



Enterococci in San Francisco Bay surface waters near seventeen deep water municipal wastewater discharges in dry and wet seasons

Report prepared for the **Bay Area Clean Water Agencies**

Submitted by **San Francisco Estuary Institute**

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Executive summary

Surface water enterococci concentration data in the deep areas of San Francisco Bay are sparse. A study was undertaken in the dry and wet season to measure enterococci concentrations near wastewater treatment plant outfalls to inform the San Francisco Bay Regional Water Quality Control Board's (SFBRWQCB) decision to allow dilution credit for the enterococci water quality criterion. Surface water samples were collected at sixteen stations in July (dry season) and January (wet season) throughout the Bay. Samples from all stations were below the 30 CFU/100 mL water quality criterion, but there was variability through the Bay and across seasons. Concentrations tended to be higher at stations in San Pablo Bay and Carquinez Strait than in Central and South Bays, and concentrations were higher at nearly all stations in the wet season compared to the dry season. This study represents the most comprehensive data set for surface water enterococci concentration in the deep water areas of San Francisco Bay and provides evidence that can be used by the SFBRWQCB to inform their decision to allow dilution credit when implementing the newly adopted enterococci water quality criterion.

Introduction

Enterococcus bacteria is the standard indicator of fecal contamination in marine waters. The Clean Water Act provides recreational water quality criteria for enterococci based on the correlation between observed enterococci concentration and human illness levels in swimmers (USEPA, 2012). In California, water contact recreation (i.e., full body contact) is one of the beneficial uses that serves as the basis for establishing water quality objectives. In March 2019, updates to the bacterial objectives for all surface waters, enclosed bays, and estuaries of California that have a beneficial use designation of water contact recreation (REC-1) was approved by the U.S. Environmental Protection Agency (SWRCB, 2019). In the updated Basin Plan, the enterococci water quality criterion was reduced from 35 CFU/100 mL to 30 CFU/100 mL. The averaging period for compliance was also changed from a geometric mean in a calendar month (not to exceed 240 MPN/100 mL) to a six-week rolling geometric mean calculated weekly (not to exceed 30 CFU/100 mL) and no more than 10% of samples can exceed 110 CFU/100 mL within a calendar month¹. These new criteria will be implemented by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) through National Discharge Pollution Elimination System (NPDES) permits. The SFBRWQCB applied the previous enterococci criterion as end-of-pipe limits. With the new criterion, however, the SFBRWQCB has indicated a willingness to use mixing zones to calculate effluent limitations, where appropriate, based on updated background (ambient) enterococci data.

Enterococci data from beaches and shallow water areas of the Bay are abundant (e.g., [Heal the Bay report cards](#)), but may not be representative of the deep channel locations where

¹ CFU/100 mL and MPN/100 mL are roughly equivalent units for bacterial counts

municipal wastewater treatment plants (WWTPs) discharge to the Bay. Data have recently been collected near the deep water outfalls for some WWTPs (AMS, 2011, 2016; unpublished data from Central Contra Costa Sanitary District, 2011). However, limited enterococci data exist for surface water (AMS, 2011) throughout the deep water areas of the Bay that can be used by the SFBRWQCB to calculate mixing zone-based effluent limitations. To provide current background enterococci data to the SFBRWQCB, the Bay Area Clean Water Agencies (BACWA)—which includes members from many WWTPs around the Bay—funded a study to collect surface water samples throughout San Francisco Bay. This report details the results of the study that was conducted between July 2019 and January 2020.

Methods

Sampling locations were selected based on: 1) outfall locations of major WWTPs (Figure 1); 2) locations of previous studies; and 3) distance from San Francisco due to sample hold times. Deep water discharge locations in the Bay were prioritized over outfalls that discharge to creeks (American Canyon, Fairfield-Suisun, Napa, Petaluma, Sonoma Valley, Yountville, St. Helena, Calistoga, Mountain View, and Las Gallinas were excluded). The outfall for Novato Sanitary District is too shallow to sample via boat in all conditions. In addition, three Lower South Bay POTW outfalls (Palo Alto, Sunnyvale, and San Jose) were excluded from this study because any dilution credit is unlikely to change their operational practices.

