TETRA TECH

Technical Memorandum

DATE: February 29, 2012

TO: Karin Graves, EPA Region 9 Water Division

FROM: Shannon Gray and Amy King

SUBJECT: Appendix A – Data Compilation and Analysis

The Long Beach City (LBC) beaches were listed as impaired by the USEPA for indicator bacteria on the 2006 and 2010 303(d) lists. The impairment stretches 4.7 miles along the coastline between the Los Angeles River estuary and Alamitos Bay/San Gabriel River estuary. It is part of San Pedro Bay and is an important recreational and tourism resource for the City of Long Beach. The LBC beaches are included on the revised consent decree but have not been assigned an Analytical Unit number. During data analyses, indicator bacteria exceedances were identified in the Los Angeles River (LAR) Estuary (from Willow Street to the mouth of the estuary). This impairment is also discussed in this memo. This technical memo serves as the first step in the development of the LBC Beaches and LAR Estuary TMDL for bacteria. Included within this memorandum is a brief watershed background, an inventory of data, analysis of available data, and a summary of pertinent studies within the region.

Although not included in this TMDL, this technical memo will review monitoring data from freshwater monitoring stations within and near the impaired drainage area. The Los Cerritos Channel coliform impairment is identified as Analytical Unit 86 in the original consent decree. Other waterbodies in the area (Colorado Lagoon and Alamitos Bay) are included on the State's 303(d) List of Impaired Waters, but are not included in the original or revised consent decree for bacteria. The revised consent decree requires that USEPA either approve a TMDL developed by the State of California TMDL for the Long Beach City beaches or establish its own, by March 24, 2012. In summary, the memorandum discusses bacteria impairments for the LBC beaches and the LAR Estuary as well as monitoring data for nearby freshwater inputs.

1. Watershed Background

This technical memorandum describes data associated with water quality impairments to the LBC beaches and LAR Estuary. Long Beach is located within Los Angeles County in southern California; jurisdictions within the direct drainage areas include the cities of Long Beach and Signal Hill. Jurisdictional boundaries are shown in Figure 1.

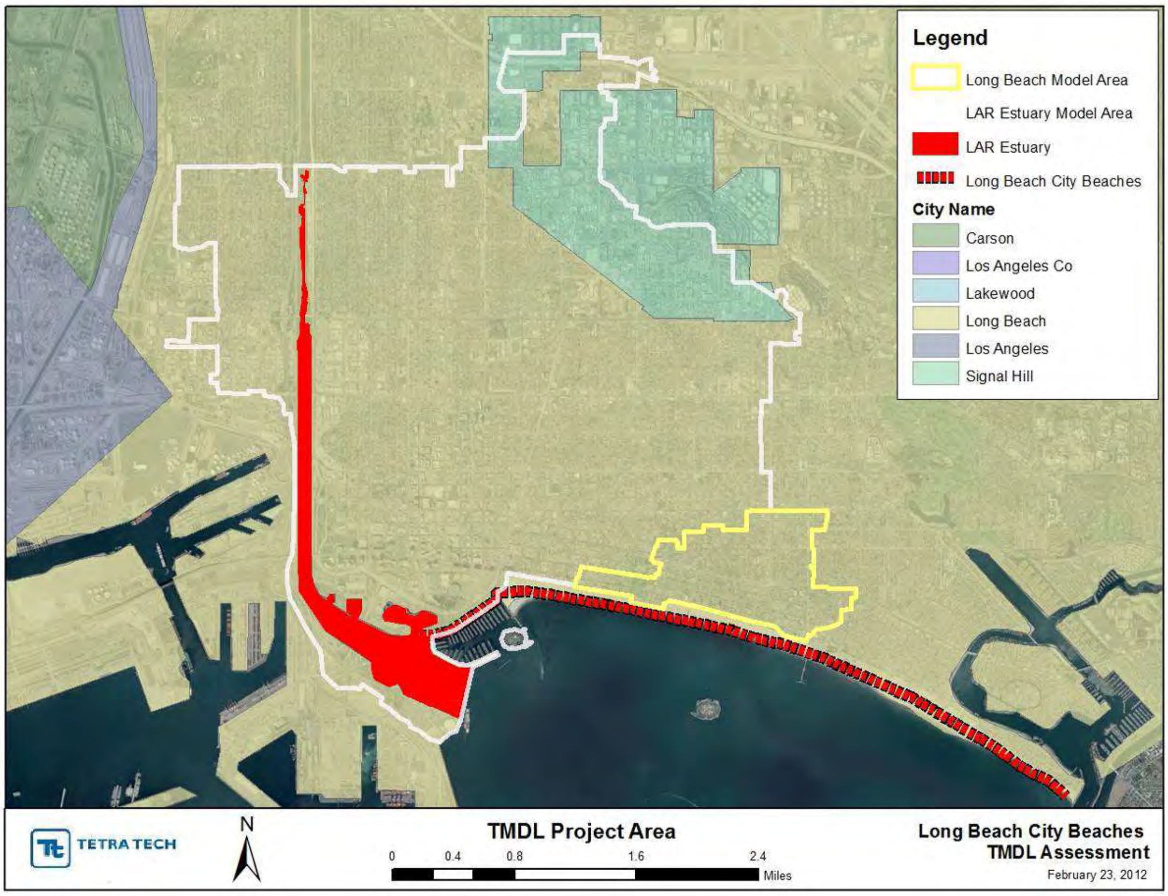


Figure 1. Project area overview

The general area of the LBC beaches can be further defined by hydrological unit 405.12 within the Basin Plan. Existing watershed maps created by the Los Angeles Regional Water Quality Control Board (LARWQCB) show the Long Beach City beaches as straddling portions of the Los Angeles River and San Gabriel River Watersheds. The LARWQCB further separates the Los Cerritos Channel/Alamitos Bay Watershed Management Area (WMA) as situated between the Los Angeles and San Gabriel Rivers, draining to the same general area as the San Gabriel River. Figure 1 further defines the areas draining directly to the LBC beaches and LAR Estuary based on subwatershed boundaries developed by the City of Long Beach. Specifically, only a small area completely within the City of Long Beach jurisdiction drains directly to the LBC beaches, while a larger area drains directly to the LAR Estuary. The area directly north of the LBC beaches direct drainage discharges to Alamitos Bay (which then discharges to San Pedro Bay immediately west of the San Gabriel River Estuary), while the area north of that contributes to the freshwater portion of Los Cerritos Channel (which ultimately flows into Alamitos Bay).

1.1. Impairment Overview

This technical memorandum addresses the California 2008-2010 Clean Water Act (CWA) 303(d) List of Water Quality Impaired Segments for indicator bacteria at LBC beaches (SWRCB, 2010). The Downtown Shoreline Marina / Marina Green Park of the City of Long Beach mark the edge of the impaired strip on the west. Impaired locations included the beach areas at: 3rd Place, 5th, 10th, 16th, 36th, 54th, 55th, 62nd, and 72nd Streets, Coronado Ave., Granada Ave., Molina Ave., and Prospect Ave. In total, the impaired area, as defined by the 303(d) List, covers a stretch of 4.7 miles and is found between the Los Angeles River to the west, and the Alamitos Bay and San Gabriel River to the east. Figure 1 highlights the 303(d) listed waterbodies addressed within this memorandum. In addition to the LBC beaches, highlighted areas include the LAR Estuary. The LAR Estuary was initially investigated as a potential source of bacteria to the LBC beaches. Although not currently on the 303(d) list of impaired waters, the data analyses presented below confirm a bacteria impairment in the LAR Estuary.

Recently a Heal the Bay report (2010) identified the Los Angeles River as a major source of bacterial contamination to the LBC beaches, stating that Long Beach water quality is dependent on rainfall and runoff volumes from the Los Angeles River. The majority of locations near the Los Angeles River continue to exceed state health standards on a regular basis; from 2006 through 2009, all of the beaches in Long Beach have scored very poorly (receiving a D or F grade) on Heal the Bay's Beach Report Card during wet weather. Despite this, the 2010 report stated that the repair of leaking or disconnected sewage pump lines and improperly working storm drain diversions may have partially alleviated some of the water quality problems to the beaches of Long Beach (Heal the Bay, 2010).

In addition to the Los Angeles River, the 2006-2007 Heal the Bay Beach Report Card also included the San Gabriel River as a potential contributor to bacteria problems in Long Beach (Heal the Bay, 2007). Although it is expected that the LBC beaches TMDL may reference bacteria contributions from the Los Angeles River and the San Gabriel River, a separate bacteria TMDL for the freshwater segments of Los Angeles River was public noticed on April 20, 2010 (LARWQCB, 2010) and a bacteria TMDL for the freshwater segments of San Gabriel River is slated for 2019. The potential contribution from these watersheds is discussed in Appendix D.

1.2. Beneficial Uses

Recreation within the impaired segments includes frequent beach traffic as well as a "dog zone" or dog-friendly beach area located near the Belmont Pier, between Roycroft and Argonne Avenue. Of great concern associated with a bacterial impairment, beneficial uses for the LBC beaches and LAR Estuary designated by the Basin Plan include both Class 1 existing noncontact and Class 2 contact recreation. Table 1 presents all beneficial uses for the two waterbodies. To protect such designations, water quality objectives (WQOs) have been established for bacteria based on marine and freshwater recreational uses. WQOs established for contact recreation and therefore, applicable to the LBC beaches and LAR Estuary, include both single sample and rolling 30-day geometric mean criteria. WQOs used to assess the beach impairments are shown in Table 2 (marine WQOs). Freshwater WQOs are also presented as these apply to the freshwater data collected by the City of Long Beach.

Table 1. Designated beneficial uses for the LBC beaches and LAR Estuary

Waterbody Name	Hydrologic Unit	Beneficial Uses
Long Beach City Beaches	405.12	REC 1 (E); REC 2 (E); NAV (E); COMM (E); MAR (E); WILD (E); SPWN (Eas)[2]; SHELL (E)
Los Angeles River Estuary	405.12	IND (E); REC 1 (E); REC 2 (E); NAV (E); COMM (E); EST (E); MAR (E); WILD (E); RARE (Ee) [2]; MIGR (Ef) [2]; SPWN (Ef) [2]; SHELL (P); WET (E)

[1] Beneficial uses include: Industrial Service Supply (IND), Navigation (NAV), Contact (REC-1) and Non-contact Recreation (REC-2), Commercial and Sport Fishing (COMM), Estuarine Habitat (EST), Marine Habitat (MAR), Wildlife Habitat (WILD), Rare, Threatened, or Endangered Species Habitat (RARE), Migration of Aquatic Organisms (MIGR), Spawning, Reproduction and/or Early Development (SPWN), Shellfish Harvesting (SHELL) and Associated Wetlands (WET).
[2] Eas: Early spawning; Ee: one or more rare species utilize for foraging and/or nesting; Ef: aquatic organisms utilize for spawning and early development (including migration areas which are heavily influenced by freshwater inputs).

Table 2. Water Quality Objectives for Long Beach City Beaches and LAR Estuary

Water Quality Objectives	Marine REC-1	Freshwater REC-1
Single Sample		
E. coli	N/A	235 CFU/100 mL[1]
Fecal coliform	400 CFU/100 mL	N/A
Enterococcus	104 CFU/100 mL	N/A
Total coliform[2]	10,000/100 mL	N/A
Rolling 30-day Geometric Mean		
E. coli	N/A	126 CFU/100 mL
Fecal coliform	200 CFU/100 mL	N/A
Enterococcus	35 CFU/100 mL	N/A
Total coliform	1,000 CFU/100 mL	N/A

[1]CFU/100 mL = Colony Forming Units/100 milliliters
[2]Total coliform shall not exceed 1,000/100 mL, if the ratio of fecal to total coliform exceeds 0.1 (this is an additional single sample limit for REC-1 marine waters; presented in the Basin Plan).
N/A: not applicable

2. Data Inventory and Analysis

To assess the impairment of the LBC beaches, data collected by the City of Long Beach and Kinnetic Laboratories were considered. The City of Long Beach conducts regular monitoring along the beaches and additional storm water monitoring during dry and wet weather at select locations. These datasets were used to evaluate the extent of impairment and general trends between monitored locations. In addition, the City of Long Beach completed a microbial source tracking (MST) study with Kinnetic Laboratories in 2008-2009. The City's data as well as the MST study are presented below. Data collected by the Council for Watershed Health during 2009-2010 in the LAR Estuary were also reviewed in this data assessment and are discussed below. In addition, other pertinent studies conducted within the region that provide further information considered for TMDL development are briefly discussed in the following section.

2.1. Beach Bacteria Analysis

A significant amount of bacterial data including *enterococcus*, fecal coliform, and total coliform have been collected by the City of Long Beach, generally on a weekly basis (note: most agencies do not measure for fecal coliform directly; different techniques are discussed in the fecal coliform discussion below; the City of Long Beach measures *E. coli* using Colilert and multiplies the results by 1.3 to estimate fecal coliform). Although the exact number of sites monitored has varied over time, approximately fifteen locations are monitored on the LBC beaches, spanning from near the mouth of the Los Angeles River, southeast to the mouth of the Alamitos Bay (Figure 2). Additional monitoring includes one station near the mouth of the Los Angeles River Estuary, which is sampled by the Council for Watershed Health (CWH) during 2009-2010 (note: the City of Long Beach sampled a different station in LAR Estuary for comparison with their 30-day study [Kinnetic Laboratory, Inc., 2009a]; section 2.3 provides additional detail on this station) . Monitoring stations are indicated on Figure 2 while, the site identification number (Site ID) and brief site description are shown in Table 3. Throughout this report, monitoring stations are referred to by their associated Station Name as shown in Table 3.

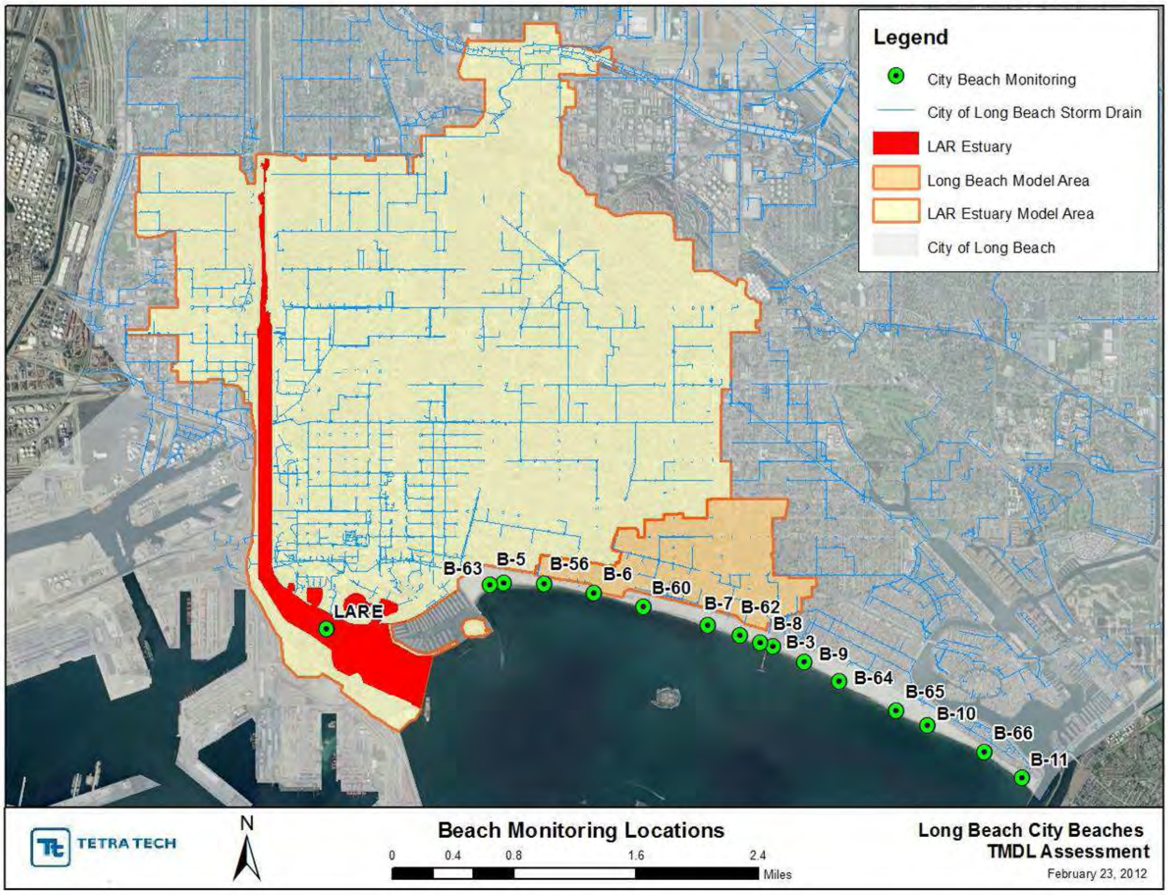


Figure 2. Location of water quality monitoring stations

Table 3. Beach Stations: Long Beach City beaches and LAR Estuary monitoring locations

Site ID	Station Name	Site Description
Long Beach City Beaches		
B63	LB-3rd Place	Long Beach City Beaches, projection of 3rd Place
B5	LB-5th Place	Long Beach City Beaches, projection of 5th Place
B56	LB-10th Place	Long Beach City Beaches, projection of 10th Place
B6	LB-16th Place	Long Beach City Beaches, projection of 16th Place
B60	LB-Molino	Long Beach City Beaches, projection of Molino Av.
B7	LB-Coronado Ave.	Long Beach City Beaches, projection of Coronado Ave.
B62	LB-36th Place	Long Beach City Beaches, projection of 36th Place
B8	LB-W. Belmont Pier	Westside of Belmont Pier
B3	LB-E. Belmont Pier	Eastside of Belmont Pier
B9	LB-Prospect	Long Beach City Beaches, projection of Prospect Av.
B64	LB-Granada	Long Beach City Beaches, projection of Granada Av.
B65	LB-54th Place	Long Beach City Beaches, projection of 54th Place
B10	LB-55th Place	Long Beach City Beaches, projection of 55th Place
B66	LB-62nd Place	Long Beach City Beaches, projection of 62nd Place
B11	LB-72nd Place	Long Beach City Beaches, projection of 72nd Place
Los Angeles River Estuary		
LARE	LAR Estuary (CWH)	Los Angeles River Estuary near mouth

This analysis considered all data collected for the waterbodies of interest from 2000 through 2010. The number of samples collected per year at each monitoring station is shown in Table 4 and additional summary statistics for each site are shown in Table 5. Monitoring data, presented by parameter, are discussed in more detail blow. Additional analysis of annual trends (identifying a greater number of exceedances during the wet season) and site specific timeseries plots are provided in Attachments 1 and Attachment 2, respectively, and are also discussed below.

Table 4. Beach Stations: Number of samples collected by monitoring station and year

Site ID	Station Name	Parameter	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Long Beach City Beaches														
B63	LB-3rd Place	Entero	49	46	47	48	51	41	46	56	59	19		462
		Fecal	51	46	47	48	51	41	48	56	59	19		466
		Total	51	46	47	48	51	41	48	56	59	19		466
B5	LB-5th Place	Entero	46	46	48	48	51	41	49	57	59	59	53	557
		Fecal	47	46	47	48	51	44	50	57	59	59	53	561
		Total	47	46	47	48	51	44	50	57	59	59	53	561
B56	LB-10th Place	Entero	48	44	46	48	51	41	46	53	67	52	55	551
		Fecal	49	44	46	48	51	44	51	53	67	52	55	560
		Total	49	44	46	48	51	44	51	53	67	52	55	560
B6	LB-16th Place	Entero	48	46	49	48	51	41	47	60	60	19		469
		Fecal	50	45	48	48	51	44	50	60	60	19		475
		Total	50	45	48	48	51	44	50	60	60	19		475
B60	LB-Molino	Entero	47	44	48	48	51	42	46	54	65	54	57	556
		Fecal	48	45	45	48	51	44	50	54	66	54	57	562
		Total	48	45	45	48	51	44	50	54	66	54	57	562
B7	LB-Coronado Ave.	Entero	45	44	46	48	51	41	46	55	57	54	57	544
		Fecal	46	44	46	48	51	41	49	55	58	54	56	548
		Total	46	44	46	48	51	41	49	55	58	54	56	548
B62	LB-36th Place	Entero	45	47	48	48	51	41	46	53	56	19		454
		Fecal	49	45	46	48	51	43	49	54	57	19		461
		Total	49	45	46	48	51	43	49	54	57	19		461
B8	LB-W. Belmont Pier	Entero							46	57	62	56	56	277
		Fecal							51	57	62	56	55	281
		Total							51	57	62	56	55	281
B3	LB-E. Belmont Pier	Entero							47	52	58	18		175
		Fecal							50	52	58	18		178
		Total							50	52	58	18		178
B9	LB-Prospect	Entero	44	44	46	48	51	41	48	51	55	50	56	534
		Fecal	45	44	45	48	51	41	52	51	55	50	55	537
		Total	45	44	45	48	51	41	52	51	55	50	55	537
B64	LB-Granada	Entero	45	44	46	48	51	41	44	50	57	49	54	529
		Fecal	46	48	50	48	51	41	47	50	57	49	54	541
		Total	46	48	50	48	51	41	47	50	57	49	54	541
B65	LB-54th Place	Entero	47	47	47	48	51	41	43	48	57	17		446
		Fecal	49	44	46	48	51	41	45	48	57	17		446
		Total	49	44	46	48	51	41	45	48	57	17		446

Site ID	Station Name	Parameter	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
B10	LB-55th Place	Entero	44	45	45	48	51	41	45	46	51	48	51	515
		Fecal	44	44	45	48	51	41	48	46	51	48	50	516
		Total	44	44	45	48	51	41	48	46	51	48	50	516
B66	LB-62nd Place	Entero	44	44	45	48	51	41	43	49	51	19		435
		Fecal	44	44	46	48	51	41	46	49	51	19		439
		Total	44	44	46	48	51	41	46	49	51	19		439
B11	LB-72nd Place	Entero	44	44	48	48	51	41	48	50	50	50	51	525
		Fecal	44	45	45	48	51	41	49	50	50	50	50	523
		Total	44	45	45	48	51	41	49	50	50	50	50	523
		Los Angeles River Estuary												
LARE	LAR Estuary	Entero										44	44	88
		Total										44	44	88

Table 5. Beach Stations: Summary statistics for beach monitoring stations

Site ID	Station Name	Parameter	Number of Samples	Start Date	End Date	Minimum (CFU/100mL)	Maximum (CFU/100mL)	Geomean (CFU/100mL)
		Long Beach City Beaches						
B63	LB-3rd Place	Entero	462	1/3/2000	5/18/2009	5	2,005	25.67
		Fecal	466	1/3/2000	5/18/2009	1	22,528	61.38
		Total	466	1/3/2000	5/18/2009	1	24,196	548.85
B5	LB-5th Place	Entero	557	1/3/2000	12/27/2010	4	2,005	25.97
		Fecal	561	1/3/2000	12/27/2010	1	24,192	58.23
		Total	561	1/3/2000	12/27/2010	1	24,196	489.90
B56	LB-10th Place	Entero	551	1/3/2000	12/27/2010	5	2,005	23.88
		Fecal	560	1/3/2000	12/27/2010	1	13,600	55.51
		Total	560	1/3/2000	12/27/2010	1	24,196	454.63
B6	LB-16th Place	Entero	469	1/3/2000	5/18/2009	5	2,005	22.84
		Fecal	475	1/3/2000	5/18/2009	1	24,192	59.23
		Total	475	1/3/2000	5/18/2009	1	24,196	432.12
B60	LB-Molino	Entero	556	1/3/2000	12/27/2010	5	2,005	27.46
		Fecal	562	1/3/2000	12/27/2010	1	31,449	70.39
		Total	562	1/3/2000	12/27/2010	1	24,196	407.76
B7	LB-Coronado Ave.	Entero	544	1/3/2000	12/27/2010	5	2,005	24.80
		Fecal	548	1/3/2000	12/27/2010	1	24,192	54.57
		Total	548	1/3/2000	12/27/2010	1	24,196	339.02
B62	LB-36th Place	Entero	454	1/3/2000	5/18/2009	5	2,005	24.27
		Fecal	461	1/3/2000	5/18/2009	1	24,196	57.29
		Total	461	1/3/2000	5/18/2009	1	24,196	371.33
B8	LB-W. Belmont Pier	Entero	277	1/3/2006	12/27/2010	10	2,005	34.40
		Fecal	281	1/3/2006	12/27/2010	10	18,337	64.21
		Total	281	1/3/2006	12/27/2010	10	24,196	385.26
B3	LB-E. Belmont Pier	Entero	175	1/3/2006	5/18/2009	10	2,005	29.90
		Fecal	178	1/3/2006	5/18/2009	10	13,600	60.38
		Total	178	1/3/2006	5/18/2009	10	24,196	388.87

Site ID	Station Name	Parameter	Number of Samples	Start Date	End Date	Minimum (CFU/100mL)	Maximum (CFU/100mL)	Geomean (CFU/100mL)
B9	LB-Prospect	Entero	534	1/3/2000	12/27/2010	5	2,005	22.08
		Fecal	537	1/3/2000	12/27/2010	9	24,192	46.30
		Total	537	1/3/2000	12/27/2010	9	24,196	266.84
B64	LB-Granada	Entero	529	1/3/2000	12/27/2010	5	2,005	20.10
		Fecal	541	1/3/2000	12/27/2010	9	16,896	44.38
		Total	541	1/3/2000	12/27/2010	9	24,196	240.42
B65	LB-54th Place	Entero	446	1/3/2000	5/18/2009	5	2,005	17.98
		Fecal	446	1/3/2000	5/18/2009	1	24,192	40.81
		Total	446	1/3/2000	5/18/2009	1	24,196	211.38
B10	LB-55th Place	Entero	515	1/3/2000	12/27/2010	5	2,005	17.15
		Fecal	516	1/3/2000	12/27/2010	9	20,190	33.48
		Total	516	1/3/2000	12/27/2010	9	24,196	197.47
B66	LB-62nd Place	Entero	435	1/3/2000	5/18/2009	5	2,005	16.87
		Fecal	439	1/3/2000	5/18/2009	9	24,196	32.51
		Total	439	1/3/2000	5/18/2009	9	24,196	197.50
B11	LB-72nd Place	Entero	525	1/3/2000	12/27/2010	5	2,005	21.55
		Fecal	523	1/3/2000	12/27/2010	9	24,192	38.58
		Total	523	1/3/2000	12/27/2010	9	24,196	256.00
Los Angeles River Estuary								
LARE	LAR Estuary	Entero	88	5/2/2009	9/29/2010	10	22,000	32.11
		Total	88	5/2/2009	9/29/2010	335	24,000	7,882.00

Enterococcus Monitoring

The annual geometric mean of *enterococcus* measured at the LBC beaches and LAR Estuary monitoring stations from 2000 to 2010 are shown in Figure 3. The shade selection for each site is determined by the location of the monitoring site with respect to the mouth of the Los Angeles River. The darker shades represent monitoring sites closest to the Los Angeles River, while shades become lighter in color as the monitoring site location moves farther to the southeast and away from the Los Angeles River.

As shown in Figure 3, monitoring sites closer to the Los Angeles River and shown in dark blue have a higher annual geometric mean trend compared to the monitoring sites farthest from the Los Angeles River. The monitoring sites with the lowest annual geometric mean trend include LB-55th Place (B10), LB-54th Place (B65), and LB-62nd Place (B66). Monitoring site LB-72nd Place (B11), although farthest from the Los Angeles River, had a higher annual geometric than the monitoring sites immediately west of LB-72nd Place. This suggests either local sources in the vicinity of the LB-72nd Place monitoring site or the Alamitos Bay/San Gabriel River may be influencing *enterococcus* concentrations in that area. Wind-induced transport of contaminated surface waters from the LAR Estuary may also be a potential source of contamination (Kinnetic Laboratory, Inc., 2009a); however, quantifying the loading of such transport under varying conditions requires additional study.

Figure 3 also demonstrates annual temporal trend for the monitoring sites immediately southeast of the mouth of the Los Angeles River. For LB-3rd Place (B63), LB-5th Place (B5), LB-10th Place (B56), LB-16th Place (B6) and LB-Molino (B60), the annual geometric mean generally increased over the ten year period. For the most southeastern sites, annual concentrations tend to remain reasonably constant until about 2010 where a significant increase in the annual *enterococcus* geometric mean was observed for nearly all southeastern sites including LB-55th Place (B10), LB-54th Place (B65) and LB-62nd Place (B66).

Data for 2009-2010 were available for a monitoring site in the LAR Estuary. In 2009, the geometric mean concentration at this site was relatively high compared to the nearby stations and in 2010, the annual geometric mean decreased and was the lowest of all stations. These data are likely skewed because the LAR Estuary station was only monitored during summer dry months, not year-round like the other stations.

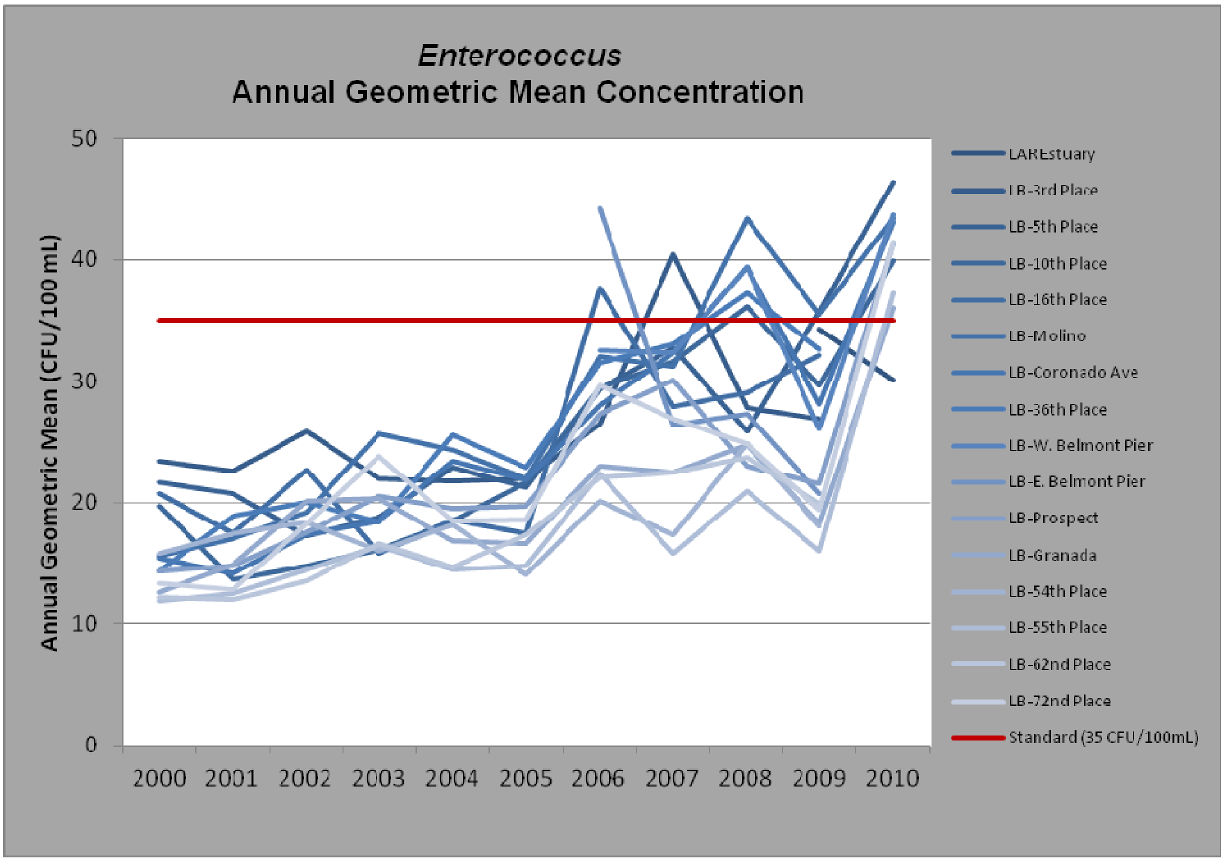


Figure 3. Annual *enterococcus* geometric mean at beaches

Similar temporal and spatial trends were observed when monthly geometric means were compared year to year, as indicated in Attachment 1; however, these additional analyses highlight some interesting details. Specifically, the graphs in Attachment 1 illustrate a general trend towards increasing geometric means over time for all monitoring sites (especially for 2000-2007; 2008-2010 is less conclusive). These graphs also illustrate that the wetter months of September through February have higher annual *enterococcus* geometric means when compared to March through October, suggesting that rainfall-runoff contributes significant concentrations of bacteria to the beaches. Spatial comparison of the graphs in Attachment 1 demonstrate a general trend of higher geometric means at monitoring sites closer to the Los Angeles River (similar to the patterns seen in Figure 3); however, evaluating the data on a monthly basis by station in Attachment 1 (and not based on a geometric mean of the entire year) highlights some variability in this trend. Specifically, LB-72nd Place (B11) and LB-62nd Place (B66) have sporadic increases in geometric means, as can be seen in 2002 through 2007 and again in 2010. These two monitoring site are farthest from the Los Angeles River. Similar trends were observed in Figure 3 above for LB-72nd Place (B11), but the graphs in Attachment 1 demonstrate that there may be additional inputs north of this station or tidal impacts that result in higher concentrations at LB-62nd Place (B66) as well.

To evaluate continuous *enterococcus* concentrations at each site, timeseries plots were developed using all data (compared to single sample maximum WQOs) and the calculated rolling geometric means (compared to the geometric mean WQO). These plots are presented by station in Attachment 2. As expected, concentrations are variable, ranging from less than 10 CFU/100 mL to greater than 1,000 CFU/100 mL. Along the beaches, it appears that monitoring sites located closer to the Los Angeles River generally exhibit a greater number of elevated concentrations and both single sample and geometric mean exceedances (those plotted above the criteria lines). While concentrations show a decreasing trend from northwest to southeast, the monitoring station located closest to the mouth of the Alamitos Bay and San Gabriel Rivers had higher concentrations and a greater number of exceedances than those stations immediately to the northwest. Overall, these stations all experienced a general increase in concentrations during the fall of 2004, which continued through later years.

