BABY BEACH BACTERIOLOGICAL SPECIAL STUDIES REPORT DANA POINT HARBOR, CALIFORNIA

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Prepared by

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TABLE OF CONTENTS

TABLES

FIGURES

Funding for this project has been provided in full or in part through a contract with the State Water Resources Control Board (SWRCB) pursuant to the Costa-Machado Water Act of 2000 (Proposition 13) and any amendments thereto for the implementation of California's Nonpoint Source Pollution Control Program. The contents of this document do not necessarily reflect the views and policies of the SWRCB, nor does mention of trade names or commercial products constitute endorsement or recommendation for use." (Gov. Code 7550, 40 CFR 31.20).

EXECUTIVE SUMMARY

Postings at Baby Beach due to high fecal indicator bacteria concentrations have been frequent and consistent since 1996. Multiple measures have been utilized to mitigate suspected sources of those bacteria, yet the postings persist. The sources of bacteria have been elusive. Seven special study bacteriological investigations have been undertaken and are reported herein to attempt to discern those sources so that effective Best Management Practices (BMPs) can be implemented at Baby Beach to mitigate sources of contamination.

Based on the bacteriological investigations conducted at Baby Beach, the following general conclusions can be reached.

1. The storm drains are significant sources of bacteria and bacteria laden sediments.
2. The storm drain plug systems currently in place are somewhat effective as detailed in the Data Mining Report (SAIC, 2003), but have not completely mitigated summertime bacterial levels at Baby Beach. Even with storm drain plugs in place, leakage from the drain is contributing measurable quantities of bacteria into the beach waters and adjacent sediments .
3. Bacteria appear to be associated with sediments and remaining viable for some period of time after deposition into sediments. The high levels of bacteria isolated from sediments using culture-based methods indicate survival in the sediments. When sediments become resuspended, bacteria concentrations in the water may increase. Thus, sediments may be a secondary source of bacteria in harbor waters.
4. Boating practices did not appear to be contributing measurable quantities of bacteria.
5. Birds may be contributing to bacterial pollution, but data collected are not sufficient to prove or disprove that birds are the cause of the persistent postings.
6. Other factors such as tide, sunlight, number of beach users, and turbidity did not appear to correlate with bacteria concentrations in water in this study.
7. Bacteria concentrations in water varied widely with time of day. The current time (7:00 a.m. to 10:00 a.m.) that Orange County Health Care Agency collects samples for AB411 compliance monitoring may be when bacteria concentrations are typically higher. Levels of the three different indicator bacteria trended similarly throughout the day. However, the causes of the trend are unclear.
8. *Bacteroides* PCR/TRFLP microbial source tracking methods currently lack sufficient specificity or sensitivity to identify the animal or human source of fecal indicator bacteria found in the environment. These methods remain under development pending verification of their usefulness in making BMP selection decisions.
9. The Community Analysis (CA) PCR/TRFLP microbial source tracking method is anticipated to be useful in to characterizing the bacterial communities at given sites. CA could potentially identify source organisms through gene sequencing

using public databases (GenBank and Ribosomal Database Project).

10. Further development and field testing of these MST methods is preferable before they can be used to analyze the Baby Beach samples.

Based on the forgoing conclusions as well as the conclusions reached in the data mining and circulation studies, a number of Best Management Practices are being evaluated in the State of the Beach Report. In the State of the Beach Report, BMPs will be evaluated and selected for implementation at Baby Beach based on the findings of the special study bacteriological investigations.

1.0 PROJECT INTRODUCTION

1.1 Site Background

Baby Beach, located in the northwestern area of Dana Point Harbor, California, has been associated for several years with routine postings due to bacterial contamination. Best management practices (BMPs) implemented to date have had limited effectiveness. A series of investigations have been conducted to attempt to discern the sources of bacteria. These include:

- Data mining
- Tidal circulation investigation
- Bacteriological special studies

Each of these investigations is being reported separately. This report is the bacteriological special studies report.

The overall project will culminate in a State of Baby Beach Report being prepared by SAIC for PFRD. The State of Baby Beach Report will briefly discuss the conclusions of the three investigations and evaluate BMPs for implementation at Baby Beach.

The reports fulfill part of the grant funding awarded to the County by the State Water Resources Control Board (SWRCB) under the Clean Beaches Initiative (CBI). The CBI helps provide solutions for improving water quality at beaches subject to chronic contamination, particularly due to bacterial sources.

Routine monitoring of beach waters for fecal indicator bacteria – total coliform, fecal coliform, and enterococci is required by State Law (AB 411). Data collected at Baby Beach has suggested the following potential sources of bacteria:

- Storm drains at west and east ends of beach that contribute human and non-human fecal contamination;
- Birds;
- Bacterial survival/re-growth in sediment;
- Human fecal contamination during beach use;
- Human fecal contamination from boating activities; and/or
- Domestic and wild animals.

Other factors may also affect bacteria concentrations. Data from the special studies presented in this report, coupled with results from the data mining and circulation study investigations, are used to evaluate whether bacteria concentrations could fluctuate due to the following influences:

- Spatial and temporal differences;
- Poor water circulation in the Baby Beach vicinity; and/or
- Resuspension of bacteria in sediments due to episodic (e.g., influenced by

storms and high waves/winds) currents and tides.

1.2 Statement of Specific Problem and Objectives

Routine bacterial monitoring of seawater at four historical near shore sampling sites at Baby Beach has often shown levels that exceed water quality standards. The sites include:

- West End (station number BDP12),
- Buoy Line (BDP13),
- Swim Area (BDP14) and
- East End (BDP15) of Baby Beach.

The Data Mining Report for Baby Beach (SAIC, 2002), suggests that the long-term trends in fecal and total coliform from 1997-2002 show a general decrease in concentration and frequency of bacterial contamination, suggesting there has been some benefit of current BMPs, such as storm drain plugs. However, *Enterococcus* values have increased slightly in concentration and frequency from 1999 to 2002.

Specific objectives of the bacterial special studies addressed in this report include the following:

- Evaluate the spatial source and magnitude of indicator bacteria, including patterns and trends to the extent practicable.
- Evaluate the species (e.g., birds, humans, etc.) generating the indicator bacteria, to the extent practicable.

2.0 STUDY APPROACH AND METHODOLOGY

A series of short-term bacterial monitoring studies were conducted by Water Quality Laboratory staff of the Orange County Public Health Laboratory (OCPHL) to identify the major source(s) of bacterial contamination at Baby Beach. The studies focused on fecal indicator testing with some evaluation of microbial source tracking (MST) methods. OCPHL staff collected water and sediment samples at Baby Beach and other locations in Dana Point Harbor. Sampling locations were documented using a global positioning system (GPS) receiver. The samples were tested for fecal indicator bacteria at the OCPHL, as detailed in the Baby Beach Bacteriological Sampling and Analysis Plan (SAP).

2.1 Approaches and Methodologies

The special studied followed two general approaches:

- Fecal indicator bacteria sampling was used to identify spatial and temporal trends or patterns of bacterial contamination. These spatial and temporal data help provide insight into the source and migration patterns of indicator bacteria that are causing exceedences of AB411 standards at Baby Beach. Water and sediment samples were tested for:

- Total coliform using membrane filtration (SM9222 B) (Standard Methods, 1999)
- *Escherichia coli* (*E. coli*) using USEPA Modified *E. coli* Method (USEPA, 2000)
- *Enterococcus* spp. using USEPA Method 1600 (USEPA, 2000)

- MST analytical methods were explored to determine if they could reasonably be used to discriminate between human or non-human sources of indicator bacteria. MST methods evaluated in this study included:
  (1) *Bacteroides-Prevotella* 16S rRNA Polymerase Chain Reaction (PCR)/ Terminal Restriction Fragment Length Polymorphism (TRFLP);
  (2) *Bacteroides thetaiotaomicron* 16S rRNA PCR/ TRFLP; and
  (3) Community Analysis (CA) 16S rRNA PCR/ TRFLP.

The most reliable and established fingerprinting methods use the gene sequence information present in the16S ribosomal-ribonucleic acid (rRNA) gene. Organisms are detected using a combination of PCR of a gene sequence and TRFLP. Briefly, PCR is used to amplify or produce numerous copies of the 16S gene. The amplified product is cut into fragments using enzymes. The sizes of the fragments are used to determine whether they are unique to human or non-human sources. Nearly all of the 16S RNAs can be amplified, as is the case using the CA method, or markers to species (i.e. *Bacteroides thetaiotaomicron*) or groups of species (*Bacteroides-Prevotella*).The Bacteroides-Prevotella (B-P) method uses genus specific primer sets to discriminate between human and “other” unidentified sources of B-P strains, i.e. from cows, dogs, seagulls, etc.

Bacteroides thetaiotaomicron (Bt) is a species specific test for Bt, which is commonly found in humans and/or present at very low levels in other species.

The Community Analysis (CA) method is a genus specific method that can be used to compare genetic differences between bacterial populations from different sample sites.

Short-term field surveys were designed by OCPHL to characterize possible sources of fecal indicator contamination at Baby Beach. Due to the high costs ($60 - $200/test) of MST analytical methods, potential sources of contamination were prioritized using fecal indicator testing. Water and sediment samples tested for fecal indicators were kept frozen for subsequent MST testing, depending on the significance of the source based on the fecal indicator results and budgetary considerations. The surveys were modified as the study progressed, based on the findings of preceding surveys.

The short-term surveys are summarized in Table 2.1-1 that also indicates the number of MST samples collected for each study. The term “routine sites” refers to sampling sites that are monitored on a weekly basis by the Health Care Agency Environmental Health Department Water Quality Section as part of the Ocean Water Protection Program.

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Table 2.1-1: Summary of Special Studies at Baby Beach

No.	Study	Purpose	Total No. Samples for Indicator Testing (incl. dup)	Sampling Date(s)	Potential MST Tests	Total No. Samples for future MST testing
1	Leaks from storm sewers into and through groundwater	Assess groundwater in sediment, below tide level as possible source of fecal indicator bacteria	50	1/21/02	Bt	25
2	Transport through groundwater	Assess groundwater in area above Baby Beach	8	9/23/02	Bt	4
3	Levels in Storm Drain Affected Sediments	Assess storm drain and nearby sediment	36 100 38	9/6/02 9/16/02 10/7/02		
4	Regrowth in Storm Drain Affected Sediments	Assess storm drain and nearby sediment	124	Weekly, 8/21–10/31/02	Ent. CA	6
5.	Nearshore Sediment	Assess nearshore sediment	24	9/17/02 (10/8/02)		
6	Boat Sewage Discharge	Assess effect of increased boating activities on fecal indicator levels at routine sampling sites	132	8/29 & 30 & 9/1, 2, 4, & 5/02	Bt Ent. CA	17 17
7	Bacterial Indicator Level Variability	Assess effect of UV, bird density, circulation, and human activities on fecal indicator levels	54 56	9/23/02 10/21/02	Bt CA Ent. CA	10, 10, 10 12, 12, 12
		Total	622			135

MST = Microbial Source Tracking
Bt = Bacteroides thetaiotaomicron
CA = Community Analysis
Ent. CA = Enterococcus Community Analysis

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3.0 RESULTS AND CONCLUSIONS

This section presents results and conclusions from the seven field and laboratory studies and the microbial source testing study. Data from each study are presented in separate appendices.

3.1 Study 1: Leaks From Storm Sewers Into and Through Groundwater: Groundwater Seeps

Study Synopsis. This study assessed fecal indicator levels in groundwater at low tide levels at the west end of the beach, near the west storm drain. Figure 3.1-1 shows the sampling locations. At each location, a shallow pit was excavated with a post shovel and a water sample was collected. Bacterial levels in the west storm drain (upstream and downstream) of the plug, in harbor water nearest the west storm drain, and in groundwater monitoring well #11 were measured. Samples were collected during a negative tide period to access ground areas that are normally below the tide level.

A channel of water running between the 49.5 N and 67.5 N sampling points (from the harbor water to the shoals) prevented the planned sample collection from 58.5 feet north of the storm drain.

If the drain were a source, high bacterial levels would be found inside the drain and near the pipe mouth. Leakage in the pipes or from other land-based sources could be indicated by the presence of high levels of bacteria in the ground well and/or seepage samples.

Results. Data for bacterial indicators and salinity at each sampling location are summarized in Figure 3.1-2, with data presented in Appendix A.

These data show high bacteria levels in samples taken from inside and near the pipe, decreasing significantly within a short distance away from the pipe mouth. The highest levels of total coliform, *E. coli*, and *Enterococcus* were found inside the pipe, in samples taken from the manhole behind the plug and just inside the pipe mouth, downstream of the plug.

Elevated counts of total coliform and *Enterococcus* also were found in harbor water and in seepage water sampled within seven feet of the pipe mouth. However, these counts were significantly lower compared to the pipe samples, indicating that substantial dilution was occurring away from the storm drain source. In contrast, the seepage water in the sample taken 17.5 feet from the pipe had only a slightly elevated total coliform count. Fecal indicators were not detected in samples taken from the monitoring well.

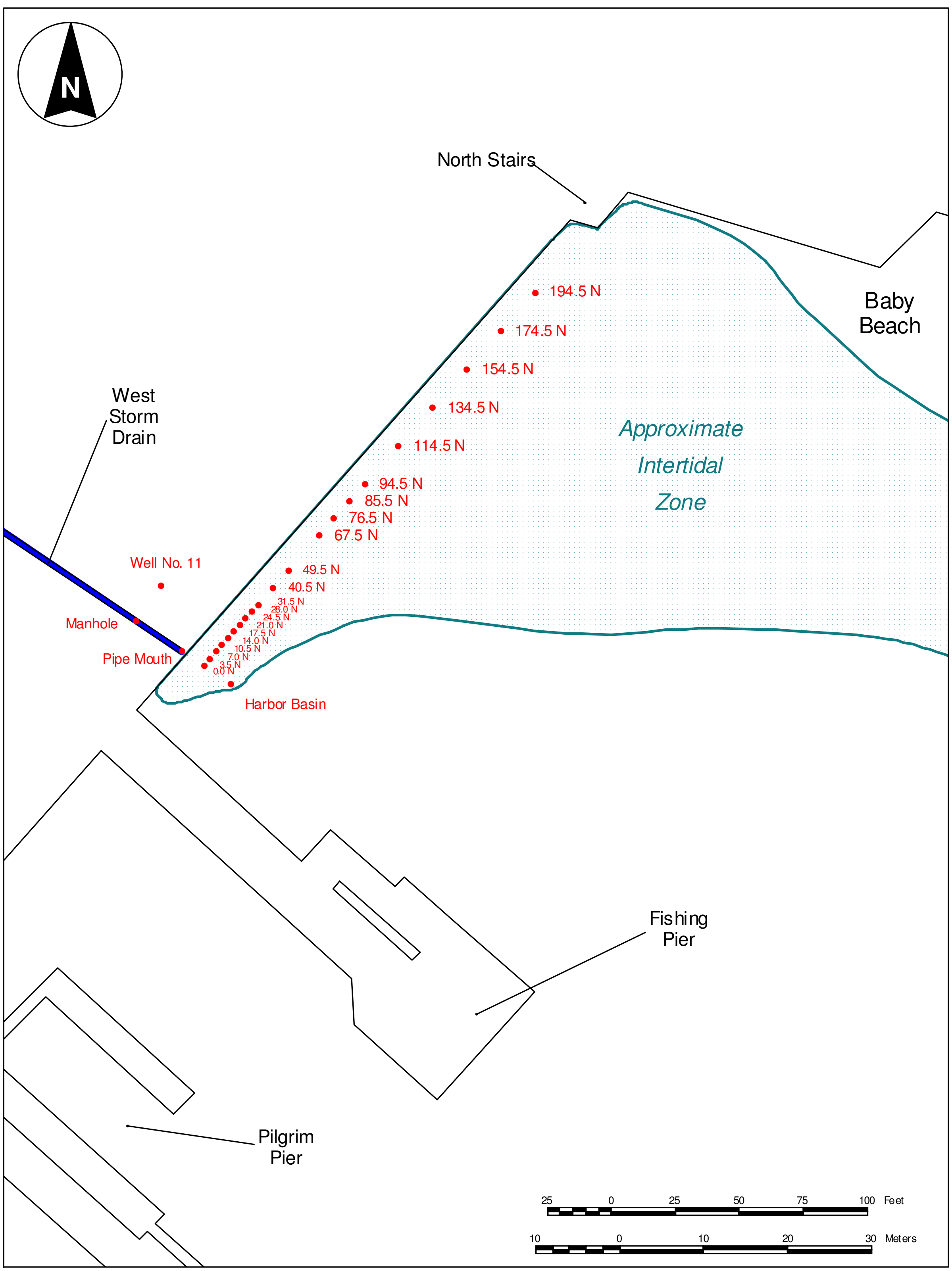

Figure 3.1-1: Sampling Stations (GIS-based) for Study of Leaks From Storm Sewers Into and Through Groundwater: Groundwater Seeps

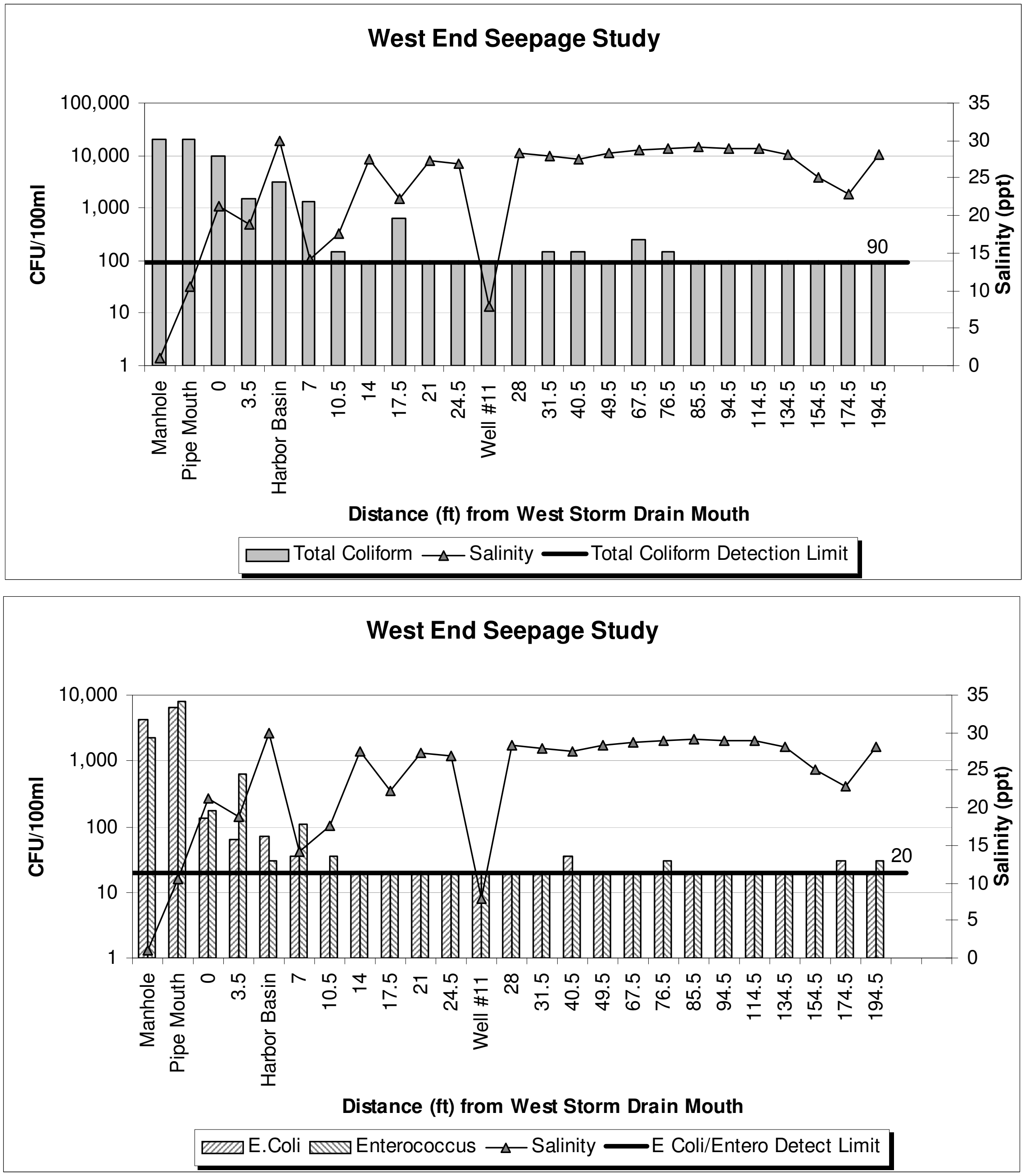

Figure 3.1-2: Bacterial Indicator and Salinity Levels in Water West End Seepage Study

A narrow channel about 50 feet north of the West End Storm drain pipe separates two general sediment types: sandy beach to the north and finer grained ("muddier") material nearer to the pipe mouth. Among the samples analyzed, the elevated bacterial indicators were found mostly in seepage samples from the finer-grained sediments near the pipe. Additional studies of bacteria in sediments are described in Sections 3.3-3.5.

Salinity data indicate fresh water in the storm drain behind the plug. In contrast, most of the seepage samples had salinity levels of 25-30 parts per thousand (ppt), similar to salinity levels of the harbor water nearest the drain(29.9 ppt), with lower values near the pipe mouth and near the northern sea wall. The salinity of seawater is approximately 35 ppt. These lower salinity values near the pipe mouth likely result from fresh water discharging from the pipe. Lower salinity values at the 17.5-foot sampling point and those near the sea wall may result from watering of nearby landscaped areas. A slow flow of water was also observed flowing down the wall near a crack in the sidewalk about 20 feet from the storm drain. The salinity of 7.8 ppt within the monitoring well indicates a predominance of fresh water at this location with some occasional seawater influence.

Conclusions. Bacterial indicator and salinity data from groundwater seepage samples suggest that:

- The West End Storm drain appears to be contributing fecal indicator bacteria to Baby Beach, even with the storm drain plug inserted.
- There appears to be little or no leakage from the West End Storm drain into groundwater.
- There appears to be no significant transport of bacteria through groundwater.
- Groundwater appears to be generally fresh-water with occasional seawater influences.

3.2 Study 2: Groundwater Monitoring Wells

Study Synopsis. Fifteen existing monitoring wells were available for sampling groundwater at Baby Beach to assess leaks from elsewhere in the storm drain system, the sewer system, or any other migration through groundwater. Groundwater samples were collected on September 23, 2002 from four wells located near the Baby Beach storm drain pipes, sewer lines, and an old leach field (Figure 3.2-1).

Well #1 was dry and could not be sampled. The groundwater samples were tested for

(1) fecal indicator bacteria to evaluate the integrity of storm drain and sewer pipes; and

(2) conductivity/salinity levels to assess potential seawater fresh-water mixing.

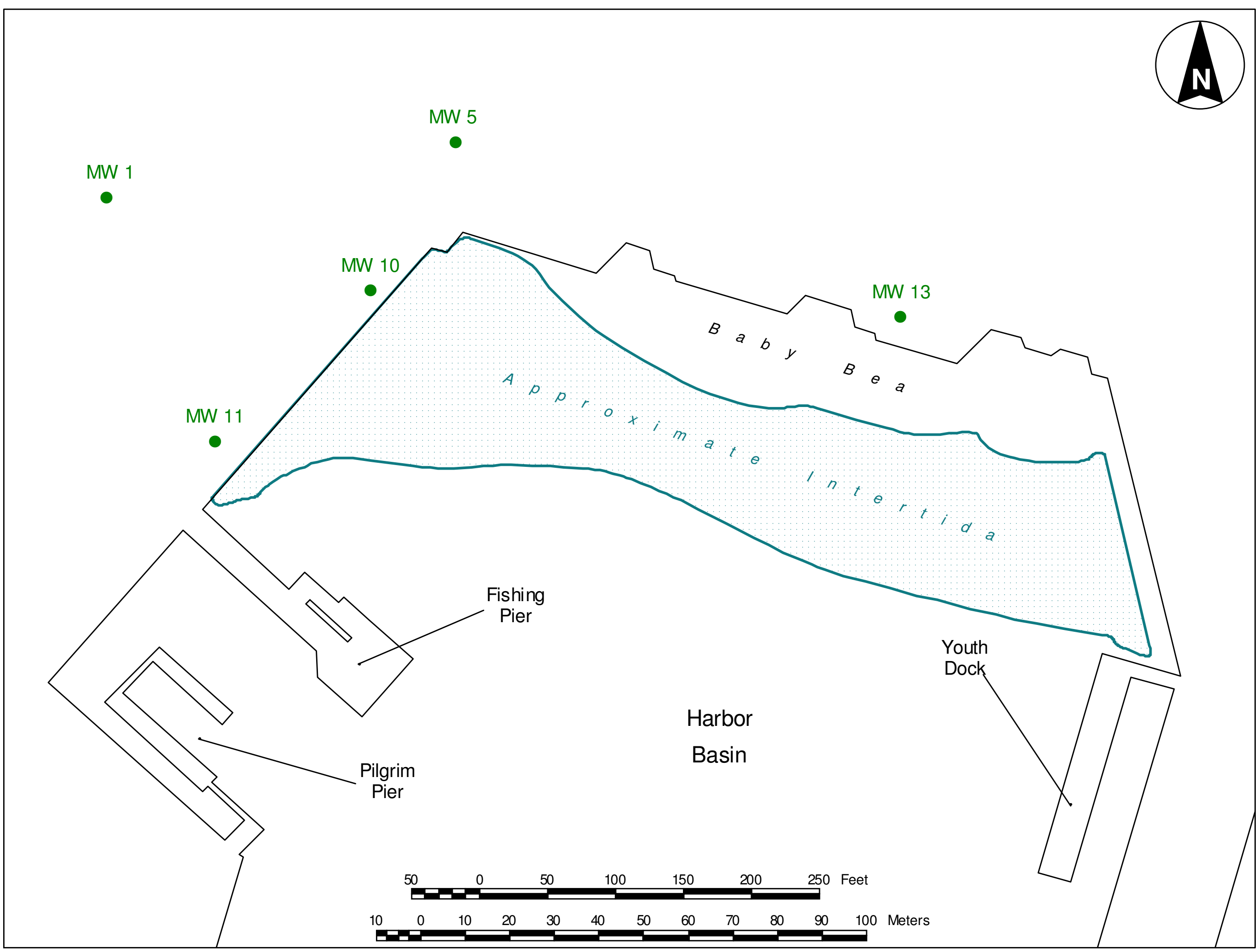

Figure 3.2-1: Sampling Stations (GIS-based) for Study of Transport through Groundwater: Groundwater Monitoring Wells.

Results. Levels of the three bacterial indicators were less than the detection limit of 10 CFU/100ml for all samples except for total coliforms in Well #5, which had an average count of 300 CFU/100ml, and *Enterococcus* in Well #13, with an average count of 40 CFU/100ml (Figure 3.2-2).

These two wells are adjacent to a sewer line, however, samples from other wells and groundwater seeps in Study 1 (Section 3.1) suggest no significant transport of bacteria is occurring through groundwater from any sewer sources.

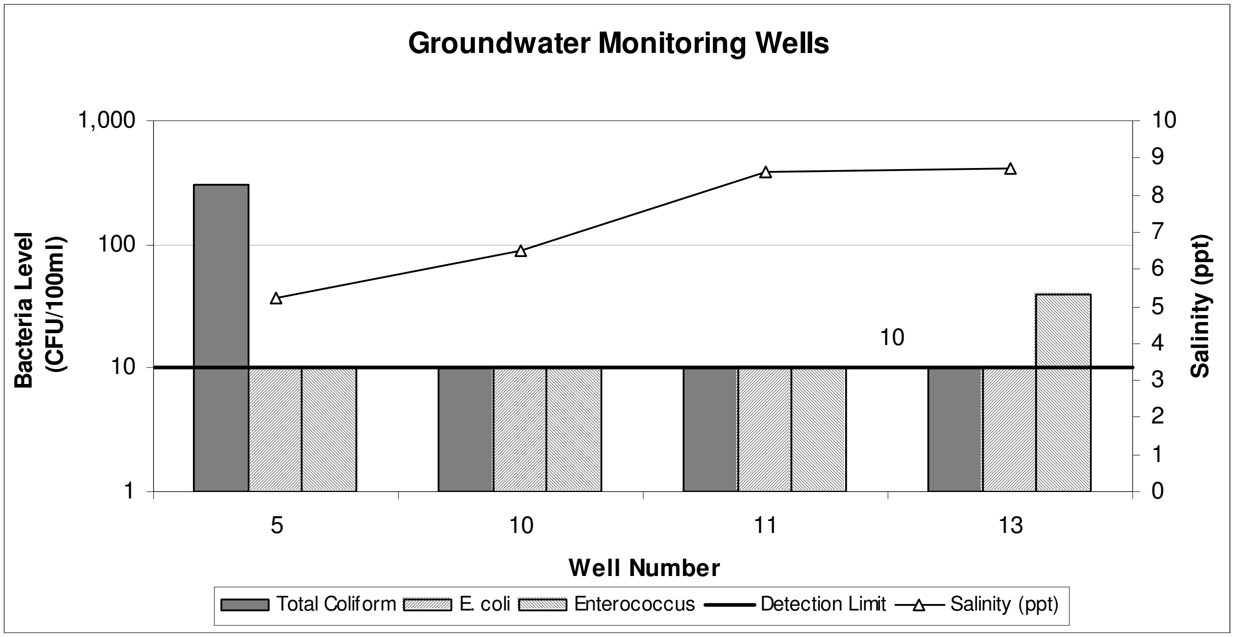

Figure 3.2-2: Bacterial Indicator and Salinity Levels in Monitoring Wells.

Bacterial indicators were not detected in well #11, located closest to the west storm drain. This well was also sampled during the groundwater seepage study (Section 3.1) on August 21, 2002, and similarly found to be free of indicator bacteria.

Salinity ranged between 5-9 ppt for all four wells, which is about ¼ the salinity of seawater, suggesting there may be occasional intrusion of seawater into the groundwater regime. Data are presented in Appendix B.

Conclusions. Bacterial levels in groundwater suggest:

- Little or no leakage was occurring from storm drains into the groundwater table.
- Little or no transport of indicator bacteria was occurring through groundwater to the beach.
- Shallow groundwater was largely fresh-water with occasional seawater influence.

3.3 Study 3: West Storm Drain Transect Studies

Three sampling events were undertaken to evaluate the presence or absence of viable indicator bacteria in sediments at Baby Beach. Note, earlier studies focused on bacteria suspended in water.

Study 1 (Section 3.1) suggested that the West End Storm drain is a contributor of indicator bacteria to Baby Beach, even with the storm drain plug installed. Of concern is whether such bacteria may remain viable and resident at Baby Beach. Other studies (e.g., Fujioka and Hardina 1995; Solo-Gabriel et al. 2000) have measured high coliform levels in sediments in areas allowed to dry in between tides. The purpose of this study was to assess the levels of viable bacteria in sediments at Baby Beach that could be resuspended during certain wind conditions or beach activities.

Three transect sampling events were undertaken:

- West Storm Drain Transect Study I
- West Storm Drain Transect Study II
- West Storm Drain Transect Study III

In each of these studies sediment transects were sampled at varying distances from the West End Storm drain to assess the levels of viable bacteria present in sediments and spatial distribution from the storm drain. This would help determine whether bacteria are being transported from the West End Storm drain to areas near the routine sampling locations where AB 411 samples are collected weekly.

3.3.1 West Storm Drain Transect Study I

Study Synopsis. Sediment samples were collected on September 6, 2002, along three transects shown in Figure 3.3-1 as extending outwards (north along the sea wall, east into the harbor basin [water], and south toward the pier) from the West Storm drain. A sediment sample was also collected at sampling Station S-6, located outside of the harbor, to represent background conditions based on Data Mining Report conclusions.

The east transect begins at the pipe mouth, while the north and south transects begin at a point 12 feet east of the storm drain pipe and continue north and south, parallel to the wall. Most samples were collected within a fine sediment area, based on visual observations.

