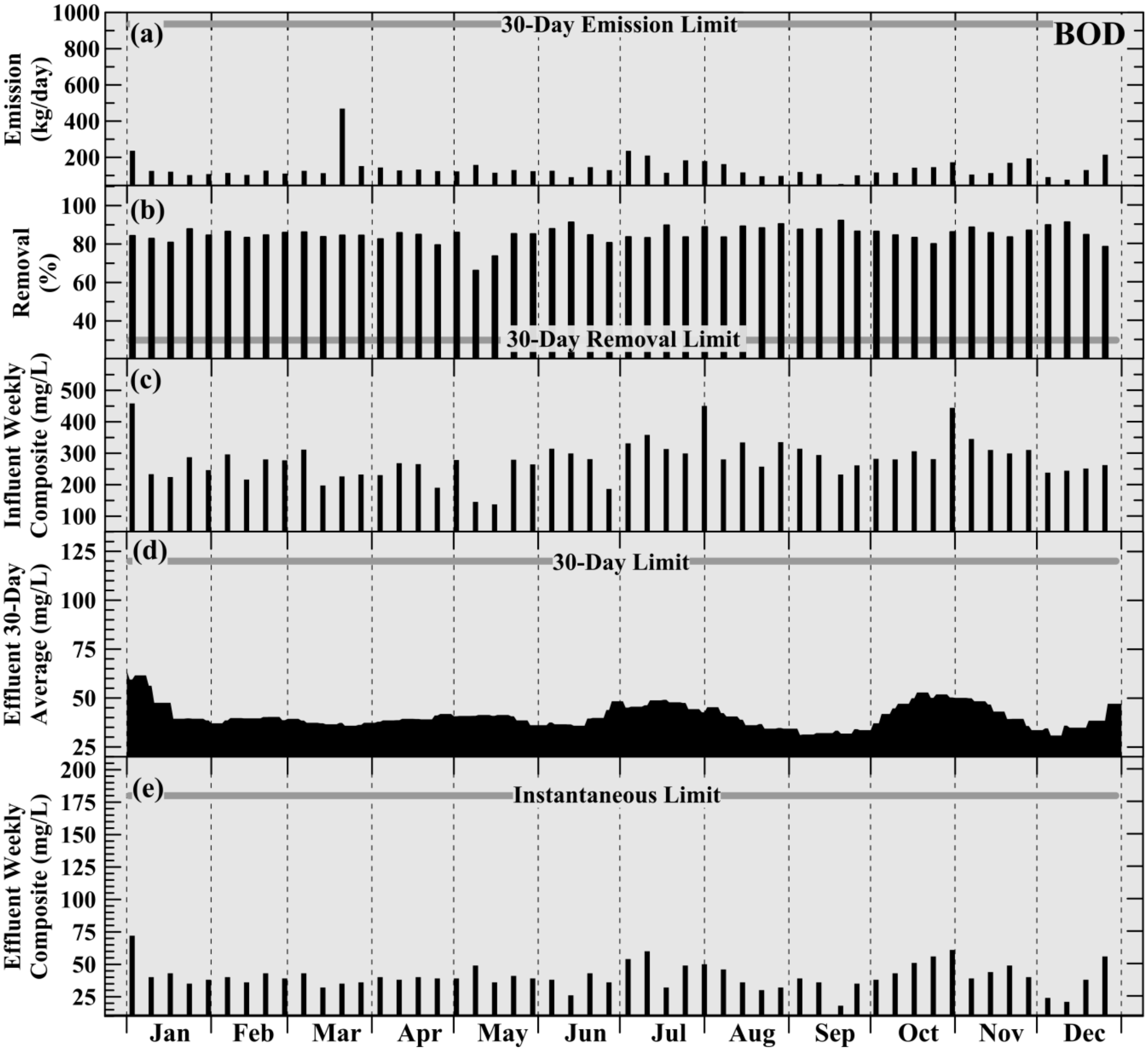

Figure 5.3 Biochemical Oxygen Demand

In conjunction with the high overall performance of the solids removal process during 2018, BOD removal was also exceptionally high. Annually, the WWTP reduced influent organics by more than 85.5%, as determined by the average of weekly composite samples analyzed for BOD (Table 5.1). Thus, the WWTP removed organic material at a rate nearly three times greater than the 30% removal rate required as part of the interim limits specified in the TSO (Figure 5.3b). The monthly removal rate even met or exceeded the 85% threshold established for secondary treatment in seven months of the year, and was just shy of the secondary standard in three of the other five months when it exceeded 84% removal.

BOD concentrations within individual effluent samples were consistently low throughout the year, and all were far below the TSO's interim limit of 180 mg/L (Figure 5.3e). Consequently, the moving 30-day average remained well below the 120-mg/L interim limit that applies to averages over calendar months (Figure 5.3d). As with TSS, the low overall BOD concentrations, combined with the low overall flow in 2018, resulted in the lowest annual BOD emission in the 33-year history of the MBCSD monitoring program. At 51 MT, it was only 15% of the projected 342 MT tons that would have been discharged if effluent had contained the permitted BOD concentration of 120 mg/L and throughput reached the average dry-weather design flow of 2.06 MGD allowed by the discharge permit (Table 5.1).

The series of individual weekly BOD emissions (Figure 5.3a) were consistently low, with the exception of the 468 kg/day that was reported on March 21st. It was double the next highest emission recorded during 2018. However, the associated BOD concentration (Figure 5.3e) was not abnormally high on that day. Clearly then, the strikingly higher BOD emission on that day was a computational artifact that resulted because of the extraordinarily high flow processed by the plant. As described in Section 4.3.1 on Page 4-3, the rainfall event that occurred on that and the following day was so heavy that plant throughput had to be estimated because the influent flume was surcharged and the effluent meter was pegged at its maximum value during a large portion of the time. Thus, the extraordinarily high BOD emission on March 21st arose solely because of the enormous amount of rainwater that flowed into the collection system. Any additional organic material associated with this rainwater inflow would have flowed into the ocean anyway. Thus, the high reported BOD emission grossly overestimated the discharge of organics of sewage origin, and therefore the anomalous BOD emission was not representative of the plant process itself. Regardless, the reported emission was only half of the 936-kg/day monthly interim emission threshold, and one-third of the 1,404-kg/day instantaneous BOD-emission threshold.

5.3 OIL AND GREASE

During 2018, the treatment process reduced average O&G concentrations within the influent stream by at least 40-fold (Table 5.1). The actual amount of the reduction cannot be precisely determined because O&G concentrations within all of the 52 weekly effluent grab samples were too low to be quantified (Figure 5.4c on the following page). The 5.0-mg/L quantification limit specified for the O&G analysis method was eight fold lower than the 40-mg/L weekly-average limit specified in the NPDES discharge permit and fifteen-fold lower than the 75-mg/L maximum-allowed daily concentration. Thus, all of the 52 effluent samples easily complied with the O&G concentration limits even though their concentrations could only be estimated. O&G was not detected in nineteen of the samples at a detection limit of 0.86 mg/L (light gray shading in the Figure 5.4c).

