Chapter 3
Microbiology

Cover photos

Top: Terra Petry (Supervising Scientist) collecting a nearshore sample.

Center: The beach at White Point looking offshore past the manifold and S5 shoreline sampling site towards the offshore sampling sites.

Bottom: Tuan Lai (Laboratory Technician II) collecting a shoreline sample.

Chapter 3 Microbiology

INTRODUCTION

The Los Angeles County Sanitation Districts (Sanitation Districts) own and operate the Joint Water Pollution Control Plant (JWPCP), which discharges secondary treated effluent into the Pacific Ocean pursuant to the Waste Discharge Requirements and National Pollutant Discharge Elimination System (NPDES) permit adopted by the Los Angeles Regional Water Quality Control Board (LARWQCB; Order No. R4-2017-0180, NPDES No. CA0053813; Appendix 1.1). Monitoring and reporting requirements for the NPDES permit are specified in the Monitoring and Reporting Program (MRP) portion of the NPDES permit. The MRP specifies several monitoring elements for the JWPCP, including receiving water (i.e. ocean) monitoring.

Assessment of coastal waters for bacteriological contamination using fecal indicator bacteria (FIB) has been a primary focus of the Sanitation Districts' monitoring program for nearly 80 years. This information is critical to protect the health of people using coastal waters for recreation or shellfish harvesting and consumption. Under the current MRP, microbiological monitoring at inshore and offshore sites (**Figure 3.1**) is used to determine compliance with the California Ocean Plan (COP) bacteriological standards (**Table 3.1**). The data collected at these sites determine whether bacteriological standards for water contact are being met. Monitoring results from inshore sites are also used to determine compliance with shellfish harvesting standards. The current MRP also requires shoreline monitoring until June 30, 2018. Shoreline monitoring is used to determine whether densities of bacteria in water contact zones were below levels ensuring public safety. The shoreline data were provided to public health officials for beach management purposes, but these locations are not compliance sites under the JWPCP permit (Table 3.1). Starting July 1, 2018, the Palos Verdes Peninsula and the Santa Monica JG7 Coordinated Integrated Monitoring Programs began collecting shoreline monitoring data; the analyses in this report include data for the full two -year span (2018-2019).

The JWPCP discharges a secondary treated effluent that is continuously disinfected. Two tunnels convey the effluent approximately six miles under the Palos Verdes headland to a manifold structure on the Palos Verdes coastline at White Point, where the tunnels connect with the ocean outfalls. Although there are no "end of pipe" limits in effect, daily bacteriological sampling at the White Point manifold is used to quantify bacterial densities discharged through the outfalls. Bacterial densities measured at the manifold are typically 3-5 orders of magnitude reduced from levels at the JWPCP before disinfection and are routinely close to or below water contact standards even before dilution in the ocean (**Appendix 3.1**). After accounting for instantaneous dilution of the JWPCP discharge at the outfalls (166:1), measured bacterial densities at the manifold are typically far below COP water contact standards.

Chapter overview

This chapter provides results for the shoreline, inshore, and offshore microbiological monitoring from 2018 and 2019. The emphasis of the analyses is to assess compliance with bacteriological standards and evaluate spatial and temporal trends in FIB, particularly as they relate to the JWPCP discharge. The remainder of this chapter describes the methodology used to collect and analyze bacteriological data, discusses temporal and spatial trends and patterns, and assesses compliance with the permit limits. This chapter is one component of the JWPCP 2018-2019 Biennial Receiving Water Monitoring Report (LACSD 2020a). The complete report includes results and analyses for all MRP receiving water monitoring requirements as well as the associated appendices. Electronic copies of the JWPCP 2018-2019 Biennial Receiving Water Monitoring Report can be obtained through the Sanitation Districts' website (https://www.lacsd.org/education/ocean_monitoring_n_research/reports/default.asp)