Results. Results of the West Storm Drain Transect Study of September 6, 2002, are shown in Figure 3.3-2. Data are tabulated in Appendix C. Bacterial indicator levels in sediments at the pipe mouth were high for total coliforms and *Enterococcus*, with average values of 26,000 CFU/10g and 6,200 CFU/10g, respectively. In contrast, levels of *E. coli* were at or below the detection limit of 200 CFU/10g.

Total coliform levels were above the detection limit of 200 CFU/10g throughout the sampling area.

Notable are the high total coliform counts of about 300,000 CFU/10g along nearly the entire length of the east transect, which is perpendicular to the seawall. The high total coliform data at three and six feet along the south transect suggest that the width of the high-total coliform path may be three to six feet south of the perpendicular line from the pipe mouth to the harbor basin.

E. coli levels were at or near the detection limit of 200 CFU/10g along the entire length of the north and south transects, and increased only slightly along the length of the east transect, between the pipe mouth and the harbor.

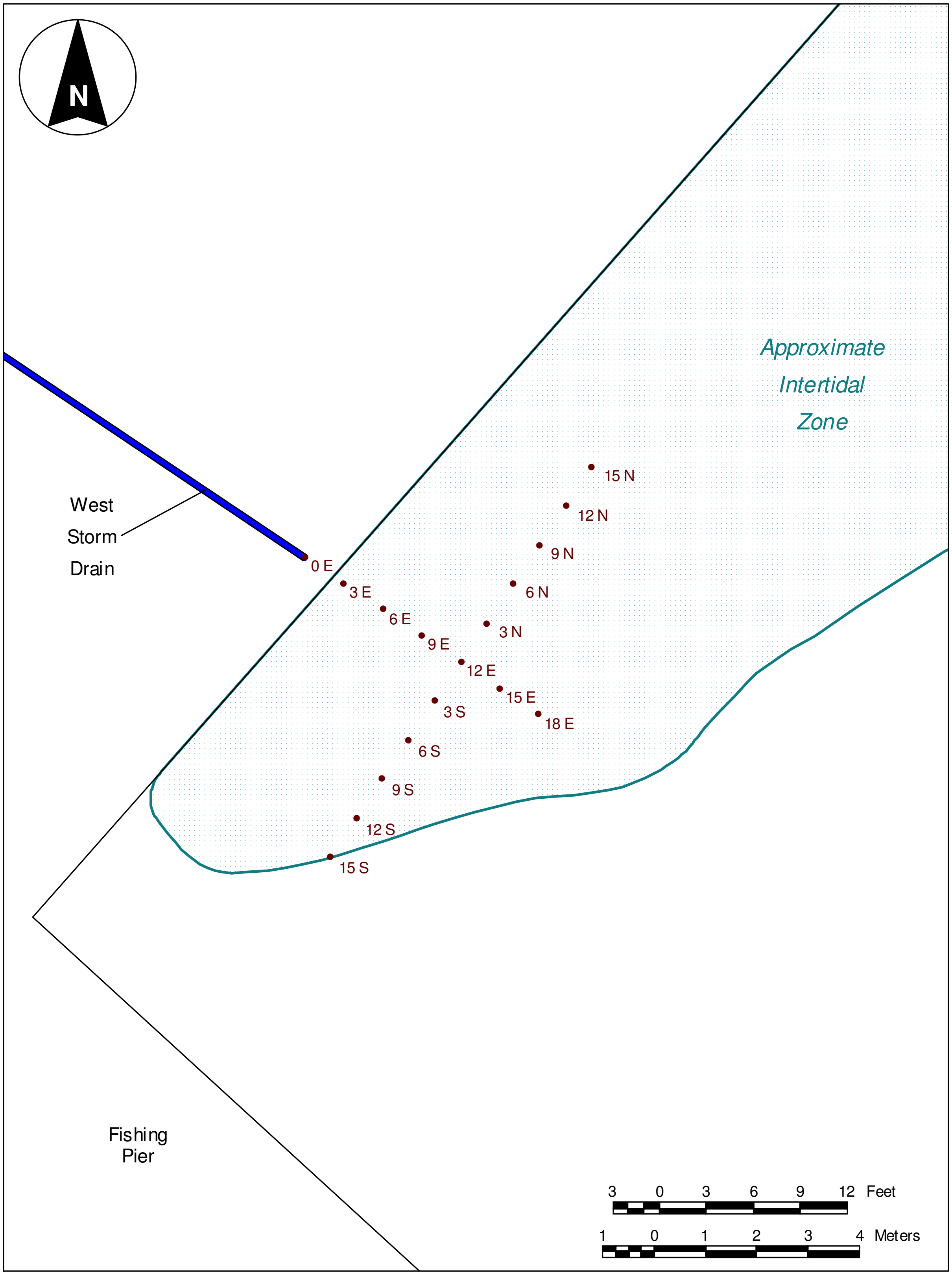

Figure 3.3-1: Sampling Stations for the West Storm Drain Transect Study I

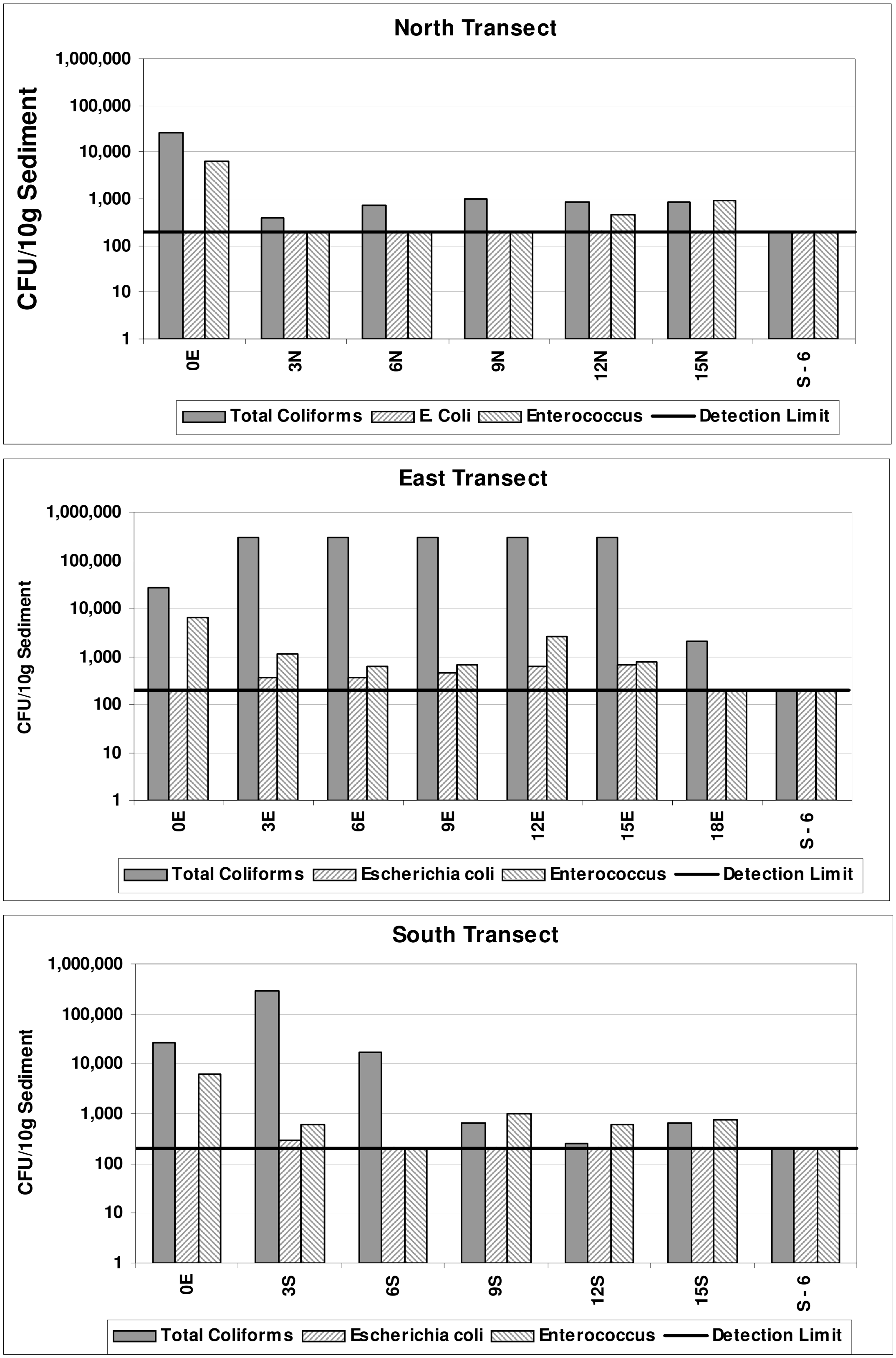

Figure 3.3-2: Transect Study I Results

Enterococcus counts remained relatively high (with values up to 2,600 CFU/10g) in the sediment samples out to 15 feet along all three transects. *Enterococcus* was not measured at 18 feet for the north and south transects, and was at the detection limit at 18 feet along the east transect.

Conclusions**.** High levels of total coliform and *Enterococcus* were found throughout the sampling zone, although generally decreasing with distance from the storm drain. These data and the relatively high counts of total coliform along the east transect suggest that:

- the storm drain appears to be a principal source of bacteria in sediments at transects extending from the storm drain
- a follow-up study should be conducted to determine the extent of sediment contamination within a larger radius away from the pipe.

3.3.2 West Storm Drain Transect Study II

Study Synopsis. The first follow-up study to West Storm Drain Transect Study I (Section 3.3.1) was conducted 10 days later on September 16, 2001. Twenty-three water samples and 23 sediment samples were collected along a transect extending from the West Storm Drain pipe mouth northward along the seawall in a pattern similar to that shown in Figure 3.1-1 for the Seepage Study. Water and sediment samples were also taken at the Buoy Line and the Swim Area.

The sediment samples from the pipe mouth out to 100 feet north of the pipe mouth were collected from below the tide line. Sediment samples from 120 to 200 feet, and those at the Buoy Line and Swim Area, were taken above the tide line. All samples were collected from sediments that were not submerged at the time of sampling.

Results. Results for total coliform, *E. coli*, and *Enterococcus* in water and sediments along the sampling transect (and the swim area and buoy line sampling points) are shown in Figure 3.3-3. Data are tabulated in Appendix C. Levels of total coliform and *E. coli* were relatively low (e.g., less than 400 CFU/100 ml) throughout the sampling zone. *Enterococcus* levels were notably higher within 20-25 feet of the pipe mouth;500-1,000 CFU/100ml in water and 2,000-3,000 CFU/10g in sediments.

Conclusions. The following conclusions can be drawn from these data:

- The high *Enterococcus* levels within a 20-30 foot radius from the pipe were consistent with results from the Seepage Study presented in Section 3.1, indicating that the pipe appears to be an important source of bacteria to nearby sediments and water.
- There is interesting visual correlation between levels of enterococci in water and sediment (Figure 3.3-3). This lends further support that sediments are reservoirs of indicator bacteria, particularly enterococci.

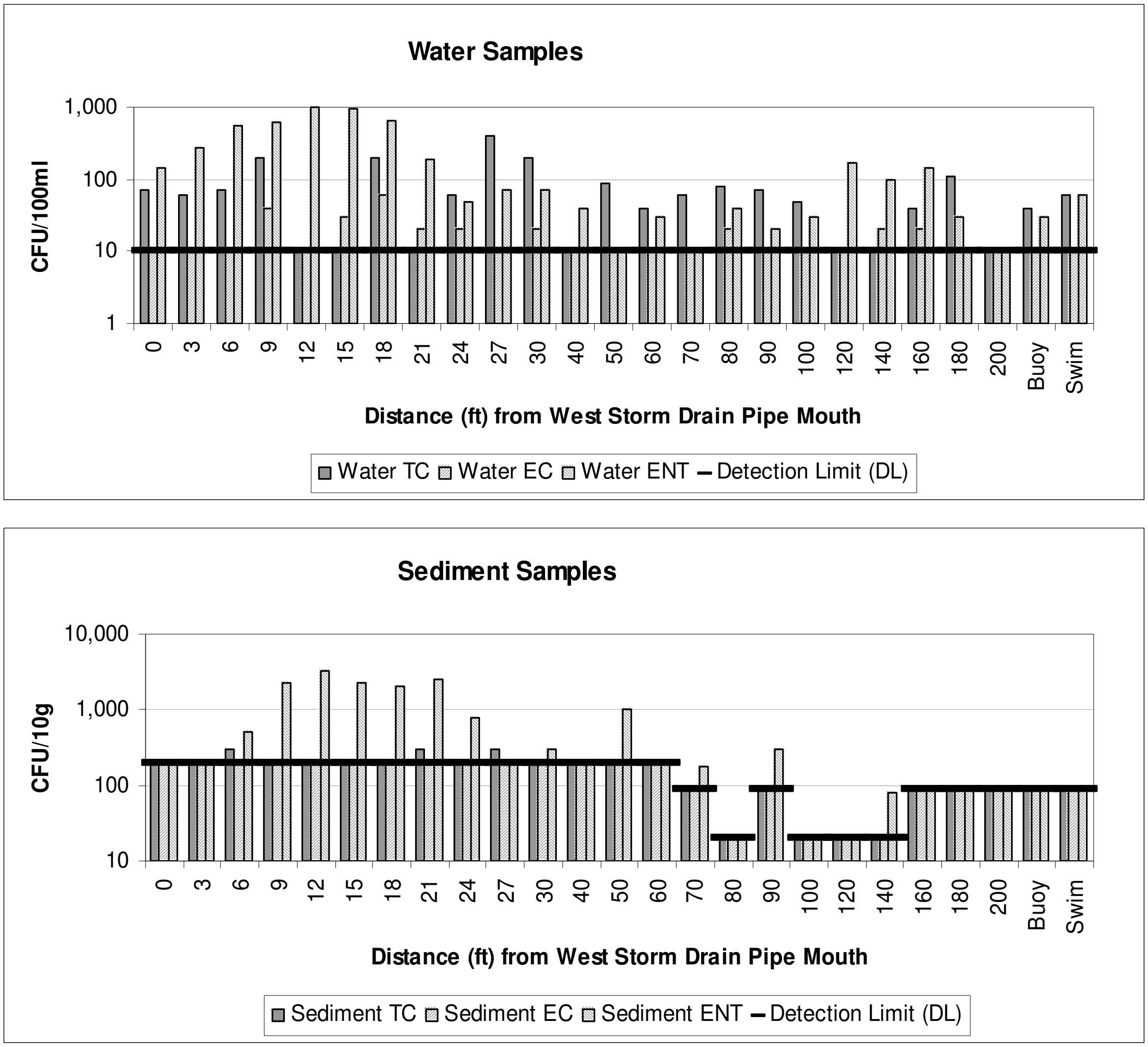

Figure 3.3-3: West End Transect II Results

- The relatively low levels of total coliforms and *E. coli* may indicate that *Enterococcus* may have higher survival rates in water as compared to total coliforms and *E .coli*. Recently, Craig et al. (2002) showed a higher decay rate for *E. coli* as compared to *Enterococcus*.

3.3.3 West Storm Drain Transect Study III

Study Synopsis. Results of the first two sediment transect studies (September 6 and 16, 2002) near the West Storm drain showed high levels of indicator bacteria in sediments within a 20-30 foot radius from the drain. The purpose of this study was to determine the extent of fecal indicator contamination in sediments at the West Storm drain outfall area. Concentrations of fecal indicators were measured in sediments collected at several stations along three transects ranging from 10 to 50 feet from the drain (Figure 3.4-1).

The sediment samples were collected on October 7, 2002, during a low tide series (–0.6 feet at 3:42 p.m.). The depth of the water at these low tide levels allowed collection of sediments that are frequently under water. The three 50-foot transects were sampled at 10-foot increments starting at the pipe mouth of the West Storm drain. The north and south transects extended along lines parallel to the seawall from a point 10 feet east of the pipe mouth. Because the water line is normally about 18 feet from the storm drain at this tide height, some of the samples along the east transect, perpendicular to the seawall, were collected by a diver.

Results. The results are presented in Figure 3.4-2 and tabulated in Appendix C. In general, the levels of bacterial indicators were very low (and near detection limits), compared to the levels shown in previous studies. Total coliform levels tended to decrease with distance away from the pipe mouth. *E. coli* and *Enterococcus* levels were generally very low at all stations, with the one exception of 1,050 CFU/10g at the 20-foot station along the south transect.

Conclusions. The levels of bacterial indicators in sediments around the West Storm drain, while generally showing a decrease with distance away from the pipe mouth, were relatively low compared with data from the previous two transect studies (Sections 3.3.1 and 3.3.2). These samples were collected at around 3:40 P.M. The highest levels of indicators in sediments were detected in samples collected at 3:30 A.M. (Transect Study I). Variation in bacterial levels may be due to differences in sampling times, bacterial die-off, and/or growth rates.

3.4 10-Week Monitoring Study: Water and Sediments

Study Synopsis. Sediment and water samples for analysis of bacterial indicators were collected at the East and West storm drain areas on a weekly basis for 10 weeks, from August 20, 2002, through October 21, 2002. The samples were collected by Environmental Health Laboratory staff at the same time that nearshore samples for AB411 compliance testing at the West End (BDP12), Buoy Line (BDP13), Swim Area (BDP14), and East End (BDP15) Stations at Baby Beach (Figure 3.4-3). Samples were also collected at a control site (S-6), located outside of the harbor.

The purpose of this study was to monitor levels of bacterial indicators and nutrients (nitrates, phosphates, and ammonia) over a 10-week period to assess temporal variation, particularly at the East and West Storm drains. Another objective of this study was to compare indicator levels at the storm drains with adjacent nearshore sites that are sampled for AB411 compliance. This was to determine if elevated bacterial concentrations at the storm drain sites is related or contributing to episodic high levels detected at the nearshore AB411 sites.

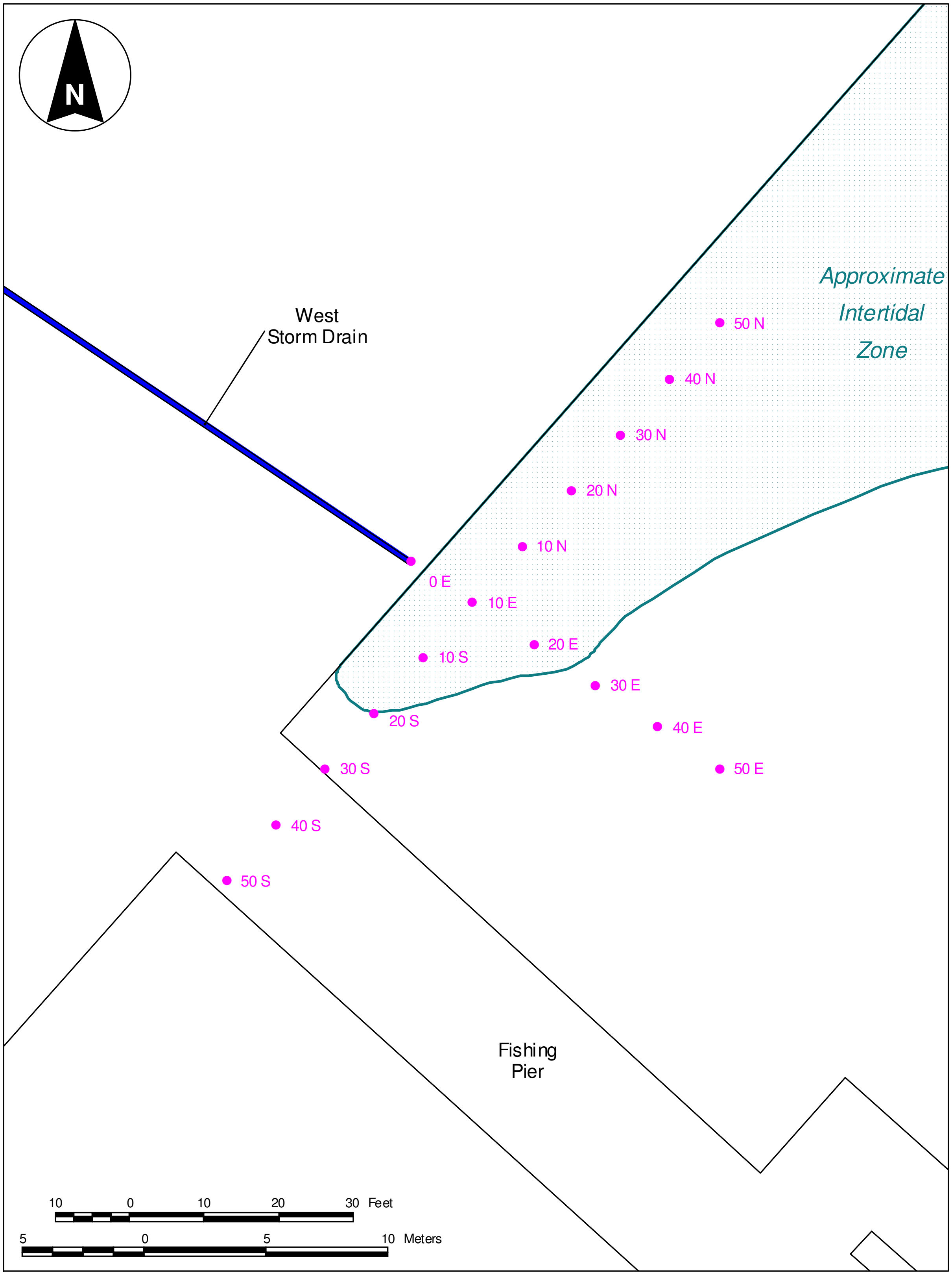

Figure 3.4-1: Sampling Locations for West Storm Drain Transect Study III

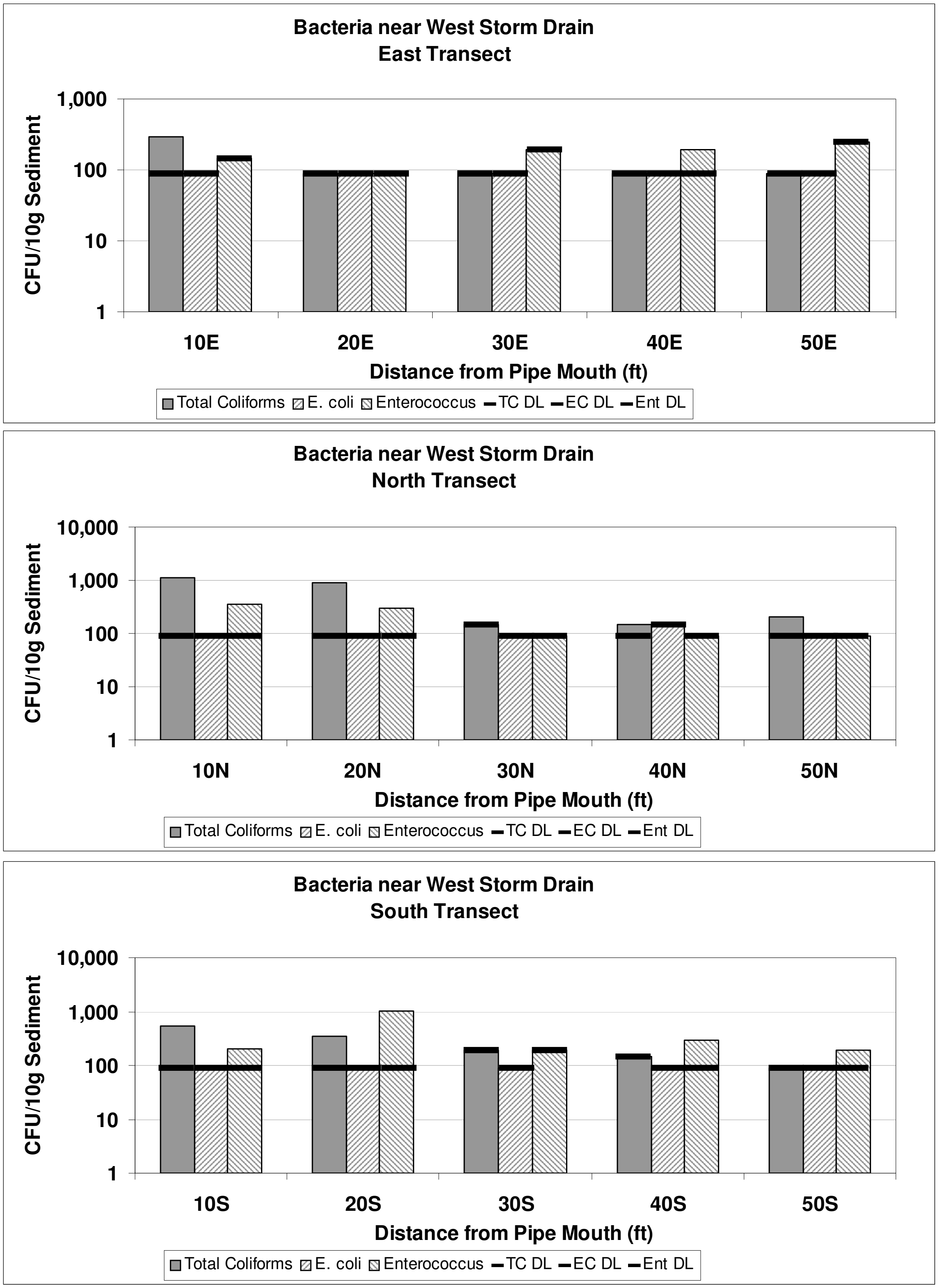

Figure 3.4-2: West End Transect III Results

Results. The design of this particular study did not lend itself to rigorous statistical analyses or final conclusions to complement other special studies on bacterial contamination described in this report. However, these data are presented to describe general observable patterns, particularly for elevated bacterial levels at the various sampling locations. Further, due to sampling limitations caused by high tides and time of day considerations, data are not available for every sampling site on each day of the study.

A total of 3 sediment samples and 21 water samples were collected at the four nearshore sites during the 10-week study (Figure 3.4-3). Data are tabulated in Appendix D. Due to the unevenness of the data set, it is not possible to conclude whether a lack of high bacterial levels indicates that contamination does not exist at a particular site on a particular day; only that data were not available. The data can be used, however, to qualitatively assess the variability of bacterial levels at each site and provide some suggestions about gradient and potential sources.

Bacterial levels ranged from extremely high (400,000 CFU/100ml in water) to below the detection limit for each indicator bacteria. The highest total coliform level was detected in both water and sediment samples at the East Storm drain on August 20, the first day of sampling for this study.

The data are shown in the following Figures (Figure 3.4-4 through Figure 3.4-7). Among the water samples, locations with total coliform levels in excess of 1,000 CFU/100ml included the West Storm drain, East Storm drain, and the Buoy Line. However, because not all stations were sampled each day, the lack of data for a station does not necessarily indicate the bacterial concentrations were below detection, only that sampling did not occur.

In sediment samples, those with total coliform levels in excess of 1,000 CFU/10g were located almost exclusively at the West Storm drain and East Storm drain, with the single exception of a high concentration (10,350 CFU/10g) detected at the East End on the last day of sampling. No sediment samples were taken at the Buoy Line station, which had high total coliform levels in water samples on two of the sampling days.

The highest levels of *E. coli* in water samples were observed at the East Storm drain, West Storm drain, and the Buoy Line sampling points. Among the sediment samples, the East Storm drain and East End had the highest *E. coli* levels, but on different days than the water maxima were observed.

Of particular note is Figure 3.4-7 which shows a box and whisker plot for each parameter in each matrix at each location. This figure shows that the bacterial levels in water were highly variable over the 10-week period. However, indicator levels below the storm drain areas were generally high, often exceeding the single sample threshold for marine water.

Nutrients such as nitrates and phosphates may enrich sediments and be metabolized by bacteria, thus enhancing their survival. Mean concentrations of nitrate as nitrogen (NO_3-N), phosphate as phosphorus (PO_4-P) and ammonia (NH_3-N) in the storm drain and control (S-6) water and sediment samples are shown in Table 3.4-1.

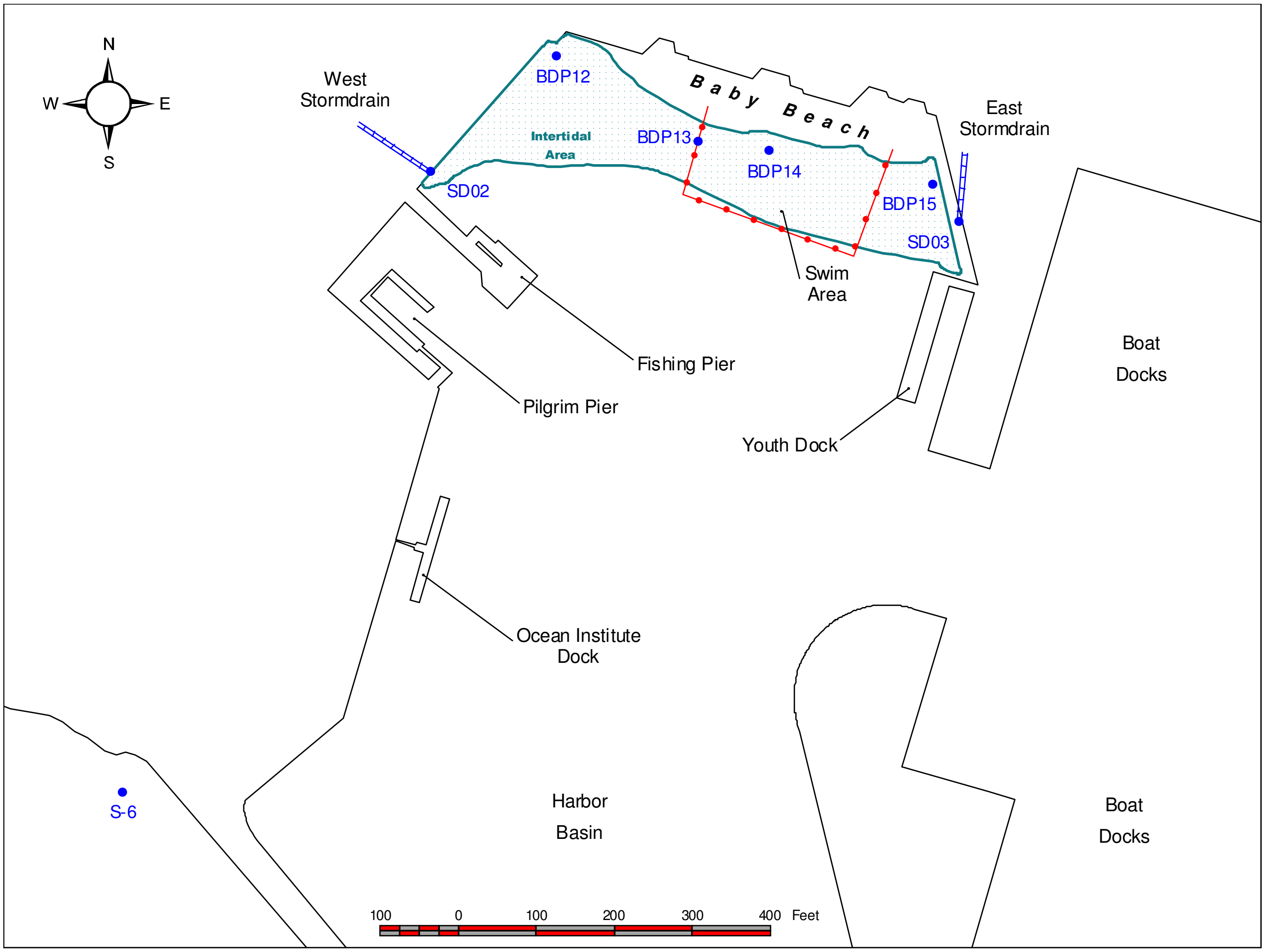

Figure 3.4-3: 10 Week Study Sampling Locations

Table 3.4-1: Concentrations of Chemical Parameters - 10 Week Study

	Mean concentrations					
	Nitrate		Phosphate		Ammonia	
	Sediment	Water	Sediment	Water	Sediment	Water
	mg/kg	mg/L	mg/kg	mg/L	mg/kg	mg/L
SD03/East Storm Drain	5.79	0.26	3.19	0.25	0.44	0.06
SD02/West Storm Drain	9.57	0.15	2.02	0.19	0.76	0.1
S-6	3.73	0.13	0.4	<0.15	<0.25	<0.05
	Ranges					
SD03/East Storm Drain	2.5 - 9.23	0.1 - 0.46	1.01 - 4.36	<0.15 - 0.44	0.3 - 0.67	<0.05 - 0.07
SD02/West Storm Drain	4.99 - 15.5	0.14 - 0.18	0.47 - 3.74	<0.15 - 0.28	0.61 - 1.07	<0.05 - 0.2
S-6	2.93 - 4.52	<0.1 - 0.16	0.4 - 0.4	<0.15 - <0.15	<0.25 - <0.25	<0.05 - <0.05

The levels for all three chemical parameters were significantly higher in sediment as compared to water samples, and mean levels of nitrate and phosphate were three to four times higher in sediments at the storm drain sites as compared to the control site.