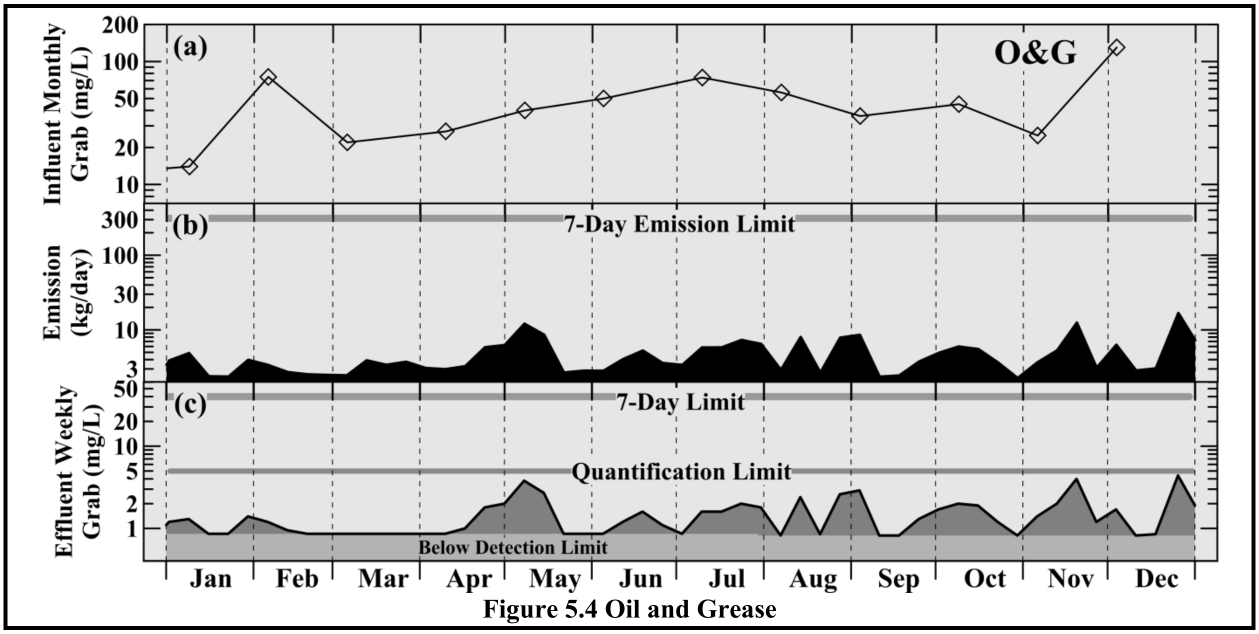

Figure 5.4 Oil and Grease

The long series of consistently low O&G concentrations measured in effluent samples collected during 2018, and in recent prior years, were unusual in the three-decade-long database. The annual median effluent concentration during 2018 (≈1.2 mg/L) was the lowest in the database, and did not arise because influent concentrations measured during the year were particularly low (Figure 5.4a). When combined with the low overall flow, all of the 2018 weekly O&G emissions were at least an order of magnitude below the allowed 312 kg/day maximum 7-day emission (note the logarithmic scale in Figure 5.4b).

5.4 PH

The MBCSD discharge permit requires that hydrogen-ion concentrations (pH) within effluent samples remain between 6 and 9 at all times. Although Section 301(h) of the Clean Water Act allows an NPDES permit to be issued that exceeds these pH limits, none of the MBCSD discharge permits allowed this exception. The general absence of heavy-industrial input into the collection system creates an influent stream with a nominal pH that routinely meets the discharge requirement even without treatment. Thus, because influent pH (dashed line in Figure 5.5) remained within the discharge limits (shaded area) throughout 2018, effluent pH measurements also remained within the allowable range by default (solid line).

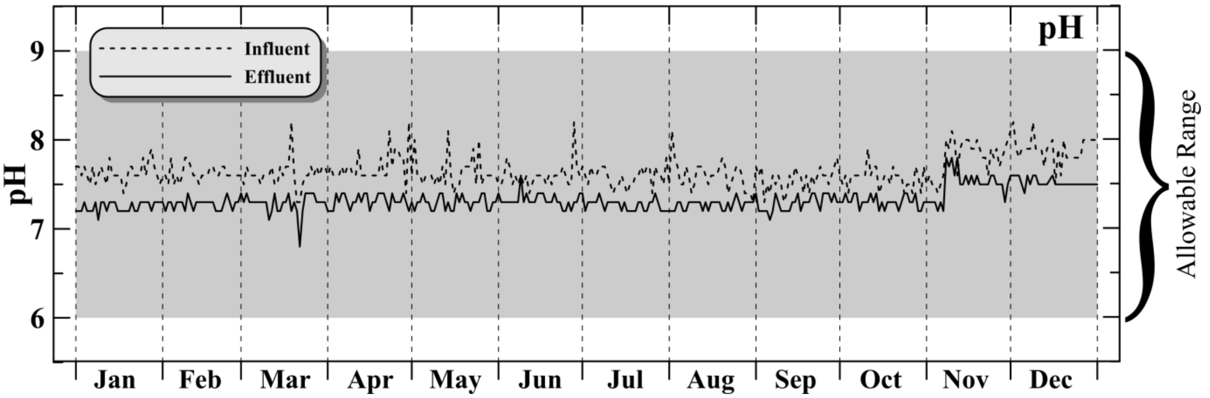

Figure 5.5 Hydrogen-Ion Concentration

The most striking feature of the pH time series shown in Figure 5.5 is the 0.3 increase in reported pH for both influent and effluent that occurred on November 8th. However, this offset does not represent an actual increase in wastewater alkalinity. Instead, it arose because the probe on the laboratory's pH meter was replaced after having been in service for two years. A review of daily meter calibrations indicates that the new probe's output is more accurate, and the pH probe will now be replaced on an annual basis.

Probe-replacement aside, a comparison of the two time histories demonstrates that the treatment process significantly moderated short-term pH fluctuations within influent[1], and slightly reduced its pH. Average annual effluent pH (7.32) was slightly less alkaline than influent (7.65) and substantially less alkaline than the receiving seawater (8.0).

5.5 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 (Section 3.2 on Plume Dispersion in MRS 2018b). Effluent temperature, shown by the upper time series in Figure 5.6, exhibits a distinct semiannual cycle that tracks seasonal insolation, in a manner similar to air-temperature fluctuations. Typically, effluent temperatures begin gradually increasing in late-winter (March), peak in late summer (September), decline slightly through November, and then drop relatively quickly during late fall (mid-November through mid-December).

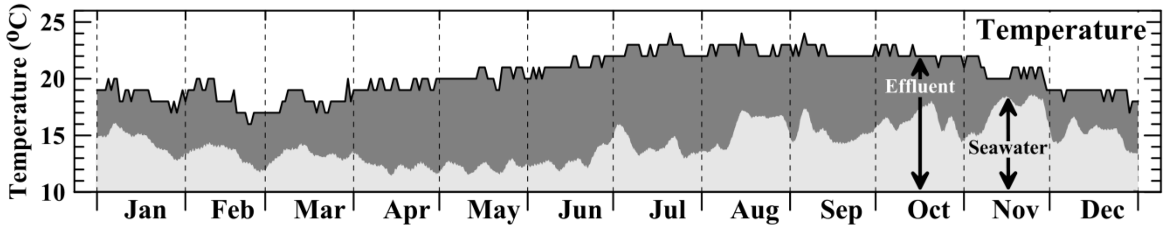

Figure 5.6 Effluent and Receiving-Water Temperature

Because of the strong and sustained influence of upwelling during 2018, seawater temperatures, shown by the light shading, did not track the seasonal-insolation trend seen in effluent temperature. In response to the onset of intense southeastward winds in April, cool deep seawater was brought to the sea surface near the discharge location. Upwelling counteracted the warming effects of solar insolation throughout spring and into early summer, and seawater temperatures were actually lower than winter temperatures during that period.

The difference in timing of insolation and upwelling produced a period of large thermal contrast, which persisted from April through mid-October (dark shading in the Figure). Effluent temperatures were at least 6ºC higher throughout most of this period. However, during May and June, the thermal contrast was much larger. It regularly exceeded 8ºC as onshore surface waters continued to warm while seawater temperature was suppressed by upwelling. This large thermal contrast would normally enhance buoyancy-induced dispersion of the effluent plume significantly. However, upwelling also causes water-column stratification, which can limit vertical movement of the plume and offset the buoyancy-enhanced turbulence to some extent. The strength of upwelling winds began to decline after mid-June and sea-

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[1] Prior to replacement of the probe, the influent pH had a 1.8% CV (coefficient of variation), while the effluent coefficient was 1.1%.

surface temperatures began a slow increase that extended through mid-September. Thus, buoyancy-induced vertical mixing of the discharge plume was greatest during the early summer of 2018 when thermal contrasts were still large and water-column stratification had decreased.

5.6 AMMONIA

The current permit reduced the ammonia sampling frequency from monthly to annually. As a result, only three monthly ammonia measurements were available for analysis in 2018, and all were collected during the first quarter. These three concentrations of ammonia as nitrogen (NH_3-N) ranged between 31 and 46 mg/L. They were comparable to the low concentrations measured historically. In fact, the long history of low ammonia concentrations demonstrated no reasonable potential for ammonia to exceed water-quality objectives, so the ammonia effluent limit was removed from the current permit's discharge requirements. Nevertheless, the prior permit was still in effect during the first two months of 2018 and as expected, all three of the 2018 measurements were well below that permit's discharge limits on ammonia. Specifically, the highest 2018 ammonia concentration (46 mg/L) was a little more than half of the most stringent limit specified in the prior permit, which was 80.4 mg/L for the six-month median.

5.7 RESIDUAL CHLORINE

Total residual chlorine (TRC) quantifies the amount of chlorine remaining in effluent grab samples that are collected after disinfection with sodium hypochlorite and subsequent dechlorination, or buffering, with sodium bisulfite. Effluent grab samples are collected when flow reaches its daily maximum, and concentrations of effluent constituents, as well as hypochlorite and bisulfite dosage, are expected to be at their highest levels. However, the daily TRC concentrations reported during 2018 were all below the 0.05-mg/L detection limit.