Percentages of single sample exceedances and geometric mean exceedances from monitoring sites along Long Beach City beaches and LAR Estuary are presented in Table 6. The spatial distribution of geometric mean exceedances are also illustrated in Figure 4. The LBC beaches monitoring stations had single sample exceedances ranging from six to 21 percent, when compared to the marine WQO. The percent of *enterococcus* geometric mean exceedances ranged from 12 to 47 percent, with the highest percent exceedances occurring at West Belmont Pier (LB-W. Belmont) and East Belmont Pier (LB-E. Belmont) stations (note: a stormdrain and dog-friendly beach are located near these monitoring stations). The LAR Estuary results were similar. Specifically, this station exceeded the single sample WQO eight percent of the time and the geometric mean WQO 31 percent of the time (Table 6).

Table 6. Beach Stations: *Enterococcus* exceedance summary for 2000-2010

Site ID	Station Name	Number of Entero Single Sample Exceedances	Total Number of Entero Single Samples	Percent of Entero Single Sample Exceedances	Number of Entero Geomean Exceedances	Total Number of Entero Geomean Samples	Percent of Entero Geomean Exceedances
Long Beach City Beaches							
B63	LB-3rd Place	58	462	12.6%	314	1,036	30.3%
B5	LB-5th Place	62	557	11.1%	411	1,394	29.5%
B56	LB-10th Place	60	551	10.9%	400	1,323	30.2%
B6	LB-16th Place	53	469	11.3%	288	1,132	25.4%
B60	LB-Molino	77	556	13.8%	567	1,403	40.4%
B7	LB-Coronado Ave.	62	544	11.4%	364	1,234	29.5%
B62	LB- 36th Place	43	454	9.5%	233	926	25.2%
B8	LB-W. Belmont Pier	57	277	20.6%	384	863	44.5%
B3	LB-E. Belmont Pier	24	175	13.7%	206	441	46.7%
B9	LB-Prospect	49	534	9.2%	254	1,109	22.9%
B64	LB-Granada	46	529	8.7%	228	1,131	20.2%
B65	LB-54th Place	36	446	8.1%	124	888	14.0%
B10	LB-55th Place	33	515	6.4%	109	936	11.6%
B66	LB-62nd Place	28	435	6.4%	102	718	14.2%
B11	LB-72nd Place	56	525	10.7%	267	1,064	25.1%
Los Angeles River Estuary							
LARE	LAR Estuary	7	88	8.0%	96	308	31.2%

Percent exceedances of the *enterococcus* geometric mean standard are shown in Figure 4. To illustrate the exceedances, monitoring stations are grouped into three categories of exceedance: (1) low, representing samples with 0 to 15 percent exceedance; (2) medium, representing samples with 15 to 30 percent exceedance; and (3) high, representing samples with over 30 percent exceedance. Six stations fell into the high category, seven stations had the medium level of exceedance, and three stations had less than 15 percent exceedances and were categorized as low. This map illustrates that exceedances are generally less frequent along the southeast end of the LBC beaches and are consistently above the geometric mean WQO near the mouth of the LAR Estuary (note: while Station B5 is categorized as medium, it is just shy of the high category at 29.5 percent exceedance). This map also clearly shows several mid-beach stations with high exceedance rates (LB-Molino [B60], LB-W. Belmont [B8] and LB-E. Belmont [B3]). As discussed in the freshwater data analysis section of this memo, storm drains discharge near these stations.

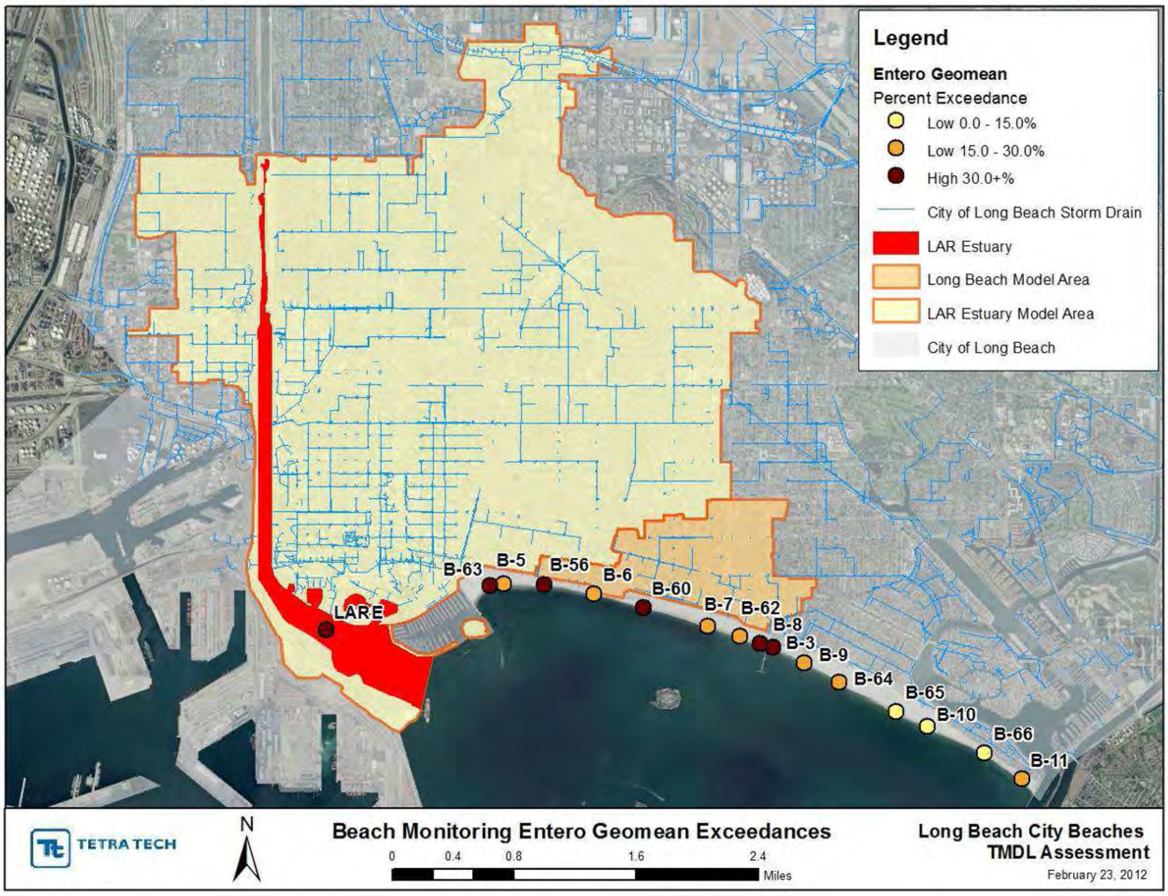


Figure 4. ***Enterococcus*** **exceedances of the geometric mean standard**

Percent exceedance of the single sample maximum WQOs by season for *enterococcus*, total coliform, fecal coliform, and total exceedance days at monitoring sites along the LBC beaches and the LAR Estuary are presented in Table 7 (note: total exceedance days identify the percentage of days that any of the marine bacteria WQOs [Table 2] are exceeded). Consistent with the TMDL, three distinct seasons are presented: summer dry, winter dry, and wet weather. Wet weather conditions are days with 0.1 inches of rain or more plus the subsequent three days, regardless of the month in which the rainfall occurs. Dry conditions are all other days (i.e., non-wet), but are further separated into summer and winter periods. The summer months range from April to October while the winter months are November through March.

Table 7. Beach Stations: Seasonal monitoring exceedances by parameter (2000-2010)

Site ID	Station Name	Summer Dry Percent Exceedance				Winter Dry Percent Exceedance				Wet Weather Percent Exceedance			
		Total Coliform	Fecal Coliform	Entero-coccus	Exc. Days	Total Coliform	Fecal Coliform	Entero-coccus	Exc. Days	Total Coliform	Fecal Coliform	Entero-coccus	Exc. Days
Long Beach City Beaches													
B63	LB-3rd Place	5.2%	6.9%	7.7%	16.8%	2.9%	8.0%	13.0%	20.4%	35.1%	24.3%	48.6%	56.8%
B5	LB-5th Place	4.2%	5.6%	7.1%	16.3%	4.5%	5.1%	9.6%	16.0%	32.7%	30.6%	44.9%	51.0%
B56	LB-10th Place	3.6%	7.6%	8.0%	17.1%	2.7%	2.7%	6.7%	12.7%	38.0%	34.0%	44.0%	48.0%
B6	LB-16th Place	3.1%	6.9%	6.6%	15.5%	4.2%	6.3%	14.0%	20.1%	26.3%	21.1%	36.8%	36.8%
B60	LB-Molino	2.6%	5.4%	7.5%	14.0%	3.1%	9.3%	16.4%	24.8%	36.7%	34.7%	51.0%	51.0%
B7	LB-Coronado Ave.	1.8%	4.1%	6.8%	11.1%	3.2%	4.5%	10.9%	16.0%	36.7%	36.7%	44.9%	49.0%
B62	LB- 36th Place	3.1%	6.6%	6.3%	14.1%	3.0%	3.8%	7.5%	14.3%	32.4%	32.4%	40.5%	45.9%
B8	LB-W. Belmont Pier	2.7%	6.5%	17.7%	22.8%	1.4%	5.7%	8.7%	14.3%	48.1%	59.3%	70.4%	81.5%
B3	LB-E. Belmont Pier	2.8%	5.6%	11.2%	14.8%	3.8%	1.9%	7.8%	15.1%	41.2%	41.2%	47.1%	58.8%
B9	LB-Prospect	1.5%	4.4%	7.1%	11.1%	1.4%	4.1%	6.1%	10.1%	29.2%	31.3%	33.3%	39.6%
B64	LB-Granada	0.6%	6.3%	6.2%	12.6%	1.4%	2.1%	4.9%	7.6%	31.3%	31.3%	37.5%	45.8%
B65	LB-54th Place	1.1%	4.3%	6.4%	9.7%	0.8%	3.1%	6.2%	6.9%	25.0%	22.2%	27.8%	36.1%
B10	LB-55th Place	0.6%	2.8%	4.0%	6.1%	0.7%	0.7%	4.2%	5.6%	29.8%	27.7%	29.8%	36.2%
B66	LB-62nd Place	0.7%	3.7%	3.0%	6.6%	2.3%	2.3%	6.2%	8.5%	32.4%	27.0%	32.4%	37.8%
B11	LB-72nd Place	0.6%	4.3%	6.4%	9.8%	3.4%	4.8%	10.7%	15.6%	30.6%	28.6%	38.8%	44.9%
Los Angeles River Estuary													
LARE	LAR Estuary	52.3%	n/s	8.0%	56.8%	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s

n/s = Not sampled

At all stations, the wet weather *enterococcus* percent exceedance was higher than the summer or winter dry season values. Specifically, at the LBC beaches, the *enterococcus* exceedances ranged from three to 18 percent during the summer dry season, four to 16 percent during the winter dry season, and 28 to 70 percent during wet weather. The *enterococcus* percent exceedance for the LAR Estuary was eight percent for the summer dry period only (note: winter dry and wet weather data were not available at this station). Overall, the West Belmont Pier station (B8) had the highest percent exceedance (70 percent during wet weather). This station is located near a stormdrain outfall as well as in close proximity to a dog-friendly beach zone.

The seasonal analyses for summer dry, winter dry, and wet weather conditions are further illustrated by Figure 5, Figure 6, and Figure 7, respectively. These maps present the percentage of total exceedance days at each station. This statistic considers exceedance of any one of the marine WQOs (Table 2). For example, if any one of the WQOs is exceeded on a given day, that day is considered an "exceedance day." Therefore, this discussion considers all of the bacterial indicators, not just *enterococcus*.

A map of the percentage of total exceedance days during summer dry conditions is shown in Figure 5. As illustrated below, all of the LBC beaches monitoring locations on the southeastern end of the beach segment had low exceedance frequencies (below 15 percent). Moving westward, the West Belmont Pier location (B8) was the first station categorized with a medium exceedance. Closer to the LAR Estuary, exceedance frequencies were generally in the medium category (15 to 30 percent exceedance), while the LAR Estuary station had the highest exceedance frequency (57 percent overall – this is largely driven by exceedances of the total coliform WQO as described below).

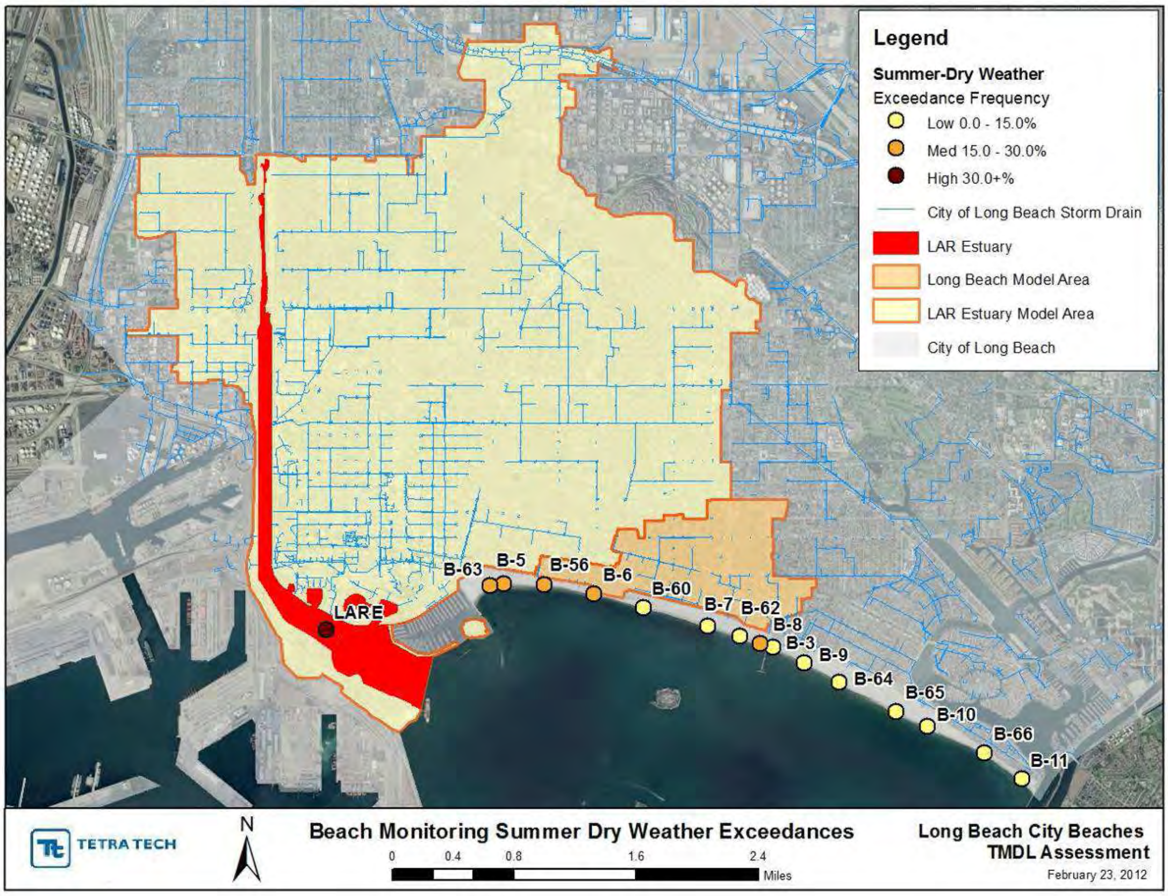


Figure 5. Exceedance frequencies during summer dry conditions

Figure 6 illustrates the exceedance frequencies associated with the winter dry weather condition. The results are generally similar to the summer dry figure above; however, more stations are identified as medium exceedance frequencies (15 to 30 percent). The stations on the southeast end of the beach segment tend to have lower exceedance frequencies than those on the western side, near the LAR Estuary. One exception to this rule is the station closest to the mouth of Alamitos Bay (B11), which had an exceedance frequency of 16 percent during winter dry conditions, likely due to local sources or wind transport (Kinnetic Laboratory, Inc., 2009a) (see Appendix D for further discussion on the influence of Alamitos Bay/San Gabriel River during the different TMDL seasons). All of the LAR Estuary monitoring occurred during the summer dry conditions; therefore, there are no data for this station during this period.

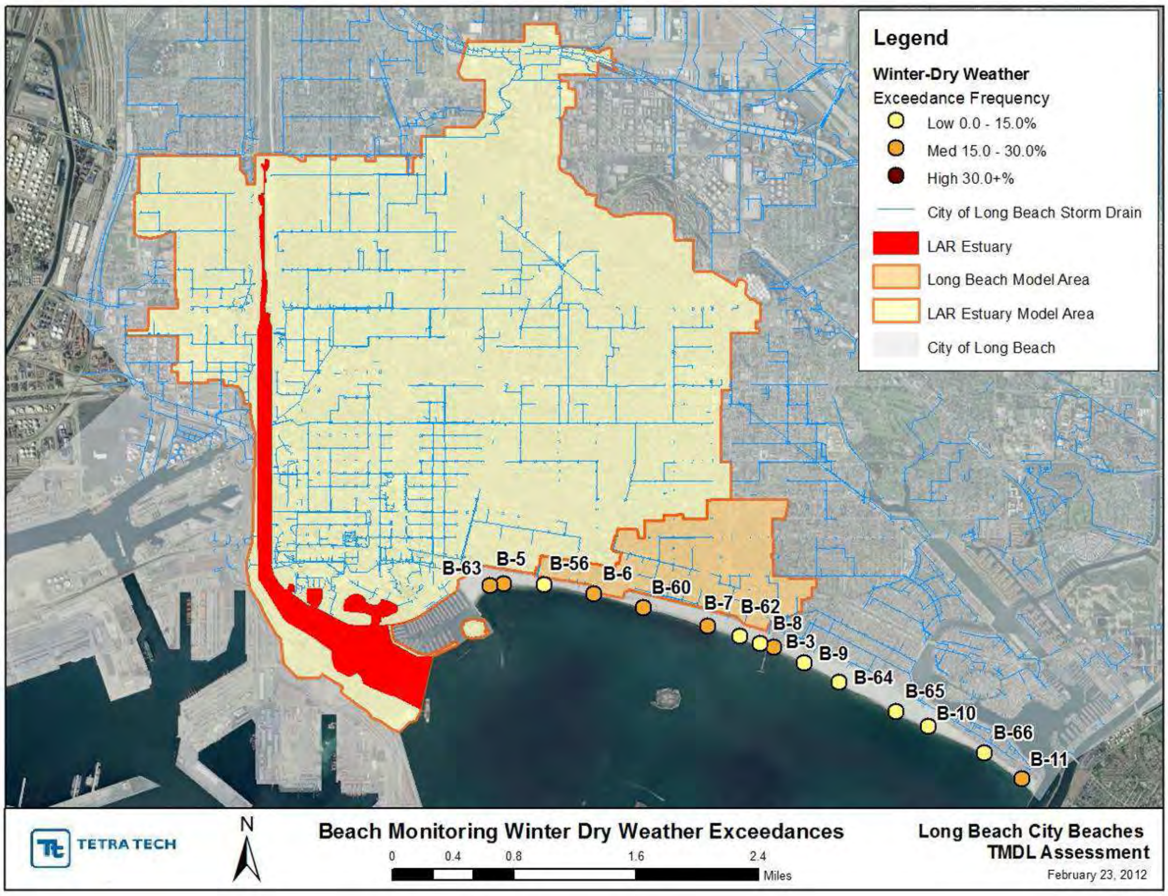


Figure 6. Exceedance frequencies during winter dry conditions

Wet weather exceedance frequencies are presented by station in Figure 7. Each of these stations had an exceedance frequency above 30 percent and was therefore categorized as high. Even though all of these stations were identified as "high", there was significant variability in the exceedance frequencies when comparing stations (Table 7). The wet weather exceedance frequencies ranged from 36 to 82 percent. Similar to the maps presented for summer dry and winter dry conditions above, the wet weather exceedance frequencies were generally lower at the southeast end of the beach segment. The highest exceedances were observed at LB-W. Belmont (B8) and LB-E. Belmont (B3), with 82 and 59 percent exceedances, respectively. The stormdrain outfall near the Belmont Pier is like discharging during wet weather events, which could contribute to these high exceedances. As noted above, the LAR Estuary only had data during summer dry conditions; therefore, no data were available to characterize exceedances at this station during wet weather.

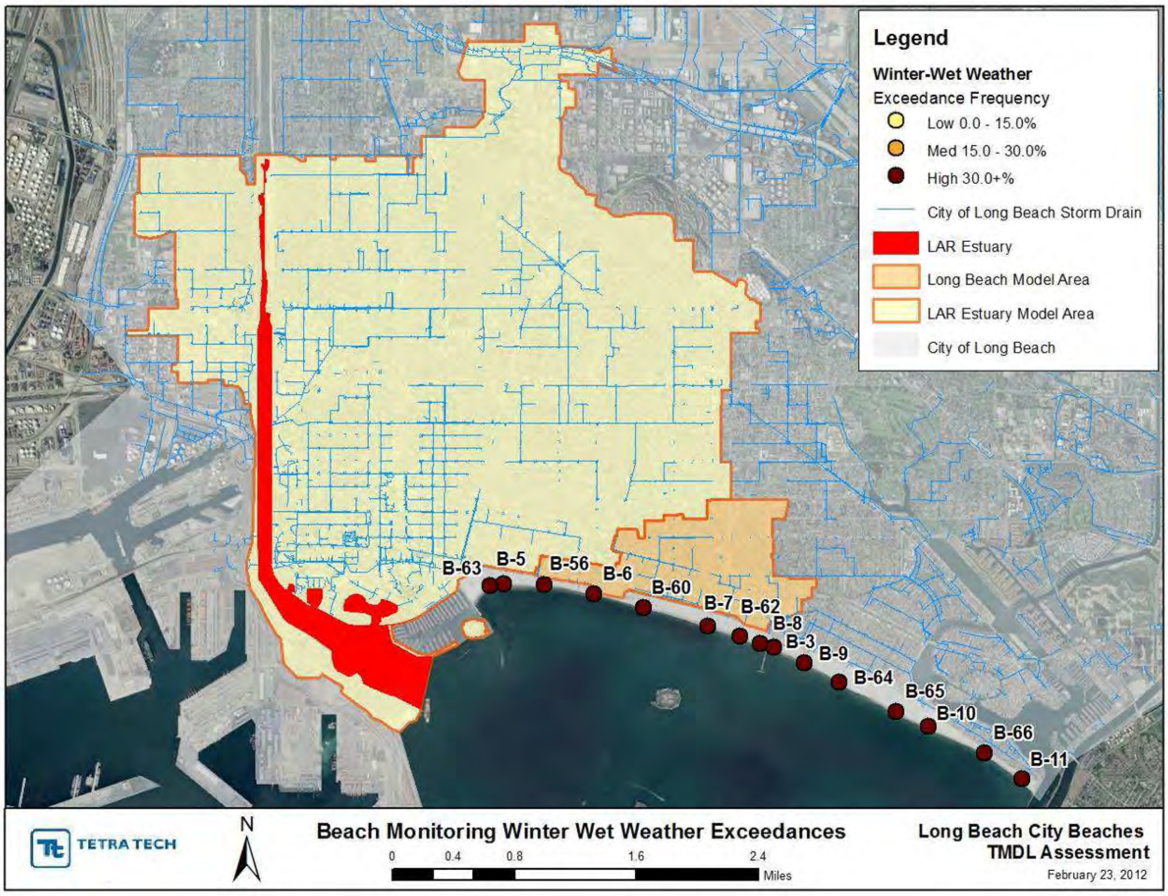


Figure 7. Exceedance frequencies during wet weather conditions

Fecal Coliform Monitoring

As previously noted, most agencies do not measure for fecal coliform directly. Specifically, the City of Long Beach measures *E. coli* using Colilert and multiplies the results by 1.3 to estimate fecal coliform. AB411 monitoring in Los Angeles County performs similar analyses and reports the results directly as fecal coliform (without any additional data translation; note: comparative studies have found no statistically significant difference between results for the two indicator bacteria). The annual geometric mean of fecal coliform measured at the LBC beaches monitoring stations from 2000 to 2010 are shown in

Figure 8 (note: fecal coliform data were not available at the LAR Estuary station). Similar to the *enterococcus* analyses, the shade selection for each site is determined by the location of the monitoring site with respect to the mouth of the Los Angeles River. The darker shades represent monitoring sites closest to the Los Angeles River. Shades become lighter in color as the monitoring site location moves southeast and farther from the Los Angeles River.

In 2006, a peak in the annual fecal coliform geometric mean was experienced at all sites as illustrated in Figure 8, this peak in the annual geometric mean ranged from 80 to 155 CFU/100 mL. The highest peaks of about 155 CFU/100 mL were experienced at LB-Molino (B60) and 16th Place (B6). Southern sites including LB-55th Place (B10), LB-54th Place (B65), LB-62nd Place (B66) and LB-72nd Place (B11) experienced a peak in 2006 of a lesser magnitude, ranging from 80 to 100 CFU/100 mL.

For most southeastern sites fecal coliform geometric mean trends tend to remain constant and below 40 CFU/100 mL with the exception of the 2006 annual geometric mean peak. As for the northwestern-most sites closer to the mouth of the Los Angeles River, no temporal trend over the 10 year period is clear; however, the fecal coliform geometric means at sites closer to the Los Angeles River Estuary mouth consistently appear to be higher than the more southeastern sites. This evaluation indicated that no annual geometric means were above the marine fecal coliform WQO of 200 CFU/100 mL.

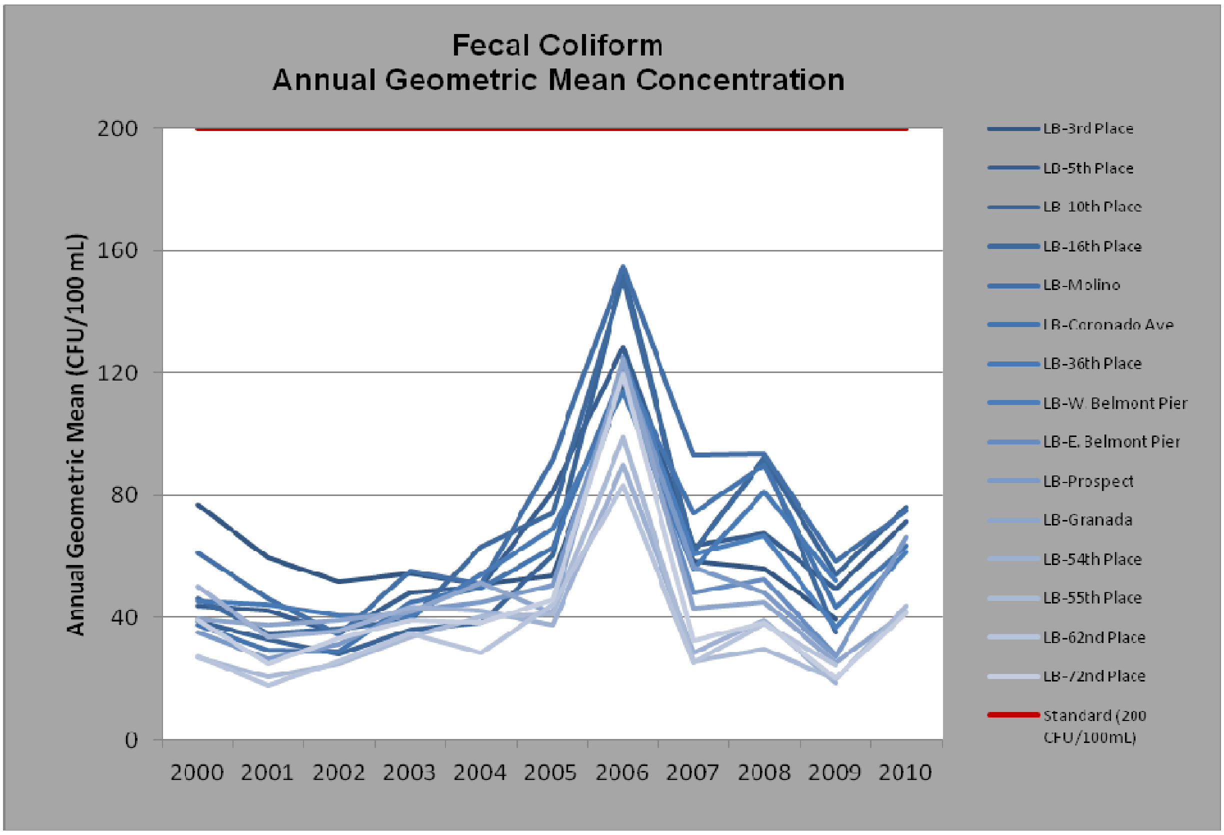


Figure 8. Annual fecal coliform geometric mean at beaches

Similar to the *enterococcus* analyses above, continuous fecal coliform concentrations were evaluated at each site using timeseries plots (presented in Attachment 2). The graphs were developed using all data (compared to single sample maximum WQOs) and the calculated rolling geometric means (compared to the geometric mean WQO). Concentrations of fecal coliform are extremely variable at each site with concentrations ranging from less than 10 CFU/100 mL to over 10,000 CFU/100 mL. This variability is expected with bacteria data. For the LBC beaches, the greatest number of single sample and geometric mean exceedances (points plotted above the criteria) occurred mid-way along the impaired segment.

Percentages of single sample exceedances and geometric mean exceedances from monitoring sites along LBC beaches are presented in Table 8. Single-sample percent exceedances ranged from approximately 4 to 11 percent within the LBC beach segment (note: fecal coliform data were not available at the LAR Estuary station). Consistent with the *enterococcus* results, the West Belmont Pier (B8) station had the highest single sample exceedance rate. Percent of fecal coliform geometric mean exceedances, ranging from approximately 5 to 13 percent, were slightly higher than the single sample exceedances (note: East Belmont Pier had the highest geometric mean exceedance rate).

Table 8. Beach Stations: Fecal coliform exceedance summary for 2000-2010

Site ID	Station Name	Number of Fecal Single Sample Exceedances	Total Number of Fecal Single Samples	Percent of Fecal Single Sample Exceedances	Number of Fecal Coliform Geomean Exceedances	Total Number of Fecal Geomean Samples	Percent of Fecal Geomean Exceedances
Long Beach City Beaches							
B63	LB-3rd Place	40	465	8.6%	112	1,065	10.5%
B5	LB-5th Place	43	560	7.7%	114	1,409	8.1%
B56	LB-10th Place	48	557	8.6%	142	1,381	10.3%
B6	LB-16th Place	37	472	7.8%	124	1,165	10.6%
B60	LB-Molino	51	561	9.1%	157	1,434	10.9%
B7	LB-Coronado Ave.	39	547	7.1%	121	1,270	9.5%
B62	LB-36th Place	36	460	7.8%	127	1,002	12.7%
B8	LB-W. Belmont Pier	32	281	11.4%	103	874	11.8%
B3	LB-E. Belmont Pier	14	178	7.9%	61	460	13.3%
B9	LB-Prospect	36	537	6.7%	114	1,089	10.5%
B64	LB-Granada	40	541	7.4%	108	1,249	8.6%
B65	LB-54th Place	24	444	5.4%	55	849	6.5%
B10	LB-55th Place	23	516	4.5%	44	941	4.7%
B66	LB-62nd Place	23	439	5.2%	42	762	5.5%
B11	LB-72nd Place	35	523	6.7%	73	1,036	7.0%
Los Angeles River Estuary							
LARE	LAR Estuary	n/s	n/s	n/s	n/s	n/s	n/s

n/s = Not sampled

Table 7 above presents the seasonal exceedance summaries for all parameters, including fecal coliform. The fecal coliform patterns observed were very similar to those for *enterococcus*. Specifically, the wet weather percent exceedances were higher than the summer or winter dry condition rates. There were no fecal coliform data for the LAR Estuary; therefore, exceedance summaries are not presented for that waterbody. For the LBC beaches, the fecal coliform exceedances ranged from three to eight percent during the summer dry season, one to ten percent during the winter dry season, and 21 to 59 percent during wet weather. These ranges are generally lower than those for *enterococcus*; however, spatial patterns are consistent (i.e., the West Belmont Pier station [B8] had the highest wet weather percent exceedance and the stations closer to LAR Estuary generally have higher fecal coliform exceedances than those towards the southeast end of the beach segment).

Total Coliform Monitoring

The annual geometric mean of total coliform measured at the LBC beaches and LAR Estuary monitoring stations from 2000 to 2010 are shown in Figure 9. The shade selection for each site is determined by the location of the monitoring site with respect to the mouth of the Los Angeles River. The darker shades represent monitoring sites closest to the Los Angeles River. Shades become lighter in color as the monitoring site location moves farther south and away from the Los Angeles River.

Monitoring sites closer to the Los Angeles River and shown in dark blue have a higher geometric mean trend compared to the monitoring sites farthest from the Los Angeles River (Figure 9, shown in a log scale). Data for the LAR Estuary were only available for summer months during 2009 and 2010. These data are shown in the darkest blue color and have the highest geometric means, when compared to all monitoring stations along the LBC beaches. The monitoring sites with the lowest annual geometric mean include LB-Granada (B64), LB-55th Place (B10), LB-54th Place (B65) and LB-62nd Place (B66). Monitoring site LB-72nd Place (B11), although farthest from the Los Angeles River, had a higher annual geometric than the monitoring sites northeast of LB-72nd Place. This suggests that local sources in the vicinity of the LB -72nd Place monitoring site may be influencing total coliform concentrations in that area. Also demonstrated in Figure 9, all LBC beaches sites experienced a decline in annual total coliform geomeans in 2009. This evaluation indicated that no annual geometric means were above the WQO of 1,000 CFU/100 mL, with the exception of the LAR Estuary station.

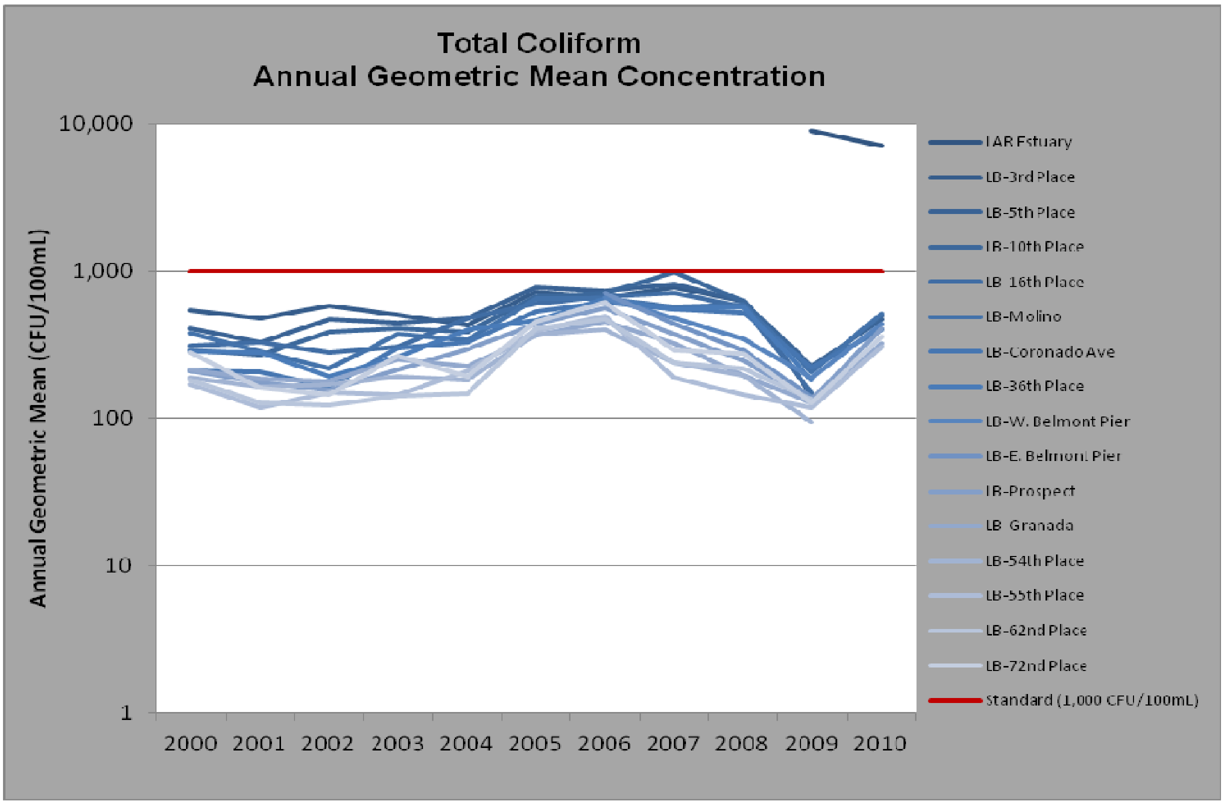


Figure 9. Annual total coliform geometric mean at beaches

Similar to the *enterococcus* and fecal coliform analyses, site-specific continuous total coliform concentrations were evaluated in Attachment 2. Specifically, timeseries plots were developed using all data (compared to single sample maximum WQOs) and the calculated rolling geometric means (compared to the geometric mean WQO). Total coliform concentrations ranged from less than 10 CFU/100 mL to over 10,000 CFU/100 mL. Similar spatial trends were observed when compared to *enterococcus* – monitoring sites located closer to the Los Angeles River generally exhibit a greater number of elevated concentrations and both single sample and geometric mean exceedances (those plotted above the criteria lines).

Percentages of single sample exceedances and geometric mean exceedances from monitoring sites along the LBC beaches and LAR Estuary are presented in Table 9. For the LBC beaches, single sample percent exceedances ranged from three to seven percent. Along the LBC beaches there was a clear distinction in total coliform geometric mean exceedances between the northern and southern sites. For the southern stations, Prospect Avenue to 72nd Place sites (B9 southeast to B11), the total coliform geometric mean percent exceedance ranged from about 6 to 16 percent. For the northwestern sites, 3rd Place to E. Belmont Pier (B63 southeast to B8), the total coliform geometric mean percent exceedances were higher and ranged from about 18 to 38 percent. The LAR Estuary station had values of 52 and 100 percent for the single sample and geometric mean exceedances, respectively.

Table 9. Beach Stations: Total coliform exceedance summary for 2000-2010

Site ID	Station Name	Number of Total Coliform Single Sample Exceedances	Total Number of Total Coliform Single Samples	Percent of Total Coliform Single Sample Exceedances	Number of Total Coliform Geomean Exceedances	Total Number of Total Coliform Geomean Samples	Percent of Total Coliform Geomean Exceedances
City of Long Beach Beaches							
B63	LB-3rd Place	32	465	6.9%	404	1,065	37.9%
B5	LB-5th Place	38	560	6.8%	375	1,409	26.6%
B56	LB-10th Place	36	557	6.5%	359	1,381	26.0%
B6	LB-16th Place	25	472	5.3%	296	1,165	25.4%
B60	LB-Molino	32	561	5.7%	289	1,434	20.2%
B7	LB-Coronado Ave.	29	547	5.3%	227	1,270	17.9%
B62	LB- 36th Place	25	460	5.4%	201	1,002	20.1%
B8	LB-W. Belmont Pier	19	281	6.8%	137	874	15.7%
B3	LB-E. Belmont Pier	12	178	6.7%	115	460	25.0%
B9	LB-Prospect	21	537	3.9%	122	1,089	11.2%
B64	LB-Granada	19	541	3.5%	118	1,249	9.4%
B65	LB-54th Place	13	444	2.9%	48	849	5.7%
B10	LB-55th Place	17	516	3.3%	63	941	6.7%
B66	LB-62nd Place	17	439	3.9%	64	762	8.4%
B11	LB-72nd Place	22	523	4.2%	167	1,036	16.1%
Los Angeles River Estuary							
LARE	LAR Estuary	46	88	52.3%	308	308	100.0%

2.2. Freshwater Bacteria Analysis

Four freshwater mass emission sites have been monitored by the City of Long Beach. These include: Belmont Pump, Bouton Creek, Dominguez Gap, and Los Cerritos Channel. Mass emission sites were sampled during both wet and dry weather and include *enterococcus*, fecal coliform, total coliform, and a more limited number of *fecal streptococus*. The locations of the four monitoring points are identified in Figure 10. As shown by the figure, these sites do not discharge directly to the impaired LBC beaches; however, they are included within this analysis due to the corresponding receiving waters' potential to impact the impaired beaches (see Appendix D). In addition, if the land uses are similar, these data could be useful to characterize the magnitude of concentrations observed in the stormdrains of the direct drainages.

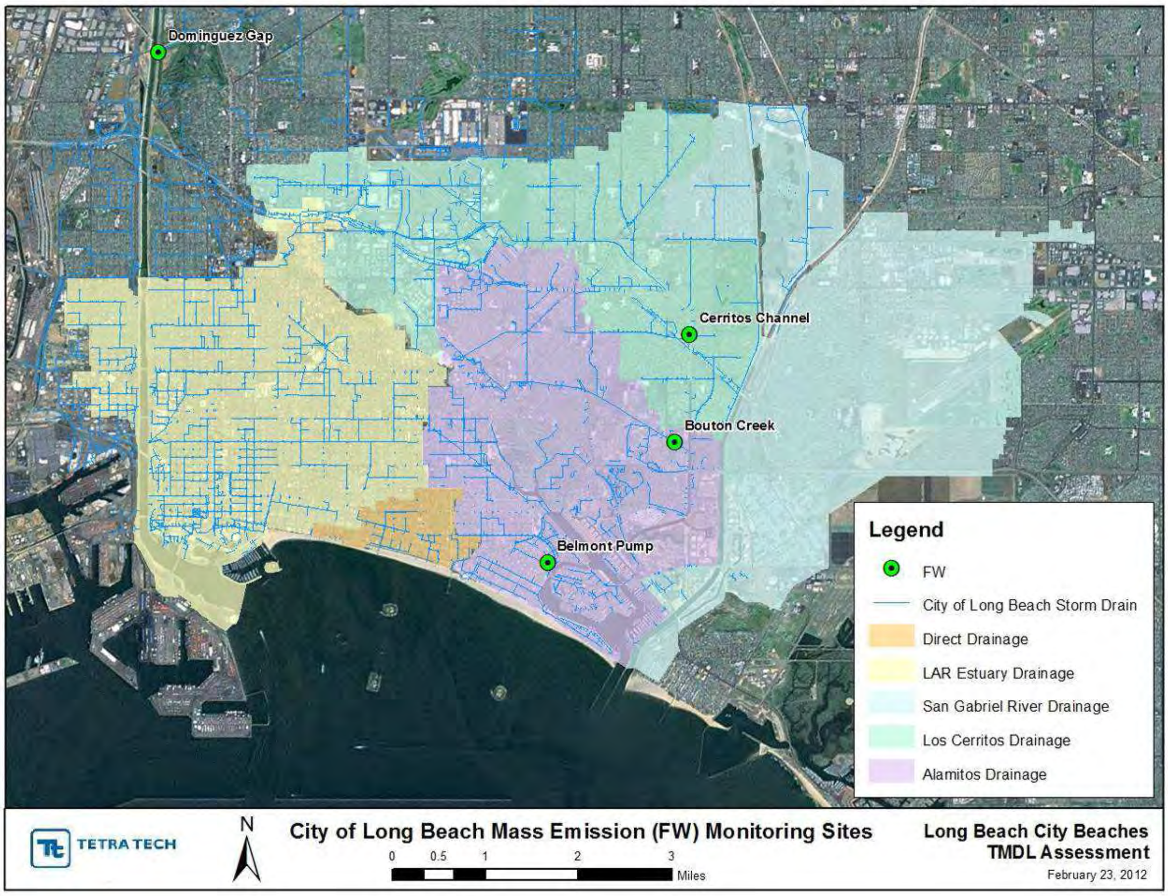


Figure 10. Location of City of Long Beach freshwater monitoring stations

As shown in Table 10 through Table 13, a large majority of the freshwater data are found to be in exceedance of the single sample bacteria standard. It should be noted that due to limited sampling (the absence of five samples within 30 days), data were not analyzed in relation to the geometric mean standard. Additionally, the freshwater data were assessed using marine standards due to lack of *E. coli* data and/or applicable freshwater standards (only an *E. coli* WQO is available for freshwater REC-1). Summary statistics and percentages of wet weather single sample exceedances of the mass emission monitoring sites are presented in Table 10 and Table 11, respectively. Fecal streptococcus was only sampled three to five times for each site. The freshwater wet weather samples show a regular exceedance of *marine* WQOs for all four sites. Overall, single-sample percent exceedances ranged from 94 to 100 percent over the 9 years of monitoring data (Table 11). This trend is seen in *enterococcus*, fecal coliform, and total coliform. Percent of single sample *enterococcus* exceedances were highest for Los Cerritos Channel with 100 percent exceedances of the 35 CFU/100 mL *marine* WQO. Percent of single sample fecal coliform and total coliform exceedances were highest for Dominguez Gap, both with exceedances of 100 percent. All four mass emission sites had peak fecal coliform and total coliform of 1,600,000 CFU/100 mL. The numeric targets for *marine* standards for fecal coliform is 400 CFU/100 mL and is 10,000 CFU/100 mL for total coliform.

Table 10. Freshwater Stations: Wet weather freshwater mass emission summary statistics

Station Name	Parameter	Number	Start Date	End Date	Minimum (CFU/100mL)	Maximum (CFU/100mL)	Geomean (CFU/100mL)
Wet Weather Samples							
Belmont Pump	Entero	37	11/12/2001	2/5/2010	39	174,000	10,803
	Fecal coliform	40	2/23/2001	2/5/2010	171	1,600,000	19,361
	Fecal Strep	3	2/23/2001	4/8/2001	10,000	19,500	13,774
	Total coliform	40	2/23/2001	2/5/2010	5,000	1,600,000	8,326
Bouton Creek	Entero	34	11/13/2001	2/5/2010	57	70,000	98,789
	Fecal coliform	38	1/27/2001	2/5/2010	230	1,600,000	6,732
	Fecal Strep	4	1/27/2001	4/9/2001	2,360	12,400	50,854
	Total coliform	38	1/27/2001	2/5/2010	700	1,600,000	8,326
Dominguez Gap	Entero	29	2/13/2003	2/5/2010	26	120,000	10,662
	Fecal coliform	32	2/13/2001	2/5/2010	1,300	1,600,000	13,704
	Fecal Strep	3	2/13/2001	3/6/2001	8,100	19,200	13,882
	Total coliform	32	2/13/2001	2/5/2010	11,000	1,600,000	67,637
Los Cerritos Channel	Entero	34	11/13/2001	2/5/2010	109	158,000	10,451
	Fecal coliform	39	1/27/2001	2/5/2010	300	1,600,000	16,649
	Fecal Strep	5	1/27/2001	4/21/2001	1,640	12,000	7,007
	Total coliform	39	1/27/2001	2/5/2010	2,800	1,600,000	85,538

Table 11. Freshwater Stations: Exceedance summary for wet weather freshwater mass emission sites

Site Name	Number of Entero Single Sample Exceedances	Total Number of Entero Single Samples	Percent of Entero Single Sample Exceedance
Belmont Pump	36	37	97.30%
Bouton Creek	32	34	94.12%
Dominguez Gap	28	29	96.55%
Los Cerritos Channel	34	34	100.00%
Site Name	**Number of Single Sample Fecal Coliform Exceedances**	**Total Number of Fecal Coliform Single Samples**	**Percent of Fecal Coliform Single Sample Exceedance**
Belmont Pump	39	40	97.50%
Bouton Creek	36	38	94.74%
Dominguez Gap	32	32	100.00%
Los Cerritos Channel	38	39	97.44%

Site Name	Number of Single Sample Total Coliform Exceedances	Total Number of Total Coliform Single Samples	Percent of Total Coliform Single Sample Exceedance
Belmont Pump	39	40	97.50%
Bouton Creek	37	38	97.37%
Dominguez Gap	32	32	100.00%
Los Cerritos Channel	37	39	94.87%

Note: Freshwater data were compared to marine WQO since freshwater WQO were not available for the parameters sampled.

Statistics and percentages of dry weather single sample exceedances of the mass emission monitoring sites are presented in Table 12 and Table 13 (note: the Belmont Pump Station no longer discharges into Alamitos Bay during the summer-dry weather period). There are fewer dry weather samples than wet weather. The dry weather samples show occasional exceedances that vary by site and indicator bacteria. The dry weather exceedances are not as significant as wet weather exceedances; however, there are exceedances for the majority of the samples. Percent of single sample *enterococcus* exceedances (above the 35 CFU/100mL *marine* WQO) were highest for Belmont Pump and Los Cerritos Channel, both having exceedances of 100 percent. Belmont Pump had the highest single sample fecal coliform exceedances at 93 percent. Percent of single sample total coliform exceedances were highest at Los Cerritos Channel with 63 percent. For all indicator bacteria, Dominguez Gap had a zero percent exceedance; however, only two dry weather samples were collected at the site. In general, dry weather samples tended to be somewhat less impacted by bacterial contamination than wet weather samples, yet they were still found to be in exceedance of the *marine* WQOs the majority of the time (Table 13).

Table 12. Freshwater Stations: Dry weather freshwater mass emission summary statistics

Station Name	Parameter	Number	Start Date	End Date	Minimum (CFU/100mL)	Maximum (CFU/100mL)	Geomean (CFU/100mL)
Dry Weather Samples							
Belmont Pump*	Entero	11	5/9/2002	5/17/2007	1,160	6,000	2,625
	Fecal coliform	15	6/21/2000	5/17/2007	110	30,000	3,132
	Fecal Strep	3	6/21/2000	6/5/2001	117	1,496	487
	Total coliform	15	6/21/2000	5/17/2007	900	90,000	16,744
Bouton Creek	Entero	14	5/14/2002	5/11/2010	70	5,500	1,088
	Fecal coliform	18	6/21/2000	5/11/2010	23	11,000	524
	Fecal Strep	3	6/21/2000	6/5/2001	130	453	248
	Total coliform	18	6/21/2000	5/11/2010	30	90,000	4,511
Dominguez Gap	Entero	2	10/12/2009	5/11/2010	10	60	25
	Fecal coliform	2	10/12/2009	5/11/2010	40	70	53
	Fecal Strep	n/a	n/a	n/a	n/a	n/a	n/a
	Total coliform	2	10/12/2009	5/11/2010	500	500	500
Los Cerritos Channel	Entero	17	5/9/2002	5/11/2010	210	57,600	1,991
	Fecal coliform	19	6/5/2001	5/11/2010	80	30,000	1,902
	Fecal Strep	1	6/5/2001	6/5/2001	864	864	864
	Total coliform	19	6/5/2001	5/11/2010	300	160,000	12,853

n/a = Not available
*Belmont Pump no longer discharges to Alamitos Bay during the summer-dry weather period.

Table 13. Freshwater Stations: Exceedance summary for dry weather freshwater mass emission sites

Site Name	Number of Entero Single Sample Exceedances	Total Number of Entero Single Samples	Percent of Entero Single Sample Exceedance
Belmont Pump*	11	11	100.00%
Bouton Creek	13	14	92.86%
Dominguez Gap	0	2	0.00%
Los Cerritos Channel	17	17	100.00%
Site Name	**Number of Single Sample Fecal Exceedances**	**Total Number of Fecal Coliform Single Samples**	**Percent of Fecal Coliform Single Sample Exceedance**
Belmont Pump*	14	15	93.33%
Bouton Creek	8	18	44.44%
Dominguez Gap	0	2	0.00%
Los Cerritos Channel	15	19	78.95%
Site Name	**Number of Single Sample Total Coliform Exceedances**	**Total Number of Total Coliform Single Samples**	**Percent of Total Coliform Single Sample Exceedance**
Belmont Pump*	9	15	60.00%
Bouton Creek	7	18	38.89%
Dominguez Gap	0	2	0.00%
Los Cerritos Channel	12	19	63.16%

Note: Freshwater data were compared to *marine* WQO since freshwater WQO were not available for the parameters sampled.
*Belmont Pump no longer discharges to Alamitos Bay during the summer-dry weather period.

As previously noted, the freshwater data were compared to *marine* WQO because freshwater WQO were not available for the parameters analyzed. However, it is significant to note that many of the stations have 100 percent exceedances of marine standards. These stations may be representative of outfalls in the region that may impact water quality of the LBC beaches.

2.3. City of Long Beach Recreational Water Quality Microbial Source Investigation Open Coastal Beaches

To supplement the routine city monitoring, a special microbial source tracking (MST) study was conducted for the City of Long Beach by Kinnetic Laboratories (2009a). Phase I of this study included 24-hour and 30-day bacterial monitoring in which sites from the mouth of the Los Angeles River Estuary (located between Queen Mary and Shoreline Harbor; this location is closer to the estuary mouth than the LARE station presented in Figure 2), southeast towards the mouth of the San Gabriel River Estuary were monitored hourly or daily, respectively. Monitoring, including *E. coli*, *enterococcus*, and total coliform, sought to evaluate temporal and spatial bacterial trends. The second phase of the Kinnetic Laboratories studies included more advanced microbial source tracking utilizing *Bacteroides* during high and low tide. Phase II also investigated the concentrations of fecal bacteria in beach sands and groundwater within the project area. Data and results from both of the study phases are summarized below.

Phase I Investigation
The 30-day investigation took place late in the dry weather season during which one rain event occurred on September 22, 2007. A geographic trend indicated that the west end of the LBC beaches is more impacted by fecal indicator bacteria (FIBs) compared to sites east of Belmont Pier. Additionally, this investigation found elevated levels of total coliform and *E. coli* at the mouth of the Los Angeles River. Results from Phase I investigation are shown in Figure 11 through Figure 14.

In Figure 11, the 30-day geometric mean trends of several LBC beaches sites are shown for *enterococcus*, *E. coli*, and total coliform bacteria in green, black, and orange lines, respectively. This figure shows significantly higher geometric means for total coliform and *E. coli* compared to *enterococcus* at the mouth of the Los Angeles River. The MST study suggests that the presence of duckweed may influence the concentrations of fecal indicator bacteria. A preliminary test indicated that duckweed may act as a sink for *enterococcus* and, as a result, may have a more influence on *enterococcus* levels than *E. coli* or total coliform.

Figure 11. Freshwater Stations: City of Long Beach 30-day geometric means from microbial source tracking study
(See Figure 2 for location of beach monitoring sites; the LARE station in Figure 2 is farther upstream than this LA River station)

The City of Long Beach MST study found that exceedances of the geometric mean criterion for total coliform were most common at sites west of Belmont Pier. Exceedances of the 30-day *enterococcus* criteria were most commonly encountered at sites between LB-10th Place (B56) and LB-16th Place (B6), with monitoring sites east of Prospect Avenue less impacted by *enterococcus*. The MST study indicated that the prevalent wind in the region normally drives the River plume towards the central portion of the beach near Belmont Pier and suggests that under the right conditions light onshore breezes may be sufficient to cause the plume to be directed onto the western end of the beach. Additionally, a salinity analysis showed strong freshwater influences at the westernmost sites suggesting that water quality of nearshore waters can be impacted by the Los Angeles River discharge.

Another notable trend in Figure 11 is the elevated *E. coli* geometric mean at the LB-Molino site. Elevations in FIBs at this site may be attributable to the Molino stormdrain located near the sample site. The MST study also identified and sampled likely sources of FIBs such as major stormdrains. In addition, ponding areas that developed in front of stormdrains were added as sampling sites due to their persistence and high level of bird activity that can impact bacterial concentrations. Summary statistics for these locations are presented in Table 14. Concentrations of *E. coli* measured in ponding water in front of the Molino stormdrain were roughly ten times higher than water coming directly out of the stormdrain. In general, high concentrations from the stormdrains and ponding areas have the potential to influence the water quality of downstream monitoring sites (and potentially other locations along the beach, depending on wind and tidal conditions).

Table 14. Freshwater Stations: Summary statistics for storm drains near the Long Beach City beaches

Site ID	Storm Drain Name	Parameter	Number of Samples	Minimum (CFU/100 mL)	Maximum (CFU/100 mL)	Geomean (CFU/100 mL)
SD1	Molino Avenue Stormdrain	*E. coli*	30	281	29,090	4,507
		Enterococcus	30	10	34,500	3,397
		Total Coliform	30	24,196	2,419,600	92,446
SD 1-Pond	Molino Avenue Stormdrain - Pond	*E. coli*	26	2,987	173,290	25,329
		Enterococcus	26	83	24,196	3,806
		Total Coliform	26	24,196	2,419,600	108,448
SD2	Redondo Street Stormdrain	*E. coli*	2	1,198	1,445	1,316
		Enterococcus	2	1,483	7,270	3,284
		Total Coliform	2	24,196	325,500	88,746
SD 2-Pond	Redondo Street Stormdrain - Pond	*E. coli*	7	581	241,960	5,025
		Enterococcus	7	909	12,033	6,525
		Total Coliform	7	24,196	1,553,100	75,101
SD3	9th Place Stormdrain	*E. coli*	21	10	325,500	8,947
		Enterococcus	21	10	24,196	4,147
		Total Coliform	21	145	2,419,600	57,649
SD5	West Belmont Pier Stormdrain	*E. coli*	29	10	198,630	9,085
		Enterococcus	29	10	27,800	3,624
		Total Coliform	29	10	2,419,600	60,984

Raw data from the MST study were evaluated independently. Specifically, daily measurements for the 30-day period at several LBC beaches sites are shown in Figure 12, Figure 13, and Figure 14 for *enterococcus*, total coliform, and *E. coli*, respectively. In all of these figures, a peak in *enterococcus*, total coliform, and *E. coli* levels for all sites is evident following a rain event that occurred on September 22, 2007. Post-rain event elevations suggest that stormdrains may be influencing the water quality of nearshore waters. This independent evaluation shows that concentrations in the Los Angeles River discharge are higher than the beach stations; however, no other spatial trend is clear. These data should be considered during further investigation to fully characterize the influence of the Los Angeles River on the LBC beaches.

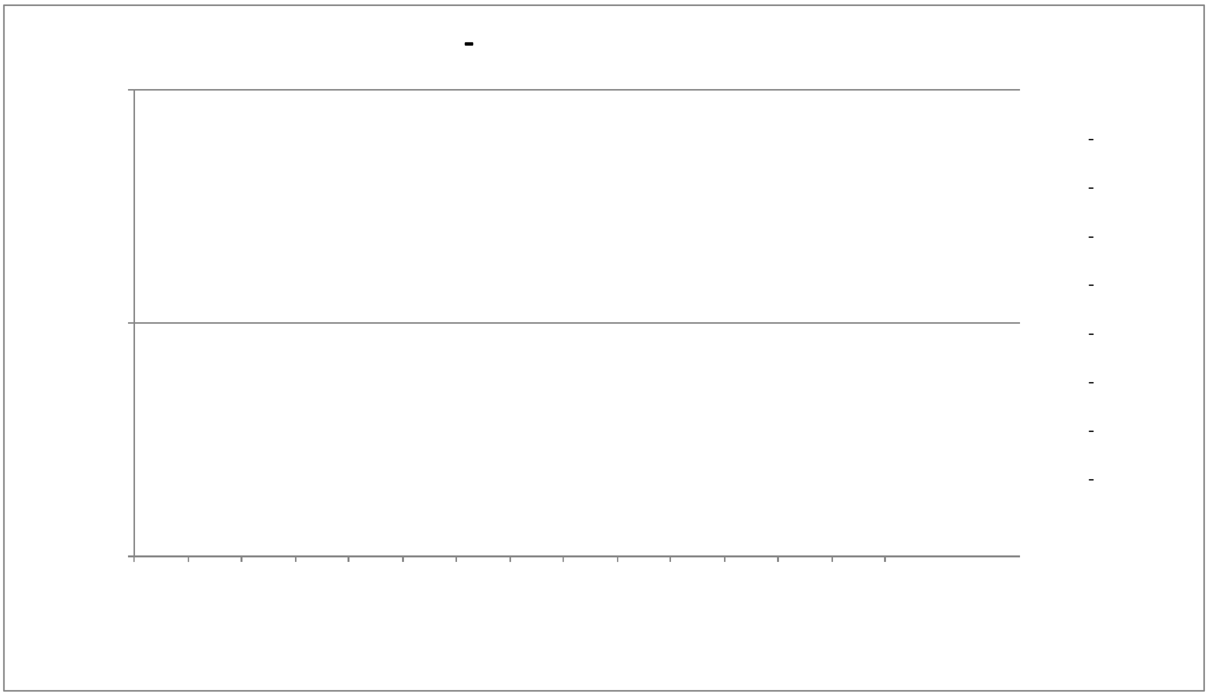


Figure 12. Freshwater Stations: *Enterococcus* 30-day sampling gradient from Los Angeles River, down the shoreline
(Note: detection limit is greater than 10 CFU/100 mL.)

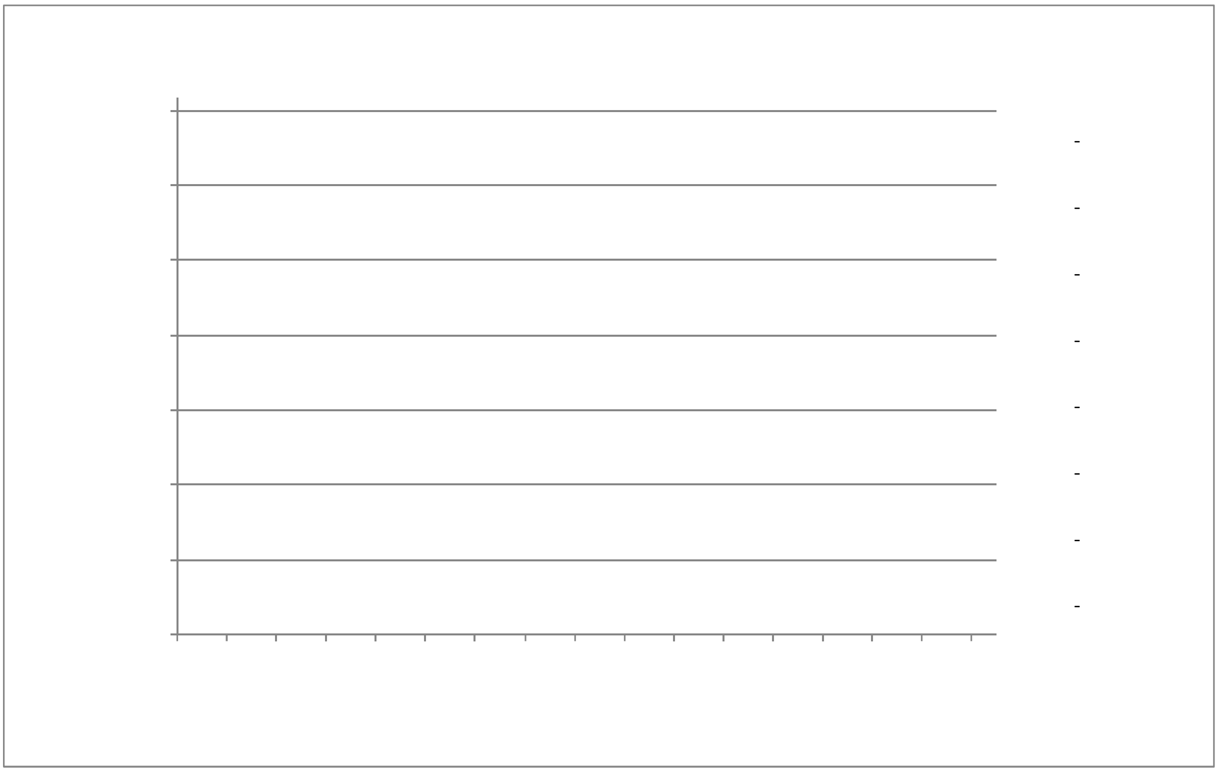


Figure 13. Freshwater Stations: Total coliform 30-day sampling gradient from Los Angeles River, down the shoreline

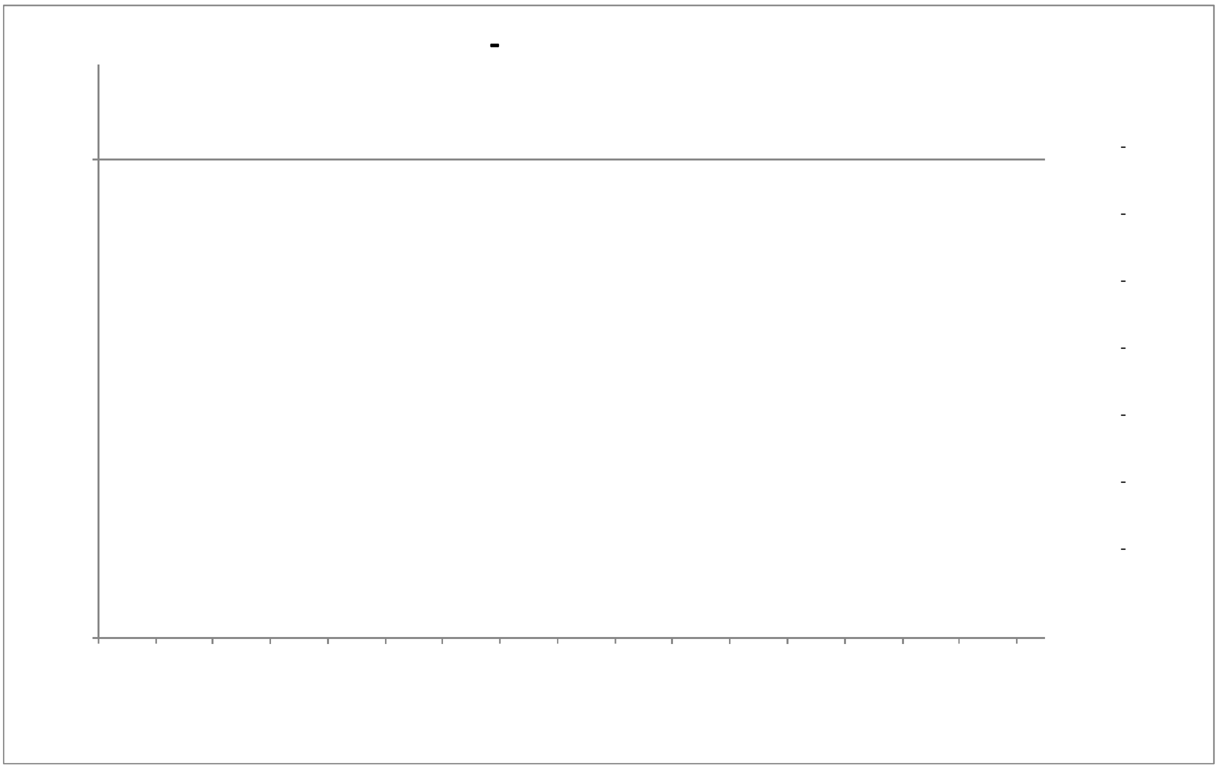


Figure 14. Freshwater Stations: *E. coli* 30-day sampling gradient from Los Angeles River, down the shoreline

The 24-hour study conducted in the Phase I investigation confirmed freshwater intrusion from the Los Angeles River; however, the study found that the freshwater intrusion did not impact *enterococcus* or *E. coli* concentrations. Salinity measurements over the 24-hour study indicated that freshwater was introduced into the western end of the study area primarily during the morning hours. During this time, salinities measured at sites immediately south of the Los Angeles River experience 10 percent reductions whereas sites east of Belmont Pier showed nominal impacts of freshwater input during this time. This depression in salinity in the western end of the beach is likely associated with water from the Los Angeles River, as also noted by the 30-day study. Overall, *enterococcus* and *E. coli* concentrations were lowest during the day and increased at night; however, neither *enterococcus* nor *E. coli* concentrations showed evidence of freshwater influence in the western end of the study area during the time of most freshwater influence.

Phase II investigation

Two microbial source tracking (MST) tests utilizing *Bacteroides* and both enterovirus and adenoviruses were conducted during high and low tide. The results of these two water quality surveys showed no evidence of human, dog, or cow fecal bacteria even with the use of very low detection limits.

The second phase also investigated the concentrations of fecal bacteria in beach sands and groundwater within the project area. This involved sand sampling along three transects starting at the top of the beach berm to investigate subsurface and/or groundwater contamination. The results indicated that the transport of contaminated water by subsurface/groundwater contamination is not likely to be an issue for the westernmost sites. On the other hand, the waters near Belmont Pier and the Molino stormdrains showed slightly elevated concentrations of FIBs in groundwater that were measured after a storm event, but further investigation is necessary. Compared to six similar regional studies, concentrations of total coliform in beach sand from the western end of the beach were the highest. These elevated levels of total coliform may be influenced by the elevated levels of total coliform typical of the Los Angeles River. Concentrations of *E. coli* were consistent with other studies, but *enterococcus* concentrations were among the lowest reported.

3. Additional Studies

In addition to bacterial monitoring, a handful of recent projects have been conducted in and around the area of concern. These include a circulation study on Alamitos Bay, a restoration project on the Colorado Lagoon, a TMDL for the Los Angeles River, and a dry weather monitoring study in Los Cerritos Channel. Each study, as it pertains to the Long Beach City Beaches Bacteria TMDL, is discussed below.

3.1. Los Cerritos Channel Copper and Bacteria Study

A draft report presenting the *Los Cerritos Channel Dry Weather Copper and Bacteria Source Investigation* was provided by the City of Long Beach and Kinnetic Laboratories (2009b). In addition to copper and bacteria, this study monitored environmental parameters such as temperature, pH, dissolved oxygen, turbidity, and flow. Of particular significance, the study found that upstream outfall loads accounted for nearly 20 to 50 percent of instream loads at Stearns Street.

3.2. Los Angeles River Total Maximum Daily Load for Bacteria

The Los Angeles River Watershed Bacteria TMDL, most recently revised June 24, 2010, identifies sources of bacteria to the mainstem of the Los Angeles River from above the Sepulveda Basin to the estuary and within select tributaries (LARWQCB, 2010). Specific to the LBC beaches, the Los Angeles River TMDL implementation plan prioritizes actions that will reduce bacterial loading and be beneficial to recreational users of the LBC beaches. Implementation of the highest priority segments will be completed within eight years of the effective date of the TMDL, stating that significantly improved water quality is expected at LBC beaches well before the complete implementation of the Los Angeles River TMDL.

3.3. Alamitos Bay Circulation Study

The Alamitos Bay Circulation Study was completed for the City of Long Beach by Moffat and Nichol in 2007 to identify any potential source of stagnation that could lead to poor water quality. This was the first study to evaluate the effect of two power plants on the Bay's circulation. Modeling efforts quantified five potential flow conditions, finding that either (1) a new tidal inlet channel with no or little power plant pumping or (2) annual high rate of pumping by the power plants provided the most net movement upstream and limited the exposure time to poor water quality at Mother's Beach.

3.4. Colorado Lagoon Restoration Project - Draft

Completed by LAS Associates, Inc. (2010) for the City of Long Beach, the Colorado Lagoon Restoration Project identifies potential implementation actions suggested to restore the Lagoon. Of particular interest, the restoration plan includes a Bird Management component to reduce the direct contribution of birds on bacterial concentrations within the Lagoon. Bird management would potentially include preventing the release of birds (ducks and geese) as well as posting signs to discourage people from feeding ducks.

4. References

Heal the Bay. 2007. 17th Annual Beach Report Card 2006-2007. May 23rd, 2007. Available at: http://www.healthebay.org/brc/annual/2007/default.asp.

Heal the Bay. 2010. Beach Report Card: Heal the Bay 20th Annual Report 2009-2010. Accessed November 29, 2010 at: http://www.healthebay.org/.

Kinnetic Laboratories Incorporated. 2009a. City of Long Beach Recreational Water Quality Microbial Source Investigation Open Coastal Beach Sites. Prepared for the City of Long Beach.

Kinnetic Laboratories Incorporated. 2009b. Draft Los Cerritos Channel Dry Weather Copper and Bacteria Source Investigation. Prepared for the City of Long Beach.

LARWQCB. 2010. Los Angeles River Watershed Bacteria Total Maximum Daily Load. California Regional Water Quality Control Board Los Angeles Region. Revised June 24th, 2010. Accessed November 29, 2010 at: http://63.199.216.6/larwqcb_new/bpa/tmdl_detail.php?rbResNo=R10-007&no=80.

LAS Associates. 2010. Final Environmental Impact Report Addendum: Colorado Lagoon Restoration Project. Prepared for the City of Long Beach. Accessed November 29, 2010 at: http://www.lbds.info/civica/filebank/blobdload.asp?BlobID=3509.

Moffat and Nichol. 2007. The Alamitos Bay Circulation Final Report. Prepared for the City of Long Beach. August 30th, 2007.

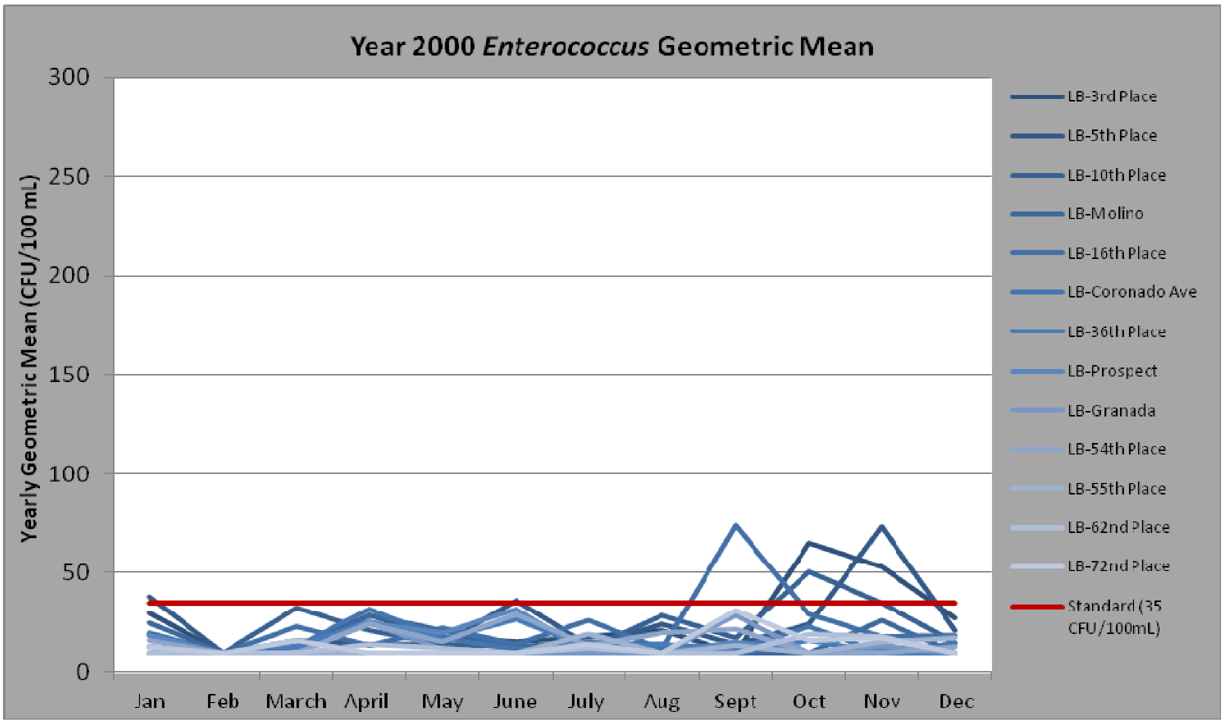
State Water Resources Control Board (SWRCB). 2010. 2008-2010 Clean Water Act Section 303(d) List of Water Quality Limited Segments Requiring TMDLs. (Approved by USEPA November 12, 2010).

Attachment 1

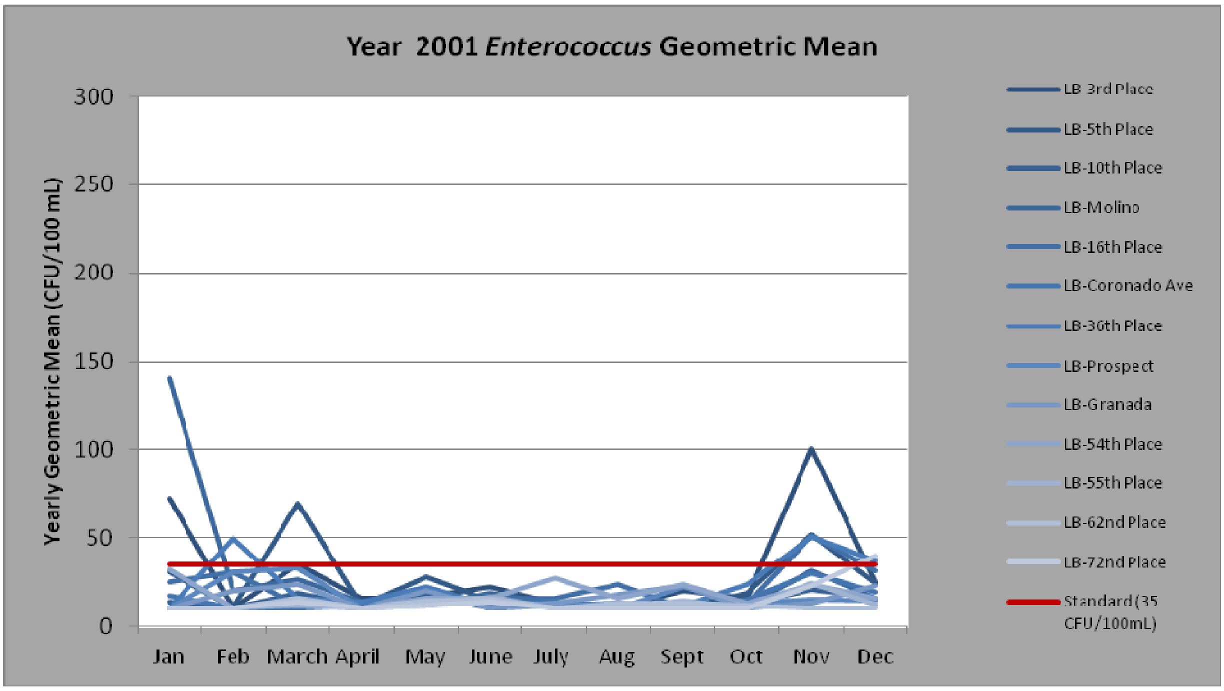
The monthly geometric mean of *enterococcus* measured at the Long Beach City beaches and the LAR Estuary monitoring stations during each year from 2000 to 2010 are shown in the figures below (beginning with 2000; note: LAR Estuary data were only available for 2009 and 2010). The shade selection for each site is determined by the location of the monitoring site with respect to the mouth of the Los Angeles River. The darker shades represent monitoring sites closest to the Los Angeles River. Shades become lighter in color as the monitoring site location moves farther southeast and away from the Los Angeles River.

For *enterococcus* data, there is generally a trend where monitoring sites closer to the Los Angeles River, those shown in dark blue, tend to have a higher geometric means compared to the monitoring sites farthest from the Los Angeles River. For LB-3rd place (B63), LB-5th Place (B5), LB-Molino (B60), LB-16th Place (B6), and LB-36th Place (B62), the annual geometric mean is generally higher than sites farther south; however, there is some variability in this trend. Specifically, LB-72nd Place (B11) and LB-62nd Place (B66) have sporadic increases in geometric mean, as can be seen in 2002 through 2007 and again in 2010. These two monitoring site are farthest from the Los Angeles River which suggests local sources in the vicinity of the 72nd Place (B11) monitoring site or the San Gabriel River/Alamitos Bay may be influencing *enterococcus* concentrations in that area.

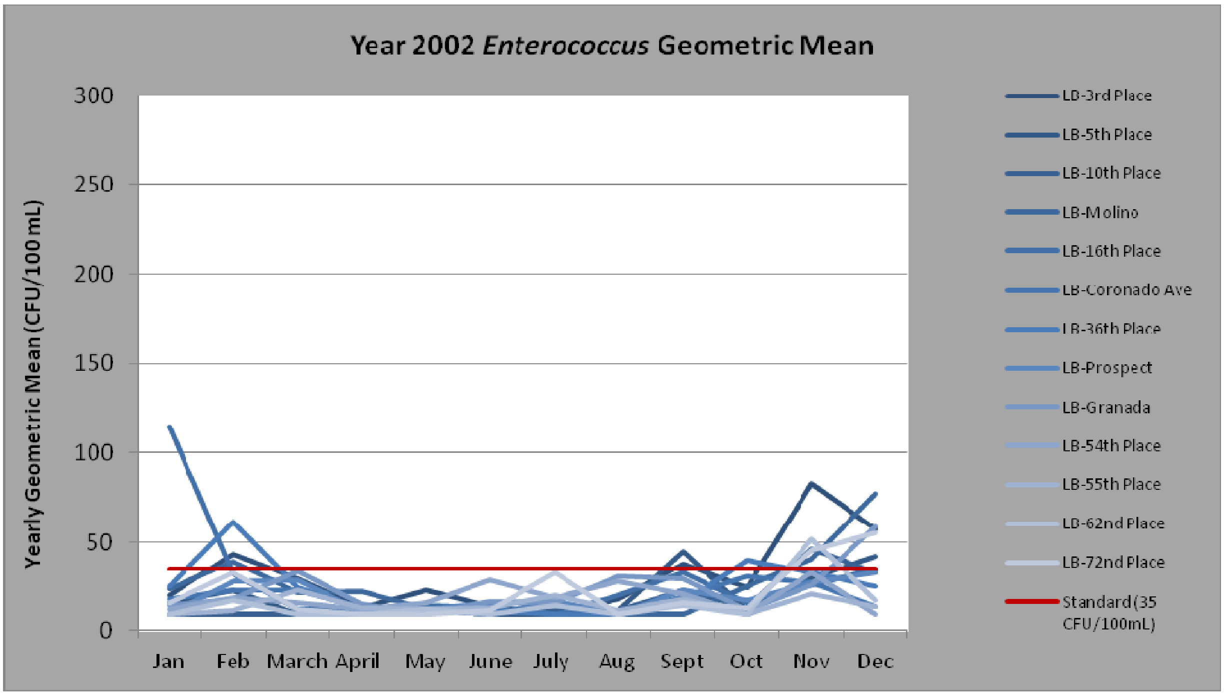
The figures below present the monthly geometric mean for bacteria data for each year; these data show a significant increase in the annual *enterococcus* geometric mean for nearly all sites beginning in September and lasting through the next several months (often into January and February of the following year). This trend correlates with the southern California wet season and suggests that rainfall-runoff contributes significant concentrations of bacteria to the beaches. Overall, *enterococcus* concentrations peaked at 271.5 CFU/100 mL in November of 2007 for the 72nd Place (B11) monitoring site, which is located near the mouth of Alamitos Bay. Additionally, there is a general trend towards increasing geometric means over time for all monitoring sites from 2000 through 2007, while this trend is a little less clear for 2008-2010. In general, there appears to be a rise in *enterococcus* geometric means above 35 CFU/100mL through time.



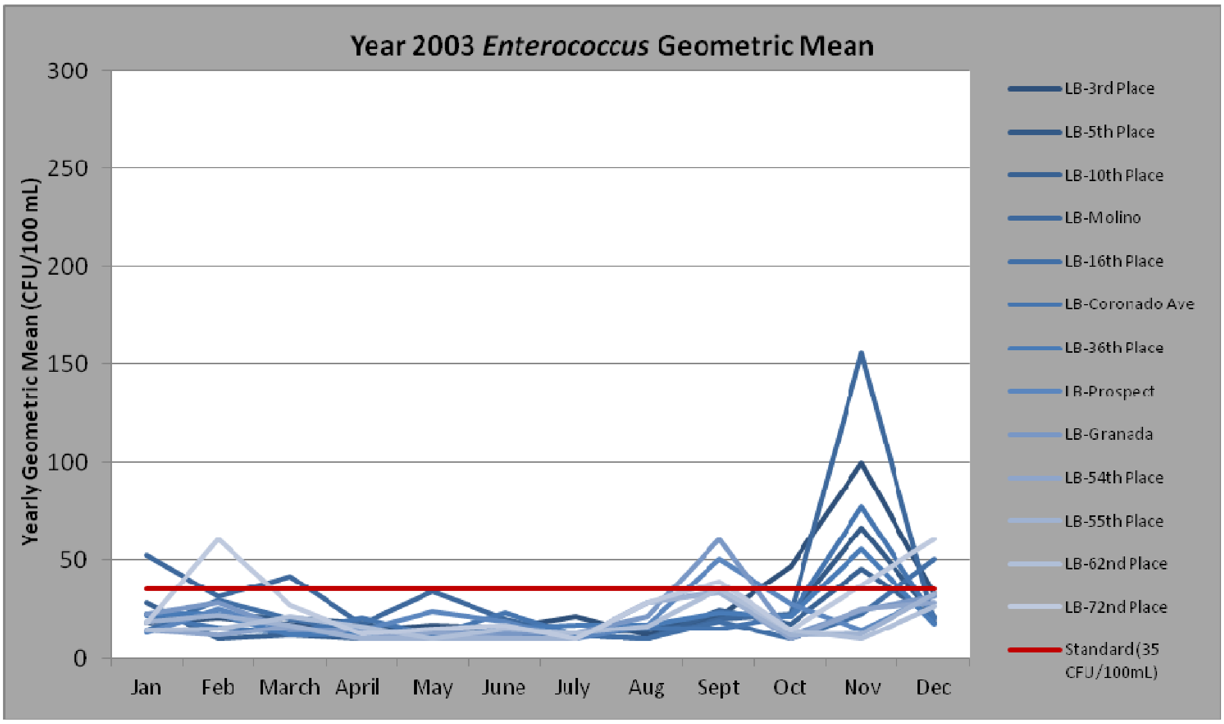
Beach Stations: Year 2000 *enterococcus* geometric mean (Note *Enterococcus* geometric mean standard equal to 35 CFU/100 mL.)



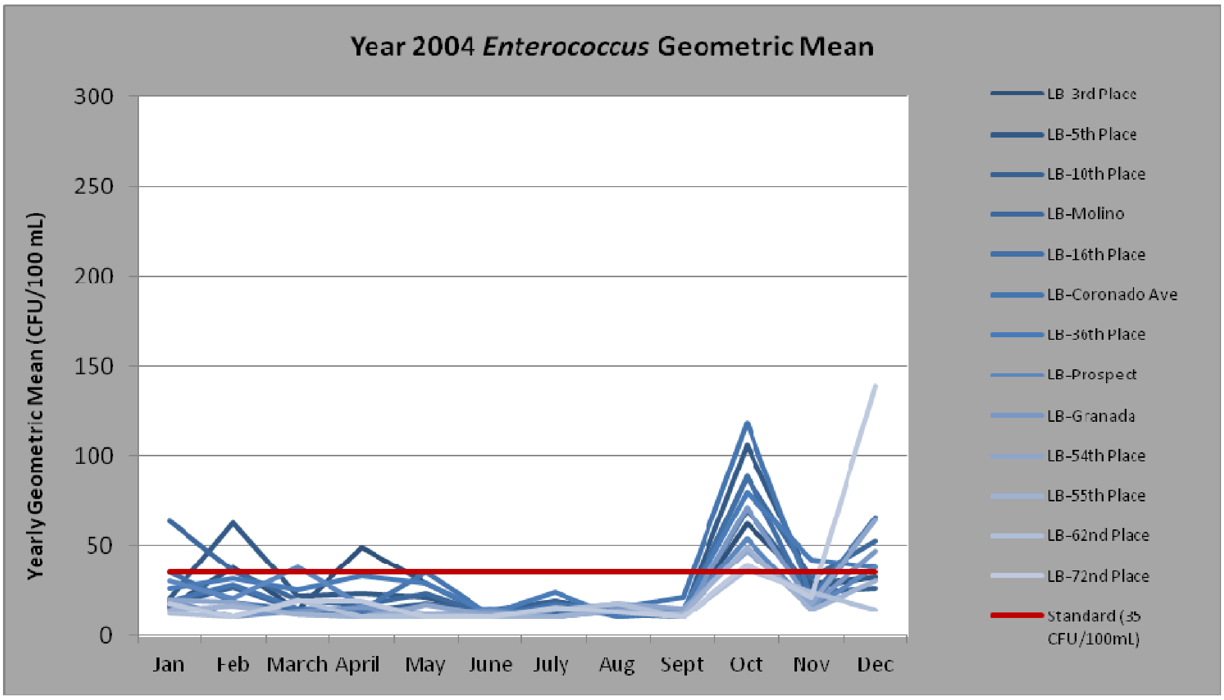
Beach Stations: Year 2001 *enterococcus* geometric mean (Note *Enterococcus* geometric mean standard equal to 35 CFU/100 mL.)



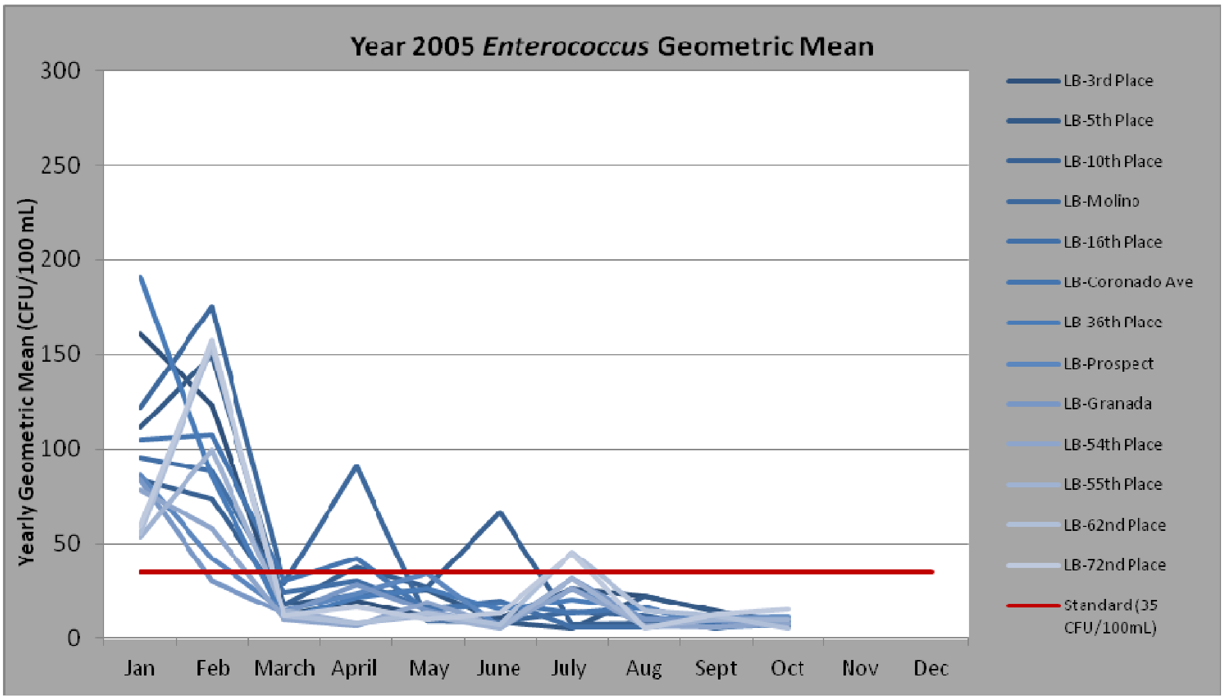
Beach Stations: Year 2002 *enterococcus* geometric mean (Note *Enterococcus* geometric mean standard equal to 35 CFU/100 mL.)



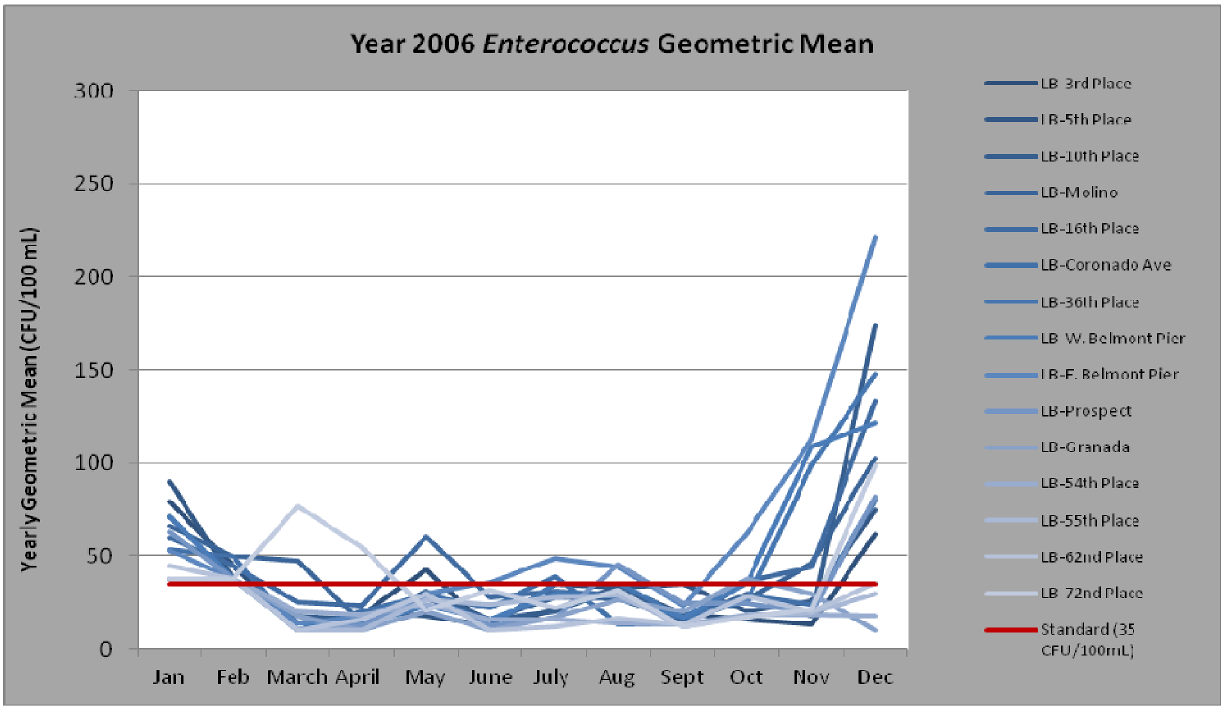
Beach Stations: Year 2003 *enterococcus* geometric mean (Note *Enterococcus* geometric mean standard equal to 35 CFU/100 mL.)



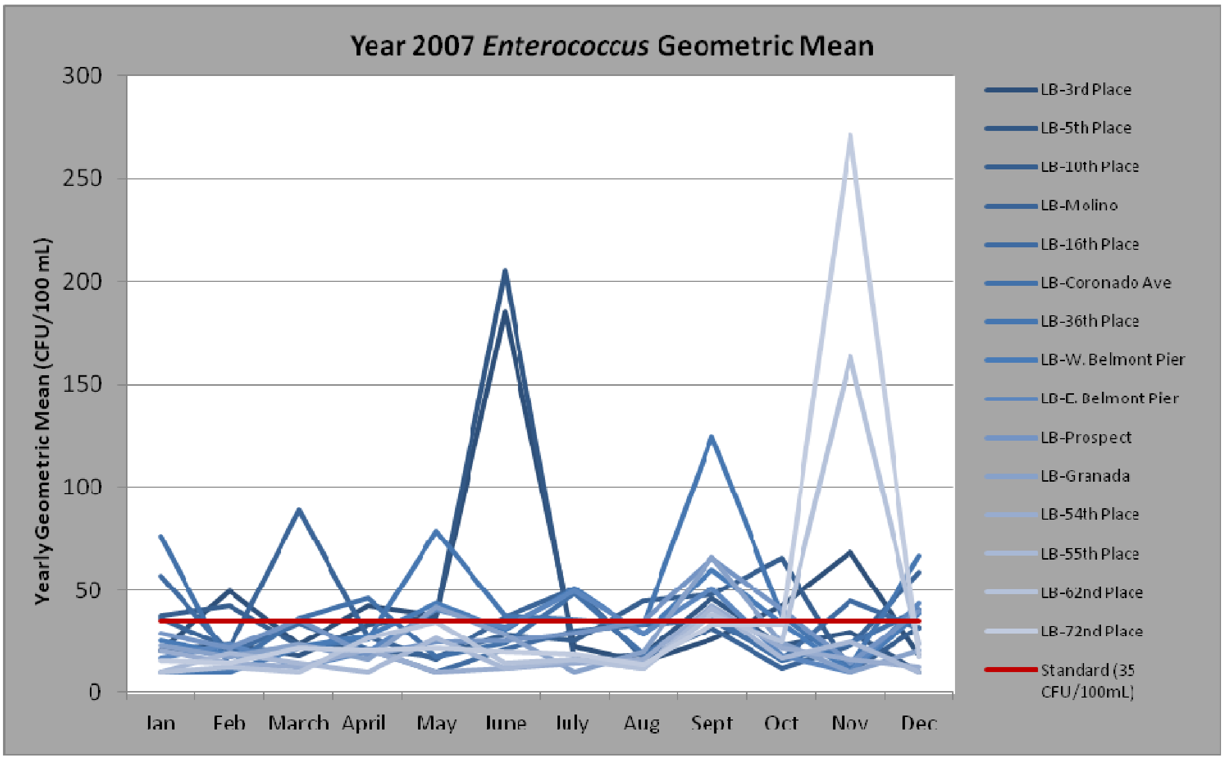
Beach Stations: Year 2004 *enterococcus* geometric mean (Note *Enterococcus* geometric mean standard equal to 35 CFU/100 mL.)



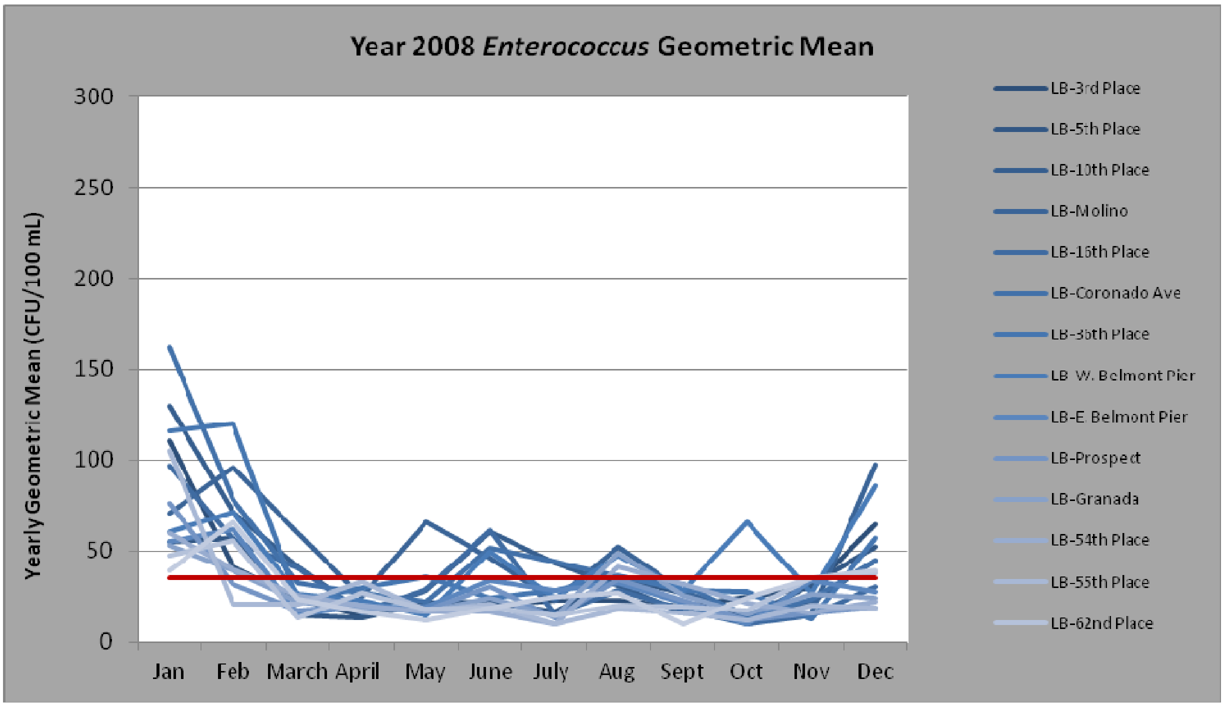
Beach Stations: Year 2005 *enterococcus* geometric mean (Note *Enterococcus* geometric mean standard equal to 35 CFU/100 mL.)



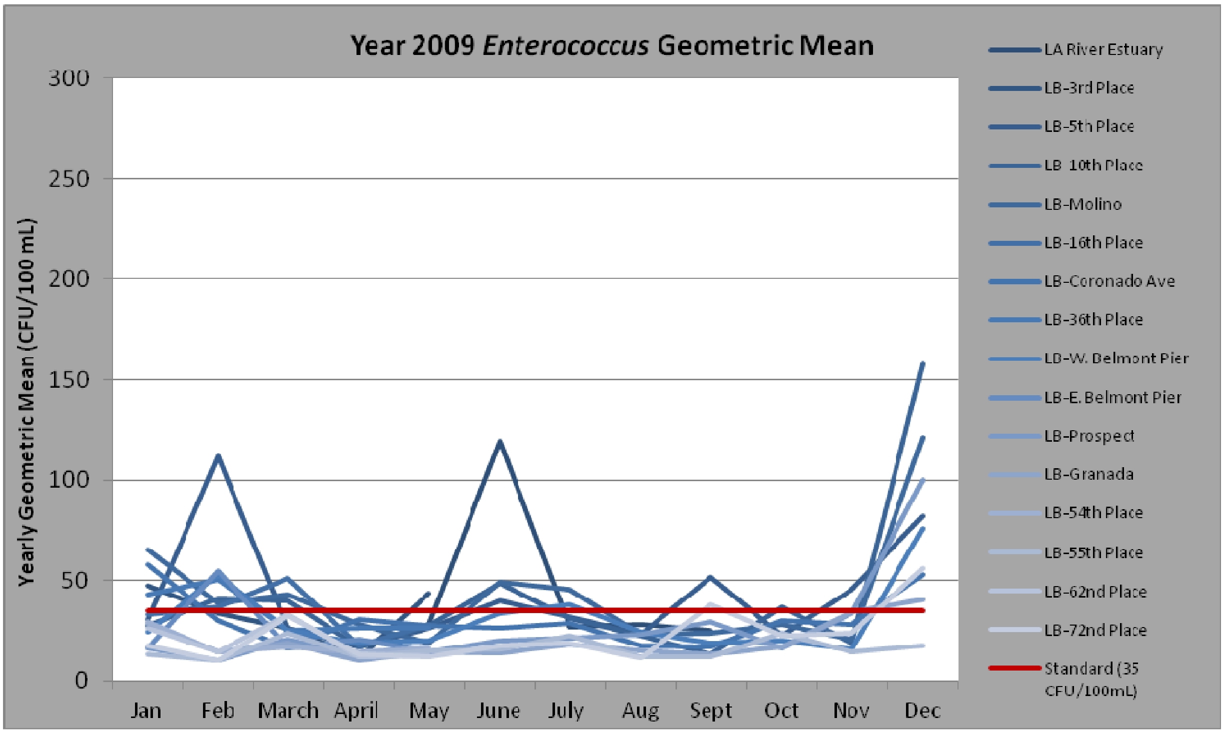
Beach Stations: Year 2006 *enterococcus* geometric mean (Note *Enterococcus* geometric mean standard equal to 35 CFU/100 mL.)



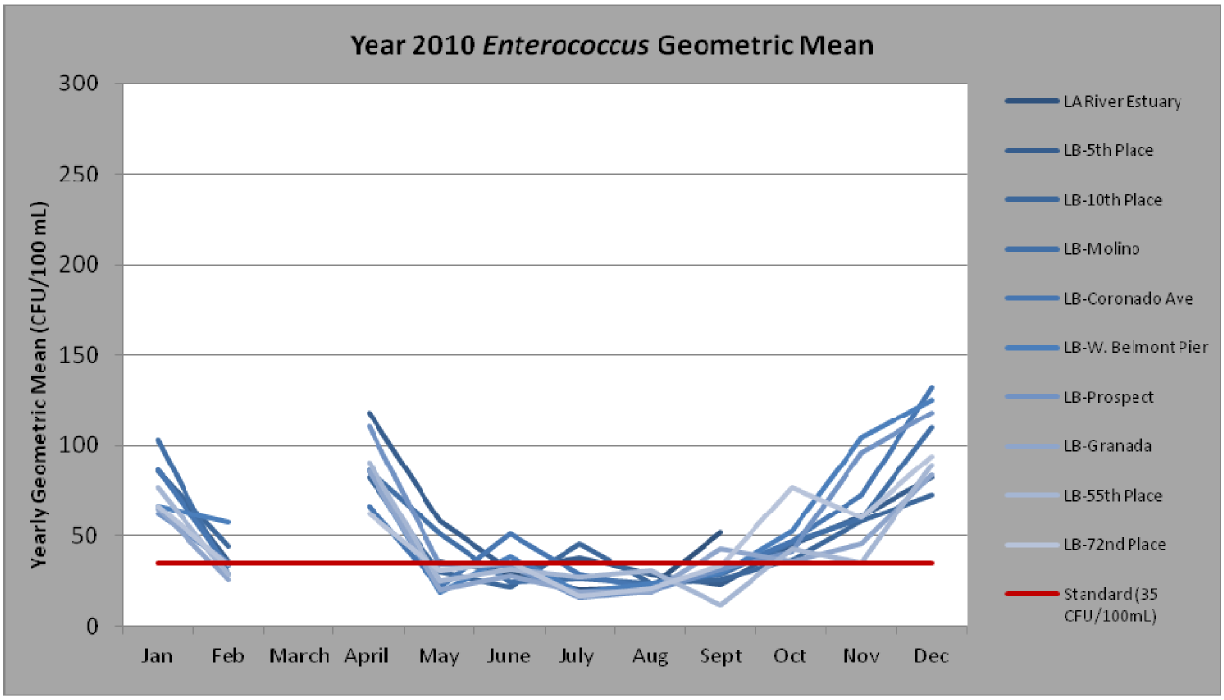
Beach Stations: Year 2007 *enterococcus* geometric mean (Note *Enterococcus* geometric mean standard equal to 35 CFU/100 mL.)



Beach Stations: Year 2008 *enterococcus* geometric mean (Note *Enterococcus* geometric mean standard equal to 35 CFU/100 mL.)



Beach Stations: Year 2009 *enterococcus* geometric mean (Note *Enterococcus* geometric mean standard equal to 35 CFU/100 mL.)



Beach Stations: Year 2010 *enterococcus* geometric mean (Note *Enterococcus* geometric mean standard equal to 35 CFU/100 mL.)

Attachment 2

Attachment 2 consists of *enterococcus*, fecal coliform, and total coliform data collected at sixteen monitoring sites spanning across the Long Beach City beaches and LAR Estuary. Sites evaluated, including abbreviated site names used throughout, are shown in the table below (identical to Table 3 above). The bacteria parameters are compared to their respective single sample and geometric mean standards at each site.

Long Beach City monitoring Station

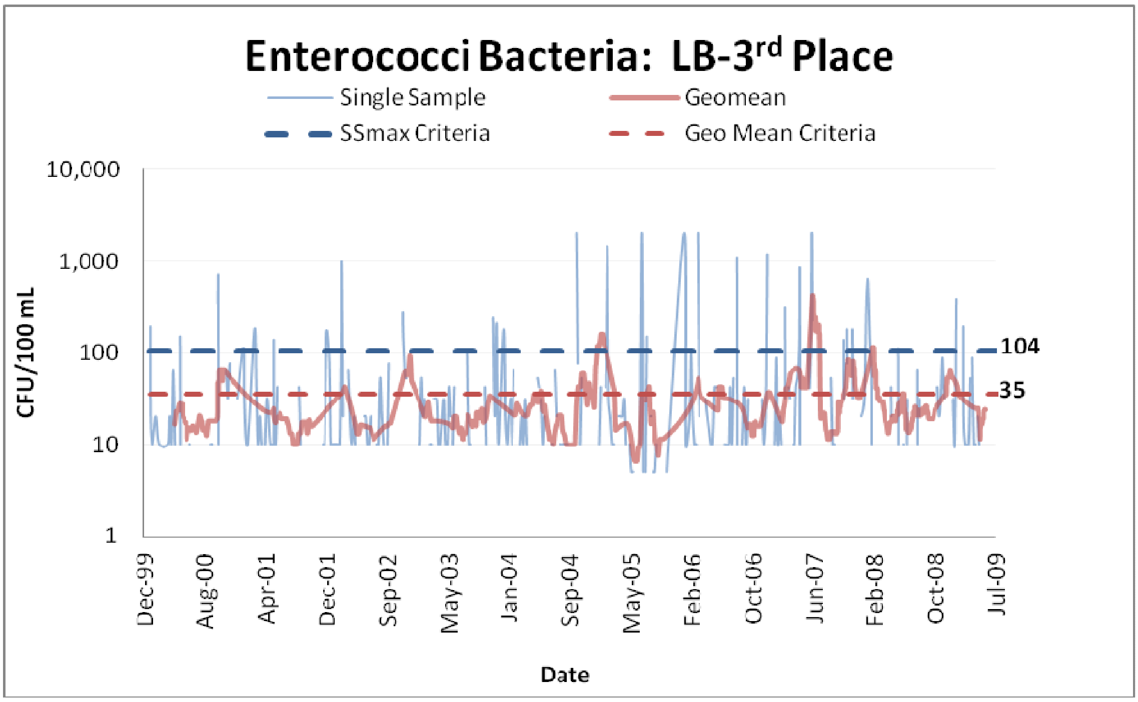
Site ID	Station Name	Site Description
Long Beach City Beaches		
B63	LB-3rd Place	Long Beach City Beaches, projection of 3rd Place
B5	LB-5th Place	Long Beach City Beaches, projection of 5th Place
B56	LB-10th Place	Long Beach City Beaches, projection of 10th Place
B6	LB-16th Place	Long Beach City Beaches, projection of 16th Place
B60	LB-Molino	Long Beach City Beaches, projection of Molino Av.
B7	LB-Coronado Ave.	Long Beach City Beaches, projection of Coronado Ave.
B62	LB-36th Place	Long Beach City Beaches, projection of 36th Place
B8	LB-W. Belmont Pier	Westside of Belmont Pier
B3	LB-E. Belmont Pier	Eastside of Belmont Pier
B9	LB-Prospect	Long Beach City Beaches, projection of Prospect Av.
B64	LB-Granada	Long Beach City Beaches, projection of Granada Av.
B65	LB-54th Place	Long Beach City Beaches, projection of 54th Place
B10	LB-55th Place	Long Beach City Beaches, projection of 55th Place
B66	LB-62nd Place	Long Beach City Beaches, projection of 62nd Place
B11	LB-72nd Place	Long Beach City Beaches, projection of 72nd Place
Los Angeles River Estuary		
LARE	LAR Estuary	Los Angeles River Estuary near mouth

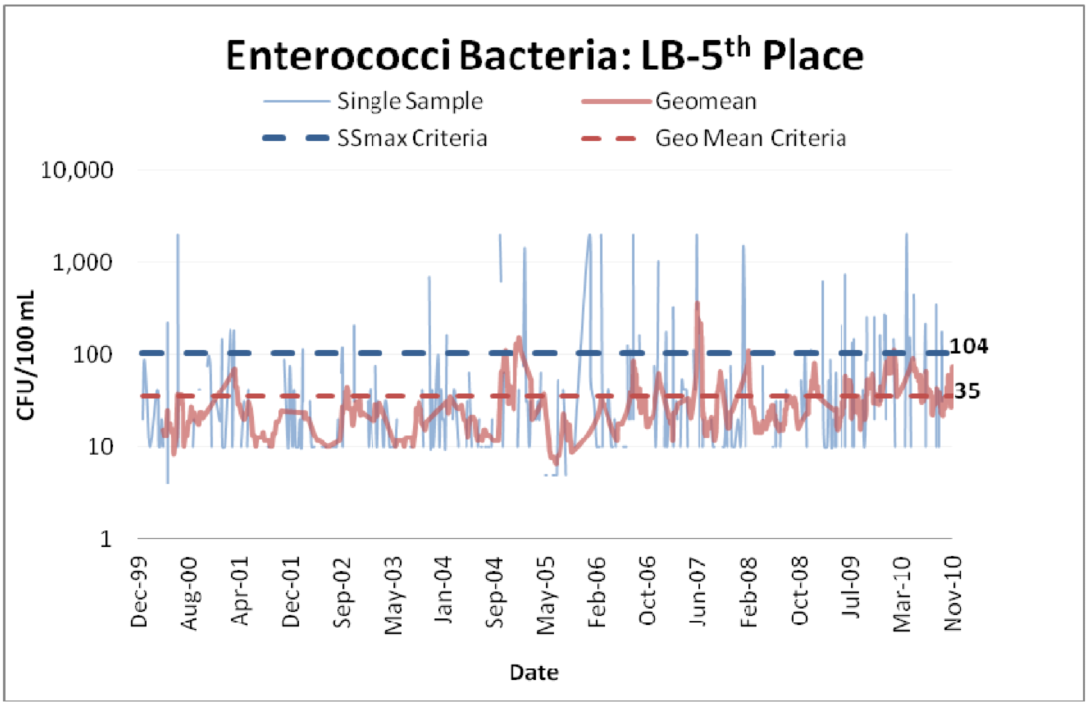
Enterococcus Bacteria

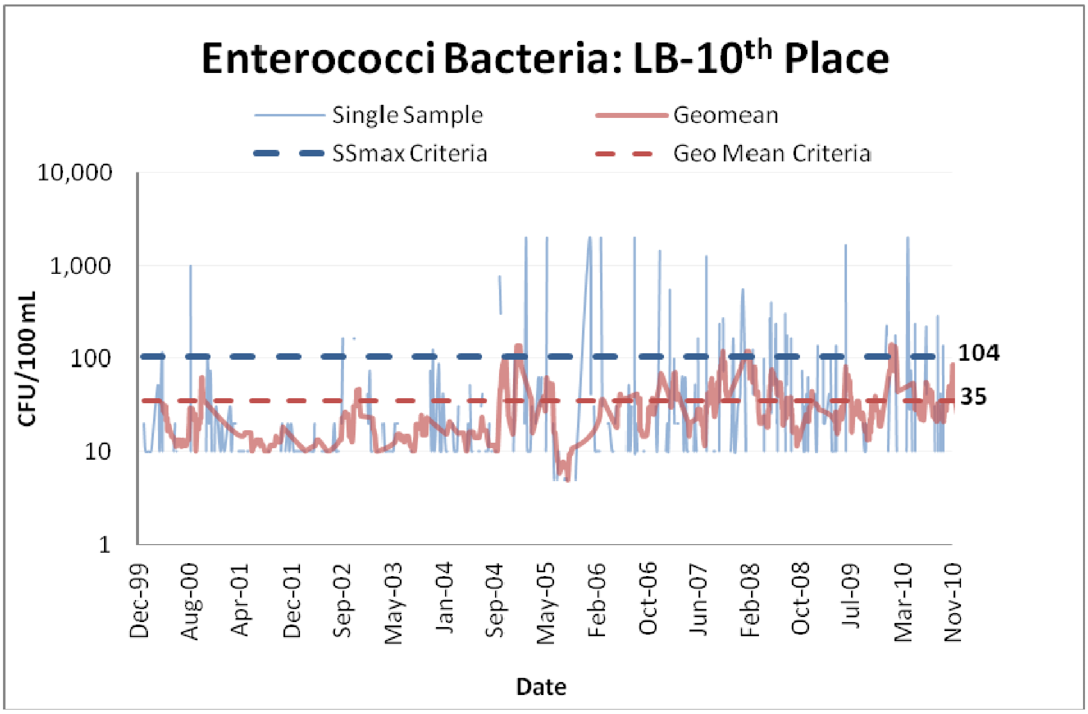
Enterococcus bacteria measurements taken at these sites from 2000 to 2010 are presented for each site in the following figures. The blue solid line represents single sample data and the red line represents the geometric mean (five sample minimum, 30-day rolling geometric mean). The blue and red dashed lines represent the single sample and geometric mean standards, respectively. The single sample standard for *enterococcus* is 104 CFU/100 mL; the geometric mean standard for *enterococcus* is 35 CFU/100 mL.

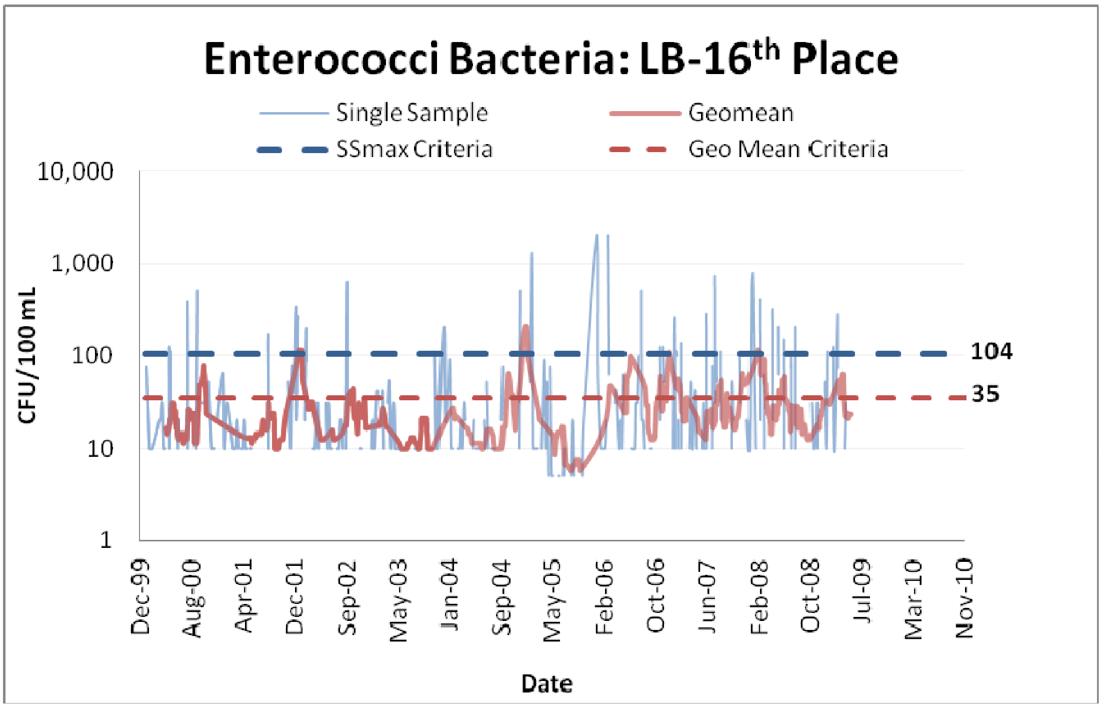
The City of Long Beach has monitored 15 locations along the shoreline of the LBC beaches. The following graphs present the *enterococcus* data collected at each of the City's monitoring sites since 2000. Graphs are presented in order from those sites closest to the mouth of the Los Angeles River to sites an increasing distance away and therefore, closer to the mouth of the Alamitos Bay and San Gabriel River. The final graph is for the LAR Estuary itself.

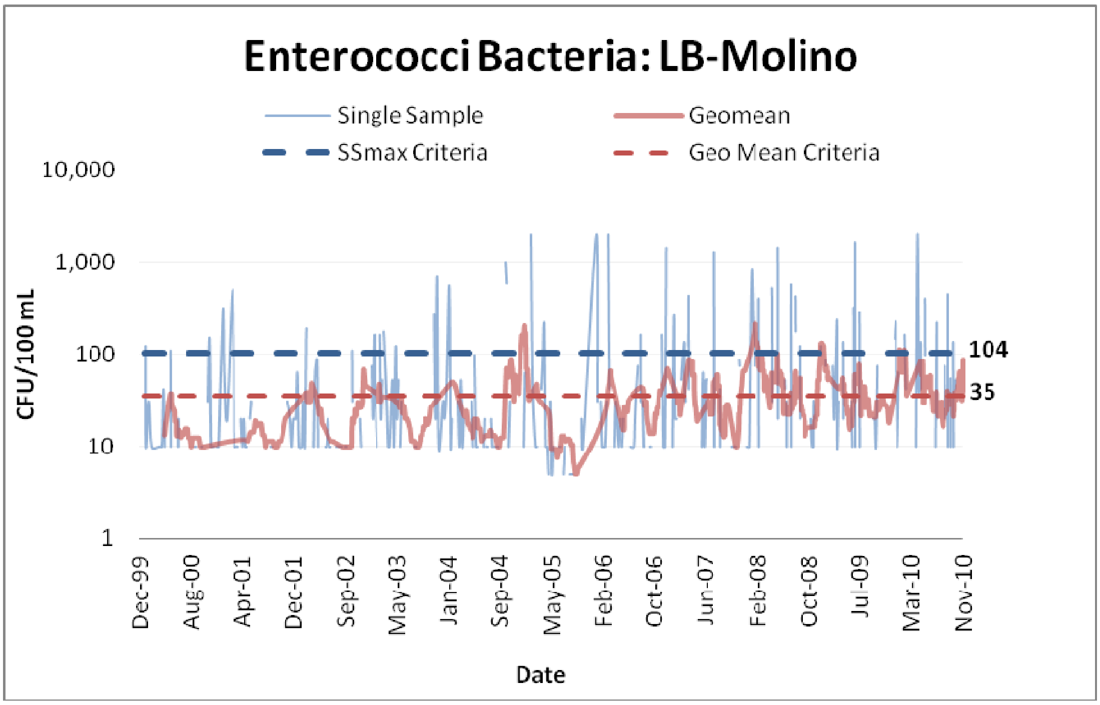
As evident in the graphs, concentrations of *enterococcus* are extremely variable at each site with concentrations ranging from less than 10 CFU/100 mL to greater than 1,000 CFU/100 mL. Despite this variability, a general trend is apparent with monitoring sites located closer to the Los Angeles River exhibiting a greater number of elevated concentrations and both single sample and geometric mean exceedances (those plotted above the criteria lines). This trend is particularity evident in monitoring locations LB-3rd Place, LB-5th Place, LB-10th Place, LB-16th Place, and LB-Molino (LB-W. Belmont and LB-E. Belmont also have many exceedances likely due to the presence of a stormdrain nearby). As shown in the data for LB-54th Place and LB-55th Place, sites located farther southeast and therefore, farther from the mouth of the Los Angeles River, generally experienced fewer exceedances. However, compared to data at LB-54th Place and LB-55th Place, the monitoring station located closest to the mouth of the Alamitos Bay and San Gabriel Rivers had higher concentrations and a greater number of exceedances. The LAR Estuary dataset was more limited (2009-2010). It did not show any exceedances of the single sample maximum WQO, but had several exceedances of the geometric mean criterion.

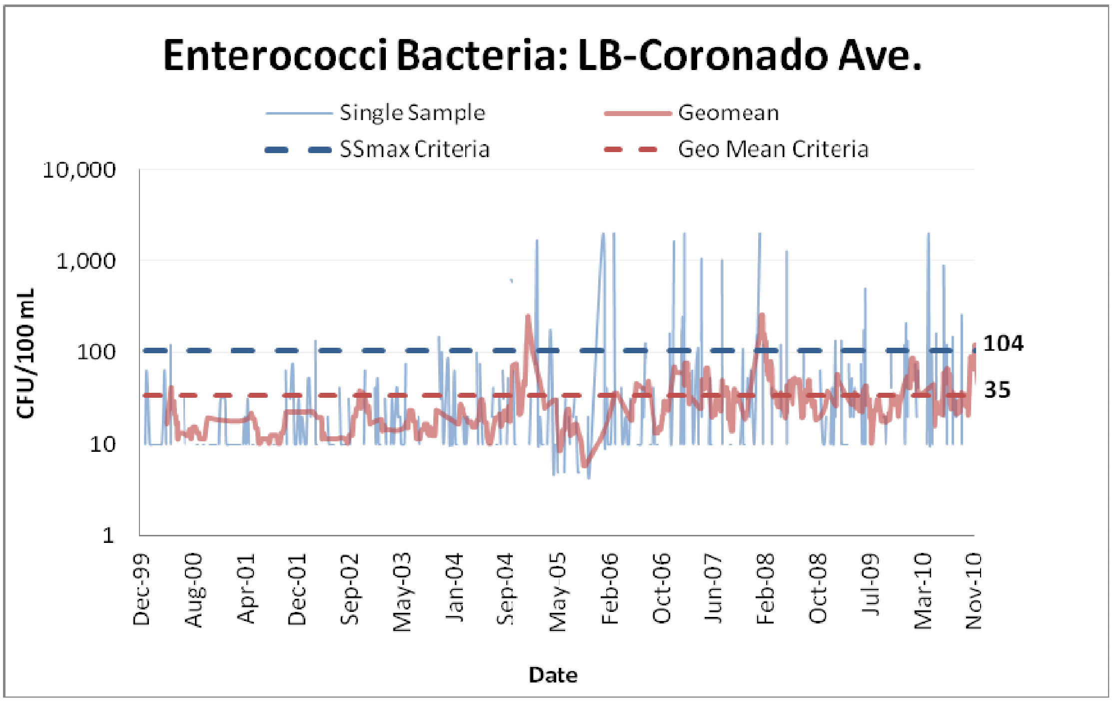


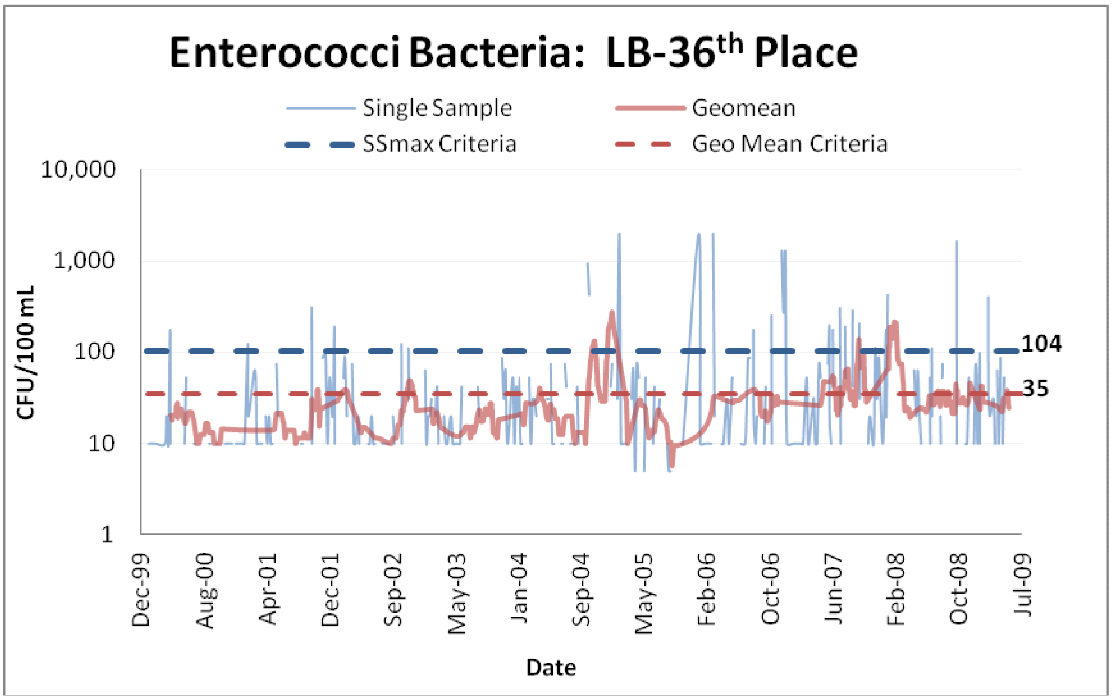

Enterococci Bacteria: LB-5th Place
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
10,000
1,000
100
10
1
CFU/100 mL
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

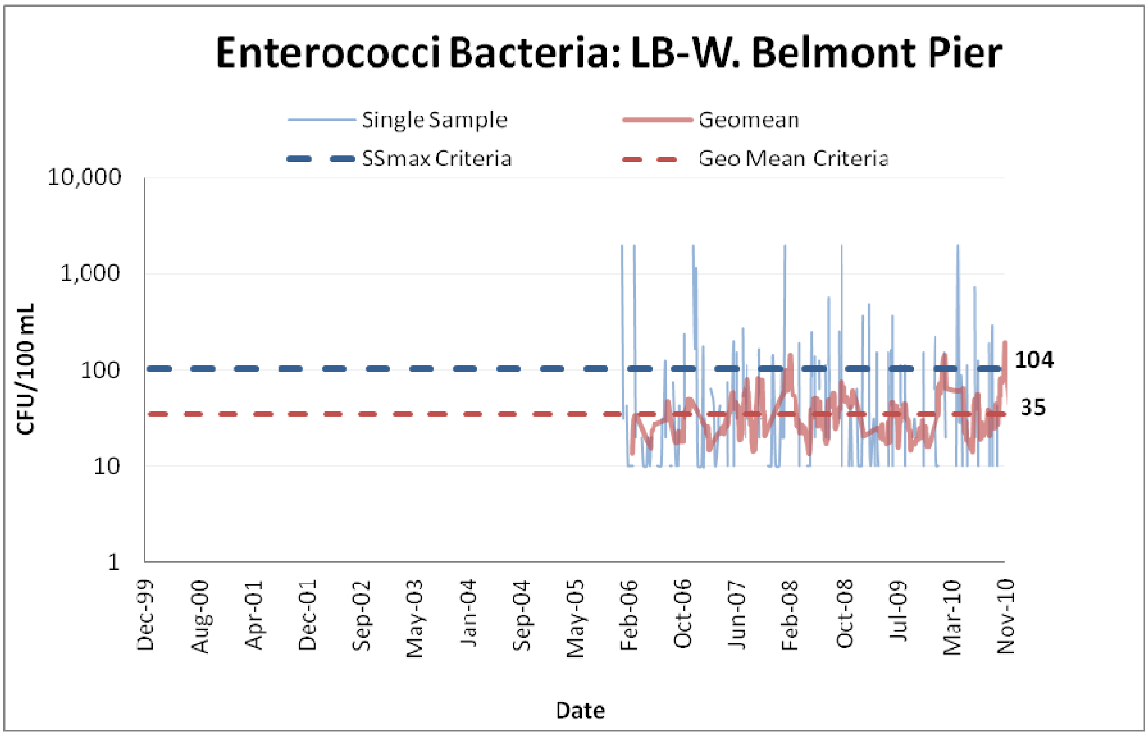

Enterococci Bacteria: LB-10th Place
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
10,000
1,000
100
10
1
CFU/100 mL
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

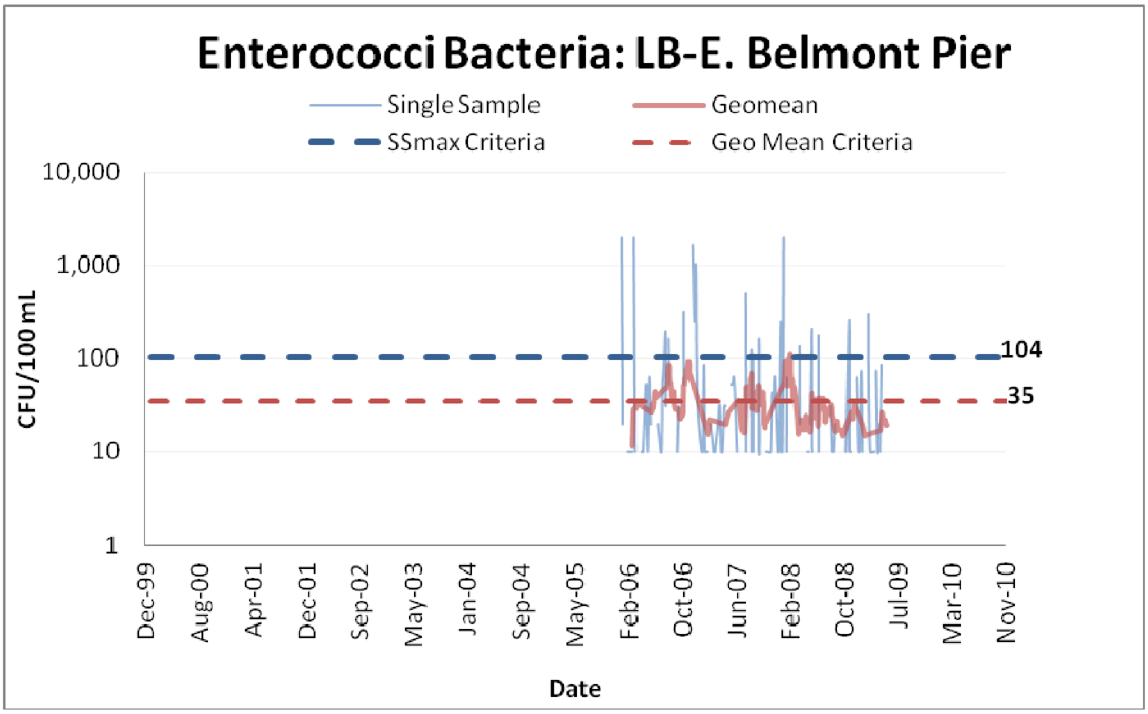

Enterococci Bacteria: LB-16th Place
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
10,000
1,000
100
10
1
CFU/100 mL
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

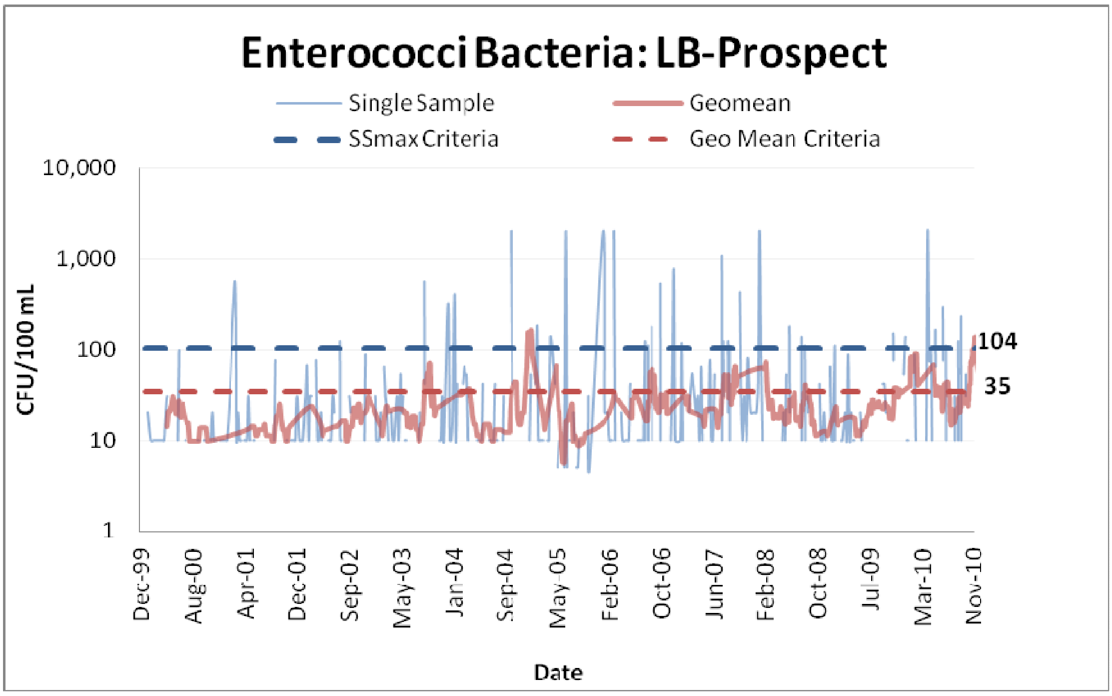

Enterococci Bacteria: LB-Molino
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
10,000
1,000
100
10
1
CFU/100 mL
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

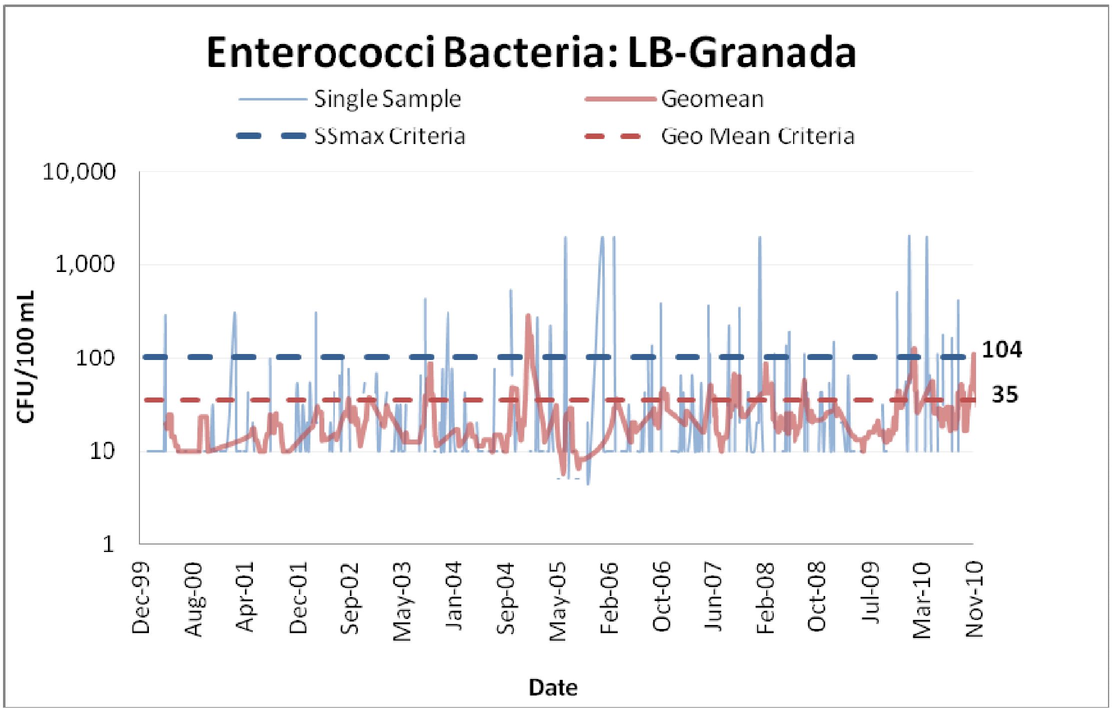

Enterococci Bacteria: LB-Coronado Ave.
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
10,000
1,000
100
10
1
CFU/100 mL
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

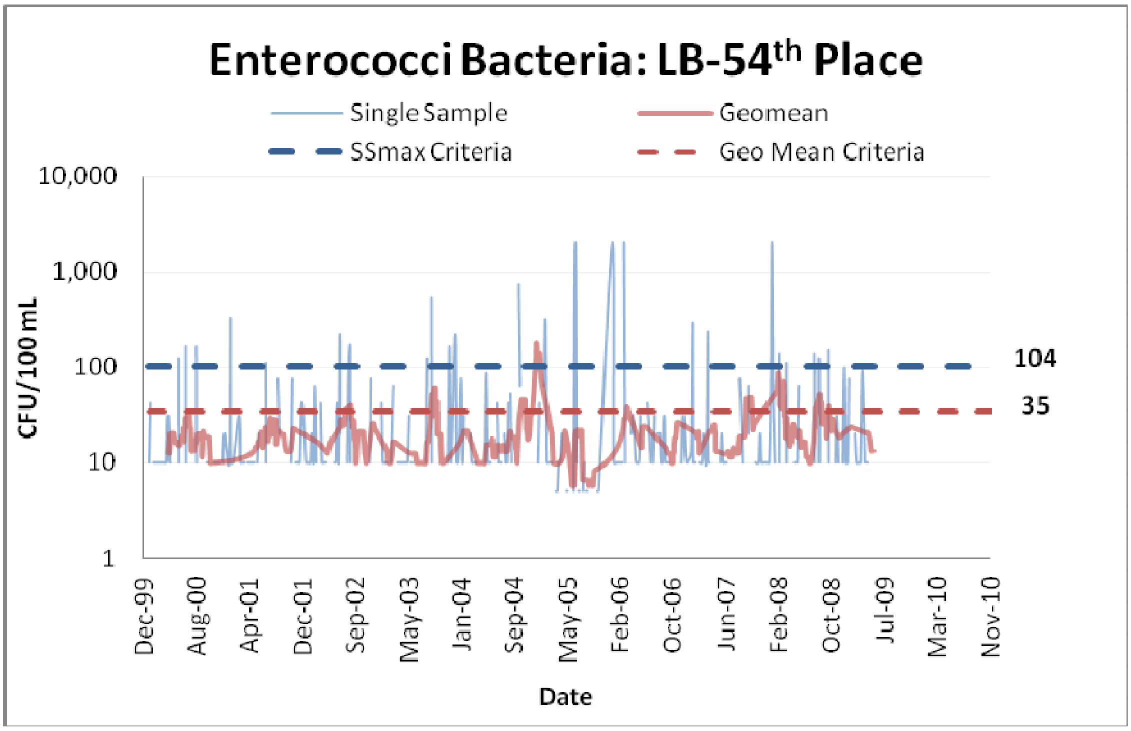

Enterococci Bacteria: LB-36th Place
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
10,000
1,000
100
10
1
CFU/100 mL
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Date

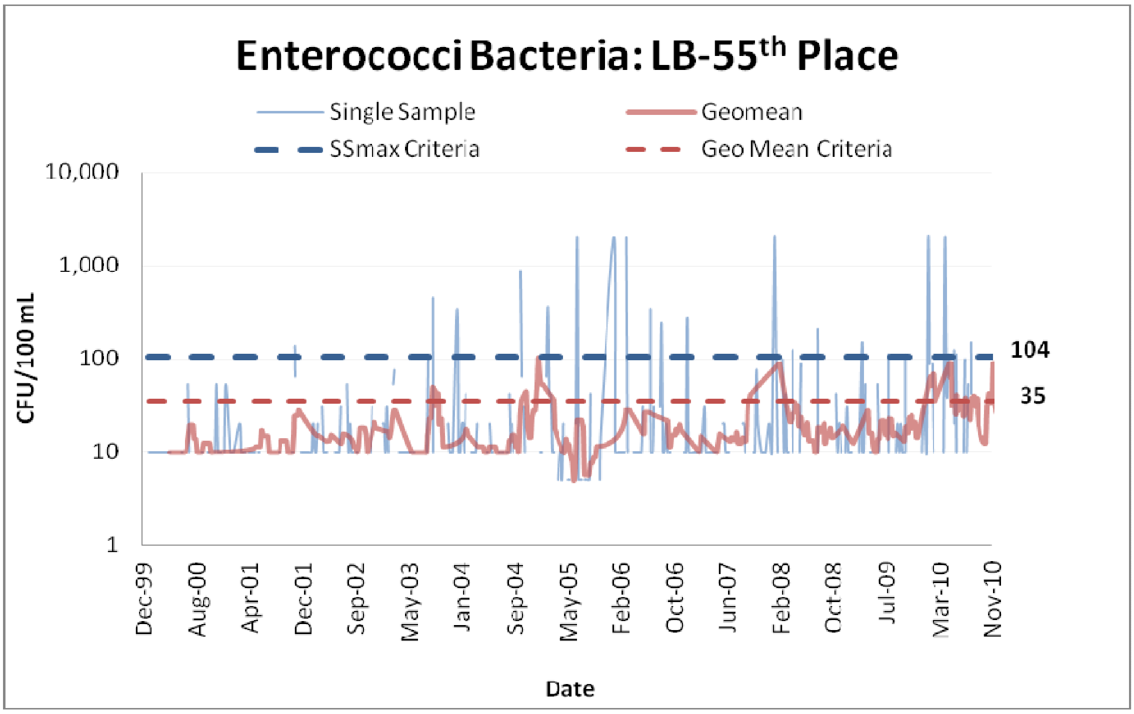

Enterococci Bacteria: LB-W. Belmont Pier
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
10,000
1,000
100
10
1
CFU/100 mL
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

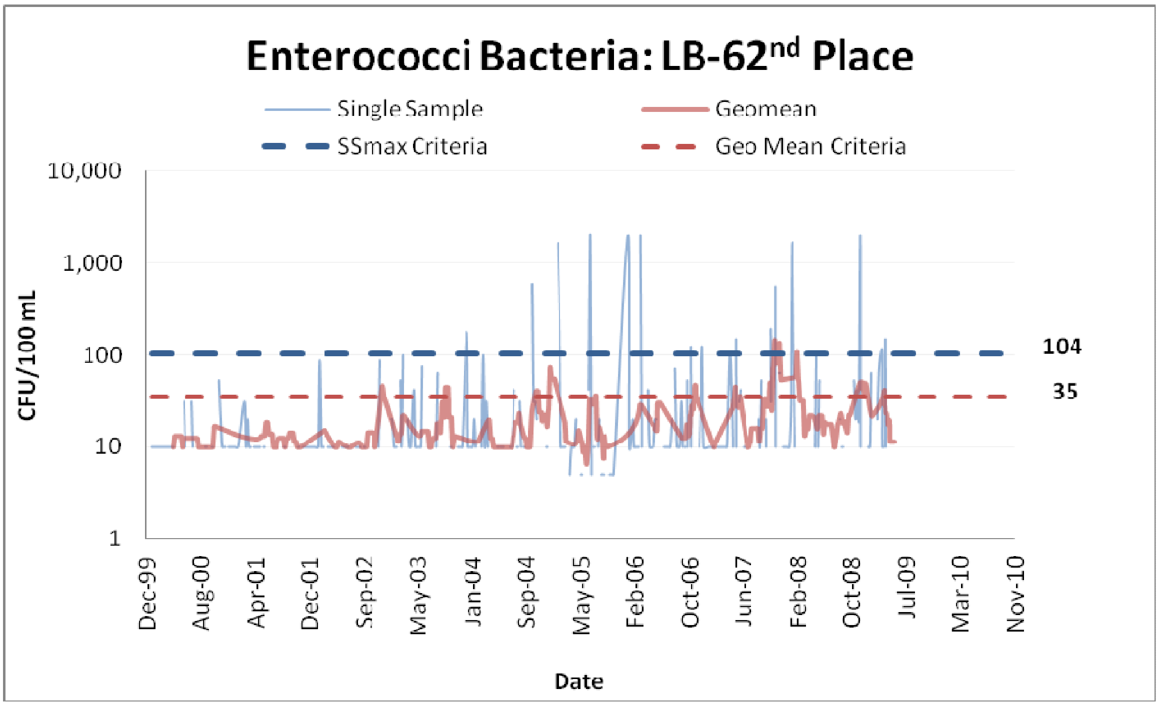

Enterococci Bacteria: LB-E. Belmont Pier
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
10,000
1,000
100
10
1
CFU/100 mL
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

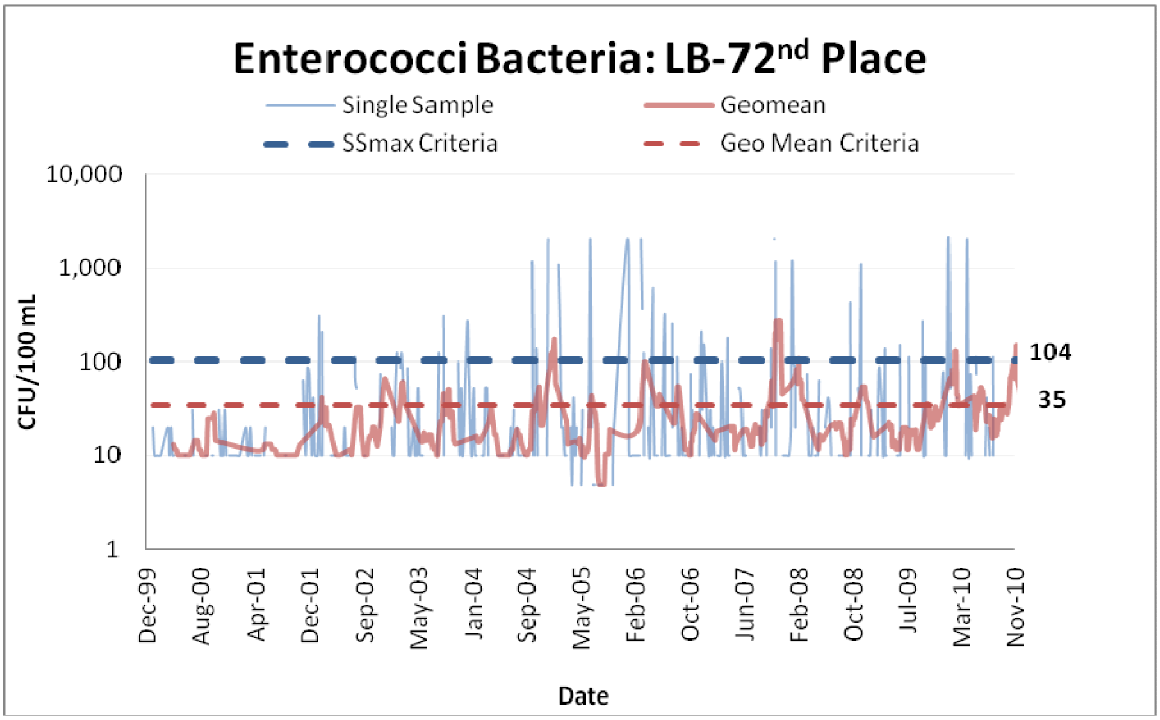

Enterococci Bacteria: LB-Prospect
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
10,000
1,000
100
10
1
CFU/100 mL
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

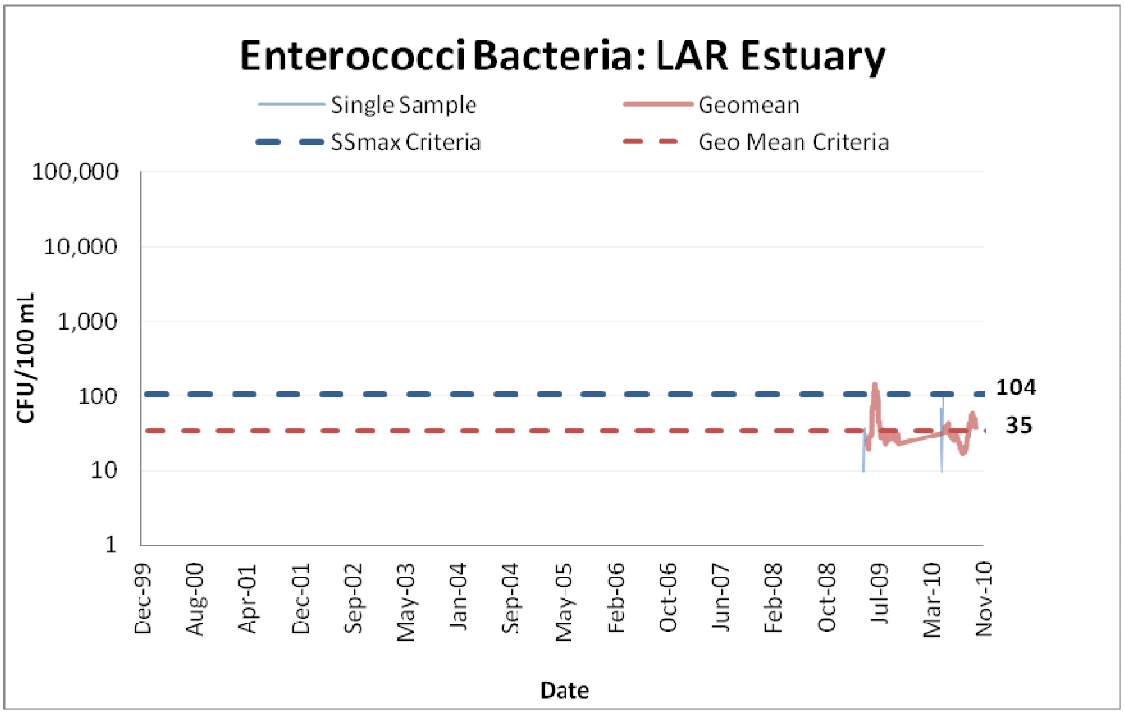

Enterococci Bacteria: LB-Granada
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
10,000
1,000
100
10
1
CFU/100 mL
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date


Enterococci Bacteria: LB-54th Place
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
10,000
1,000
100
10
1
CFU/100 mL
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date


Enterococci Bacteria: LB-55th Place
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
10,000
1,000
100
10
1
CFU/100 mL
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date


Enterococci Bacteria: LB-62nd Place
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
CFU/100 mL
10,000
1,000
100
10
1
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date


Enterococci Bacteria: LB-72nd Place
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
CFU/100 mL
10,000
1,000
100
10
1
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

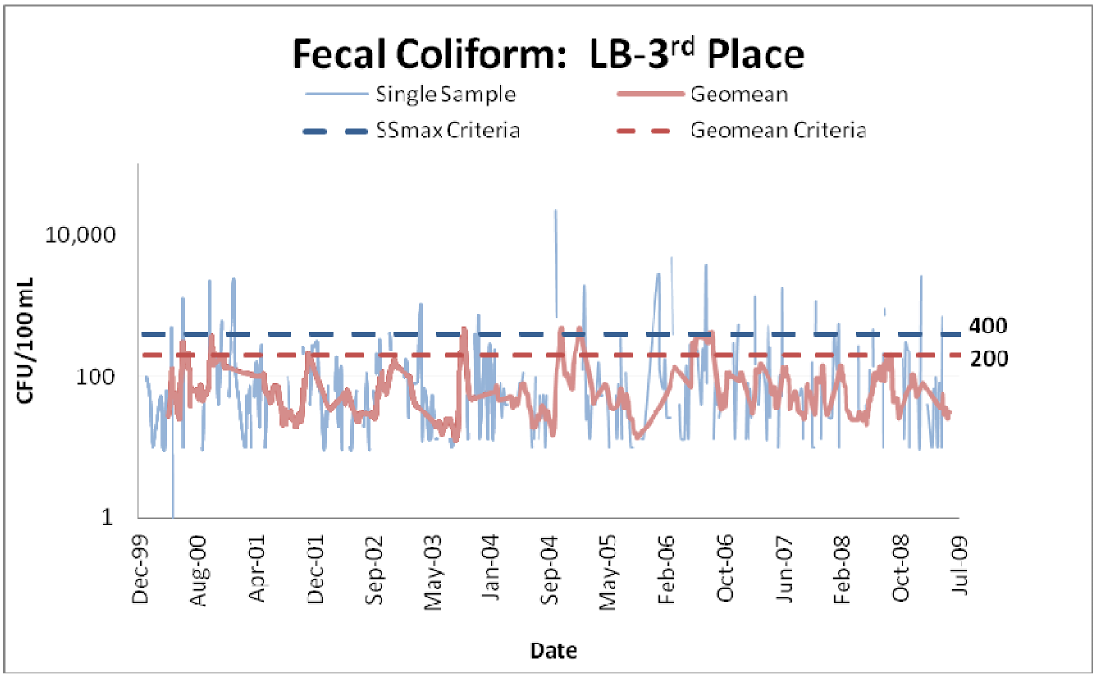

Enterococci Bacteria: LAR Estuary
Single Sample
Geomean
SSmax Criteria
Geo Mean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
104
35
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

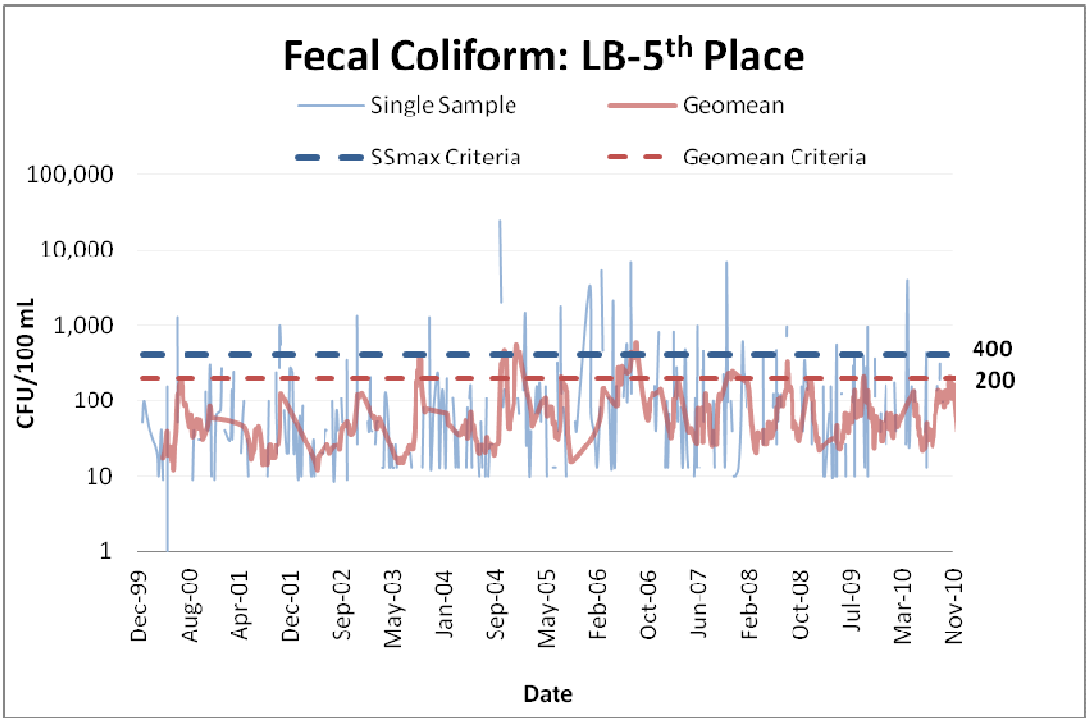
Fecal coliform bacteria

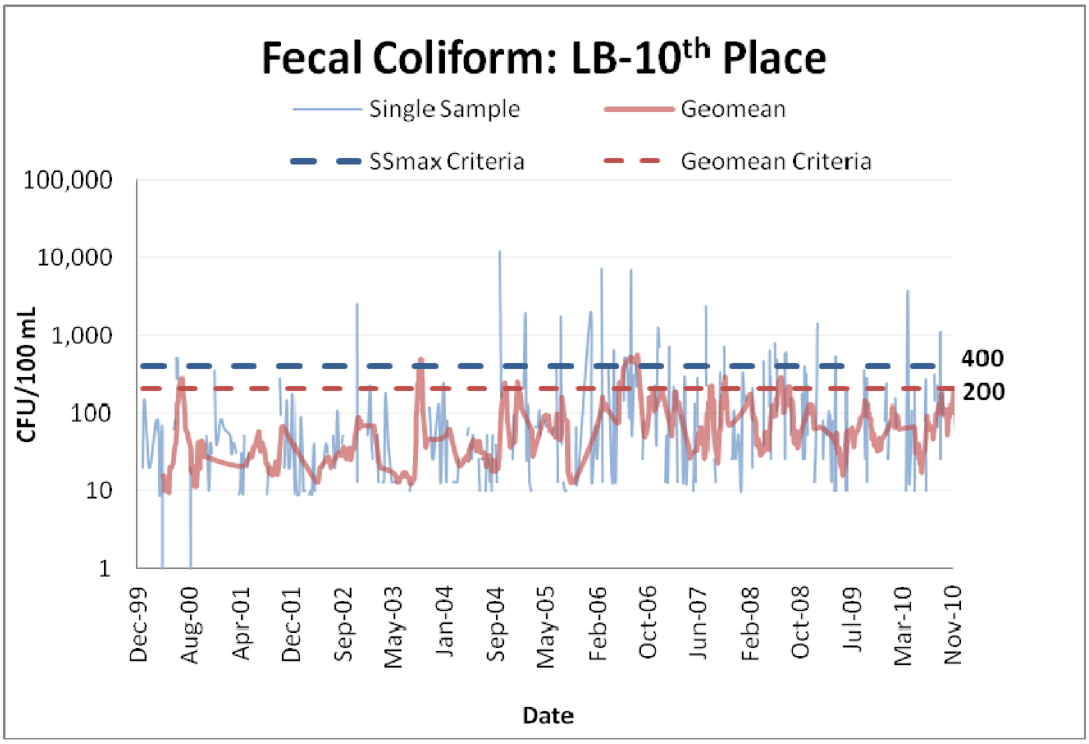
Fecal coliform bacteria measurements taken at these sites from 2000 to 2010 are presented for each site in the following figures. The blue solid line represents single sample data and the red line represents geometric mean (five-sample minimum, 30-day rolling geometric mean). The blue and red dashed lines represent the single sample and geometric mean standards, respectively. The single sample standard for fecal coliform is 400 CFU/100 mL; the geometric mean standard for fecal coliform is 200 CFU/100 mL.

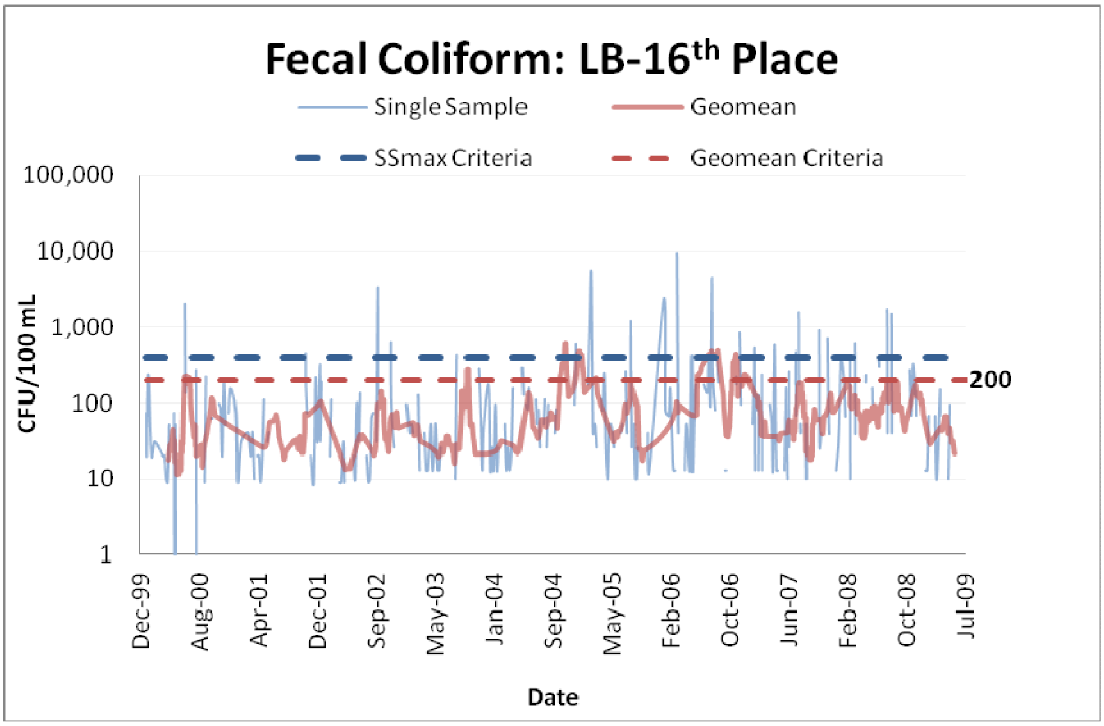
The City of Long Beach has monitored 15 locations along the shoreline of the LBC beaches. The following graphs present the fecal coliform data collected at each of the City's monitoring sites since 2000. Graphs are presented in order from those sites closest to the mouth of the Los Angeles River to sites an increasing distance away and therefore, closer to the mouth of the Alamitos Bay and San Gabriel River (note: fecal coliform data were not available for the LAR Estuary monitoring station).

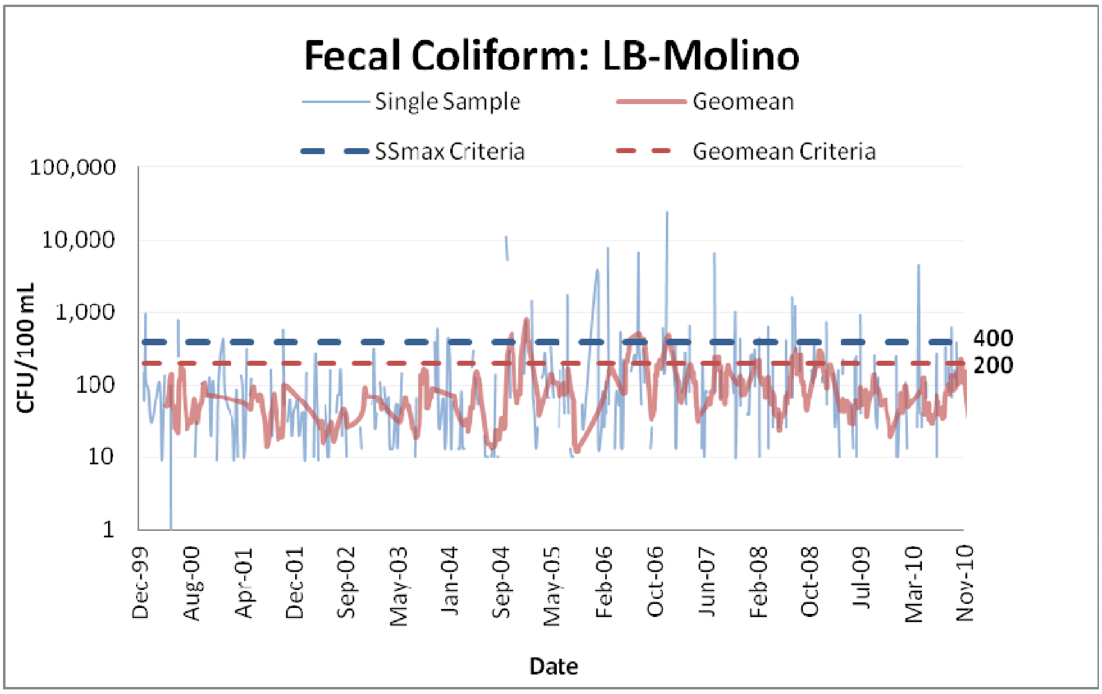
Concentrations of fecal coliform are extremely variable at each site with concentrations ranging from less than 10 CFU/100 mL to over 10,000 CFU/100 mL. The greatest number of single sample and geometric mean exceedances (points plotted above the criteria lines) occurred at LB-Molino, LB-W. Belmont Pier, and LB-E. Belmont Pier.

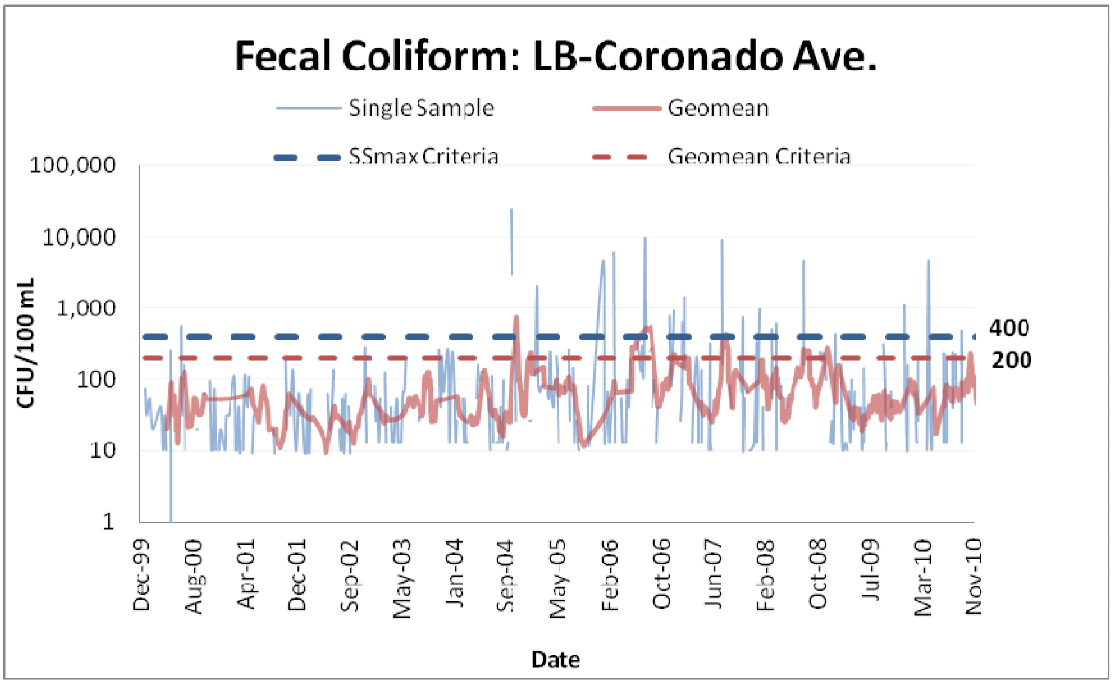


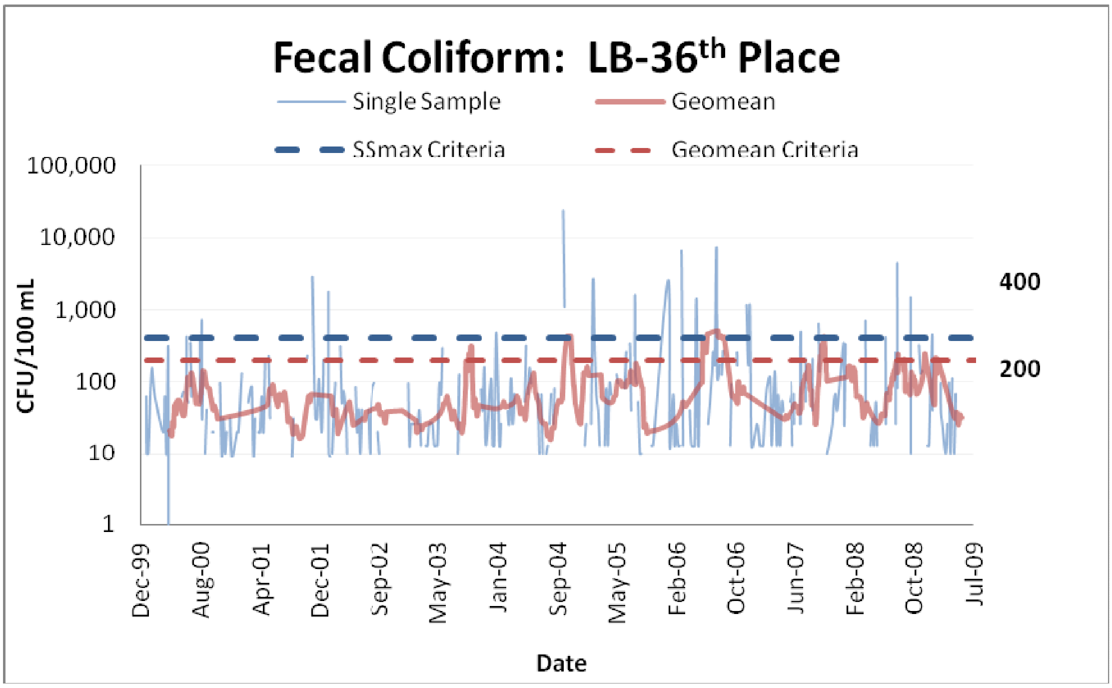

Fecal Coliform: LB-5th Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

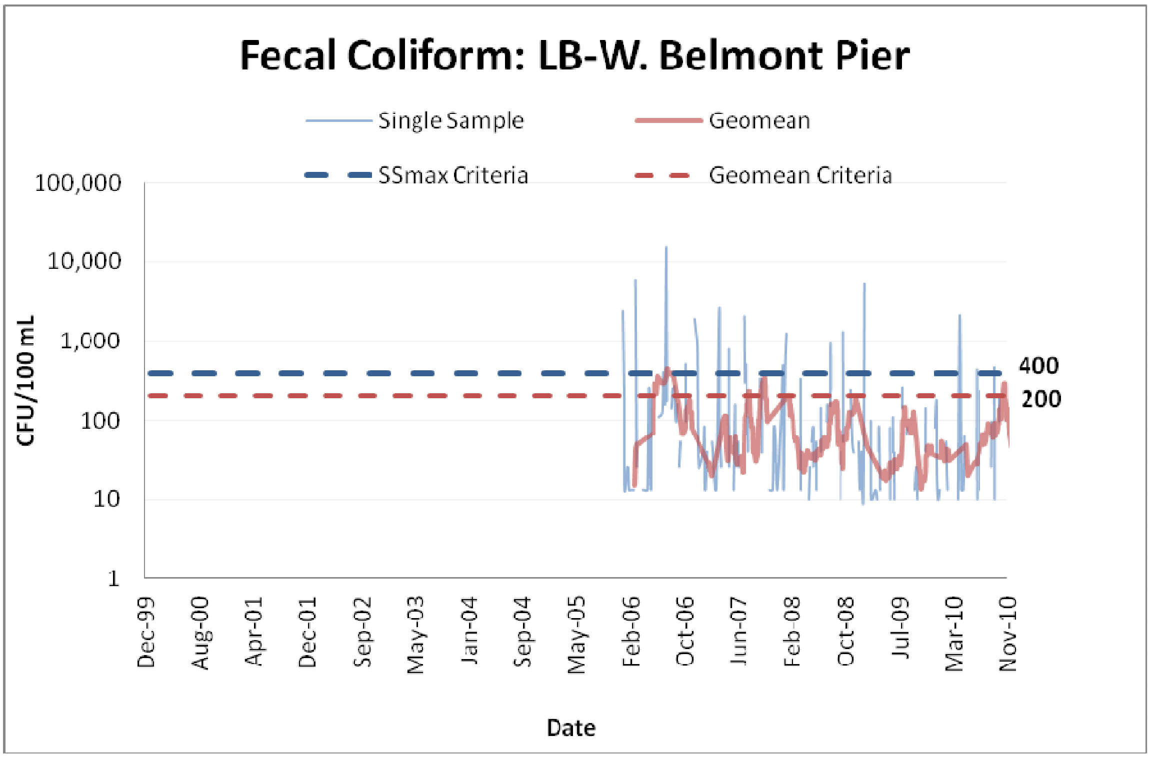

Fecal Coliform: LB-10th Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

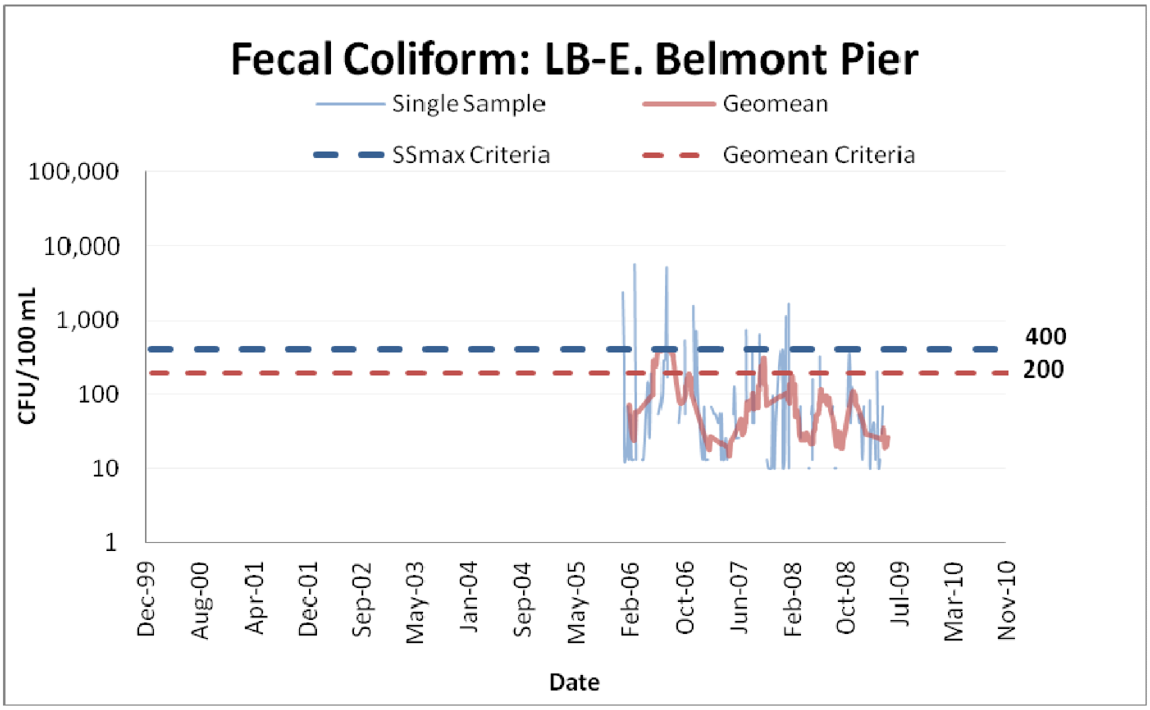

Fecal Coliform: LB-16th Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Date

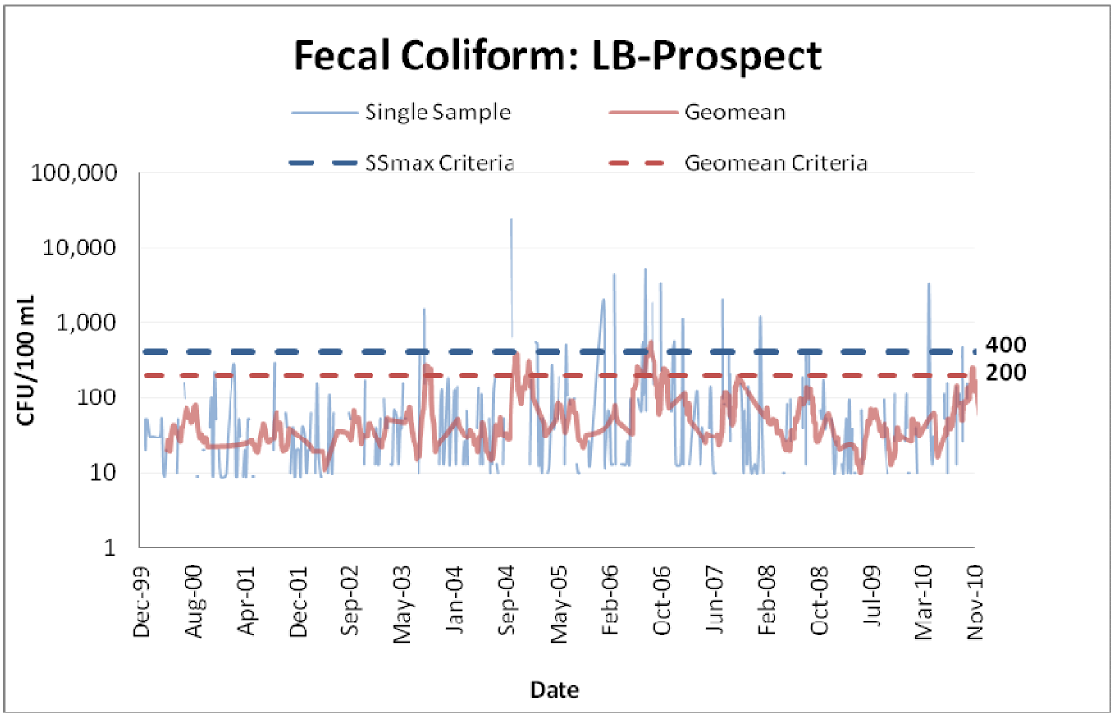

Fecal Coliform: LB-Molino
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

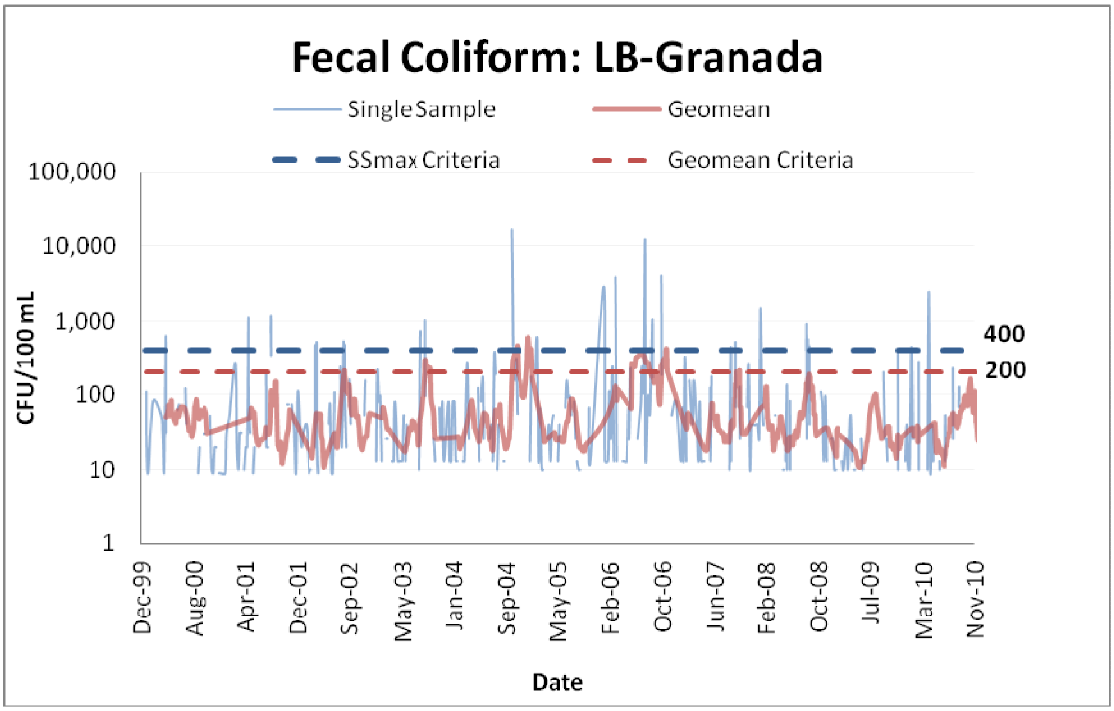

Fecal Coliform: LB-Coronado Ave.
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

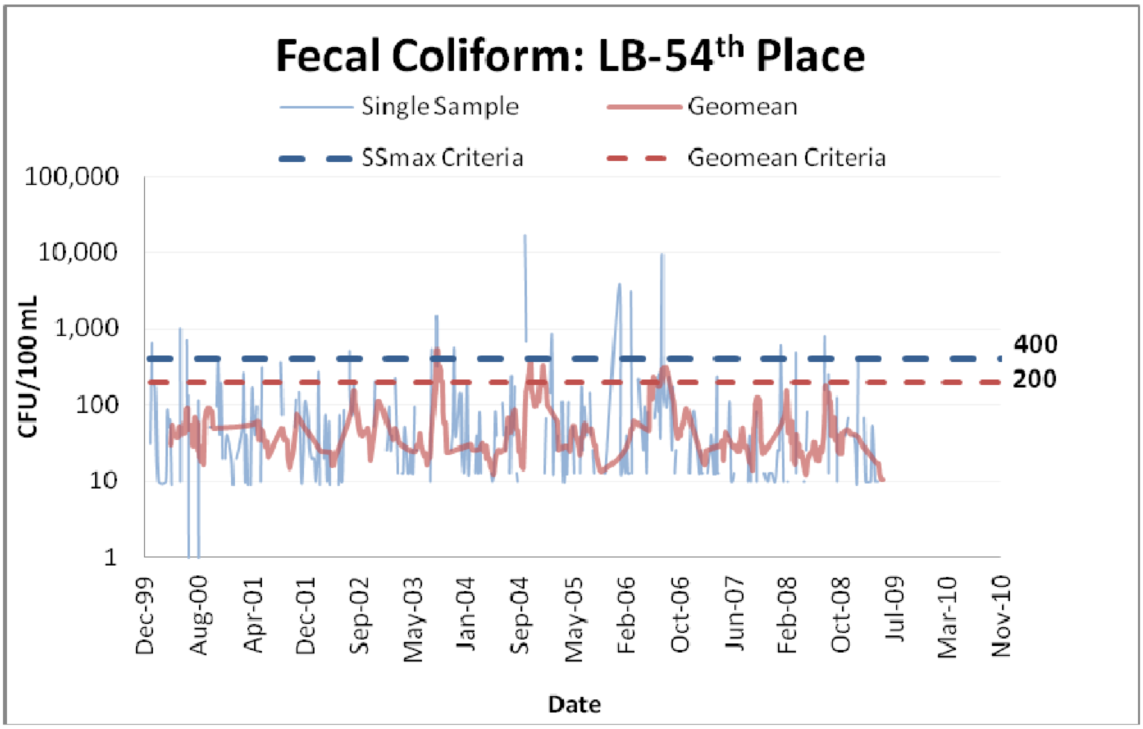

Fecal Coliform: LB-36th Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Date


Fecal Coliform: LB-W. Belmont Pier
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

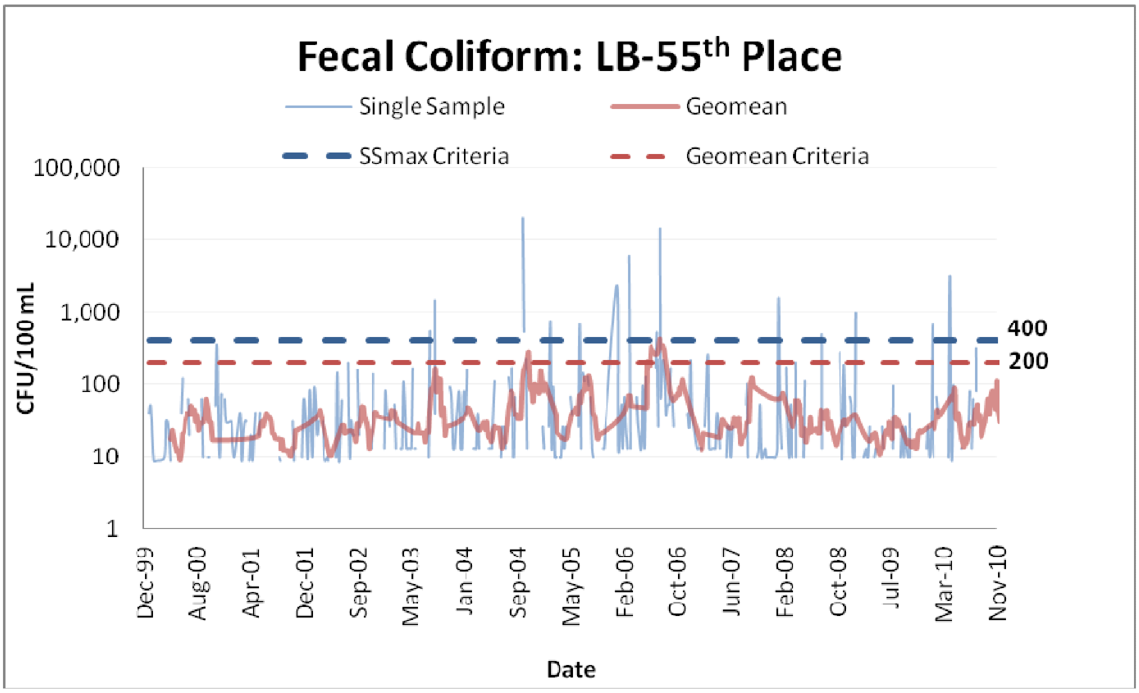

Fecal Coliform: LB-E. Belmont Pier
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date


Fecal Coliform: LB-Prospect
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

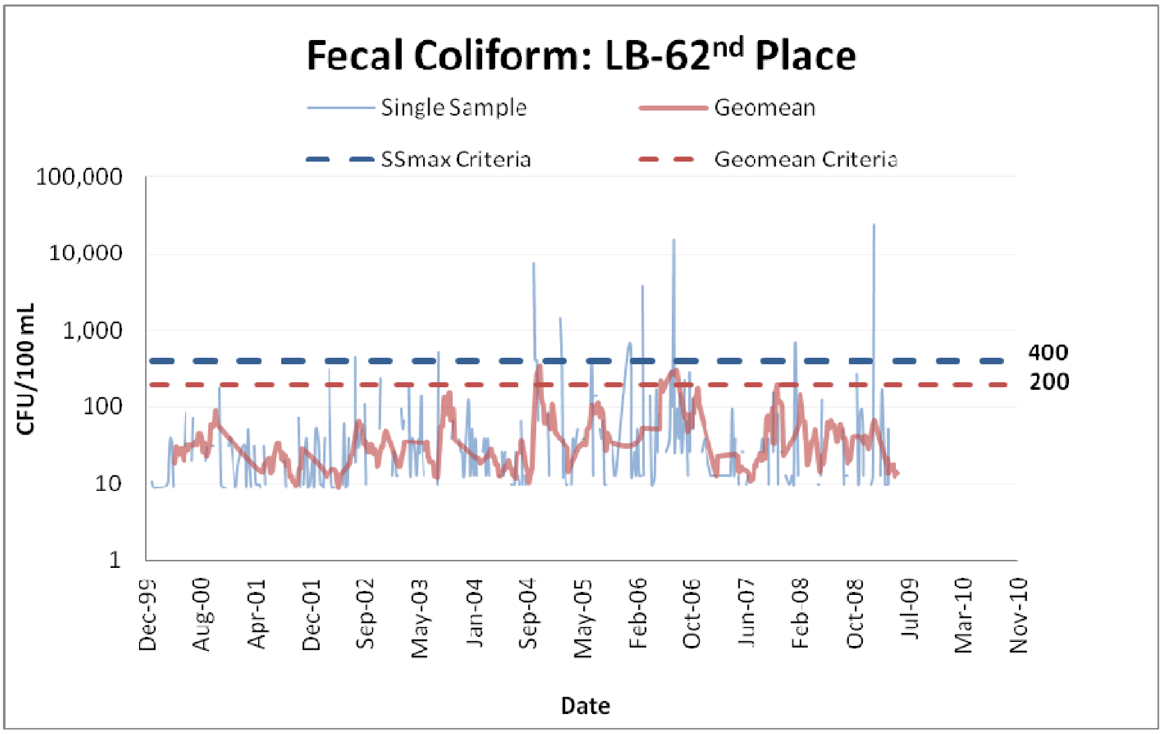

Fecal Coliform: LB-Granada
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date



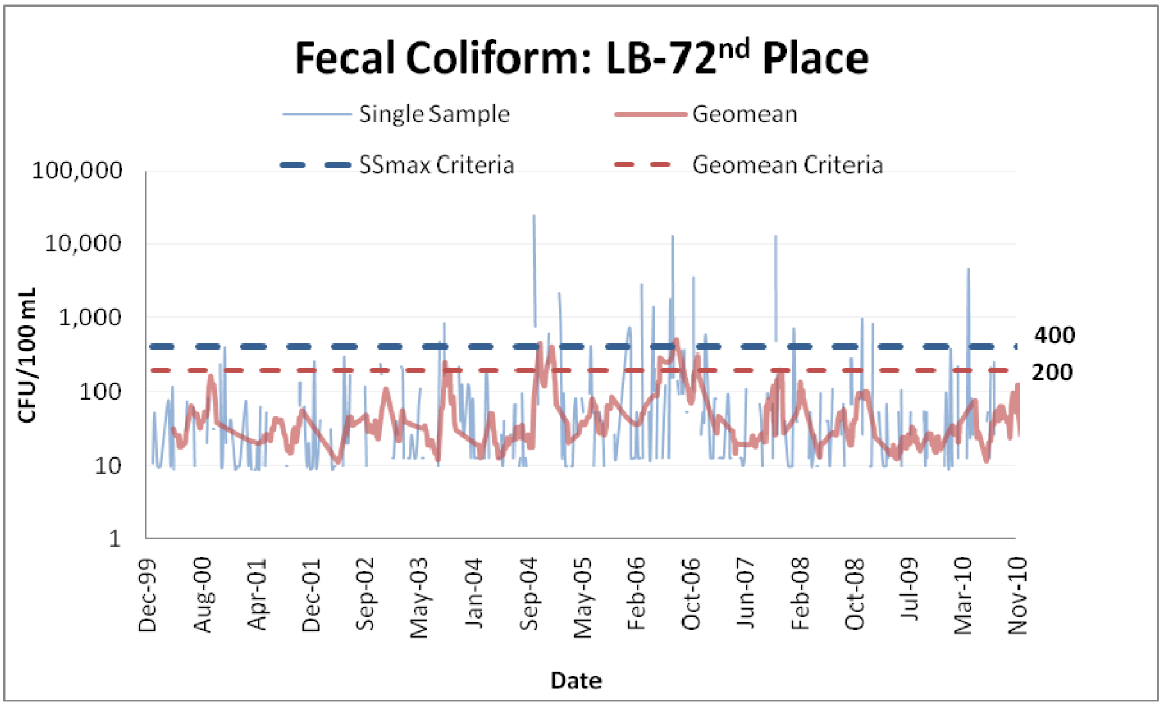
Fecal Coliform: LB-54th Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date



Fecal Coliform: LB-55th Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date



Fecal Coliform: LB-62nd Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date



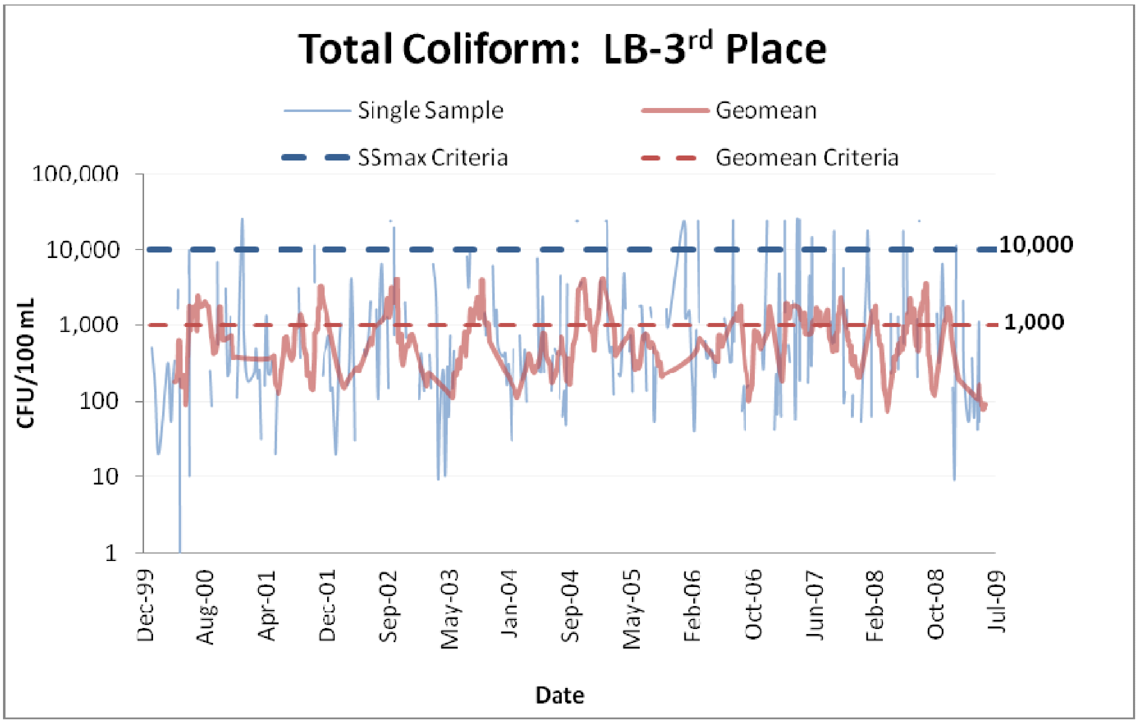
Fecal Coliform: LB-72nd Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
400
200
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

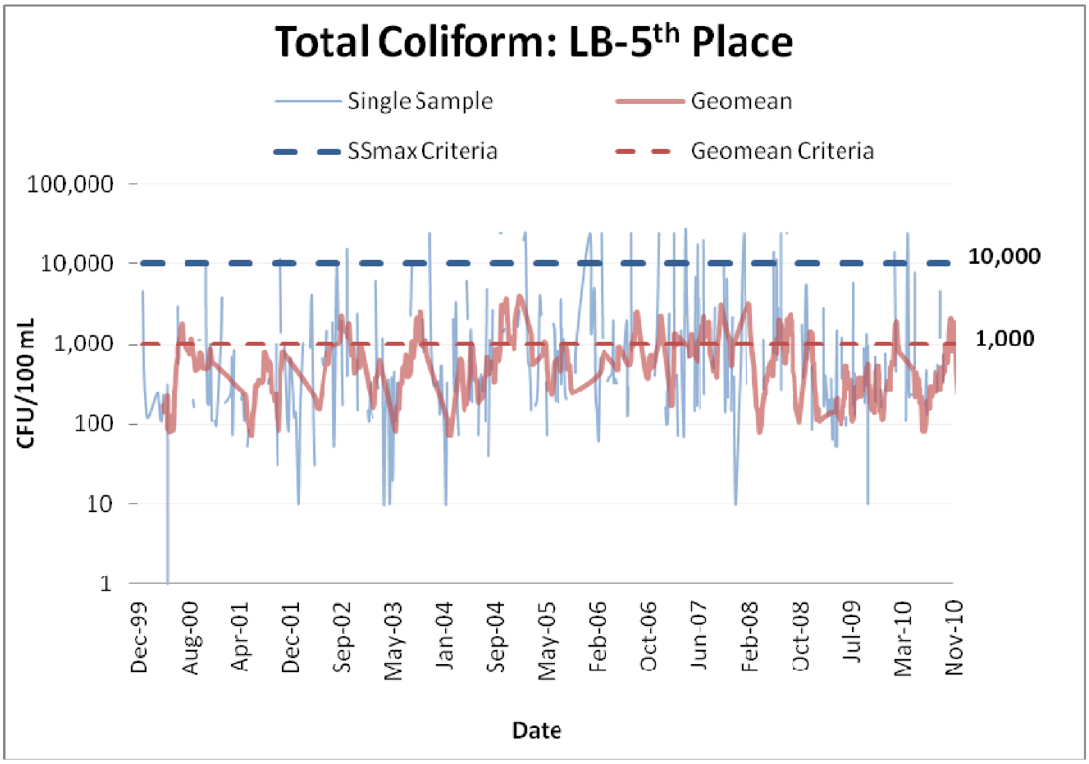
Total coliform bacteria

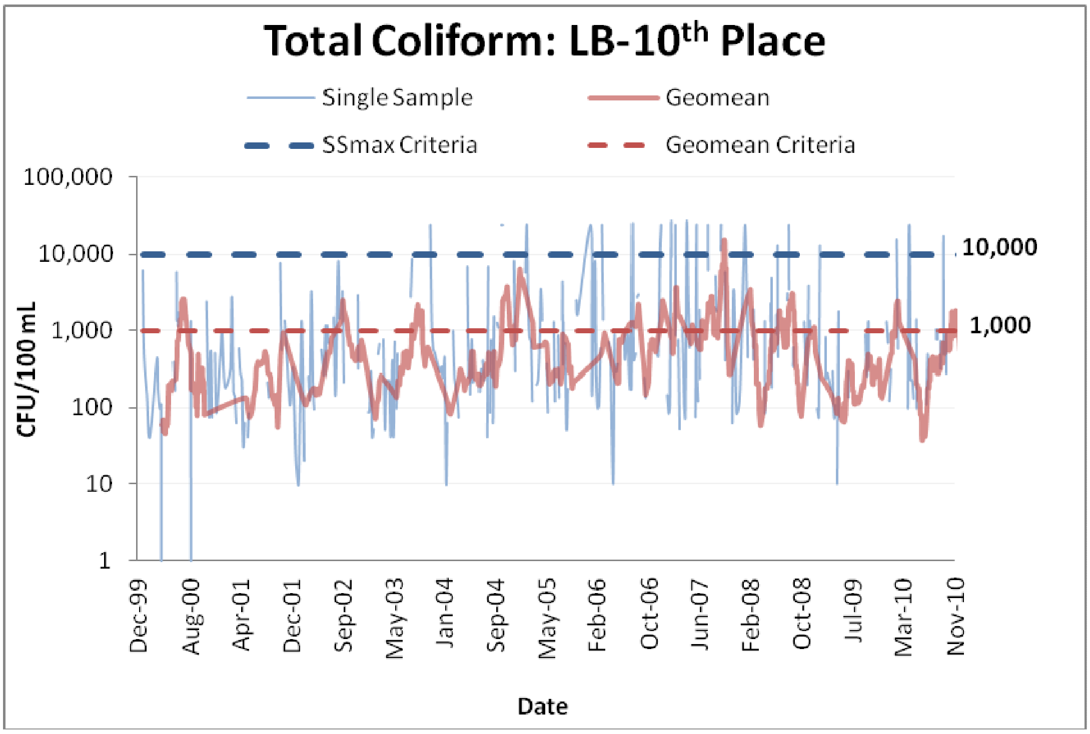
Total coliform bacteria measurements taken at these sites from 2000 to 2010 are presented for each site in the following tables. The blue solid line represents single sample data and the red line represents geometric mean (five-sample minimum, 30-day rolling geometric mean). The blue and red dashed lines represent the single sample and geometric mean standards, respectively. The single sample standard for total coliform is 10,000 CFU/100 mL; the geometric mean standard for total coliform is 1,000 CFU/100 mL.

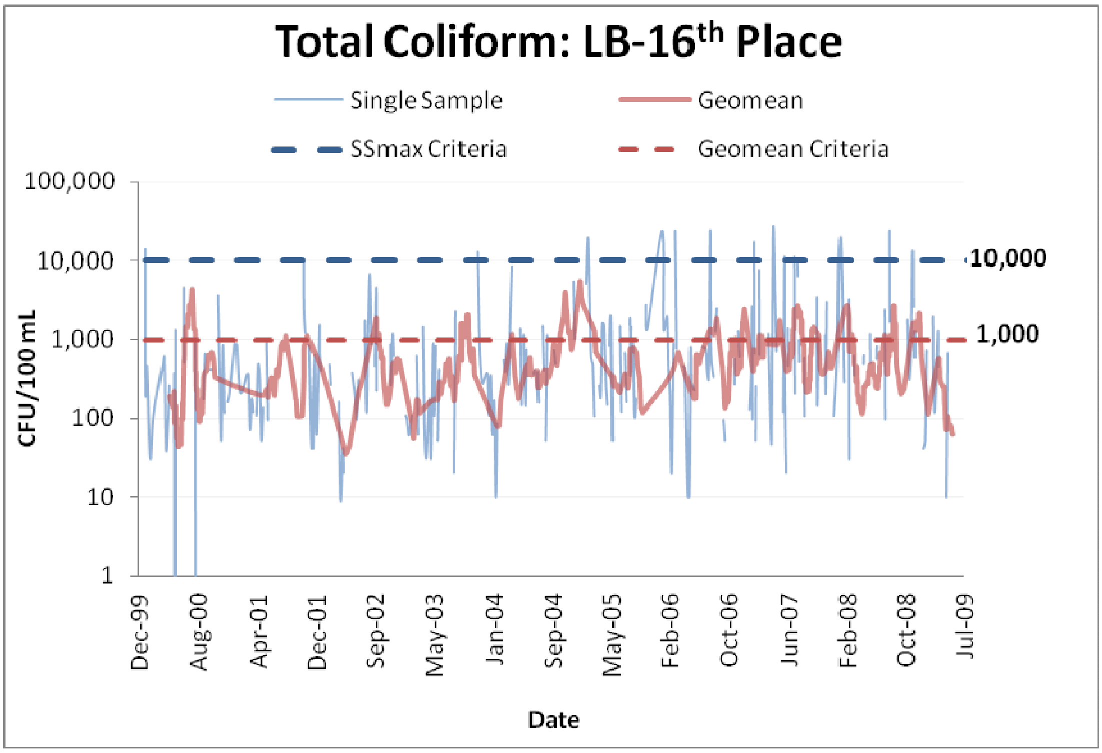
The City of Long Beach has monitored 15 locations along the shoreline of the LBC beaches. The following graphs present the total coliform data collected at each of the City's monitoring sites since 2000. Graphs are presented in order from those sites closest to the mouth of the Los Angeles River to sites an increasing distance away and therefore, closer to the mouth of the Alamitos Bay and San Gabriel River. The final graph is for the LAR Estuary itself.

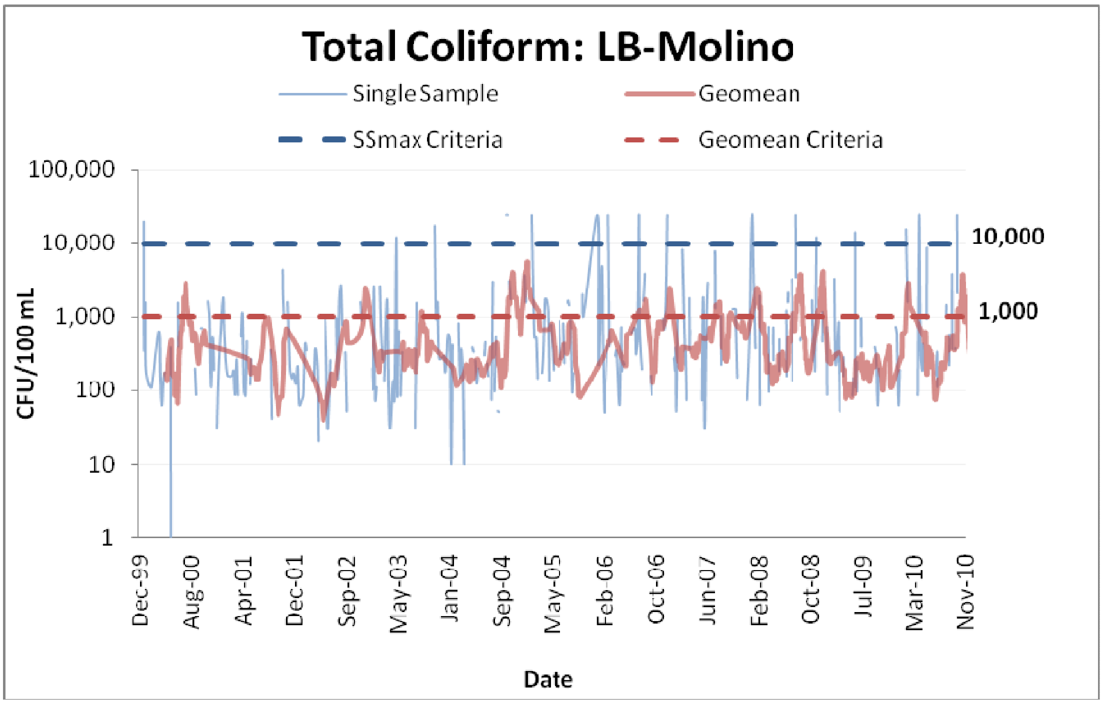
Total coliform concentrations are extremely variable at each site with ranging from less than 10 CFU/100 mL to over 10,000 CFU/100 mL. Despite this variability, a general trend is apparent with monitoring sites located closer to the Los Angeles River exhibiting a greater number of both single sample and geometric mean exceedances (points plotted above the criteria lines). This trend is particularity evident in monitoring locations LB-3rd Place, LB-5th Place, LB-10th Place and LB-16th Place (LB-W. Belmont also had many exceedances during the period it was sampled, likely due to the presence of a stormdrain nearby). Sites such as located farther southeast and therefore, farther from the mouth of the Los Angeles River, generally experience fewer exceedances as shown in the data for LB-54th Place and LB-55th Place. The LAR Estuary dataset was more limited (2009-2010). It showed exceedances of both criteria.

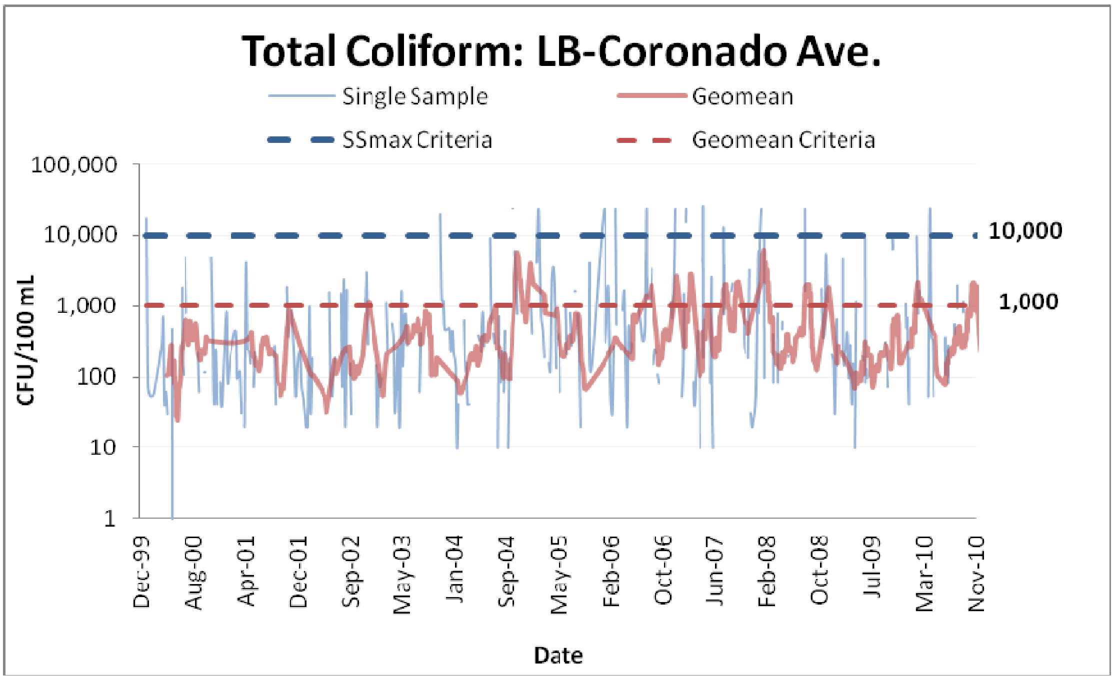


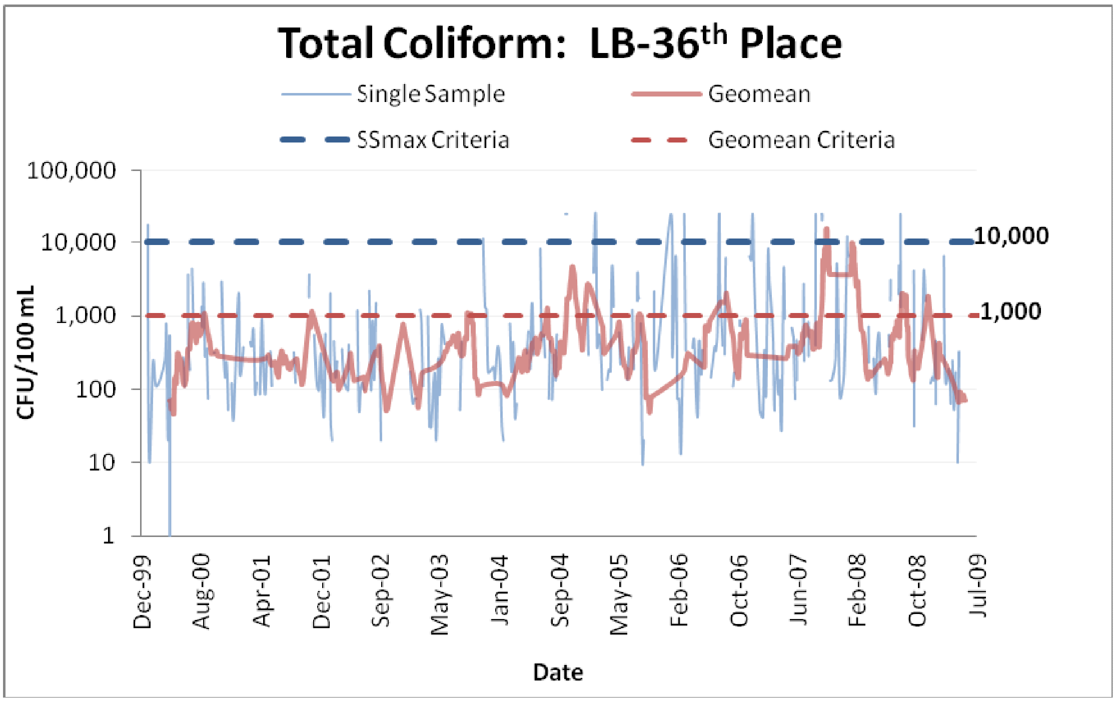

Total Coliform: LB-5th Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

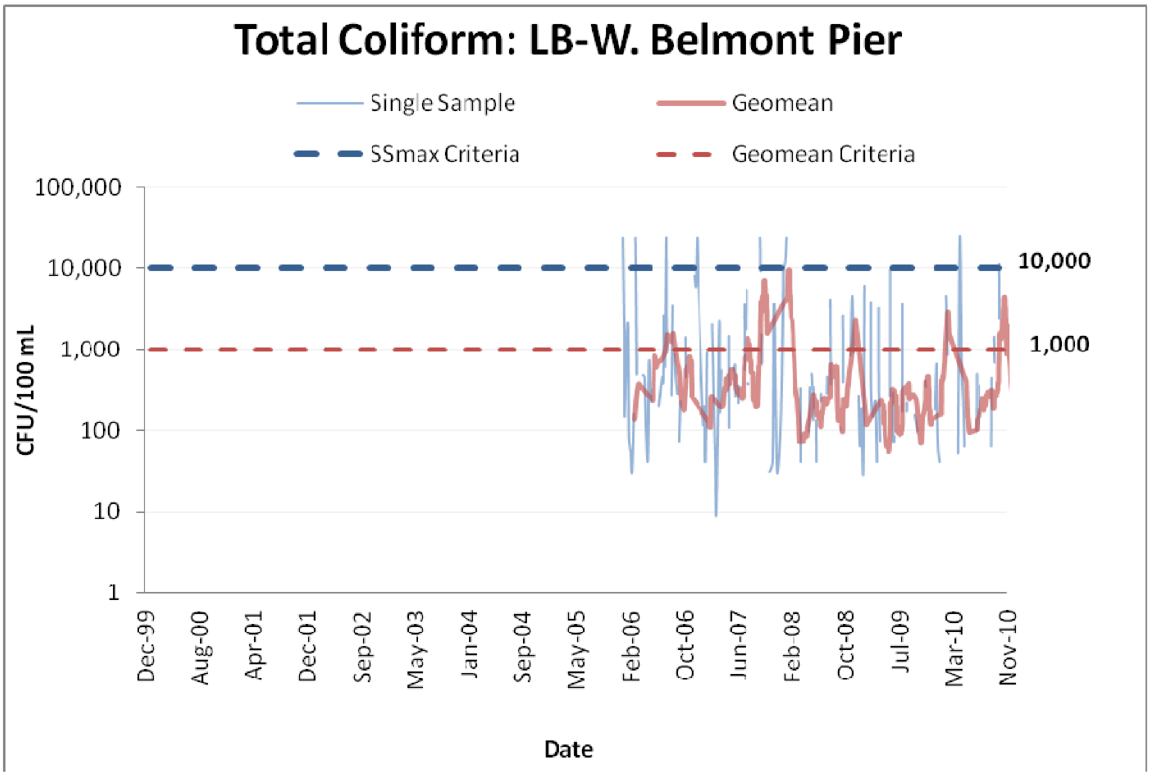

Total Coliform: LB-10th Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

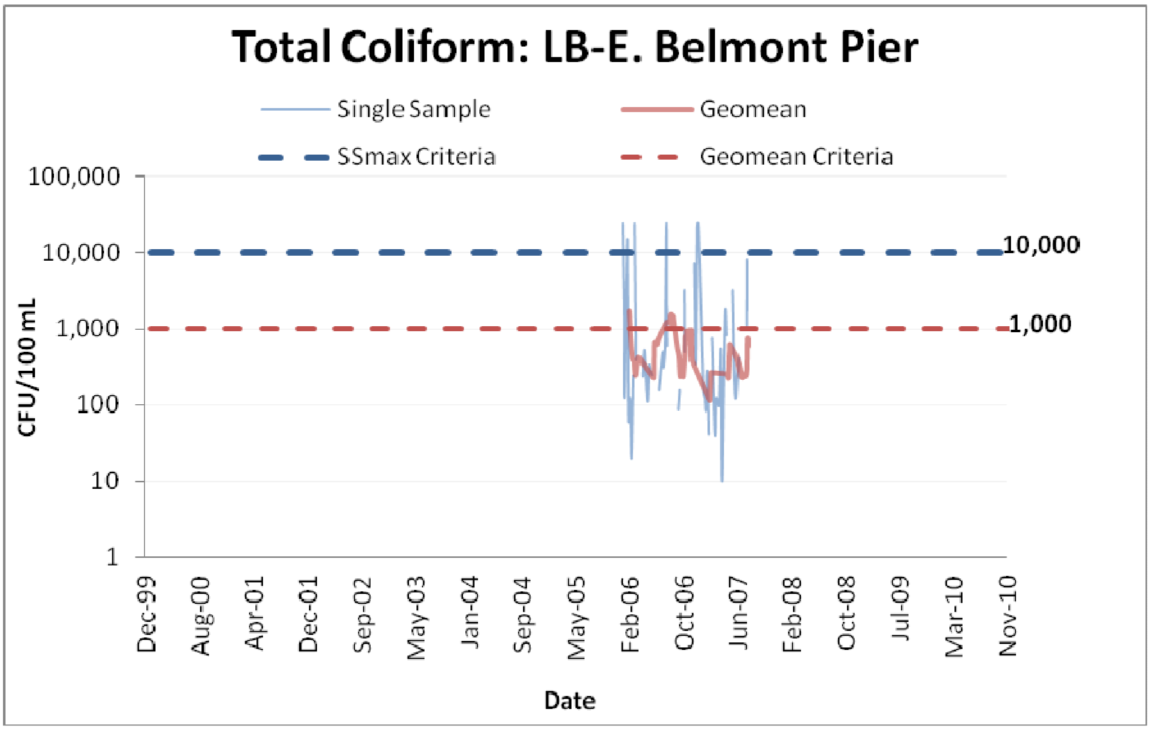

Total Coliform: LB-16th Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Date

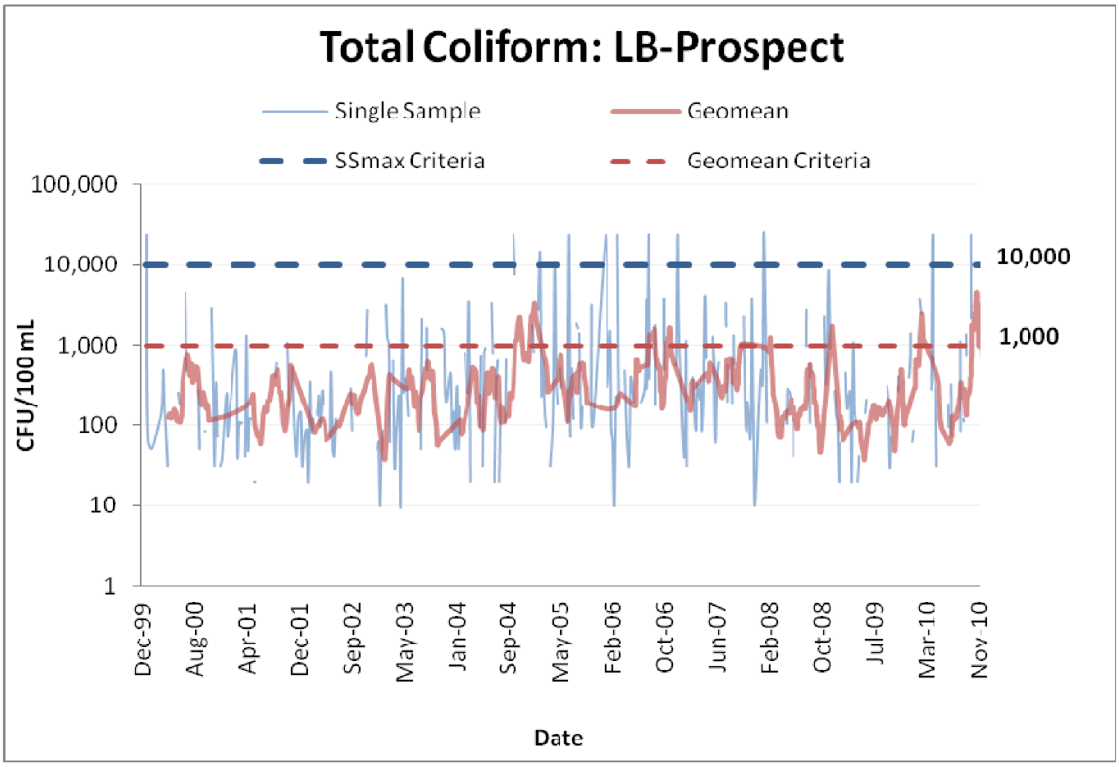

Total Coliform: LB-Molino
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

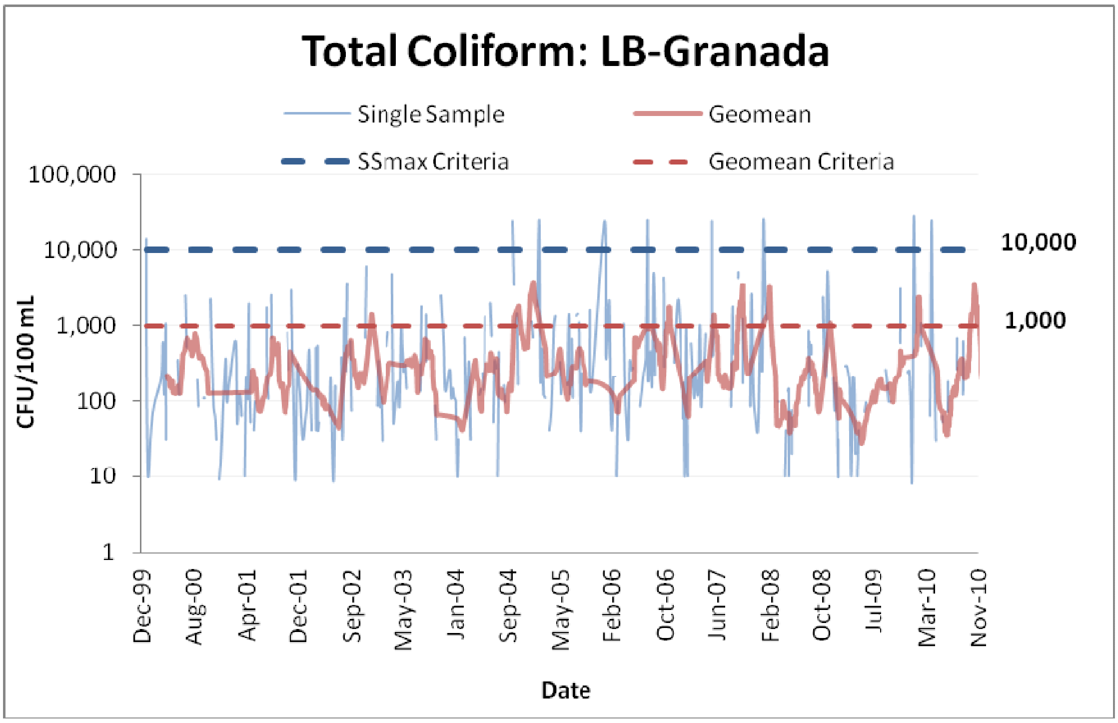

Total Coliform: LB-Coronado Ave.
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

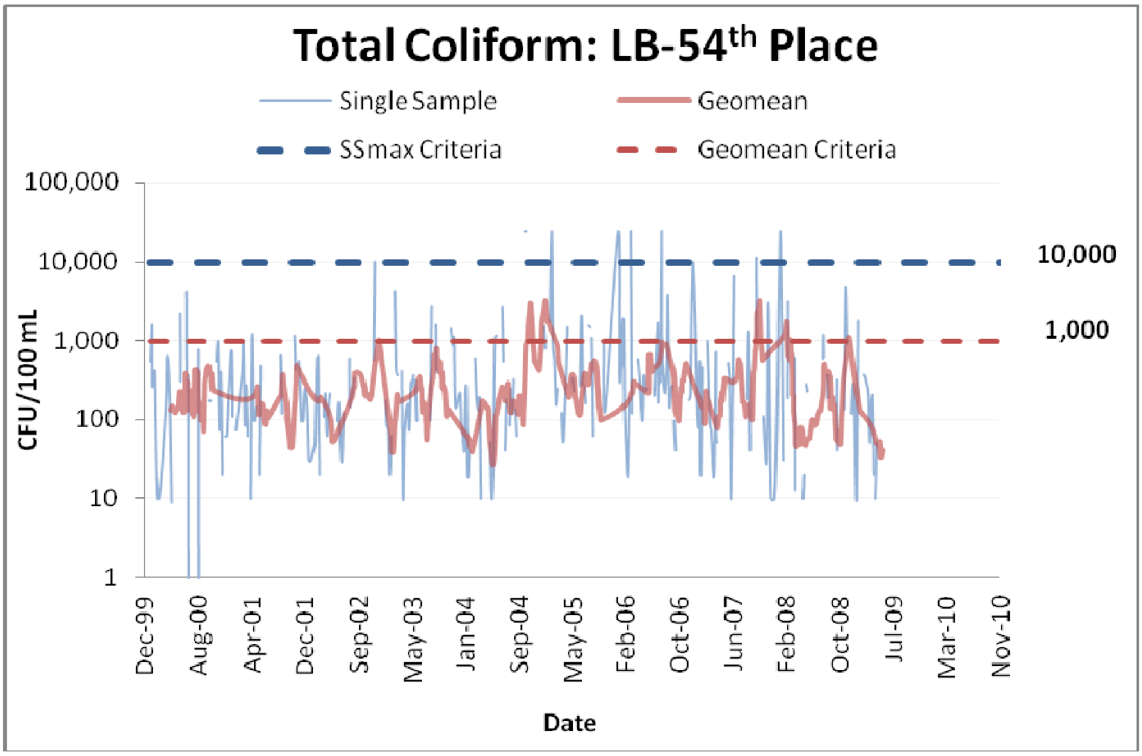

Total Coliform: LB-36th Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Date

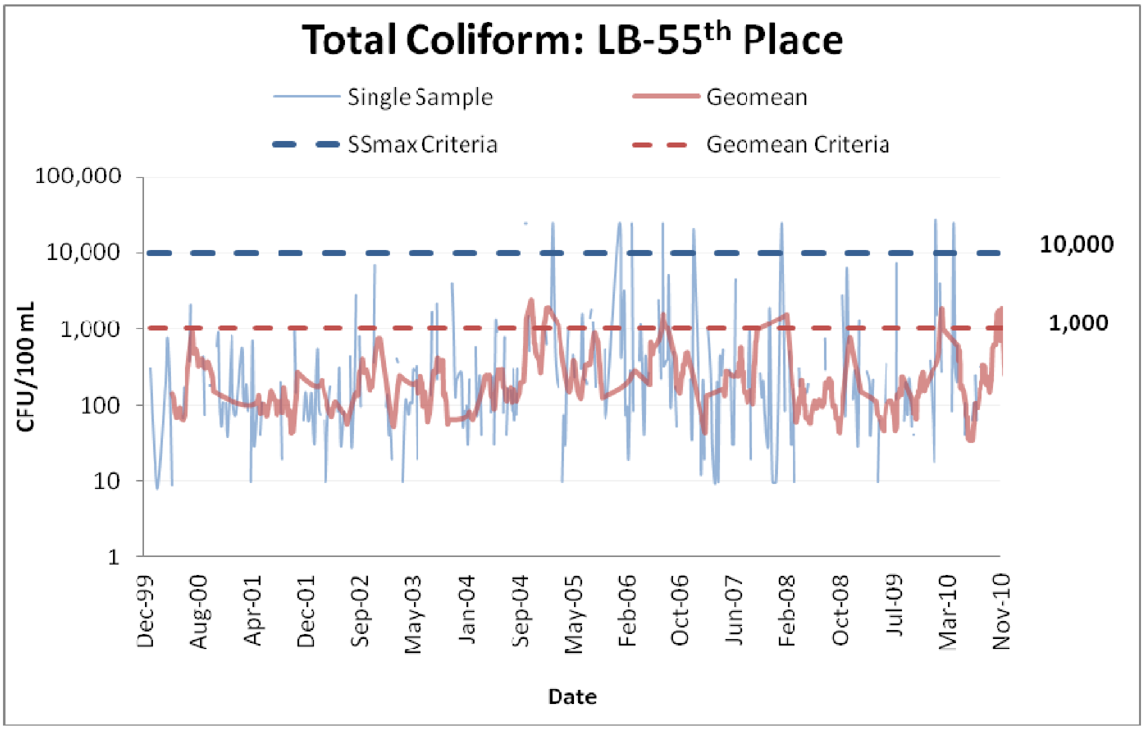

Total Coliform: LB-W. Belmont Pier
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

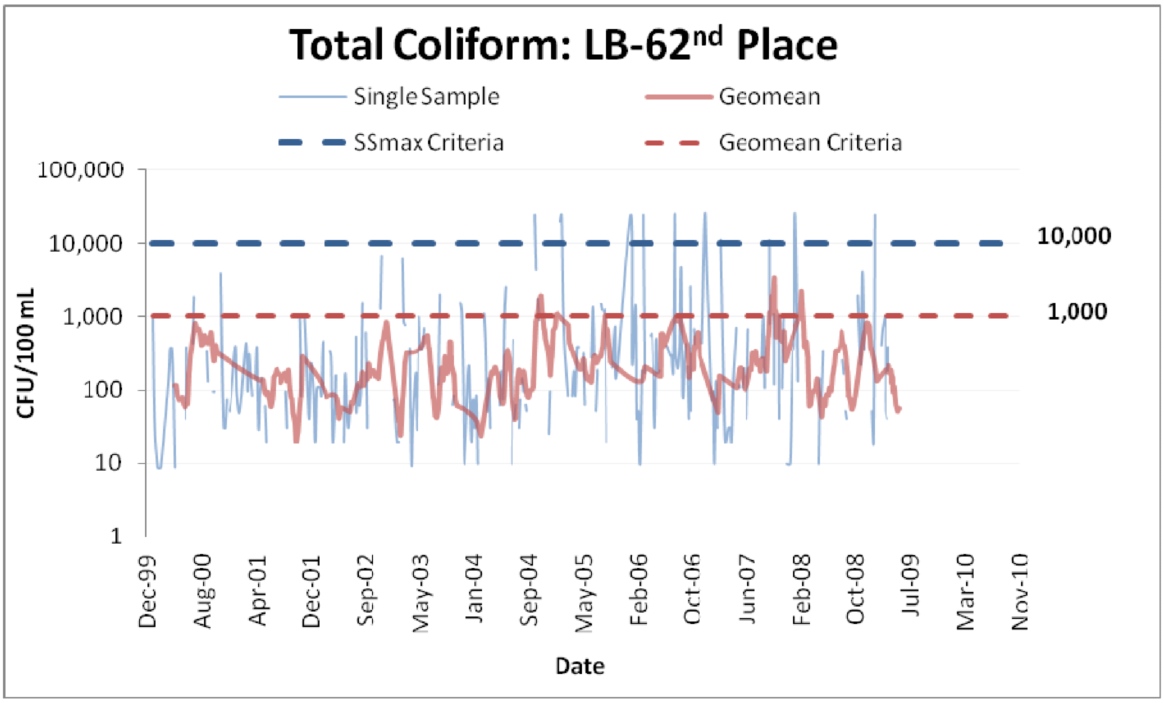

Total Coliform: LB-E. Belmont Pier
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

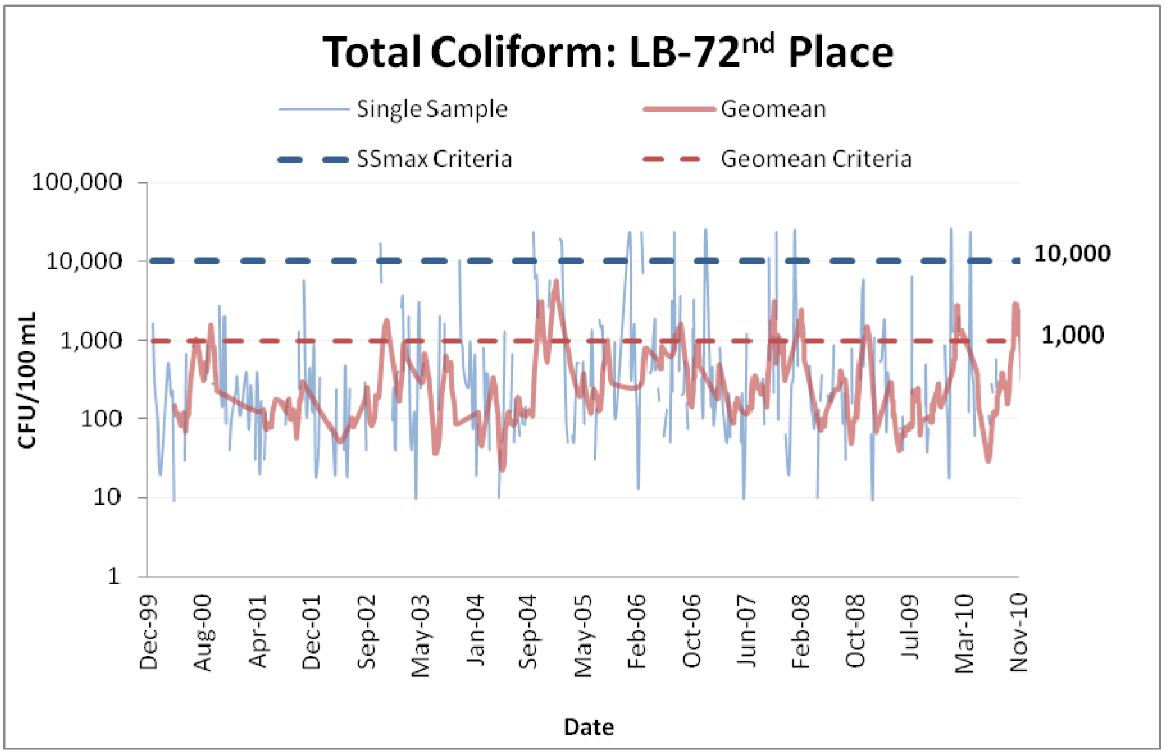

Total Coliform: LB-Prospect
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date

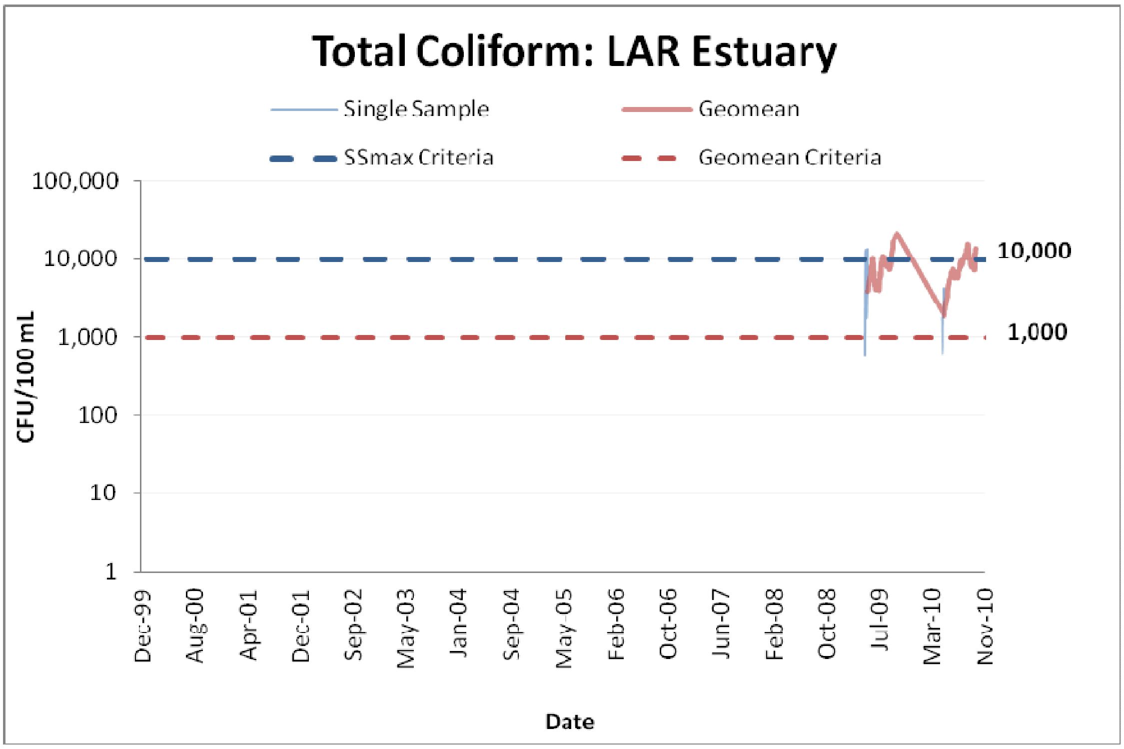

Total Coliform: LB-Granada
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date


Total Coliform: LB-54th Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date


Total Coliform: LB-55th Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
CFU/100 mL
100,000
10,000
1,000
100
10
1
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date


Total Coliform: LB-62nd Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date


Total Coliform: LB-72nd Place
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date


Total Coliform: LAR Estuary
Single Sample
Geomean
SSmax Criteria
Geomean Criteria
100,000
10,000
1,000
100
10
1
CFU/100 mL
10,000
1,000
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
May-03
Jan-04
Sep-04
May-05
Feb-06
Oct-06
Jun-07
Feb-08
Oct-08
Jul-09
Mar-10
Nov-10
Date