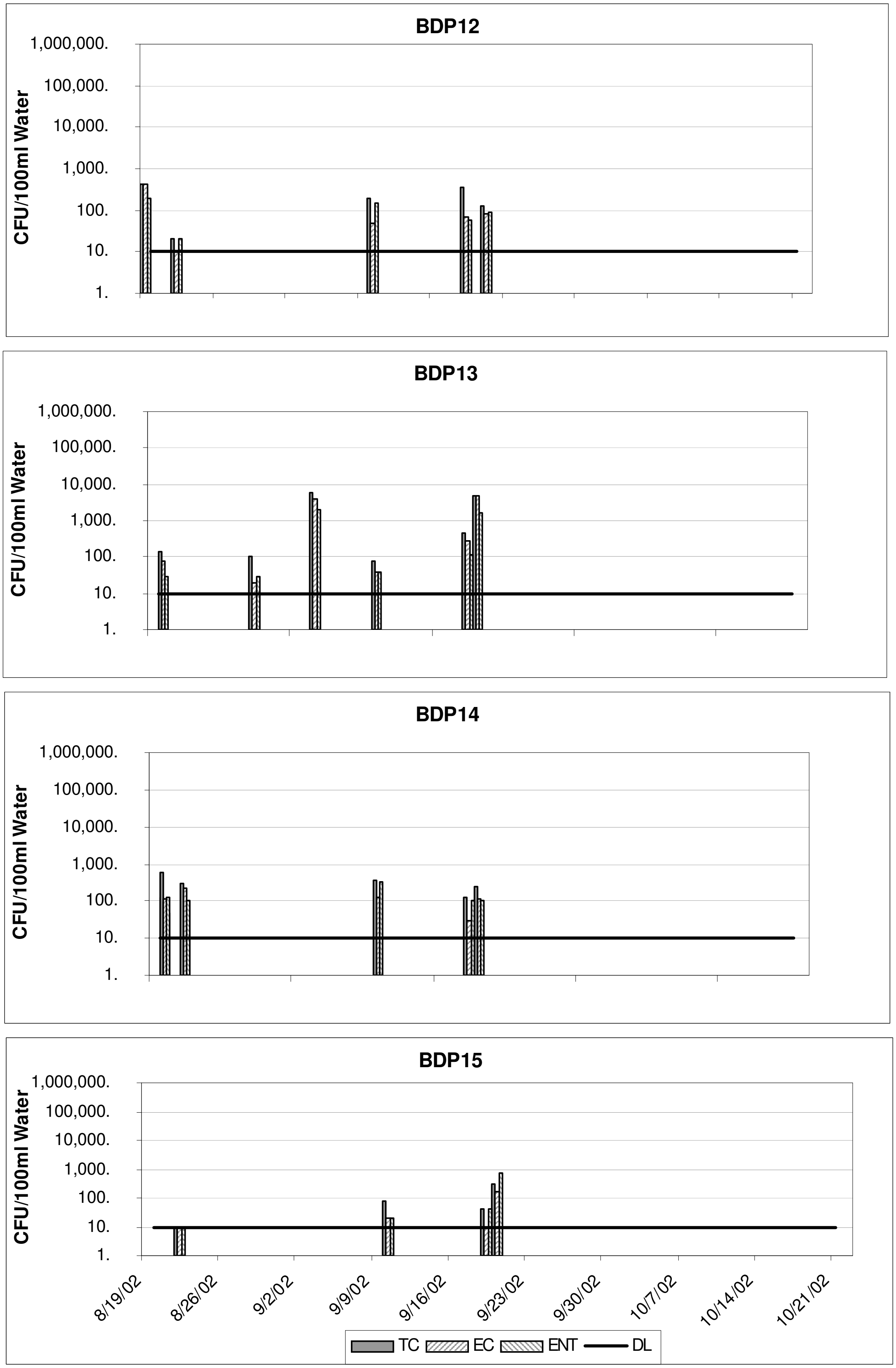

Figure 3.4-4: 10 Week Study Water Sampling Results

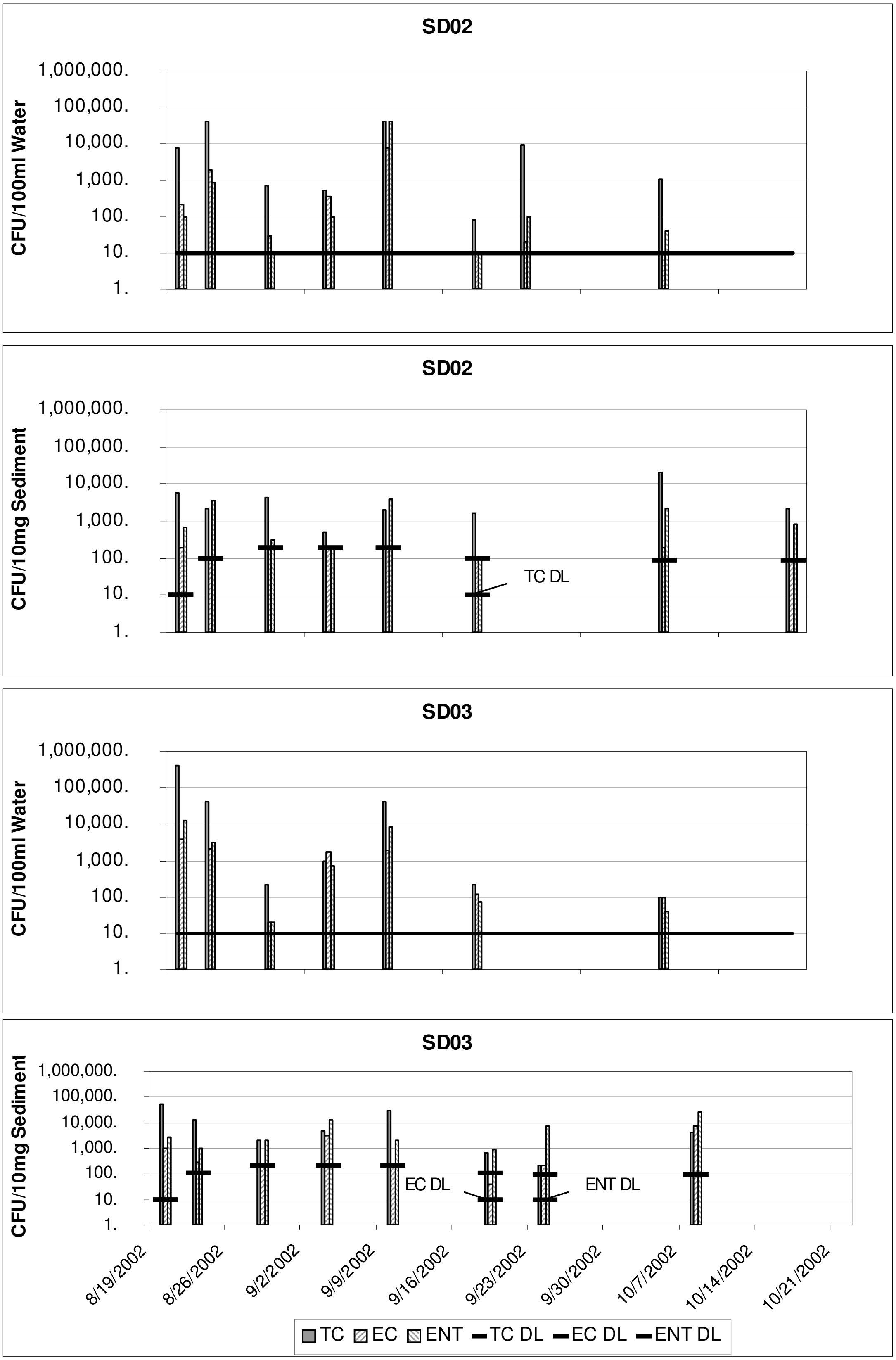

Figure 3.4-5: 10 Week Study - Storm Drains - Water and Sediments

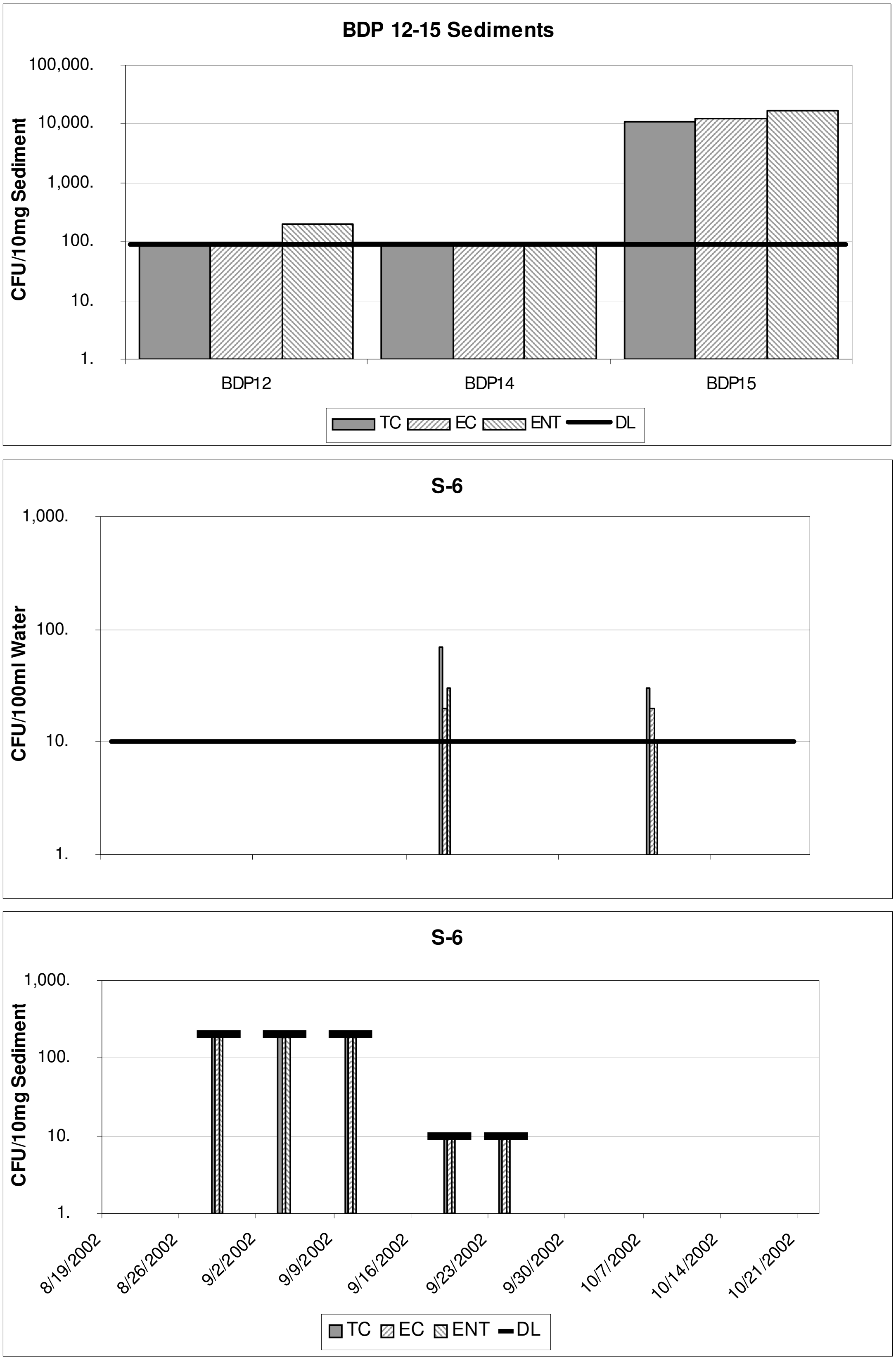

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Figure 3.4-6: 10 Week Study - Beach Sediments and Background

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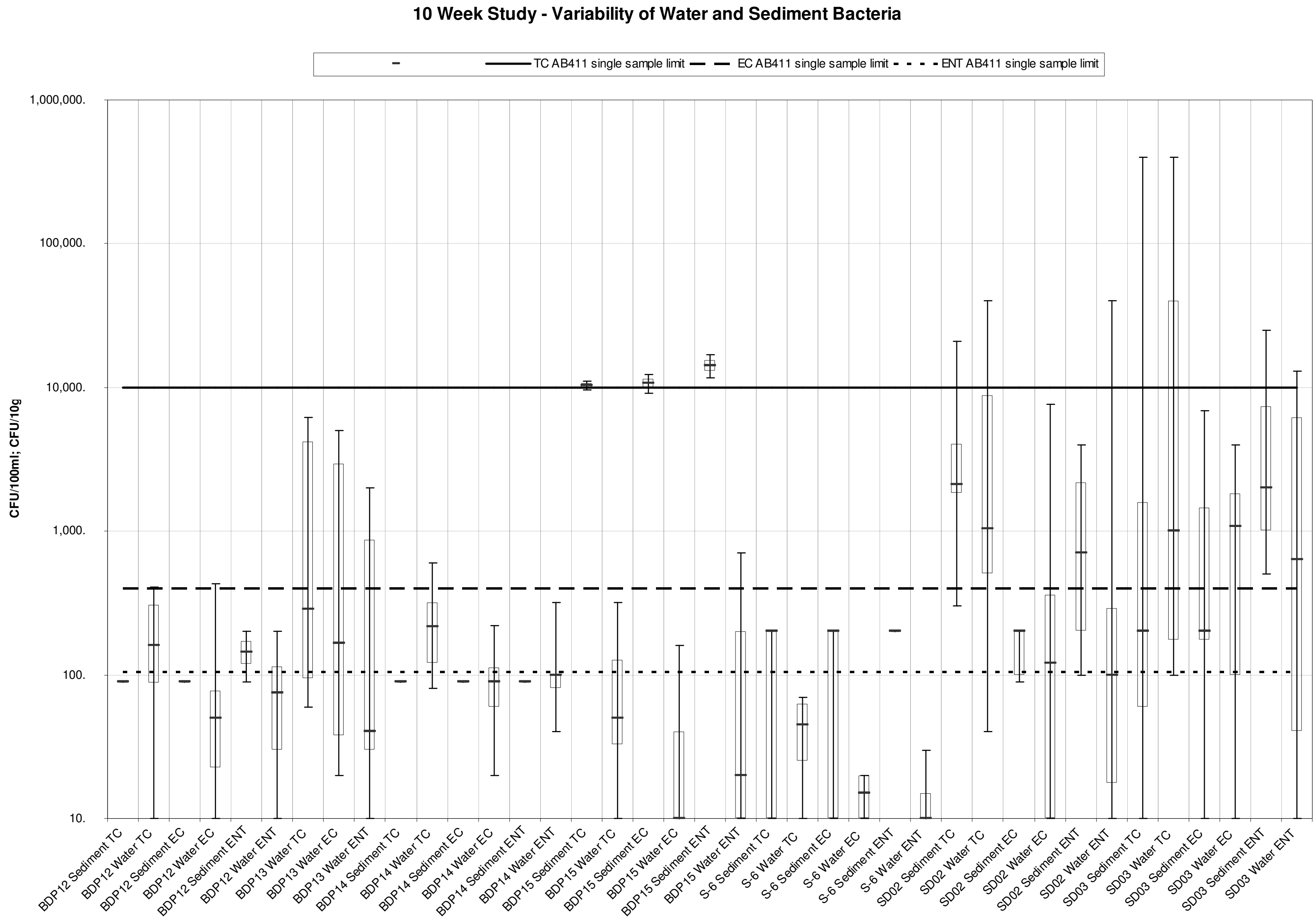

Figure 3.4-7: 10 Week Study Variability

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Overall, the mean levels of nitrate, phosphates and ammonia in water and sediments were similar at both storm drain sites, with the exception of higher levels of ammonia in sediments at the West Storm drain.

Conclusions. Study results suggest that:

- Most of the higher levels of bacteria in water and sediment samples were found near the storm drains.
- High day-to-day variability can occur for these bacterial indicators.
- Phosphates, nitrates, and ammonia can be naturally present in sediments, although higher levels at the storm drain outfall areas as compared to the control site suggest that sediments near both drains may be sinks for nutrients and pollutants.

3.5 Sediment Analysis Study

Study Synopsis. Numerous studies have shown that *E. coli* and *Enterococcus* can be detected in soil and natural vegetation in the absence of fecal contamination in many coastal areas (e.g., Fujioka and Shizumura 1985; Lopez-Torres et al., 1987). The purpose of this study was to evaluate the levels of fecal indicator bacteria in sandy sediments at Swim Area and East End sampling stations near Baby Beach.

Surface and subsurface sediment samples were collected at low tide (-0.6 ft at 4:33 p.m.) on October 8. Twelve samples were collected along 70-foot long transects at the Swim Area and East End, as illustrated in Figure 3.5-1.

Duplicate samples were collected at 10-foot increments up to 30 feet above and 30 feet below the water line, for a total of 24 samples.

Results. Total coliform and *E. coli* were generally below detection limit in sediments sampled along the 70-foot transects in the Swim Area and East End of Baby Beach. However, relatively high *Enterococcus* levels were detected at low tide elevations near the East End. Data are tabulated in Appendix E. As shown in Figure 3.6-1, the highest levels of bacterial indicators along the two transects were for *Enterococcus* in sediments collected from below the water line along the East End transect, ranging from 350 to 5,250 CFU/10g. All other sediment samples collected during this study had *Enterococcus* levels that were below the detection limit of 90 CFU/10g.

Total coliform values along the two transects were all below detection (i.e., less than 90 CFU/10g), except for two samples along the East End transect with average levels of 145 CFU/10g (20 feet above and 30 feet below the water line). These values are relatively low compared to total coliform counts observed from sediments collected elsewhere along Baby Beach (e.g., West Storm Drain Transect Study I samples; see Section 3.1).

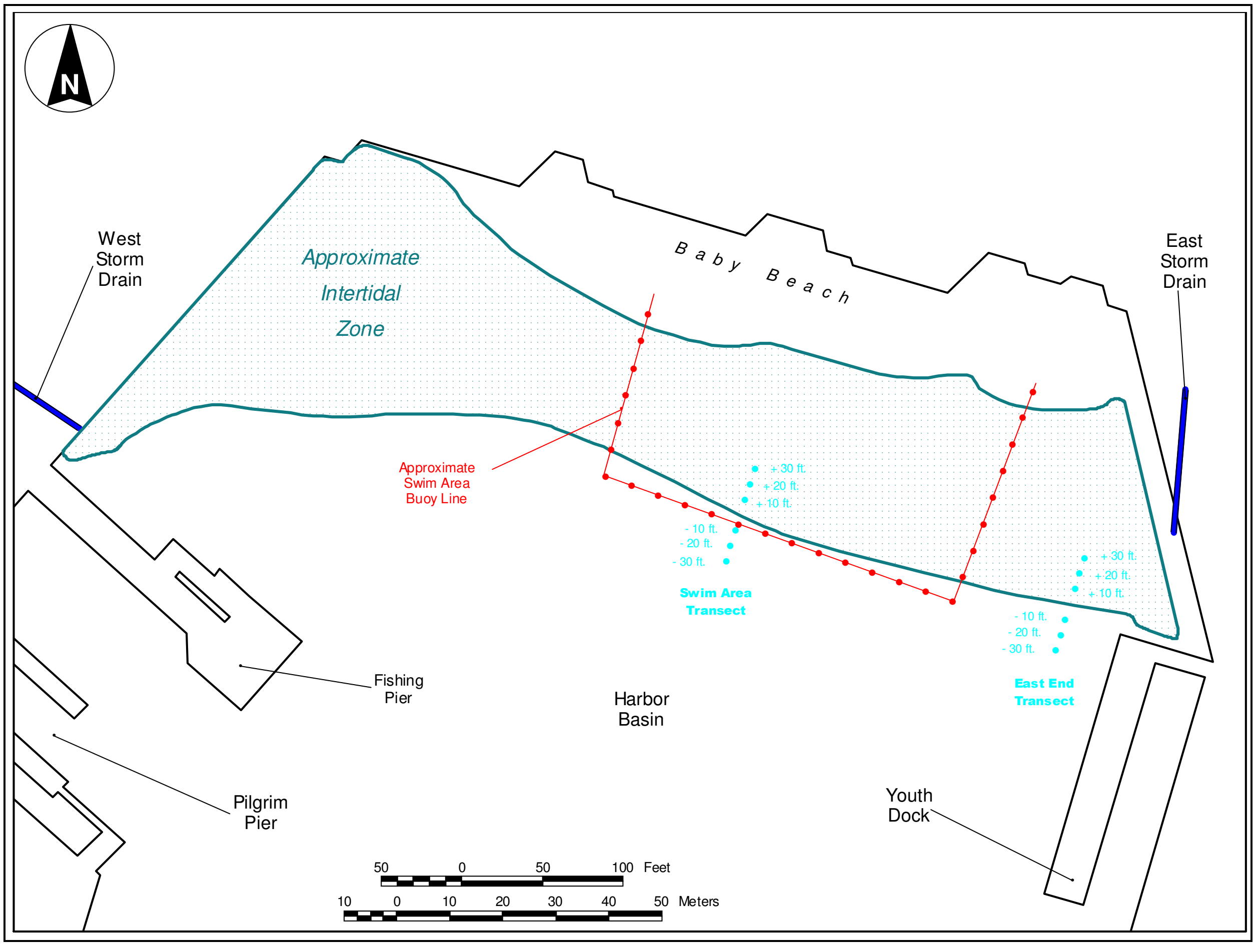


Figure 3.5-1: Sediment Study Sampling Locations

E. coli was not detected in any of the samples collected for this study (i.e., all. these samples were below the detection limit of 90 CFU/10g).

Conclusions. Localized high levels of *Enterococcus* were found in sediments below the water line at Baby Beach. These sediments may represent a source of high bacterial levels in overlying waters following episodes of high surf or currents that can resuspend bacteria sediments. This occurrence was noted during the Boat Study (Section 3.6), however, further studies are needed to document the dispersal of bacteria into water due to physical disturbances of sediments.

3.6 Boat Sewage Discharge Study

Study Synopsis. The objective of the boat sewage discharge study, conducted on six days between August 29 and September 5, 2002 (Table 3.6-1), was to evaluate boats as a potential source of indicator bacteria.

The Labor Day holiday weekend is usually a high-use period for boats in the anchorage area of the harbor. The study was planned to span the time from a few days before the holiday to a few days afterwards. The hypothesis investigated was that bacterial counts would increase with higher boat use during the holiday weekend. Surface water

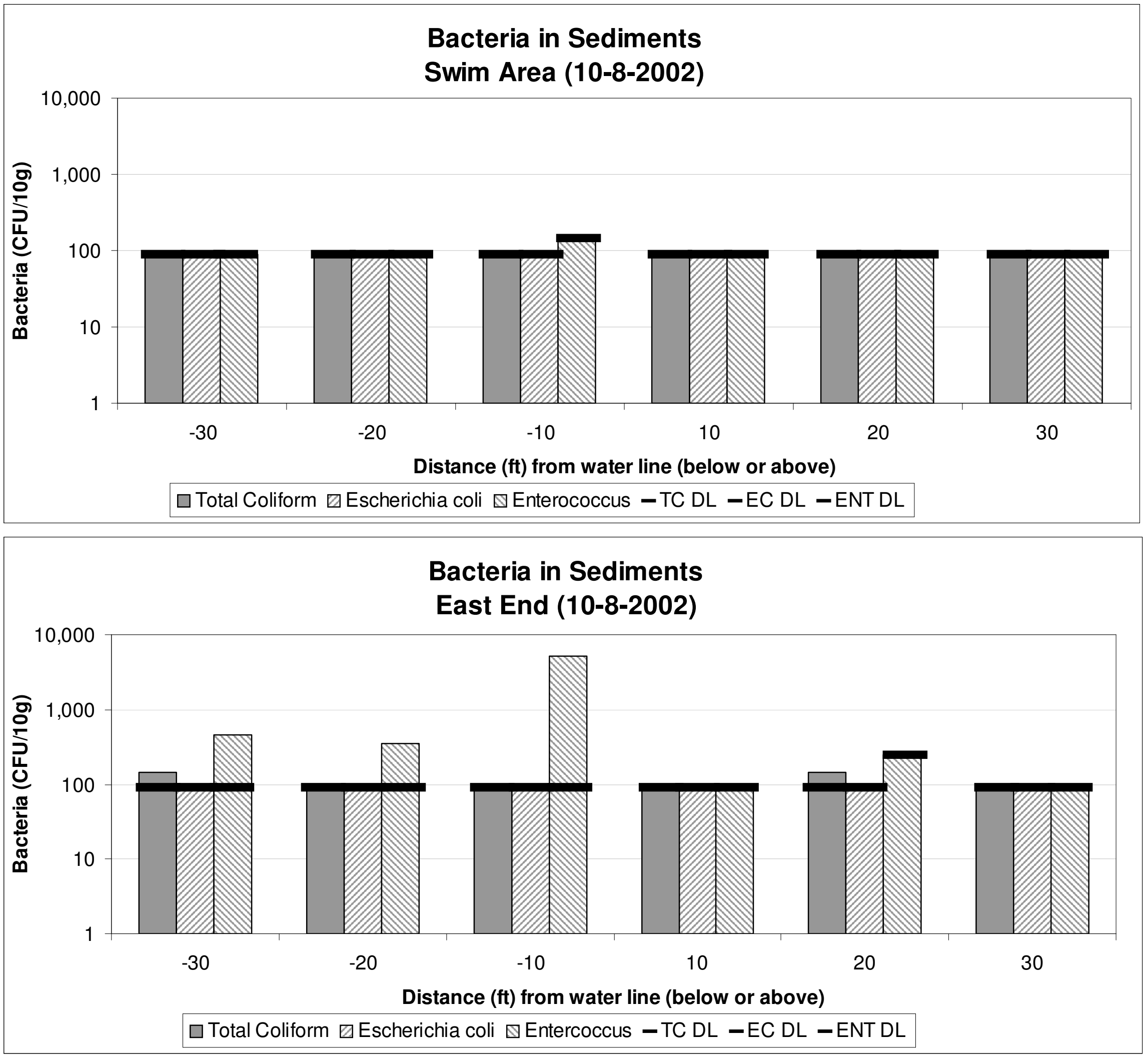


Figure 3.6-1: Bacteria in Sediments at Swim Area and East End

Table 3.6-1: Sampling Days for the Boat Sewage Discharge Study

Sun	Mon	Tue	Wed	Thurs	Fri	Sat
Aug 25	26	27	28	29 *Day 1*	30 *Day 2*	31
Sept 1 *Day 3*	2 Labor Day *Day 4*	3	4 *Day 5*	5 *Day 6*	6	7

samples were collected at 11 sampling stations on each of six days and analyzed for three fecal indicators.

Bacterial indicators (dependent variables) included:

- Total coliforms

- *E. coli*
- *Enterococcus*

Potentially associated factors (independent variables) that were noted included:

- Collection location: Four routine sampling stations near the beach, pier, and youth dock; five stations around and in the federal anchorage area; and two control stations, where bacterial levels were expected to be low. GPS locations were recorded on Day 2;
- Collection time. Samples were typically collected at the time of morning when a 3.5-foot tide level occurred on each of 6 days;
- Number of anchored boats;
- Approximate number of people engaged in various activities;
- Approximate wave height; and
- Wind conditions.

Results. Figure 3.6-2 lists the external parameters observed on each sampling day. Figure 3.6-3 through Figure 3.6-8 show the bacteria levels observed at each location on each sampling day. As shown in the figures, bacterial counts were relatively low overall, with the highest levels of all three bacterial indicators occurring on Day 5, the Wednesday after Labor Day weekend. Data are tabulated in Appendix F.

The numbers of boats anchored in the harbor and the number of people observed on the beach, both shown in Figure 3.6-2, increased over the weekend, peaking on Sunday (Day 3). However, bacteria counts were not observed to increase with increasing boat and beach usage.