Because none of the 364[1] samples collected during 2018 had a detectable concentration of TRC, they easily complied with all the permit limits regardless of averaging period. Namely, even if the actual TRC concentrations in all the 2018 samples were just under the detection limit, they would have to be five-fold higher to approach the six-month median limit of 0.268 mg/L.

The complete absence of detectable TRC concentrations during 2018 resulted from a careful balancing of the complex chlorination and dechlorination processes to obtain adequate disinfection (coliform reduction) without dosing the marine environment with excess chlorine. The complexity arises because chlorine demand is constantly changing due to continuous variations in flow and organic loading within the wastestream. Hypochlorite and bisulfite dose is normally controlled by both total-chlorine-residual and flow-paced pumps that automatically inject precisely measured amounts of these chemicals into the wastestream. However, the disinfection process occasionally requires direct operator intervention on short notice. An auto-dialing alarm system is linked to the process to notify operators by phone immediately upon an unusual excursion in TRC at any time day or night. A narrow range on the alarm points facilitate a quick response, but at the expense of numerous false alarms.

5.8 COLIFORM BACTERIA

The efficacy of the disinfection process is tracked by regular measurements of coliform populations within effluent samples. As part of the NPDES permit provisions, samples collected on five consecutive days each week were analyzed for the most probable number of total coliform organisms per 100 ml

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[1] TRC was not reported in one daily sample. This constituted an exception to the minimum analysis-frequency requirement in the permit and represents the only departure from perfect compliance with the requirements of the monitoring and reporting program during 2018.

(MPN/100 ml). Figure 5.7b shows that when there are detectable coliform populations (black bars), their densities vary widely among individual measurements. WWTP personnel strive to maintain densities at or below the detection limit of 2 MPN/100 ml,[1] and during 2018, over half of the 284 measurements were at or below this detection level (see the inset in Figure 5.7b). Accordingly, the median coliform density for the year was also below the detection threshold and an order-of-magnitude below the 23-MPN/100 ml monthly permit limit (Table 5.1).

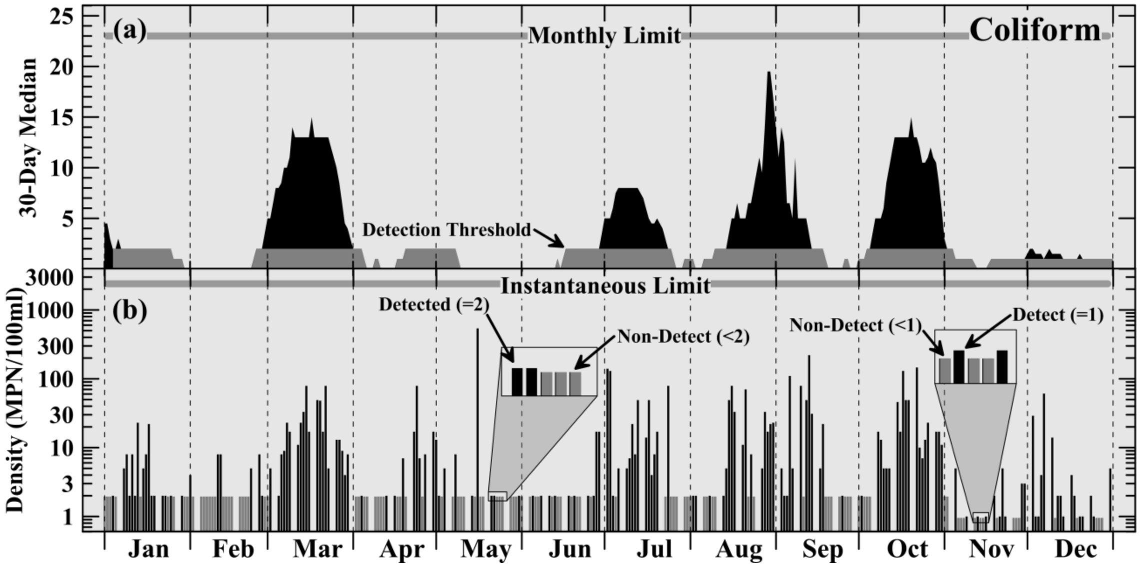

Figure 5.7 Coliform Bacteria

However, due to the complexities of the disinfection process, slightly elevated coliform density is occasionally observed within individual samples. The timing of these unusually elevated densities tends to be randomly distributed, indicating that their occurrence is not related to an ongoing issue with the plant process, or to some external factor. Specifically, the highest population density (540 MPN/100 ml) was measured on May 16th, while the next highest (240 MPN/100 ml) occurred on September 13th. Both of these extrema were less than one-fourth of the 2,400-MPN/100 ml permit limit on instantaneous coliform density (Figure 5.7b[2]).

Additionally, the magnitude of these isolated excursions did not contribute to longer-term trends because those trends were assessed using the 30-day moving median as the central-tendency statistic (Figure 5.7a). Instead, clusters of much smaller, but measurable densities (Figure 5.7b) dictated the timing and magnitude of the four distinct quantifiable excursions in the moving median (black shading in Figure 5.7a). The first of these clusters spans the month of March when a series of intense rainstorms caused wide fluctuations in daily flows that proved more of a challenge for the disinfection process. Similarly, the second cluster in July resulted from processing an increased proportion of sewage-derived wastewater during the summer tourist season, and particularly around the Independence Day Holiday.

The third cluster also occurred during the summer tourist season. It briefly approached the monthly limit of 23-MPN/100 ml when it peaked above 15 MPN/100 ml over a three-day period at the end of August.

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[1] The coliform detection level declined to 1 MPN/100 ml after November.20th.

[2] Note the logarithmic density scale in the figure.

However, this brief excursion was immaterial to the compliance evaluation. By necessity[1], compliance with the 30-day bacterial requirement is evaluated at the end of each month using a 30-day look-back period (Table 5.1). This effectively shifts the clusters shown in Figure 5.7a to the right by 15 days. That shift places the peaks of first and fourth clusters to the end of March and October. Accordingly, the maximum monthly density of 13 MPN/100 ml was reported for both of those months in Table 5.1. Regardless, both the maximum of the moving median and the month-end determinations were well within the long-term discharge limit.

5.9 TOXICITY

During 2018, multiple chronic[2] toxicity tests were conducted on composite effluent samples (Table 5.2). They measured the effluent's potential to impact a variety of marine organisms by exposing those organisms to a range of effluent dilutions in the laboratory. As with bioassays conducted over the prior 25 years, the 2018 results found consistently low effluent toxicity, with levels far less than those allowed by the discharge permit.

Table 5.2 Comparison of Measured Chronic Toxicity Levels with Permit Limits

Sample Dates	Bioassay Test	End Point (%)	Concentration (TUc)	Limit (TUc)
30 January	Red Abalone (*Haliotis rufescens*) Larval Development	5.6	17.9	134
23, 24,& 26 July	Red Abalone (*Haliotis rufescens*) Larval Development	5.6	17.9	134
23, 24,& 26 July	Giant Kelp (*Macrocystis pyrifera*)			
	Kelp Spore Germination	10.	10.0	134
	Kelp Germ Tube Growth	10.	10.0	134
23, 24,& 26 July	Topsmelt (*Atherinops affinis*)			
	Larval Survival	32.	3.12	134
	Larval Growth	32.	3.12	134

Chronic bioassays have historically been conducted using giant kelp zoospores (*Macrocystis pyrifera*). Toxicity screening studies conducted in 1993 indicated that giant kelp 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). Over the following 17 years, MBCSD bioassays repeatedly demonstrated that giant kelp zoospores were only minimally affected by exposure to the treatment plant effluent. As required by the previous discharge permit, however, a new screening study was conducted on effluent samples collected in July 2009 and January 2010. Those screening assays assessed the effluent's effect on the development of larval red abalone (*Haliotis rufescens*) in addition to that of giant kelp. These screening bioassays indicated that larval abalone were slightly more sensitive to MBCSD effluent than kelp zoospores; therefore, subsequent bioassays were conducted using larval abalone, at least through January 2018, when the previous discharge permit was still in effect.

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[1] Retrospective monthly compliance evaluations are required to be submitted after the end of each month and thus cannot include results from samples that are yet to be collected (in the subsequent month). Because the 30-day moving median is centered on each day of interest, it is a more informative measure of the performance of disinfection process because it can be correlated with process changes or external events.

[2] Acute bioassay testing requirements were eliminated in the previous MBCSD discharge permit, in accordance with prior updates to the 2005 COP.

The January 2018 chronic toxicity test results (first line of Table 5.2) measured growth response in larval red abalone after exposure to a range of effluent dilutions (MRS 2018c).[1] The results of the January 2018 abalone bioassay again confirmed that the effluent continued to exhibit low marine toxicity. Both chronic-toxicity endpoints were less than one-seventh of the applicable permit limit 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 abalone were exposed to effluent concentrations as high as 5.6%, whereas the permit allows adverse effects in concentrations as low as 0.75%.