Previous enterococci data have been collected near the outfalls of San Jose, East Bay Dischargers Authority (EBDA), and Central Contra Costa Sanitation District (CCCSD). The EBDA and CCCSD outfalls are included in the study. Delta Diablo was excluded from the main sampling because it is too far from San Francisco to adhere to the six-hour sample hold time for enterococcus samples, but they collected their own samples to coincide with the July sampling.

Water samples were collected by the San Francisco Public Utilities Commission (SFPUC) from one meter below the water surface on July 16-17, 2019 (dry season), and January 23-24, 2020 (wet season), to characterize background enterococci conditions in San Francisco Bay. Grab samples were collected in 100 mL sterile containers at 16 stations throughout the Bay in the dry season and 17 stations in the wet season that were between 500 and 1000 feet away from deep water WWTP discharge locations (actual sampled locations in Tables 1 and 2 in the Appendix). The extra sample in the wet season was collected near San Francisco North Point, which is only allowed to discharge during wet weather events. One field duplicate was collected on each sampling day. Sampling was conducted over two days in order to adhere to the sample hold time of six hours. All samples were delivered to Cel Analytical within six hours of the first sample collection time.

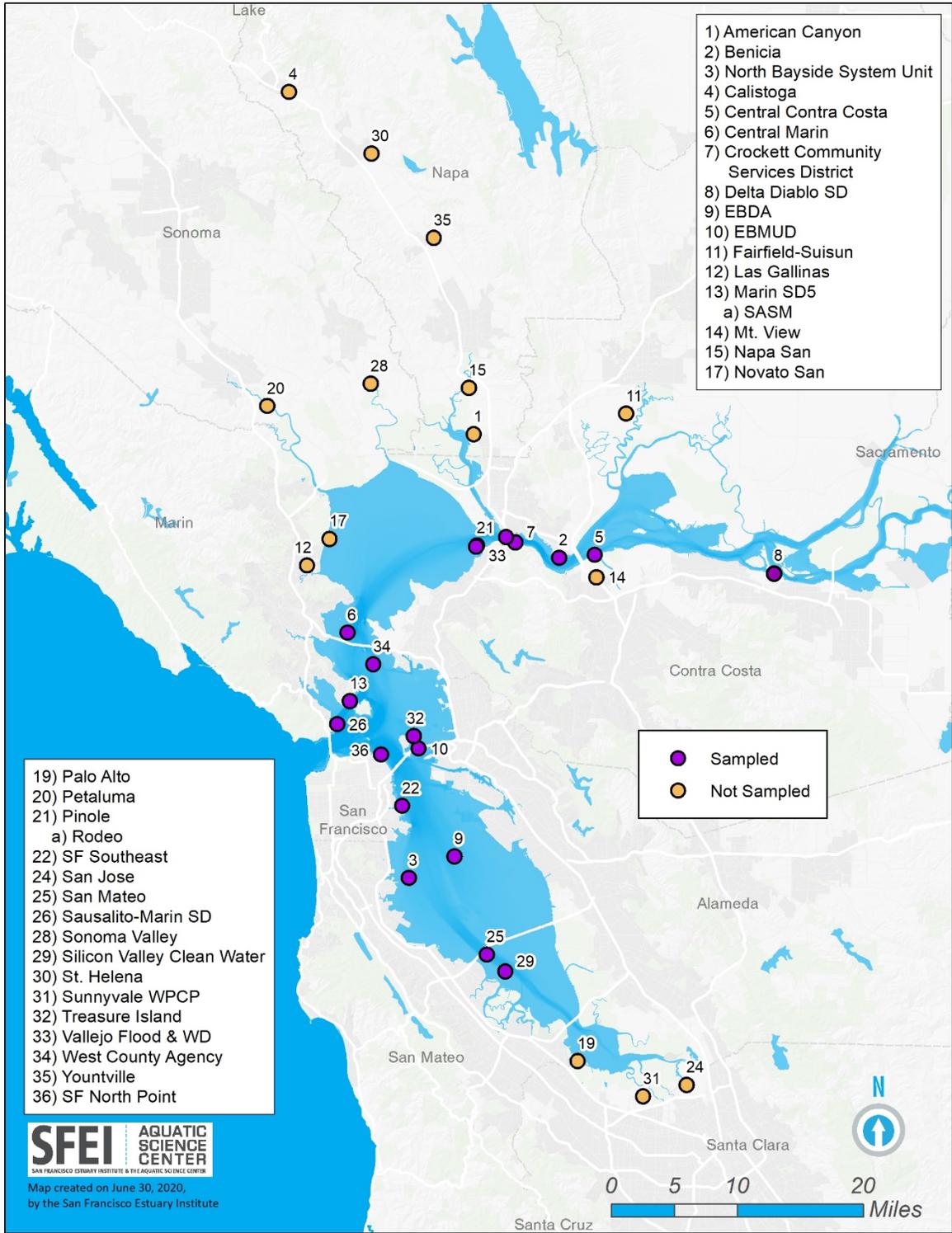


Figure 1. Outfall locations of all municipal wastewater treatment plants (WWTPs) that discharge to San Francisco Bay. Locations in purple denote the WWTP locations that were sampled as part of this study.

Dry season sampling (July 2019) began 56 days after the last rain event. Average discharge from the Sacramento River (USGS gage 11455420 at Rio Vista) for the two collection days was 7850 ft³/s and -3442 ft³/s from the San Joaquin River (USGS gage 11337190). Wet season sampling (January 2020) began two days after the last rain event of 0.4 inches at the Oakland Airport and seven days after a rain event of 1.1 inches. Average discharge from the Sacramento River (USGS gage 11455420 at Rio Vista) for the two collection days was 10770 ft³/s and 1080 ft³/s from the San Joaquin River (USGS gage 11337190).

Samples were analyzed using EPA Method 1600, whereby water was filtered through a membrane and incubated for 24 hours at 41°C on mEI agar. Colonies greater than or equal to 0.5 mm in diameter with a blue halo were enumerated. One lab blank and one reference sample were included in each batch. Membrane filtration was the method of choice for this study because a method detection limit lower than 10 CFU/100 mL was desired; the method detection limit was 1 CFU/100 mL.

Results

Enterococci concentrations varied throughout the Bay, as well as between seasons (Figure 2), ranging from below 1 CFU/100 mL to 11 CFU/100 mL. Many samples were at or below (marked with an asterisk in Figure 2) the method detection limit (MDL; 1 CFU/100 mL) for both dry and wet sampling events. Concentrations were lower during the dry season (July) than wet season (January), with the single exception of the sample collected nearest the Vallejo Flood and Wastewater District outfall. At that station, the enterococci concentration was twice as high during the dry season. Concentrations also were generally higher in both seasons at the five stations in or near to Carquinez Strait and at Central Marin Sanitation in San Pablo Bay than at stations in Central and South Bays. Those were the only stations where enterococci concentrations were greater than the MDL during the dry season. One station (North Point) was only monitored in the wet season, and had a low concentration similar to surrounding stations. The difference between dry and wet season samples was greatest near the outfalls of Benicia (station 2), San Francisco Southeast (station 13), San Mateo (station 16), and Central Contra Costa Sanitation District (station 1).

Discussion

All surface water samples measured near 17 municipal WWTP outfall locations were substantially below the 30 CFU/100 mL water quality criteria recently adopted for California waters designated as REC-1 in dry and wet weather sampling. The sampling locations were geographically distributed throughout the Bay, ranging from Carquinez Strait to South Bay. Although these grab samples represent a snapshot in time, the measured concentrations were consistent with other limited surface water samples collected near the East Bay Dischargers

Authority outfall (AMS, 2016; all but one sample were at or below 10 MPN/100 mL) and were lower than concentrations near the Central Contra Costa Sanitary District outfall (unpublished data, 2011). Concentrations did increase at most sites during the wet season. Water Year 2020 (October 2019 to October 2020) is thus far the fourth driest water year in San Francisco since record keeping began in 1850. With only one wet season sample, it is not possible to determine if enterococci concentrations would be higher during wetter years. Sampling in dry and wet seasons provides a range of possible conditions near WWTP outfalls throughout the Bay. This study represents the most extensive sampling of surface water enterococci concentration in deep channel areas for San Francisco Bay and provides evidence to the SFBRWQCB to inform their decision to allow dilution credit when implementing the newly adopted enterococci water quality criterion.

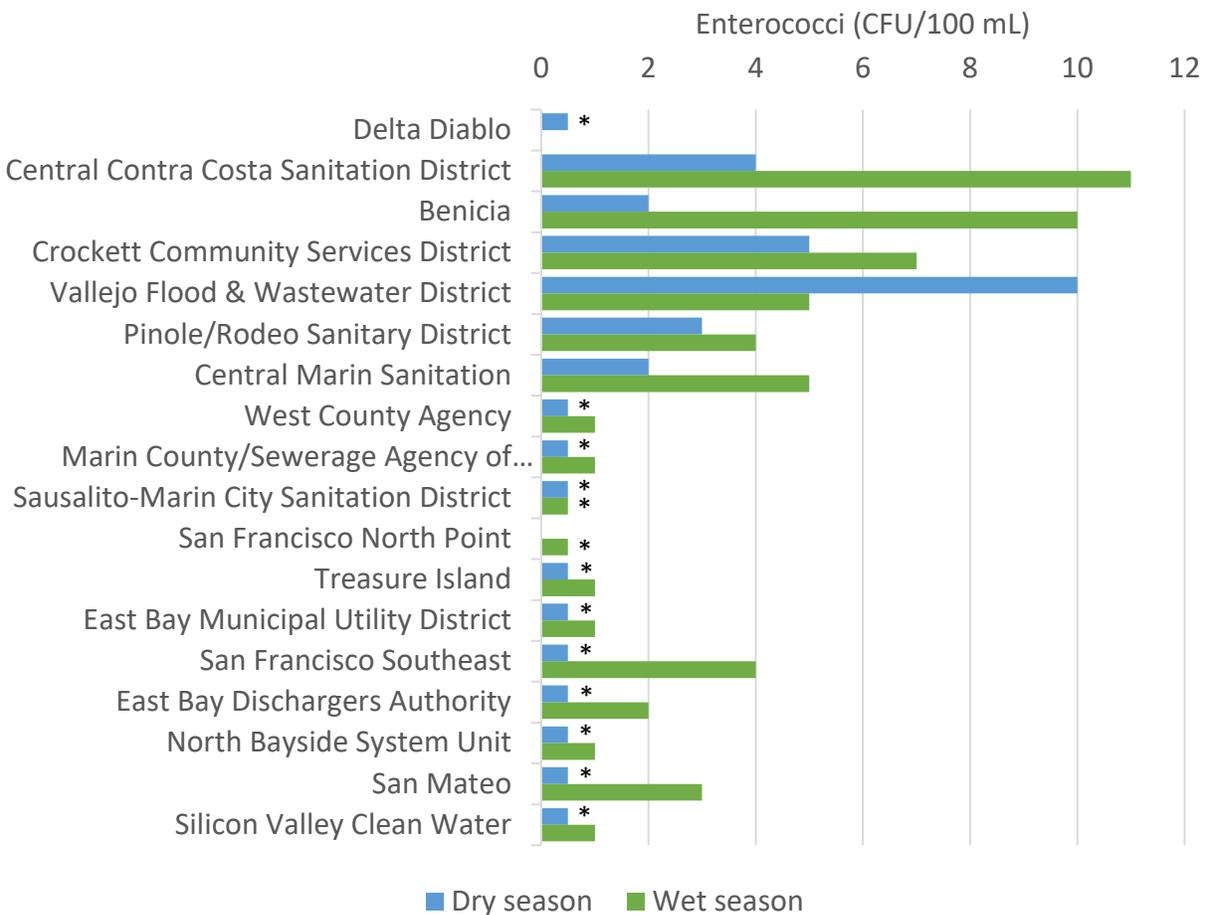


Figure 2. Enterococci concentration (CFU/100 mL) for dry (blue bars) and wet (green bars) season sampling near seventeen WWTP discharge locations. Asterisks denote samples below the method detection limit (1 CFU/100 mL).

Acknowledgements

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Appendix

Table 1. July 2019 sampling locations and conditions.

Station	Latitude (degrees north)	Longitude (degrees east)	Station depth (ft)	Wind (kts)	Weather	Tidal conditions
Central Contra Costa Sanitation District	38.0462	-122.0989	18	6-10	Sunny	Ebb
Benicia	38.0393	-122.1486	14	1-5	Sunny	Ebb
Crockett Community Services District	38.0574	-122.2128	58	6-10	Sunny	Ebb
Vallejo Flood & Wastewater District	38.0909	-122.2550	16	1-5	Sunny	Ebb
Pinole/Rodeo Sanitary District	38.0819	-122.2738	9	6-10	Sunny	Flood
Central Marin Sanitation	37.9471	-122.4560	37	1-5	Sunny	Flood
West County Agency	37.9116	-122.4192	37	6-10	Sunny	Flood
Marin County/Sewerage Agency of Southern Marin	37.8684	-122.4516	98	6-10	Sunny	Flood
Sausalito-Marin City Sanitation District‡	37.8409	-122.4675	123	6-10	Sunny	Flood
Treasure Island	37.8310	-122.3594	41.3	6-10	Sunny/clear	Flood
East Bay Municipal Utility District	37.8180	-122.3491	27.4	1-5	Sunny/clear	Flood
San Francisco Southeast	37.7514	-122.3702	38.9	0	Sunny/clear	Flood
EBDA	37.6945	-122.2957	23.7	6-10	Sunny/clear	Flood
North Bayside System Unit	37.6664	-122.3575	17.2	0	Sunny/clear	Slack
San Mateo	37.5797	-122.2436	45.1	1-5	Sunny/clear	Slack
Silicon Valley Clean Water	37.5629	-122.2185	9.7	1-5	Sunny/clear	Slack

Table 2. January sampling locations and conditions.

Station	Latitude (degrees north)	Longitude (degrees east)	Station depth (ft)	Wind (kts)	Weather	Tidal conditions
Central Contra Costa Sanitation District	38.0468	-122.0990	26	0	Clear	Flood
Benicia	38.0400	-122.1510	18	0	Clear	Flood
Crockett Community Services District	38.0574	-122.2134	70	0	Clear	Flood
Vallejo Flood & Wastewater District	38.0890	-122.2532	24	0	Clear	Flood
Pinole/Rodeo Sanitary District	38.0525	-122.2724	15	0	Clear	Flood
Central Marin Sanitation	37.9473	-122.4566	26	0	Clear	Ebb
West County Agency	37.9133	-122.4186	36	1-5	Clear	Ebb
Marin County/Sewerage Agency of Southern Marin	37.8696	-122.4514	102	1-5	Clear	Ebb
Sausalito-Marin City Sanitation District‡	37.8441	-122.4693	97	1-5	Clear	Ebb
North Point*	37.8085	-122.4033	18	1-5	P. cloudy	Slack
Treasure Island	37.8310	-122.3594	50	1-5	P. cloudy	Slack
East Bay Municipal Utility District	37.8180	-122.3491	38	1-5	P. cloudy	Flood
San Francisco Southeast	37.7514	-122.3702	45	1-5	P. cloudy	Flood
EBDA	37.6945	-122.2957	24	1-5	P. cloudy	Flood
North Bayside System Unit	37.6664	-122.3575	25	0	P. cloudy	Flood
San Mateo	37.5797	-122.2436	54	0	P. cloudy	Flood
Silicon Valley Clean Water	37.5629	-122.2185	12	0	P. cloudy	Flood

*Only sampled during the wet season when discharge is allowed at this location.