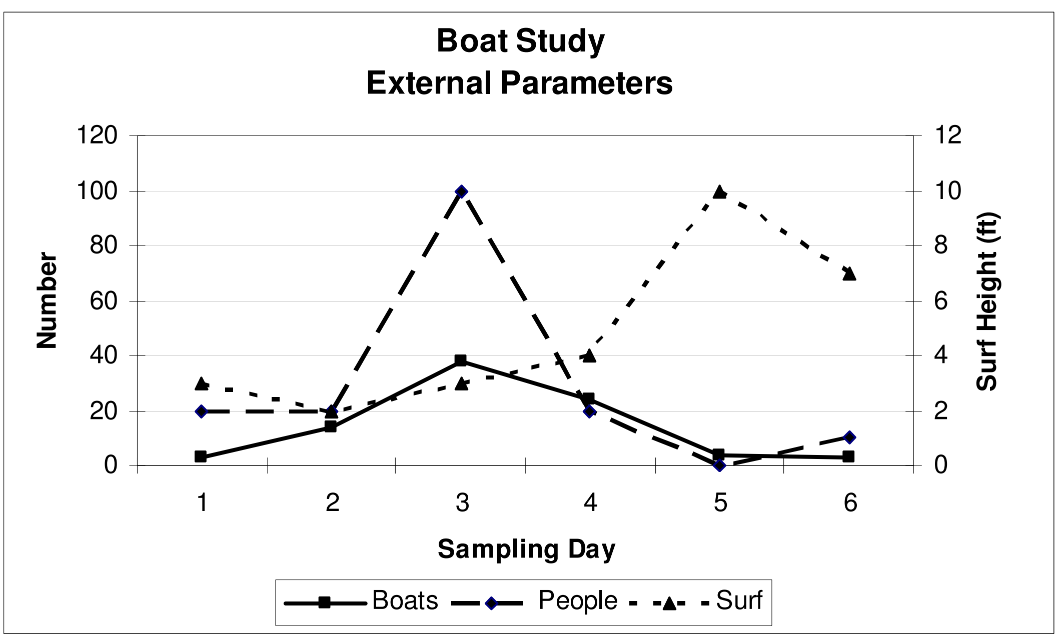


Figure 3.6-2: Boat Study External Parameters

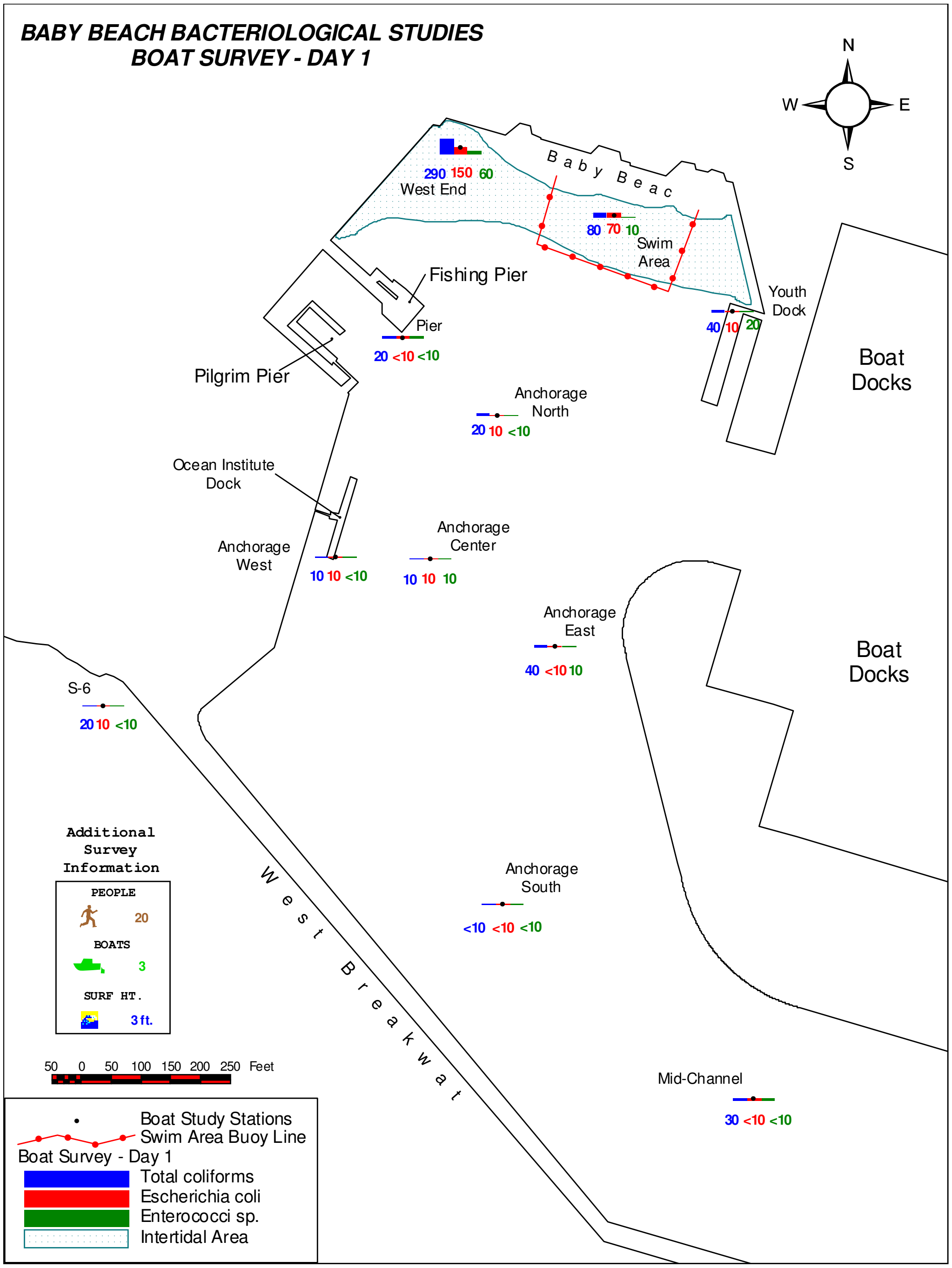


Figure 3.6-3: Bacteria Levels in Water Boat Study Day 1

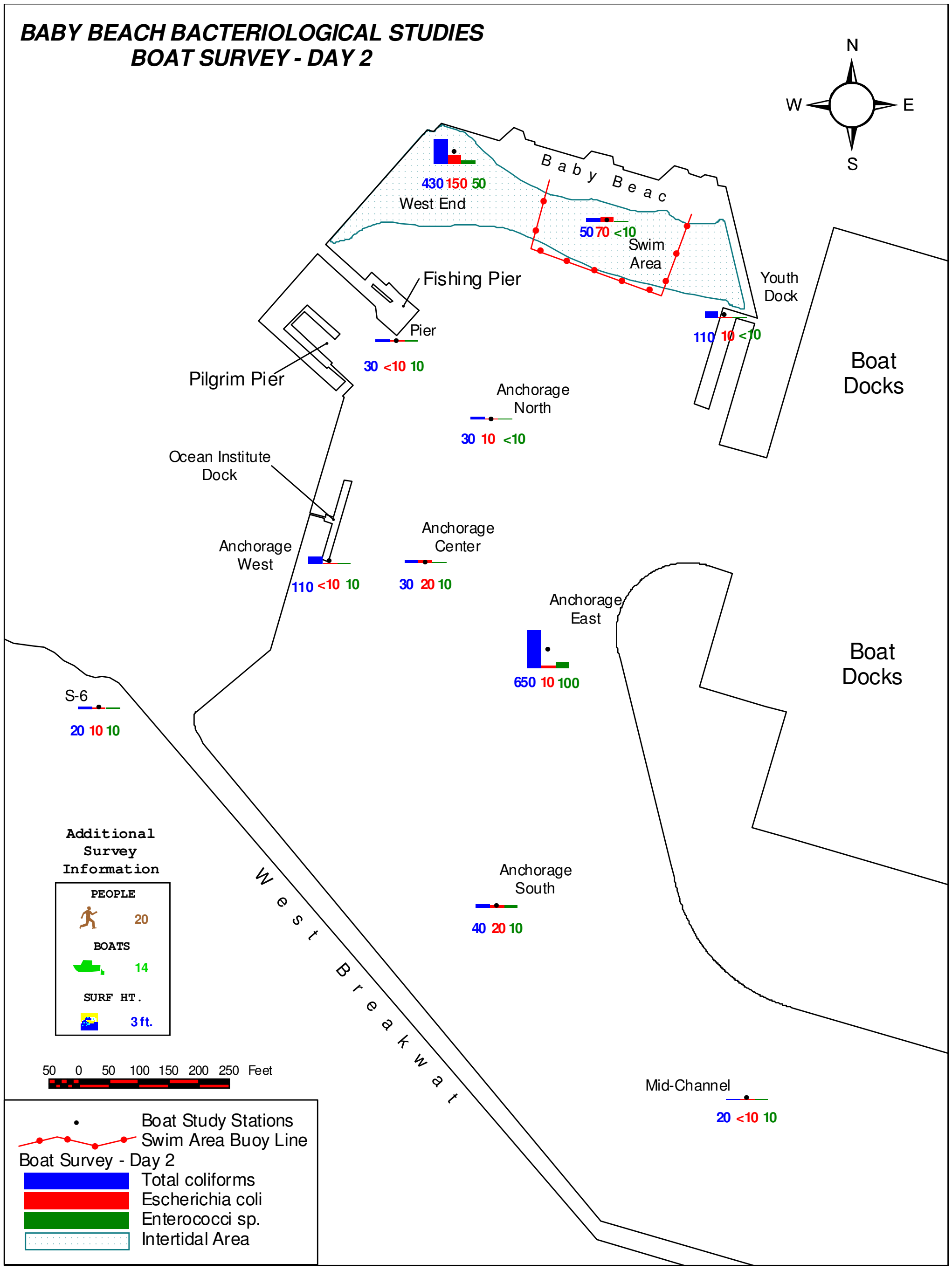


Figure 3.6-4: Bacteria Levels in Water Boat Study Day 2

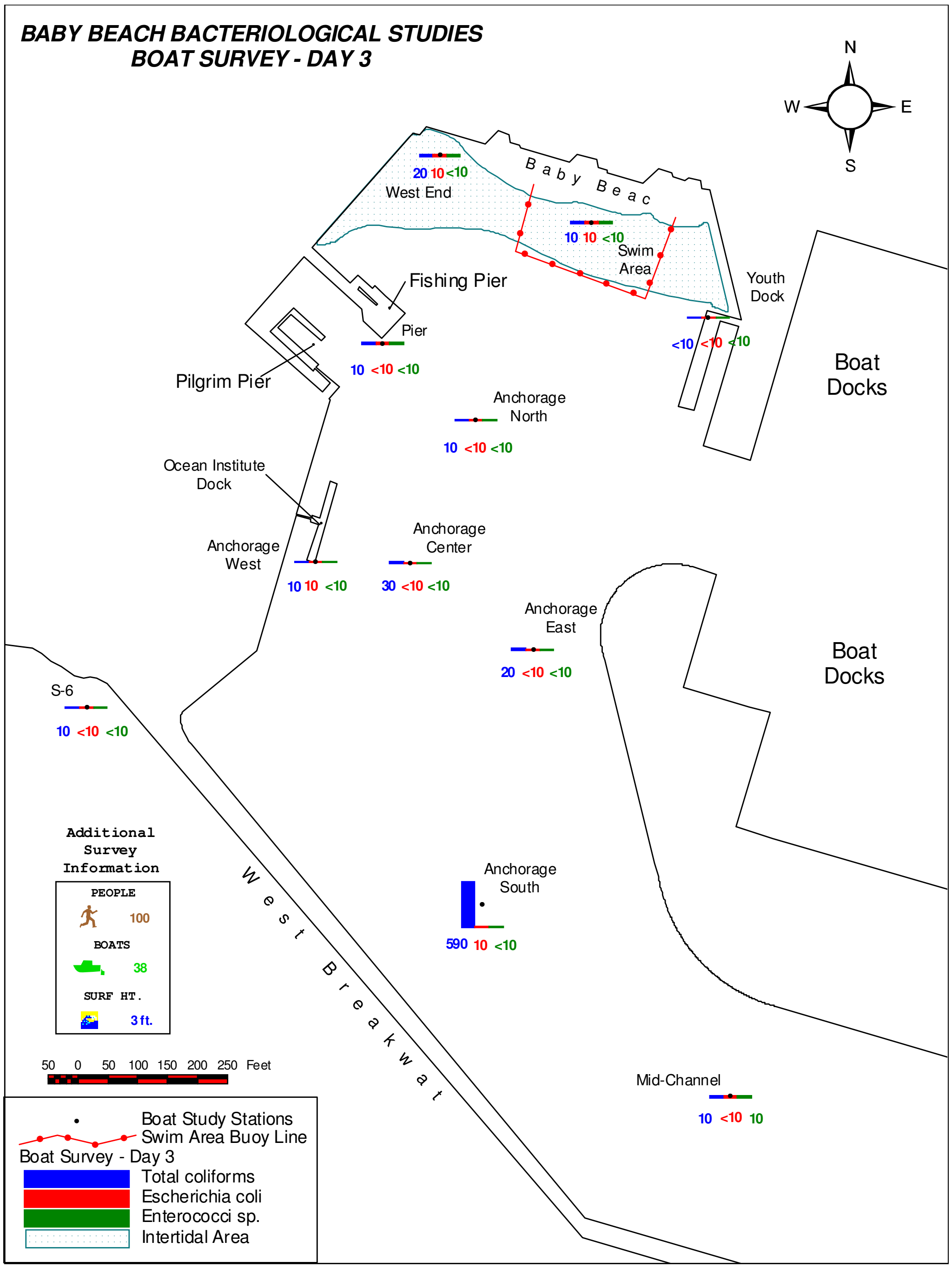


Figure 3.6-5: Bacteria Levels in Water Boat Study Day 3

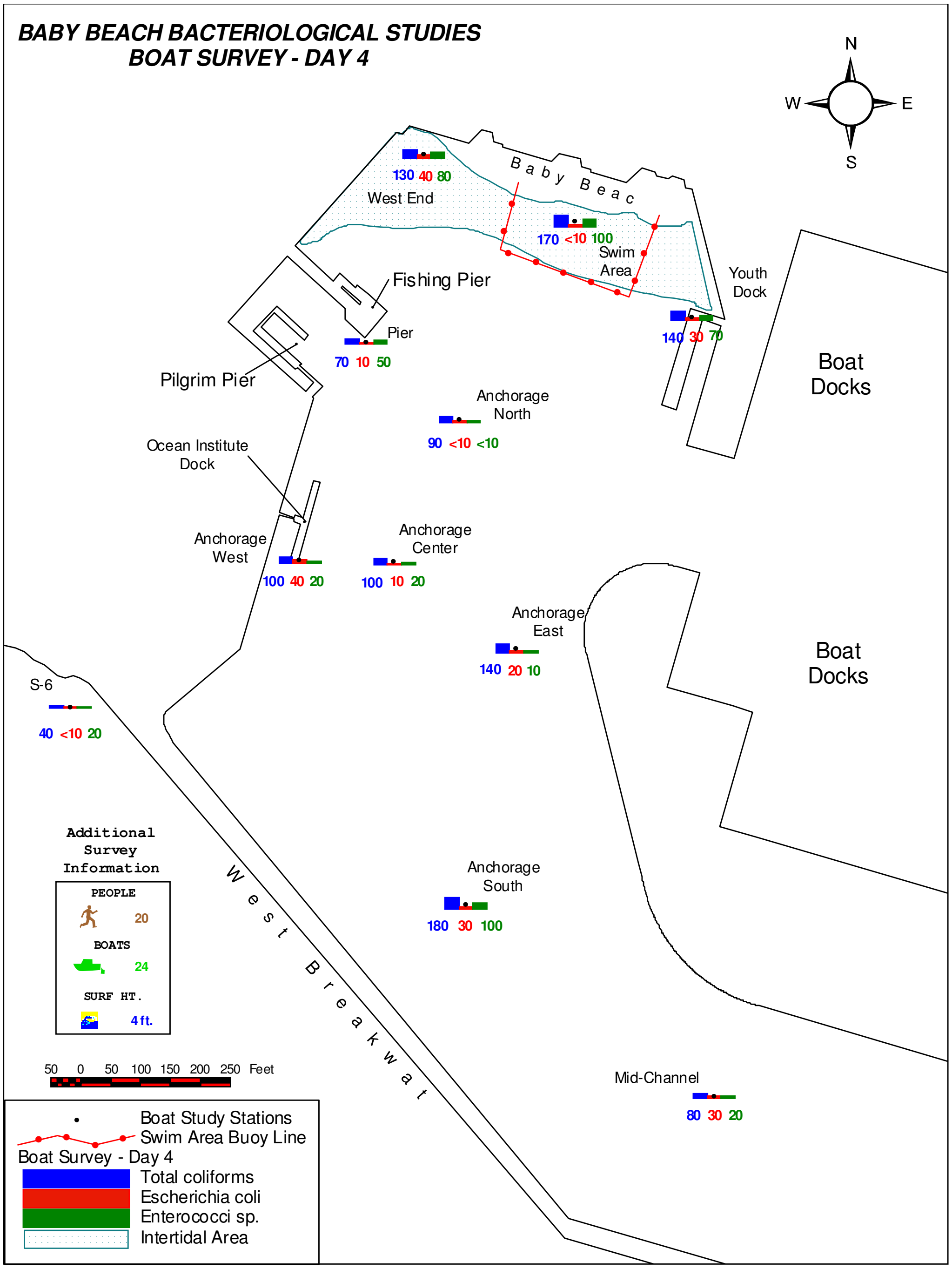


Figure 3.6-6: Bacteria Levels in Water Boat Study Day 4

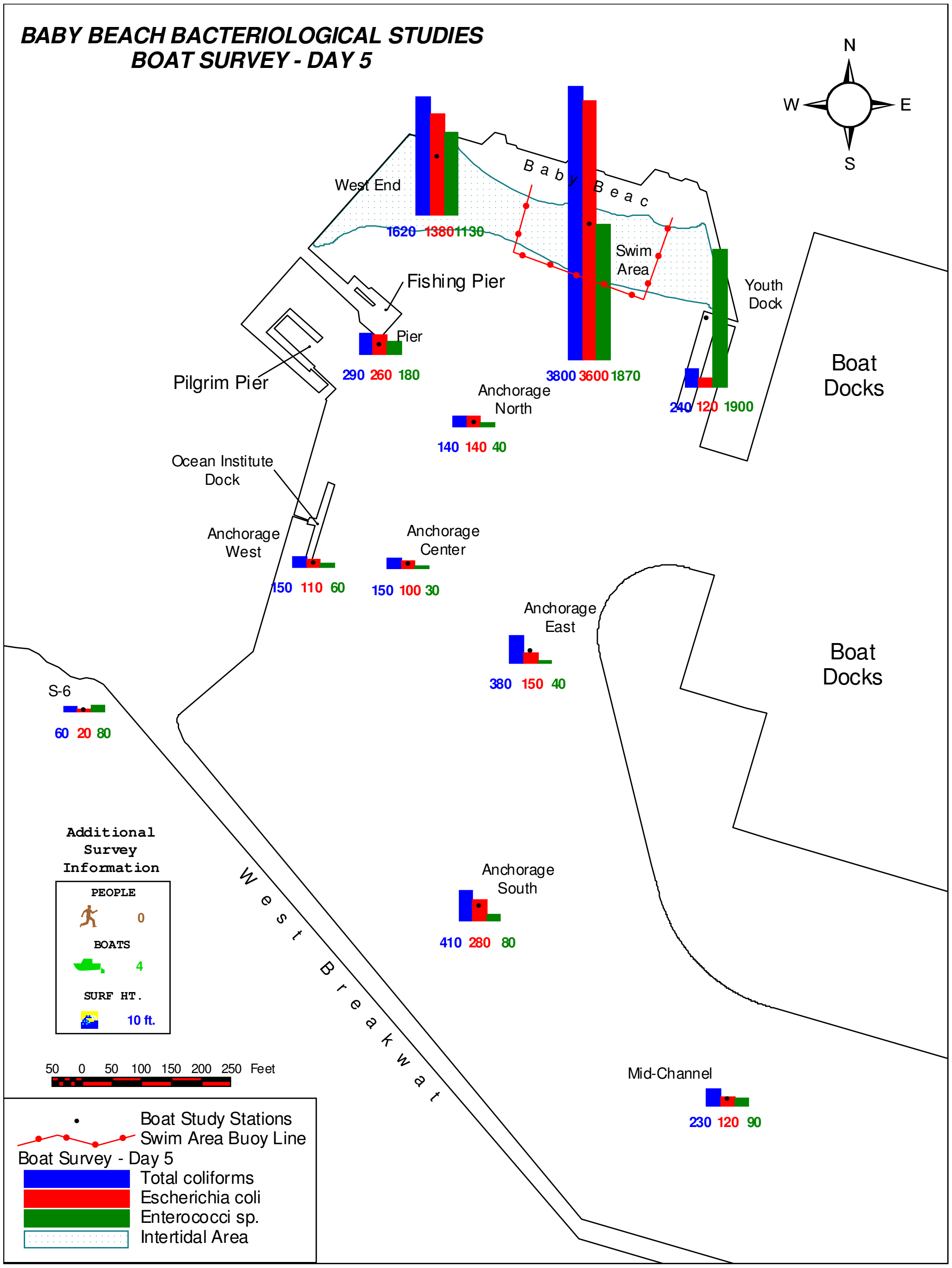


Figure 3.6-7: Bacteria Levels in Water Boat Study Day 5

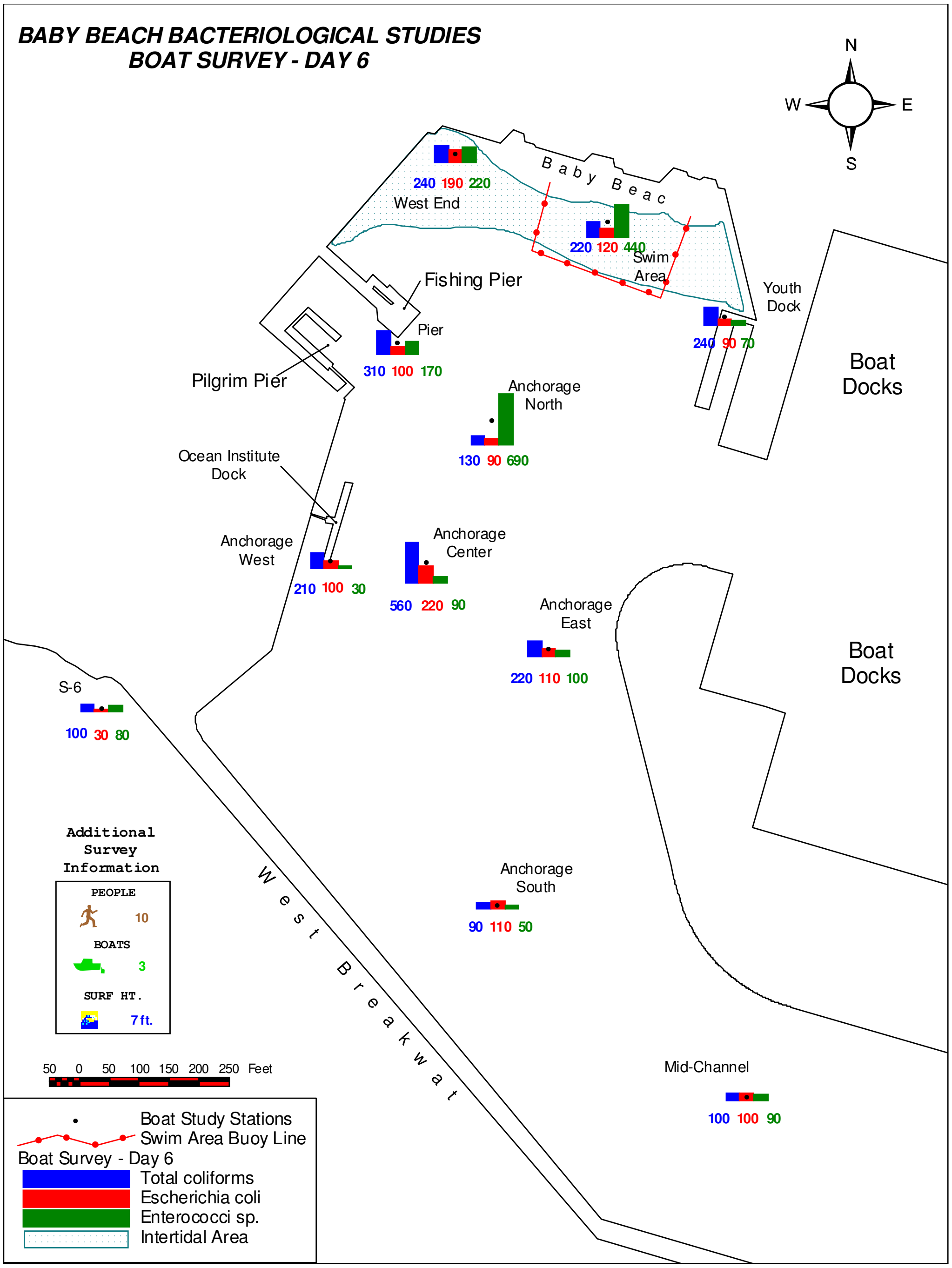


Figure 3.6-8: Bacteria Levels in Water Boat Study Day 6

On the day with the most boats anchored in the area (Day 3, Sunday: 38 boats), bacterial counts were among the lowest recorded during the study. The highest measured bacterial concentrations did not occur over the weekend, but later in the Labor Day week (Wednesday and Thursday), after the number of boats and people had decreased to pre-Labor Day (background) levels.

Wave heights were observed to be 2-4 feet along the seaward margin of the breakwater during the first four days. However, wave heights of 7-10 feet were observed during Days 5 and 6. Days 5 and 6 exhibited the highest bacterial levels at almost every station. This suggests a relationship between the bacterial indicator concentration and surf height.

It is notable that the highest bacterial levels occurred at the Swim Area and West End sampling stations. While all stations including the control location (S-6) show similar trends, the highest average levels occurred at the routine sampling stations used for AB411 monitoring.

These results suggest that greater wave action may increase bacteria concentrations in the water. Increased wave action may be causing additional re-suspension of finer-grained sediments in the harbor due to the stronger currents in the harbor.. Data collected and presented in this report suggests that bacteria may reside in sediments. If those sediments become re-suspended, this could increase the concentrations of bacteria detected in water. The data from this boating study suggests that this re-suspension of bacteria-contaminated sediments may in fact occur at Baby Beach and may be one of the reasons for some of the observed concentrations of bacteria during AB411 compliance monitoring.

<u>Conclusions</u>**.** The following could be concluded:

- Boating and beach activities during this holiday weekend did not appear to result in detectable releases of indicator bacteria to the Baby Beach area of Dana Point Harbor
- Increased wave height appeared to coincide with increased aqueous bacteria concentrations, suggesting that bacteria-contaminated sediment may reside at Baby Beach and become resuspended under certain wind and current conditions.

3.7 Bacterial Indicator Level Variability Studies (12-Hour Studies)

<u>Study Synopses</u>**.** Two 12-hour studies were performed at four sampling points: West End (BDP12), Swim Area (BDP14), East End Storm drain (SD03) and West End Storm drain (SD02) at Baby Beach. The objective was to determine the effects of various factors on bacterial indicator concentrations over a 12-hour spring tidal cycle, from one low tide to the next.

The bacterial indicators (dependent variables) included:

- Total coliforms
- *E. coli*

- *Enterococcus spp.*

Potentially associated factors (independent variables) included:

- Collection location – West Storm Drain, West End, Swim Area, and East End
- Collection time – 5:00 A.M. through 5:00 P.M., at 2-hour intervals
- Bird count
- Number of humans in water
- Number of nearby boats
- Tide height
- Water temperature
- Specific conductivity
- Dissolved oxygen
- pH
- Total dissolved solids
- Dissolved oxygen saturation percentage
- Turbidity
- Solar irradiance (second study only)

3.7.1 12-Hour Study I

The first 12-hour study was conducted on 23 September 2002, from 5:00 A.M. to 5:00 P.M. Data are tabulated in Appendix G.

Results. As shown in Figure 3.7-1 and Figure 3.7-2, bacterial counts were relatively low (less than 1,000 CFU/100ml), with exceptions at 5:00 A.M. at the West Storm drain (total coliforms), 7:00 A.M. at West Storm drain (total coliforms) and Swim Area (all three indicators), and 3:00 P.M. at the West Storm drain (total coliforms) and Swim Area (*Enterococcus*).

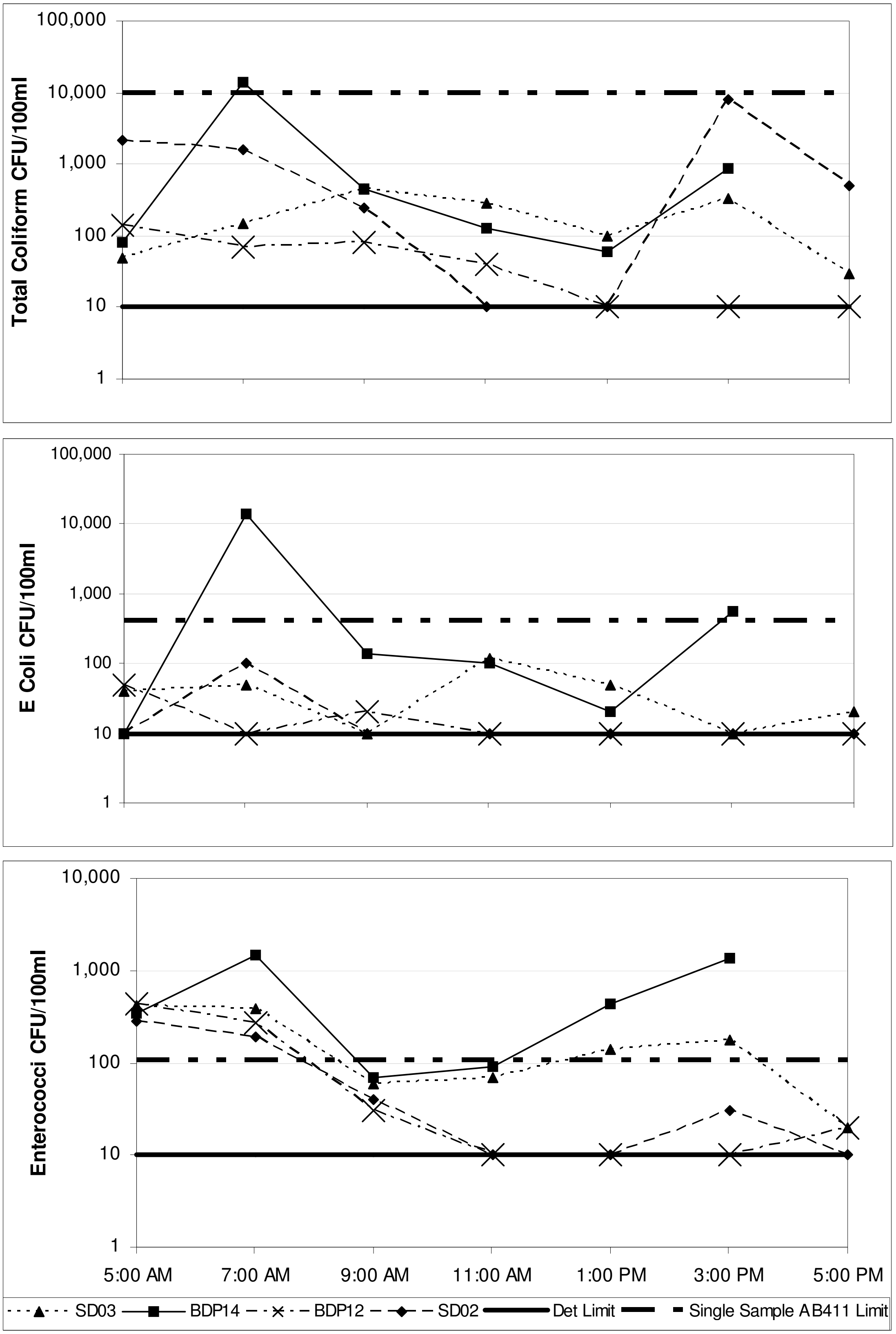


Figure 3.7-1: 12 Hour Study I - Bacteria Concentrations

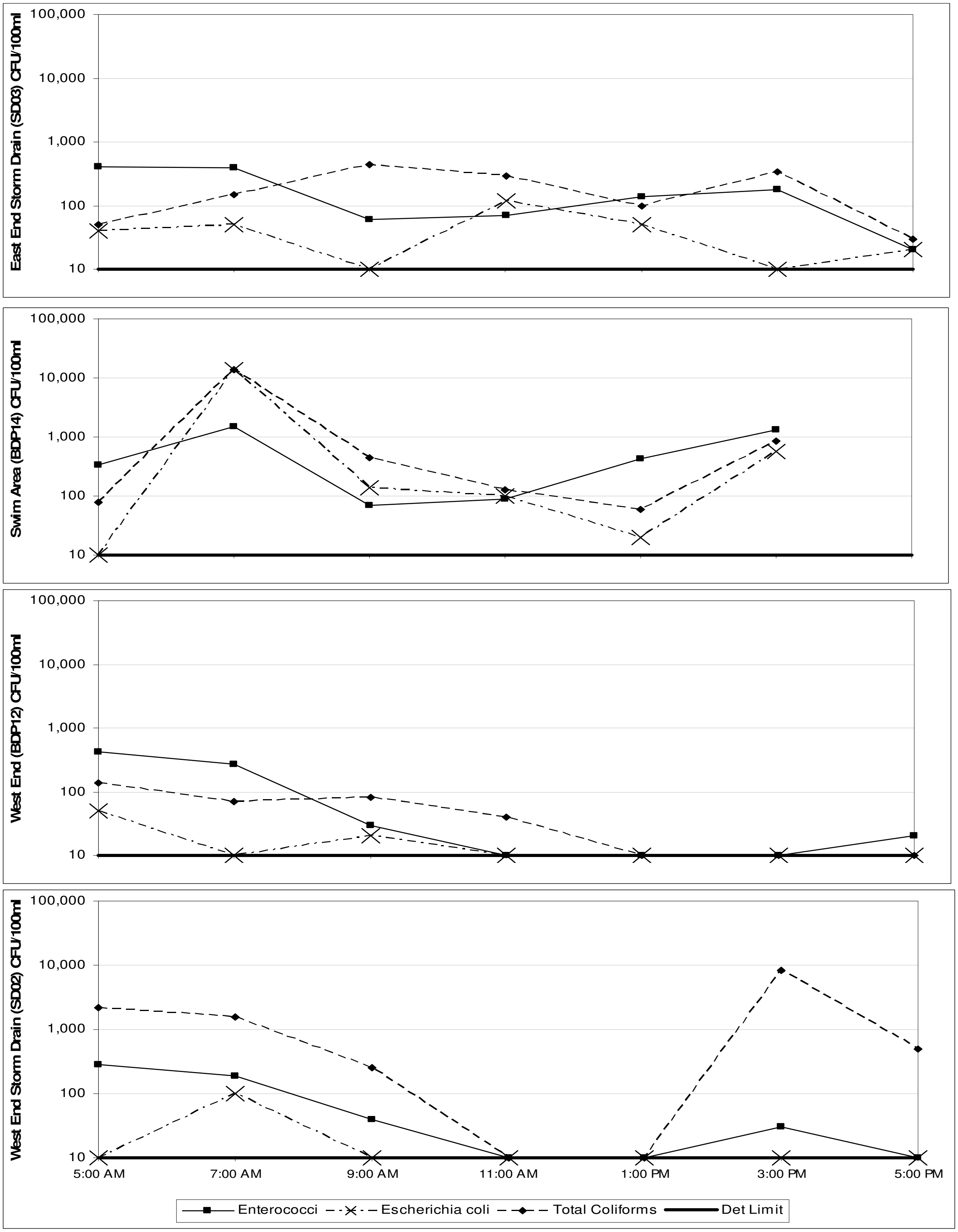


Figure 3.7-2: 12 Hour study I Bacteria Trend Analysis

The charts in Figure 3.7-1 and Figure 3.7-2 show the following peaks in bacterial counts greater than 1,000 CFU/100ml:

Table 3.7-1: 12 Hour Study I - Bacteria Counts Greater than 1,000 CFU/100ml				
Time of Day	*Location*		*Type of Bacteria*	*Average Count (CFU/100ml)*
5:00 AM	West End Storm drain	SD02	Total coliforms	2,200
7:00 AM	Swim Area	BDP14	Total coliforms	14,000
7:00 AM	Swim Area	BDP14	E. coli	14,000
7:00 AM	Swim Area	BDP14	Enterococcus	1,470
7:00 AM	West End Storm drain	SD02	Total coliforms	1,590
3:00 PM	Swim Area	BDP14	Enterococcus	1,330
3:00 PM	West End Storm drain	SD02	Total coliforms	8,200

The peaks levels were detected primarily during early morning (7:00 A.M.) and mid-afternoon (3:00 P.M.) and only at the Swim Area and the West Storm drain. The largest peaks for each of the three indicators was detected at 7:00 A.M. in the Swim Area.