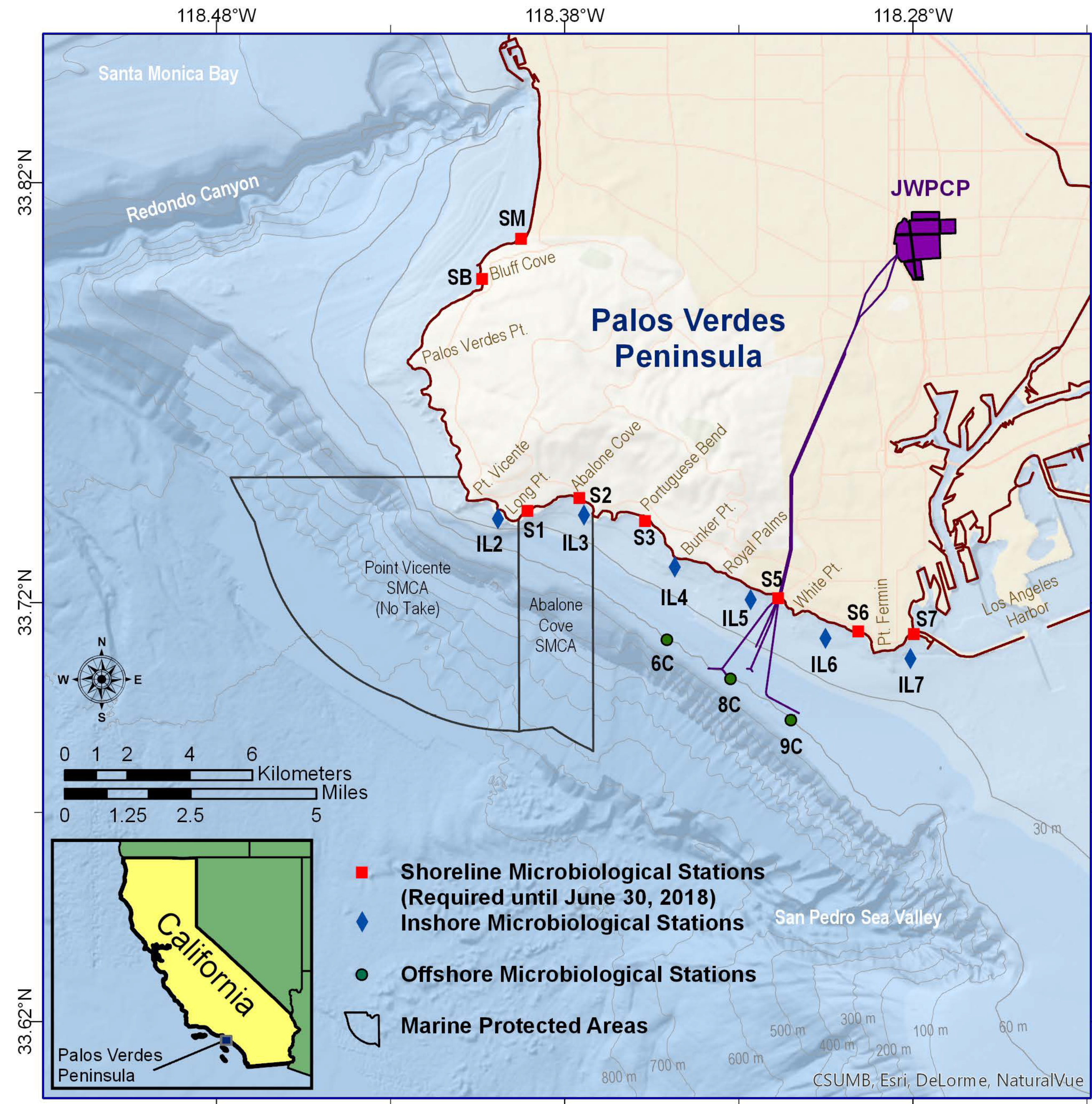

Figure 3.1 Microbiological Sampling Sites

Map of shoreline, inshore, and offshore fecal indicator bacteria (total coliform, fecal coliform, and enterococcus) sampling sites used for assessment of human health risk from water contact and local shellfish consumption.

MATERIALS AND METHODS

Field sampling

Shoreline seawater samples were collected weekly for the first half of 2018 from the wave wash at eight shoreline sites, and stored in sterile 500 ml bottles. Visual observations of water color, turbidity, odor, and any unusual or abnormal amounts of floating or suspended matter were recorded at the time samples were collected. Weather conditions, air temperature, tidal height, and human and animal activity were noted together with the time and date of sample collection. The shoreline seawater samples were transported on ice to the JWPCP Water Quality Laboratory (WQL) and analyzed to determine concentrations of total coliform (TC), fecal

Table 3.1 Microbiological Monitoring and Reporting Program

Summary of the microbiological monitoring and reporting requirements under the current (R4-2017-0180, effective date; Nov. 1, 2017) NPDES permit (CA0053813) for the JWPCP.

Shoreline (through June 30, 2018)		
	Sampling locations	Eight sites (SM, SB, S1 to S3, S5 to S7) in wave wash zone
	Sampling frequency	Weekly
	Sampling parameters	Total coliform, fecal coliform, enterococcus, visual observations
	Compliance	Not applicable
Inshore		
	Sampling locations	Six sites (IL2 to IL7) 0.5m below surface
	Sampling frequency	Monthly
	Sampling parameters	Total coliform, fecal coliform, enterococcus, visual observations
	Compliance	Yes - water contact and shellfish standards (see below)
Offshore		
	Sampling locations	Three sites (6C, 8C, 9C) 0.5m below surface
	Sampling frequency	Monthly
	Sampling parameters	Total coliform, fecal coliform, enterococcus, visual observations
	Compliance	Yes - water contact standards (see below)
Water contact standards		**Single sample maximum (SSM)**
		Total coliform density shall not exceed 10,000/100 ml
		Fecal coliform density shall not exceed 400/100 ml
		Enterococcus density shall not exceed 104/100 ml
		Total coliform density shall not exceed 1,000/100 ml when fecal coliform/total coliform ratio exceeds 0.1
		Geometric mean limits
		Total coliform density shall not exceed 1,000/100 ml
		Fecal coliform density shall not exceed 200/100 ml
		Enterococcus density shall not exceed 35/100 ml
		Additional Limits
		Total coliform density shall not exceed 1,000/100 ml in more than 20% of samples in any 30-day period
Shellfish standards		**Shellfish harvesting standards**
		Median total coliform density for any 6-month period shall not exceed 70/100 ml
		No more than 10% of total coliform samples during any 6-month period shall exceed 230/100 ml

coliform (FC), and enterococcus (ENT) bacteria. The standard operating procedure (SOP) for shoreline sampling is provided in **Appendix 3.2.**

Grab samples were also collected from the White Point manifold each day. Manifold samples were collected in sterile 250mL glass bottles and transported on ice to the laboratory. These samples were analyzed for chlorine residual, TC, and ENT per the MRP. The manifold samples were also analyzed for FC five times a month.

Seawater samples from six inshore and three offshore sites were collected once a month using a Niskin bottle. Aliquots for each analysis were drawn into appropriate sterile sample containers. The samples were iced onboard the boat and transported to the JWPCP WQL for analysis of TC, FC, and ENT bacteria. Visual observations equivalent to those at shoreline sites were also recorded for each sampling event. The SOP for inshore and offshore water sampling for FIB is provided in **Appendix 3.3.**

The Sanitation Districts maintain a rain gauge at the JWPCP plant. The Sanitation Districts' staff note any measurable precipitation (defined as more than 0.1 inches of rain in accordance with local public health agencies) over the previous 24 hours to determine whether significant rain event has occurred. If a sample result exceeds the single sample maximum (SSM) at an inshore, offshore or shoreline site, at any time that a precipitation advisory was not in effect, the site is resampled, generally within 48 hours. Accelerated sampling is continued until all FIB are below SSM standards.

Laboratory analyses and data treatment

The Sanitation Districts' laboratories are certified by the State of California under the Environmental Laboratory Accreditation Program (ELAP). The JWPCP WQL uses approved methods as defined in the permit and ELAP quality assurance/quality control (QA/QC) requirements for sample collection, analyses, and reporting. All field samples were collected and handled in accordance with the QA/QC criteria required by both test method SOPs and the Sanitation Districts' QA/QC program. In accordance with the field sampling SOP, all samples were placed on ice in the field and were analyzed within six hours of collection. Field observation forms document relevant sampling information and include a sample chain-of-custody.

The FIB methods used for compliance with the MRP include those approved for recreational water quality monitoring by the ELAP program. Total and FC analyses primarily utilized membrane filtration (MF), with multiple tube fermentation (MTF) available as a backup if turbidity or background growth was suspected to interfere with the MF method. Enterococcus analysis used MF according to method EPA M-1600 (USEPA 2004). Laboratory SOPs describing the analytical procedures employed for measuring FIB are provided in **Appendix 3.4**. Colony counting, calculation of results, data verification, and reporting all followed standard methods guidelines, with one exception. In 2017, an update to Standard Methods (20th Edition) called for both typical and atypical colonies to be to be included for reported counts of total coliforms; however, this change was inadvertently missed, and only typical colonies were reported through August 18, 2019. Staff immediately updated the SOPs, analyzed the consequences of this deviation, and found no impacts on compliance with permit requirements. The laboratory SOPs are reviewed annually, updated, and referenced according to the current Standard Methods Online version (APHA 2006). Plates with bacterial counts above or below the ideal counting range were given greater than (>) or less than (<) qualifiers. However, these qualifiers were dropped, and the counts treated as discrete values during the calculation of compliance with water contact and shellfish standards and statistical analyses and graphics used in this report. This approach should have minimal effect on statistics, since most receiving water FIB analyses have a reporting level of 1 CFU/100 mL.

The 2018-2019 FIB data were spatially and temporally evaluated graphically against FIB monitoring results from shoreline, inshore, and offshore sampling since 1972. The temporal and spatial patterns of TC at shoreline sites were further evaluated graphically back to 1934 by assessing the annual percentage of TC samples above 1,000 CFU/100 mL using interpolated data from a figure for the 1934 to 1958 period (Rawn et al. 1959).

To identify potential impacts, and spatial and temporal patterns associated with the JWPCP discharge, rain data were excluded following Order R4-2017-0180, which states that "during a wet weather event, stormwater runoff will impact shoreline, inshore and offshore stations. The day of rain (0.1 inch and greater) plus three following days of bacteriology data should be excluded from SSM and Geometric mean limits." A discussion of rain effects on shoreline and inshore FIB is included in **Appendix 3.5**.

Data management and reporting

All bacteriological samples collected at shoreline, inshore, offshore, and manifold sampling sites were processed by the JWPCP WQL. All results were summarized and submitted to the LARWQCB in monthly reports (LACSD 2019-2020). These reports included all discrete bacteriological results, calculated geometric mean values, and all permit compliance objectives. All observational data recorded at the time of sample collection were also provided in the monthly reports. A complete data set of microbiological sampling results for the 2018 and 2019 monitoring years were submitted to the LARWQCB electronically in August of 2019 (LACSD 2019) and 2020 (LACSD 2020b), respectively.

In addition, all shoreline data were transmitted by email (electronic file) to the Los Angeles County Department of Public Health County Water Quality Program who uses these data to manage beach advisory postings and closures throughout Los Angeles County. The electronic file was also sent to LARWQCB staff, Los Angeles County staff responsible for storm water management, and selected consultants working for local beach cities who implement the coordinated monitoring plan for the Santa Monica Bay Beaches Bacteria wet and dry weather Total Maximum Daily Load (TMDL). The State Water Resources Control Board provides a portal to access historical FIB data at https://mywaterquality.ca.gov/safe_to_swim/index.html. The NPDES reported shoreline data collected by the Sanitation Districts are available at this site. The Sanitation Districts also supported the efforts of the environmental advocacy group Heal the Bay by sending them shoreline bacteriological data each week (through June 2018).

RESULTS

Throughout 2018-2019, 757, 144, and 72 discrete samples were collected at shoreline, inshore, and offshore sites, respectively. Samples were analyzed for TC, FC, and ENT totaling 2,873 results. For assessment purposes, shoreline monitoring results are displayed graphically in **Figure 3.2** as a series of box and whisker plots. In 2018-2019, shoreline concentrations of TC, FC, and ENT ranged from <1 to 3,800, <1 to 1,600, and <1 to 3,200 CFU/100 mL, respectively. FIB at shoreline sites are often below detection (ND). In 2018-2019 the percentage of TC, FC, and ENT reported as ND at shoreline sites was 19%, 46%, and 52%, respectively. When detected, shoreline FIB levels are usually low, as confirmed by the box plots in Figure 3.2. In 2018-2019, the 95th percentile levels of TC, FC, and ENT at shoreline sites were 547, 145, and 230 CFU/100 mL, respectively.

Box and whisker plots of inshore and offshore monitoring data are presented in **Figure 3.3**. FIB levels at inshore sites are well below levels at the shoreline. Concentrations of TC, FC, and ENT from inshore samples ranged from <1 to 50, <1 to 20, and <1 to 4 CFU/100 mL, respectively. In 2018-2019 the percentage of TC,

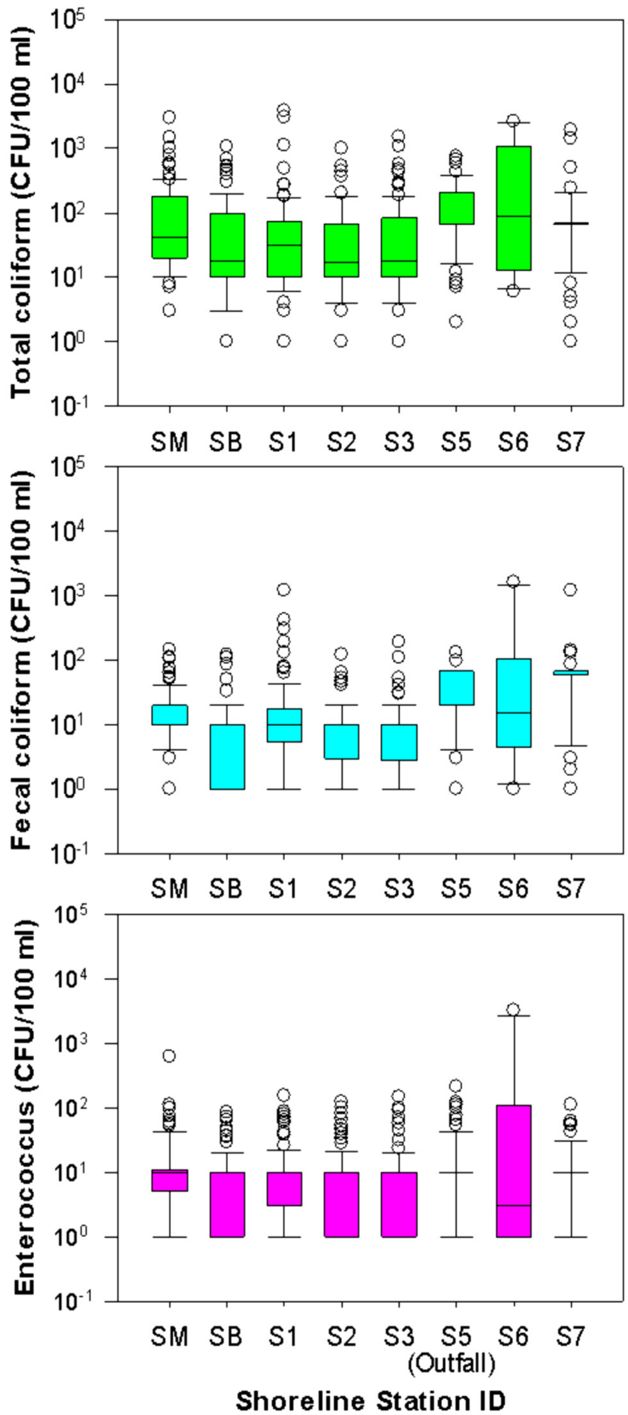

Figure 3.2 Shoreline Fecal Indicator Bacteria (FIB) Concentrations

Concentration of FIB in Palos Verdes shoreline water samples from 2018-2019. Plots show the median value (line in box), 25th and 75th percentile value range (box), 95% confidence intervals (whiskers), and discrete results beyond the 95% confidence intervals (open circles). No box means >75% of results were below detection. The location of the offshore discharge point (outfall) is identified.

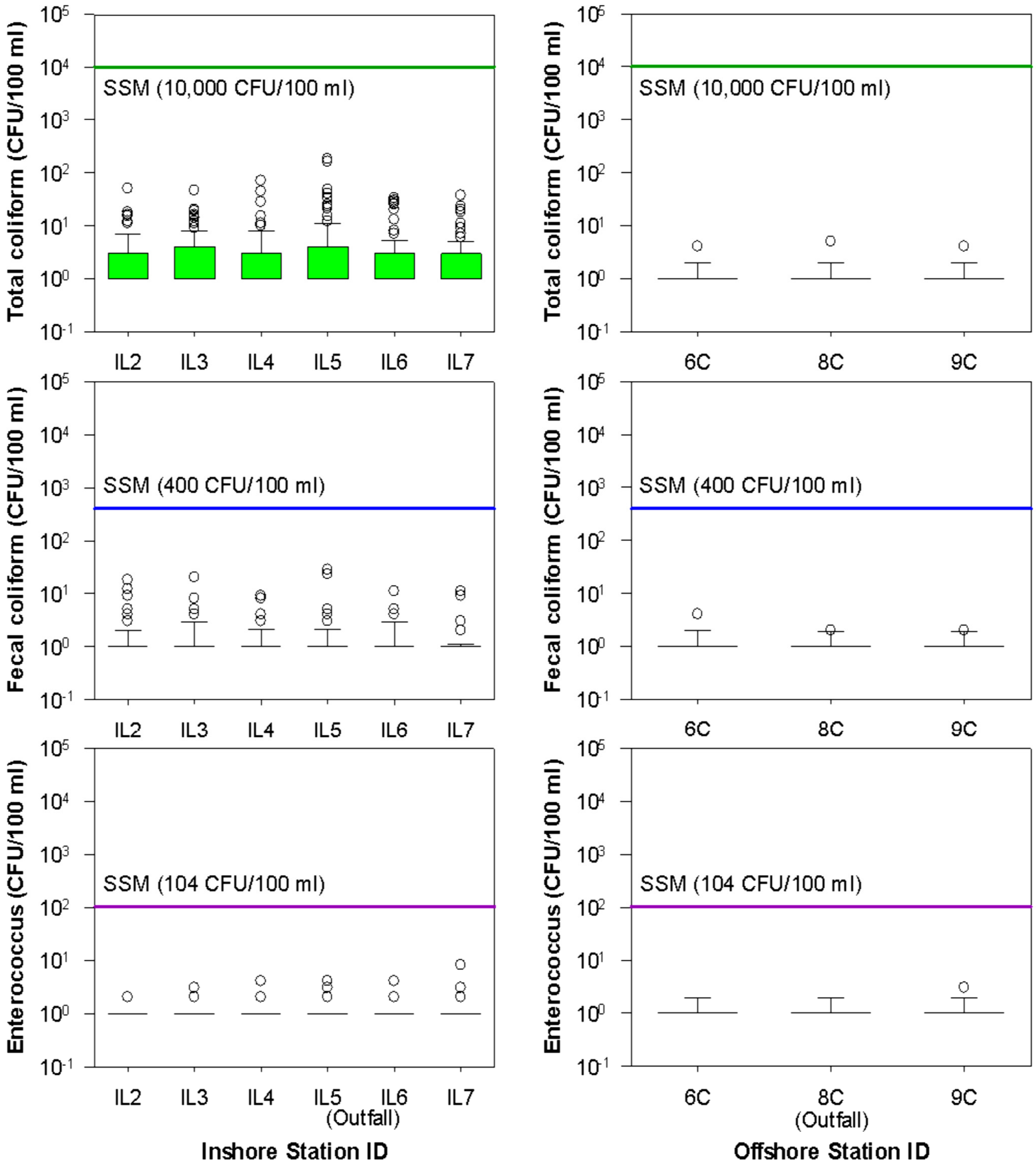

Figure 3.3 Inshore/Offshore Fecal Indicator Bacteria (FIB) Concentrations

Concentration of FIB in inshore (IL) and offshore (C) water samples collected along the Palos Verdes coastline from 2018-2019. Plots show the median value (line in box), 25th and 75th percentile value range (box), 95% confidence intervals (whiskers), and discrete results beyond the 95% confidence intervals (open circles). Plots with no visible box indicate that >75% of the results at the station were below detection levels. The location of the offshore discharge point (outfall) relative to the sample sites is identified. Single sample maximum (SSM) limits for compliance with water contact standards are provided for reference.

FC, and ENT samples below detection at inshore sites was 46%, 76%, and 95%, respectively.

When they are detected, inshore FIB levels are usually very low. This is confirmed by the box plots in Figure 3.3. In 2018-2019, the 95th percentile levels of TC, FC, and ENT at inshore sites were 14, 3, and 2 CFU/100 mL, respectively. The offshore sites, which are closest to the JWPCP discharge, had the lowest concentrations of TC, FC, and ENT ranging from <1 to 12, <1 to 4, and <1 to 3 CFU/100 mL, respectively. The percentage of TC, FC, and ENT below detection at offshore sites was 65%, 88%, and 96%, respectively. In 2018-2019, the 95th percentile levels of TC, FC, and ENT at offshore sites were 6, 3, and 2 CFU/100 mL, respectively.

DISCUSSION

Compliance Assessment

During 2018 and 2019, three results from one single site measured above the SSM FIB standards at an inshore or offshore site. Those results, which were above all three SSM standards of 10,000 CFU/100 ml, 400 CFU/100 ml, 104 CFU/100 ml for TC, FC, and ENT respectively, occurred while a rain advisory was in effect, and therefore compliance was met. There are no final effluent limits for FIB in the JWPCP permit, however, to assure that the JWPCP effluent does not contribute FIB to the receiving water, JWPCP effluent is continuously disinfected, and daily grab samples of effluent at the White Point manifold are tested for FIB. For 2018-2019, average levels of TC, FC, and ENT in manifold samples were 3,597, 514, and 10 CFU/100 ml, respectively. The percentage of days with TC, FC, or ENT below detection at the manifold was 2%, 3%, and 76%, respectively. The 95th percentile levels of TC, FC, and ENT at the manifold were 13,787, 1,675, and 19 CFU/100 ml, respectively.

In summary, during 2018-2019, no inshore or offshore monitoring site exceeded COP standards as a result of the JWPCP discharge (Table 3.1). **Appendix 3.6** lists monthly maximum single sample and geometric mean levels of each FIB and assesses monthly maximum values for shellfish standards (Table 3.1) at all inshore and offshore sites. The shoreline sites are not intended for use as compliance sites for JWPCP, as stated in the NPDES permit. To support the management of beach postings and closures by public health officials, and provide data in support of the SMBBB TMDL, the Sanitation Districts carried out accelerated sampling at shoreline sites whenever an SSM was exceeded and when there was no rain advisory in effect. In total, at all shoreline sites, 23 exceedances of SSM FIB standards occurred in 2018-2019; 17 of those exceedances were on days without a rain advisory. Four of those observations were FC results greater than the SM of 400 CFU/100 ml, and 13 were ENT results greater than the SSM of 104 CFU/100 ml. In each case accelerated sampling was performed within 48 hours and confirmed the shoreline levels were below the SSM.

Spatial and temporal patterns

Shoreline sites on the Palos Verdes peninsula, both at White Point, as well as up to several kilometers upcoast and downcoast have been sampled since the 1930s. Although some historical data (between 1959 and 1970) have so far been unrecoverable, a graphical summary of 1934 to 1958 data allowed an estimate of the annual percentage of shoreline samples exceeding a TC level of 1,000 CFU/100 ml (TC standard) during those years. In **Figure 3.4**, these historical results are plotted with comparable annual exceedance rates calculated for the 1972 to 2019-time frame. The shoreline site nearest the discharge point at White Point is S5 and is shown in red, shoreline sites upcoast and downcoast are colored in orange, yellow, green, and blue to represent increasing distance from the discharge. The early time period between 1934 and the 1950s, shows the large effect that discharge of effluent had on historical shoreline FIB levels, particularly at the shoreline site S5. In 1934 and 1935, no sites exceeded the TC standard. Then, in 1937, to manage increasing flows, the Sanitation Districts put the 60-inch ocean outfall into service. In response, annual exceedance rates of the TC standard increased to as high as 20% at site S5. After WWII, flows at JWPCP increased rapidly. The Sanitation Districts added a second tunnel and a 72-inch outfall in 1947, and by 1953, 36% of all shoreline samples exceeded the TC standard.

Despite the addition of an outfall extension and improved diffuser onto the 72-inch

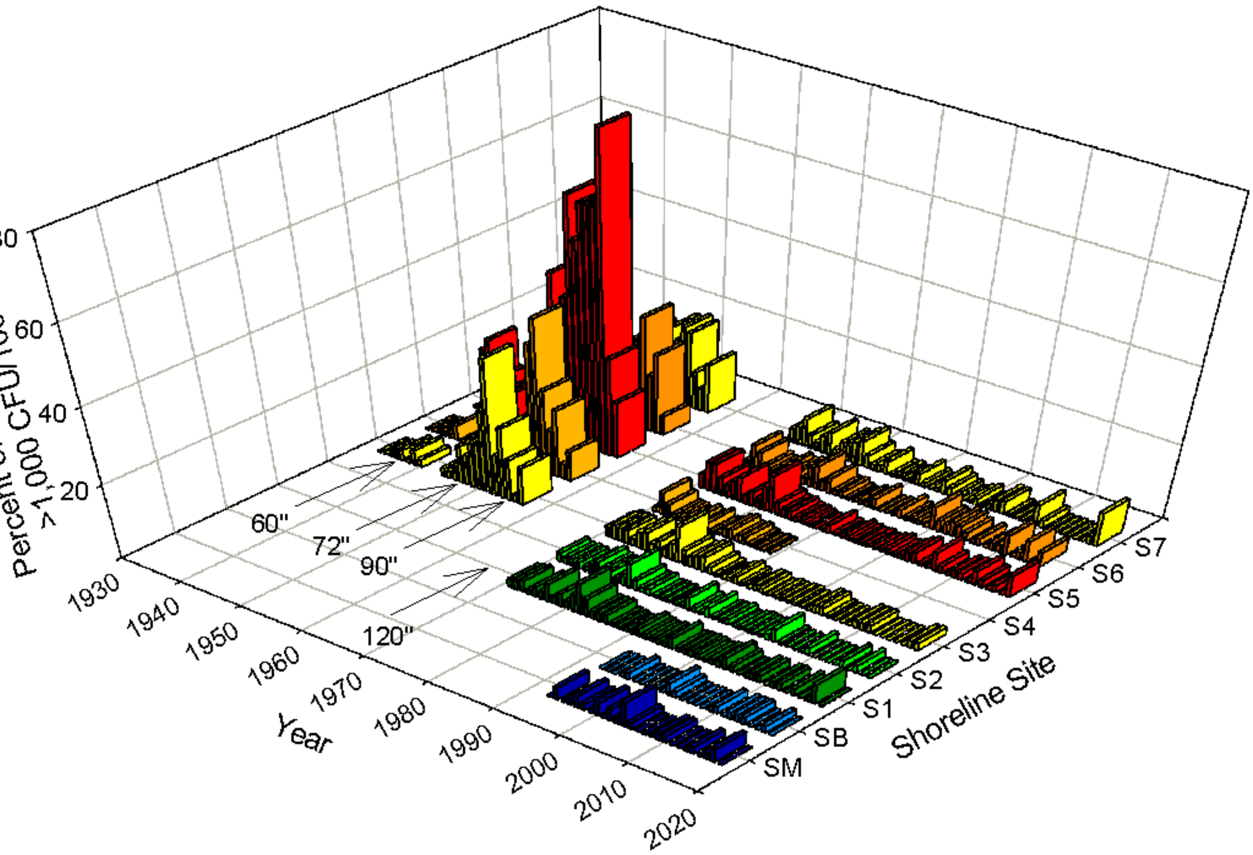

Figure 3.4 History of Shore Sampling Sites
The annual percentage of total coliform samples at shoreline sampling sites exceeding 1,000 CFU/100 ml is plotted for the period 1934 to 2019. Site S5 (red) is nearest the discharge point. Sites are colored in orange, yellow, green, and blue at increasing distances upcoast or downcoast. The map in Figure 3.1 shows locations of the sites. Data has not been recovered for the period 1959 to 1971. Site S4 was abandoned due to access/safety issues in 1991. The start years for each of the Sanitation Districts four outfalls are shown. The 60" outfall was taken out of regular service in 1958, the 72" outfall was taken out of regular service in 1966.

outfall, in December 1953, shoreline bacterial levels remained high. In 1956, the TC standard at site S5 was exceeded 80% of the year (the highest exceedance rate at any shoreline site in the Sanitation Districts' data records). However, in October 1956 the 90-inch outfall, which extended further offshore, and had a deeper diffuser, was put into service. The improvement in shoreline results was immediate, in 1957 and 1958, average shoreline and site S5 TC standard exceedances dropped to just 10% and 15%, respectively.

The chronology published in JWPCP Annual Reports (LACSD 2019-2020), documents that in 1959 the JWPCP completed a chlorination system. It is believed that from 1959 until the beginning of the 1980s, at least intermittent disinfection was applied to the effluent. It is also possible that disinfection was used at JWPCP prior to 1959, which could also explain the improvement in shoreline conditions after 1956.

In 1966, during the period where historical data is missing, a second deep water outfall (120-inch) was put in service and the 72-inch outfall was retired from regular use. From this time forward, with the rare exception of extreme hydraulic events when infiltration from heavy rainfall required the temporary opening of the shallower outfalls, all effluent was discharged further offshore, in deeper water through modern diffusers designed to maximize initial dilution and to trap the effluent below the pycnocline.

By 1972, when the data record is again available, the benefit of the deeper outfalls and at least some disinfection is clear. In 1972 only 2% of all shoreline samples exceeded TC levels of

1,000 CFU/100 mL, and at site S5 the number was just 4%. Since the 1970s, the JWPCP has undergone extensive upgrades. In 1983 the JWPCP began to treat part of the effluent to secondary levels, and in late 2002, the JWPCP began full secondary treatment of all effluent. Also, since the 1970s it is believed that various operational adjustments increased the reliability of the disinfection system and, at some point in the 1980s, a commitment was made to disinfect JWPCP effluent continuously.

The quantitative data from 1972 to present, which also include inshore and offshore sites, are used to further illustrate temporal and spatial trends by plotting average TC concentrations (CFU/100 mL) for a baseline (1972), for three periods of increasing treatment (advanced primary from 1973-1983, partial secondary from 1984-2002, full secondary from 2003-2017), and continued full secondary for the current reporting period 2018-2019). **Figure 3.5** uses a simplified depiction of the sampling locations relative to the coastline (x-axis labeled with geographic landmarks) and depth (z-axis). Mean TC concentrations at each site are depicted with vertical bars on the Y-axis. In interpreting Figure 3.5 it should be noted that shoreline sites (red bars) have been monitored consistently since 1972. However, monitoring at inshore sites (yellow bars) has been less consistent as sites were relocated (18 m depth from 1972 to 1992 and 9 m depth since 1992) and sampling evolved from being done only at the surface (1972 to 1988) to being done at surface and bottom (1988-2017) and back to surface only in the current period (2018-2019).

Prior to 1984 the JWPCP discharged primary effluent, and during some periods when strong density stratification was expected to keep the effluent trapped below the surface (i.e. during summer), disinfection was not used.

During the roughly two decades when partial secondary treatment was provided at JWPCP, average shoreline and inshore FIB levels declined, with the decline more pronounced at inshore sites. At the same time, the frequency of TC >1,000 CFU/100 mL at shoreline and inshore dropped to 1.3% and 0.8%, respectively.

Since 2003, and the advent of full secondary treatment, levels of TC at inshore sites have been reduced further and are now typically an order of magnitude lower than shoreline sites. During the period of secondary treatment from 2003 to 2017, the frequency of TC >1,000 CFU/100 mL at shoreline and inshore was 1.2% and 0.2%, respectively.

Throughout 2018-2019, the JWPCP continuously discharged full secondary treated, disinfected effluent, and the frequency of TC >1,000 CFU/100 mL at the shoreline and inshore for this latest two-year period was 2.8% and 0.3%, respectively. The remaining low levels of shoreline FIB that are still detected after the introduction of full secondary treatment with continuous disinfection are believed to be from shore-based sources and not from the JWPCP discharge. This conclusion is supported by the results from the offshore sites located directly over the discharge, where levels of TC are generally even lower than at inshore sites, and often below detection.

In each time period in Figure 3.5, variations in the average levels of FIB were observed between shoreline sites. During the 2018 -2019 survey period, average TC levels ranged from 61 CFU/100 mL at shoreline site S2 to 430 CFU/100 mL at shoreline site S6, average FC levels ranged from 11 CFU/100 mL at shoreline site S2 to 157 CFU/100 mL at shoreline site S6, and average ENT levels ranged from 10 CFU/100 mL at shoreline site SB to 306 CFU/100 mL at shoreline site S6. This variability likely reflects differences in the local environments at these individual shoreline sites. For example, some sites may be more influenced by delayed runoff from rain or nearby storm drains, some sites may have significant animal or bird populations, while other sites such as Cabrillo Beach, may have large numbers of recreational visitors and bathers.

During 2018-2019, FIB levels at the inshore and offshore sites were typically more comparable between sites and were generally low. Average TC ranged from 2 to 6 CFU/100 mL, while average FC and ENT were 1 CFU/100 mL at all inshore sites.

During 2018-2019, 72% of FIB samples at inshore sites and 83% of FIB samples at offshore sites were below detection. The high frequency of non-detects make assessment of alongshore spatial patterns in the inshore and offshore difficult and somewhat immaterial. Based upon the average bacteria levels at the inshore and offshore sites, there is no trend or apparent gradient of bacteria levels up or down coast associated with the outfall area.

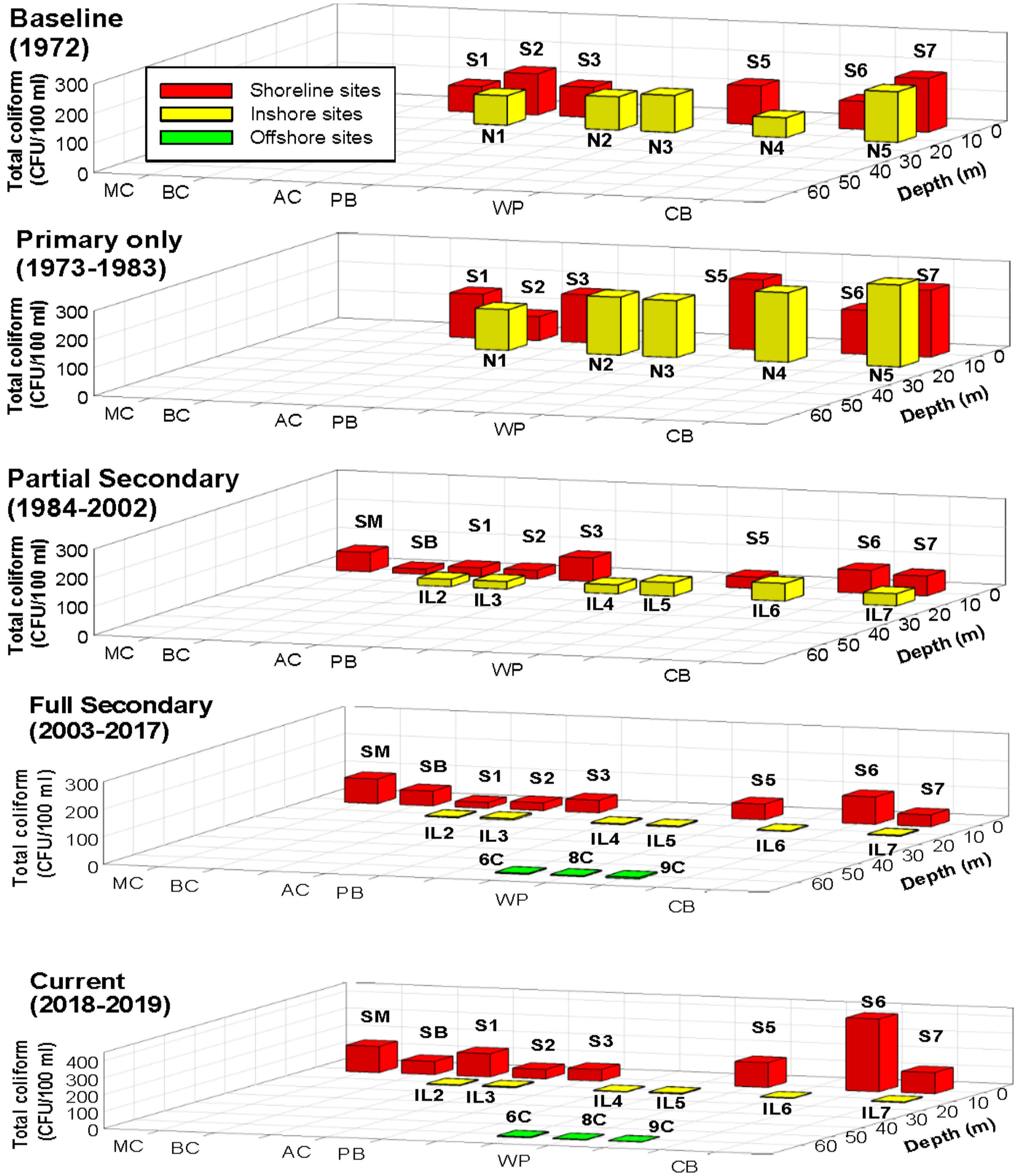

Figure 3.5 Spatial and Temporal Trends in Total Coliform Concentrations

Mean total coliform concentrations from shoreline (S1, S2, S3, S5, S6, S7, SB, and SM), inshore (IL2, IL3, IL4, IL5, IL6, IL7), and offshore (9C, 8C, 7C) sampling locations (Figure 3.1) from 1972 through 2019. Spatial trends are depicted by depth and the relative location of shoreline geographic landmarks (CB = Cabrillo Beach, WP = White Point, PB = Portuguese Bend, AC = Abalone Cove, BC = Bluff Cove, and MC = Malaga Cove). The outfall discharge zone is in 60 meters of water off White Point. Temporal trends are assessed by comparison of a 1972 baseline with three periods with increasing treatment and the current, 2018-2019 period.

Since the adoption of full secondary treatment in October 2002, no apparent increasing or decreasing temporal trends were observed in the concentration of FIB at specific sites. The remaining variability in bacteria levels in Figure 3.5, (specifically the differences seen between the 2003-2017 period and the 2018-2019 period), and the year-to-year differences in the percentage of TC above 1,000 CFU/100 mL at the shoreline sites plotted in Figure 3.4, are believed to be due to natural variability unrelated to the JWPCP discharge.

In summary, historical shoreline data show that as the JWPCP flows increased from the 1930s to the early 1950s, levels of shoreline bacteria also rose rapidly. In the 1950s and 60s construction of deeper ocean outfalls extending further offshore and equipped with improved diffusers to maximize initial dilution, and the initiation of effluent disinfection, reduced shoreline bacteria levels. However, inshore FIB monitoring by the Sanitation Districts from data records beginning in 1972, show that in the 1970s FIB levels in the inshore were still elevated and nearly equivalent to levels at shoreline sites. In the 1980s through the early 2000s, treatment levels at JWPCP were increased and disinfection was made continuous. By 2003, these actions had reduced the inshore FIB levels to about 1/10th or less of shoreline levels and the remaining FIB at inshore sites are now primarily from shoreline runoff.

Regional Monitoring

The Sanitation Districts are participating in the Bight '18 regional Microbiology study. The goal of the study is to determine the performance of EPA Method 1642: Male-Specific (F+) and Somatic Coliphage in Recreational Waters and Wastewater by Ultrafiltration (UF) and Single Agar Layer (SAL) Procedure in southern California coastal waters. Sampling has been conducted, and analyses are currently ongoing.

CONCLUSIONS

The Sanitation Districts performed all bacteriological monitoring requirements as described in the JWPCP NPDES permit. The results indicate that JWPCP achieved 100% compliance with all water contact and shellfish harvesting microbiological standards throughout 2018-2019.

Spatial patterns of average FIB levels at shoreline sites show that while differences exist between sites there is no pattern suggestive of an association with the JWPCP discharge during 2018-2019. Current FIB levels at inshore sites are one to two orders of magnitude lower than at shoreline sites. Offshore sites, located directly above the JWPCP discharge area, have always had the lowest levels of FIB, since offshore sampling was initiated in 2006. The shoreline and inshore spatial patterns in 2018-2019 are like those observed since the 1990s, and particularly since the JWPCP began full secondary treatment in late 2002. These patterns suggest that the shoreline is the primary source of bacteria to the inshore waters.

Historical data show that prior to the construction of deeper outfalls, and before the JWPCP effluent was continuously disinfected, the discharge had a significant effect on shoreline bacteria levels, with the highest bacteria levels proximal to the discharge. Subsequently, in the period from 1983 to 2002, as the JWPCP was upgraded from primary to full secondary treatment, the levels of FIB at the inshore were reduced by one to two orders of magnitude below shoreline levels.

Temporal and spatial patterns and variability of FIB in 2018-2019 were comparable to the previous thirteen years during which the JWPCP operated full secondary with continuous disinfection.

LITERATURE CITED

[APHA] American Public Health Association. 2017. Standard methods for the examination of water and wastewater, 23rd edition. part 9000. American Public Health Association, Washington D.C.

[LACSD] Los Angeles County Sanitation Districts. 2018-2020. Monthly, quarterly, and annual Joint Water Pollution Control Plant self-monitoring reports. Whittier, CA: Sanitation Districts of Los Angeles County, Treatment Plant Monitoring Group, Technical Services Department.

[LACSD] Los Angeles County Sanitation Districts. 2019. 2018 annual receiving water data summary report [compact disk].

Whittier, CA: Sanitation Districts of Los Angeles County, Ocean Monitoring and Research Group, Technical Services Department.

[LACSD] Los Angeles County Sanitation Districts. 2020a. Joint Water Pollution Control Plant biennial receiving water monitoring report 2018-2019.Whittier, CA: Sanitation Districts of Los Angeles County, Ocean Monitoring and Research Group, Technical Services Department.

[LACSD] Los Angeles County Sanitation Districts. 2020b. 2019 annual receiving water data summary report [electronic file]. Whittier, CA: Sanitation Districts of Los Angeles County, Ocean Monitoring and Research Group, Technical Services Department.

Rawn AM, Bowerman FR, Brooks NH. 1959. Diffusers for disposal of sewage in sea water. American Society of Civil Engineers, Sanitary Engineering Division 86 (SA 2). p. 65-105.

[USEPA] United States Environmental Protection Agency. 2004. Method 1600: Enterococci in water by membrane filtration using membrane-enterococcus indoxyyl-b-glucoside agar (mEI).Washington, DC: United States Environmental Protection Agency, Office of Water. Report No.: EPA- 821-R-04-023.