The current permit again required an initial screening study to determine the marine species that is most sensitive to effluent exposure. To that end, three bioassays were conducted in July 2018 (MRS 2018d). They assessed: 1) the development of larval red abalone (*Haliotis rufescens*); 2) the germination of kelp (*Macrocystis pyrifera*) spores and the growth of kelp germ tubes; and 3) the survival and growth of larval topsmelt (*Atherinops affinis)*. Although these organisms are highly sensitive to contaminants, adverse effects were not observed within effluent-seawater mixtures that were at least seven times more concentrated than that allowed by the discharge permit.

The series of three bioassays conducted on the July-2018 effluent samples were substantially more involved than the toxicity assessments performed on MBCSD effluent samples over the prior 25 years. First, the new NPDES discharge permit requires annual testing of three marine species on three separate occasions to determine the most sensitive organism. However, repeating these screening bioassays over the next two years is highly unlikely to yield any additional insight into organism sensitivity, and thus there is no environmental or technical basis for continuing this intensive screening requirement. This is evident from the results of the tests conducted on the July-2018 effluent samples. Namely, larval abalone specimens were found to be significantly more sensitive than the other two test organisms, and the July-2018 abalone test result (17.9 TUc in the second line of Table 5.2) was identical to that measured in the nine prior abalone bioassays conducted over the past 5 years, including the January-2018 toxicity test (first row of Table 5.2).

The second unnecessarily onerous aspect of the new permit's toxicity testing requirement is that dilution and control test waters need to be collected "*from an area of the receiving waters, typically upstream*" of the discharge. Collection of ambient seawater from an offshore location near the outfall involves the mobilization of an offshore survey vessel and immediate vehicle transport of the heavy, iced seawater samples from Morro Bay to the bioassay laboratory in Ventura California. Depending on the timing of the three screening toxicity tests, offshore seawater collection may be required on up-to three separate occasions. Such an effort is unwarranted because, in contrast to discharges to onshore surface waterbodies or within enclosed bays, the receiving waters of the open Pacific Ocean are relatively uniform and there is no advantage to collecting seawater near the outfall, as opposed to seawater collected in the open ocean near the toxicity testing facility (e.g. culture water from the abalone farm's seawater intake). This fact was demonstrated during the July-2018 bioassay when control tests were conducted using pure seawater from three different sources (MRS 2018d). No statistically significant differences were found among the toxicity endpoints from the three control-seawater sources.

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[1] The semiannual effluent reports contain raw test data, pertinent quality assurance/quality control (QA/QC) data, and chains of custody for the chronic bioassays conducted during 2018 (MRS 2018cd).

5.10 NUTRIENTS

During the review process for the prior MBCSD discharge permit, concerns were raised regarding the relative contribution of nutrients discharged to the ocean by coastal treatment plants and their potential role in the promotion of harmful algal blooms (HABs). Because increased human activity and pollution are now thought to be contributing factors to the recently observed increase in the frequency and intensity of HABs, the USEPA proposed a conservation measure for "*Regular monitoring of nutrient loading from the* [MBCSD] *facility's ocean outfall*" in their biological evaluation (USEPA 2007).

Historically, open-ocean dischargers, such as the MBCSD treatment plant, have not been required to monitor for 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) promulgated in the COP. However, in response to the USEPA conservation measure regarding nutrient loading and its potential for HAB stimulation, MRS (2008b) designed and instituted a nutrient-monitoring requirement for the MBCSD effluent monitoring program that included the semiannual analyses of nitrate $[\mathrm{NO_3^-}]$, urea $[\mathrm{CO(NH_2)_2}]$, ortho-phosphate $[\mathrm{(PO_4)^{3-}}]$, and dissolved silica $[\mathrm{SiO_2}]$. These particular compounds were selected because they represent limiting macronutrients for phytoplankton growth within the euphotic zone of the ocean, and have been associated with the stimulation of phytoplankton growth (Kudela and Cochlan 2000). Ammonia $[\mathrm{NH_3}]$ is another nitrogen compound typically associated with phytoplankton growth. However, ammonia concentrations are already regularly measured as part of the MBCSD discharge permit's waste-discharge requirements. RWQCB staff retained the nutrient-monitoring requirement in the current permit because nutrient discharge continues to be a concern along the central California coastal region, where agriculture is a major activity, and where other wastewater treatment plants are required to monitor for nutrients.

HABs occur when periodic explosions of growth in naturally occurring algae result in extensive monoculture blooms of particular species that are harmful to humans and other life. In addition to harm caused through the production of toxins by these species, large phytoplankton blooms can negatively affect the marine ecosystem simply from their accumulated biomass. Historically, processes such as coastal upwelling and river runoff have been implicated as the primary factors that 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). In particular, the upwelling process, which is prevalent within central California coastal waters, has been chiefly implicated in the generation of HABs along the central California coastline (Trainer et al. 2000, Kudela et al. 2005).

However, over the last decade, the extent and duration of phytoplankton blooms have been increasing within the upwelling zones along central and southern California coastlines (Nezlin et al. 2012). Additionally, upwelling alone cannot account for the recent observed distributions, suggesting that anthropogenic nutrient input could be a contributing factor in the stimulation of phytoplankton biomass that promote HABs. Within highly localized nearshore areas adjacent to large wastewater dischargers offshore southern California, nutrient loads within the discharges are comparable to the nutrient flux associated with upwelling (Howard et al. 2014).

In fulfillment of the current permit requirement, nutrient assays of MBCSD effluent were conducted on grab samples collected in January and July 2018. The results were consistent with those of prior years, and demonstrate that nutrient concentrations within the MBCSD effluent, and their mass loading to the marine environment from discharge, are small compared to: 1) other central- and southern-California coastal dischargers, 2) the contribution from regional streams and rivers, and 3) the nitrogen flux from localized upwelling (Table 5.3).

Table 5.3 Nutrient Concentrations and Loading from Central-Coast Ocean Discharges

		Concentration (mg/L)				Mass Emission (kg)			
Source		**Nitrate**	**Urea**	**Phosphate**	**Silica**	**Nitrate**	**Urea**	**Phosphate**	**Silica**
MBCSD	January	<0.01	0.079	0.80	12.0	≈31.	108.	2,130.	15,000.
	July	≈0.04	0.094	2.62	12.0				
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.
Streams and Rivers[1]		3.58	0.021	0.14	25.6	1,660,000.	33,500.	340,000.	25,200,000.
Localized Upwelling[2]		9.53	—	2.0	—	1,818,000.	—	377,000.	—

Although concentrations of urea within MBCSD effluent (≤ 0.094 mg/L) were comparable to those of the three large central-coast WWTP's to the north (≤ 0.110 mg/L), the concentrations of nitrate, phosphate, and silica within MBCSD effluent were all substantially less than those of the other dischargers. The MBCSD nitrate levels, in particular, were two orders of magnitude lower than those of the other WWTP's within the central-coast region. Nitrate and silica concentrations within MBCSD effluent were also less than the average concentrations found within central-coast rivers and streams; although, urea and phosphate concentrations were higher, as was the case for the other central-coast WWTP's.

Irrespective of effluent nutrient concentrations, potential marine bio-stimulatory effects from nutrient discharge are dictated by the total mass nutrient emission contributed by the various sources (right side of Table 5.3). After accounting for the relatively small volume of wastewater discharged by the MBCSD, its total nutrient loading[3] to the marine environment during 2018 was 35-times smaller than any of the three large WWTP's, all of which discharge into the waters of the Monterey Bay National Marine Sanctuary. Similarly, total nutrient loading from the MBCSD discharge was three orders-of-magnitude smaller than the contribution from runoff within the central-coast region. Lastly, and most relevant for evaluating the potential impacts on HAB stimulation, the nitrogen flux from the MBCSD outfall was four orders of magnitude smaller than the flux from the Orange County discharge, which was found to be comparable to that of localized upwelling (last row in Table 5.3).

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[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)

[2] McLaughlin et al. 2017 found that the nitrate volume discharged by the Orange County Sanitation District was comparable to the nitrogen flux from localized upwelling.

[3] Sum of the emissions from the four nutrient compounds listed on the right side of the Table

6.0 CHEMICAL CONSTITUENTS

In addition to the effluent properties and bioassay results described above, 78 chemical contaminants are regulated by the COP, and have their effluent concentrations limited in the discharge permit (SWRCB 2015; RWQCB 2018a). Effluent composite samples were analyzed in January and July 2018 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 human health from exposure to both carcinogenic and noncarcinogenic substances.