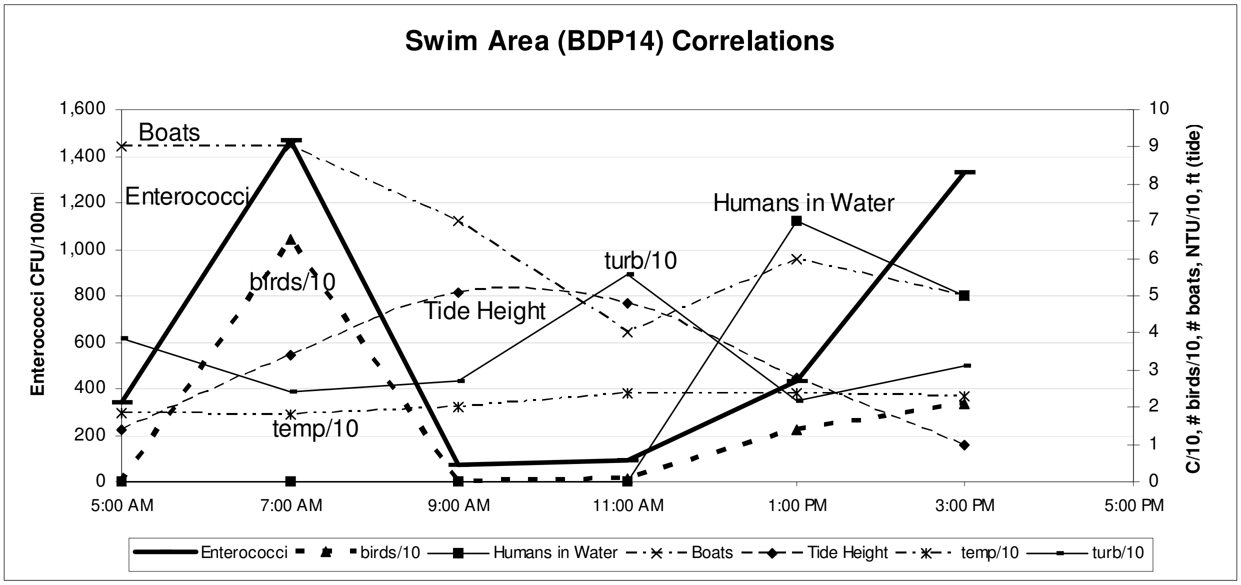
Figure 3.7-3 and Figure 3.7-4 compare enterococci concentrations with some of the other parameters measured during the sampling period. The high number of birds observed at the Swim Area may be related to peak levels of enterococci , however, the data are limited. Bird droppings on the sand were submerged by the incoming tide, which may have released bacteria into the water. Although this observation was noted, additional sampling is needed to draw firm conclusions.

The data suggest a possible relationship between turbidity and enterococci concentrations in the storm drain areas. However, slight differences between sampling events could also be attributed to measurement errors associated with the sampling and analytical techniques.

Conclusions**.** Based on the limited data from this 12-hour study, it appears that:

- Bacteria concentrations vary significantly with time of day
- There may be some relationship between number of birds and bacteria concentrations in water.

After this first 12-hour study, it was recommended that a follow-up study (Section 3.7.2) focus additionally on noting the numbers and locations of birds, humans and boats every 30 minutes rather than hourly, for a more accurate assessment.



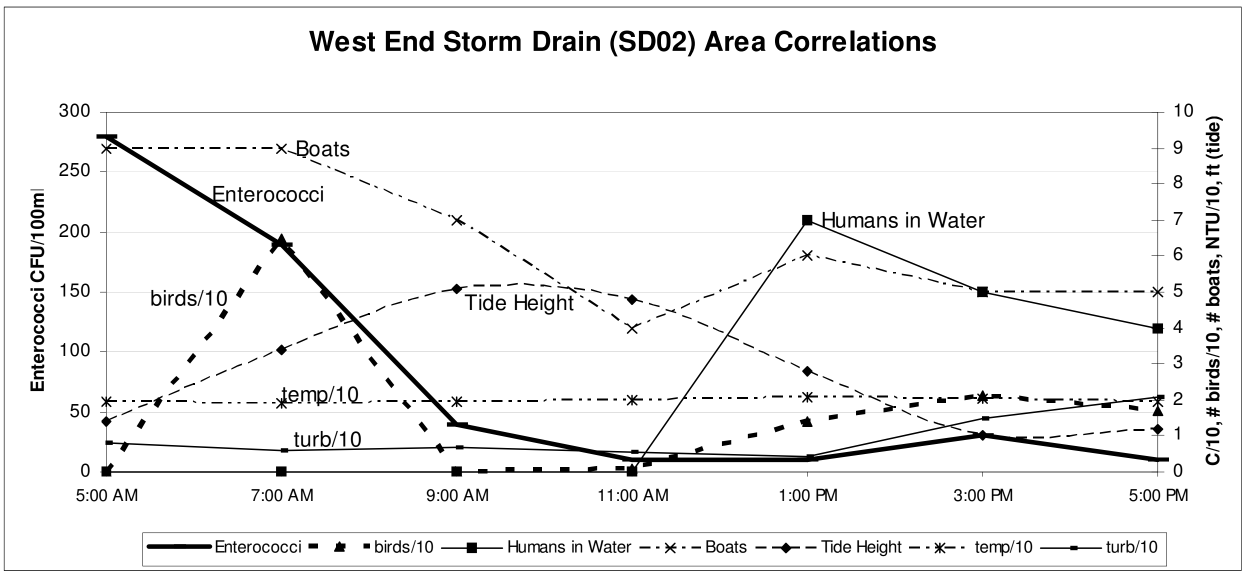
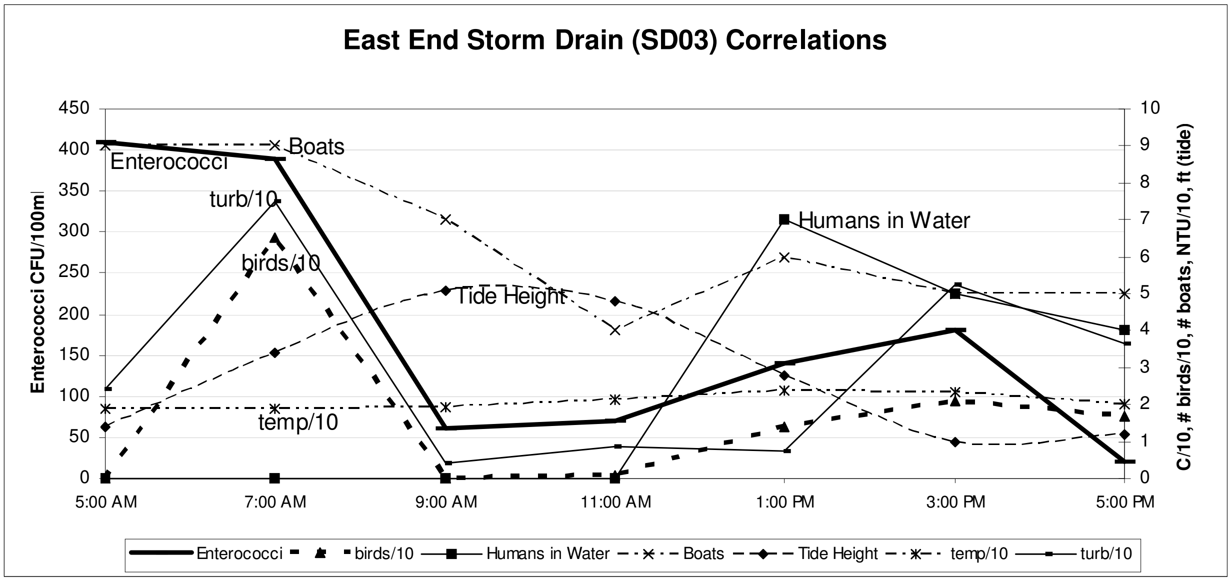


Figure 3.7-3: 12 Hour Study I - Visible Correlations Between Indictor Levels and Other Measured Parameters at the Swim Area and West End Storm Drain



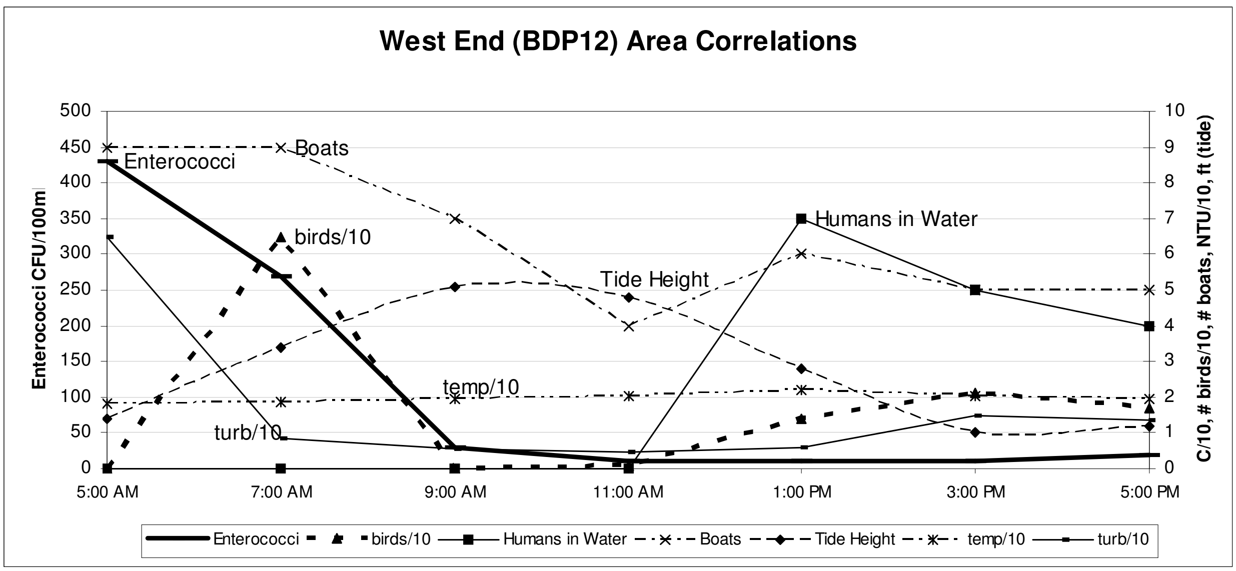


Figure 3.7-4: 12 Hour Study I - Visible Correlations Between Indicator Level and Other Measured Parameters at the East Storm Drain and West End

It was also recommended that an irradiance meter, which would measure actual radiant flux per unit area (rather than a qualitative estimate based on time of day) be used to better estimate solar irradiance at each sampling point and time.

3.7.2 12-Hour Study II

The purpose of this follow-up 12-hour study, conducted on October 21, 2002, was to replicate the first 12-hour bacterial indicator variability study to determine whether trends seen previously would recur under similar (spring tide) conditions. As before, bacterial indicator levels were compared to the number of beach users, boats and birds present near the sampling areas, and different sunlight and tidal conditions. The sampling scheme was similar to that for the September 23 study (Section 3.7.1), except for the following:

- Numbers of humans in the water, birds at the beach, and boats at anchor were recorded every 30 minutes instead of every hour as before;
- Light intensity was measured using a photo light meter;
- Fecal coliforms, *E. coli* and *Enterococcus* were quantified from seagull samples collected on the sand to determine the potential loading of bacteria from seagulls to the near shore sampling sites; and
- Enterococci isolated from a subset of water, sediment and gull samples were identified to species level. The *Enterococcus* species found in gull droppings were compared to isolates from water and sediment samples.

Results. As shown in Figure 3.7-5 and Figure 3.7-6, bacterial counts were again relatively low (less than 1,000 CFU/100ml). However, for this second study, the higher counts were detected at 9:00 A.M. at the East End (all three indicators); 11:00 A.M. at the East End (total coliforms and *E. coli*), Swim Area (total coliforms), and West End (all three indicators); and 5:00 P.M. at the East End (all three indicators). Data are tabulated in Appendix G.

The charts in Figure 3.7-5 Figure 3.7-6 exhibit the following peaks in bacterial counts greater than 1,000 CFU/100ml (Table 3.7-2):

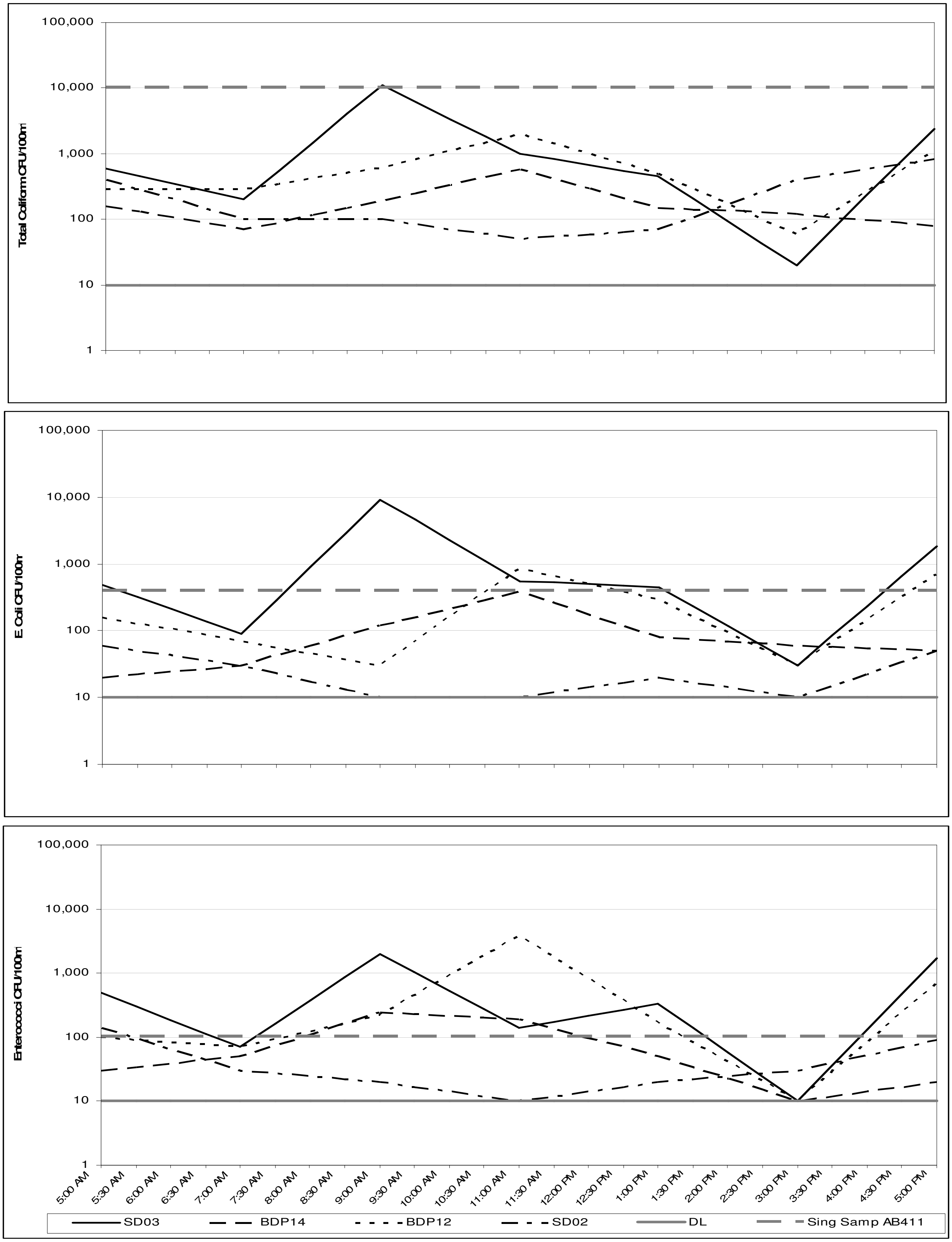


Figure 3.7-5: 12-hour Study II Bacteria Concentrations

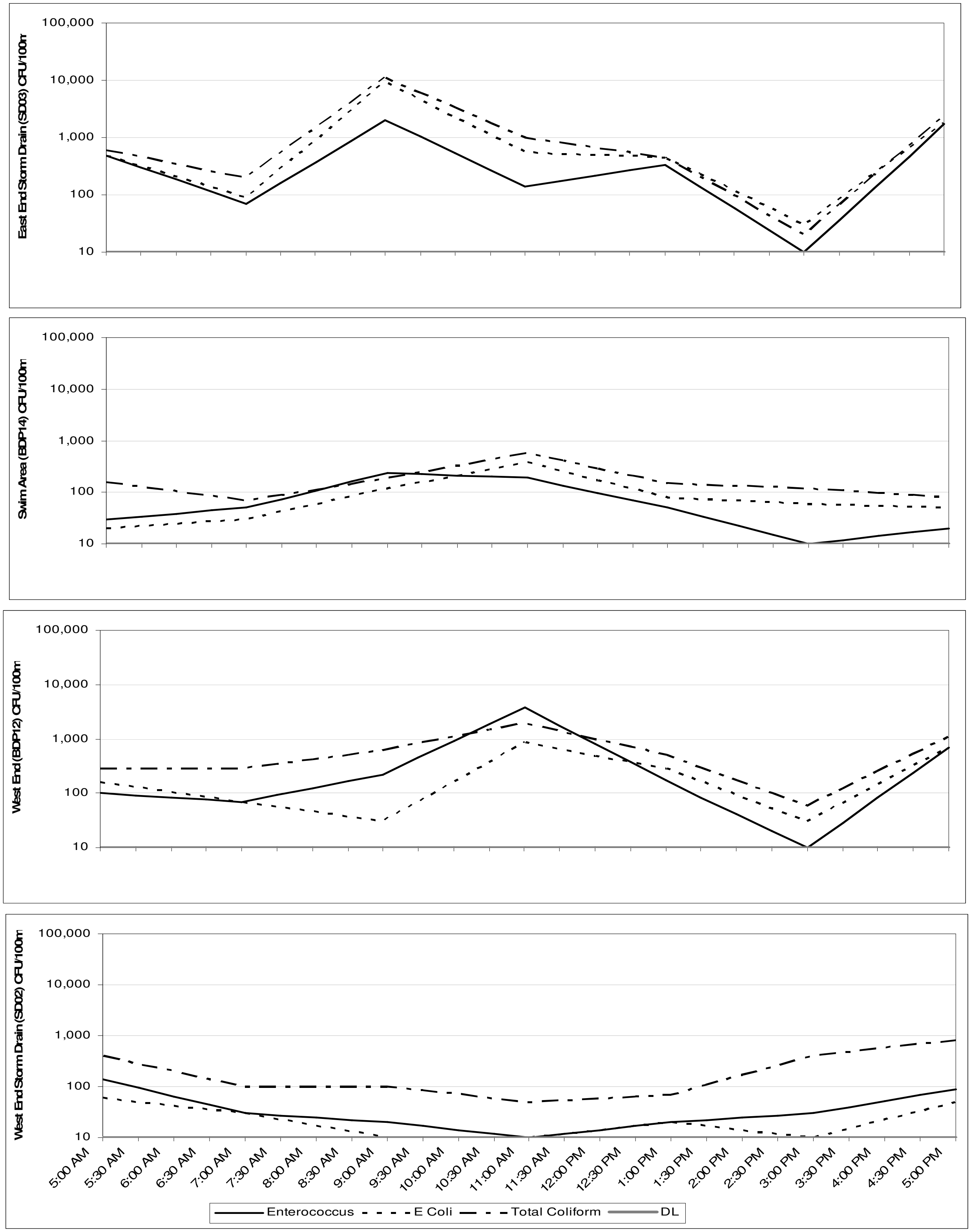


Figure 3.7-6: 12 Hour Study II Bacteria Trend Analysis

Table 3.7-2: Peak Bacteria Counts 12 Hour Study II

Time of Day	Location	Station	Type of Bacteria	Bacteria Count (CFU/100ml)
9:00 AM	East End Storm Drain	SD03	E coli	9,200
9:00 AM	East End Storm Drain	SD03	Enterococci	2,000
9:00 AM	East End Storm Drain	SD03	Total Coliform	11,000
11:00 AM	East End Storm Drain	SD03	Total Coliform	1,000
11:00 AM	West End	BDP12	Enterococci	3,800
11:00 AM	West End	BDP12	Total Coliform	2,000
5:00 PM	East End Storm Drain	SD03	E coli	1,820
5:00 PM	East End Storm Drain	SD03	Enterococci	1,700
5:00 PM	East End Storm Drain	SD03	Total Coliform	2,400
5:00 PM	West End	BDP12	Total Coliform	1,090

The peaks were detected primarily near mid morning (9:00 A.M. and 11:00 A.M.) and late -afternoon (5:00 P.M.). In addition, the maximum concentrations were detected mostly at the West End and the East End sampling locations. The largest peaks for total coliform and *E. coli* occurred at 9:00 A.M. for the East End and 11:00 A.M. for *Enterococcus* at the West End.

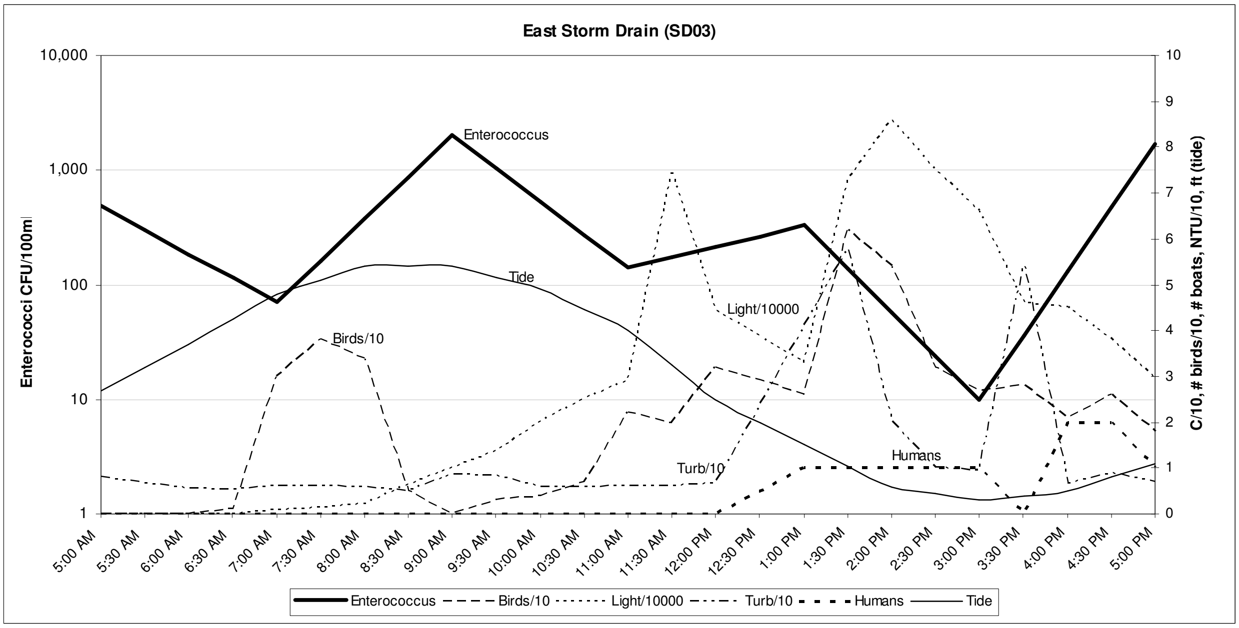
Bird counts on October 21, 2002, showed an early morning peak around 7:00 to 8:00 A.M., similar to that observed in the first 12-hour study on September 23 (Figure 3.7-7 and Figure 3.7-8). The numbers of birds decreased later in the morning and increased again around 3:00 P.M., at the same time as low tide.

The potential correlation between bird and bacteria levels suggested during the first 12-hour study was not evident during the second study.

Light-related effects on bacterial levels were not evident from this second 12-hour study. Some of the lowest bacteria levels of the day occurred in the dark, early morning hours, when higher concentrations would be expected if die-off occurs during daylight. Correlations between bacterial levels and other measured parameters are not clear based on the data collected during this second 12-hour study.

3.7.3 Comparison of Enterococcus species in Seagull Stool

Enterococci species can be found in soil, on plants, humans and animals. Since bacterial source tracking methods are still developmental, enterococci isolates were speciated by OCPHL and archived for future MST studies. Bacterial speciation alone is not very reliable for identifying sources of contamination. However, the differences in the *distribution* of enterococci species in water, humans and animals could provide additional insight on the significance of potential sources. Some species are only found commonly in one host specie, but only occasionally in others. For example, *Enterococci avium* is a primary component in poultry and found in lower percentages in humans. OCPHL is continuing to investigate differences in enterococci species in water, sediments and gulls.



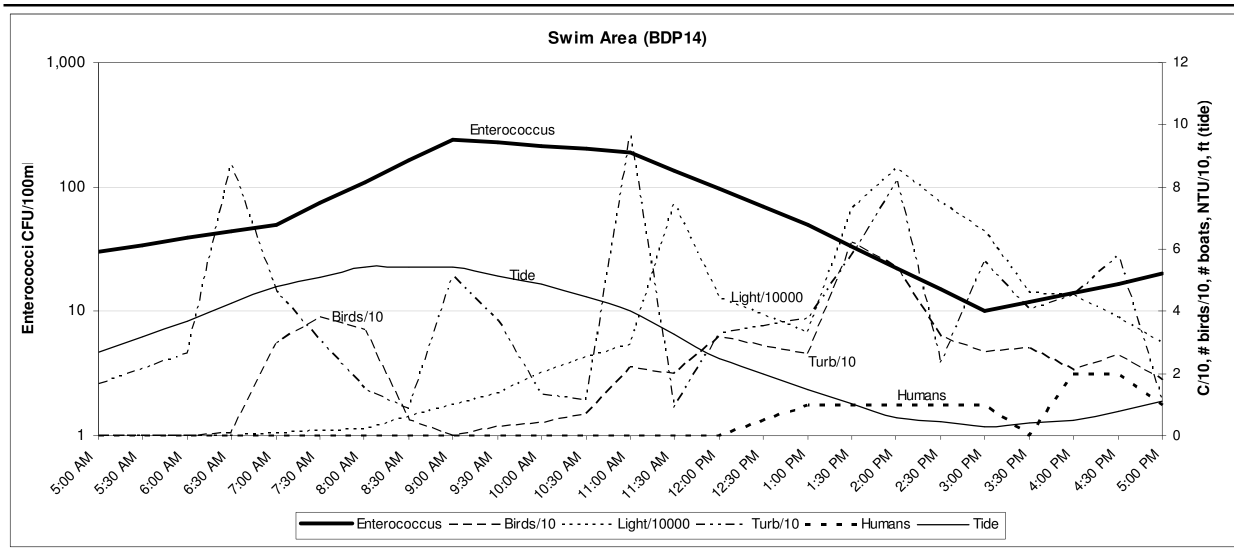


Figure 3.7-7: 12 Hour Study II Visible Correlations East Storm Drain (SD03) and Swim Area (BDP14)

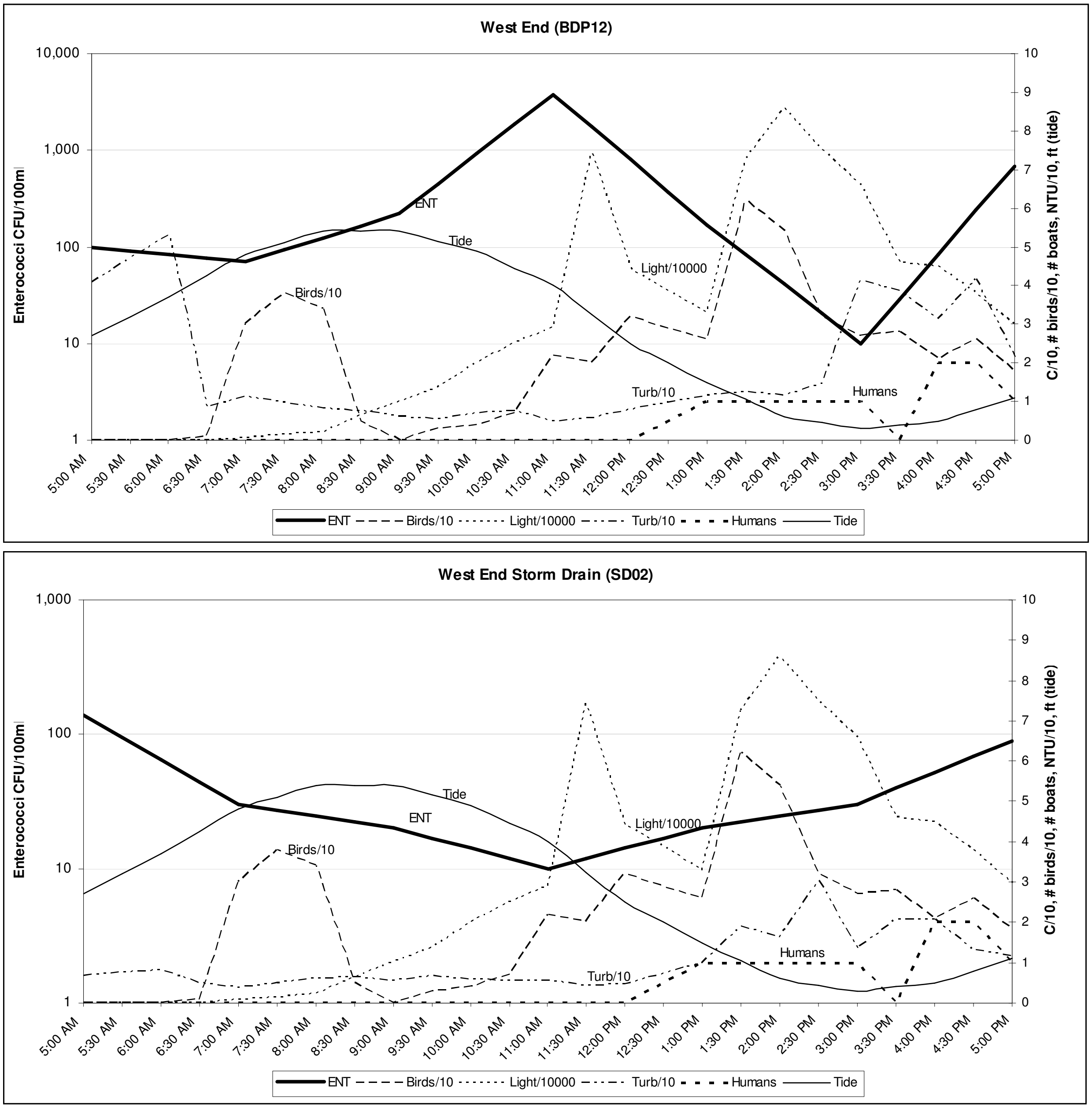


Figure 3.7-8: 12 Hour Study II Visible Correlations West End (BDP12) and West End Storm Drain (SD02)

Bacteria growing on mEI media used to detect enterococci were speciated using API 20 STREP (Biomérieux, France). Preliminary speciation results are presented in Table 3.7-3. Some enterococci species found in water at Baby Beach were also present in sediments and gull stools. The data presented in this report are preliminary. The Orange County Public Health Care Agency is continuing the enterococci speciation work as part of a separate study.

