Appendix D

Santa Monica Bay Shoreline Monitoring Municipal Separate Storm Sewer System (MS4) Report(2006-07)

SANTA MONICA BAY SHORELINE MONITORING
MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) REPORT
(July 1, 2006 – June 30, 2007)
Monitoring and Assessment by the City of Los Angeles Environmental Monitoring Division

I. INTRODUCTION

Santa Monica Bay (SMB) plays a very important part in Southern California's recreation, tourism, and commercial economy, but for decades it has been used as a repository for point and non-point source discharges. These discharges include those from wastewater treatment plants, storm drains, rivers, and creeks. Major concerns regarding the effects of these discharges on the natural environment, recreation, and other beneficial uses of the Bay, in addition to public health, led to the regulation of treatment plant discharges. Because of effluent discharge from the Hyperion Treatment Plant (HTP) into Santa Monica Bay waters, the City of Los Angeles (CLA) has been monitoring Santa Monica Bay shoreline water since the late 1940's. Historic water quality monitoring data has indicated that Hyperion's discharge has no discernible impact on the water quality of the SMB shoreline. Instead, test results suggest that runoff to the Bay originating inland and reaching the Bay via storm drains (particularly during periods of heavy rainfall), sewage spills, and illicit discharges, is an important source of contamination (CLA, EMD 2005).

Urban runoff, which mainly originates from rainfall and street runoff (Dojiri et al., 2003) and reaches Santa Monica Bay through approximately 200 outlets, is the largest nonpoint source of pollution to Santa Monica Bay. Street runoff can result from irrigation, domestic, commercial, and industrial activities. It has been estimated that Santa Monica Bay receives a flow of 10-25 million gallons per day from storm drains during dry weather (SMBRP 1996). During rain events, the concentrations of pollutants (heavy metals, human and animal wastes, petroleum- and automobile-based chemicals) are more dilute, but the mass loading is much larger due to wash-down effects of the rain on the surrounding urban environment.

The City of Los Angeles has taken numerous actions to improve water quality in Santa Monica Bay. The CLA collaborated with the City of Santa Monica on the Santa Monica Urban Runoff Recycling Facility (SMURRF), which processes 500,000 gallons of runoff per day during dry weather. Additionally, the City of Los Angeles's Watershed Protection Division has employed Low-Flow Diversion systems to direct flows from major storm drains to HTP during dry weather. Also, the City's Environmental Monitoring Division (EMD) provided co-leadership and proactive participation in drafting the Coordinated Shoreline Monitoring Plan for the state and federally mandated Santa Monica Bay Beaches Bacterial Total Maximum Daily Load (SMBBB TMDL) program. The SMBBB TMDLs, which became effective July 2003, have stringent compliance requirements for Santa Monica Bay shoreline storm drains. Based on daily monitoring, the summer and winter dry-weather SMBBB TMDLs allow for zero and up to three annual exceedences of AB 411 standards, respectively. Compliance must be obtained within three years for the summer dry-weather period and within six years for winter dry-weather. The wet-weather portion, which allows for up to seventeen annual exceedances, must be met within eighteen years. The implementation of the coordinated monitoring plan began in November 2004. With the approval from the Regional Water Quality Control Board (RWQCB), the shoreline monitoring requirements under the SMBBB TMDL were incorporated into the Municipal Separate Storm Water Sewer System (MS4) permit to promote consistency of the monitoring programs and to conserve resources and staffing, while improving compliance monitoring and protecting public health.

The following changes in the MS4 monitoring program became effective in November 2004:

- Sampling locations moved from 50 yards from storm drains to point zero.
- Monitoring frequency decreased from seven to six days per week.
- Frequency of enterococcus testing changed from five times per month to five days per week.
- Enterococcus testing method changed from membrane filtration to the chromogenic substrate method.
- In July 2005, monitoring frequency for nine stations was reduced to 5 days per week.
- In July 2005, monitoring frequency for nine stations was reduced to weekly.

This report summarizes the City of Los Angeles EMD's Santa Monica Bay shoreline bacteriological data for the Fiscal Year 2006-2007 (July 1, 2006 to June 30, 2007). The bacteriological data consists of bacterial densities for three groups of indicator bacteria. These indicator groups are the total coliforms, fecal coliforms/*E. coli*, and the enterococci. Their presence in water, especially fecal coliforms/*E. coli* and enterococci, is an indicator of recent fecal contamination, which is the major source of many waterborne diseases (Csuros and Csuros 1999). Monitoring indicator bacteria is currently one of the most efficient means of predicting the presence pathogen in marine water.

EMD prepares the daily shoreline report and evaluates the data relative to the California State AB411 bathing water quality standards for bacterial densities (Table 1). The Santa Monica Bay shoreline bacterial data are then reported to the Los Angeles County Department of Health Services (LACDHS). Subsequently, LACDHS takes steps (such as posting health hazard warning signs for beach users) to notify beach goers when an exceedance of bacterial standards occurs.