As has been the case in the historical record of 3,802 chemical assays spanning 26 years of MBCSD effluent monitoring, the 2018 analyses detected concentrations of only a few ubiquitous compounds at levels well below the regulatory limits (Table 6.1 on the following page). Those compounds are discussed below, while detailed discussions 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 were provided in the semiannual self-monitoring reports (MRS 2018cd).

The chemical assays found only five of the 78 regulated chemical compounds present in quantifiable amounts within the 2018 effluent samples.[1] The measured concentrations for all five compounds were significantly less than the permitted limits. Annual mass emissions of these compounds also met the goals identified in the discharge permit's reporting provisions. The compounds with quantifiable concentrations included three trace metals (copper, lead, and zinc), selenium, and radionuclides.

The analyses also detected the presence of nine additional compounds in the semiannual effluent samples, but at concentrations that were too low for reliable quantification. Specifically, the concentrations of these compounds were higher than the method detection limit (MDL)[2] but less than the minimum reporting level (ML).[3] Reporting of these detected-but-not-quantified concentrations is required under the current NPDES discharge permit; although they are not compared to effluent limits for compliance determinations except when the effluent limit is less than the MDL or ML. In those cases, compliance is indeterminate because the chemical analysis method was incapable of quantifying concentrations down to the effluent limit. Section V.C.3.b of the current permit requires a Pollutant Minimization Program if "*There is evidence showing that the pollutant is present in the effluent above the calculated effluent limitation.*" Such evidence includes a detected compound that has a permit limit less than the MDL. During 2018, fourteen chemical compounds had permit limits below their respective MDL or ML.[4] All were reported as "not detected," and there is no other evidence suggesting that any of the compounds exceeded the effluent limit. Thus, a Pollutant Minimization Program is not needed.

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[1] Quantifiable concentrations are listed in bold typeface in Table 6.1.

[2] 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.

[3] The Minimum Level (ML) for individual chemical compounds are as specified in the COP, and represent the method-specific minimum concentration of a substance that can be reliably measured in a sample given the current analytical performance level achieved by most certified laboratories within California.

[4] The fourteen compounds include: Aldrin, benzidine, bis (2-chloroethyl) ether, chlordane, 3,3-dichlorobenzidine, 1,3-dichloropropene, dieldrin, heptachlor, heptachlor epoxide, hexachlorobenzene, PAH, PCB, toxaphene, and 2,4,6-trichlorophenol

Table 6.1 Chemical Compounds Detected within Effluent Samples

	Concentration (µg/L)			Mass Emission (kg/yr)	
Compound	**Limit**	**January**	**July**	**Goal**	**Measured**
Protection of Marine Aquatic Life					
Arsenic	670.	≈0.97[1]	≈1.6	17.	≈1.68
Chromium VI[2]	270.	<1.2[3]	≈1.6	93.	<1.75
Copper	140.	**11.**	**20.**	690.	**19.3**
Lead	270.	**0.54**	**2.3**	465.	**1.76**
Nickel	670.	≈4.8	≈3.9	142.	≈5.43
Selenium	2,010.	**2.9**	≈1.8	65.	≈2.94
Zinc	1,620.	**41.**	**60.**	244.	**63.**
Cyanide	130.	<1.7	≈2.5	71.	<2.62
Radionuclides (pCi/L) α	15.	—[4]	**0.006**	—	—
Radionuclides (pCi/L) β	50.	—	**13.**	—	—
Protection of Human Health (Non-Carcinogens)					
Chromium III[2]	25,500,000.	—	≈1.6	—	—
Toluene	11,400,000.	—	≈0.57	4.	≈0.71
Protection of Human Health (Carcinogens)					
Beryllium	4.42	—	≈0.99	28.	≈1.24
Chloroform	17,400.	—	≈0.83[5]	5.	≈0.93
1,4-Dichlorobenzene	2,410.	—	≈0.18	57.	≈0.22
Dioxin (pg/L)	0.52	—	≈0.0313	1.48 mg	≈0.039 mg

6.1 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 within the local sedimentary environment, including the marine sediments within Estero Bay. Accordingly, all three of the metals were detected in quantifiable amounts within seafloor sediment samples collected at all the benthic survey stations, including the distant Reference Station B1 (MRS 2019). These metals enter the wastewater collection system through erosion of natural mineral deposits along the central California coast as well as through corrosion of household plumbing systems. Regardless of their source, the effluent metal concentrations were at most one-seventh of levels deemed deleterious to marine organisms, and the highest metal emission was one-fourth of the emission goal recommended in the discharge permit.

These three metals have been detected at quantifiable levels in more than half of the effluent samples collected during the last 26 years; therefore, they do not represent a new or increased source of

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[1] The "*approximation*" symbol (≈) indicates that the detected concentration, designated with an "*as estimated*" qualifier, was too low to be reliably quantified, namely, it was below the prescribed Minimum concentration Level (ML). Accurately quantified "*as measured*" concentrations are indicated by bold typeface.

[2] The total chromium concentration is reported instead of the trivalent or hexavalent oxidation states alone.

[3] The "*less-than*" symbol (<) indicates that the substance was not detected at a concentration above the MDL, which is listed after the "<" symbol.

[4] The "*dash*" symbol (—) indicates that analysis of the compound was not required as part of the monitoring program, or that a mass-emission goal was not specified in the discharge permit.

[5] The reported concentration was above the PQL and accordingly, was not identified "*as estimated*" by the chemistry laboratory. However, in accordance with the guidance from the COP and the NPDES permit, the reported value is listed here as an estimated concentration because the measured value was below the 2.0-µg/L chloroform ML.

contaminants entering the collection system. Moreover, statistical analyses of the long monitoring history unequivocally demonstrate that there is no reasonable potential for these effluent metal concentrations to exceed discharge permit limits.

6.2 SELENIUM

Selenium, a naturally occurring metalloid within the mineralogy of the central California coast, was also detected within the 2018 effluent samples. Selenium concentrations have been found to increase slightly within MBCSD effluent samples when these naturally occurring compounds are mobilized within surficial soils following rainstorms. Rainwater inflow into the collection system from the storms that preceded the effluent sample collection on January 30th (refer to Figure 4.1 on Page 4-1) may account for the increased presence of quantifiable concentrations found in that sample. Conversely, the absence of measureable rainfall prior to the July sampling event resulted in a lower (unquantifiable) selenium concentration. Regardless of its source, the selenium concentrations found in the 2018 effluent samples were two orders of magnitude below levels deemed deleterious to marine organisms, which are encapsulated in its permit limit.

6.3 RADIONUCLIDES

As with the trace metals and metalloids described above, the presence of measurable alpha (α) and beta (β) radioactivity within the MBCSD effluent samples is commonplace. The regular detection of radionuclides within MBCSD effluent samples arises 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.

Permit limits for other constituents are based on their potential for adverse impacts after discharge. As such, they incorporate an allowance for the 133-fold minimum dilution that occurs immediately after discharge. Limits on radioactivity, however, are based on the California Code of Regulations, Title 22, §64441 and §64443, and are the same as those established for drinking water. Thus, they do not account for post-discharge dilution. Regardless of their origin, the levels of radioactivity measured within the July 2018 effluent sample were well within drinking-water standards.

The low decay levels measured within the July 2018 effluent samples were typical of most prior effluent samples and of naturally occurring sediments within 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.

7.0 BIOSOLIDS

The monitoring and reporting requirements of the current NPDES permit (RWQCB 2018a) stipulate characterization of biosolids in accordance with 40 CFR 503 (USGPO 1997b). To that end, a complete description of sludge production and disposal activities covering 2018 was submitted by the MBCSD to the USEPA, RWQCB, and SLO EHS (MBCSD 2019b). That letter-report and its eight attachments are incorporated in this annual monitoring report by reference. The disposition of the 104 dry metric tons of biosolids generated by the WWTP between November 2017 and October 2018 is briefly summarized in this Chapter. This Chapter also discusses the major chemical compounds that were found within the biosolids produced by the plant, because they lend insight into the performance of the WWTP and because they determine the suitability of biosolids for composting and land application (MRS 2018e).