The average concentration of enterococci detected in gull stools was 1.4 x 10^7 CFU/g, which is consistent with densities reported in the literature. Most notably, species found in gull stool were also founding sediment and water. Note that compliance monitoring results under AB411 do not speciated enterococci isolates. Thus, enterococci found in water during compliance monitoring activities may be those that thrive in gulls and gulls could play a role in the dissemination of enterococci in water and sediments.

Table 3.7-3: Speciation of bacteria isolated using mEI media.

Identification	No. Isolates (%)		
	Water (N=14)	Seagull Stool (N=18)	Sediment (N=23)
Enterococcus avium	0	4 (7.4%)	3 (7.1%)
Enterococcus durans	2 (7.4%)	4 (7.4%)	4 (9.5%)
Enterococcus faecalis	3 (11.1%)	26 (48.1%)	10 (23.8%)
Enterococcus faecium	7 (25.9%)	11 (20.4%)	7 (16.7%)
Enterococcus gallinarum	2 (7.4%)	0	8 (19.0%)
Enterococcus viridans	0	0	1 (2.4%)
Streptococcus bovis	8 (29.6%)	5 (9.3%)	3 (7.1%)
Streptococcus uberis	0	0	1 (2.4%)
Unable to identify[a]	5 (18.5%)	4 (7.4%)	5 (11.9%)
Total	27	54	42

[a]isolates that were unidentifiable using API 20 STREP.
N = number of samples speciated

Conclusions. Although birds may be a source of enterococci to sediments and water, this association was not conclusive based on the results of these studies. Some confounding factors could have been tidal activity and high variability of indicator concentrations in water. In the first 12-hour study, there appeared to be a relationship between peak levels of birds and bacterial counts. The second 12-hour study did not show the same correlation, but may indicate a lag in bacterial peaks due .to the hydrodynamics related to incoming tides and dispersion of bird-related bacteria, which may have differed between the two studies. It is recommended that further studies of the bird-bacteria relationship include detailed tracking of bird locations in relation to the sampling points and increased sampling.

A number of isolates from the mEI media were identified as *Streptococcus spp.* (29.6%), or could not be identified (18.5%) using API 20 STREP. The fecal streptococcus group, also found in the gastrointestinal tract of warm-blooded animals is closely related to enterococci. Typical bacterial colonies isolated using mEI are considered “presumptive” for enterococci identification. Confirmation using alternate test methods is typically not done for routine monitoring samples other than for quality control. Determining host species of enterococci at Baby Beach will require testing additional gull, sediment and water samples to obtain a larger, more diversified collection of isolates for (1) accurate species identification, (2) determination of species distribution in water, seagull and sediment samples, and (3) further discrimination using molecular typing methods.

If gulls are shown to be a significant source of enterococci in near-shore marine waters that remain viable for some time in the marine environment, with the current marine recreational water quality threshold for a single sample is 104 enterococci/100 ml, it may be possible that unsafe-water advisories are the result of bacteria originating from gulls. The question arises then: what are the risks of human pathogens being associated with those gull-derived enterococci populations? Previous epidemiological studies (USEPA, 1986) showed a correlation between gastrointestinal illness and numbers of enterococci detected in water, but did not identify the sources of bacteria. The public health risk for disease could differ depending on whether the levels of fecal indicators in water are due to recent fecal contamination events from humans, animals and birds, or regrowth and resuspension.

No statistically significant correlation between bacterial levels and the parameters measured were found in this second 12-hour study. Occasional spikes in bacteria levels may be due to localized events (such as birds or resuspended sediments) that are transitory temporally and spatially and also short in duration (less than 2 hours). Some events were indicated by concentration increases in all three indicators, while others involved a single indicator. However, no single source of peak bacterial levels was identified.

3.8 Microbial Source Tracking/Validation Study

Study Synopsis. Three experimental Microbial Source Tracking (MST) techniques were evaluated by Orange County Public Health Laboratory (OCPHL) to assess the extent to which the methods could be used to identify fecal contamination in water samples as human vs. nonhuman and also to compare microbial diversity in test samples. The following three methods were explored:

(1) *Bacteroides-Prevotella* 16S rRNA Polymerase Chain Reaction (PCR)/Terminal Restriction Fragment Length Polymorphism (TRFLP)

(2) *Bacteroides thetaiotaomicron* 16S rRNA PCR/TRFLP

(3) Microbial Community Analysis (CA) 16S rRNA PCR/TRFLP

The methods are described in the Sampling and Analysis Plan (Orange County Public Health Laboratory, December 2002). No significant variances to the sampling or analytical procedures described in the Sampling and Analysis Plan occurred.

The ability of both *Bacteroides* PCR/TRFLP methods to discriminate between human and nonhuman fecal sources (i.e., sewage, rodents, cats, dogs and seagulls) was evaluated. The two *Bacteroides* methods differed in the type of PCR primers that are used to detect various host-specific (human vs. animal) markers for *Bacteroides* or *Prevotella* species.

The CA method is also a PCR/TRFLP technique that compares the DNA fingerprints of whole bacterial communities rather than individual species. In this study, CA was evaluated for its ability to discriminate the microbial diversity (i.e., number of different species of bacteria between samples) using universal PCR primer sets.

Test samples were prepared by OCPHL and sent to two MST research laboratories, Oregon State University (OSU) and Orange County Water District (OCWD). The test samples were spiked with known fecal material and sent to the laboratories blind (i.e. spike material not identified). Blind samples were analyzed in duplicate to assess method accuracy and reproducibility. The test samples included feces from animals and seagulls as well as sewage influent and effluent. Positive and negative controls included various matrices either with or without the addition of known concentrations of bacteria.

Results. The detection of human and nonhuman markers in sewage and fecal samples using both *Bacteroides* PCR/TRFLP methods is shown in Table 3.8-1. In this table, detection of molecular markers is indicated as positive (+) or negative (-).

The *Bacteroidetes* marker was used by OSU to determine if a sample contained human or nonhuman fecal *Bacteroides* strains. This was done with the sewage samples, but not with the rodent, dog, cat or gull samples which are known to contain *Bacteroidetes*. according to researchers at OSU. .

Table 3.8-1: Detection of Host-specific Markers in Fecal and Sewage Samples Using Two Bacteroides 16S rRNA PCR/TRFLP Methods

		***Bacteroides/Prevotella* primers (OSU)**			***Bacteroides* species specific primers (OCWD)**	
Sample type	**No. samples**	***Bacteroidetes*** Human and nonhuman marker	**HF10** Human marker	**CF128** Bovine marker	***B. ovatus*** Human and nonhuman marker	***B. theta-iotaomicron*** Human marker
Rodent	6	Not tested[a]	-	-	+	-
Dog	6	Not tested[a]	**+** [b]	**Weak+** [b]	+	**Weak+** [b]
Cat	6	Not tested[a]	**+** [b]	-	**-**	-
Seagull	6	Not tested[a]	-	-	+	-
Sewage influent	3	+	+	-	+	+
Sewage effluent	2	+	+	-	+	+

[a] Samples were not tested by OSU as they were expected to test positive using general *Bacteroidetes* primers
[b] False positive
Bold cells depict false positive or false negative results

Bacteroidetes marker was detected in sewage influent and effluent samples, as expected. The human marker, HF10, was found in sewage, dog and cat samples and was not detected in rodent and seagull samples. HF10 was also detected in the negative control samples (Table 3.8-2).

Table 3.8-2: Detection of Bacteroides Host-specific Markers in Control Samples

Control sample	***Bacteroides/Prevotella* primers (OSU)**			***Bacteroides* species specific primers (OCWD)**	
	Bacteroidetes Human and nonhuman marker	**HF10** Human marker	**CF128** Bovine marker	***B. ovatus*** Human and nonhuman	***B. theta-iotaomicron*** Human marker
Bacteroides thetaiotaomicron	+	-	-	-	+
Bacteroides ovatus	+	-	-	+	-
Sterile marine water #1	**Weak+**	-	-	-	-
Sterile marine water #2	-	-	-	-	-
Sterile marine water #3	**+**	-	Not tested	-	-
Sterile PBS	**+**	-	Not tested	-	-
Sterile membrane	-	-	Not tested	Not tested	Not tested

The negative control samples consisted of either sterile marine water or phosphate buffered saline (PBS). Interestingly HF10 was not detected in the control sample spiked with *B. thetaiotaomicron* (*Bt*) a common species of *Bacteroides* found in human feces. A third marker used by OSU CF128 (bovine) was weakly detected in the dog sample.

In comparison, the *Bacteroides* primers used by OCWD were more specific in selecting markers from *B. ovatus* and *B. thetaiotaomicron*. As expected the *B. ovatus* marker was detected in sewage, seagull, and rodent fecal samples as well as the positive control sample. The *B. ovatus* marker was not detected in the cat sample; however, this organism may not have been present in this sample. *B. thetaiotaomicron* was detected in sewage samples as expected although the dog sample was also weakly positive for this human marker.

Based on these results the *Bacterioides* methods are not yet highly reliable for discriminating between human and nonhuman sources. There were several false positives and at least one false negative using the B-P method and one false positive using Bt. It is important to note that the “false positive” results may not be due entirely to methodological deficiencies. The detection of human markers in animals could indicate sharing of bacteria between humans and animals existing in close proximity or inability of bacterial typing methods to discriminate strains that are highly similar. In either case, this makes it difficult to rely on the *Bacterioides* methods as currently designed for accurate fecal indicator source identification.

The Community Analysis (CA) method focused on amplifying markers from different 16S rRNA markers from different organisms. As shown in Table 3.8-3 the method successfully identified samples #1-4 as being identical in bacterial community structure that were also unidentical to sample #5 as expected. One sample (#6) could not be successfully amplified.

Table 3.8-3: Diversity (number of organisms) Detected in Control Samples Using Microbial Community Analysis of the 16S rRNA Gene

Sample Number	Organisms	Concentration of each organism per sample	No. (diversity) of organisms detected by OCWD	Comparison to community structure of sample #1
1	*Escherichia coli, Salmonella typhimurium, Enterococcus faecalis*	1×10^8	3	NA
2	Duplicate of #1	1×10^8	3	Identical
3	*Escherichia coli, Salmonella typhimurium, Enterococcus faecalis*	1×10^4	3	Identical
4	Duplicate of above	1×10^4	3	Identical
5	*Staphylococcus aureus, Klebsiella pneumoniae, Enterococcus faecalis*	1×10^7	3	Unidentical
6	Duplicate of above	1×10^7	Unable to amplify	Not done

The ability of CA to amplify 16S rRNA Gene fragments from multiple species within a community and generate a genetic "fingerprint" of the community is important. This allows the method to compare environmental samples with samples from different or known environments to determine "fit" or "match" and is therefore, not library-dependent. In fact, it may not be possible to develop libraries of "known *communities*" because of the high diversity of communities over large geographic areas and changes due to environmental selective pressures. Individual members of the community structure may be identified or further validated using public databases (GenBank and Ribosomal Database Project) or by gene sequencing. Even so, similarities between communities at different sites and at different sampling times could be compared w/o a library or despite these changes.

Conclusions.

Bacteroides methods. Since the MST methods evaluated are newly developed techniques, determination of method sensitivity and specificity requires extensive testing beyond the scope of this study. The detection of *Bacteroides* human markers in dog and cat fecal samples indicates that both *Bacteroides* methods require further optimization to increase method specificity. Further testing with a larger number and variety of fecal samples is recommended. Nondetection of HF10 (human) marker in controls spiked with *B. thetaiotaomicron* and *B. ovatus*, which can be present in human feces, raises questions with regards to the sensitivity and the usefulness of this marker for detection of human contamination.

Testing for the presence of a combination of markers may improve the sensitivity of this method. It is unknown why the HF10 (human) marker was detected in sterile control samples, although these may have been false-positive results due to DNA carryover or contamination, which can occur while performing PCR. Implementing additional PCR quality control steps may help to reduce contamination rates.

Community Analysis. CA has potential for comparing the similarity of DNA fingerprints of bacterial communities between sampling locations impacted by storm strains versus non-impacted sites or between bacterial populations in sediments versus overlying water. We were able to show that CA could distinguish samples comprised of three different kinds of bacteria samples in liquid media. Ideally, the usefulness of CA should be tested with field samples with a more diversified population in a complex medium such as marine water. In addition, the use of CA to speciate environmental isolates using currently available databases has not been widely tested.

The results of the three MST methods evaluated indicate that they have potential application for discriminating between human and nonhuman fecal contamination. As a result of this evaluation and other ongoing studies, OSU and OCWD have made modifications to improve the sensitivity and specificity of the *Bacteroides* methods. Method optimization is routinely done when using novel PCR-based methods that are not yet standardized. The *Bacteroides* methods evaluated in this study may be more efficient than other bacterial source tracking techniques for predicting sources of contamination as being human or nonhuman. Unlike most of the currently available MST methods, these techniques are based on detecting *human-specific* molecular markers. Since human strains may occasionally be present in other animals, this complicates identifying specific bacterial sources, irregardless of the type of MST method employed. In response to this complexity, OCWD and OSU are currently developing a semi-quantitative component to the *Bacteroides* methods to increase method specificity. The ability to quantify the level of markers detected in water samples is useful when bacterial contamination is due multiple sources, which is the most likely situation. The quantitative component should lower the percentages of false positive and negative results.

Due to the uncertainties associated with these methods, further development to improve the accuracy for identifying the sources of bacteria is preferable before analyzing the Baby Beach samples.

4.0 INTEGRATED CONCLUSIONS

Based on the bacteriological investigations conducted at Baby Beach, the following general conclusions can be reached:

- The storm drains are significant sources of bacteria and bacteria laden sediments.
- The storm drain plug systems currently in place are somewhat effective as detailed in the Data Mining Report (SAIC, 2003), but have not completely mitigated summertime bacterial levels at Baby Beach. Even with storm drain plugs in place, leakage from the drain is contributing measurable quantities of bacteria into the beach waters and adjacent sediments.
- Bacteria appear to be associated with sediments and remain viable for some period of time after deposition into sediments. The high levels of bacteria are

isolated from sediments using culture-based methods indicate survival in the sediments. When sediments become resuspended, bacteria concentrations in the water may increase. Thus, sediments may be a secondary source of bacteria in harbor waters.

- Boating practices did not appear to be contributing measurable quantities of bacteria.
- Birds may be contributing to bacterial pollution, but data collected are not sufficient to prove or disprove that birds are the cause of the persistent postings.
- Other factors such as tide, sunlight, number of beach users, and turbidity did not appear to correlate with bacteria concentrations in water in this study.
- Bacteria concentrations in water varied widely with time of day. The current time (7:00 a.m. to 10:00 a.m.) that Orange County Health Care Agency collects samples for AB411 compliance monitoring may be when bacteria concentrations are typically higher. Levels of the three different indicator bacteria trended similarly throughout the day. However, the causes of the trend are unclear.
- *Bacteroides* PCR/TRFLP microbial source tracking methods currently lack sufficient specificity or sensitivity to identify the animal or human source of fecal indicator bacteria found in the environment. These methods remain under development pending verification of their usefulness in making BMP selection decisions.
- The Community Analysis (CA) PCR/TRFLP microbial source tracking method is anticipated to be useful in to characterizing bacterial communities at given sites. CA could potentially identify bacteria sources by gene sequencing and/or using public databases (GenBank and Ribosomal Database Project).
- Further development and field testing of these MST methods is preferable before they can be used to analyze the Baby Beach samples.

Based on the forgoing conclusions as well as the conclusions reached in the data mining and circulation studies, a number of Best Management Practices are evaluated in the State of the Beach Report. In the State of the Beach Report, BMPs are evaluated and selected for implementation at Baby Beach based on the findings of the special study bacteriological investigations.

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APPENDIX A - TABULATED DATA FOR SECTION 3.1

Table A-1. Data From Special Study on Storm Sewer Leaks Into and Through Groundwater.

WB #	Location (Inches from Storm Drain Mouth)	Total	E. coli	Ent
02.WB.00188	0"	> 10,000	200	250
02.WB.00188'		> 10,000	70	100
Average		> 10,000	135	175
02.WB.00189	42"	> 2,200	40	270
02.WB.00189'		900	90	360
Average		> 1,550	65	630
02.WB.00190	84"	1,100	50	70
02.WB.00190'		1,500	20	150
Average		1,300	35	110
02.WB.00191	126"	200	20	50
02.WB.00191'		< 90	20	< 20
Average		< 145	20	< 35
02.WB.00192	168"	90	< 20	< 20
02.WB.00192'		< 90	< 20	< 20
Average		< 90	< 20	< 20
02.WB.00193	210"	300	< 20	20
02.WB.00193'		1,000	< 20	< 20
Average		650	< 20	< 20
02.WB.00194	252"	< 90	< 20	< 20
02.WB.00194'		< 90	< 20	< 20
Average		< 90	< 20	< 20
02.WB.00195	294"	< 90	< 20	< 20
02.WB.00195'		<90	< 20	< 20
Average		< 90	< 20	< 20
02.WB.00196	336"	< 90	< 20	20
02.WB.00196'		< 90	20	< 20
Average		< 90	< 20	< 20
02.WB.00197	378"	< 90	20	20
02.WB.00197'		200	< 20	20
Average		< 145	< 20	< 20
02.WB.00198	486"	200	50	20
02.WB.00198'		90	< 20	< 20
Average		145	< 35	< 20
02.WB.00199	594"	< 90	< 20	< 20
02.WB.00199'		< 90	20	< 20
Average		< 90	< 20	< 20
02.WB.00200	810"	400	20	< 20
02.WB.00200'		90	20	< 20
Average		245	20	< 20
02.WB.00201	918"	90	20	40
02.WB.00201'		200	20	< 20
Average		145	20	< 30
02.WB.00202	1026"	< 90	< 20	< 20
02.WB.00202'		< 90	20	< 20
Average		< 90	< 20	< 20
02.WB.00203	1134"	< 90	< 20	< 20

Table A-1. Data From Special Study on Storm Sewer Leaks Into and Through Groundwater.				
WB #	**Location (Inches from Storm Drain Mouth)**	**Total**	**E. coli**	**Ent**
02.WB.00203'		90	20	< 20
Average		< 90	< 20	< 20
02.WB.00204	1374"	< 90	< 20	< 20
02.WB.00204'		< 90	< 20	< 20
Average		< 90	< 20	< 20
02.WB.00205	1614"	< 90	< 20	< 20
02.WB.00205'		< 90	20	< 20
Average		< 90	< 20	< 20
02.WB.00206	1854"	< 90	< 20	20
02.WB.00206'		< 90	20	< 20
Average		< 90	< 20	< 20
02.WB.00207	2094"	< 90	40	20
02.WB.00207'		< 90	< 20	< 20
Average		< 90	< 30	< 20
02.WB.00208	2334"	< 90	< 20	< 20
02.WB.00208'		< 90	< 20	40
Average		< 90	< 20	< 30
02.WB.00209	Manhole	> 20,000	6,200	2,310
02.WB.00209'		> 20,000	2,400	2,180
Average		> 20,000	4,300	2,245
02.WB.00210	West End Pipe Mouth	> 20,000	7,200	9,400
02.WB.00210'		> 20,000	6,200	6,400
Average		> 20,000	6,700	7,900
02.WB.00211	Well #11	< 90	< 20	< 20
02.WB.00211'		< 90	< 20	< 20
Average		< 90	< 20	< 20
02.WB.00212	Harbor water nearest storm drain	> 4,300	70	20
02.WB.00212'		1,800	70	40
Average		> 3,050	70	30

APPENDIX B - TABULATED DATA FOR SECTION 3.2

Table B-1. Data for Groundwater Monitoring Wells.

Well #	Water Depth from bottom	Total Coliform	Escherichia coli	Enterococci	Salinity (%)	Conductivity (mS)
1	Dry	NA	NA	NA	NA	NA
1 Dup	Dry	NA	NA	NA	NA	NA
1 Avg	Dry	NA	NA	NA	NA	NA
5	2' 10"	> 600	< 10	<10	5.2	7.07
5 Dup	2' 10"	< 10	< 10	10	5.2	7.07
5 Avg	2' 10"	**<> 300**	< 10	< 10	5.2	7.07
10	3' 7"	< 10	< 10	10	6.5	8.74
10 Dup	3' 7"	10	< 10	< 10	6.5	8.74
10 Avg	3' 7"	< 10	< 10	< 10	6.5	8.74
11	4' 3"	< 10	< 10	< 10	8.6	11.13
11 Dup	4' 3"	< 10	< 10	10	8.6	11.13
11 Avg	4' 3"	< 10	< 10	< 10	8.6	11.13
13	2' 0"	10	< 10	20	8.7	11.45
13 Dup	2' 0"	< 10	< 10	60	8.7	11.45
13 Avg	2' 0"	< 10	< 10	40	8.7	11.45

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APPENDIX C - TABULATED DATA FOR SECTION 3.3

Table C-1. Data for WSD Transect Study I.

Pipe Mouth to 15 ft North			
Sample Site	**Total Coliforms**	**Escherichia coli**	**Enterococcus**
Pipe mouth	> 28,000	200	9,400
Pipe mouth'	> 24,000	< 200	3,000
Pipe mouth Avg	> 26,000	< 200	6,200
3 ft North	300	< 200	< 200
3 ft North'	500	< 200	200
3 ft North Avg	400	< 200	< 200
6 ft North	700	< 200	200
6 ft North'	800	< 200	< 200
6 ft North Avg	750	< 200	< 200
9 ft North	1,000	< 200	< 200
9 ft North'	1,000	< 200	200
9 ft North Avg	1,000	< 200	< 200
12 ft North	1,000	< 200	700
12 ft North'	700	< 200	200
12 ft North Avg	850	< 200	450
15 ft North	1,000	< 200	1,700
15 ft North'	700	< 200	200
15 ft North Avg	850	< 200	950
Pipe Mouth to 18 ft East			
Sample Site	**Total Coliforms**	**Escherichia coli**	**Enterococcus**
3 ft East	> 300,000	500	2,000
3 ft East'	> 300,000	< 200	300
3 ft East Avg	> 300,000	< 350	1,150
6 ft East	> 300,000	200	200
6 ft East'	> 300,000	500	1000
6 ft East Avg	> 300,000	350	600
9 ft East	> 300,000	200	500
9 ft East'	> 300,000	700	800
9 ft East Avg	> 300,000	450	650
12 ft East	> 300,000	500	700
12 ft East'	> 300,000	700	4,500
12 ft East Avg	> 300,000	600	2,600
15 ft East	> 300,000	1,000	1,000
15 ft East'	> 300,000	300	500
15 ft East Avg	> 300,000	650	750
18 ft East	> 2,000	200	< 200
18 ft East'	> 2,000	< 200	< 200
18 ft East Avg	> 2,000	< 200	< 200
Pipe Mouth to 15 ft South			
Sample Site	**Total Coliforms**	**Escherichia coli**	**Enterococcus**
3 ft South	> 300,000	300	< 200
3 ft South'	> 300,000	300	1,000
3 ft South Avg	> 300,000	300	< 600
6 ft South	> 30,000	200	200
6 ft South'	5,000	< 200	< 200
6 ft South Avg	> 17,500	< 200	< 200
9 ft South	300	< 200	1,700
9 ft South'	1,000	< 200	300
9 ft South Avg	650	< 200	1000
12 ft South	200	200	200
12 ft South'	300	< 200	1,000
12 ft South Avg	250	< 200	600
15 ft South	300	< 200	500
15 ft South'	1,000	200	1,000
15 ft South Avg	650	< 200	750
S - 6	< 200	< 200	< 200
S - 6'	< 200	< 200	< 200
S - 6 Avg	< 200	< 200	< 200

Table C-2. Data for WSD Transect Study II.

Distance North From Pipe Mouth	Water TC	Sediment TC	Water EC	Sediment EC	Water ENT	Sediment ENT
0	70	< 200	< 10	< 200	140	< 200
3	60	< 200	10	< 200	280	200
6	70	300	< 10	< 200	550	500
9	200	200	40	< 200	620	2,300
12	< 10	200	10	< 200	990	3,300
15	< 10	200	30	< 200	950	2,200
18	200	200	60	< 200	660	2,000
21	10	300	20	< 200	190	2,500
24	60	< 200	20	< 200	50	800
27	400	300	< 10	< 200	70	200
30	200	< 200	20	< 200	70	300
40	< 10	< 200	< 10	< 200	40	< 200
50	90	< 200	10	< 200	10	1,000
60	40	200	10	< 200	30	< 200
70	60	< 90	10	< 90	10	180
80	80	< 20	20	< 20	40	20
90	70	< 90	< 10	< 90	20	300
100	50	20	10	< 20	30	20
120	< 10	< 20	< 10	< 20	170	< 20
140	< 10	< 20	20	< 20	100	80
160	40	< 90	20	< 90	140	< 90
180	110	< 90	30	< 90	< 10	< 90
200	< 10	< 90	< 10	< 90	< 10	< 90
Buoy Line	40	< 90	< 10	< 90	30	< 90
Swim Area	60	< 90	10	< 90	60	< 90

Table C-3. Data for WSD Transect Study III.

Sample #	Location	Total Coliforms	Escherichia coli	Enterococcus
02.WB.00413	10' East	90	< 90	200
	10' East Dup	500	< 90	< 90
	10' East Avg	295	< 90	< 145
02.WB.00414	20' East	90	< 90	< 90
	20' East Dup	< 90	< 90	< 90
	20' East Avg	< 90	< 90	< 90
02.WB.00415	30' East	< 90	< 90	300
	30' East Dup	90	< 90	< 90
	30' East Avg	< 90	< 90	< 195
02.WB.00416	40' East	< 90	< 90	300
	40' East Dup	< 90	< 90	90
	40' East Avg	< 90	< 90	195
02.WB.00417	50' East	< 90	< 90	400
	50' East Dup	< 90	< 90	< 90
	50' East Avg	< 90	< 90	< 245
02.WB.00418	10' North	800	< 90	300
	10' North Dup	1400	90	400
	10' North Avg	1100	< 90	350
02.WB.00419	20' North	300	< 90	200
	20' North Dup	1500	< 90	400
	20' North Avg	900	< 90	300
02.WB.00420	30' North	< 90	< 90	< 90
	30' North Dup	200	<90	90
	30' North Avg	< 145	< 90	< 90
02.WB.00421	40' North	200	< 90	< 90
	40' North Dup	90	200	< 90
	40' North Avg	145	< 145	< 90
02.WB.00422	50' North	200	< 90	90
	50' North Dup	200	< 90	< 90
	50' North Avg	200	< 90	< 90
02.WB.00423	10' South	600	< 90	200
	10' South Dup	500	90	200
	10' South Avg	550	< 90	200
02.WB.00424	20' South	300	< 90	700
	20' South Dup	400	< 90	1,400
	20' South Avg	350	< 90	1,050
02.WB.00425	30' South	300	< 90	< 90
	30' South Dup	< 90	< 90	300
	30' South Avg	< 195	< 90	< 195
02.WB.00426	40' South	200	< 90	500
	40' South Dup	< 90	< 90	90
	40' South Avg	< 145	< 90	295
02.WB.00427	50' South	< 90	< 90	90
	50' South Dup	< 90	< 90	300
	50' South Avg	< 90	< 90	195

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APPENDIX D - TABULATED DATA FOR SECTION 3.4

Table D-1. Data for 10-week Monitoring Study.

WB #	Subsample	Date Collected	Submitter	Location	Time Collected	Tide	Specimen Type	MF-Total	m-Tec	MF-Ent
02.WB.00213	Duplicate	08/20/02	WL	Baby Beach West Storm Drain	6:33 AM	3.5 F	Marine Water	> 7,600	220	100
02.WB.00213		08/20/02	WL	Baby Beach West Storm Drain	6:33 AM	3.5 F	Marine Water	> 8,000	210	100
02.WB.00213	Avg	08/20/02	WL	Baby Beach West Storm Drain	6:33 AM	3.5 F	Marine Water	> 7,800	215	100
02.WB.00214	Duplicate	08/20/02	WL	Baby Beach West Storm Drain	6:36 AM	3.5 F	Sediment	> 4,000	200	200
02.WB.00214		08/20/02	WL	Baby Beach West Storm Drain	6:36 AM	3.5 F	Sediment	6,000	200	700
02.WB.00214	Avg	08/20/02	WL	Baby Beach West Storm Drain	6:36 AM	3.5 F	Sediment	> 5,000	200	450
02.WB.00215	Duplicate	08/20/02	WL	Baby Beach East Storm Drain	6:50 AM	3.5 F	Marine Water	> 400,000	4,000	13,000
02.WB.00215		08/20/02	WL	Baby Beach East Storm Drain	6:50 AM	3.5 F	Marine Water	> 400,000	2,000	10,000
02.WB.00215	Avg	08/20/02	WL	Baby Beach East Storm Drain	6:50 AM	3.5 F	Marine Water	> 400,000	3,000	11,500
02.WB.00216	Duplicate	08/20/02	WL	Baby Beach East Storm Drain	6:54 AM	3.5 F	Sediment	> 51,000	1,000	2,700
02.WB.00216		08/20/02	WL	Baby Beach East Storm Drain	6:54 AM	3.5 F	Sediment	> 40,000	< 10	2,000
02.WB.00216	Avg	08/20/02	WL	Baby Beach East Storm Drain	6:54 AM	3.5 F	Sediment	> 45,500	< 505	2,350
02.WB.00217	Duplicate	08/23/02	EH	Baby Beach East Storm Drain	7:44 AM	3.3 F	Sediment	> 12,000	300	1,000
02.WB.00217		08/23/02	EH	Baby Beach East Storm Drain	7:44 AM	3.3 F	Sediment	> 9,000	300	1,000
02.WB.00217	Avg	08/23/02	EH	Baby Beach East Storm Drain	7:44 AM	3.3 F	Sediment	> 10,500	300	1,000
02.WB.00218	Duplicate	08/23/02	EH	Baby Beach East Storm Drain	7:41 AM	3.3 F	Marine Water	> 40,000	600	2,000
02.WB.00218		08/23/02	EH	Baby Beach East Storm Drain	7:41 AM	3.3 F	Marine Water	> 40,000	2,200	3,000
02.WB.00218	Avg	08/23/02	EH	Baby Beach East Storm Drain	7:41 AM	3.3 F	Marine Water	> 40,000	1,400	2,500
02.WB.00219	Duplicate	08/23/02	EH	Baby Beach West Storm Drain	7:29 AM	3.0 F	Sediment	2,000	< 100	3500
02.WB.00219		08/23/02	EH	Baby Beach West Storm Drain	7:29 AM	3.0 F	Sediment	2,200	< 100	2200
02.WB.00219	Avg	08/23/02	EH	Baby Beach West Storm Drain	7:29 AM	3.0 F	Sediment	2,100	< 100	2850
02.WB.00220	Duplicate	08/23/02	EH	Baby Beach West Storm Drain	7:26 AM	3.0 F	Marine Water	40	> 2,000	860
02.WB.00220		08/23/02	EH	Baby Beach West Storm Drain	7:26 AM	3.0 F	Marine Water	> 40,000	400	900
02.WB.00220	Avg	08/23/02	EH	Baby Beach West Storm Drain	7:26 AM	3.0 F	Marine Water	> 20,020	> 1,200	880
02.WB.00232	Duplicate	08/29/02	WL	Baby Beach West Storm Drain	8:00 AM	2.7 F	Marine Water	740	30	< 10
02.WB.00232		08/29/02	WL	Baby Beach West Storm Drain	8:00 AM	2.7 F	Marine Water	600	10	< 10
02.WB.00232	Avg	08/29/02	WL	Baby Beach West Storm Drain	8:00 AM	2.7 F	Marine Water	670	20	< 10
02.WB.00233	Duplicate	08/29/02	WL	Baby Beach West Storm Drain	8:00 AM	2.7 F	Sediment	4,300	< 200	200
02.WB.00233		08/29/02	WL	Baby Beach West Storm Drain	8:00 AM	2.7 F	Sediment	2,800	< 200	300
02.WB.00233	Avg	08/29/02	WL	Baby Beach West Storm Drain	8:00 AM	2.7 F	Sediment	3,550	< 200	250
02.WB.00234	Duplicate	08/29/02	WL	Baby Beach Buoy Line	8:00 AM	2.7 F	Marine Water	60	20	30
02.WB.00234		08/29/02	WL	Baby Beach Buoy Line	8:00 AM	2.7 F	Marine Water	100	20	10
02.WB.00234	Avg	08/29/02	WL	Baby Beach Buoy Line	8:00 AM	2.7 F	Marine Water	80	20	20
02.WB.00235	Duplicate	08/29/02	WL	Baby Beach East Storm Drain	8:00 AM	2.7 F	Marine Water	220	< 10	10
02.WB.00235		08/29/02	WL	Baby Beach East Storm Drain	8:00 AM	2.7 F	Marine Water	130	20	20
02.WB.00235	Avg	08/29/02	WL	Baby Beach East Storm Drain	8:00 AM	2.7 F	Marine Water	175	< 15	15
02.WB.00236	Duplicate	08/29/02	WL	Baby Beach East Storm Drain	8:00 AM	2.7 F	Sediment	2,000	< 200	500
02.WB.00236		08/29/02	WL	Baby Beach East Storm Drain	8:00 AM	2.7 F	Sediment	1,000	200	2,000
02.WB.00236	Avg	08/29/02	WL	Baby Beach East Storm Drain	8:00 AM	2.7 F	Sediment	1,500	< 200	1,250
02.WB.00237	Duplicate	08/29/02	WL	S-6	11:00 AM	4.5 F	Sediment	< 200	< 200	< 200
02.WB.00237		08/29/02	WL	S-6	11:00 AM	4.5 F	Sediment	< 200	< 200	< 200

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Table D-1. Data for 10-week Monitoring Study.