Table 1. AB411 Bathing Standards

Density of bacteria in a single sample shall not exceed:

- 10,000 total coliform bacteria/100 ml; or
- 400 fecal coliform bacteria/100 ml; or
- 104 enterococcus bacteria/100 ml; or
- 1,000 total coliform bacteria/100 ml, if the ratio of fecal/total coliform exceeds 0.1

Current indicator bacterial quantification methods depend on incubation and growth of bacteria in the laboratory. Results are presently obtained approximately 18 to 24 hours after sample collection, thus preventing early notification of public health and contamination source identifications. Beginning in November 2004, the chromogenic substrate method was used for all SMB shoreline indicator bacterial quantification, including enterococcus, which had previously been quantified using membrane filtration, an analytical method that took 48 hours to complete. The City also participated in the Southern California Coastal Water Research Project Rapid Indicator Detection Methods Study to develop newer methods that can provide results faster.

II. MATERIALS AND METHODS

A. SAMPLE COLLECTION

Geographically, EMD monitors 18 SMB shoreline stations ranging from Surfrider Beach (S1, Malibu Lagoon) in Malibu southward to Malaga Cove (S18) in Palos Verdes Estates (Figure 1). On November 1, 2004, the City of Los Angeles participated in the Coordinated Shoreline Monitoring Plan (CSMP) for the Santa Monica Bay Beaches Bacterial TMDLs. Some TMDL monitoring requirements were incorporated into the MS4 permit, and as a result, the monitoring frequency of nine stations, S3, S8, S11 through S15, S17, and S18, was reduced from seven days to one day per week. The monitoring frequency of the remaining nine stations, S1, S2, S4 through S7, S9, S10, and S16, was changed from seven to five days per week. All shoreline stations were sampled at point zero, which is defined as the point at which the discharge from a storm drain or creek initially mixes with the receiving water. A station having no storm drain or creek associated with it is referred to as an open beach site. All samples were collected at ankle-depth level during daylight hours.

In addition to the above compliance samples, Ballona Creek was sampled daily from midbridge at Centinela Avenue and weekly from midbridge at Pacific Avenue.

B. SAMPLE ANALYSIS

Water samples from 18 stations were collected and analyzed according to Standard Methods (APHA 1998) for all bacterial indicators. Total coliform and *E. coli* bacterial densities were determined by the chromogenic substrate method following Standard Methods section 9223, and *Enterococcus* density was determined by Enterolert™, per manufacturer's instructions. For the Ballona Creek stations sampled at Centinela and Pacific Avenue, total coliform and *E. coli* were determined by chromogenic substrate and enterococcus by membrane filtration.

Quality assurance and quality control procedures were conducted to confirm the validity of the analytical data collected. All areas impacting reported data were subjected to standard microbiological quality control procedures in accordance with Standard Methods (APHA 1998). These areas included sampling techniques, sample storage and holding time, facilities, personnel, equipment, supplies, media, and analytical test procedures. Duplicate analyses also were performed on ten percent of all samples. When quality control results were not within acceptable limits, corrective action was taken. This quality assurance program helped ensure the production of uniformly high quality and defensible data. In addition, EMD participates annually in the performance evaluation program managed by the California State Department of Health Services (CSDHS) as part of its Environmental Laboratory Accreditation Program (ELAP); CSDHS biennially certifies EMD.

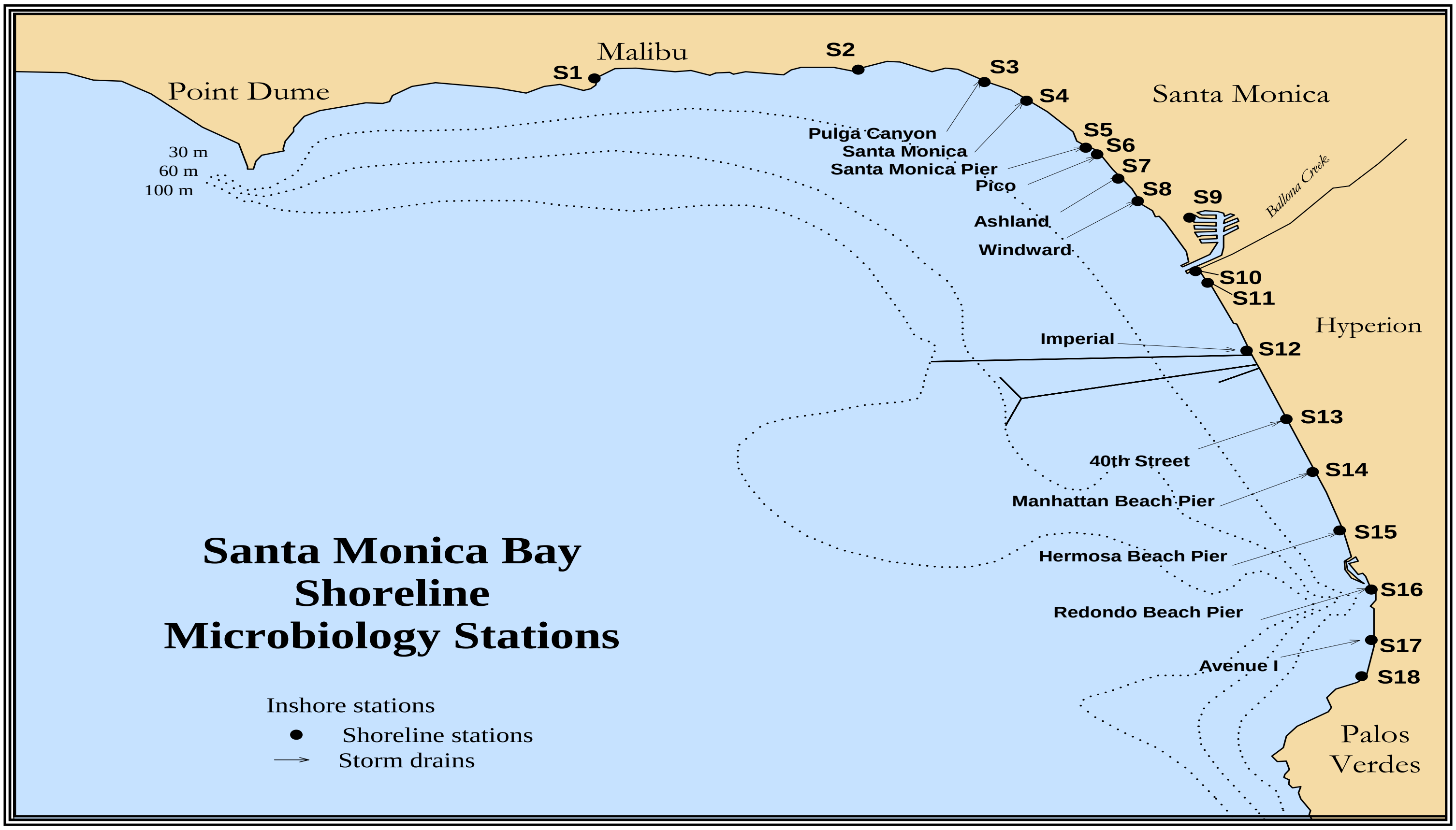

Figure 1. Location of Santa Monica Bay shoreline monitoring stations, stormdrains, and piers.

C. DATA ANALYSIS

The results obtained from microbiological samples are generally not normally distributed. To compensate for a skewed distribution and to obtain a nearly normal distribution, data must be log-normalized prior to analysis. Geometric means are the best estimate of central tendency for log-normalized data and were calculated for each bacterial indicator group. Annual geometric means were calculated for all shoreline sampling sites.

Shoreline data were divided into periods of wet and dry weather to examine the effects of runoff from storm drains on indicator bacterial concentrations. The MS4 permit has defined wet weather as the day of rain plus three days following the rain event. Rain data were obtained from the National Weather Service's Downtown Los Angeles, University of Southern California (USC) records.

III. RESULTS

Rainfall

During the 2006-2007 year, measurable rainfall occurred over the target period. The total rainfall for Year 2006-2007 was 3.2 inches, which is slightly higher than last year's rainfall of 2.63 inches for Los Angeles (based on measurements at Downtown Los Angeles, USC rain gauge). The highest rainfall amount was in Feb. Only trace amounts to no rainfall was recorded for July, August and September of 2006 and May and June 2007 (Figure 2).

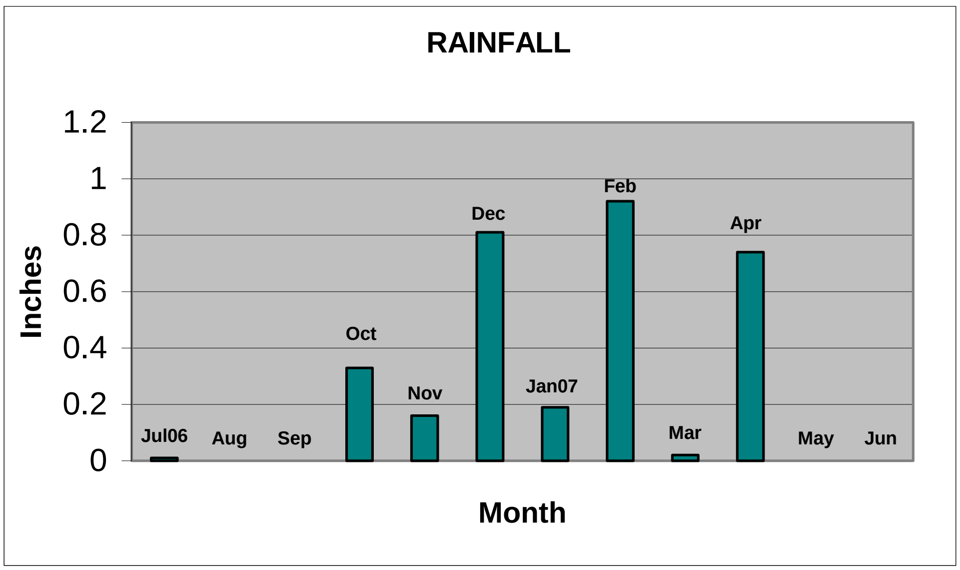

Figure 2. Monthly rainfall amounts at Downtown Los Angeles, USC, July 2006 to June 2007.

Shoreline Stations

The annual geometric means for all indicator bacteria were higher during wet weather than during dry weather (Figure 3). The highest bacterial densities during periods of dry weather were often found either at stations associated with flowing storm drains, at stations adjacent to piers, or at stations with compromised circulation. Northern Santa Monica Bay includes stations from Malibu (S1, Malibu Lagoon) to Marina Del Rey (S9, Mother's Beach, Marina Del Rey). The northern SMB shoreline stations' annual bacterial geometric means generally were higher than those of the southern SMB shoreline stations for all indicator bacteria. Dry-weather geometric means for all three indicators were consistently highest at northern Bay

SANTA MONICA BAY MS4 SHORELINE STATIONS

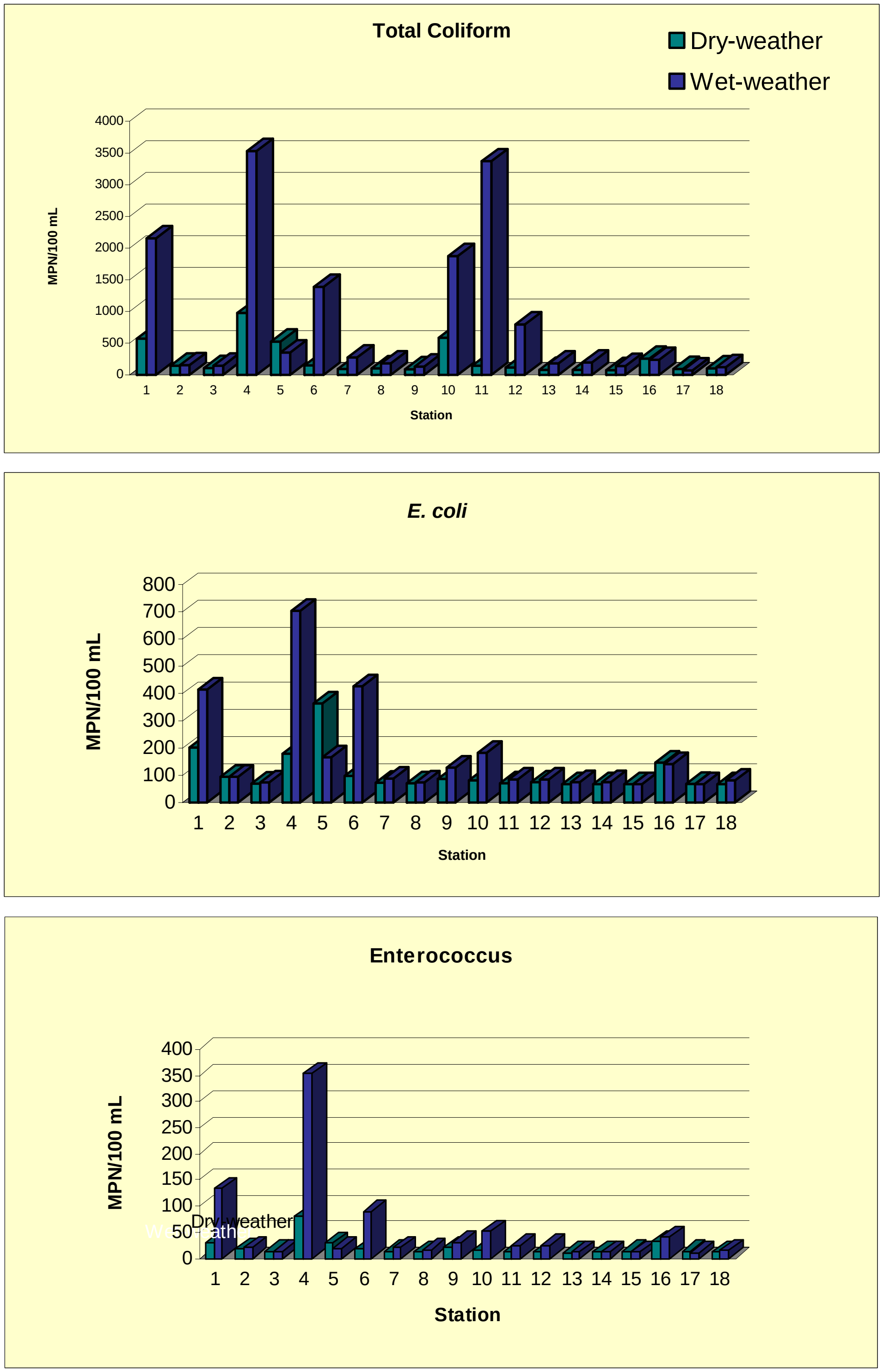

Figure 3. Annual geometric means for indicator bacteria at each shoreline station in Santa Monica Bay during Fiscal Year 2006-2007 wet and dry weather.

stations S4 (Santa Monica Canyon), S1, and S5 (Santa Monica Pier). As previously noted, wet-weather geometric means for all bacterial indicators were higher than those for dry-weather. Sampling locations in the northern Bay with the highest wet-weather bacterial densities for all three indicators were stations S4, S1, and S6.

Southern Santa Monica Bay includes all of the stations south of Ballona Creek, starting from station S10 (Ballona Creek) to station S18 (Malaga Cove, Palos Verdes Estates). The bacterial densities at the south SMB shoreline stations were typically lower than those in the north SMB, with the exception of stations S10 and S16 (Redondo Beach Pier). During the dry-weather period, stations S10 and S16 had the highest total coliform geometric means in the southern Bay, while the highest *E. coli* and enterococcus geometric means were found at station S16. The highest, *E. coli* and enterococcus wet-weather geometric means were at stations S10 and S16. The highest wet-weather total coliform densities in the southern Bay were at stations S10, S11(Culver SD) and S12 (Imperial Hwy storm drain) (Figure 3).

Ballona Creek

The monthly geometric means for the two Ballona Creek sampling locations, Centinela and Pacific Avenues, were calculated using data from wet- and dry-weather periods. At the Centinela sampling station, the highest overall monthly geometric means for total coliform, *E. coli*, and enterococcus were during the period of July through December 2006, with the highest densities in August (Figure 4); the majority of these months are in the summer dry-weather period of April 1 – October 31. The lowest monthly geometric means for total coliforms, *E. coli*, and enterococcus were during the period from January to June 2007, with the lowest densities in March and May 2007.

The Pacific Ave station is located downstream from Centinela and is closer to the mouth of Ballona Creek. At this station, the total coliform geometric means were highest in July 2006. *E. coli* and enterococcus geometric means were highest from November 2006 to February 2007 (Figure 4). Geometric means for total coliform were lowest in September and November of 2006, and January, March, and May of 2007. Lowest *E. coli* geometric means were in September 2006 and January and May of 2007. Enterococcus geometric means were lowest in August and September of 2006, and May of 2007. The bacterial indicator geometric means at Pacific were generally lower than at the Centinela station.

BALLONA CREEK STATIONS

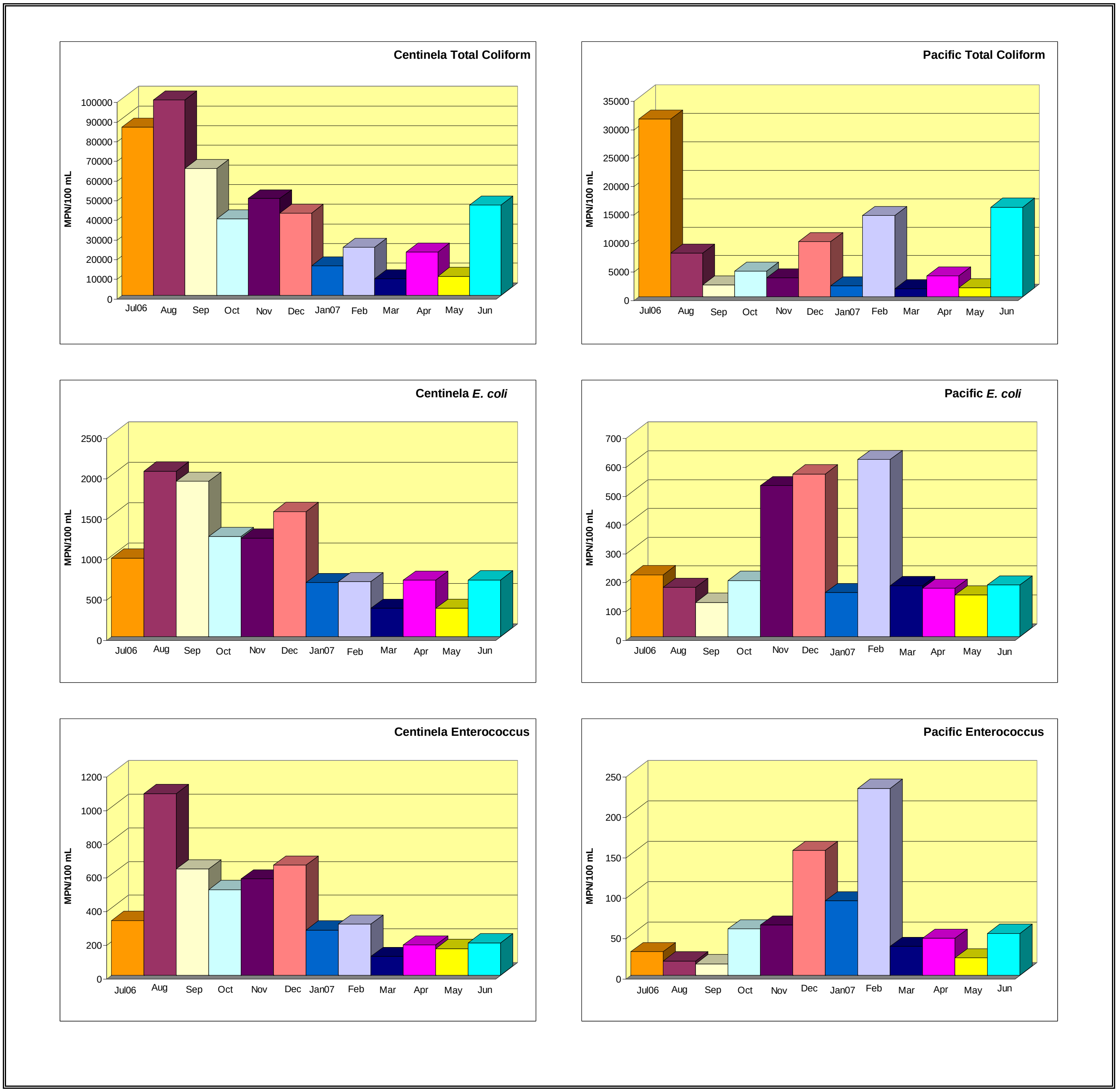

Figure 4. Monthly geometric means for indicator bacteria at Ballona Creek stations, dry- and wet-weather combined. Centinela and Pacific Avenues, July 2005 to June 2006.

Water Quality Standards Compliance

Table 2 lists the percent compliance for all AB411 bathing water quality standards for SMB shoreline stations during Fiscal Year 2006-2007. The percent compliances are based on dry-weather bacterial densities and reflect a measure of water quality for public health. Station S5 (Santa Monica Pier) was the station with lowest percent compliance of water quality standards and highest number of standard exceedances (Figure 5). Next in order of lowest percent compliance were stations S4 (Santa Monica Storm Drain) and S1 (Malibu Lagoon), S16 (Redondo Beach Pier), and S2 (Temescal Canyon SD). Of these five stations, four are in the northern part of the Santa Monica Bay.

Southern stations S13 (40th Street, Manhattan Beach and S18 (Malaga Cove, Palos Verdes Estates) were 100% compliant for all standards. This was a decrease compared to last year when five stations were 100% compliant. There were no northern SMB stations with 100% compliance for all standards, although station S8 was very close to this achievement.

Table 2. Percent compliance of bacterial densities at EMD Santa Monica Bay shoreline stations with California AB411 bathing water standards during dry weather from July 1, 2005 through June 30, 2006.

STATION	TOTAL[1]	*E. COLI* [2]	ENTERO[3]	EC:TC[4] RATIO
S01	92.3	78.1	74.2	86.9
S02	100	93.1	92.7	93.5
S03	100	98.1	100	98.1
S04	**91.2**	86.5	82.3	**71.2**
S05	98.8	**73.1**	**59.6**	91.5
S06	98.1	96.9	94.6	95.0
S07	100	100	99.6	97.3
S08	100	100	100	98.1
S09	100	98.1	95.4	93.1
S10	94.6	98.1	98.5	96.5
S11	98.1	100	100	98.1
S12	96.2	98.1	98.1	100
S13	100	100	100	100
S14	100	100	100	98.1
S15	100	100	100	98.1
S16	100	91.2	85.4	84.6
S17	100	100	100	98.1
S18	100	100	100	100

[1]10,000 Total coliform bacteria/100ml
[2]400 *E. coli* bacteria/100ml
[3]104 Enterococcus bacteria/100ml
[4]Total coliform level greater than 1000 bacteria/100ml and *E. coli*:TC ratio is greater than 0.1

The number of exceedances of the AB411 standards during the dry-weather 2006-2007 period is presented in Table 3. As mentioned above, station S5, followed by stations S4 and S1 had the most exceedances. The southern part of the Bay had the most stations in compliance; the major exceptions, for the second year in a row, being stations S16 (Redondo Beach Pier), which had a high exceedance frequency for all indicators, except total coliform, and S10, which had the highest frequency for total coliform.

Table 3. Number of exceedances of AB411 standards at SMB shoreline stations during dry-weather from July 1, 2006 through June 30, 2007.

Station	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18
TC Exceedances	20	0	0	23	3	5	0	0	0	14	1	2	0	0	0	0	0	0
EC Exceedances	67	19	0	46	105	14	1	0	12	4	0	1	0	0	0	38	0	0
ENT Exceedances	34	17	1	75	22	13	7	1	18	9	1	0	0	1	1	40	1	0
EC/TC Ratio Exceedances	57	18	1	35	70	8	0	0	5	5	0	1	0	0	0	23	0	0
Total Exceedances	**178**	**54**	**2**	**179**	**200**	**40**	**8**	**1**	**35**	**32**	**2**	**4**	**0**	**1**	**1**	**101**	**1**	**0**

Below, Figure 5 shows the number of exceedances compared to the number of storm drain flow days for MS4 stations. There is no evident correlation between the amount of flow (or the number of days of flow) and the number of exceedances. For example while stations S1 and S4 both had high exceedances and flows, station S2 also had a high number of flow days but with a low number of exceedances, and station S5 showed just the opposite, a low number of flow days with high numbers of exceedance.

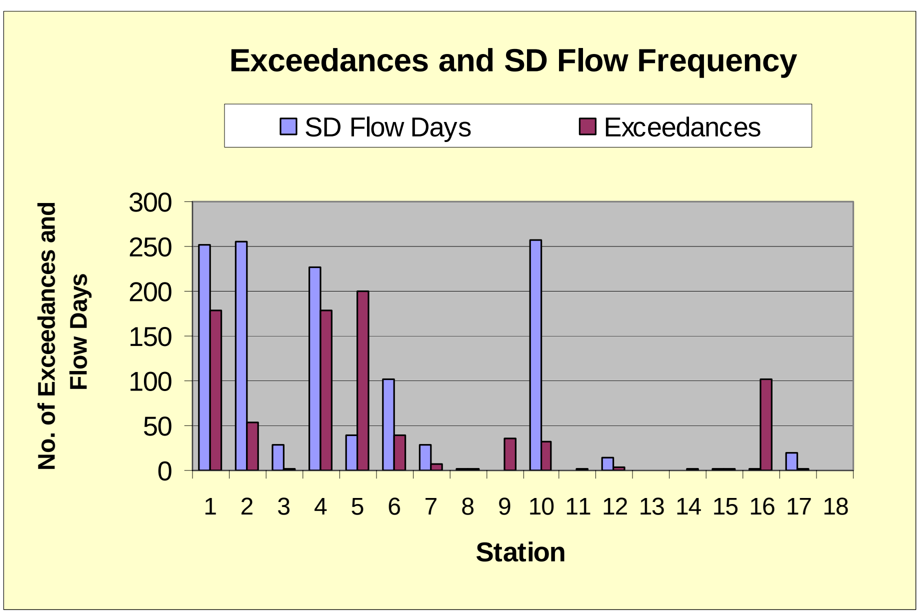

Figure 5. Number of Storm Drain Flows compared to dry-weather exceedances at SMB MS4 stations for the 2006 - 2007 year.

Field Observations

Table 4 provides a summary of field observations of plastic goods (tampon inserters), rubber goods (prophylactic rings), and grease particles. All are considered to be materials of sewage origin (MOSOs), which, when found, trigger an incidence of treatment plant non-compliance. No grease particles have been observed since 1998. The occurrence of plastic and rubber goods along the SMB shoreline decreased markedly from 1994 to 2004 (CLA, EMD, 2005). During Fiscal Year 2006-2007, none of the 18 stations had any observed incidences of plastic goods, rubber goods, or grease particles.

Table 4. Number of visual observations of material of sewage origin at shoreline stations, during Fiscal Year 2005-2006

Materials of Sewage Origin (FY 05-06)							
Statio	PG*	RG*	GP*	Statio	PG*	RG*	GP*
S1	0	0	0	S10	0	0	0
S2	0	0	0	S11	0	0	0
S3	0	0	0	S12	0	0	0
S4	0	0	0	S13	0	0	0
S5	0	0	0	S14	0	0	0
S6	0	0	0	S15	0	0	0
S7	0	0	0	S16	0	0	0
S8	0	0	0	S17	0	0	0
S9	0	0	0	S18	0	0	0
***LEGEND** **PG-PLASTIC GOODS** **RG-RUBBER GOODS** **GP-GREASE PARTICLES**							

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IV. DISCUSSION

Historic monitoring data of Santa Monica Bay has indicated that the wastewater discharge from the Hyperion Treatment Plant has no observable impact on water quality at CLA monitored shoreline stations. Urban runoff has been identified as one of the major contributors of bacterial contamination to Santa Monica Bay (RWQCB, 2005). The effects of urban runoff on impacted shorelines have been studied extensively by regulatory agencies, environmental organizations, and universities. Runoff flows over rooftops, freeways, parking lots, construction sites, industrial facilities, and other impervious and non-impervious surfaces, collect pollutants and transport them through open channels and underground pipes directly to the Bay. Even in dry-weather, ten to twenty-five million gallons of water flow daily through storm drains into Santa Monica Bay (Santa Monica Bay Restoration Commission, 2004).

Past water quality data has shown that sites with high bacterial densities were associated with either a storm drain (or a lagoon) and/or a large heavily used pier. Storm drain data suggests that the number of flow days, in conjunction with the rate of flow and the location of the site, can be predictive of high bacterial indicator densities (CLA, EMD 2005).[1] Southern stations S11 through S18 (excluding S16, proximal to a large, active pier), had lower overall counts than did the northern sites. It seems apparent that sites associated with storm drains with few flow days and low-flow rates contributed lower bacterial contamination overall, confirming that urban flow and runoff is the major contributor of pollutants to these shoreline receiving waters. The size and activity of the watershed drained by the storm drains also, more than likely, plays a large part in this. This investigation would involve a scale of study outside of the present scope of SMB MS4 monitoring.

Table 5. Storm drain flow occurrences, Fiscal Year 2005-2006.

Northern Stations	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
Flow Days	251	255	28	226	40	102	29	1	0
Average Flow rate	3	4	2	3	1	2	1	3	0
Location	Lagoon	Storm Drain	Storm Drain	Storm Drain	Pier	Storm Drain	Storm Drain	Storm Drain	Open Beach
Southern Stations	**S10**	**S11**	**S12**	**S13**	**S14**	**S15**	**S16**	**S17**	**S18**
Flow Days	258	0	14	0	0	2	2	20	0
Average Flow rate	3	0	2	0	0	0	2	2	0
Location	Storm Drain	Storm Drain	Storm Drain	Storm Drain	Pier	Pier	Pier	Storm Drain	Open Beach

***FLOW RATE**
1 - Low
2 - Moderate
3 - Heavy
4 – Ponded

The northern part of the Bay has a number of consistently flowing storm drains. Stations S1 and S4 are sites with high densities, a high number of observed flow days, and high average flow rates, as does station S5, although it had fewer flow days and a low flow rate (Tables 3 and 5). Stations S1, S4, and S5 are located near a lagoon, storm drain, and pier, respectively. Surfrider Beach (Station S1, Malibu Lagoon) has been designated as one of the most polluted beaches in Santa Monica Bay (CLA, EMD 2003). It is located at the outlet of the entire Malibu Creek watershed, which has a drainage area equal to approximately 105 square miles. When the lagoon is breached, it brings a heavy discharge of pollutants into the surf zone, resulting in increased bacterial densities in the Bay. Station S4 has a large watershed area that contains horse corrals, a golf course, and some houses on septic systems, all of which most likely contributed to its having the

[1] It is important to note that the position of the mouth of storm drain contributes to the observed number of flow days. Storm drain position (buried in sand, submerged, or extended too far in the surf) or the location of the mouth of the drain, may obscure visibility or make the storm drain inaccessible. Flow observations are noted to the best of the observer's ability, but due to safety concerns, observers are not allowed under piers or to venture far into the surf to improve visibility.

highest bacterial densities of all stations. Station S5 (Santa Monica Pier) is adjacent to a large, highly active pier with restaurants, restrooms, an aquarium, and is frequented by a large tourist population.

In its efforts to improve water quality, the City of Los Angeles has employed storm water low-flow diversion structures. The CLA has a program geared toward increasing the number of dry-weather storm drain flows diverted to sanitary sewers. Overall, data for Fiscal Year 2006-2007 exhibited a decrease in AB411 standard exceedances compared to the previous fiscal year.

Ballona Creek is a concrete channel with year-round flow and a drainage area equal to approximately 89 square miles. The Centinela station is under tidal influence when ocean tides exceed 3.5 feet. The Pacific station is located downstream of Centinela and is close to the shoreline. It is sampled to assess the effect that tidal dilution may have on the upstream bacterial levels. This dilution effect is suggested by the decreased geometric means for total coliform, fecal coliform/*E. coli*, and enterococcus at Pacific as compared to Centinela.

Studies have shown that urban runoff and storm drain flows leading into the Bay, not effluent discharged from HTP, are the major contributors of shoreline pollution. The largest source of stormwater pollution is the general public. They are contributors of trash containing fast-food wrappers, cigarette butts, Styrofoam containers, motor oil, antifreeze, pesticides, sewage overflow, and pet waste (CLA, EMD 2005). Plans to reduce stormwater pollution and urban runoff, which include structural best management practices (BMPs) and educational programs geared toward the general public, businesses, and City employees, are expected to contribute to improving and protecting water quality along the Santa Monica Bay shoreline.

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