7.1 SOLIDS TREATMENT PROCESS

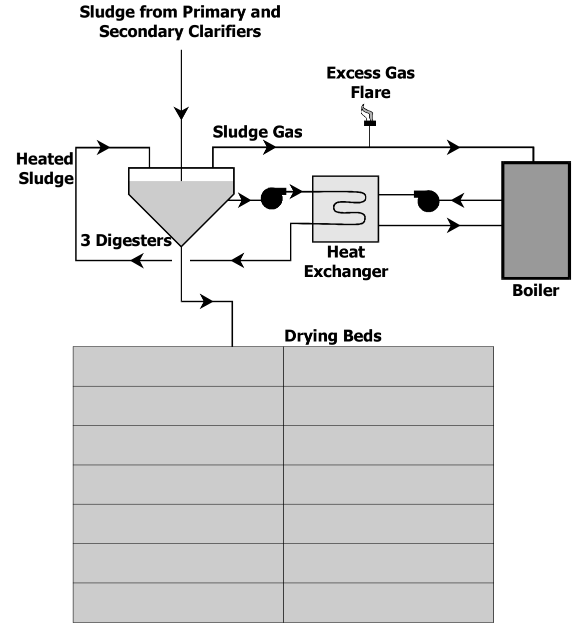


Figure 7.1 Biosolids Process Schematic

Solids removed by the clarifiers (Figure 3.3 on Page 3-11) are processed as shown in the schematic of Figure 7.1. Sludge is stabilized within two mixed-primary digesters that heat the sludge to temperatures between 95°F and 98°F (35°C to 37°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 sludge is transferred to solar drying beds. The primary digesters' capacities are 170,544 gallons and 191,500 gallons, and the secondary digester's capacity is 166,056 gallons, giving a total capacity of 528,100 gallons (2 megaL).

Stabilized sludge drawn from the secondary digester was transferred to one of 12 sludge-drying beds. Each of these 5,200 ft^2 (483 m^2) beds has an under-drain and decanting system that recirculates runoff through the treatment process. Once dried, the biosolids were removed from the beds and stored in a concrete containment area that also drained rainfall runoff through the treatment system. Biosolids were stored in this area until they were removed from the WWTP. Biosolids storage times are generally less than one year.

On October 25th and 26th, all 104 tons of biosolids in storage the WWTP were hauled to the Liberty Composting Facility, which operates under Solid Waste Information System Permit No. 15-AA-0287. The biosolids transferred to the Liberty Composting Facility were used for soil amendment after composting was completed at the facility. Prior to shipping, the MBCSD provided a Title 22 Certification for Non-hazardous Materials and a Class-B biosolid certification statement based in part on the chemical analyses described below.

7.2 CHEMICAL COMPOUNDS

In compliance with the Monitoring and Reporting Program, chemical analyses were conducted on a composite of biosolid samples collected from the drying beds on 29 August 2018. Those beds contained all the biosolids that were ready for shipment from the WWTP at the time. The full laboratory results, including chains of custody, instrument calibration reports, and analyses of method blanks and spikes, were reported by MRS (2018e). They are compared with regulatory limits in Table 7.1.

The data in the table show that biosolid contaminant concentrations were significantly less than regulatory thresholds that would designate them as hazardous, or that would 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 a few compounds were detected, primarily naturally occurring trace metals.

All trace-metal concentrations were below the total threshold limit concentrations (TTLC) that would designate the biosolids as hazardous. Dry-weight concentrations for all detected metals in the biosolid sample were well below the federally mandated thresholds, including the monthly limit for materials suitable for agricultural land application (as represented in the three right-most columns of Table 7.1). The other compounds listed in Table 7.1 further characterize the biosolids, as mandated in the waste discharge requirements. Additionally, a modified WET test (STLC) for Hexavalent chromium and total dissolved solids was conducted in response to a request from the composter.

Table 7.1. 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	%	89.7	—[6]	—	—	—	—	—
Cyanide	ppm	4.4	—	—	—	4.9	—	—
Antimony	ppm	≈3.5[7]	—	15.	500.	≈3.9	—	—
Arsenic	ppm	≈1.0	—	5.	500.	≈1.2	41.	75.
Barium	ppm	130.	—	100.	10,000.	150.	—	—
Beryllium	ppm	ND	—	0.75	75.	ND	—	—
Boron	ppm	14.	—	—	—	16.	—	—
Cadmium	ppm	1.6	—	1.	100.	1.7	39.	85.
Chromium (Total)	ppm	32.	—	560.	2,500.	36.	1,200.	3,000.
Chromium (Hexavalent)	ppm	≈0.37	ND	5.	500.	≈0.41	—	—
Cobalt	ppm	≈2.4	—	80.	8,000.	≈2.7	—	—
Copper	ppm	320.	8.3	25.	2,500.	350.	1,500.	4,300.
Lead	ppm	19.	—	5.	1,000.	21.	300.	840.
Mercury	ppm	0.84	—	0.2	20.	0.93	17.	57.
Molybdenum	ppm	12.	—	350.	3,500.	13.	18.	75.
Nickel	ppm	22.	—	20.	2,000.	24.	420.	420.
Selenium	ppm	3.5	—	1.	100.	3.9	36.	100.
Silver	ppm	2.0	—	5.	500.	2.2	—	—
Thallium	ppm	ND	—	7.	700.	ND	—	—
Vanadium	ppm	14.	—	24.	2,400.	16.	—	—
Zinc	ppm	870.	—	250.	5,000.	970.	2,800.	7,500.
Methylene chloride	ppm	0.019	—	—	—	0.022	—	—
Hydrogen-Ion	pH	6.19	—	—	—	—	—	—
Phosphate	ppm	71,000.	—	—	—	79,000.	—	—
Ammonia	ppm	6,900.	—	—	—	7,600.	—	—
TKN	ppm	36,000.	—	—	—	40,000.	—	—
Organic Nitrogen	ppm	29,100.	—	—	—	32,400.	—	—
Nitrate as NO_3	ppm	870.	—	—	—	970.	—	—
Oil & Grease	ppm	55,000.	—	—	—	61,000.	—	—
Total Dissolved Solids	ppm	—	5,400.	—	—	—	—	—

[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 10 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] "—" indicates that the measurement was not required or its limit was 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 minimum level (ML) but above the method detection limit (MDL).

8.0 REFERENCES

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.

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.

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.

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.

Diaz, R.J. and R. Rosenberg. 1995. Marine benthic hypoxia: A review of its ecological effects and the behavioral responses of benthic macrofauna. Oceanography and Marine Biology Annual Review 33:245-303.

Hewson, I. *et al.* 2014. "Densovirus Associated with Sea-Star Wasting Disease and Mass Mortality." Proceedings of the National Academy of Sciences of the United States of America 111.48 (2014): 17278–17283.

Howard, M.D.A., M. Sutula, D.A. Caron, Y. Chao, J.D. Farrara, H. Frenzel, B. Jones, G. Robertson, K. McLaughlin, and A. Sengupta. 2014. Anthropogenic nutrient sources rival natural sources on small scales in the coastal waters of the southern California bight. Limnol. Oceanogr. 59: 285-297.

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

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.

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**). 1997. 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**). 2006. 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**). 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**). 2016. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2015 Annual Report. Submitted 29 March 2016 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.

Marine Research Specialists (**MRS**). 2017. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2016 Annual Report. Submitted 31 March 2017 to the City of Morro Bay and Cayucos Sanitary District, Morro Bay, CA.

Marine Research Specialists (**MRS**). 2018a. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, First Quarter Receiving-Water Survey, March 2018. Submitted 26 April 2018.

Marine Research Specialists (**MRS**). 2018b. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2017 Annual Report. Submitted 30 March 2018.

Marine Research Specialists (**MRS**). 2018c. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Semiannual Effluent Sampling Chemical and Bioassay Analysis Results, January 2018. Submitted 19 February 2018.

Marine Research Specialists (**MRS**). 2018d. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, Semiannual Effluent Sampling Chemical and Bioassay Analysis Results, July 2018. Submitted 15 August 2018.

Marine Research Specialists (**MRS**). 2018e. Offshore Monitoring and Reporting Program Residual Biosolids Chemical Analysis Results, August 2018. Submitted 20 September 2018.

Marine Research Specialists (**MRS**). 2019. City of Morro Bay and Cayucos Sanitary District, Offshore Monitoring and Reporting Program, 2018 Benthic Report, February 2019. Submitted 1 February 2019.

McLaughlin, K., N.P. Nezlin, M.D.A. Howard, C.D.A. Beck, R.M. Kudela, M. Mengel, and G.L. Robertson. 2017. Rapid nitrification of wastewater ammonium near coastal ocean outfalls, Southern California, USA. Estuar. Coast. Shelf Sci. 186: 263-275.

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 *Toxomplasma gondii* infection of southern sea otters (*Enhydra lutris nereis*). International Journal for Parasitology 32(2002) 997-1066.

[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**). 2018. The City of Morro Bay-Cayucos Wastewater Treatment Plant Monthly Monitoring Report; May 2018 Monitoring Form submitted to CIWQS 20 June 2018; CIWQS ID: 2009428.