WB #	Subsample	Date Collected	Submitter	Location	Time Collected	Tide	Specimen Type	MF-Total	m-Tec	MF-Ent
02.WB.00237	Avg	08/29/02	WL	S-6	11:00 AM	4.5 F	Sediment	< 200	< 200	< 200
02.WB.00282	Duplicate	09/04/02	WL	Baby Beach West Storm Drain	6:00 AM	3.6 F	Marine Water	510	300	100
02.WB.00282		09/04/02	WL	Baby Beach West Storm Drain	6:00 AM	3.6 F	Marine Water	500	350	100
02.WB.00282	Avg	09/04/02	WL	Baby Beach West Storm Drain	6:00 AM	3.6 F	Marine Water	505	325	100
02.WB.00283	Duplicate	09/04/02	WL	Baby Beach West Storm Drain	6:00 AM	3.6 F	Sediment	500	< 200	< 200
02.WB.00283		09/04/02	WL	Baby Beach West Storm Drain	6:00 AM	3.6 F	Sediment	300	< 200	< 200
02.WB.00283	Avg	09/04/02	WL	Baby Beach West Storm Drain	6:00 AM	3.6 F	Sediment	400	< 200	< 200
02.WB.00284	Duplicate	09/04/02	WL	Baby Beach Buoy Line	6:00 AM	3.6 F	Marine Water	4,000	2,600	1,900
02.WB.00284		09/04/02	WL	Baby Beach Buoy Line	6:00 AM	3.6 F	Marine Water	6,200	4,000	2,000
02.WB.00284	Avg	09/04/02	WL	Baby Beach Buoy Line	6:00 AM	3.6 F	Marine Water	5,100	3,300	1,950
02.WB.00285	Duplicate	09/04/02	WL	Baby Beach East Storm Drain	6:00 AM	3.6 F	Marine Water	1,000	1,650	590
02.WB.00285		09/04/02	WL	Baby Beach East Storm Drain	6:00 AM	3.6 F	Marine Water	1,000	1,550	680
02.WB.00285	Avg	09/04/02	WL	Baby Beach East Storm Drain	6:00 AM	3.6 F	Marine Water	1,000	1,600	635
02.WB.00286	Duplicate	09/04/02	WL	Baby Beach East Storm Drain	6:00 AM	3.6 F	Sediment	4,600	3,200	11,800
02.WB.00286		09/04/02	WL	Baby Beach East Storm Drain	6:00 AM	3.6 F	Sediment	4,600	2,800	8,600
02.WB.00286	Avg	09/04/02	WL	Baby Beach East Storm Drain	6:00 AM	3.6 F	Sediment	4,600	3,000	10,200
02.WB.00287	Duplicate	09/04/02	WL	S-6	6:00 AM	3.6 F	Sediment	< 200	< 200	< 200
02.WB.00287		09/04/02	WL	S-6	6:00 AM	3.6 F	Sediment	< 200	< 200	< 200
02.WB.00287	Avg	09/04/02	WL	S-6	6:00 AM	3.6 F	Sediment	< 200	< 200	< 200
02.WB.00317	Duplicate	09/10/02	EH	Baby Beach West Storm Drain	6:25 AM	1.7 F	Marine Water	> 40,000	7600	> 40,000
02.WB.00317		09/10/02	EH	Baby Beach West Storm Drain	6:25 AM	1.7 F	Marine Water	> 40,000	7200	> 40,000
02.WB.00317	Avg	09/10/02	EH	Baby Beach West Storm Drain	6:25 AM	1.7 F	Marine Water	> 40,000	7400	> 40,000
02.WB.00318	Duplicate	09/10/02	EH	Baby Beach West Storm Drain	6:25 AM	1.7 F	Sediment	2,000	200	4,000
02.WB.00318		09/10/02	EH	Baby Beach West Storm Drain	6:25 AM	1.7 F	Sediment	2,000	200	3,500
02.WB.00318	Avg	09/10/02	EH	Baby Beach West Storm Drain	6:25 AM	1.7 F	Sediment	2,000	200	3,750
02.WB.00319	Duplicate	09/10/02	EH	Baby Beach East Storm Drain	6:35 AM	1.7 F	Marine Water	> 40,000	1,760	7,200
02.WB.00319		09/10/02	EH	Baby Beach East Storm Drain	6:35 AM	1.7 F	Marine Water	> 40,000	1,840	8,600
02.WB.00319	Avg	09/10/02	EH	Baby Beach East Storm Drain	6:35 AM	1.7 F	Marine Water	> 40,000	1,800	7,900
02.WB.00320	Duplicate	09/10/02	EH	Baby Beach East Storm Drain	6:35 AM	1.7 F	Sediment	22,000	200	2,000
02.WB.00320		09/10/02	EH	Baby Beach East Storm Drain	6:35 AM	1.7 F	Sediment	28,000	200	2,000
02.WB.00320	Avg	09/10/02	EH	Baby Beach East Storm Drain	6:35 AM	1.7 F	Sediment	25,000	200	2,000
02.WB.00321	Duplicate	09/10/02	EH	S-6	6:50 AM	1.8 F	Sediment	< 200	< 200	< 200
02.WB.00321		09/10/02	EH	S-6	6:50 AM	1.8 F	Sediment	< 200	< 200	< 200
02.WB.00321	Avg	09/10/02	EH	S-6	6:50 AM	1.8 F	Sediment	< 200	< 200	< 200
02.WB.00372	Duplicate	09/19/02	WL	Baby Beach East Storm Drain	7:30 AM	4.8 F	Marine Water	160	120	70
02.WB.00372		09/19/02	WL	Baby Beach East Storm Drain	7:30 AM	4.8 F	Marine Water	220	40	40
02.WB.00372	Avg	09/19/02	WL	Baby Beach East Storm Drain	7:30 AM	4.8 F	Marine Water	190	80	55
02.WB.00373	Duplicate	09/19/02	WL	Baby Beach East Storm Drain	7:30 AM	4.8 F	Sediment	640	40	820
02.WB.00373		09/19/02	WL	Baby Beach East Storm Drain	7:30 AM	4.8 F	Sediment	500	100	800
02.WB.00373	Avg	09/19/02	WL	Baby Beach East Storm Drain	7:30 AM	4.8 F	Sediment	570	70	810
02.WB.00374	Duplicate	09/19/02	WL	Baby Beach West Storm Drain	7:30 AM	4.8 F	Marine Water	80	10	10
02.WB.00374		09/19/02	WL	Baby Beach West Storm Drain	7:30 AM	4.8 F	Marine Water	60	< 10	< 10
02.WB.00374	Avg	09/19/02	WL	Baby Beach West Storm Drain	7:30 AM	4.8 F	Marine Water	70	< 10	< 10
02.WB.00375	Duplicate	09/19/02	WL	Baby Beach West Storm Drain	7:30 AM	4.8 F	Sediment	1,600	< 100	< 100
02.WB.00375		09/19/02	WL	Baby Beach West Storm Drain	7:30 AM	4.8 F	Sediment	1,400	< 100	< 100

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Table D-1. Data for 10-week Monitoring Study.

WB #	Subsample	Date Collected	Submitter	Location	Time Collected	Tide	Specimen Type	MF-Total	m-Tec	MF-Ent
02.WB.00375	Avg	09/19/02	WL	Baby Beach West Storm Drain	7:30 AM	4.8 F	Sediment	1,500	< 100	< 100
02.WB.00376	Duplicate	09/19/02	WL	S-6	7:30 AM	4.8 F	Marine Water	60	20	< 10
02.WB.00376		09/19/02	WL	S-6	7:30 AM	4.8 F	Marine Water	70	10	30
02.WB.00376	Avg	09/19/02	WL	S-6	7:30 AM	4.8 F	Marine Water	65	15	< 20
02.WB.00377	Duplicate	09/19/02	WL	S-6	7:30 AM	4.8 F	Sediment	< 10	< 10	10
02.WB.00377		09/19/02	WL	S-6	7:30 AM	4.8 F	Sediment	< 10	< 10	< 10
02.WB.00377	Avg	09/19/02	WL	S-6	7:30 AM	4.8 F	Sediment	< 10	< 10	< 10
02.WB.00409	Duplicate	09/24/02	EH	Baby Beach West Storm Drain	6:32 AM	3.4 F	Marine Water	9,000	20	100
02.WB.00409		09/24/02	EH	Baby Beach West Storm Drain	6:32 AM	3.4 F	Marine Water	8,800	10	50
02.WB.00409	Avg	09/24/02	EH	Baby Beach West Storm Drain	6:32 AM	3.4 F	Marine Water	8,900	15	75
02.WB.00411	Duplicate	09/24/02	EH	Baby Beach East Storm Drain	6:52 AM	3.4 F	Sediment	< 90	200	4,300
02.WB.00411		09/24/02	EH	Baby Beach East Storm Drain	6:52 AM	3.4 F	Sediment	200	< 90	6,900
02.WB.00411	Avg	09/24/02	EH	Baby Beach East Storm Drain	6:52 AM	3.4 F	Sediment	< 145	< 145	5,600
02.WB.00412	Duplicate	09/24/02	EH	S-6	7:06 AM	3.4 F	Sediment	< 10	< 10	< 10
02.WB.00412		09/24/02	EH	S-6	7:06 AM	3.4 F	Sediment	< 10	< 10	< 10
02.WB.00412	Avg	09/24/02	EH	S-6	7:06 AM	3.4 F	Sediment	< 10	< 10	< 10
02.WB.00432	Duplicate	10/08/02	WL	Baby Beach East Storm Drain	7:00 AM	4.2 F	Marine Water	100	100	20
02.WB.00432		10/08/02	WL	Baby Beach East Storm Drain	7:00 AM	4.2 F	Marine Water	100	100	40
02.WB.00432	Avg	10/08/02	WL	Baby Beach East Storm Drain	7:00 AM	4.2 F	Marine Water	100	100	30
02.WB.00433	Duplicate	10/08/02	WL	Baby Beach East Storm Drain	7:00 AM	4.2 F	Sediment	4,200	6,900	23,000
02.WB.00433		10/08/02	WL	Baby Beach East Storm Drain	7:00 AM	4.2 F	Sediment	4,200	6,800	25,000
02.WB.00433	Avg	10/08/02	WL	Baby Beach East Storm Drain	7:00 AM	4.2 F	Sediment	4,200	6,850	24,000
02.WB.00434	Duplicate	10/08/02	WL	Baby Beach West Storm Drain	7:00 AM	4.2 F	Marine Water	> 1,080	10	20
02.WB.00434		10/08/02	WL	Baby Beach West Storm Drain	7:00 AM	4.2 F	Marine Water	> 1,000	10	40
02.WB.00434	Avg	10/08/02	WL	Baby Beach West Storm Drain	7:00 AM	4.2 F	Marine Water	> 1,040	10	30
02.WB.00435	Duplicate	10/08/02	WL	Baby Beach West Storm Drain	7:00 AM	4.2 F	Sediment	21,000	200	2,100
02.WB.00435		10/08/02	WL	Baby Beach West Storm Drain	7:00 AM	4.2 F	Sediment	16,100	200	2,200
02.WB.00435	Avg	10/08/02	WL	Baby Beach West Storm Drain	7:00 AM	4.2 F	Sediment	18,550	200	2,150
02.WB.00436	Duplicate	10/08/02	WL	S-6	7:00 AM	4.2 F	Marine Water	10	< 10	10
02.WB.00436		10/08/02	WL	S-6	7:00 AM	4.2 F	Marine Water	30	20	< 10
02.WB.00436	Avg	10/08/02	WL	S-6	7:00 AM	4.2 F	Marine Water	20	< 15	< 10
02.WL.04705	Duplicate	08/20/02	EH	Baby Beach West End	6:41 AM	3.5 F	Marine Water	> 410	390	200
02.WL.04705		08/20/02	EH	Baby Beach West End	6:41 AM	3.5 F	Marine Water	> 390	430	100
02.WL.04705	Avg	08/20/02	EH	Baby Beach West End	6:41 AM	3.5 F	Marine Water	> 400	410	150
02.WL.04706	Duplicate	08/20/02	EH	Baby Beach Buoy Line	6:42 AM	3.5 F	Marine Water	140	70	30
02.WL.04706		08/20/02	EH	Baby Beach Buoy Line	6:42 AM	3.5 F	Marine Water	100	80	20
02.WL.04706	Avg	08/20/02	EH	Baby Beach Buoy Line	6:42 AM	3.5 F	Marine Water	120	75	25
02.WL.04707	Duplicate	08/20/02	EH	Baby Beach Swim Area	6:45 AM	3.5 F	Marine Water	80	90	50
02.WL.04707		08/20/02	EH	Baby Beach Swim Area	6:45 AM	3.5 F	Marine Water	120	60	40
02.WL.04707	Avg	08/20/02	EH	Baby Beach Swim Area	6:45 AM	3.5 F	Marine Water	100	75	45
02.WL.04708	Duplicate	08/20/02	EH	Baby Beach Swim Area	6:48 AM	3.5 F	Marine Water	400	110	120
02.WL.04708		08/20/02	EH	Baby Beach Swim Area	6:48 AM	3.5 F	Marine Water	600	90	100
02.WL.04708	Avg	08/20/02	EH	Baby Beach Swim Area	6:48 AM	3.5 F	Marine Water	400	110	120
02.WL.04768	Duplicate	08/22/02	EH	Baby Beach West End	10:48 AM	4.5 E	Marine Water	> 20	< 10	20
02.WL.04768		08/22/02	EH	Baby Beach West End	10:48 AM	4.5 E	Marine Water	< 10	10	< 10

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Table D-1. Data for 10-week Monitoring Study.

WB #	Subsample	Date Collected	Submitter	Location	Time Collected	Tide	Specimen Type	MF-Total	m-Tec	MF-Ent
02.WL.04768	Avg	08/22/02	EH	Baby Beach West End	10:48 AM	4.5 E	Marine Water	**< > 15**	< 10	< 10
02.WL.04769	Duplicate	08/22/02	EH	Baby Beach Swim Area	10:51 AM	4.5 E	Marine Water	> 310	160	90
02.WL.04769		08/22/02	EH	Baby Beach Swim Area	10:51 AM	4.5 E	Marine Water	260	220	100
02.WL.04769	Avg	08/22/02	EH	Baby Beach Swim Area	10:51 AM	4.5 E	Marine Water	> 310	190	95
02.WL.04770	Duplicate	08/22/02	EH	Baby Beach East End	10:54 AM	4.5 E	Marine Water	> 10	< 10	< 10
02.WL.04770		08/22/02	EH	Baby Beach East End	10:54 AM	4.5 E	Marine Water	10	< 10	10
02.WL.04770	Avg	08/22/02	EH	Baby Beach East End	10:54 AM	4.5 E	Marine Water	> 10	< 10	< 10
02.WL.05114	Duplicate	09/10/02	EH	Baby Beach West End	7:08 AM	1.9 F	Marine Water	200	50	150
02.WL.05114		09/10/02	EH	Baby Beach West End	7:08 AM	1.9 F	Marine Water	110	20	120
02.WL.05114	Avg	09/10/02	EH	Baby Beach West End	7:08 AM	1.9 F	Marine Water	155	35	135
02.WL.05115	Duplicate	09/10/02	EH	Baby Beach Buoy Line	7:11 AM	1.9 F	Marine Water	70	30	40
02.WL.05115		09/10/02	EH	Baby Beach Buoy Line	7:11 AM	1.9 F	Marine Water	80	40	40
02.WL.05115	Avg	09/10/02	EH	Baby Beach Buoy Line	7:11 AM	1.9 F	Marine Water	75	35	40
02.WL.05116	Duplicate	09/10/02	EH	Baby Beach Swim Area	7:14 AM	1.9 F	Marine Water	170	120	320
02.WL.05116		09/10/02	EH	Baby Beach Swim Area	7:14 AM	1.9 F	Marine Water	350	80	310
02.WL.05116	Avg	09/10/02	EH	Baby Beach Swim Area	7:14 AM	1.9 F	Marine Water	260	100	315
02.WL.05117	Duplicate	09/10/02	EH	Baby Beach East End	7:19 AM	1.9 F	Marine Water	60	20	20
02.WL.05117		09/10/02	EH	Baby Beach East End	7:19 AM	1.9 F	Marine Water	80	< 10	10
02.WL.05117	Avg	09/10/02	EH	Baby Beach East End	7:19 AM	1.9 F	Marine Water	70	< 15	15
02.WL.05292	Duplicate	09/19/02	EH	Baby Beach West End	9:44 AM	4.7 E	Marine Water	340	70	60
02.WL.05292		09/19/02	EH	Baby Beach West End	9:44 AM	4.7 E	Marine Water	190	50	10
02.WL.05292	Avg	09/19/02	EH	Baby Beach West End	9:44 AM	4.7 E	Marine Water	265	60	35
02.WL.05293	Duplicate	09/19/02	EH	Baby Beach Buoy Line	9:48 AM	4.7 E	Marine Water	> 430	250	110
02.WL.05293		09/19/02	EH	Baby Beach Buoy Line	9:48 AM	4.7 E	Marine Water	> 470	270	60
02.WL.05293	Avg	09/19/02	EH	Baby Beach Buoy Line	9:48 AM	4.7 E	Marine Water	> 450	260	85
02.WL.05294	Duplicate	09/19/02	EH	Baby Beach Swim Area	9:52 AM	4.7 E	Marine Water	> 110	30	100
02.WL.05294		09/19/02	EH	Baby Beach Swim Area	9:52 AM	4.7 E	Marine Water	> 120	20	60
02.WL.05294	Avg	09/19/02	EH	Baby Beach Swim Area	9:52 AM	4.7 E	Marine Water	> 115	25	80
02.WL.05295	Duplicate	09/19/02	EH	Baby Beach East End	9:56 AM	4.7 E	Marine Water	40	10	40
02.WL.05295		09/19/02	EH	Baby Beach East End	9:56 AM	4.7 E	Marine Water	> 40	10	20
02.WL.05295	Avg	09/19/02	EH	Baby Beach East End	9:56 AM	4.7 E	Marine Water	> 40	10	30
02.WL.05325	Duplicate	09/20/02	EH	Baby Beach West End	6:47 AM	4.3 F	Marine Water	130	30	60
02.WL.05325		09/20/02	EH	Baby Beach West End	6:47 AM	4.3 F	Marine Water	80	80	90
02.WL.05325	Avg	09/20/02	EH	Baby Beach West End	6:47 AM	4.3 F	Marine Water	105	55	75
02.WL.05326	Duplicate	09/20/02	EH	Baby Beach Buoy Line	6:50 AM	4.3 F	Marine Water	5,000	5,000	1,640
02.WL.05326		09/20/02	EH	Baby Beach Buoy Line	6:50 AM	4.3 F	Marine Water	4,800	5,000	1,670
02.WL.05326	Avg	09/20/02	EH	Baby Beach Buoy Line	6:50 AM	4.3 F	Marine Water	4,900	5,000	1,655
02.WL.05327	Duplicate	09/20/02	EH	Baby Beach Swim Area	6:53 AM	4.3 F	Marine Water	180	60	80
02.WL.05327		09/20/02	EH	Baby Beach Swim Area	6:53 AM	4.3 F	Marine Water	250	110	100
02.WL.05327	Avg	09/20/02	EH	Baby Beach Swim Area	6:53 AM	4.3 F	Marine Water	215	85	90
02.WL.05328	Duplicate	09/20/02	EH	Baby Beach East End	6:56 AM	4.3 F	Marine Water	> 270	100	690
02.WL.05328		09/20/02	EH	Baby Beach East End	6:56 AM	4.3 F	Marine Water	> 320	160	700
02.WL.05328	Avg	09/20/02	EH	Baby Beach East End	6:56 AM	4.3 F	Marine Water	> 295	130	695
02.WB.00457		10/21/02	WL	Baby Beach West Storm Drain	7:00 AM	4.8 F	Sediment	1,900	< 90	800

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Table D-1. Data for 10-week Monitoring Study.

WB #	Subsample	Date Collected	Submitter	Location	Time Collected	Tide	Specimen Type	MF-Total	m-Tec	MF-Ent
02.WB.00457	Duplicate	10/21/02	WL	Baby Beach West Storm Drain	7:00 AM	4.8 F	Sediment	2,200	< 90	700
02.WB.00457	Avg	10/21/02	WL	Baby Beach West Storm Drain	7:00 AM	4.8 F	Sediment	2,050	< 90	750
02.WB.00458		10/21/02	WL	Baby Beach West End	7:00 AM	4.8 F	Sediment	< 90	< 90	200
02.WB.00458	Duplicate	10/21/02	WL	Baby Beach West End	7:00 AM	4.8 F	Sediment	< 90	< 90	< 90
02.WB.00458	Avg	10/21/02	WL	Baby Beach West End	7:00 AM	4.8 F	Sediment	< 90	< 90	< 145
02.WB.00459		10/21/02	WL	Baby Beach Swim Area	7:00 AM	4.8 F	Sediment	< 90	< 90	< 90
02.WB.00459	Duplicate	10/21/02	WL	Baby Beach Swim Area	7:00 AM	4.8 F	Sediment	< 90	< 90	< 90
02.WB.00459	Avg	10/21/02	WL	Baby Beach Swim Area	7:00 AM	4.8 F	Sediment	< 90	< 90	< 90
02.WB.00460		10/21/02	WL	Baby Beach East End	7:00 AM	4.8 F	Sediment	9,600	12,300	16,800
02.WB.00460	Duplicate	10/21/02	WL	Baby Beach East End	7:00 AM	4.8 F	Sediment	11,100	9,100	11,700
02.WB.00460	Avg	10/21/02	WL	Baby Beach East End	7:00 AM	4.8 F	Sediment	10,350	10,700	14,250

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APPENDIX E - TABULATED DATA FOR SECTION 3.5

Table E-1. Data for Sediment Analysis Study.

Sample #	Location	Distance	Total Coliform	Escherichia coli	Enterococcus
02.WB.00437	Swim Area	10' Above	< 90	< 90	< 90
	Swim Area	10' Above'	< 90	< 90	< 90
	Swim Area	10' Above Avg	< 90	< 90	< 90
02.WB.00438	Swim Area	20' Above	< 90	< 90	< 90
	Swim Area	20' Above'	< 90	< 90	< 90
	Swim Area	20' Above Avg	< 90	< 90	< 90
02.WB.00439	Swim Area	30' Above	< 90	< 90	< 90
	Swim Area	30' Above'	< 90	< 90	< 90
	Swim Area	30' Above Avg	< 90	< 90	< 90
02.WB.00440	Swim Area	10' Below	< 90	< 90	200
	Swim Area	10' Below'	< 90	< 90	< 90
	Swim Area	10' Below Avg	< 90	< 90	< 145
02.WB.00441	Swim Area	20' Below	< 90	< 90	< 90
	Swim Area	20' Below'	< 90	< 90	< 90
	Swim Area	20' Below Avg	< 90	< 90	< 90
02.WB.00442	Swim Area	30' Below	< 90	< 90	90
	Swim Area	30' Below'	< 90	< 90	< 90
	Swim Area	30' Below Avg	< 90	< 90	< 90
02.WB.00443	East End	10' Above	< 90	< 90	< 90
	East End	10' Above'	< 90	< 90	90
	East End	10' Above Avg	< 90	< 90	< 90
02.WB.00444	East End	20' Above	90	< 90	400
	East End	20' Above'	200	< 90	< 90
	East End	20' Above Avg	145	< 90	< 245
02.WB.00445	East End	30' Above	< 90	< 90	< 90
	East End	30' Above'	< 90	< 90	90
	East End	30' Above Avg	< 90	< 90	< 90
02.WB.00446	East End	10' Below	< 90	< 90	10200
	East End	10' Below'	< 90	< 90	300
	East End	10' Below Avg	< 90	< 90	5250
02.WB.00447	East End	20' Below	< 90	< 90	500
	East End	20' Below'	< 90	< 90	200
	East End	20' Below Avg	< 90	< 90	350
02.WB.00448	East End	30' Below	200	< 90	500
	East End	30' Below'	90	< 90	400
	East End	30' Below Avg	145	< 90	450

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APPENDIX F - TABULATED DATA FOR SECTION 3.6

Table F-1. Data for Boat Sewage Discharge Study.

Sample Site	Day 1 (3 Boats)			Day 2 (14 Boats)			Day 3 (38 Boats)			Day 4 (24 Boats)			Day 5 (3 Boats)			Day 6 (3 Boats)		
	Total	E.coli	Ent	Total	E.coli	Ent	Total	E.coli	Ent	Total	E.coli	Ent	Total	E.coli	Ent	Total	E.coli	Ent
Pier	20	< 10	< 10	30	< 10	20	10	< 10	< 10	40	10	< 10	290	230	180	310	100	170
Pier'	10	< 10	< 10	30	< 10	10	10	< 10	< 10	70	< 10	50	210	260	30	210	100	50
Pier Avg	15	< 10	< 10	30	< 10	< 15	10	< 10	< 10	55	< 10	< 30	250	245	105	260	100	110
West End	290	110	30	400	150	50	20	< 10	< 10	130	10	< 10	850	970	660	240	80	220
West End'	140	150	60	430	30	40	< 10	10	< 10	110	40	80	1620	1380	1130	220	190	200
West End Avg	215	130	45	415	90	15	< 15	< 10	< 10	120	25	< 45	1235	1175	895	230	135	210
Swim Area	80	70	10	30	60	< 10	10	10	< 10	140	< 10	100	2400	2200	1350	180	100	440
Swim Area'	40	10	< 10	50	70	< 10	10	10	< 10	170	< 10	30	3800	3600	1870	220	120	90
Swim Area Avg	60	40	< 10	40	65	< 10	10	10	< 10	155	< 10	65	3100	2900	1610	200	110	265
Youth Dock	40	10	10	70	< 10	< 10	< 10	< 10	< 10	140	30	70	240	120	1900	230	90	70
Youth Dock'	10	10	20	110	10	< 10	< 10	< 10	< 10	110	10	50	170	120	690	240	40	50
Youth Dock Avg	25	10	15	90	< 10	< 10	< 10	< 10	< 10	125	20	60	205	120	1295	235	65	60
Anchorage-North	< 10	10	< 10	20	10	< 10	10	< 10	< 10	90	< 10	10	120	140	30	110	90	690
Anchorage-North'	20	< 10	< 10	30	< 10	< 10	10	< 10	< 10	60	< 10	< 10	140	110	40	130	60	90
Anchorage-North Avg	< 15	< 10	< 10	25	< 10	< 10	10	< 10	< 10	75	< 10	< 10	130	125	35	120	75	390
Anchorage-East	40	< 10	10	650	10	100	20	< 10	< 10	40	20	10	280	130	20	210	100	50
Anchorage-East'	10	< 10	< 10	350	10	50	10	< 10	< 10	140	20	10	380	150	40	220	110	100
Anchorage-East Avg	25	< 10	< 10	500	10	75	15	< 10	< 10	90	20	10	330	140	30	215	105	75
Anchorage-Center	10	< 10	< 10	30	< 10	< 10	30	< 10	< 10	50	< 10	10	110	100	30	390	120	90
Anchorage-Center'	< 10	10	10	20	20	10	20	< 10	< 10	100	10	20	150	40	< 10	560	220	80
Anchorage-Center Avg	< 10	< 10	< 20	25	< 15	< 10	25	< 10	< 10	75	< 10	15	130	70	< 20	475	170	85
Anchorage-West	< 10	< 10	< 10	110	< 10	10	10	10	< 10	100	10	20	90	60	10	210	80	30
Anchorage-West'	10	10	< 10	110	< 10	10	10	< 10	< 10	100	40	10	150	110	60	200	100	20
Anchorage-West Avg	< 10	< 10	< 10	110	< 10	10	10	< 10	< 10	100	25	15	120	85	35	205	90	25
Anchorage-South	< 10	< 10	< 10	40	< 10	10	590	10	< 10	180	20	30	410	280	20	90	110	50
Anchorage-South'	< 10	< 10	< 10	40	20	< 10	30	< 10	< 10	100	30	100	370	270	80	30	10	10
Anchorage-South Avg	< 10	< 10	< 10	40	< 15	< 10	310	< 10	< 10	140	25	65	390	275	50	60	60	30
Mid-Channel	10	< 10	< 10	20	< 10	< 10	10	< 10	< 10	80	20	20	230	100	90	100	70	40
Mid-Channel'	30	< 10	< 10	10	< 10	10	10	< 10	10	70	30	20	230	120	80	50	100	90
Mid-Channel Avg	20	< 10	< 10	15	< 10	< 10	10	< 10	< 10	75	25	20	230	110	85	75	85	65
S-6	< 10	< 10	< 10	20	< 10	10	< 10	< 10	< 10	20	< 10	20	20	10	30	100	10	< 10
S-6'	20	10	< 10	10	10	< 10	10	< 10	< 10	40	< 10	20	60	20	80	50	30	80
S-6 Avg	< 15	< 10	< 10	15	< 10	< 10	< 10	< 10	< 10	30	< 10	20	40	15	55	75	20	< 45

Notes:

Day 1: Thurs, 29 Aug; 0930 — 3 boats, few people, buoys were being serviced by harbor patrol at time of collection
Day 2: Fri, 30 Aug; 0930 — 14 boats, buoys were being serviced by harbor patrol at time of collection
Day 3: Sun, 1 Sept; 1118 — 38 boats, many people swimming, fishing from pier, quite a bit of boating activities
Day 4: Mon, 2 Sept; 0600 — 24 boats, majority of boats at anchor were side-tied to each other, these boats were pulling anchor and leaving as samples were being taken
Day 5: Wed, 4 Sept; 0540 — 4 boats, high surf washing over breakwall, no people
Day 6: Thurs, 5 Sept; 0600 — 3 boats, rare people, continued high surf, slightly diminished from Wednesday

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APPENDIX G - TABULATED DATA FOR SECTION 3.7

Table G-1. Data for Bacterial Indicator Level Variability Studies (Study I).

Sample Site	Collection Time	Total Coliforms	Escherichia coli	Enterococci	Birds	Humans in Water	Boats	Tide Height	Temp (C)	SpC (mS/cm)	DO (mg/L)	pH	TDS (g/L)	DO% (Sat)	Turb (NTU)
West Storm Drain	5:00 AM	> 610	< 10	250	0	0	9	1.4	19.43	51	7.57	7.1	32.6	101.1	8.2
West Storm Drain'	5:00 AM	2200	< 10	280	0	0	9	1.4	19.43	51	7.57	7.1	32.6	101.1	8.2
West Storm Avg	5:00 AM	> 2200	< 10	265	0	0	9	1.4	19.43	51	7.57	7.1	32.6	101.1	8.2
West End	5:00 AM	140	50	370	0	0	9	1.4	18.06	51	8.61	7.62	32.6	110.5	64.7
West End'	5:00 AM	110	50	430	0	0	9	1.4	18.06	51	8.61	7.62	32.6	110.5	64.7
West End Avg	5:00 AM	125	50	400	0	0	9	1.4	18.06	51	8.61	7.62	32.6	110.5	64.7
Swim Area	5:00 AM	80	10	340	0	0	9	1.4	18.38	51.4	8.5	7.8	32.9	109.8	38.6
Swim Area'	5:00 AM	70	10	310	0	0	9	1.4	18.38	51.4	8.5	7.8	32.9	109.8	38.6
Swim Area Avg	5:00 AM	75	10	325	0	0	9	1.4	18.38	51.4	8.5	7.8	32.9	109.8	38.6
East End	5:00 AM	30	20	410	0	0	9	1.4	18.69	51.2	8.71	7.89	32.8	116.9	24.1
East End'	5:00 AM	50	40	340	0	0	9	1.4	18.69	51.2	8.71	7.89	32.8	116.9	24.1
East End Avg	5:00 AM	40	30	375	0	0	9	1.4	18.69	51.2	8.71	7.89	32.8	116.9	24.1
West Storm Drain	7:00 AM	980	30	120	65	0	9	3.4	19.2	51	8.8	7.9	32.6	117	6.1
West Storm Drain'	7:00 AM	> 1590	100	190	65	0	9	3.4	19.2	51	8.8	7.9	32.6	117	6.1
West Storm Avg	7:00 AM	> 1285	65	155	65	0	9	3.4	19.2	51	8.8	7.9	32.6	117	6.1
West End	7:00 AM	60	10	250	65	0	9	3.4	18.82	51.1	9.51	7.93	32.7	125.5	8.4
West End'	7:00 AM	70	< 10	270	65	0	9	3.4	18.82	51.1	9.51	7.93	32.7	125.5	8.4
West End Avg	7:00 AM	65	< 10	260	65	0	9	3.4	18.82	51.1	9.51	7.93	32.7	125.5	8.4
Swim Area	7:00 AM	4000	3400	690	65	0	9	3.4	18.2	51.3	8.25	7.98	32.8	107.7	24.1
Swim Area'	7:00 AM	14000	14000	1470	65	0	9	3.4	18.2	51.3	8.25	7.98	32.8	107.7	24.1
Swim Area Avg	7:00 AM	9000	8700	1080	65	0	9	3.4	18.2	51.3	8.25	7.98	32.8	107.7	24.1
East End	7:00 AM	150	30	370	65	0	9	3.4	18.8	51.4	10.63	7.98	32.9	134.1	74.9
East End'	7:00 AM	90	50	390	65	0	9	3.4	18.8	51.4	10.63	7.98	32.9	134.1	74.9
East End Avg	7:00 AM	120	40	380	65	0	9	3.4	18.8	51.4	10.63	7.98	32.9	134.1	74.9
West Storm Drain	9:00 AM	200	< 10	20	0	0	7	5.1	19.38	51	11.19	7.99	32.6	149.3	6.7
West Storm Drain'	9:00 AM	250	10	40	0	0	7	5.1	19.38	51	11.19	7.99	32.6	149.3	6.7
West Storm Avg	9:00 AM	225	< 10	30	0	0	7	5.1	19.38	51	11.19	7.99	32.6	149.3	6.7
West End	9:00 AM	80	20	30	0	0	7	5.1	19.62	51.1	13.34	7.98	32.7	178.9	5.7
West End'	9:00 AM	60	20	20	0	0	7	5.1	19.62	51.1	13.34	7.98	32.7	178.9	5.7
West End Avg	9:00 AM	70	20	25	0	0	7	5.1	19.62	51.1	13.34	7.98	32.7	178.9	5.7
Swim Area	9:00 AM	400	130	20	0	0	7	5.1	20.21	50.6	9.74	8.04	32.4	138.7	27.1
Swim Area'	9:00 AM	440	140	70	0	0	7	5.1	20.21	50.6	9.74	8.04	32.4	138.7	27.1
Swim Area Avg	9:00 AM	420	135	45	0	0	7	5.1	20.21	50.6	9.74	8.04	32.4	138.7	27.1
East End	9:00 AM	440	10	60	0	0	7	5.1	19.24	51.1	9.73	8.02	32.7	124	4.3
East End'	9:00 AM	110	< 10	20	0	0	7	5.1	19.24	51.1	9.73	8.02	32.7	124	4.3
East End Avg	9:00 AM	275	< 10	40	0	0	7	5.1	19.24	51.1	9.73	8.02	32.7	124	4.3
West Storm Drain	11:00 AM	10	< 10	< 10	1	0	4	4.8	19.88	51.2	13.19	8.04	32.8	177.9	5.3
West Storm Drain'	11:00 AM	< 10	< 10	< 10	1	0	4	4.8	19.88	51.2	13.19	8.04	32.8	177.9	5.3
West Storm Avg	11:00 AM	< 10	< 10	< 10	1	0	4	4.8	19.88	51.2	13.19	8.04	32.8	177.9	5.3

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Table G-1. Data for Bacterial Indicator Level Variability Studies (Study I).

Sample Site	Collection Time	Total Coliforms	Escherichia coli	Enterococci	Birds	Humans in Water	Boats	Tide Height	Temp (C)	SpC (mS/cm)	DO (mg/L)	pH	TDS (g/L)	DO% (Sat)	Turb (NTU)
West End	11:00 AM	< 10	10	10	1	0	4	4.8	20.42	51	13.2	8.05	32.6	164	4.6
West End'	11:00 AM	40	10	< 10	1	0	4	4.8	20.42	51	13.2	8.05	32.6	164	4.6
West End Avg	11:00 AM	< 25	10	< 10	1	0	4	4.8	20.42	51	13.2	8.05	32.6	164	4.6
Swim Area	11:00 AM	130	100	80	1	0	4	4.8	23.85	50.7	8.36	8.03	32.5	121.2	55.7
Swim Area'	11:00 AM	120	50	90	1	0	4	4.8	23.85	50.7	8.36	8.03	32.5	121.2	55.7
Swim Area Avg	11:00 AM	125	75	85	1	0	4	4.8	23.85	50.7	8.36	8.03	32.5	121.2	55.7
East End	11:00 AM	100	80	30	1	0	4	4.8	21.35	51.1	8.88	8.05	32.7	120.7	8.5
East End'	11:00 AM	290	120	70	1	0	4	4.8	21.35	51.1	8.88	8.05	32.7	120.7	8.5
East End Avg	11:00 AM	195	100	50	1	0	4	4.8	21.35	51.1	8.88	8.05	32.7	120.7	8.5
West Storm Drain	1:00 PM	< 10	< 10	< 10	14	7	6	2.8	20.62	51	11.47	8.05	32.6	156.8	4.1
West Storm Drain'	1:00 PM	10	< 10	< 10	14	7	6	2.8	20.62	51	11.47	8.05	32.6	156.8	4.1
West Storm Avg	1:00 PM	< 10	< 10	< 10	14	7	6	2.8	20.62	51	11.47	8.05	32.6	156.8	4.1
West End	1:00 PM	10	< 10	< 10	14	7	6	2.8	22.04	50.8	11.29	8.05	32.5	150.4	6.1
West End'	1:00 PM	< 10	10	10	14	7	6	2.8	22.04	50.8	11.29	8.05	32.5	150.4	6.1
West End Avg	1:00 PM	< 10	< 10	< 10	14	7	6	2.8	22.04	50.8	11.29	8.05	32.5	150.4	6.1
Swim Area	1:00 PM	60	20	430	14	7	6	2.8	23.84	50.7	9.58	8.03	32.5	138.8	21.7
Swim Area"	1:00 PM	30	10	320	14	7	6	2.8	23.84	50.7	9.58	8.03	32.5	138.8	21.7
Swim Area Avg	1:00 PM	45	15	375	14	7	6	2.8	23.84	50.7	9.58	8.03	32.5	138.8	21.7
East End	1:00 PM	100	30	140	14	7	6	2.8	23.6	50.8	10.05	8.06	32.5	145.1	7.4
East End'	1:00 PM	100	50	110	14	7	6	2.8	23.6	50.8	10.05	8.06	32.5	145.1	7.4
East End Avg	1:00 PM	100	40	125	14	7	6	2.8	23.6	50.8	10.05	8.06	32.5	145.1	7.4
West Storm Drain	3:00 PM	> 5600	< 10	30	21	5	5	1.0	20.5	50.5	12.79	8.13	32.3	174	14.9
West Storm Drain'	3:00 PM	> 8200	< 10	10	21	5	5	1.0	20.5	50.5	12.79	8.13	32.3	174	14.9
West Storm Avg	3:00 PM	> 6900	< 10	20	21	5	5	1.0	20.5	50.5	12.79	8.13	32.3	174	14.9
West End	3:00 PM	< 10	< 10	10	21	5	5	1.0	20.54	50.9	11.44	8.08	32.6	156.1	14.7
West End'	3:00 PM	< 10	10	< 10	21	5	5	1.0	20.54	50.9	11.44	8.08	32.6	156.1	14.7
West End Avg	3:00 PM	< 10	< 10	< 10	21	5	5	1.0	20.54	50.9	11.44	8.08	32.6	156.1	14.7
Swim Area	3:00 PM	850	570	1330	21	5	5	1.0	22.96	51.3	9.73	8.08	32.8	147.4	31.2
Swim Area'	3:00 PM	620	370	750	21	5	5	1.0	22.96	51.3	9.73	8.08	32.8	147.4	31.2
Swim Area Avg	3:00 PM	735	470	1040	21	5	5	1.0	22.96	51.3	9.73	8.08	32.8	147.4	31.2
East End	3:00 PM	340	10	180	21	5	5	1.0	23.27	51.3	10.83	8.1	32.8	155.8	52.3
East End'	3:00 PM	230	< 10	70	21	5	5	1.0	23.27	51.3	10.83	8.1	32.8	155.8	52.3
East End Avg	3:00 PM	285	< 10	125	21	5	5	1.0	23.27	51.3	10.83	8.1	32.8	155.8	52.3
West Storm Drain	5:00 PM	> 490	10	< 10	17	4	5	1.2	19.65	51.7	11.12	8.07	33.1	154.6	20.9
West Storm Drain'	5:00 PM	> 160	< 10	< 10	17	4	5	1.2	19.65	51.7	11.12	8.07	33.1	154.6	20.9
West Storm Avg	5:00 PM	> 325	< 10	< 10	17	4	5	1.2	19.65	51.7	11.12	8.07	33.1	154.6	20.9
West End	5:00 PM	< 10	< 10	< 10	17	4	5	1.2	19.47	50.9	12.91	8.03	32.6	157	13.4
West End'	5:00 PM	10	< 10	20	17	4	5	1.2	19.47	50.9	12.91	8.03	32.6	157	13.4
West End Avg	5:00 PM	< 10	< 10	< 15	17	4	5	1.2	19.47	50.9	12.91	8.03	32.6	157	13.4
East End	5:00 PM	10	20	< 10	17	4	5	1.2	20.14	51.1	9.19	8.06	32.7	122	36.4
East End'	5:00 PM	30	< 10	20	17	4	5	1.2	20.14	51.1	9.19	8.06	32.7	122	36.4
East End Avg	5:00 PM	20	< 15	< 15	17	4	5	1.2	20.14	51.1	9.19	8.06	32.7	122	36.4

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Table G-2. Data for Bacterial Indicator Level Variability Studies (Study II).

WB Number	Sample Site	Time	Total Coliform	Escherichia coli	Enterococci
02.WB.00449	West Storm	5:00 AM	> 400	50	140
02.WB.00449	West Storm'	5:00 AM	> 350	60	140
02.WB.00449	West Storm Avg	5:00 AM	> 375	55	140
02.WB.00450	West End	5:00 AM	290	160	60
02.WB.00450	West End'	5:00 AM	230	130	100
02.WB.00450	West End Avg	5:00 AM	260	145	80
02.WB.00451	Swim Area	5:00 AM	160	20	20
02.WB.00451	Swim Area'	5:00 AM	140	10	30
02.WB.00451	Swim Area Avg	5:00 AM	150	15	25
02.WB.00452	East End	5:00 AM	600	490	490
02.WB.00452	East End'	5:00 AM	380	250	230
02.WB.00452	East End Avg	5:00 AM	490	370	360
02.WB.00453	West Storm	7:00 AM	90	10	30
02.WB.00453	West Storm'	7:00 AM	100	30	30
02.WB.00453	West Storm Avg	7:00 AM	95	20	30
02.WB.00454	West End	7:00 AM	290	40	40
02.WB.00454	West End'	7:00 AM	120	70	70
02.WB.00454	West End Avg	7:00 AM	205	55	55
02.WB.00455	Swim Area	7:00 AM	70	20	50
02.WB.00455	Swim Area'	7:00 AM	70	30	40
02.WB.00455	Swim Area Avg	7:00 AM	70	25	45
02.WB.00456	East End	7:00 AM	170	50	10
02.WB.00456	East End'	7:00 AM	200	90	70
02.WB.00456	East End Avg	7:00 AM	185	70	40
02.WB.00465	West Storm	9:00 AM	100	< 10	10
02.WB.00465	West Storm'	9:00 AM	80	< 10	20
02.WB.00465	West Storm Avg	9:00 AM	90	< 10	15
02.WB.00466	West End	9:00 AM	620	30	220
02.WB.00466	West End'	9:00 AM	270	10	100
02.WB.00466	West End Avg	9:00 AM	445	20	160
02.WB.00467	Swim Area	9:00 AM	170	100	240
02.WB.00467	Swim Area'	9:00 AM	190	120	240
02.WB.00467	Swim Area Avg	9:00 AM	180	110	240
02.WB.00468	East End	9:00 AM	11000	8800	1000
02.WB.00468	East End'	9:00 AM	11000	9200	2000
02.WB.00468	East End Avg	9:00 AM	11000	9000	1500
02.WB.00469	West Storm	11:00 AM	50	< 10	10
02.WB.00469	West Storm'	11:00 AM	40	< 10	< 10
02.WB.00469	West Storm Avg	11:00 AM	45	< 10	< 10
02.WB.00470	West End	11:00 AM	1600	560	2800
02.WB.00470	West End'	11:00 AM	2000	860	3800
02.WB.00470	West End Avg	11:00 AM	1800	710	3300
02.WB.00471	Swim Area	11:00 AM	520	340	120
02.WB.00471	Swim Area'	11:00 AM	580	380	190
02.WB.00471	Swim Area Avg	11:00 AM	550	360	155
02.WB.00472	East End	11:00 AM	> 1000	460	140
02.WB.00472	East End'	11:00 AM	> 900	550	120
02.WB.00472	East End Avg	11:00 AM	> 950	505	130
02.WB.00473	West Storm	1:00 PM	70	20	20
02.WB.00473	West Storm'	1:00 PM	60	20	10
02.WB.00473	West Storm Avg	1:00 PM	65	20	15
02.WB.00474	West End	1:00 PM	100	20	30
02.WB.00474	West End'	1:00 PM	500	290	170
02.WB.00474	West End Avg	1:00 PM	300	155	100
02.WB.00475	Swim Area	1:00 PM	130	80	50
02.WB.00475	Swim Area'	1:00 PM	150	60	< 10
02.WB.00475	Swim Area Avg	1:00 PM	140	70	< 30
02.WB.00476	East End	1:00 PM	450	450	280
02.WB.00476	East End'	1:00 PM	430	450	330
02.WB.00476	East End Avg	1:00 PM	440	450	305
02.WB.00477	West Storm	3:00 PM	400	< 10	30
02.WB.00477	West Storm'	3:00 PM	330	10	10

Table G-2. Data for Bacterial Indicator Level Variability Studies (Study II).

WB Number	Sample Site	Time	Total Coliform	Escherichia coli	Enterococci
02.WB.00477	West Storm Avg	3:00 PM	365	< 10	20
02.WB.00478	West End	3:00 PM	60	30	< 10
02.WB.00478	West End'	3:00 PM	50	< 10	10
02.WB.00478	West End Avg	3:00 PM	55	< 20	< 10
02.WB.00479	Swim Area	3:00 PM	90	40	10
02.WB.00479	Swim Area'	3:00 PM	120	60	10
02.WB.00479	Swim Area Avg	3:00 PM	105	50	10
02.WB.00480	East End	3:00 PM	20	< 10	< 10
02.WB.00480	East End'	3:00 PM	10	30	< 10
02.WB.00480	East End Avg	3:00 PM	15	< 20	< 10
02.WB.00481	West Storm	5:00 PM	> 830	10	90
02.WB.00481	West Storm'	5:00 PM	> 700	50	40
02.WB.00481	West Storm Avg	5:00 PM	> 765	30	65
02.WB.00482	West End	5:00 PM	> 1090	10	680
02.WB.00482	West End'	5:00 PM	> 1000	> 700	690
02.WB.00482	West End Avg	5:00 PM	> 1045	> 355	685
02.WB.00483	Swim Area	5:00 PM	80	50	< 10
02.WB.00483	Swim Area'	5:00 PM	60	< 10	20
02.WB.00483	Swim Area Avg	5:00 PM	70	< 30	< 15
02.WB.00484	East End	5:00 PM	2400	1810	1590
02.WB.00484	East End'	5:00 PM	2400	1820	1700
02.WB.00484	East End Avg	5:00 PM	2400	1815	1645

Table G-3. Tabulated Data for Bacterial Indicator Level Variability Studies (Study III)

02.WB.00#	Time	Location	Tide	Birds	Humans	Boats	Light (LUX)	Temp (C)	SpC (ms/cm)	DO (mg/L)	pH	TDS (g/L)	DO% (Sat)	Turb (NTU)
452	5:00 AM	East End Storm Drain	2.7 F	0	0	5	2	16.68	51.3	11.97	8.00	32.8	151.6	8.2
	5:30 AM	East End Storm Drain												
	6:00 AM	East End Storm Drain	3.7 F	0	0	5	2	16.71	51.4	15.94	8.05	32.9	202.2	5.5
	6:30 AM	East End Storm Drain		1	0	5	2	16.78	51.2	11.52	8.07	32.8	146.2	5.2
456	7:00 AM	East End Storm Drain	4.8 F	30	0	5		16.83	51.3	15.66	8.08	32.8	191.3	6.2
	7:30 AM	East End Storm Drain		38	0	5	1490							
	8:00 AM	East End Storm Drain	5.4 F	34	0	5	2200	16.82	51.3	14.64	8.09	32.8	186.0	6.0
	8:30 AM	East End Storm Drain		5	0	3	6330	16.86	51.3	13.27	8.10	32.8	168.8	5.1
468	9:00 AM	East End Storm Drain	5.4 E	0	0	3	10100	16.89	51.3	13.64	8.11	32.8	194.2	8.6
	9:30 AM	East End Storm Drain		3	0	3	13700	16.92	51.3	13.23	8.12	32.8	189.1	8.5
	10:00 AM	East End Storm Drain	4.9 E	4	0	3	20100	17.03	51.3	11.33	8.13	32.8	136.6	5.8
	10:30 AM	East End Storm Drain		7	0	3	25100	17.14	51.2	10.49	8.15	32.8	129.1	5.9
472	11:00 AM	East End Storm Drain	4.0 E	22	0	3	29200	17.42	51.2	14.57	8.15	32.8	168.7	6.3
	11:30 AM	East End Storm Drain		20	0	3	74400	17.59	51.2	11.92	8.17	32.8	153.7	6.3
	12:00 PM	East End Storm Drain	2.5 E	32	0	3	44400	17.87	51.1	12.83	8.18	32.7	166.3	6.8
	12:30 PM	East End Storm Drain												
476	1:00 PM	East End Storm Drain	1.5 E	26	1	3	33000							
	1:30 PM	East End Storm Drain		62	1	3	72700	20.04	51.0	9.89	8.25	32.6	133.7	57.9
	2:00 PM	East End Storm Drain	0.6 E	54	1	3	86000	19.21		12.24	8.25		132.5	20.3
	2:30 PM	East End Storm Drain		32	1	3	75000	19.77	51.1	11.93	8.24	32.7	160.6	10.1
480	3:00 PM	East End Storm Drain	0.3 L	27	1	3	66000	19.54	51.1	13.56	8.21	32.7	161.7	9.5
	3:30 PM	East End Storm Drain		28	0	3	46000	19.49	51.0	7.83	8.21	32.6	104.8	54.3
	4:00 PM	East End Storm Drain	0.5 F	21	2	3	45000	19.45	51.1	7.74	8.18	32.7	103.1	6.6
	4:30 PM	East End Storm Drain		26	2	3	38000	19.26	51.1	7.70	8.17	32.7	102.5	9.1
484	5:00 PM	East End Storm Drain	1.1 F	18	1	3	29700	19.06	51.1	10.87	8.17	32.7	144.2	7.1
451	5:00 AM	Swim Area	2.7 F	0	0	5	2	16.64	51.5	16.58	7.94	33.0	210.0	16.4
	5:30 AM	Swim Area												
	6:00 AM	Swim Area	3.7 F	0	0	5	2	16.60	51.7	13.47	8.04	33.1	170.7	26.6
	6:30 AM	Swim Area		1	0	5	2	16.41		14.89	8.07		143.2	87.2
455	7:00 AM	Swim Area	4.8 F	30	0	5		16.71	51.4	9.90	8.09	32.9	125.5	46.5
	7:30 AM	Swim Area		38	0	5	1490							
	8:00 AM	Swim Area	5.4 F	34	0	5	2200	16.69	51.3	11.21	8.11	32.8	142.0	14.7
	8:30 AM	Swim Area		5	0	3	6330	16.75	51.3	9.41	8.13	32.8	119.4	8.6
467	9:00 AM	Swim Area	5.4 E	0	0	3	10100	15.14		22.80	8.12		217.1	51.5
	9:30 AM	Swim Area		3	0	3	13700	16.95	51.2	9.41	8.13	32.8	124.1	36.8
	10:00 AM	Swim Area	4.9 E	4	0	3	20100	17.33	51.3	9.53	8.13	32.8	119.5	13.1
	10:30 AM	Swim Area		7	0	3	25100	17.72	51.1	9.51	8.14	32.7	119.9	11.6
471	11:00 AM	Swim Area	4.0 E	22	0	3	29200	18.51	51.1	11.35	8.14	32.7	148.9	96.3
	11:30 AM	Swim Area		20	0	3	74400	19.37	51.5	14.25	8.16	33.0	190.6	9.1
	12:00 PM	Swim Area	2.5 E	32	0	3	44400	19.13		11.55	8.17		124.9	32.6
	12:30 PM	Swim Area												
475	1:00 PM	Swim Area	1.5 E	26	1	3	33000	19.74		12.73	8.20		139.5	37.6
	1:30 PM	Swim Area		62	1	3	72700	20.59	51.2	8.44	8.23	32.8	115.4	58.0

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Table G-3. Tabulated Data for Bacterial Indicator Level Variability Studies (Study III)

02.WB.00#	Time	Location	Tide	Birds	Humans	Boats	Light (LUX)	Temp (C)	SpC (ms/cm)	DO (mg/L)	pH	TDS (g/L)	DO% (Sat)	Turb (NTU)
	2:00 PM	Swim Area	0.6 E	54	1	3	86000	21.20	51.5	12.04	8.29	33.0	154.4	82.1
	2:30 PM	Swim Area		32	1	3	75000	21.38	51.7	10.72	8.32	33.1	149.1	23.0
479	3:00 PM	Swim Area	0.3 L	27	1	3	66000	21.17		9.46	8.33		134.9	55.9
	3:30 PM	Swim Area		28	0	3	46000	21.09	51.5	12.97	8.30	33.0	161.9	40.6
	4:00 PM	Swim Area	0.5 F	21	2	3	45000	21.02	51.1	12.32	8.29	32.7	169.7	45.1
	4:30 PM	Swim Area		26	2	3	38000	19.57		10.12	8.25		108.0	58.0
483	5:00 PM	Swim Area	1.1 F	18	1	3	29700	19.45	50.7	7.76	8.23	32.4	104.2	10.9
450	5:00 AM	West End	2.7 F	0	0	5	2	16.43	51.1	9.42	7.74	32.7	120.2	40.7
	5:30 AM	West End												
	6:00 AM	West End	3.7 F	0	0	5	2	16.23	51.0	8.70	8.00	32.6	110.5	53.3
	6:30 AM	West End		1	0	5	2	16.43	51.2	14.02	8.04	32.8	196.7	8.5
454	7:00 AM	West End	4.8 F	30	0	5		16.59	51.3	15.77	8.08	32.8	199.5	11.1
	7:30 AM	West End		38	0	5	1490							
	8:00 AM	West End	5.4 F	34	0	5	2200	16.72	51.3	12.62	8.10	32.8	149.3	8.2
	8:30 AM	West End		5	0	3	6330	16.79	51.3	10.83	8.11	32.8	130.7	7.5
466	9:00 AM	West End	5.4 E	0	0	3	10100	16.85	51.3	13.42	8.12	32.8	190.9	6.0
	9:30 AM	West End		3	0	3	13700	16.88	51.2	10.90	8.13	32.8	138.6	5.5
	10:00 AM	West End	4.9 E	4	0	3	20100	16.99	51.2	9.55	8.14	32.8	121.7	7.1
	10:30 AM	West End		7	0	3	25100	17.16	51.2	11.23	8.15	32.8	136.0	7.6
470	11:00 AM	West End	4.0 E	22	0	3	29200	17.46	51.2	11.45	8.16	32.8	147.2	5.0
	11:30 AM	West End		20	0	3	74400	17.79	51.2	11.33	8.17	32.8	155.9	5.8
	12:00 PM	West End	2.5 E	32	0	3	44400	18.77	51.1	14.19	8.16	32.7	169.1	7.9
	12:30 PM	West End												
474	1:00 PM	West End	1.5 E	26	1	3	33000	19.07	51.0	15.04	8.22	32.6	193.3	11.7
	1:30 PM	West End		62	1	3	72700	19.77	50.9	8.56	8.25	32.6	115.0	12.5
	2:00 PM	West End	0.6 E	54	1	3	86000	19.93	50.9	11.99	8.24	32.6	161.6	11.4
	2:30 PM	West End		32	1	3	75000	20.89	50.8	13.30	8.26	32.5	182.6	14.7
478	3:00 PM	West End	0.3 L	27	1	3	66000	21.81	50.6	12.34	8.26	32.4	172.3	41.2
	3:30 PM	West End		28	0	3	46000	21.65	50.8	13.50	8.23	32.5	188.0	38.5
	4:00 PM	West End	0.5 F	21	2	3	45000	21.23	50.8	12.66	8.21	32.5	174.9	31.4
	4:30 PM	West End		26	2	3	38000	20.41	50.9	9.58	8.19	32.6	126.4	41.6
482	5:00 PM	West End	1.1 F	18	1	3	29700	19.76	50.9	11.04	8.17	32.6	139.8	21.6
449	5:00 AM	West End Storm Drain	2.7 F	0	0	5	2	17.06	50.3	8.98	7.00	32.2	114.1	6.8
	5:30 AM	West End Storm Drain												
	6:00 AM	West End Storm Drain	3.7 F	0	0	5	2	17.01	50.9	13.52	8.03	32.6	172.0	8.3
	6:30 AM	West End Storm Drain		1	0	5	2	16.95	51.1	14.21	8.05	32.7	180.9	5.1
453	7:00 AM	West End Storm Drain	4.8 F	30	0	5		16.83	51.2	16.02	8.07	32.8	203.4	3.8
	7:30 AM	West End Storm Drain		38	0	5	1490							
	8:00 AM	West End Storm Drain	5.4 F	34	0	5	2200	16.90	51.2	15.44	8.09	32.8	196.4	6.1
	8:30 AM	West End Storm Drain		5	0	3	6330	16.90	51.2	15.41	8.10	32.8	174.3	6.4
465	9:00 AM	West End Storm Drain	5.4 E	0	0	3	10100	16.94	51.2	11.23	8.11	32.8	143.0	5.6
	9:30 AM	West End Storm Drain		3	0	3	13700	16.95	51.3	10.10	8.11	32.8	128.6	6.8
	10:00 AM	West End Storm Drain	4.9 E	4	0	3	20100	17.01	51.2	12.93	8.15	32.8	164.8	5.8
	10:30 AM	West End Storm Drain		7	0	3	25100	17.16	51.2	8.01	8.15	32.8	102.4	5.5

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Table G-3. Tabulated Data for Bacterial Indicator Level Variability Studies (Study III)

02.WB.00#	Time	Location	Tide	Birds	Humans	Boats	Light (LUX)	Temp (C)	SpC (ms/cm)	DO (mg/L)	pH	TDS (g/L)	DO% (Sat)	Turb (NTU)
469	11:00 AM	West End Storm Drain	4.0 E	22	0	3	29200	17.30	51.2	10.87	8.16	32.8	139.3	5.4
	11:30 AM	West End Storm Drain		20	0	3	74400	17.42	51.2	10.33	8.15	32.8	132.7	4.3
	12:00 PM	West End Storm Drain	2.5 E	32	0	3	44400	17.72	51.1	14.24	8.18	32.7	170.0	4.7
	12:30 PM	West End Storm Drain												
473	1:00 PM	West End Storm Drain	1.5 E	26	1	3	33000	18.19	50.9	8.64	8.18	32.9	112.6	9.9
	1:30 PM	West End Storm Drain		62	1	3	72700	18.67	49.7	11.97	8.18	31.8	149.2	19.0
	2:00 PM	West End Storm Drain	0.6 E	54	1	3	86000	18.85	50.1	13.52	8.19	32.1	177.8	16.3
	2:30 PM	West End Storm Drain		32	1	3	75000	18.90	50.8	11.70	8.21	32.5	169.1	30.3
477	3:00 PM	West End Storm Drain	0.3 L	27	1	3	66000	19.24	50.7	10.97	8.19	32.5	154.2	13.4
	3:30 PM	West End Storm Drain		28	0	3	46000	19.47	50.5	14.62	8.16	32.3	195.1	20.6
	4:00 PM	West End Storm Drain	0.5 F	21	2	3	45000	19.47	50.5	14.20	8.16	32.3	189.5	20.6
	4:30 PM	West End Storm Drain		26	2	3	38000	19.33	50.7	11.31	8.17	32.5	150.6	13.1
481	5:00 PM	West End Storm Drain	1.1 F	18	1	3	29700	19.06	50.6	14.30	8.15	32.4	189.3	11.7

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