[City of] Morro Bay and Cayucos Sanitary District (**MBCSD**). 2019a. Morro Bay/Cayucos Wastewater Treatment Plant Time Schedule Order No. R3-2018-0019 Fourth Quarter Progress Report. Prepared by Carollo Engineers. 30 January 2019.

[City of] Morro Bay and Cayucos Sanitary District (**MBCSD**). 2019b. Morro Bay/Cayucos Wastewater Treatment Plant 2018 Annual Sewage Sludge Report. Letter to M. Robinson of the California Regional Water Quality Control Board, Central Coast Region from J. Gunderlock, Wastewater Treatment & Collections System Supervisor, MBCSD. 1 February 2019.

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.

National Oceanic and Atmospheric Administration (**NOAA**). 1991. 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 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.

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."

Nezlin, N., M.A. Sutula, R.P. Stumpf, and A. Sengupta. 2012. Phytoplankton blooms detected by seawifs along the central and southern California coast. J. Geophsical Res. 117: C07004.

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+appendicies.

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. **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. **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.

Regional Water Quality Control Board (**RWQCB**) - Central Coast Region. **2018a**. Waste Discharge Requirements (Order No. R3-2017-0050) and National Pollutant Discharge Elimination System (Permit No. CA0047881) for the Morro Bay and Cayucos Wastewater Treatment Plant Discharge to the Pacific Ocean, Morro Bay, San Luis Obispo County. Effective 1 March 2018.

Regional Water Quality Control Board (**RWQCB**) - Central Coast Region. **2018b**. Time Schedule Order No. R3-2018-0019 requiring the City of Morro Bay and Cayucos Sanitary District to comply with the requirements prescribed in National Pollutant Discharge Elimination System Permit No. CA0047881, Order No. R3-2017-0050 as renewed or revised. Dated 27 June 2018.

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.

Smith, A.L. 1981. Comparison of Macrofaunal Invertebrates in Sand Dollar (*Dendraster excentricus*) Beds and in Adjacent Areas Free of Sand Dollars. Marine Biology 65, 191-198.

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**). 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**). 2015. Water Quality Control Plan Ocean Waters of California. California Environmental Protection Agency. Effective 28 January 2016. cop2015.pdf [Accessed 31 January 2019].

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.

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.

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. 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.

Appendix A WWTP Specifications

Parameter	Quantity
Waste Loading	
Flow (MGD)	
Average dry-weather flow	2.06
PSDWF	2.36
Peak dry-weather flow	6.64
PWWF	6.60
Strength	
BOD$_5$ (mg/L)	280
Suspended solids (mg/L)	280
Grit (ft^3/mg)	10
Waste quantities at PSDWF	
BOD$_5$ (mt/day)	2.5
Suspended Solids (mt/day)	2.5
Grit (ft^3/day)	23.6
Preliminary Treatment	
Mechanically Cleaned Bar Screen	
Number	1
Capacity (MGD)	8.2
Channel Monster	
Number	1
Capacity (MGD)	7.0
Influent Pumps (variable speed)	
Number	3
Capacity each (MGD)	3.3
Total head (m)	9.6
Aerated Grit-Removal Tanks	
Number	1
Length (m)	9.1
Width (m)	4.9
Depth (m)	2.4
Detention time at PWWF (min)	6.3
Grit Pumps	
Number	2
Capacity (gpm)	250
Primary Treatment	
Sedimentation Tanks	
Number	2
Diameter (m)	
Tank 1	15.2
Tank 2	12.2
Average side water depth (m)	
Tank 1	2.74
Tank 2	2.74
Surface loading rate PSDWF (10^3 L/m^2/day)	29.74
Detention time at PWWF (hr.)	2.2
Total Treatment	
Overall treatment efficiencies (%)	
BOD$_5$	57
Suspended solids	75
Expected effluent quality (mg/L)	
BOD$_5$	120
Suspended solids	70
Solids stabilization	
Anaerobic digester loading (mt/day)	
Primary solids	1.6
Secondary solids	0.4
Assumed sludge volatile content (%)	
Primary solids	70
Secondary solids	82
Sludge volume (m^3/day)	50.7
Digester 1 (existing, fixed cover)	
Diameter (m)	12.2
Side water depth (m)	4.9
Volume (m^3)	629
Digester 2 (existing, fixed cover)	
Diameter (m)	12.2
Side water depth (m)	5.8
Volume (m^3)	725
Digester 3 (new, floating cover)	
Diameter (m)	10.7
Side water depth (m)	6.9
Volume (m^3)	646
Hydraulic detention time based on net volume of digesters 2 and 3 (days)	23
Assumed volatile solids reduction (%)	55
Expected sludge gas production (m^3/day)	804
Sludge Drying Beds	
Number	12
Length each (m)	49.4
Width each (m)	9.8
Solids Loadings (kg ft^{-1} yr^{-1})	78.3

Parameter	Quantity
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
Stand-by (2-speed)	
Capacity (gpm)	960 1660
Total head (m)	3.4 4.4

Parameter	Quantity
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

Morro Bay/Cayucos Wastewater Treatment Plant

Outfall/Diffuser Annual Report

Name of Discharger: MBCSD

NPDES Permit Number: R3-2017-0050

Name of Diver/Inspector: Zeke Porter / Craig Porter

Firm & Address: 15730 morro Rd Atascadero CA 93442

Telephone Number: (805) 674 - 6702

Outfall Length: 5160 Feet Depth of Water: 50' Feet

Design of Diffuser (physical dimensions, shape, include sketch):

Number of Ports: 34 Number Ports Open: 28 Diffuser Level? 5"-32"

End of Diffuser Open? ___ Closed? ✓

Outfall Marked by Bouys? Yes: X No: ___ Type: SPAr (2)

Diffusers Operating as Designed? Yes: X No: ___

Breaks in Outfall Line Noted? Yes: ___ No: X if yes, describe

Describe Problems Noted: NONE

Corrected Action Needed: Replace SPar Bouys and attachments

Physical Description of Environment Around Outfall (i.e. fish noted, debris, sediment, etc.):

Fish, Sand Dollars, ANENOMES, Starfish

Direction of Plume in Relationship to Shoreline: NO Visible plume Noted at surface of water

Pictures Taken? Yes: ✓ VIDEO No: ___ (Include copies if taken)

Signature of Diver/Inspection

Date 11/8/2018

E Craig Porter

Signature of ~~Diver/Inspection~~ Diving Superintendent

Date 11/8/2018

\\WWTP3\Files\AA-Update O & M Manual\O & M Update Emergency Notifications & Forms Binder\O & M Update Forms MCC-A Admin\Outfall Inspection Report Form\Outfall Inspection Report Form

Appendix C

Date: April 13, 2018

California Regional Water Quality Control Board
Central Coast Region
Attn: Monitoring and Reporting Review Section
895 Aerovista Place, Suite 101
San Luis Obispo, CA 93401

Dear Mr. Robertson:

Facility Name: Morro Bay/Cayucos Sanitary District
Wastewater Treatment Plant

Address: 955 Shasta Avenue
Morro Bay, CA 93442

Contact Person: Mr. John Gunderlock
Job Title: Wastewater/Collections Supervisor
Phone Number: 805.772.6272

WDR/NPDES Order Number: Order No. R3-2017-0050
WDID Number 3400103001

Type of Report (circle one): [✓ **Monthly**] **Quarterly** **Semi-Annual** **Annual**

Month(s) (circle applicable months*):
JAN **FEB** [✓ **MAR**] **APR** **MAY** **JUN**
JUL **AUG** **SEP** **OCT** **NOV** **DEC**

***Annual Reports** (circle the first month of the reporting period)

Year: 2018

Violation(s) (Place an X by the appropriate choice): X **No** (there are no violations to report) ____ **Yes**

If Yes is marked (complete a-g):

a) Parameter(s) in Violation:

b) Section(s) of WDR/NPDES Violated:

c) Reported Value(s)

d) WDR/NPDES Limit/Condition:

e) Dates of Violation(s)
(reference page of report/data sheet):

f) Explanation of Cause(s):
(attach additional information as needed)

g) Corrective Action(s):
(attach additional information as needed)

On March 21st and 22nd a heavy rain event of 4.8 inches caused surcharging of the influent line and influent flow metering parshal flume. As reported in the CIWQS database, the totalized influent flow meter recorded values of 5.017 MGD on March 21st and 3.104 MGD on the 22nd. Plant operations staff recognize that the influent line and meter were surcharged for periods of time during these two days and as such, staff analyzed and compared flow rates throughout the month. All flow totals reported seem reasonably except the 5.017 MGD and 3.104 MGD on March 21st and 22nd, which appears to be significantly over totalized. Computations performed by Douglas A. Coats, Ph.D. of Marine Research Specialists indicate that the total daily flow on **21 March 2018** was close to **3.5 MG**, and on **22 March 2018**, it was **2.5 MG**. These values incorporate 1.5 MGD of baseline flow each day, and 3 MG of inflow to the collection system resulting from 4.8 inches of rainfall from the two-day storm that arrived during that time.

Douglas Coats based his computation on the following:

1) Rainwater inflow computations provided an overall estimate of flow into the collection system during the storm period.
    a) On average, 0.63 MG of rainwater flows into the plant for each inch of rain that falls within the collection-system's watershed.
        i) This is based on an analysis of inflow during 14 storm events that have impinged on the collection system in the past.
        ii) Thus, the 4.8 inches of rainfall recorded from 20 March thru 22 March would be expected to generate an additional 3.0 MG of plant throughput over the two days in question.

- b) The baseline plant flow rate was determined to be 1.5 MGD from reliable flow measurements recorded in the days following the storm
  - i) This baseline flow rate incorporates the longer-term influence of groundwater infiltration from an elevated water table but excludes direct short-term inflow influences from rainwater inflow.
- 2) Accurate flow measurements recorded during portions of 21 and 22 March 2018 established proportional allocation of rainwater inflow between the two days in question.
  - a) Significant portions of the high-sampling frequency measurements made on the two days were found to be reliable.
    - i) Both meters recorded similar flow data over the initial 10.6 hours of 21 March, and over the last 19.3 hours of 22 March
      - (1) During those times, the influent flume did not appear to be surcharged and the effluent meter was operational (not pegged at its maximum reading).
  - b) These flow measurements accounted for 1 MG of plant throughput on the 21st, and 1.6 MG on the 22nd, for a total of 2.6 MG over the two days in question.
    - i) This left approximately 3.4 MG flow unaccounted for from the 6 MG flow determined for the two days combined:
      - (1) 1.5 MG baseline on both the 21st and 22nd plus the 3 MG from rainwater inflow.
  - c) The 3.4 MG was allocated between the two days based on the data-gap durations on the two days:
    - i) 13.4 hours (74% of gap=2.5 MG) on the 21st; and 4.7 hours (26%=0.9 MG) on the 22nd.
  - d) Adding the gap allocations to the measured flows yields the estimates of daily plant throughput:
    - i) For the **21st** (1.0 MG + 2.5 MG = **3.5 MGD**),
    - ii) and the **22nd** (1.6 MG + 0.9 MG = **2.5 MGD**)

In accordance with the Standard Provisions and Reporting Requirements, I certify under penalty of law that this document and all attachments were prepared under my direction or supervision following a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my knowledge of the person(s) who manage the system, or those directly responsible for data gathering, 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.

If you have any questions or require additional information, please contact me at the number provided above.

Sincerely,

4/13/18

Name: Mr. John Gunderlock
Title: Wastewater Treatment/Collections
System Supervisor

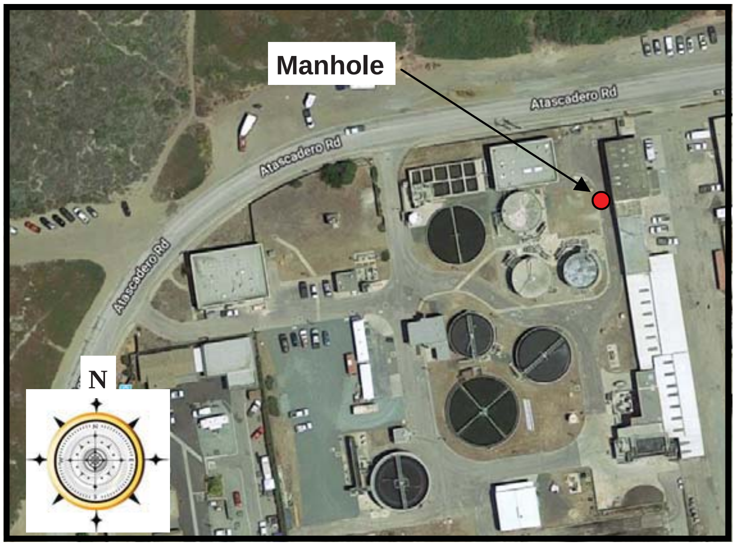
Appendix D

Morro Bay WWTP - 27” Influent Palmer Bowlus

MH Location: **Morro Bay**
Wastewater Treatment Plant
160 Atascadero Road
Morro Bay, CA 93442

Pipe Size: **30”**

Time Period: **12-8-2018, 8:00 - 11:30 a.m.**



Transducer in Manhole

Flow Meter

Site/Vault Condition

- 30” influent line transitions into a 27” Palmer Bowlus flume with a drop on the effluent into a 30” line. This system does very well at preventing a downstream surcharge.
- Influent flow is laminar with very little turbulence.
- There was approximately 2 inches of silt and rocks on the influent side of the flume. Before the calibration this was jetted, the jetting did not remove all of the sand and rock.
- It was noted that there had been a back-up inside of the flume manhole due to high water marks and debris on the ladder and fiberglass grate.

Siemens LUT 430 flow meter with an XRS-5 ultrasonic transducer.

- Transmitter is mounted inside of a NEMA 4X cabinet.
- Conduit into cabinet has been sealed with silicone to help prevent H2S intrusion
- Cable and wiring penetrations into the LUT were open, all wiring was removed, wire ferrules and cord grips were installed to help prevent H2S intrusion and for good wire connections.
- A Hobo 4 channel data logger is connected to this meter to log all flow data.

Gold Coast Environmental

1868 Palma Drive, Suite I, Ventura, CA 93003 www.goldcoastenv.com O: 805.498.3811

FLOW MONITORING SYSTEM CALIBRATION CERTIFICATE

Company Name: Morro Bay Wastewater Treatment Facility **I.W. Permit #:**

Discharge/Calibration Address: 160 Atascadero Drive, Morro Bay, CA

Mailing Address:

Service Date: 12-3-18 **Time:** 9:00 **Expires:** 12-3-19 **Calibration Type:** Hydraulic ____ Instrument: X

Open Channel: X **Closed Pressurized Pipe:** ___ **Influent Pipe Size:** 30" **Effluent Pipe Size:** 30"

Primary Measuring Device

Manufacturer: American Sigma **Weir: Type & Size:**

Flume: Parshall ____ **Palmer-Bowlus** 27" **Trapezoidal** ____ **Cut Throat:** ____ **Other**

Flume Depth – Top of Flume to Top of M.H.: 11'-6" **Max. Head:** 21" **Flow at Max Head:** 7083.333

Instrument Information: Secondary Device

GPS Coordinates: 35.3797, -120.8604

Manufacturer: Siemens Hydroranger 200 HMI **Serial Number:** PBD/FO190143

Meter Type: Bubbler ____ **Ultrasonic** X **Electromagnetic** ____ **Area Velocity** ____

Transducer Height: 40.125" **Blanking Distance:** 11.8" **Recorder 100% Span** 7083.333 **GPM**

Totalizer on Arrival 9156072 **Totalizer on Departure** 9156917 **Totalizer Multiplier** x100

Sampling Signal Contact Closure Frequency: 1 Closure per n/a **Gallons Discharged**

Flow Rate and Level On Arrival: 759 GPM @ 6.3" **Flow Rate and Level On Departure:** 600 GPM @ 5.8"

CALIBRATING SYSTEM		EXISTING METER				ERROR	
Head in Inches	GPM	Instrument Head in Inches	Flow Rate GPM Indicator Recorder		Total Discharge Gallons	Recorder (Level)	Totalizer (Flow)
0	0	0	0		0	0	0
6"	674.6	5.9"	685			1.681%	1.529%
9"	1371	8.9"	1396			1.117%	1.807%
12"	2344	12.0"	2389			0.00%	1.902%
18"	5197	18.0"	5232			0.00%	0.671%

Method of Calibration: Manhole was entered to measure the distance to the bottom of the flume underneath the transducer, the offset to the zero plain was then measured at a 4.125" offset. The transducer was then removed from the mount above the flume and placed on an ultrasonic calibration stand. The above chart shows the various levels the meter was tested/calibrated too. At 6.00" the meter was displaying 5.625", the meter was calibrated to read 6.0". There were no further adjustments required.

Corrective Measures: Most 27" Palmer Bowlus flumes have a 3.5" offset, this particular flume has a 4.125" offset to zero. During the first calibration we did we did not use the 4.125" offset, therefore this resulted in a bad calibration. A second calibration was performed a week later and the flume was then manually measured to confirm the difference, and it was measured at 4.125". Once this was taken into consideration the level in the meter matched the measured level. The result of this adjustment decreased the previous weeks flow rate by 288,000 GPD.

Signature: