PRELIMINARY CHARACTERIZATION
OF FECAL COLIFORM CONTRIBUTIONS
TO PORTAGE BAY
FROM THE HERMOSA BEACH AREA
2000 - 2001

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(LIBC)

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1. INTRODUCTION

The Lummi Indian Reservation (Reservation) is located at the mouth of the Nooksack River and along the western border of Whatcom County, Washington (Figure 1). The Nooksack River drains a 786 square mile watershed and discharges primarily into Bellingham Bay. Portage Bay is located along the western portion of Bellingham Bay.

Between 1997 and 1998, 180 acres of shellfish beds in Portage Bay were closed (downgraded from “Approved” to “Restricted” classifications under the National Shellfish Sanitation Program [NSSP]) to commercial harvest due to fecal coliform contamination (Figure 2). In consultation with the Lummi Nation and under the Shellfish Consent Decree (Order Regarding Shellfish Sanitation, *United States v. Washington [Shellfish]*, Civil Number 9213, Subproceeding 89-3, Western District of Washington, 1994), the Washington Department of Health (DOH) is responsible to the federal Food and Drug Administration (FDA) to ensure that the NSSP standards for certification of shellfish growing waters are met on the Reservation.

The Nooksack River was implicated as the principle source of fecal coliform contamination by the Washington Department of Health (DOH) (DOH 1997). Prior to the closure of the shellfish beds, the Washington Department of Ecology initiated a Fecal Coliform Total Maximum Daily Load (TMDL) and nutrient characterization for the Nooksack River in response to violations of the fecal coliform water quality standard (WAC 173-201A).

As part of the overall response to the shellfish bed closure, the Lummi Water Resources Division conducted a study to evaluate the impacts of potential fecal coliform bacteria sources in the Hermosa Beach area of the Reservation along the nearshore waters of Portage Bay (Figure 3). This study started in 1998 and was designed to characterize runoff from the Hermosa Beach area over a three-year period. This report presents the results measured during the third year of the study and an analysis of the results for all three years of the study. The results for the first year of study are presented in the report, *Preliminary Characterization of Fecal Coliform Contributions to Portage Bay from the Hermosa Beach Area* (LWRD 1999). The study was funded by the U.S. Environmental Protection Agency (EPA).

The water quality data collected during the third year of the study (2000 - 2001) were evaluated at the time and found to support the preliminary conclusions drawn after the first year of the study (1998 - 1999). However, due to time and resource constraints, the data were not more completely analyzed and the results documented into a formal report until recently.

In November 2003, due to improved water quality conditions, approximately 75 percent of the closed Portage Bay shellfish beds were re-opened to commercial harvest. In May 2006, the remaining closed shellfish growing areas were reclassified as “approved” for harvest. The water quality improvements that resulted in the reclassification are generally attributed to the combined effects of water quality monitoring (both in Portage Bay and the Nooksack River watershed); compliance enforcement inspections by the EPA, Washington Department of Ecology, and Washington Department of Agriculture; and technical assistance and financial support to Nooksack River watershed dairy operations and municipalities.

The Lummi Shore Road Restoration Project rebuilt a section of roadway immediately prior to and during Year 3 of this study in the Hermosa Beach area. This construction project resulted in alterations to the impervious area (i.e., removal of asphalt, rebuilding of roadbed, and ultimately increased impervious area), temporary removal of one culvert, permanent removal of one culvert, and placement of six additional culverts. During Year 3 these six new culverts were assigned sample site numbers 60 through 71 to correspond with the paired sampling at each culvert (see Section 2—Methods) and incorporated into the sampling once they were installed.

This document is organized into five sections and one appendix: The first section is this introduction, the second section describes the study methods, the third section presents and discusses the results, the fourth section is a summary, and the fifth section lists the cited references. Appendix A contains the measured data for Year 3 in a tabular format.

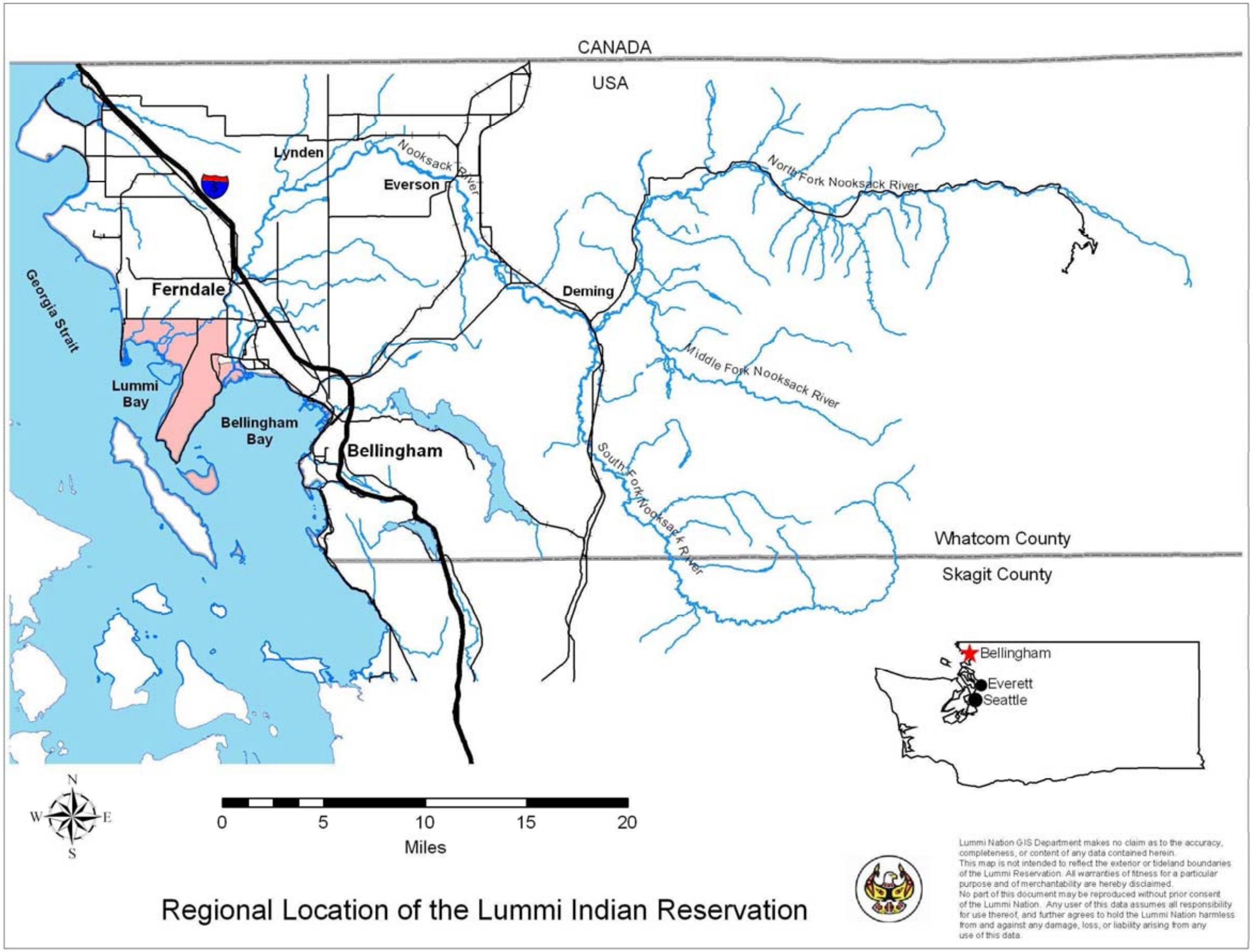


Figure 1. Regional location of the Lummi Indian Reservation.

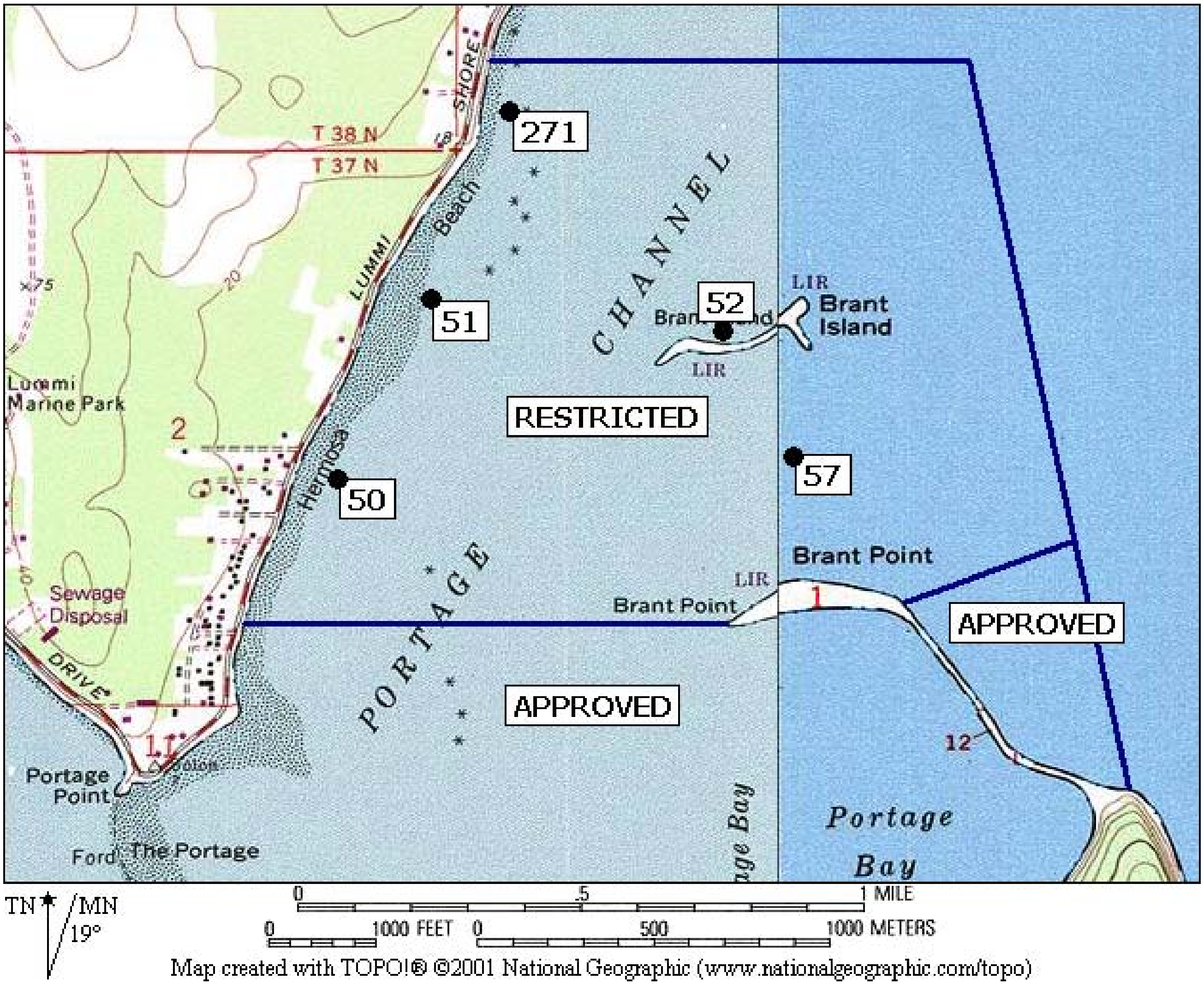
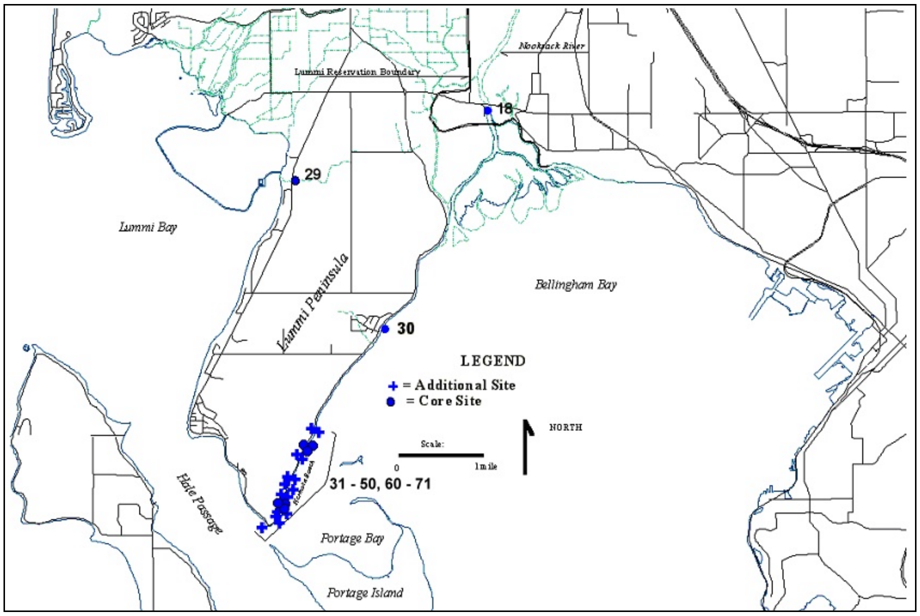
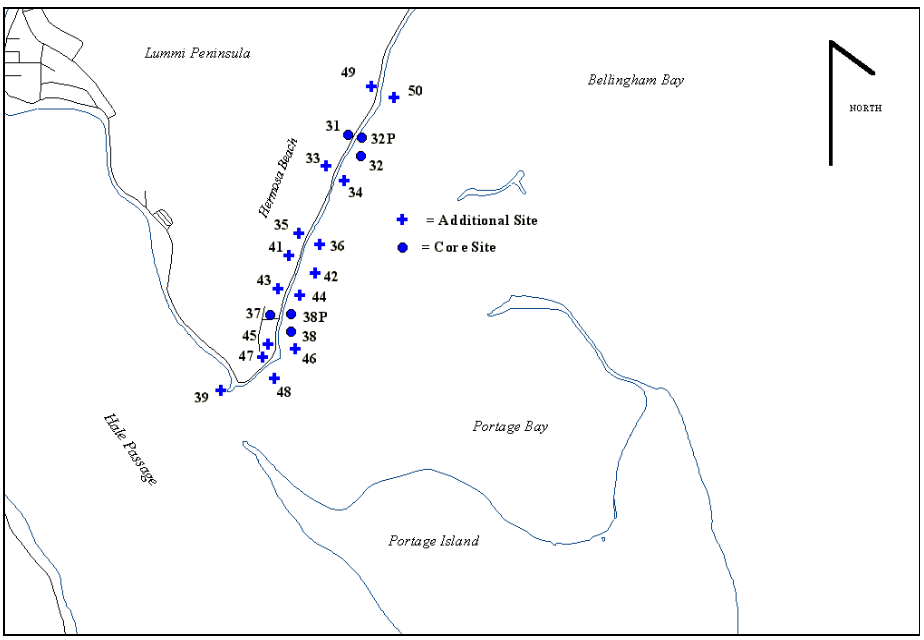


Figure 2. Areas closed to commercial shellfish harvest in Portage Bay during the study period. Sample sites (shown by black dot with adjacent number) are Washington Department of Health sample sites.



(a)



(b)

Figure 3. Location of "core" and "additional" sample sites. "Core" sites were sampled daily or more frequently during each 14-day period, and "additional" sites were sampled twice during each 14-day period. Frame (b) contains an expanded view of the sample site locations in the Hermosa Beach area. As part of the Lummi Shore Road Restoration Project, six new culverts were installed and one culvert (formerly sample sites 49 and 50) was removed. Due to scale issues, sample sites 60 to 71 (sample pairs associated with each new culvert) are not shown. Sample sites 60 through 63 (2 sample pairs) occur north of "additional" sample site pair 35 – 36. Sample sites 64 through 71 (4 sample pairs) occur between the "core" sample site group of 31, 32, 32P and "additional" sample site pair 49 –50. Sample sites 49 and 50 are shown for reference and were not sampled during the 2000 – 2001 sample period (Year 3).

2. STUDY DESIGN

As depicted in Figure 3 and described in greater detail below, there were 34[1] sample locations (sites or stations) in this three-year study. Over the course of two separate 14 consecutive day sampling efforts each year, 9 sites were sampled daily (or more frequently during storms), and the remaining 25 sites were sampled twice at intervals several days apart during each 14-day period. The first 14-day sampling effort for Year 3 of the study occurred during the onset of overland flow ("first flush") in the fall (10/17/00 to 1/4/01). The second 14-day sampling effort occurred during baseflow conditions in the winter (2/14/01 to 2/28/01). During the fall sampling period, flow was not continuous. Both biological and physical parameters were sampled at every site.

2.1. Parameters Measured

At each site, fecal coliform and *Escherichia coli* (*E. Coli*) samples were collected; temperature, salinity, and conductivity were measured in situ. Sample collection and in-situ measurements were performed pursuant to an EPA-approved Quality Assurance/Quality Control Plan. Where feasible, stratification due to salinity was recorded, and flow volume was measured or estimated for freshwater discharges. Nooksack River discharge (flow) was determined by the U.S. Geological Survey gage located on the Mainstem Nooksack River in Ferndale, Washington. Fecal coliform and *E. Coli* were enumerated at a contracted Washington certified analytical laboratory using the membrane filtration technique with steps included to recover stressed organisms.

2.2. Sample Strategy

As stated above, there were two separate 14 consecutive day sample collection periods during each year of the study. One period was during the onset of overland flow and the other occurred during the rainy season when streams were supported by baseflow. The trigger for the commencement of the fall sampling period was the first appearance of overland flow at Site 31. Flow is at times not continuous from day-to-day at Site 31, in which case sampling was suspended until flow resumed at Site 31. In addition, safety concerns and holidays (which impact the laboratory schedule) also impacted the schedule.

Site 31 was chosen as the indicator stream because it contributes water directly to the closed shellfish beds, is in close proximity to a Department of Health (DOH) sample site, and has the largest contributing area of nearby local watersheds. In addition, Site 31 is sampled monthly as part of the Lummi Water Resources Division ambient surface water quality monitoring program.

As depicted in Figure 3, there were a total of 34 sample sites during Year 3, 9 of which are used for both the daily and storm sampling efforts (referred to as "core" sites when describing their location). The remaining 25 sites are referred to as "additional" sites. There were three different

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[1] The number of sites increased to 34 from 24 due to the rebuilding of a portion of Lummi Shore Road with more culverts. Six new culverts were installed and one culvert was removed.

sampling regimes used during each 14-day sample period: 1) daily sampling of 9 core sites, 2) more frequent sampling of the 9 core sites during storms, and 3) sampling at the 25 additional sites twice during each 14-day run, several days apart (referred to as the "Additional Sample Run"). Table 1 summarizes the design of the sampling regime and collection frequency.

Table 1. Sample site and collection design for both 14-day sample run periods during Year 3.

Sampling Regime	Frequency of Sample Collection	Number of Sample Sites	Number of Times Each Site Sampled	Total Number of Samples Collected
Daily[A]	1 sample per 24-hours	9	28	252
Storm[A]	5 samples over 2 to 3 storm events	9	3	27
Additional	One sample site twice during each of the 14-day sample runs	25	4	100
--	Total number of samples collected	--	--	379

[A] The term "core" is used to describe the locations of the daily and storm sample sites.

2.2.1. Core Site Sampling

The nine core sites shown in Figure 3 were sampled once per day during each 14-day sample run. Six (6) of the nine core sites are located in two separate areas along Hermosa Beach. Within each of these two areas, a cluster of three samples were collected. Figure 4 illustrates the location of the three samples collected within each area. One site is the freshwater source[2], the second site is in the freshwater dilution zone (plume), and the third site is the marine water of Portage Bay outside of the influence of the freshwater discharge.

The remaining three core sites are: 1) Site 29—a freshwater stream that does not discharge to Portage Bay that was used as a reference site to generally indicate background conditions, 2) Site 18—the Nooksack River at Marine Drive Bridge (near the mouth), and 3) Site 30—a marine site that is approximately half way between the mouth of the Nooksack River and Portage Bay along the western shoreline of Bellingham Bay.

The culvert at Sample Site 31 was removed after October 18, 2000 and replaced between October 25 and 31, 2000. The October 20, 2000 "daily" sample was impacted by this change, and Sites 64 and 65 were sampled in lieu of Sites 31 and 32. (Sites 64 and 65 are treated separately as "additional" sites in this report).

[2] These sites are referred to as "freshwater" or "upland," but may not always contain freshwater. Marine waters can sometimes enter these sites during high tides and/or storms.

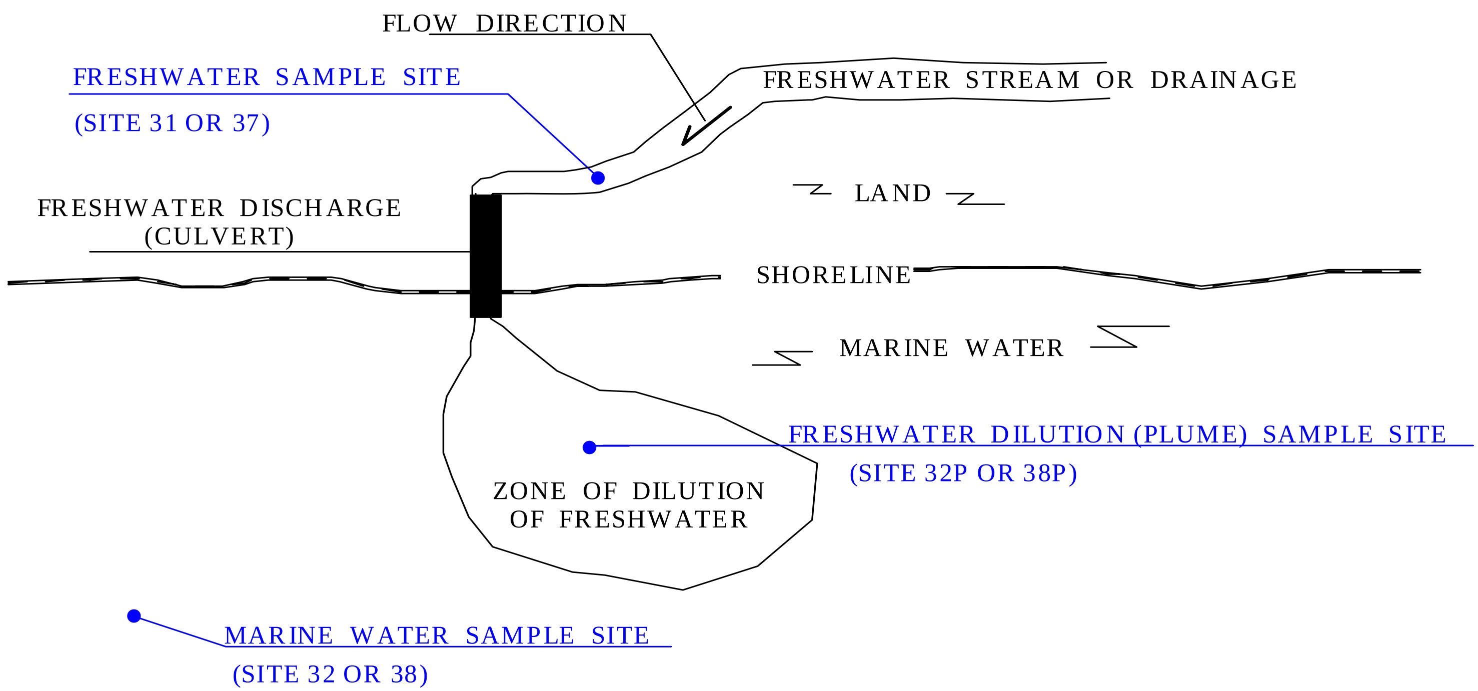

Figure 4. Illustration of the locations of the three sample sites in the vicinity of a freshwater discharge for the daily and storm (core) sample sites.

2.2.2. Additional Site Sampling

Twenty-four (24) of the 25 "additional" sampling sites occur along Hermosa Beach (Figure 3). Fourteen culverts discharge surface water to Portage Bay, two of which were sampled as core sites. The 24 additional samples along Hermosa Beach were collected in pairs at the remaining twelve surface water discharge points to Portage Bay. One sample was collected from the freshwater source, and the other sample collected from the adjacent marine water outside the area of influence of the freshwater discharge. The remaining site (Site 39) is in Hale Passage immediately northwest of Portage Bay. This site is intended to provide a preliminary assessment of fecal coliform densities in a part of Hale Passage that occasionally contributes water to southwestern Portage Bay.

2.3. Quality Assurance and Quality Control

All samples were collected following the established quality assurance and quality control (QA/QC) protocols identified in the QA/QC plan submitted to the Environmental Protection Agency (EPA) in 1995. Data used for this report are preliminary and subject to revision. Verification and standardization of the data has not occurred (scheduled for completion by December 31, 2006).

Fecal coliform and *E. Coli* samples were analyzed at a Washington State certified laboratory using the membrane filtration method with steps included to recover stressed organisms. Field QA/QC for the fecal coliform and *E. Coli* consisted of transferring sterile water from a sealed container into a sample bottle for analysis at the laboratory.

Salinity, conductivity, and temperature were measured in situ in accordance with manufacturer's instructions, and the meter and probe were regularly measured against National Institute of Standards and Technology (NIST) traceable standards. Ten percent (10 %) of the salinity, temperature, and conductivity measurements were duplicated in the field to quantify precision.

2.4. Deviations from Original Study Design

There were minor deviations from the sampling program described in the workplan for this study (LIBC 1998).

- Sites 18 and 30 were changed from "additional" sites to "core" sites.
- Ten "additional" sites were added in response to the rebuilding of Lummi Shore Road.
- Plume and background marine samples were collected in locations based on either the existence of a visible plume from the freshwater discharge or proximity to the outfall. Use of salinity to determine the area of the plume prior to fecal coliform sample collection was not performed due to the potential for fecal coliform contamination of the water by the sampler. In no case did subsequent salinity sampling indicate that plume and background sample locations were mis-located.

3. RESULTS AND DISCUSSION

The results of the water quality sampling for all 34 sites that were sampled during Year 3 are presented in tabular format in Appendix A. In this section of the report, the results of Year 3 are presented first, followed by results of the three years of study combined. Year 3 differed from previous years in that the "first flush" period occurred over several months instead of within a single month, and Lummi Shore Road was rebuilt in the northern portion of Hermosa Beach, altering the number and location of sample sites. The regional climate was primarily responsible for the extended sampling period, although flow at Site 31 appeared to occur more frequently due to road-runoff than it had prior to construction, and the occurrence of holidays precluded sampling on some days due to the schedule of the contracted analytical laboratory.

3.1. Year Three Results

Year 3 data from core sites are presented in Table 2 below and graphically following this discussion (Figures 5 through 17). Year 3 data from the additional sites are reported in Appendix A and depicted graphically in Figures 14 through 17.

Table 2. Geometric means for fecal coliform and *E. Coli* for core sample sites and fecal coliform loading for core sample sites with freshwater discharge.

Sample Site	Season	Fecal Coliform Geometric Mean (col./100ml)	*E. Coli* Geometric Mean (col./100ml)	Fecal Coliform Loading Geometric Mean (col./second)
18	Both	43.3	31.0	22,346,818
	First Flush	92.7	62.1	65,451,090
	Baseflow	19.3	14.9	7,162,448
29	Both	9.7	8.3	570
	First Flush	14.9	14.7	442
	Baseflow	6.1	4.5	747
30	Both	9.0	8.2	--
	First Flush	12.5	12.5	--
	Baseflow	6.4	5.3	--
31	Both	11.6	12.1	311
	First Flush	21.0	22.9	174
	Baseflow	6.6	6.6	502
32P	Both	15.7	14.4	--
	First Flush	37.9	33.9	--
	Baseflow	6.5	6.2	--
32	Both	7.7	6.2	--
	First Flush	25.4	24.1	--
	Baseflow	2.3	1.6	--
37	Both	19.3	19.1	68
	First Flush	257.7	254.5	600
	Baseflow	1.2	1.2	2
38P	Both	17.0	13.9	--
	First Flush	91.0	91.0	--
	Baseflow	2.9	1.9	--
38	Both	5.1	4.0	--
	First Flush	11.4	10.4	--
	Baseflow	2.1	1.4	--

Table 2 shows that the bacteria geometric mean at all sample sites were greater during the "first flush" period than during the "baseflow" period. Reductions in bacteria geometric means between the "first flush" and "baseflow" periods are an order of magnitude for all but Site 18, which shows an approximate 4- to 5-times reduction. Fecal coliform and *E. Coli* densities are similar between sites and seasons, with the greatest difference during the "first flush" at Site 18.

Fecal coliform loading (loading) from the Nooksack River (Site 18) is between 4 and 7 orders of magnitude greater than freshwater discharges from Lummi Peninsula sites 29, 31, and 37, and loading decreases by an order of magnitude between the "first flush" and "baseflow" periods. Sites 29 and 31 showed a greater "baseflow" period loading than during the "first flush" as the decrease in fecal coliform density was not sufficient to offset the increase in flow. Site 37 loadings were much smaller during the "baseflow period" than during the "first flush," likely due to a three-order-of-magnitude drop in the fecal coliform geometric mean without an increase in discharge. However, "baseflow" flow measurements are limited for Site 37.

Figures 5 through 8 show fecal coliform and flows from core sample sites 18, 29, 31, and 37 that discharge to marine waters. These figures show the same patterns evident from Table 2—that bacteria levels are elevated during the "first flush" period relative to the "baseflow" period. Flows for Lummi Peninsula sample sites 29, 31, and 37 are all low during the "first flush" period. In contrast, Nooksack River flows are elevated during the "first flush" period relative to the "baseflow" period. These flow dynamics result in the greater loading from the Nooksack River during the "first flush" period relative to the "baseflow" period, and the opposite pattern for Lummi Peninsula sample sites, except for Site 37. The loadings from the Lummi Peninsula sample sites are much lower than the Nooksack River loadings, but increase during the "baseflow" period due to increased flows at Sites 29 and 31. Site 37 flow information during the "baseflow" period is sparse (often the culvert outlet is buried by the beach, or the marine water is too close to the outfall to obtain a flow measurement), but available data indicate that "first flush" and "baseflow" period flow volumes are similar at Site 37, which coupled with a decrease in fecal coliform density, explains why fecal coliform loadings are lower during the "baseflow" period for this site.

Figures 9 through 11 show fecal coliform and salinity for marine core sample sites. Elevated fecal coliform levels tend to occur when salinities are lower. Background salinity is generally 29 parts per thousand (ppt.) or greater, a lower salinity indicates freshwater influence (see Sample Site 39 in Appendix A during the "baseflow period"). Although low fecal coliform densities occur with low salinities, and elevated bacteria occur over a range of salinities, it is evident from these graphs that elevated bacteria densities tend to occur when salinities are low, and low bacteria levels tend to occur when salinities are elevated. Marine water sample sites were located outside the zone of influence of nearby freshwater discharges (Figure 4), indicating that lower salinities in Portage Bay are not due to freshwater discharges from Hermosa Beach. This conclusion is corroborated by the small flow volumes associated with freshwater discharges from Hermosa Beach. The Nooksack River is responsible for the lower salinity at marine water sites, which is also often evident visually because of the elevated turbidity of the Nooksack River compared to marine water.

The high counts observed at sites 32P and 32 on October 17, 2000 (Figure 12) occurred during a storm with eelgrass, other seaweed, and debris in the surf zone and on the beach. The debris appears to be the most obvious explanation for the high counts in the marine waters.

Figures 12 and 13 show the die off and/or dilution of fecal coliform bacteria at the two areas where the freshwater, zone of freshwater dilution in marine water (plume), and marine water were sampled. When background fecal coliform counts in Portage Bay were low, there was substantial die off and/or dilution of fecal coliform bacteria between the freshwater runoff and the marine waters of Portage Bay. Fecal coliform die off and/or dilution spanned 2 to 3 orders of magnitude when freshwater counts were elevated and marine counts were low (see Table 3 for examples). Often freshwater discharges percolated into the beach sediments prior to reaching marine water and did not flow across the surface of the beach during the fall sampling period.

Table 3. Examples of die off and/or dilution when freshwater bacteria levels were elevated and background marine bacteria levels were low.

Sample Site Number	**November 8, 2000 Fecal Coliform (col./100m)**	**December 16, 2000 Fecal Coliform (col./100m)**
31 (freshwater)	100.0	--
32P (plume)	0.8	--
32 (marine water)	0.8	--
37 (freshwater)	20,000.0	4,000.0
38P (plume)	1,600.0	22.0
38 (marine water)	1.8	8.0

Elevated fecal coliform densities occur in marine waters when nearby freshwater discharges have low fecal coliform densities (see Table 4 for examples). Marine water salinities are depressed for the examples provided in Table 4, and Hermosa Beach freshwater discharges are low, indicating a Nooksack River source of fecal coliform bacteria.

Table 4. Examples of low fecal coliform levels in freshwater discharge and elevated background marine bacteria levels.

Sample Site Number	**December 21, 2000 Fecal Coliform (col./100m)**	**February 15, 2001 Fecal Coliform (col./100m)**
31 (freshwater)	8.0	--
32P (plume)	58.0	--
32 (marine water)	50.0	--
37 (freshwater)	10.0	9.0
38P (plume)	110.0	42.0
38 (marine water)	120.0	48.0

Fecal coliform densities at core and additional sites (Figures 14 through 17) when the sites were sampled ("Additional Sample Run") were variable, but were generally associated with very low or zero[3] freshwater discharges, or the water in the ditch or catch basin was saline, indicating that marine waters of Portage Bay had entered the drainage system. The "baseflow" period fecal coliform densities were very low. Marine waters adjacent to the culvert outfalls do not appear impacted by upland discharges.

The data indicate that runoff from the Hermosa Beach area is not a substantial source of fecal coliform bacteria to Portage Bay and suggests the Nooksack River is a source of elevated bacteria levels in Portage Bay. Due to the combination of the numerous variables involved (e.g., tides, Nooksack River flow, density of fecal coliform in the Nooksack River, winds), and the relatively low numbers of samples, it is not possible to precisely determine trends regarding fecal coliform dynamics in and around Portage Bay from a single year of this study. Confounding effects include runoff infiltrating into beach sediments prior to the discharge reaching marine water, marine waters entering culverts and the ditches along Lummi Shore Road during higher tides and/or during storms, variable Nooksack River influences on Portage Bay, and the variability of fecal coliform bacteria in the natural environment.

[3] Water may be in a ditch or catch basin but not at a sufficient level to flow through the culvert to Portage Bay.

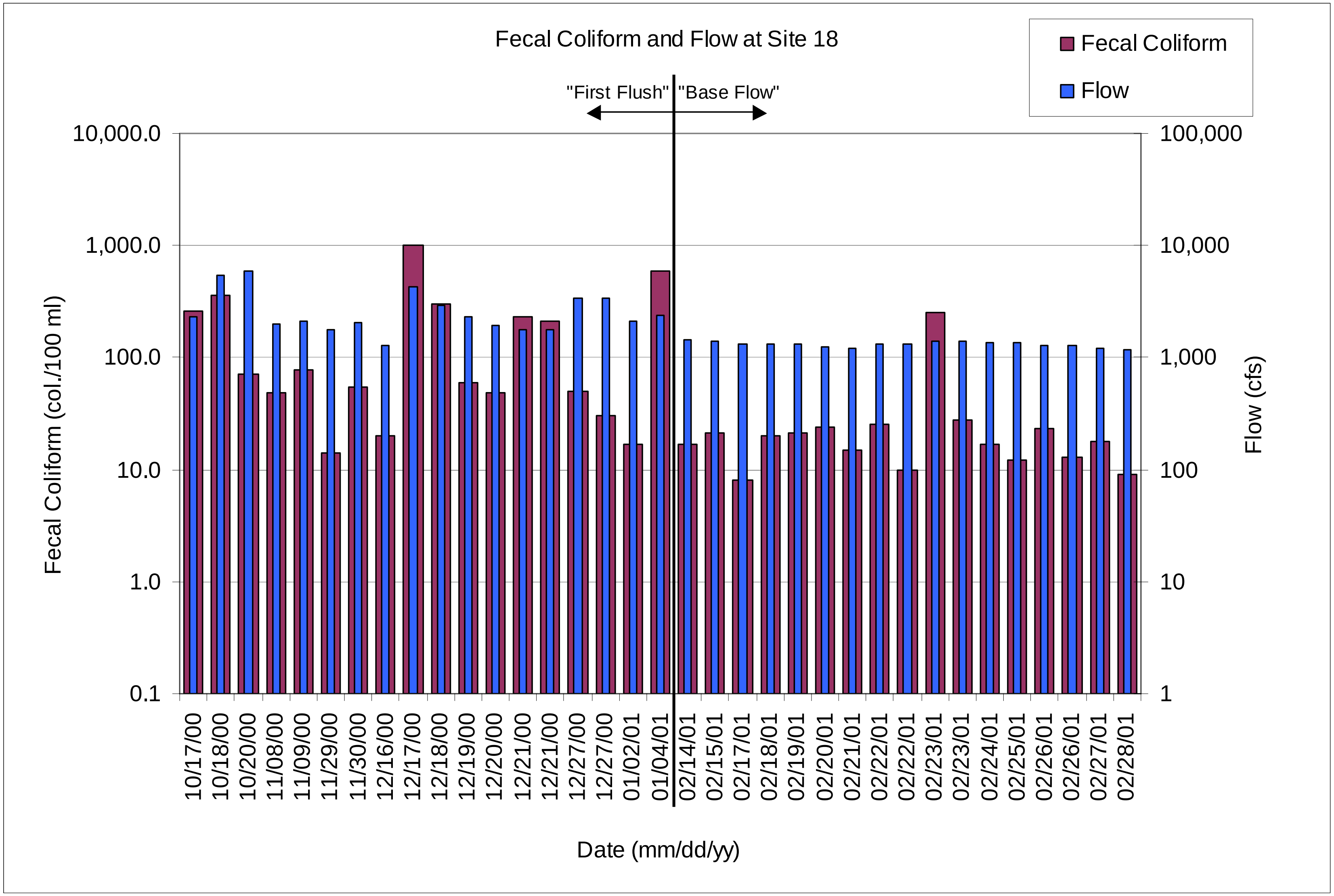

Figure 5. Fecal coliform densities and discharge at Sample Site 31. The secondary y-axis (Flow) scale is different than that used for the other flow graphs in this document.

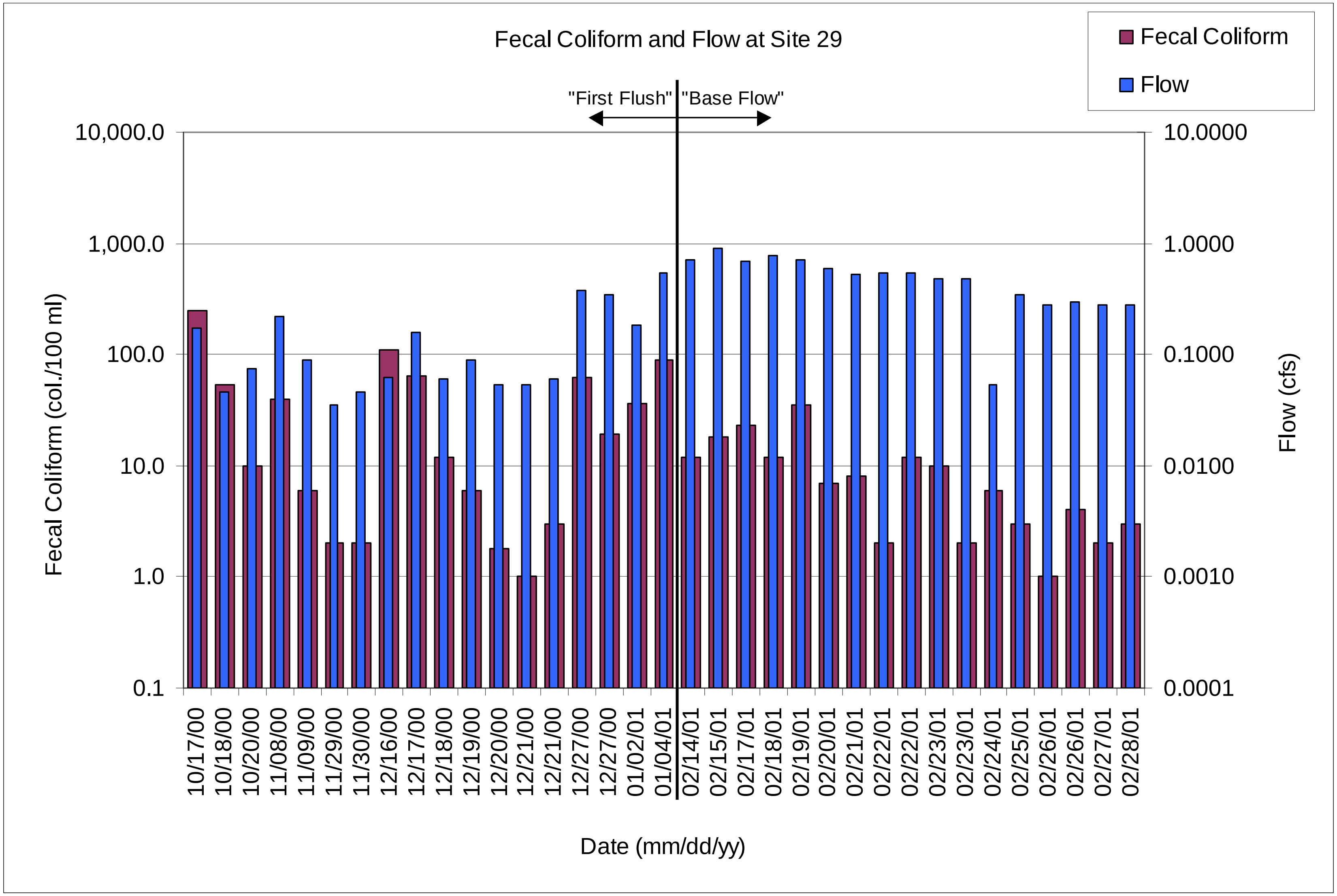

Figure 6. Fecal coliform densities and discharge at Sample Site 29. The number of significant digits on the secondary y-axis (Flow) suggests more accuracy than exists.

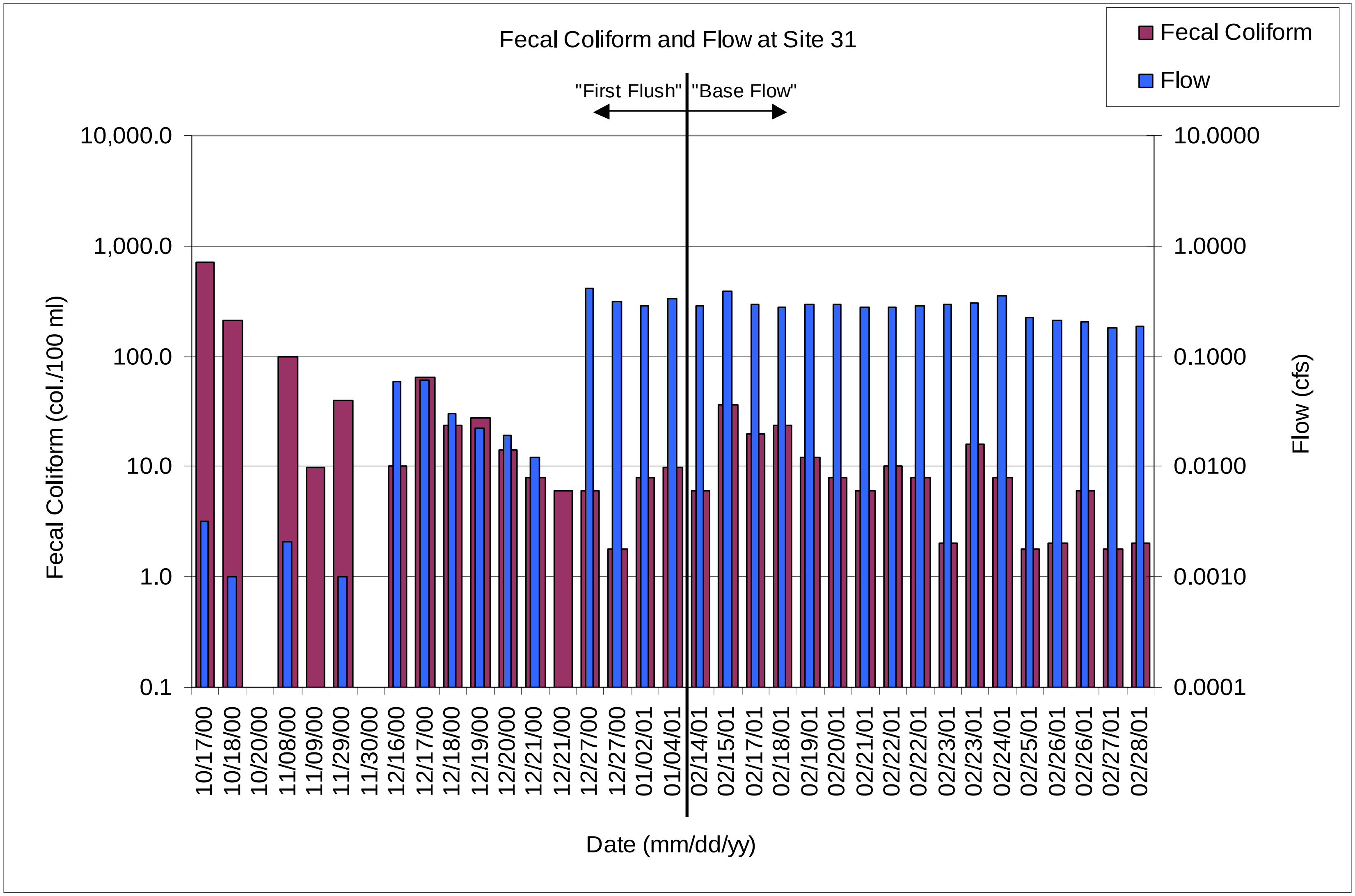

Figure 7. Fecal coliform densities and discharge at Sample Site 31. There was zero discharge on 11/30/00 and flow could not be measured on 12/21/00. Site 31 was not sampled on October 20, 2000 because the culvert had been removed (Section 2.2.1.). The number of significant digits on the secondary y-axis (Flow) suggests more accuracy than exists.

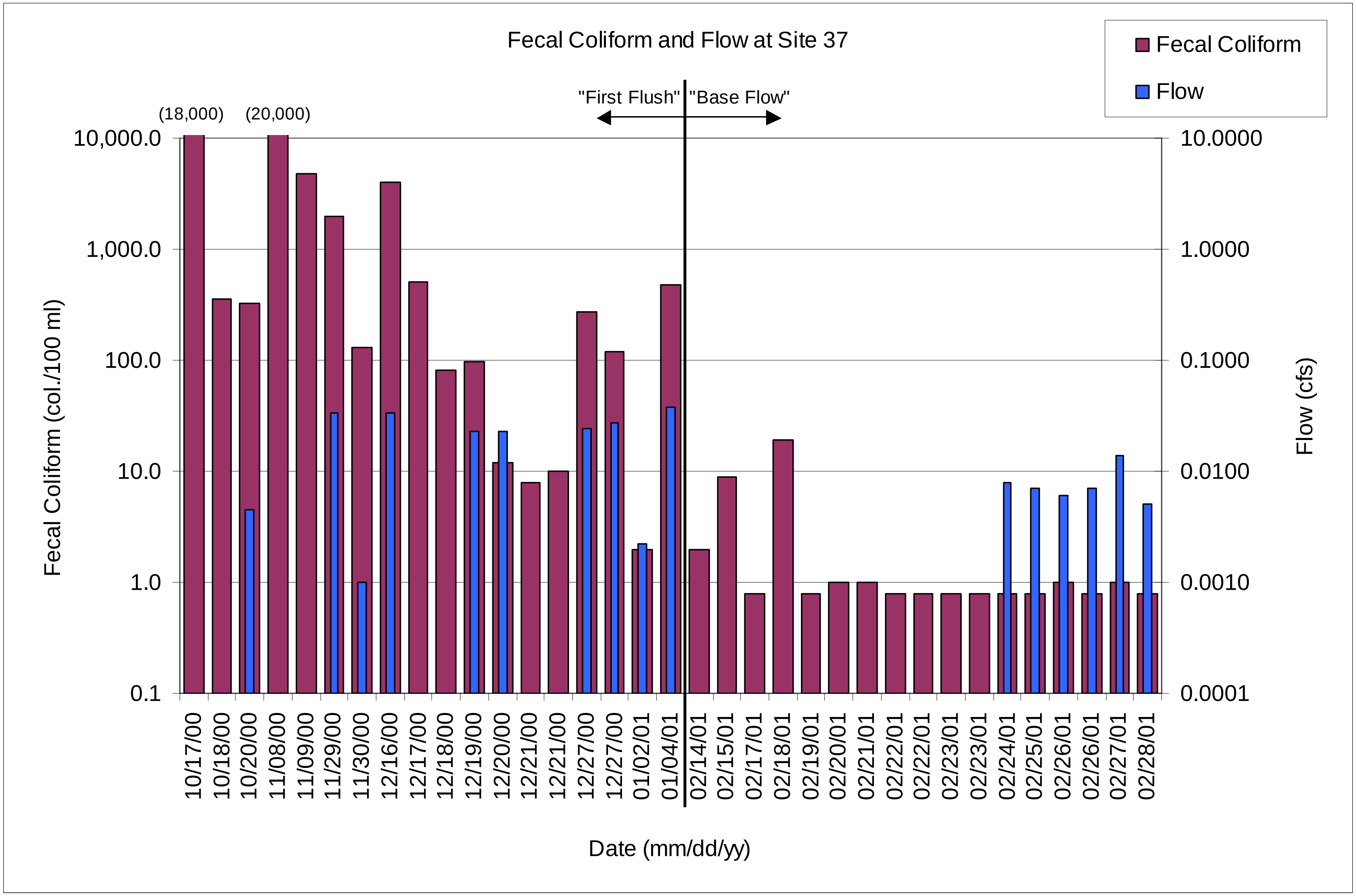

Figure 8. Fecal coliform densities and discharge at Site 37. Flow cannot be measured often at this site due to lack of surface flow across the beach (water often percolates into and through the beach sediments) and a closed drainage system at the culvert inlet. The number of significant digits on the secondary y-axis (Flow) suggests more accuracy than exists.

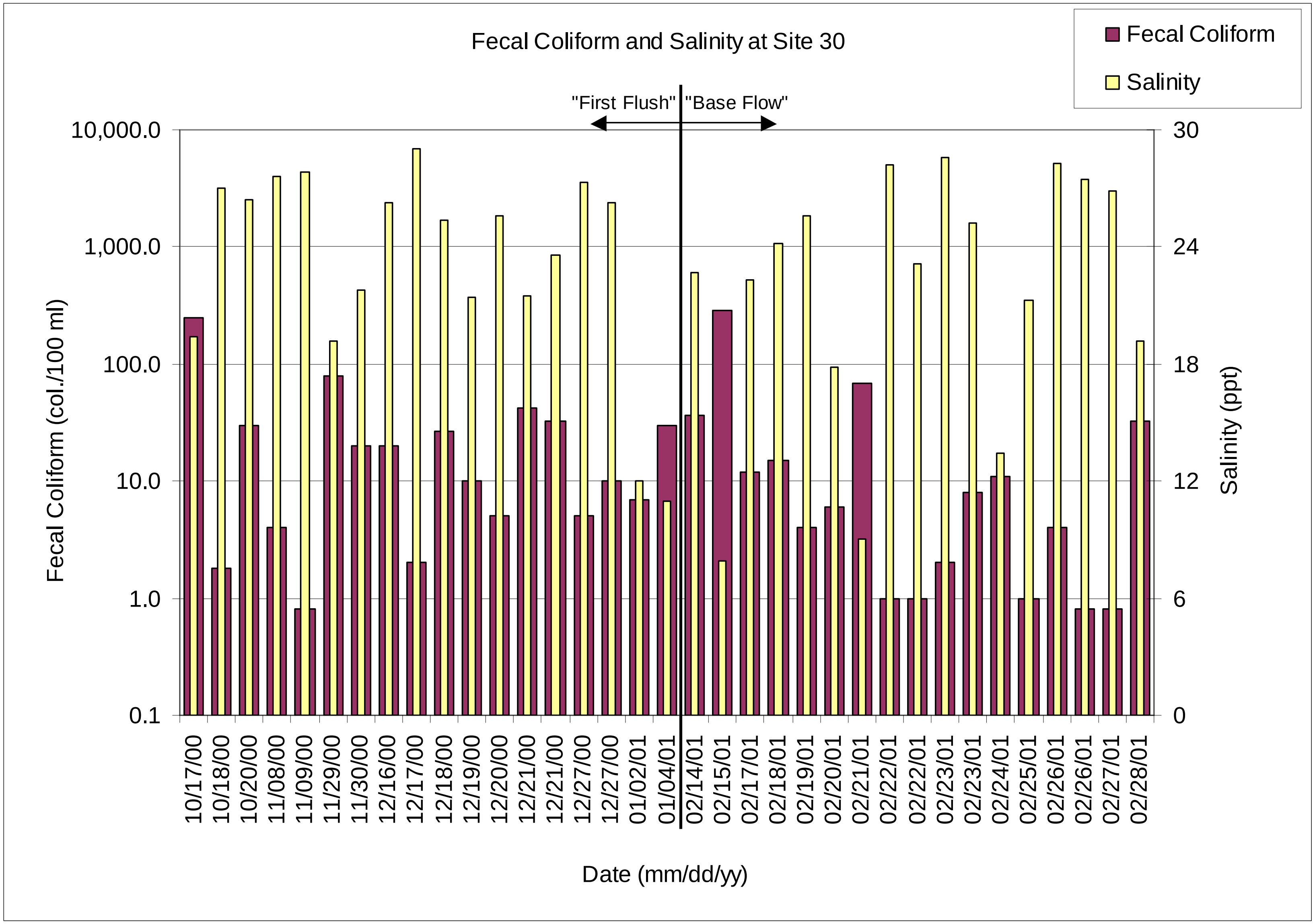

Figure 9. Fecal coliform density and salinity at Sample Site 30.

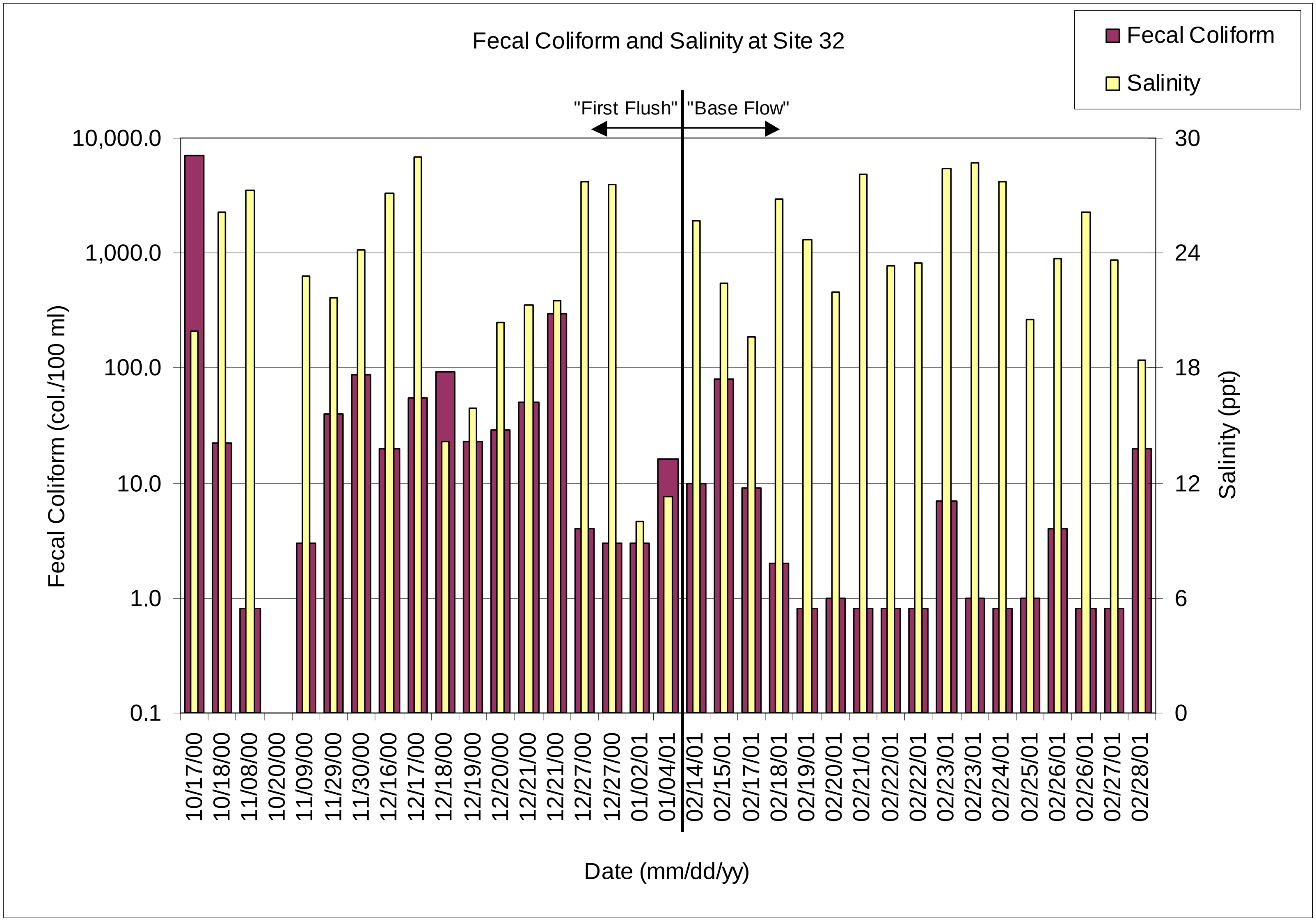

Figure 10. Fecal coliform density and salinity at Sample Site 32. Site 32 was not sampled on October 20, 2000 because the culvert at Site 31 had been removed (see Section 2.2.1.).

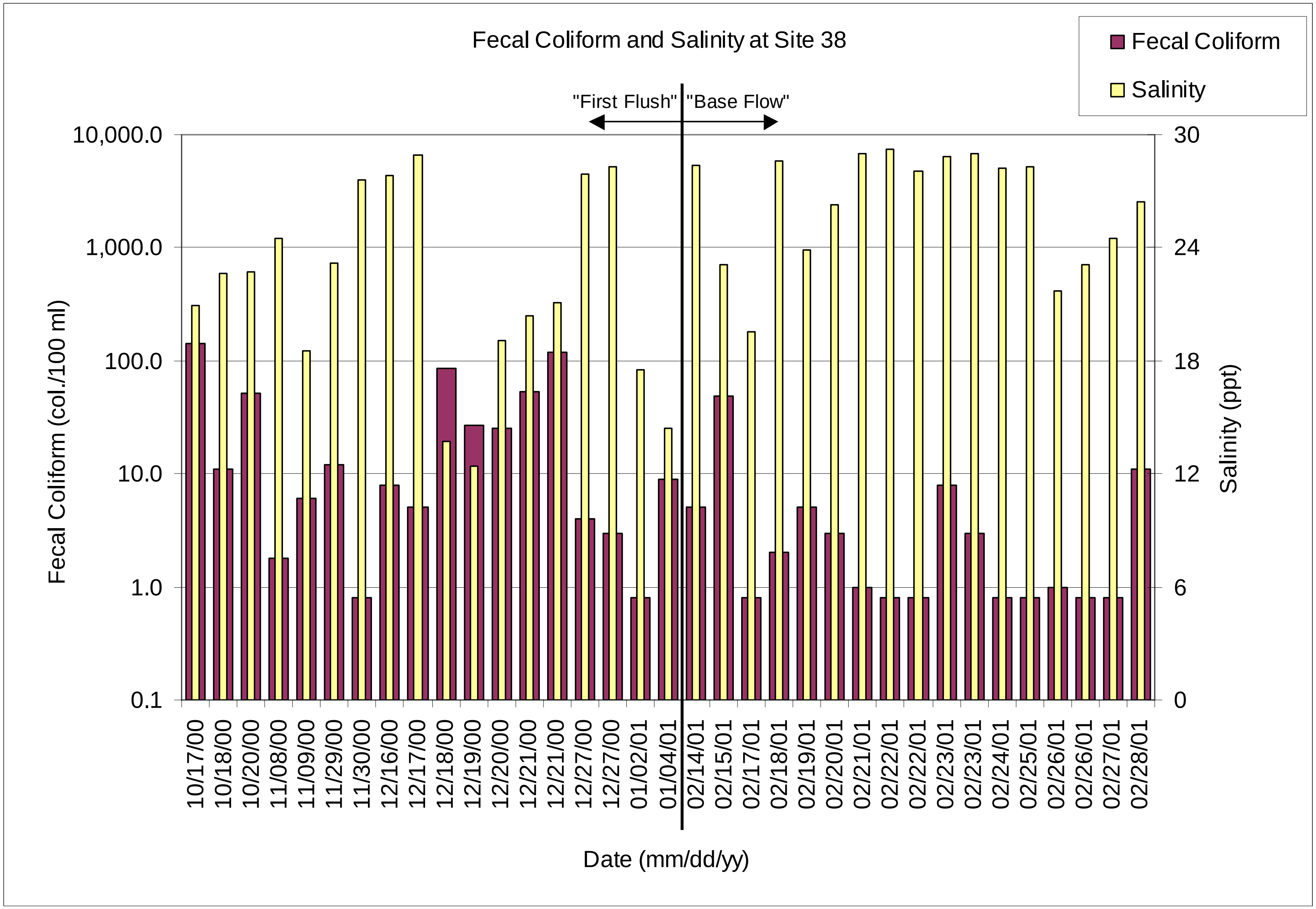

Figure 11. Fecal coliform density and salinity at Sample Site 38.

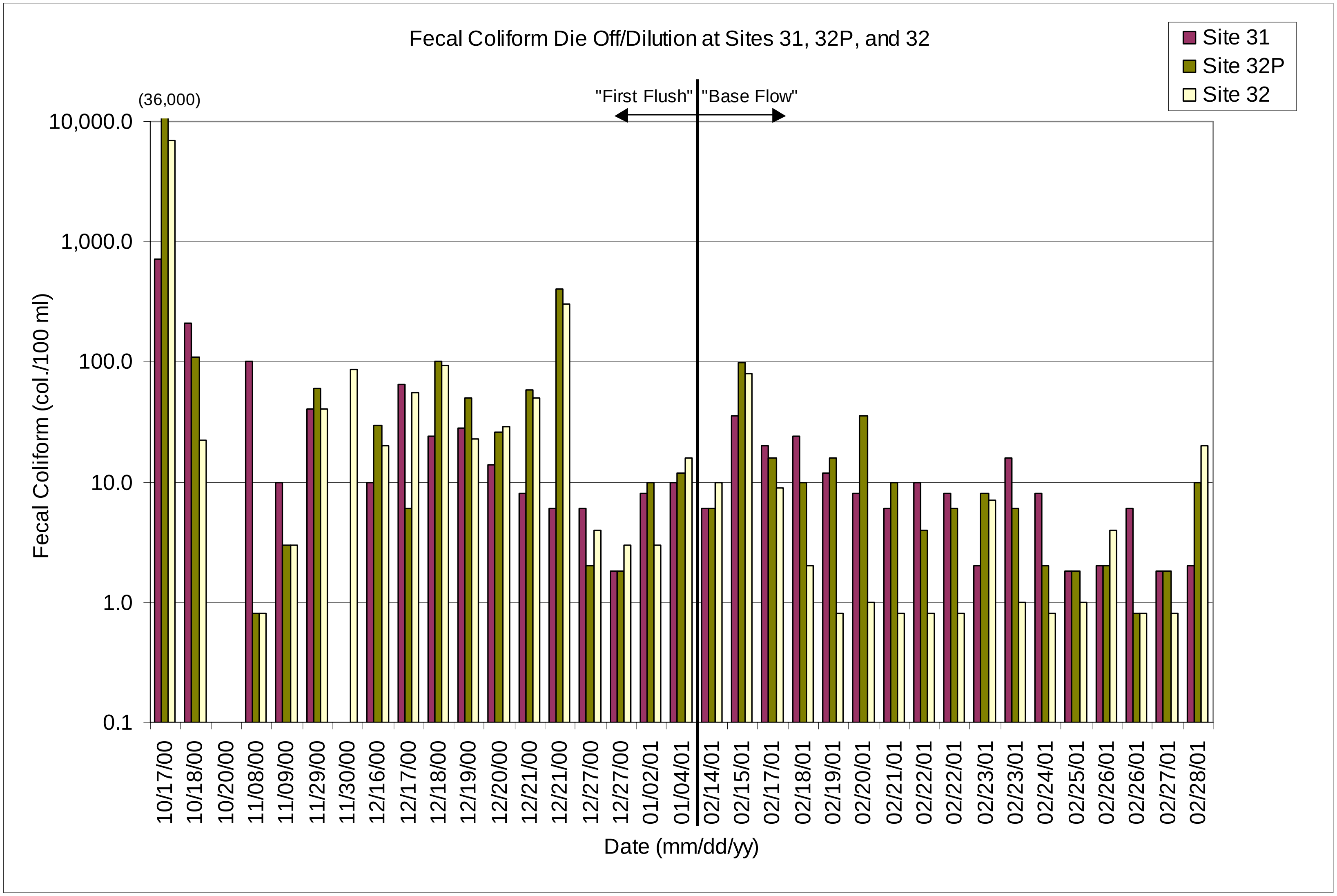

Figure 12. Fecal coliform densities over time at Sample Sites 31, 32P, and 32. Sample Site 31 is the freshwater source, Sample Site 32 is the marine water of Portage Bay, and 32P is the plume or mixing zone between Sample Sites 31 and 32. Site 31 was not sampled on October 20, 2000 because the culvert had been temporarily removed (see Section 2.2.1.).

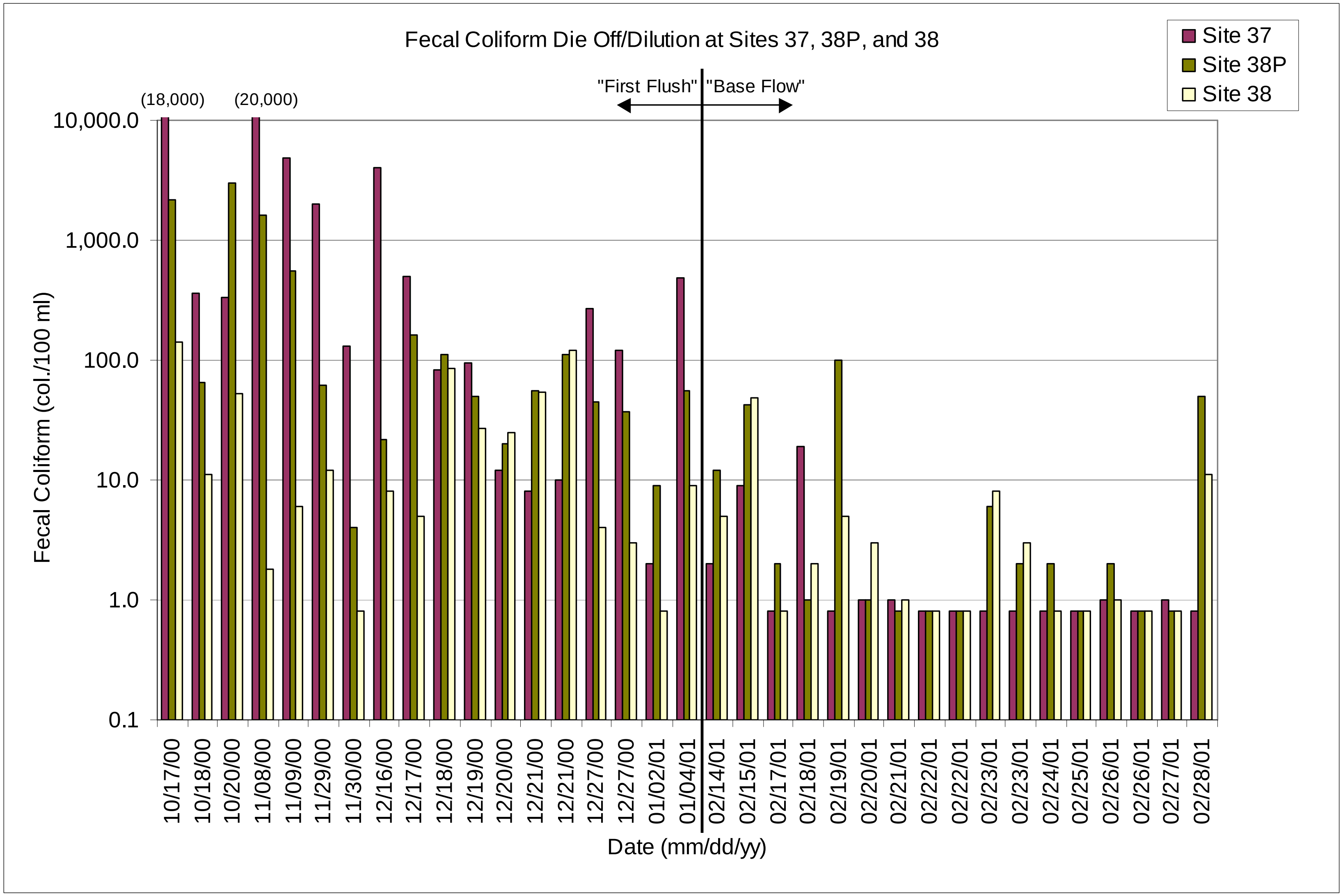

Figure 13. Fecal coliform densities over time at Sample Sites 37, 38P, and 38. Sample Site 37 is the freshwater source, Sample Site 38 is the marine water of Portage Bay, and 38P is the plume or mixing zone between Sample Sites 37 and 38.

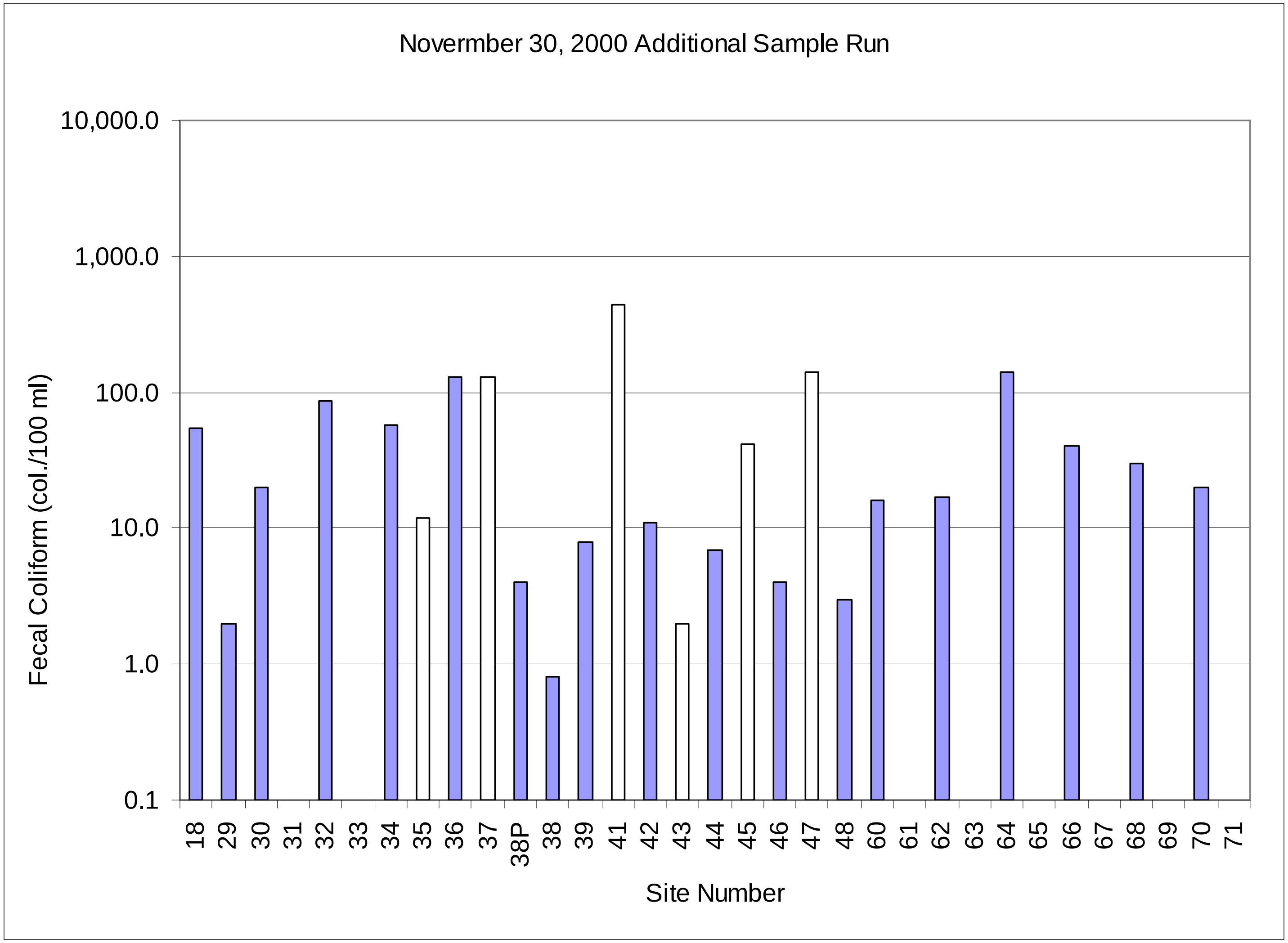

Figure 14. Fecal coliform densities during the November 30, 2000 Additional Sample Run. Hollow bars denote Hermosa Beach freshwater sample sites, solid fill denotes marine water sites. Discharge at Site 37 was much less than 0.0022 cfs. Discharge was not measured at Sites 41 or 47, but salinities were 17.3 ppt and 19.7 ppt, respectively. Sites without fecal coliform information indicate that there was no flow at those sites.

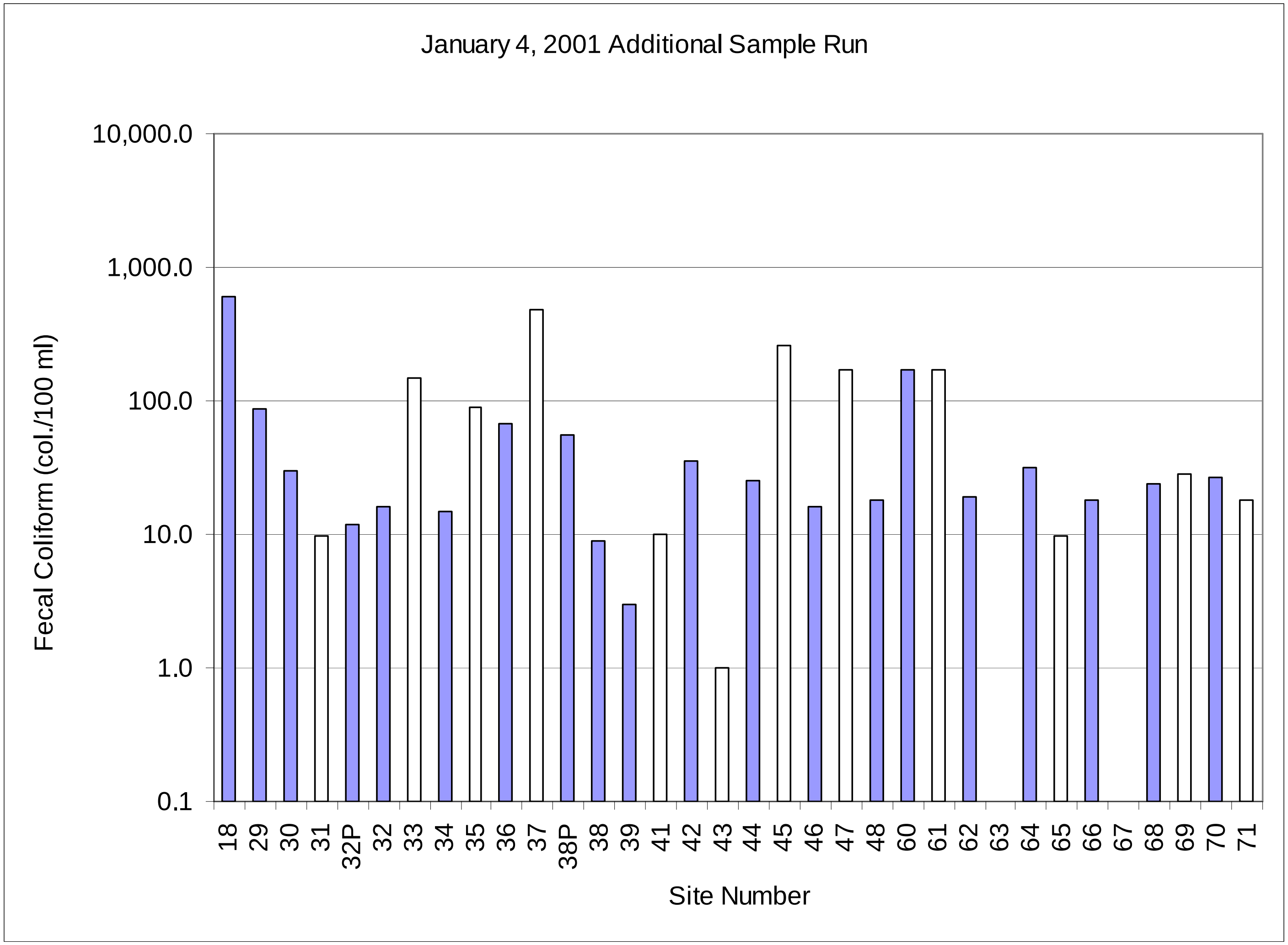

Figure 15. Fecal coliform densities during the January 4, 2001 Additional Sample Run. Hollow bars denote Hermosa Beach freshwater sample sites, solid fill denotes marine water sites. Discharges were: 0.021 cfs at Site 33; 0.038 cfs at Site 37; 0.158 cfs at Site 45; and 0.057 cfs at Site 61. Discharge was not measured at Site 47, but the salinity was 6.2 ppt. Sites without fecal coliform information were too shallow to sample.

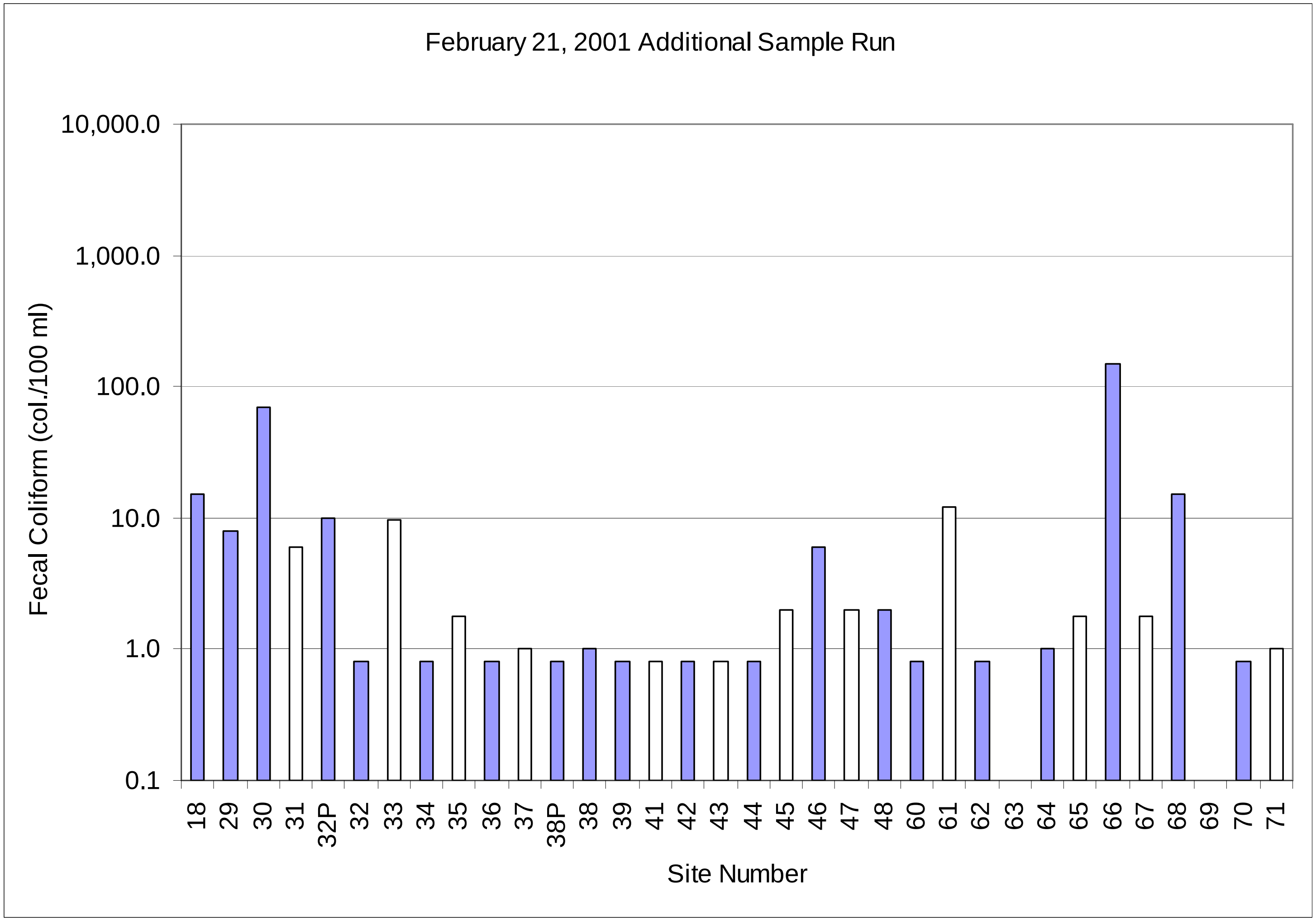

Figure 16. Fecal coliform densities during the February 21, 2001 Additional Sample Run. Hollow bars denote Hermosa Beach freshwater sample sites, solid fill denotes marine water sites. Sites without fecal coliform information were too shallow to sample.

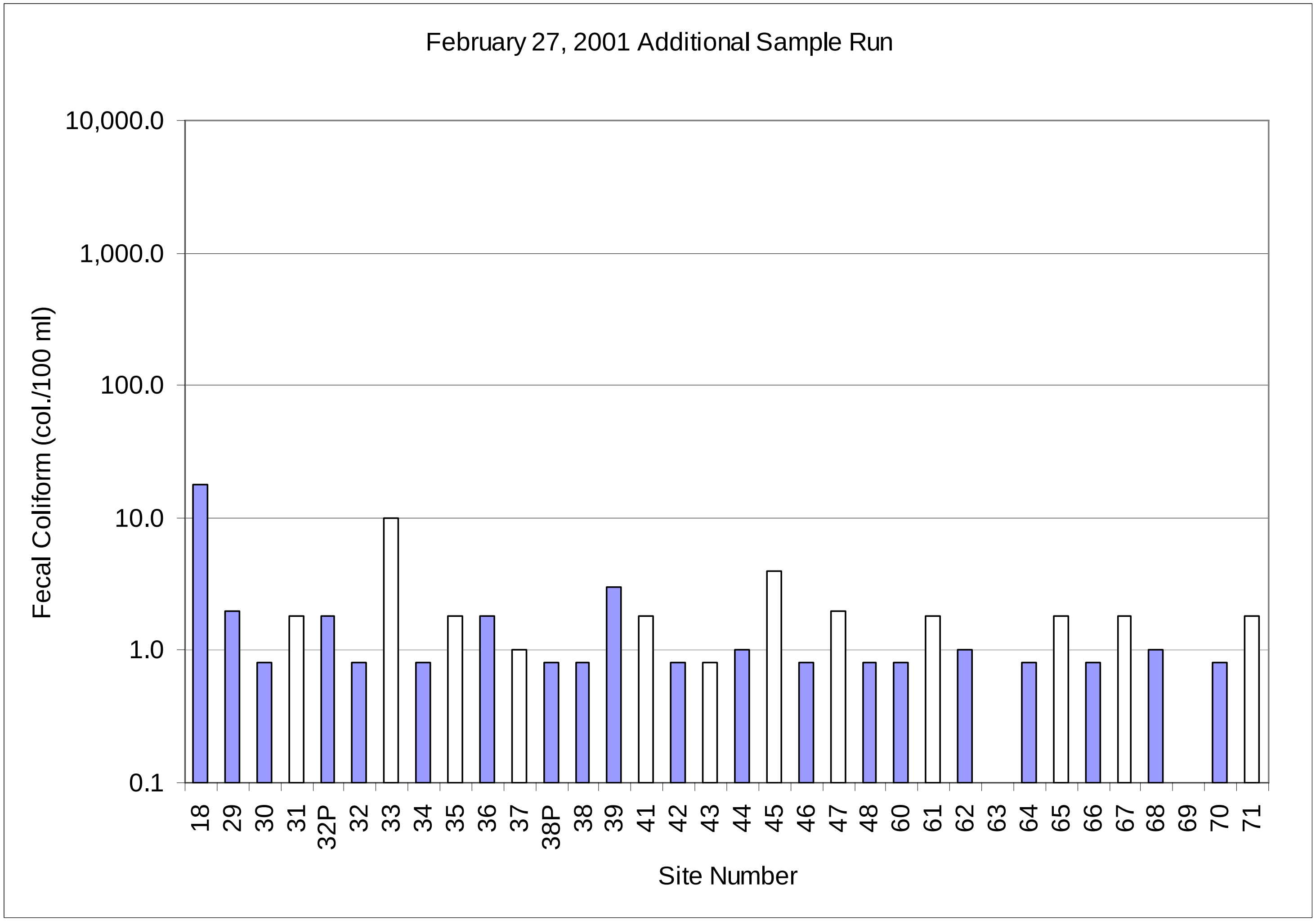

Figure 17. Fecal coliform densities during the February 27, 2001 Additional Sample Run. Hollow bars denote Hermosa Beach freshwater sample sites, solid fill denotes marine water sites. There was no flow at Site 63 and Site 69 Sites was too shallow to sample.

3.2. Three Years Results Combined

Statistical results of water quality sampling over the three-year study period are presented in Tables 5 through 7 and discussed below. Table 5 shows that the results of each from the three years and all three years combined were similar—Hermosa Beach uplands do not appear to be a substantial source of bacteria to Portage Bay; Hermosa Beach freshwater discharges to Portage Bay contain elevated levels of bacteria during the "first flush," but flows are low at that time, resulting in a small bacteria loading; and bacteria levels were lower during subsequent "baseflow" conditions. The Nooksack River also contains elevated fecal coliform densities and loads during the "first flush" compared to "baseflow," and fecal coliform loading associated with the Nooksack River is many orders of magnitude greater than that of Hermosa Beach freshwater discharges. Year 2 (1999-2000) appears to most clearly represent this relationship. Year 3 (2000-2001) "first flush" sampling was distributed over several months compared to the first two years (Figure 18).

As shown in Figure 18, the "first flush" from Hermosa Beach occurs at the same time as the Nooksack River "first flush" as evidenced by the increase in flows with the onset of the rainy season in the fall.

Geometric means at each "core" site for each season over the three-year study period are shown in Table 5. The freshwater core sites showed varied results over the three-year period.

- Nooksack River (Site 18) bacteria densities were variable during the three-year period, but the fecal coliform loading decreased over this period. This difference is likely due to the large influence of decreased flows that occurred during the third year (Figure 18), despite relatively high fecal coliform levels. "First flush" fecal coliform loadings were consistently greater than "baseflow" period loadings.
- Site 29 bacteria densities and fecal coliform loading were variable, but the overall loading (both "first flush" and "baseflow" combined) decreased over the three year period. The cause(s) of the variability of bacteria densities at Site 29, which is a relatively undeveloped watershed that discharges to Lummi Bay, is not evident.
- Site 31 "first flush" bacteria densities decreased over the three year period, and "baseflow" bacteria densities were variable and low. Fecal coliform loadings were consistently greater during the "baseflow" period than during the "first flush" due to increased flows.
- Site 37 had the highest "first flush" geometric means of the freshwater core sites, and "first flush" fecal coliform loadings were consistently greater than "baseflow" period loading. "Baseflow" period bacteria density and loading are among the lowest encountered at any site during the three year study. Bacteria levels dropped considerably after the first year of study, which may correspond to the discontinuation of a nearby horse paddock. The number of flow measurements is low at Site 37 compared to the other freshwater sites due to difficulties in obtaining flow measurements at Site 37.

Variability at background marine water core sites was less between sites than for the freshwater core sites. Bacteria densities decreased over the three year period during the "first flush" period at each site. "Baseflow" period bacteria levels were variable and low. Plume core sites showed bacteria density distributions intermediate to the freshwater and background marine water core sites.

The correspondence between Nooksack River loading and background marine water bacteria levels suggest that the Nooksack River is the primary source of bacteria to Portage Bay. Background marine water bacteria levels in the vicinity of Hermosa Beach freshwater discharges appear to be independent of the condition of the Hermosa Beach freshwater discharge. This is supported by findings in each year's individual analysis that:

- High bacteria levels occur in marine water when bacteria levels in nearby freshwater discharges are low.
- There is a substantial reduction (i.e., die off and/or dilution) of bacteria densities in the marine waters when fresh water bacteria levels are elevated.
- The relative bacteria loading of the Hermosa Beach discharges ranges from thousands to millions of times smaller than the Nooksack River bacteria loading.

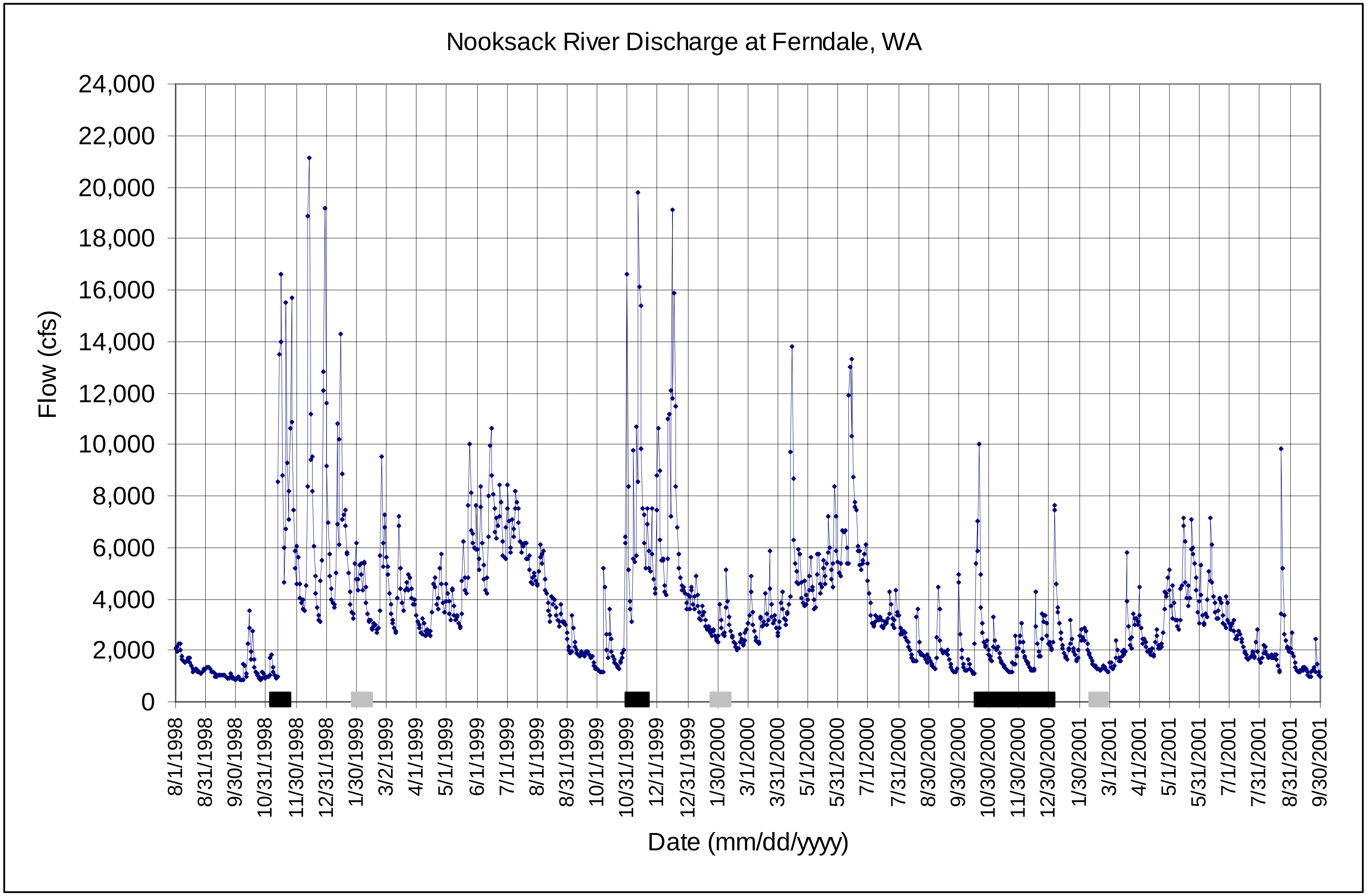

Figure 18. Nooksack River flows at Ferndale, Washington. Black rectangles along the x-axis show the “first flush” sampling period, and the grey rectangles along the x-axis show the “baseflow” sampling period.

Table 5. Geometric means for fecal coliform and *E. Coli* for core sample sites and fecal coliform loading for core sample sites with freshwater discharge for each year of study and all three years combined.

Sample Site	Year	Season	Fecal Coliform Geometric Mean (col./100 ml)	*E. Coli* Geometric Mean (col./100 ml)	Fecal Coliform Loading Geometric Mean (col./second)
18	1	Both	67.0	66.0	104,229,598
		First Flush	98.5	97.5	181,962,165
		Baseflow	47.7	46.7	63,748,570
	2	Both	41.1	37.4	54,417,269
		First Flush	69.1	56.6	157,746,205
		Baseflow	24.5	24.6	18,772,173
	3	Both	43.3	31.0	22,346,818
		First Flush	92.7	62.1	65,451,090
		Baseflow	19.3	14.9	7,162,448
	1 through 3	Both	48.9	41.9	49,115,783
		First Flush	85.4	68.9	119,958,355
		Baseflow	28.3	25.8	20,465,180
29	1	Both	54.1	43.0	12,671
		First Flush	65.5	54.1	2,515
		Baseflow	48.5	38.1	29,830
	2	Both	28.1	23.9	2,281
		First Flush	9.9	10.1	284
		Baseflow	79.5	56.8	18,340
	3	Both	9.7	8.3	570
		First Flush	14.9	14.7	442
		Baseflow	6.1	4.5	747
	1 through 3	Both	22.7	19.1	2,188
		First Flush	17.5	16.9	531
		Baseflow	28.7	21.4	7,419
30	1	Both	36.2	36.0	--
		First Flush	73.3	72.5	--
		Baseflow	21.1	21.1	--
	2	Both	12.3	11.6	--
		First Flush	43.2	37.7	--
		Baseflow	3.5	3.6	--
	3	Both	9.0	8.2	--
		First Flush	12.5	12.5	--
		Baseflow	6.4	5.3	--
	1 through 3	Both	15.3	14.5	--
		First Flush	31.3	29.7	--
		Baseflow	7.8	7.4	--
31	1	Both	24.7	24.7	1,391
		First Flush	98.7	98.7	415
		Baseflow	7.9	7.9	3,767
	2	Both	22.0	20.4	506
		First Flush	44.0	44.5	66
		Baseflow	11.0	9.3	3,849
	3	Both	11.6	12.1	311
		First Flush	21.0	22.9	174
		Baseflow	6.6	6.6	502
	1 through 3	Both	18.4	18.2	599
		First Flush	43.5	45.0	158
		Baseflow	8.3	7.9	1,938

Table 5. Geometric means for fecal coliform and *E. Coli* for core sample sites and fecal coliform loading for core sample sites with freshwater discharge for each year of study and all three years combined.

Sample Site	Year	Season	Fecal Coliform Geometric Mean (col./100 ml)	*E. Coli* Geometric Mean (col./100 ml)	Fecal Coliform Loading Geometric Mean (col./second)
32P	1	Both	28.3	26.3	--
		First Flush	66.3	55.4	--
		Baseflow	15.2	15.2	--
	2	Both	25.3	20.0	--
		First Flush	51.5	33.7	--
		Baseflow	12.5	11.8	--
	3	Both	15.7	14.4	--
		First Flush	37.9	33.9	--
		Baseflow	6.5	6.2	--
	1 through 3	Both	22.4	19.6	--
		First Flush	49.7	39.1	--
		Baseflow	10.8	10.5	--
32	1	Both	22.8	19.3	--
		First Flush	38.8	32.9	--
		Baseflow	14.3	12.0	--
	2	Both	8.6	7.2	--
		First Flush	31.6	23.1	--
		Baseflow	2.4	2.2	--
	3	Both	7.7	6.2	
		First Flush	25.4	24.1	
		Baseflow	2.3	1.6	
	1 through 3	Both	11.3	9.3	
		First Flush	31.2	26.1	
		Baseflow	4.3	3.5	
37	1	Both	518.7	295.7	19,492
		First Flush	6,684.4	4,033.0	57,873
		Baseflow	63.2	41.7	1,684
	2	Both	19.6	19.6	709
		First Flush	256	256	709
		Baseflow	1.5	1.5	--
	3	Both	19.3	19.1	68
		First Flush	257.7	254.5	600
		Baseflow	1.2	1.2	1.8
	1 through 3	Both	53.8	42.5	821
		First Flush	651.8	516.4	2,750
		Baseflow	4.9	4.1	28
38P	1	Both	85.4	82.2	--
		First Flush	553.2	553.2	--
		Baseflow	18.3	17.1	--
	2	Both	16.5	14.5	--
		First Flush	91.1	89.8	--
		Baseflow	3.0	2.3	--
	3	Both	17.0	13.9	--
		First Flush	91.0	91.0	--
		Baseflow	2.9	1.9	--
	1 through 3	Both	27.8	24.4	--
		First Flush	152.5	151.7	--
		Baseflow	5.4	4.2	--

Table 5. Geometric means for fecal coliform and *E. Coli* for core sample sites and fecal coliform loading for core sample sites with freshwater discharge for each year of study and all three years combined.

Sample Site	Year	Season	Fecal Coliform Geometric Mean (col./100 ml)	*E. Coli* Geometric Mean (col./100 ml)	Fecal Coliform Loading Geometric Mean (col./second)
38	1	Both	17.1	14.0	--
		First Flush	37.7	35.2	--
		Baseflow	8.1	5.9	--
	2	Both	9.2	8.5	--
		First Flush	26.2	22.7	--
		Baseflow	3.0	3.0	--
	3	Both	5.1	4.0	--
		First Flush	11.4	10.4	--
		Baseflow	2.1	1.4	--
	1 through 3	Both	9.0	7.6	--
		First Flush	21.9	19.8	--
		Baseflow	3.7	2.9	--

Table 6 and 7 present the results of correlation analysis performed using the “correlation” data analysis tool in Microsoft Excel 2000. Significance testing was also performed in Excel 2000 using the “regression” data analysis tool. The amount of significance testing performed was limited to six potential relationships that most clearly show the influence of the Nooksack River on marine core sites. The rationale for the limited use of significance testing is that the data are preliminary and subject to revision, the six selected correlations are unique, and they are central to the evaluation of the Nooksack River influence on Portage Bay. Fecal coliform and fecal coliform loading data were transformed using the formula of $X' = Log_{10}(X+1)$ (Zar 1984). Correlations using both transformed and non-transformed data are presented in Table 6 for evaluation. Table 7 presents a summary of Table 6, which contains the full results matrix of the correlation analysis. In the paragraphs below, when fecal coliform density and loading results are discussed, it is based on the logarithm transformed fecal coliform density and loading.

As shown in Tables 6 and 7, the influence of the Nooksack River (Site 18) is apparent on the core marine sites, and there is a notable lack of influence of Site 31 on core marine water sites. Although Site 37 fecal coliform densities and loadings are associated with Site 38 fecal coliform densities and loading, Site 37 also has similar correlations with every other sample site, which diminishes the associations between sites 37 and 38. In addition the number of observations for flow (and therefore loading) are low compared to the other freshwater sites. The Hermosa Beach upland sites (31 and 37) appear to have no influence on core marine site water quality. These results are consistent with the other reported results from this study.

Nooksack River (Site 18) flow is significantly and negatively related to the salinity of sites 30, 32, and 38. The salinity of each marine water core sites is significantly and negatively related to the fecal coliform density at that site. The above relationships are supported by associations of Nookack River fecal coliform density and loading to marine water core sites, and the association of salinity and fecal coliform between marine water core sites. In summary, the three years of data indicate that the Nooksack River influences salinity in Portage Bay, and bacteria in the Nookack River water further impacts Portage Bay water quality.

Site 31 flow and fecal coliform loading correlate strongly with Site 29 flow and loading. The two watersheds are large for the Lummi Peninsula and are also relatively undeveloped. The association of Nooksack River fecal coliform loading to Site 31 fecal coliform density may indicate that the contributing watersheds respond similarly to the climate, though the scales of the two watersheds are vastly different.

Table 6. Correlation coefficients for non-plume core sites using data from all three years of study. The order of sites and parameters presented is to facilitate comparison between site types (e.g., marine water) and location. “FC” is fecal coliform, “Load” is fecal coliform load, and “Sal.” is salinity. Where “Log” precedes a parameter name, the parameter results were transformed using the formula: Logarithm (parameter value +1) using a base 10 logarithm for the correlation analysis. Matrix is continued on the next page. Non-logarithm transformed data is presented for comparison.

Site No. / Parameter		18					30			32			38		
		FC	Log FC	Load	Log Load	Flow	Sal.	FC	Log FC	Sal.	FC	Log FC	Sal.	FC	Log FC
18	FC	1.000	--	--	--	--	--	--	--	--	--	--	--	--	--
	Log FC	0.815	1.000	--	--	--	--	--	--	--	--	--	--	--	--
	Load	0.830	0.781	1.000	--	--	--	--	--	--	--	--	--	--	--
	Log Load	0.644	0.897	0.801	1.000	--	--	--	--	--	--	--	--	--	--
	Flow	0.095	0.323	0.519	0.671	1.000	--	--	--	--	--	--	--	--	--
30	Sal.	0.064	-0.140	-0.212	-0.421	-0.614	1.000	--	--	--	--	--	--	--	--
	FC	0.067	0.255	0.186	0.318	0.291	-0.429	1.000	--	--	--	--	--	--	--
	Log FC	0.047	0.314	0.213	0.451	0.448	-0.620	0.794	1.000	--	--	--	--	--	--
32	Sal.	-0.031	-0.243	-0.270	-0.457	-0.523	0.713	-0.324	-0.486	1.000	--	--	--	--	--
	FC	0.125	0.194	0.049	0.145	0.011	-0.024	0.503	0.273	-0.065	1.000	--	--	--	--
	Log FC	0.332	0.544	0.393	0.583	0.350	-0.335	0.688	0.717	-0.465	0.536	1.000	--	--	--
38	Sal.	-0.078	-0.300	-0.294	-0.480	-0.494	0.644	-0.288	-0.407	0.931	-0.082	-0.460	1.000	--	--
	FC	0.103	0.275	0.297	0.365	0.398	-0.192	0.472	0.404	-0.338	0.275	0.531	-0.273	1.000	--
	Log FC	0.208	0.481	0.364	0.591	0.499	-0.381	0.603	0.670	-0.587	0.306	0.787	-0.586	0.702	1.000
31	FC	0.179	0.280	0.263	0.289	0.188	-0.184	0.146	0.199	-0.089	0.065	0.111	-0.087	0.019	0.093
	Log FC	0.253	0.400	0.432	0.459	0.428	-0.177	0.329	0.335	-0.094	0.145	0.242	-0.119	0.179	0.296
	Load	0.093	0.151	0.124	0.153	0.054	-0.163	0.009	0.072	-0.054	-0.048	-0.042	-0.042	0.008	0.017
	Log Load	0.029	-0.032	0.053	-0.038	-0.020	-0.050	-0.083	-0.111	0.071	-0.121	-0.267	0.115	-0.082	-0.193
	Flow	-0.130	-0.160	-0.193	-0.141	-0.212	-0.065	-0.205	-0.162	-0.008	-0.120	-0.227	0.028	-0.154	-0.204
37	FC	0.093	0.252	0.189	0.241	0.160	0.069	0.243	0.239	0.110	0.122	0.171	0.078	0.102	0.121
	Log FC	0.293	0.522	0.466	0.634	0.537	-0.258	0.396	0.504	-0.235	0.158	0.464	-0.250	0.294	0.492
	Load	0.208	0.330	0.529	0.393	0.370	-0.104	0.272	0.293	0.035	-0.048	0.230	0.144	0.383	0.214
	Log Load	0.310	0.378	0.506	0.460	0.398	0.348	0.066	0.034	0.329	-0.397	-0.121	0.435	0.210	0.085
	Flow	0.168	0.220	0.293	0.275	0.227	-0.074	0.256	0.259	-0.028	-0.084	0.168	0.001	0.401	0.347
29	FC	0.047	0.103	0.084	0.171	0.173	-0.149	0.204	0.067	-0.054	0.248	0.103	-0.095	0.102	0.139
	Log FC	0.094	0.094	0.151	0.205	0.211	-0.221	0.133	0.037	-0.100	0.116	-0.001	-0.104	0.103	0.060
	Load	-0.029	-0.015	-0.035	0.054	0.003	-0.184	-0.071	-0.055	0.018	-0.044	-0.097	0.013	-0.068	-0.024
	Log Load	-0.031	-0.099	-0.022	-0.016	0.033	-0.173	0.009	-0.074	-0.012	0.000	-0.193	0.022	-0.040	-0.138
	Flow	-0.030	-0.052	-0.047	-0.007	-0.085	-0.161	-0.081	-0.023	-0.003	-0.114	-0.130	0.057	-0.121	-0.150

Table 6. Continued. Correlation coefficients for non-plume core sites using data from all three years of study. The order of sites and parameters presented is to facilitate comparison between site types (e.g., marine water) and location. “FC” is fecal coliform, “Load” is fecal coliform load, and “Sal.” is salinity. Where “Log” precedes a parameter name, the parameter results were transformed using the formula: Logarithm (parameter value +1) using a base 10 logarithm for the correlation analysis. Non-logarithm transformed data is presented for comparison.

Site No. / Parameter		31					37					29				
		FC	Log FC	Load	Log Load	Flow	FC	Log FC	Load	Log Load	Flow	FC	Log FC	Load	Log Load	Flow
18	FC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Log FC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Load	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Log Load	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Flow	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
30	Sal.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	FC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Log FC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
32	Sal.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	FC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Log FC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
38	Sal.	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	FC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Log FC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
31	FC	1.000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Log FC	0.639	1.000	--	--	--	--	--	--	--	--	--	--	--	--	--
	Load	0.833	0.444	1.000	--	--	--	--	--	--	--	--	--	--	--	--
	Log Load	0.310	0.386	0.487	1.000	--	--	--	--	--	--	--	--	--	--	--
	Flow	-0.175	-0.230	0.210	0.595	1.000	--	--	--	--	--	--	--	--	--	--
37	FC	0.317	0.616	0.057	0.135	-0.234	1.000	--	--	--	--	--	--	--	--	--
	Log FC	0.360	0.683	0.147	0.006	-0.326	0.618	1.000	--	--	--	--	--	--	--	--
	Load	0.140	0.505	0.044	0.329	-0.135	0.773	0.514	1.000	--	--	--	--	--	--	--
	Log Load	0.113	0.656	0.033	0.521	-0.125	0.533	0.891	0.611	1.000	--	--	--	--	--	--
	Flow	-0.114	0.094	-0.034	0.164	0.355	0.069	0.318	0.338	0.465	1.000	--	--	--	--	--
29	FC	0.103	0.339	0.129	0.396	0.190	0.529	0.281	0.333	0.599	0.406	1.000	--	--	--	--
	Log FC	0.089	0.317	0.189	0.582	0.420	0.371	0.280	0.345	0.607	0.414	0.811	1.000	--	--	--
	Load	-0.088	0.002	0.228	0.528	0.661	0.024	0.060	0.024	0.070	0.494	0.575	0.605	1.000	--	--
	Log Load	-0.083	0.032	0.123	0.728	0.693	0.123	-0.008	0.255	0.278	0.467	0.605	0.856	0.715	1.000	--
	Flow	-0.165	-0.228	0.092	0.536	0.808	-0.177	-0.117	-0.029	-0.047	0.413	0.133	0.380	0.719	0.716	1.000

Table 7. Selected correlation coefficients from Table 6. Asterixes (*) denote the six correlations were tested for significance, which are significant at an alpha of 0.05 (less 5 percent probability).

Grouping	Site and Parameter Pairs	Correlation Coefficient
Nooksack River to Marine Water Core Sites	18—Flow to 30—Salinity *	-0.614
	18—Flow to 32—Salinity *	-0.523
	18—Flow to 38—Salinity *	-0.494
	18—LogFC to 30—LogFC	0.314
	18—LogFC to 32—LogFC	0.544
	18—LogFC to 38—LogFC	0.481
	18—LogLoad to 30—LogFC	0.451
	18—LogLoad to 32—LogFC	0.583
	18—LogLoad to 38—LogFC	0.591
Core Marine Sites to Core Marine Sites	30—Salinity to 32—Salinity	0.713
	30—Salinity to 38—Salinity	0.644
	32—Salinity to 38—Salinity	0.931
	30—LogFC to 32—LogFC	0.717
	30—LogFC to 38—LogFC	0.670
	32—LogFC to 38—LogFC	0.787
Within Core Marine Sites	30—Sal. to 30—LogFC *	-0.620
	32—Sal. to 32—LogFC *	-0.465
	38—Sal. to 38—LogFC *	-0.586
Freshwater Core Sites To Freshwater Core Sites	18—LogLoad to 31—LogFC	0.459
	31—Flow to 29—Flow	0.808
	31—LogLoad to 29—LogLoad	0.728

4. CONCLUSIONS

While the results are preliminary, it does not appear that local runoff is a substantial source of fecal coliform to Portage Bay. Fecal coliform densities were elevated during the onset of overland flow in the fall during the “first flush” period from the Hermosa Beach freshwater sites. However, the quantity of flow at this time was very small. Fecal coliform densities in the runoff generally decreased as the rainy season progressed. When background (marine water) densities of fecal coliform are low and the fecal coliform densities in the freshwater sources elevated, the reduction (die off and/or dilution) of fecal coliform bacteria between the freshwater source and marine waters spanned between 2 and 3 orders of magnitude. In addition, marine water did not appear impacted by Hermosa Beach freshwater discharges and elevated bacteria levels occur in marine waters independent of local (Hermosa Beach) freshwater sources. Fecal coliform loading from the Nookack River is many orders of magnitude greater than that from Hermosa Beach freshwater discharges, and the Nooksack River is a source of elevated bacteria densities to Portage Bay. These patterns were consistent during the three-year study.

In summary, the preliminary results over the three-year period are consistent and it is reasonable to conclude that:

- The Hermosa Beach uplands are not a substantial source of bacteria to Portage Bay.
- Freshwater contributions to Portage Bay from Hermosa Beach were not the cause of the “Restricted” classification in place at the time.
- The Nooksack River has a significant influence on salinity in Portage Bay.
- The Nooksack River has a significant influence on fecal coliform densities in Portage Bay.

5. REFERENCES

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APPENDIX A. TABLE OF RESULTS

DATA ARE DRAFT AND
PRELIMINARY, SUBJECT TO REVISIONS

Key to terms used in Appendix A:
(Arranged in the order found in the Appendix).

Column	Item	Description
Date	6/2/98	Month/day/year
Time	13:50	24 hour time, 1:50 pm
Sampler	AR	Andy Ross
	KT	Keith Tom
	LDD	Lenny Dixon
	SH	Steve Heywood
	TM	Tom Morris
Strat.?	0	Water column not stratified with respect to salinity
	1	Water column is stratified with respect to salinity
If strat., sample location.	T	Water sample collected from upper strata
	B	Water sample collected from lower strata
Probe Water Temp.		Water temperature measured with probe on conductivity meter
Nt		Note An asterix (*) means that the number of colonies on the plate was outside of the desired range of 20 to 60 Two asterixes (**) indicate that *E coli.* could not be differentiated
Descriptive Flow rate	CFS	Cubic feet per second
	<<<	Much less than
	<	Less than
Flow Method	VIS	Visual estimation
	NB	Neutral buoyancy object
	VOL	Volumetric
	(C/B)	Catch Basin (where flow observed)
	ST	Staff Gage
	USGS	U.S. Geological Survey flow gage data
Flow direction	us	Upstream
	ds	Downstream
	ne	None evident
	NW, SW, etc.	Compass direction from which current flowing (only compass directions are capitalized).
Depth	m	Depth in meters
	VG	Elevation of the line vegetation along the shoreline
	VG-1	1 foot below the line of vegetation, applies for water levels above and below line of vegetation (e.g., VG+2).

Lummi Indian Reservation Hermosa Beach Fecal Coliform Study, Fall 2000 to Winter 2001

PRELIMINARY, SUBJECT TO REVISIONS

DATA NOT VERIFIED AND NOT STANDARDIZED

Sample Site Number	Date (mm/dd/yy)	Time (24 hrs)	Sampler	Stratified? 0 = No 1 = Yes	If Strat., Sample Depth	Probe Water Temp (C)	Conductivity (micromhos/cm)	Salinity (ppt)	Fecal Coliform (col./100 ml)	Nt	E. Coli. (col./100 ml)	Nt	Fecal Coliform Loading (col./sec)	Numeric Flow Rate (cfs)	Descriptive Flow Rate (cfs)	Flow Method	Flow Direction (from)	Depth (m)	Comments
18	10/17/00	9:33	KT	0		9.7	123	0.0	260.0		260.0		167,832,350.4	2280		USGS	ds	VG-0.91	
18	10/18/00	11:34	KT	0		10.1	84	0.0	360.0		360.0		545,285,268.0	5350		USGS	ds	VG-0.61	Brown, muddy water.
18	10/20/00	12:20	KT, SH	0		9.5	79	0.0	72.0		72.0		119,860,836.5	5880		USGS	ds	VG-0.91	
18	11/08/00	13:18	AR	0		7.2	105	0.0	49.0		49.0		27,884,291.8	2010		USGS	ds	0.46	Water clear, water level low.
18	11/09/00	10:12	AR	0		6.7	74	0.0	77.0		77.0		46,216,182.3	2120		USGS	ds		Browish water
18	11/29/00	15:14	AR	0		4.9	111	0.0	14.0		14.0		6,976,027.5	1760		USGS	ds		Clear, calm, low water.
18	11/30/00	9:43	KT	0		5.3	120	0.0	55.0		55.0		32,232,984.3	2070		USGS	ds	VG	
18	12/16/00	13:08	KT	0		1.1	128	0.0	20.0		20.0		7,304,444.4	1290		USGS		VG-0.91	Wind blowing waves upstream.
18	12/17/00	10:58	KT	0		2.5	85	0.0	1,000.0		1,000.0		1,206,082,680.0	4260		USGS	ds	VG	Ice chuncks floating downstream, brown water.
18	12/18/00	11:43	KT	0		2.8	100	0.0	300.0		1.8		248,011,368.0	2920		USGS	ds	VG-0.46	Water is very brown.
18	12/19/00	12:56	KT	0		3.4	113	0.0	60.0		60.0		38,730,542.4	2280		USGS	ds	VG-1.22	
18	12/20/00	11:50	KT	0		2.9	117	0.0	49.0		49.0		27,190,652.7	1960		USGS	ds	VG-1.22	Brown water
18	12/21/00	10:35	KT	0		3.3	123	0.0	230.0		60.0		115,257,337.8	1770		USGS	ds	VG-1.52	
18	12/21/00	13:10	KT	0		3.4	121	0.0	210.0		100.0		105,234,960.6	1770		USGS	ds	VG-0.91	
18	12/27/00	10:28	KT	0		5.8	101	0.0	50.0	*	50.0	*	47,563,824.0	3360		USGS	ds	VG-0.91	
18	12/27/00	13:15	KT	0		5.8	101	0.0	30.0	*	30.0	*	28,538,294.4	3360		USGS	ds	VG-1.22	
18	01/02/01	15:38	AR	0		5.4	117	0.0	17.0		17.0		10,107,312.6	2100		USGS	ds		
18	01/04/01	9:28	KT	0		6.0	114	0.0	600.0		600.0		399,196,380.0	2350		USGS	ds	VG-0.91	Water very brown, turbid.
18	02/14/01	11:12	KT	0		3.6	137	0.0	17.0		17.0		6,882,598.6	1430		USGS	ds	VG-0.91	
18	02/15/01	10:56	KT	0		3.1	139	0.0	21.0		0.8		8,383,124.0	1410		USGS	ds	VG-0.91	
18	02/17/01	12:08	KT	0		2.5	140	0.0	8.0		8.0		2,944,427.2	1300		USGS	ds	VG-0.61	Water is clear.
18	02/18/01	12:38	KT	0		4.8	137	0.0	20.0		12.0		7,361,068.0	1300		USGS	ds	VG-0.61	
18	02/19/01	10:32	KT	0		5.5	136	0.0	21.0		21.0		7,788,576.2	1310		USGS	ds	VG-0.91	Water is clear.
18	02/20/01	11:01	KT	0		4.8	142	0.0	24.0		24.0		8,493,540.0	1250		USGS	ds	VG-0.91	
18	02/21/01	9:32	KT	0		4.8	143	0.0	15.0		15.0		5,181,059.4	1220		USGS	ds		
18	02/22/01	10:04	KT	0		6.6	143	0.0	25.0		25.0		9,201,335.0	1300		USGS	ds	VG-1.07	Water is clear.
18	02/22/01	13:06	KT	0		7.5	142	0.0	10.0		10.0		3,680,534.0	1300		USGS	ds	VG-1.22	
18	02/23/01	10:07	KT	0		6.3	134	0.0	250.0		210.0		98,383,505.0	1390		USGS	ds	VG-0.61	
18	02/23/01	12:38	KT	0		6.5	133	0.0	28.0		21.0		11,018,952.6	1390		USGS	ds	VG-0.91	
18	02/24/01	10:35	AR	0		6.0	133	0.0	17.0		17.0		6,593,818.2	1370		USGS	ds	VERY LOW	Fishing ducks in River, clear water.
18	02/25/01	11:28	KT	0		5.4	132	0.0	12.0		12.0		4,620,485.8	1360		USGS	ds	VG--0.91	
18	02/26/01	9:57	KT	0		5.0	134	0.0	23.0		23.0		8,269,876.8	1270		USGS	ds	VG-0.76	
18	02/26/01	12:07	KT	0		5.4	135	0.0	13.0		13.0		4,674,278.2	1270		USGS	ds	VG-0.91	Clear water
18	02/27/01	9:57	KT	0		5.2	136	0.0	18.0		18.0		6,166,310.0	1210		USGS	ds	VG-0.76	
18	02/28/01	9:22	KT	0		4.9	139	0.0	9.0		7.0		3,006,713.2	1180		USGS	ds	VG-0.61	
29	10/17/00	12:19	KT	0		11.2	154	0.0	250.0		250.0		12,124.5	0.1713		ST	ds	0.0800	
29	10/18/00	13:10	KT	0		11.5	162	0.0	54.0		54.0		710.9	0.0465		ST	ds	0.0396	
29	10/20/00	14:50	KT, SH	0		11.3	190	0.0	10.0	*	10.0	*	209.8	0.0741		ST	ds	0.0518	
29	11/08/00	11:34	AR	0		7.1	154	0.0	40.0	*	40.0	*	2,514.1	0.222		ST	ds	0.0945	
29	11/09/00	12:59	AR	0		6.2	159	0.0	6.0	*	6.0	*	153.4	0.0903		ST	ds	0.0558	
29	11/29/00	15:02	AR	0		5.5	158	0.0	2.0	*	2.0	*	19.8	0.035		ST	ds	0.0335	
29	11/30/00	15:25	KT, TM	0		7.3	164	0.0	2.0	*	2.0	*	26.3	0.0465		ST	ds	0.0396	
29	12/16/00	16:04	KT, LDD	0		0.1	158	0.0	110.0		110.0		1,955.8	0.0628		ST	ds	0.1615	
29	12/17/00	13:06	KT	0		0.7	149	0.0	64.0		64.0		2,893.7	0.1597		ST	ds	0.0792	
29	12/18/00	13:25	KT	0		0.8	154	0.0	12.0	*	12.0	*	202.1	0.0595		ST	ds	0.0457	
29	12/19/00	14:41	KT	0		1.6	159	0.0	6.0	*	6.0	*	153.4	0.0903		ST	ds	0.0579	
29	12/20/00	14:00	KT	0		1.1	166	0.0	1.8		1.8		26.9	0.0528		ST	ds	0.0427	
29	12/21/00	12:39	KT	0		2.3	166	0.0	1.0		0.8		14.9	0.0528		ST	ds	0.0427	
29	12/21/00	14:36	KT	0		2.6	167	0.0	3.0		3.0		50.5	0.0595		ST	ds	0.0457	
29	12/27/00	12:56	KT	0		5.7	161	0.0	62.0		62.0		6,687.8	0.381		ST	ds	0.1250	
29	12/27/00	15:34	KT	0		5.9	162	0.0	19.0		19.0		1,855.8	0.345		ST	ds	0.1189	
29	01/02/01	12:45	AR	0		5.9	166	0.0	36.0		36.0		1,869.3	0.1834		ST	ds	0.0838	
29	01/04/01	15:41	KT	0		6.3	152	0.0	88.0		88.0		13,503.6	0.542		ST	ds	0.1494	
29	02/14/01	14:09	KT	0		3.2	148	0.0	12.0	*	12.0	*	2,381.6	0.701		ST	ds	0.1737	
29	02/15/01	13:38	KT	0		1.9	141	0.0	18.0	*	18.0	*	4,668.0	0.916		ST	ds	0.2073	
29	02/17/01	13:58	KT	0		2.9	146	0.0	23.0		23.0		4,447.5	0.683		ST	ds	0.1707	
29	02/18/01	14:29	KT	0		4.7	240	0.0	12.0		12.0		2,636.4	0.776		ST	ds	0.1859	
29	02/19/01	12:20	KT	0		3.7	145	0.0	35.0		0.8		7,134.6	0.72		ST	ds	0.1768	
29	02/20/01	13:30	KT	0		4.4	146	0.0	7.0		7.0		1,163.3	0.587		ST	ds	0.1554	
29	02/21/01	15:41	KT	0		5.2	147	0.0	8.0		8.0		1,177.8	0.52		ST	ds	0.1463	
29	02/22/01	12:21	KT	0		6.1	144	0.0	2.0	*	2.0	*	306.9	0.542		ST	ds	0.1494	
29	02/22/01	14:45	KT	0		6.6	144	0.0	12.0		12.0		1,841.4	0.542		ST	ds	0.1494	
29	02/23/01	11:54	KT	0		5.2	145	0.0	10.0		10.0		1,353.3	0.478		ST	ds	0.1402	
29	02/23/01	14:22	KT	0		5.6	146	0.0	2.0	*	2.0	*	270.7	0.478		ST	ds	0.1402	
29	02/24/01	12:29	AR	0		5.5	145	0.0	6.0	*	6.0	*	89.7	0.0528		ST	ds	0.0418	
29	02/25/01	13:47	KT	0		4.7	144	0.0	3.0		3.0		293.0	0.345		ST	ds	0.1189	
29	02/26/01	11:51	KT	0		3.0	148	0.0	1.0		1.0		79.3	0.28		ST	ds	0.1067	
29	02/26/01	14:38	KT	0		4.5	146	0.0	4.0		4.0		335.2	0.296		ST	ds	0.1097	
29	02/27/01	15:44	KT	0		4.4	145	0.0	2.0		2.0		158.5	0.28		ST	ds	0.1067	
29	02/28/01	10:59	KT	0		2.5	146	0.0	3.0		0.8		237.8	0.28		ST	ds	0.1067	

Lummi Indian Reservation Hermosa Beach Fecal Coliform Study, Fall 2000 to Winter 2001

PRELIMINARY, SUBJECT TO REVISIONS

DATA NOT VERIFIED AND NOT STANDARDIZED

Sample Site Number	Date (mm/dd/yy)	Time (24 hrs)	Sampler	Stratified? 0 = No 1 = Yes	If Strat., Sample Depth	Probe Water Temp (C)	Conductivity (micromhos/cm)	Salinity (ppt)	Fecal Coliform (col./100 ml)	Nt	E. Coli. (col./100 ml)	Nt	Fecal Coliform Loading (col./sec)	Numeric Flow Rate (cfs)	Descriptive Flow Rate (cfs)	Flow Method	Flow Direction (from)	Depth (m)	Comments
30	10/17/00	9:54	KT	0		11.4	32,500	19.4	250.0		250.0						ne	0.46	3 to 4 ft. waves from SE.
30	10/18/00	11:52	KT	0		11.7	43,100	27.0	1.8		1.8						S	0.91	Bay calm, 1' waves.
30	10/20/00	13:18	KT, SH	0		11.3	42,200	26.4	30.0	*	30.0	*					S	0.61	
30	11/08/00	13:02	AR	0		9.8	43,900	27.6	4.0		4.0						S	0.91	Clear calm water.
30	11/09/00	9:58	AR	0		9.1	44,500	27.8	0.8		0.8						N	0.61	
30	11/29/00	14:47	AR	0		6.7	32,000	19.2	80.0		80.0						ne	0.61	
30	11/30/00	9:57	KT, TM	0		7.1	35,900	21.8	20.0	*	20.0	*					S	0.61	Majority of Bellingham Bay is brown, 2' to 5' waves.
30	12/16/00	13:30	KT, LDD	0		4.6	41,200	26.3	20.0	*	20.0	*					ne	0.30	Wind and waves from SE, 3' to 4' waves.
30	12/17/00	11:16	KT	0		6.1	46,500	29.0	2.0		2.0						S	0.61	Lots of wood and debris along shore.
30	12/18/00	11:58	KT	1	T	5.2	41,200	25.4	27.0		27.0						S	0.76	Bellingham Bay calm and clear.
30	12/18/00	11:58	KT	1	B	5.4	44,000	27.2											
30	12/19/00	13:18	KT	1	T	5.1	35,400	21.4	10.0		10.0						N	0.61	Bellingham Bay calm and clear.
30	12/19/00	13:18	KT	1	B	6.0	44,200	27.5											
30	12/20/00	12:20	KT	0		4.7	41,600	25.6	5.0		5.0						S	0.46	Bellingham Bay calm and clear, lots of wood debris along shoreline.
30	12/21/00	10:50	KT	1	T	4.1	35,800	21.5	42.0		42.0						N	0.76	Bellingham Bay calm and clear.
30	12/21/00	10:50	KT	1	B	4.8	40,000	24.4											
30	12/21/00	13:28	KT	0		4.8	38,900	23.6	33.0		33.0						S	0.61	1' to 2' waves from SE.
30	12/27/00	10:50	KT	0		6.8	44,100	27.3	5.0		5.0						N	0.76	2' to 3' waves from E.
30	12/27/00	13:35	KT	1	T	6.9	44,100	26.3	10.0		10.0						N	0.61	Bay calm and clear.
30	12/27/00	13:35	KT	1	B	6.9	43,600	26.9											
30	01/02/01	14:50	AR	1	T	6.3	--	12.0	7.0		7.0						N	0.61	Clear water
30	01/02/01	14:50	AR	1	B	7.1	34,500	20.4											
30	01/04/01	9:44	KT	1	T	6.0	19,300	11.0	30.0		30.0						N	0.76	Bay is calm and clear.
30	01/04/01	9:44	KT	1	B	6.7	39,200	24.0											
30	02/14/01	11:33	KT	0		5.3	37,500	22.7	36.0		36.0						S	0.76	2' to 3' waves from SE.
30	02/15/01	11:18	KT	0		1.9	14,230	7.9	290.0		290.0						N	0.76	
30	02/17/01	12:27	KT	1	T	4.7	38,900	22.3	12.0	*	6.0	*					E	0.91	Bellingham Bay calm and clear.
30	02/17/01	12:27	KT	1	B	4.8	41,900	25.8											
30	02/18/01	12:59	KT	0		5.5	39,900	24.2	15.0		15.0						S	0.91	
30	02/19/01	10:49	KT	1	T	5.3	41,700	25.6	4.0		4.0						N	0.91	Waves from NE, current appears to be wind driven.
30	02/19/01	10:49	KT	1	B	5.3	42,100	26.0											
30	02/20/01	11:22	KT	1	T	5.2	29,900	17.8	6.0		3.0						S	0.91	Bellingham Bay calm and clear.
30	02/20/01	11:22	KT	1	B	6.4	43,600	27.3											
30	02/21/01	9:50	KT	1	T	2.9	16,700	9.0	69.0		69.0						N	0.91	Bellingham Bay calm and clear.
30	02/21/01	9:50	KT	1	B	5.9	46,100	28.6											
30	02/22/01	10:06	KT	0		7.5	46,100	28.2	1.0		1.0						N	0.76	Bellingham Bay calm and clear.
30	02/22/01	13:27	KT	1	T	8.3	37,700	23.1	1.0		1.0						S	0.91	
30	02/22/01	13:27	KT	1	B	8.2	39,300	24.1											
30	02/23/01	10:28	KT	0		6.7	45,900	28.6	2.0		2.0						S	0.76	1' to 3' waves from SE.
30	02/23/01	12:54	KT	0		6.8	41,000	25.2	8.0	*	8.0	*					S.	0.76	
30	02/24/01	10:52	AR	1	T	6.6	22,900	13.4	11.0		9.0						ne	0.53	1' waves from SE, water clear green.
30	02/24/01	10:52	AR	1	B	7.6	36,100	22.1											
30	02/25/01	11:51	KT	1	T	6.0	35,100	21.3	1.0		1.0						S	0.61	
30	02/25/01	11:51	KT	1	B	7.2	43,200	27.1											
30	02/26/01	10:16	KT	0		7.2	45,500	28.3	4.0		0.8						N	0.76	Bellingham Bay clear, 1' to 3' waves.
30	02/26/01	12:30	KT	0		8.3	43,900	27.5	0.8		0.8						S	0.61	
30	02/27/01	10:14	KT	1	T	6.3	43,300	26.9	0.8		0.8						N	0.76	Bellingham Bay calm and clear.
30	02/27/01	10:14	KT	1	B	6.3	44,800	27.8											
30	02/28/01	9:40	KT	1	T	4.7	32,300	19.2	33.0		33.0						S	0.91	1' to 2' waves from SE.
30	02/28/01	9:40	KT	1	B	5.0	35,600	21.4											
31	10/17/00	11:37	KT	0		12.0	57	0.0	710.0		710.0		643.2	0.0032		VOL	ds		
31	10/18/00	12:16	KT	0		12.8	177	0.0	210.0		210.0		59.5	0.001		VOL	ds		0.0032m deep at culvert outlet.
31	11/08/00	12:44	AR	0		7.9	353	0.0	100.0	*	100.0	*	59.5	0.0021	<0.0022	VIS	ds	0.06	
31	11/09/00	8:45	AR	0		4.2	777	0.1	9.8		9.8						ds	0.03	
31	11/29/00	13:39	AR	0		6.1	677	0.1	40.0		40.0		11.3	0.001	<<<0.0022	VIS	ds	0.04	Turbid water.
31	11/30/00	11:35	KT, TM	DRY, NO FLOW									0.0	0		VIS			
31	12/16/00	14:00	KT, LDD	0		4.6	5,240	2.7	10.0	*	40.0	*	167.0	0.059		NB	ds	0.10	Flow from ditch to north and south.
31	12/17/00	11:45	KT	0		3.2	192	0.0	64.0		64.0		1,105.3	0.061		NB	ds	0.05	Majority of flow from the north.
31	12/18/00	12:31	KT	0		2.8	193	0.0	24.0		24.0		203.8	0.03		NB	ds	0.05	
31	12/19/00	13:41	KT	0		3.4	193	0.0	28.0		28.0		174.4	0.022		NB	ds	0.05	
31	12/20/00	12:46	KT	0		2.3	185	0.0	14.0	*	14.0	*	75.3	0.019		NB	ds	0.03	
31	12/21/00	11:18	KT	0		3.3	186	0.0	8.0	*	8.0	*	27.2	0.012		NB	ds	0.05	
31	12/21/00	13:56	KT	0		3.5	183	0.0	6.0	*	6.0	*					ds	0.05	Unable to measure flow due to high tide and waves.
31	12/27/00	11:30	KT	0		5.5	180	0.0	6.0	*	6.0	*	708.4	0.417		NB	ds	0.09	
31	12/27/00	14:32	KT	0		5.8	178	0.0	1.8		1.8		158.0	0.31		NB	ds	0.08	
31	01/02/01	14:31	AR	0		6.1	173	0.0	8.0	*	8.0	*	645.3	0.2849		VOL	ds		Water tannin colored.
31	01/04/01	11:47	KT	0		5.9	162	0.0	9.8		9.8		926.7	0.334		VOL	ds	0.10	
31	02/14/01	12:51	KT	0		2.6	100	0.0	6.0	*	6.0	*	487.5	0.287		VOL	ds	0.05	
31	02/15/01	11:49	KT	0		1.6	99	0.0	36.0		36.0		3,985.2	0.391		VOL	ds	0.08	
31	02/17/01	12:59	KT	0		1.8	102	0.0	20.0		20.0		1,670.4	0.295		VOL	ds	0.06	
31	02/18/01	13:23	KT	0		3.8	98	0.0	24.0		24.0		1,882.2	0.277		VOL	ds	0.08	
31	02/19/01	11:22	KT	0		2.8	100	0.0	12.0	*	12.0	*	998.8	0.294		VOL	ds	0.06	

Lummi Indian Reservation Hermosa Beach Fecal Coliform Study, Fall 2000 to Winter 2001

PRELIMINARY, SUBJECT TO REVISIONS

DATA NOT VERIFIED AND NOT STANDARDIZED

Sample Site Number	Date (mm/dd/yy)	Time (24 hrs)	Sampler	Stratified? 0 = No 1 = Yes	If Strat., Sample Depth	Probe Water Temp (C)	Conductivity (micromhos/cm)	Salinity (ppt)	Fecal Coliform (col./100 ml)	Nt	E. Coli. (col./100 ml)	Nt	Fecal Coliform Loading (col./sec)	Numeric Flow Rate (cfs)	Descriptive Flow Rate (cfs)	Flow Method	Flow Direction (from)	Depth (m)	Comments
31	02/20/01	11:50	KT	0		3.5	101	0.0	8.0	*	8.0	*	663.6	0.293		VOL	ds	0.08	
31	02/21/01	11:34	KT	0		3.5	100	0.0	6.0	*	6.0	*	477.3	0.281		VOL	ds	0.05	
31	02/22/01	10:50	KT	0		5.6	104	0.0	10.0	*	10.0	*	775.7	0.274		VOL	ds	0.08	
31	02/22/01	13:47	KT	0		6.8	103	0.0	8.0	*	8.0	*	645.5	0.285		VOL	ds	0.08	
31	02/23/01	10:50	KT	0		4.5	99	0.0	2.0	*	2.0	*	168.2	0.297		VOL	ds	0.08	
31	02/23/01	13:24	KT	0		5.3	101	0.0	16.0	*	16.0	*	1,377.1	0.304		VOL	ds	0.08	
31	02/24/01	11:21	AR	0		5.3	103	0.0	8.0	*	8.0	*	792.7	0.35		VOL	ds		
31	02/25/01	12:26	KT	0		4.9	101	0.0	1.8		1.8		114.7	0.225		VOL	ds		
31	02/26/01	10:37	KT	0		2.9	101	0.0	2.0	*	2.0	*	120.0	0.212		VOL	ds	0.06	Surface flow to beach.
31	02/26/01	13:23	KT	0		4.6	102	0.0	6.0	*	6.0	*	344.8	0.203		VOL	ds	0.06	Surface flow to beach.
31	02/27/01	11:46	KT	0		3.7	102	0.0	1.8		1.8		91.2	0.179		VOL	ds	0.08	Surface flow to beach.
31	02/28/01	10:09	KT	0		2.2	102	0.0	2.0	*	2.0	*	105.9	0.187		VOL	ds	0.08	
32P	10/17/00	10:13	KT	0		11.5	32,500	19.8	5,100.0	*	5,100.0	*					S	0.15	
32P	10/17/00	11:27	KT	0		11.6	32,600	19.8	36,000.0	*	36,000.0	*					ne	0.13	2" to 8" waves.
32P	10/18/00	12:08	KT	0		12.5	41,600	26.0	110.0		110.0						S	0.15	
32P	11/08/00	12:34	AR	0		8.4	39,800	24.5	0.8		0.8						ne	0.09	Calm, clear.
32P	11/09/00	8:50	AR	0		8.6	37,100	22.7	3.0		3.0						ne	0.05	Clear, 4" waves.
32P	11/29/00	13:33	AR	0		6.6	35,700	21.6	60.0		60.0						ne	0.08	
32P	12/16/00	13:50	KT, LDD	0		5.4	43,500	26.3	30.0	*	30.0	*					S	0.08	
32P	12/17/00	11:32	KT	0		5.8		12.9	6.0		6.0						S	0.08	Salinity varied from 2.4 to 23.4 ppt., conductivity too variable to record.
32P	12/18/00	12:20	KT	0		3.2		7.8	100.0		100.0						S	0.08	Salinity varied from 3.0 to 12.6 ppt., conductivity too varialble to record.
32P	12/19/00	13:30	KT	0		4.4		14.2	50.0		50.0						S	0.08	Conductivity too variable to record.
32P	12/20/00	12:35	KT	0		2.5		6.4	26.0		26.0						S	0.05	Conductivity too variable to record.
32P	12/21/00	11:06	KT	0		4.6		6.2	58.0		58.0						N	0.08	Conductivity too variable to record.
32P	12/21/00	13:45	KT	0		3.7		9.3	400.0		400.0						S	0.05	Conductivity too variable to record.
32P	12/27/00	11:08	KT	0		5.6		5.5	2.0	*	2.0	*					N	0.08	Conductivity too variable to record.
32P	12/27/00	13:52	KT	0		6.9		7.4	1.8		1.8						N	0.05	Conductivity too variable to record.
32P	01/02/01	14:20	AR	0		6.8		9.6	10.0	*	10.0	*						0.05	Salinity varied from 2.6 to 11.4, ppt., conductivity too variable to record.
32P	01/04/01	11:38	KT	0		6.0		4.6	12.0	*	1.8						N	0.15	Conductivity too variable to record.
32P	02/14/01	12:38	KT			4.7		12.3	6.0	*	6.0	*					S	0.08	Salinity varied from 3.8 to 20.8 ppt., conductivity too variable to record.
32P	02/15/01	11:38	KT	0		2.4		6.4	98.0		98.0						N	0.05	Conductivity too variable to record.
32P	02/17/01	12:48	KT	0		2.9		7.5	16.0		16.0						S	0.08	Conductivity too variable to record.
32P	02/18/01	13:12	KT	0		4.4		7.4	10.0	*	10.0	*					S	0.08	Conductivity too variable to record.
32P	02/19/01	11:09	KT	0		3.6		7.0	16.0	*	16.0	*					N	0.05	Conductivity too variable to record.
32P	02/20/01	11:38	KT	0		6.7		4.6	36.0		36.0						S	0.05	Conductivity too variable to record.
32P	02/21/01	11:20	KT	0		6.7		11.9	10.0	*	10.0	*					S	0.08	Salinity varied from 3.5 to 20.3 pptl., conductivity too variable to record.
32P	02/22/01	10:38	KT	0		7.3		7.3	4.0	*	4.0	*					N	0.04	Salinity varied from 0.6 to 13.9 ppt., conductivity too variable to record.
32P	02/22/01	13:41	KT	0		7.7		6.7	6.0	*	6.0	*					N	0.04	Salinity varied from 0.1 to 13.2 ppt., conductivity too variable to record.
32P	02/23/01	10:41	KT	0		5.8		6.6	8.0	*	8.0	*					N	0.05	Salinity varied from 0.1 to 12.1 ppt., conductivity too variable to record.
32P	02/23/01	13:14	KT	0		6.5		13.5	6.0	*	6.0	*					N	0.05	Salinity varied from 1.4 to 12.1 ppt., conductivity too variable to record.
32P	02/24/01	11:13	AR	0		6.5		9.7	2.0	*	2.0	*					N	0.08	Salinity varied from 3.4 to 16.0 ppt., conductivity too variable to record.
32P	02/25/01	12:13	KT	0		9.2		6.0	1.8		1.8						N	0.05	Salinity varied from 1.8 to 10.2 ppt., conductivity too variable to record.
32P	02/26/01	10:28	KT	0		6.6		9.5	2.0		2.0						N	0.05	Salinity varied from 6.9 to 12.1 ppt., conductivity too variable to record.
32P	02/26/01	13:08	KT	0		11.1		15.5	0.8		0.8						S	0.04	Salinity varied from 9.8 to 21.2 ppt., conductivity too variable to record.
32P	02/27/01	11:34	KT	0		9.2		8.9	1.8		1.8						S	0.05	Salinity varied from 9.6 to 13.2 ppt., conductivity too variable to record.
32P	02/28/01	9:58	KT	0		2.6		7.4	10.0	*	4.0	*					N	0.05	Salinity varied from 1.6 to 13.2 ppt., conductivity too variable to record.
32	10/17/00	11:33	KT	0		11.5	32,600	19.9	7,000.0		7,000.0						S	0.46	Wind stron from south.
32	10/18/00	12:13	KT	0		11.8	41,800	26.1	22.0		22.0						S	0.76	
32	11/08/00	12:38	KT	0		9.7	43,700	27.3	0.8		0.8						N	0.76	
32	11/09/00	9:00	KT	1	T	8.4	33,100	22.8	3.0		33.0						N	0.61	Calm conditions, gradual change in salinity.
32	11/09/00	9:00	KT	1	B	9.2	41,800	26.0											
32	11/29/00	13:35	AR	1	T	6.6		21.7	40.0		40.0						S	0.76	Conductivity too variable to record. Salinity varied from 21.4 to 21.9 ppt.
32	11/29/00	13:35	AR	1	B	6.8	37,000	22.6											
32	11/30/00	11:38	KT, TM	0		7.4	39,500	24.2	87.0		87.0						S	0.76	1' to 3' waves.
32	12/16/00	13:56	KT, LDD	0		5.4	44,000	27.1	20.0	*	20.0	*					S	0.61	
32	12/17/00	11:39	KT	0		6.5	46,600	29.0	55.0		55.0						S	0.91	
32	12/18/00	12:26	KT	1	T	3.6	24,900	14.2	93.0		93.0								
32	12/18/00	12:26	KT	1	B	5.1	41,000	25.5											
32	12/19/00	13:35	KT	1	T	4.2	27,000	15.9	23.0		23.0						S	0.46	
32	12/19/00	13:35	KT	1	B	4.5	29,300	17.2											
32	12/20/00	12:41	KT	0		3.5	34,100	20.4	29.0		29.0						S	0.46	
32	12/21/00	11:13	KT	0		4.6	35,400	21.3	50.0		50.0						N	0.46	
32	12/21/00	13:50	KT	0		4.7	35,600	21.5	300.0		300.0						S	0.46	
32	12/27/00	11:14	KT	0		7.0	44,600	27.7	4.0		3.0						N	0.46	
32	12/27/00	14:20	KT	0		7.2	44,400	27.6	3.0		3.0						N	0.46	
32	01/02/01	14:25	AR	1	T	6.5	17,700	10.0	3.0		3.0						S	0.61	
32	01/02/01	14:25	AR	1	B	6.9	37,100	22.6											
32	01/04/01	11:43	KT	1	T	6.2	19,600	11.3	16.0		0.8						N	0.46	
32	01/04/01	11:43	KT	1	B	6.3	20,700	12.0											
32	02/14/01	12:44	KT	0		5.9	41,700	25.7	10.0		1.0						S	0.76	

Lummi Indian Reservation Hermosa Beach Fecal Coliform Study, Fall 2000 to Winter 2001

PRELIMINARY, SUBJECT TO REVISIONS

DATA NOT VERIFIED AND NOT STANDARDIZED

Sample Site Number	Date (mm/dd/yy)	Time (24 hrs)	Sampler	Stratified? 0 = No 1 = Yes	If Strat., Sample Depth	Probe Water Temp (C)	Conductivity (micromhos/cm)	Salinity (ppt)	Fecal Coliform (col./100 ml)	Nt	E. Coli. (col./100 ml)	Nt	Fecal Coliform Loading (col./sec)	Numeric Flow Rate (cfs)	Descriptive Flow Rate (cfs)	Flow Method	Flow Direction (from)	Depth (m)	Comments
32	02/15/01	11:44	KT	0		3.5	35,900	22.4	80.0		80.0						N	0.61	
32	02/17/01	12:54	KT	1	T	3.7	32,900	19.6	9.0		9.0						S	0.61	
32	02/17/01	12:54	KT	1	B	4.7	41,900	25.5											
32	02/18/01	13:17	KT	0		5.7	43,400	26.8	2.0		0.8						S	0.76	
32	02/19/01	11:17	KT	0		5.7	40,400	24.7	0.8		0.8						N	0.76	
32	02/20/01	11:43	KT	1	T	5.7	36,500	22.0	1.0		1.0						S	0.91	
32	02/20/01	11:43	KT	1	B	5.6	39,800	24.3											
32	02/21/01	11:28	KT	0		6.7	45,200	28.1	0.8		0.8						S	0.76	
32	02/22/01	10:42	KT	1	T	7.9		23.3	0.8		0.8						S	0.76	Conductivity too variable to record. Salinity varied from 18.2 to 28.3 ppt.
32	02/22/01	10:42	KT	1	B	7.5	46,500	29.1											
32	02/22/01	13:44	KT	1	T	8.4	38,200	23.5	0.8		0.8						N	0.76	
32	02/22/01	13:44	KT	1	B	8.0	43,400	26.9											
32	02/23/01	10:46	KT	0		6.9	45,600	28.4	7.0		7.0						N	0.61	
32	02/23/01	13:20	KT	0		7.2	46,100	28.7	1.0		0.8						N	0.61	
32	02/24/01	11:17	AR	1	T	7.2	44,700	27.7	0.8		0.8						ne	0.76	Water clear-green. Salinity changes gradually with depth.
32	02/24/01	11:17	AR	1	B	7.3	45,500	28.4											
32	02/25/01	12:19	KT	1	T	6.4	34,200	20.5	1.0		1.0						S	0.76	Salinity changes about 3" below surface.
32	02/25/01	12:19	KT	1	B	7.5	45,200	28.3											
32	02/26/01	10:33	KT	0		6.1	39,300	23.7	4.0		4.0						N	0.61	
32	02/26/01	13:16	KT	0		7.3	42,200	26.1	0.8		0.8						S	0.76	
32	02/27/01	11:40	KT	1	T	5.8	38,600	23.6	0.8		0.8						S	0.91	
32	02/27/01	11:40	KT	1	B	6.1	40,400	24.9											
32	02/28/01	10:04	KT	0		4.7	30,600	18.4	20.0		0.8						N	0.76	
33	11/30/00	11:40	KT, TM	DRY, NO FLOW									0.0	0		VIS			
33	01/04/01	12:09	KT	0		6.7	303	0.0	150.0		150.0		891.8	0.021		NB		0.05	Inflow froim north and south.
33	02/21/01	12:00	KT	0		8.8	221	0.0	9.8		9.8						ds	0.05	Majority of flow from north.
33	02/27/01	12:04	KT	0		9.4	284	0.0	10.0	*	10.0	*					ds	0.08	
34	11/30/00	11:54	KT, TM	0		7.5	40,100	24.6	58.0		58.0						S	0.76	
34	01/04/01	12:03	KT	0		6.3	20,400	11.6	15.0		15.0						N	0.30	
34	02/21/01	11:48	KT	0		6.7	45,200	28.1	0.8		0.8						S	0.61	
34	02/27/01	11:57	KT	0		6.0	40,300	24.7	0.8		0.8						N	0.61	
35	11/30/00	13:06	KT, TM	1	T	7.8	29,600	17.3	12.0		12.0						ne	0.20	Salinity changes gradually with depth.
35	11/30/00	13:06	KT, TM	1	B	7.6	36,100	21.7											
35	01/04/01	12:50	KT	1	T	6.9	3,400	1.7	90.0	*	9.8						ne	0.61	Water backed up into ditch by high tide. Dirty water.
35	01/04/01	12:50	KT	1	B	6.6	33,900	20.4											
35	02/21/01	13:42	KT	0		6.5	246	0.0	1.8		1.8							0.15	Majority of inflow from north, south and west inflows a trickle.
35	02/27/01	12:59	KT	0		8.2	348	0.0	1.8		1.8							0.08	Majority of inflow from north, south and west inflows a trickle.
36	11/30/00	13:01	KT, TM	0		7.7	41,400	25.6	130.0		130.0						S	0.91	
36	01/04/01	12:45	KT	0		6.3	20,400	11.8	67.0		67.0						N	0.45	Culvert outlet under water.
36	02/21/01	13:36	KT	0		7.3	46,400	28.9	0.8		0.8						S	0.91	
36	02/27/01	12:50	KT	1	T	6.8	33,800	20.7	1.8		1.8						N	0.76	
36	02/27/01	12:50	KT	1	B	6.5	40,100	24.4											
37	10/17/00	11:57	KT	0		12.5	862	0.2	18,000.0	*	18,000.0	*					ds	0.08	Dark tanin color. Water percolates into beach, does not re-emerge.
37	10/18/00	12:45	KT	0		12.9	624	0.0	360.0		360.0						ds	0.08	
37	10/20/00	15:15	KT, SH	0		12.5	721	0.1	330.0		3,300.0		420.4	0.0045	0.0022 to 0.0045	VIS	ds	0.09	Water percolates into beach, does not re-emerge.
37	11/08/00	12:20	AR	0		10.1	209	0.0	20,000.0		20,000.0						ds	0.10	
37	11/09/00	9:29	AR	0		10.3	704	0.1	4,800.0		4,800.0						ds	0.09	Inflow from north.
37	11/29/00	13:56	AR	0		8.8	411	0.0	2,000.0		2,000.0		19,252.0	0.034		NB	ds		Sampled at culvert outlet.
37	11/30/00	14:16	KT, TM	0		9.6	637	0.1	130.0		130.0		36.8	0.001	<<<0.0022	VIS	ds	0.08	
37	12/16/00	15:19	KT, LDD	0		5.8	398	0.0	4,000.0		4,000.0		38,504.0	0.034		NB	ds	0.14	
37	12/17/00	12:10	KT	0		7.6	681	0.1	500.0		500.0						ds	0.10	
37	12/18/00	13:04	KT	0		7.7	651	0.1	82.0		82.0						ds	0.05	
37	12/19/00	14:06	KT	0		8.0	620	0.0	96.0		96.0		625.1	0.023		NB	ds	0.09	
37	12/20/00	13:30	KT	0		7.8	626	0.0	12.0	*	12.0	*	78.1	0.023		NB	ds	0.09	
37	12/21/00	11:45	KT	0		7.8	625	0.0	8.0		8.0						ds	0.09	
37	12/21/00	14:16	KT	0		7.9	533	0.0	10.0		0.8						ds	0.10	
37	12/27/00	11:59	KT	0		8.4	569	0.0	270.0		270.0		1,834.6	0.024		NB	ds	0.09	
37	12/27/00	15:08	KT	0		8.2	576	0.0	120.0		120.0		917.3	0.027		NB	ds	0.09	
37	01/02/01	14:08	AR	0		9.2	585	0.0	2.0	*	2.0	*	1.2	0.0022		VIS	ds	0.10	
37	01/04/01	14:13	KT	0		7.7	160	0.0	480.0		480.0		5,164.1	0.038		NB	ds	0.11	
37	02/14/01	13:33	KT	0		7.8	588	0.0	2.0		2.0						ds	0.08	
37	02/15/01	13:12	KT	0		6.2	565	0.0	9.0		9.0						ds	0.08	
37	02/17/01	13:32	KT	0		7.8	569	0.0	0.8		0.8						ds	0.09	
37	02/18/01	13:54	KT	0		8.0	551	0.0	19.0		19.0						ds	0.08	

Lummi Indian Reservation Hermosa Beach Fecal Coliform Study, Fall 2000 to Winter 2001

PRELIMINARY, SUBJECT TO REVISIONS

DATA NOT VERIFIED AND NOT STANDARDIZED

Sample Site Number	Date (mm/dd/yy)	Time (24 hrs)	Sampler	Stratified? 0 = No 1 = Yes	If Strat., Sample Depth	Probe Water Temp (C)	Conductivity (micromhos/cm)	Salinity (ppt)	Fecal Coliform (col./100 ml)	Nt	E. Coli. (col./100 ml)	Nt	Fecal Coliform Loading (col./sec)	Numeric Flow Rate (cfs)	Descriptive Flow Rate (cfs)	Flow Method	Flow Direction (from)	Depth (m)	Comments
37	02/19/01	11:49	KT	0		8.1	571	0.0	0.8		0.8						ds	0.08	
37	02/20/01	12:50	KT	0		8.8	604	0.0	1.0		1.0						ds	0.08	
37	02/21/01	14:52	KT	0		9.0	586	0.0	1.0		1.0						ds	0.08	
37	02/22/01	11:50	KT	0		9.6	581	0.0	0.8		0.8						ds	0.08	
37	02/22/01	14:15	KT	0		10.0	585	0.0	0.8		0.8						ds	0.08	
37	02/23/01	11:23	KT	0		8.7	588	0.0	0.8		0.8						ds	0.08	
37	02/23/01	13:50	KT	0		8.8	590	0.0	0.8		0.8						ds	0.08	
37	02/24/01	11:50	KT	0		8.8	579	0.0	0.8		0.8		1.8	0.008		NB	ds	0.08	
37	02/25/01	13:18	KT	0		9.4	579	0.0	0.8		0.8		1.6	0.007		NB	ds	0.08	
37	02/26/01	11:07	KT	0		8.2	578	0.0	1.0		1.0		1.7	0.006		NB	ds	0.08	Discharge percolates into beach, emerges above Portage Bay water level.
37	02/26/01	13:56	KT	0		9.5	586	0.0	0.8		0.8		1.6	0.007		NB	ds	0.08	Discharge percolates into beach, emerges above Portage Bay water level.
37	02/27/01	14:16	KT	0		9.6	581	0.0	1.0		1.0		4.0	0.014		NB	ds	0.76	
37	02/28/01	10:33	KT	0		7.6	580	0.0	0.8		0.8		1.1	0.005		NB	ds	0.70	
38P	10/17/00	11:49	KT	0		11.6	33,700	20.6	2,200.0		2,200.0						ne		Depth variable from 0.102 to 0.254 m.
38P	10/18/00	12:34	KT	0		12.1	41,500	26.2	65.0		65.0						E	0.15	
38P	10/20/00	15:10	KT, AR	0		11.4	36,900	22.7	3,000.0	*	3,000.0	*					S	0.10	
38P	11/08/00	12:06	AR	0		9.3		16.6	1,600.0		1,600.0						N	0.06	Conductivity too variable to record.
38P	11/09/00	9:15	AR	0		7.9		15.0	550.0		550.0						N	0.05	Clear water, waves from SE. Conductivity too variable to record.
38P	11/29/00	13:50	AR	0		7.0		20.9	62.0		62.0						S		Depth varied from 0.025 to 0.152 m. Conductivity too variable to record.
38P	11/30/00	14:01	KT, TM			8.3	41,650	21.0	4.0	*	4.0	*					S	0.10	
38P	12/16/00	15:01	KT, LDD	0		5.8		12.8	22.0		22.0						S	0.08	Conductivity too variable to record.
38P	12/17/00	12:00	KT	0		7.5		15.1	160.0		160.0						S	0.15	Conductivity varied from 10,000 to 37,000 us/cm, and salinity varied from 7.9 to 27.2 ppt.
38P	12/18/00	12:50	KT	0		4.2	24,600	14.1	110.0		110.0						S	0.08	
38P	12/19/00	13:55	KT	0		5.4		6.2	50.0		50.0						N	0.08	Conductivity too variable to record.
38P	12/20/00	13:18	KT	0		6.7		6.9	20.0		20.0						S	0.08	Conductivity too variable to record, salinity varied from 1.2 to 12.6 ppt.
38P	12/21/00	11:35	KT	0		5.4		7.1	55.0		55.0						N	0.10	Conductivity too variable to record.
38P	12/21/00	14:05	KT	0		4.8		14.1	110.0		110.0						S	0.05	Conductivity too variable to record.
38P	12/27/00	11:48	KT	0		7.9		7.6	45.0		45.0						N	0.05	Conductivity too variable to record.
38P	12/27/00	14:49	KT	0		7.3		6.3	37.0		37.0						N	0.06	Conductivity too variable to record.
38P	01/02/01	13:55	AR	0		7.5	18,300	10.7	9.0		9.0						N	0.05	
38P	01/04/01	14:20	KT	0		7.2		9.3	56.0		56.0								Conductivity too variable to record.
38P	02/14/01	13:20	KT	0		6.6		16.1	12.0	*	12.0	*					S	0.05	Conductivity too variable to record.
38P	02/15/01	12:42	KT	0		3.5		17.9	42.0		8.0						N	0.05	Conductivity too variable to record.
38P	02/17/01	13:18	KT	0		4.8	29,800	16.9	2.0	*	1.8						S	0.05	
38P	02/18/01	13:43	KT	0		7.4		24.9	1.0		1.0						S	0.05	Conductivity too variable to record.
38P	02/19/01	11:39	KT	0		6.8		20.3	100.0	*	100.0	*					N	0.05	Conductivity too variable to record.
38P	02/20/01	12:38	KT	0		8.2	36,400	24.7	1.0		1.0						N	0.05	Conductivity varied from 30,900 to 41,800 us/cm, salinity ranged from 23.9 to 25.5 ppt.
38P	02/21/01	14:41	KT	0		8.6		23.4	0.8		0.8						N	0.08	Conductivity too variable to record. Salinity varied from 19.7 to 27.1 ppt.
38P	02/22/01	11:38	KT	0		9.2	44,100	27.3	0.8		0.8						N	0.05	Conductivity varied from 43,700 to 44,400 us/cm. Salinity varied from 26.9 to 27.6 ppt.
38P	02/22/01	14:01	KT	0		9.4	38,100	25.2	0.8		0.8						N	0.06	Conductivity varied from 36,000 to 40,200 us/cm. Salinity varied from 23.8 to 26.6 ppt.
38P	02/23/01	11:14	KT	0		7.3	41,500	26.5	6.0	*	1.8						S	0.05	Conductivty varied from 40,800 to 42,100 us/cm. Salinity varied from 25.7 to 27.2 ppt.
38P	02/23/01	13:39	KT	0		8.2	41,200	26.6	2.0	*	2.0	*					S	0.05	Conductivity varied from 40,100 to 42,300 us/cm. Salinity varied from 25.4 to 27.8 ppt.
38P	02/24/01	11:40	AR	0		7.5		26.0	2.0		2.0						ne	0.06	Conductivity too variable to record. Salinity varied from 25.3 to 26.7 ppt.
38P	02/25/01	13:04	KT	0		10.8	41,000	25.1	0.8		0.8						ne	0.08	Conductivity varied from 40,100 to 41,900 us/cm. Salinity ranged from 24.3 to 25.8 ppt.
38P	02/26/01	10:56	KT	0		7.2		13.9	2.0	*	2.0	*					N	0.05	Conductivity too variable to record.. Salinity varied from 8.6 to 19.1 ppt.
38P	02/26/01	13:40	KT	0		8.3		16.2	0.8		0.8						N	0.05	Conductivity too variable to record.. Salinity varied from 11.4 to 21.0 ppt.
38P	02/27/01	14:02	KT	0		10.6		9.4	0.8		0.8						N	0.05	Conductivity too variable to record.. Salinity varied from 0.6 to 18.2 ppt.
38P	02/28/01	10:21	KT	0		5.7	39,400	24.1	50.0		0.8						S	0.05	
38	10/17/00	11:53	KT	1	T	11.5	34,200	20.9	140.0		140.0						ne	0.76	
38	10/17/00	11:53	KT	1	B	11.4	36,100	22.3											
38	10/18/00	12:39	KT	1	T	11.8	42,500	22.6	11.0		11.0						S	0.76	
38	10/18/00	12:39	KT	1	B	11.6	43,200	27.0											
38	10/20/00	15:12	KT, AR	0		11.2	36,900	22.7	52.0		52.0						S	0.76	Grey/brown water, 6" waves.
38	11/08/00	12:08	AR	1	T	9.1	39,900	24.5	1.8		1.8						N	0.91	Calm, clear water.
38	11/08/00	12:08	AR	1	B	9.3	41,600	25.8											
38	11/09/00	9:18	AR	1	T	7.4	31,000	18.5	6.0		6.0						N	0.61	
38	11/09/00	9:18	AR	1	B	9.4		27.0											Conductivity too variable to record.
38	11/29/00	13:52	AR	1	T	6.9	38,000	23.2	12.0	*	12.0	*					ne	0.76	Green/clear water.
38	11/29/00	13:52	AR	1	B	7.0	38,600	23.6											
38	11/30/00	14:09	KT, TM	0		8.2	44,300	27.6	0.8		0.8						S	0.76	
38	12/16/00	15:09	KT, LDD	0		5.7	44,800	27.8	8.0		8.0						S	0.61	
38	12/17/00	12:06	KT	0		6.4	46,300	28.9	5.0		5.0						S	0.91	
38	12/18/00	12:58	KT	1	T	3.8	23,100	13.7	86.0		86.0						S	0.61	
38	12/18/00	12:58	KT	1	B	5.2	41,400	25.3											
38	12/19/00	14:02	KT	1	T	4.2	21,200	12.4	27.0		27.0						N	0.46	
38	12/19/00	14:02	KT	1	B	4.2	22,700	13.1											
38	12/20/00	13:24	KT	1	T	3.5	32,000	19.1	25.0		25.0						S	0.61	
38	12/20/00	13:24	KT	1	B	3.6	33,400	19.9											
38	12/21/00	11:41	KT	0		4.4	34,100	20.4	54.0		54.0						N	0.61	
38	12/21/00	14:10	KT	0		4.5	35,100	21.1	120.0		120.0						S	0.46	

Lummi Indian Reservation Hermosa Beach Fecal Coliform Study, Fall 2000 to Winter 2001

PRELIMINARY, SUBJECT TO REVISIONS

DATA NOT VERIFIED AND NOT STANDARDIZED

Sample Site Number	Date (mm/dd/yy)	Time (24 hrs)	Sampler	Stratified? 0 = No 1 = Yes	If Strat., Sample Depth	Probe Water Temp (C)	Conductivity (micromhos/cm)	Salinity (ppt)	Fecal Coliform (col./100 ml)	Nt	E. Coli. (col./100 ml)	Nt	Fecal Coliform Loading (col./sec)	Numeric Flow Rate (cfs)	Descriptive Flow Rate (cfs)	Flow Method	Flow Direction (from)	Depth (m)	Comments
38	12/27/00	11:53	KT	0		7.2	44,900	27.9	4.0		0.8						N	0.46	
38	12/27/00	14:58	KT	0		7.3	45,500	28.3	3.0		3.0						N	0.46	
38	01/02/01	14:00	AR	1	T	6.7		17.5	0.8		0.8						N	0.76	Conductivity too variable to record, salinity ranged from 17.3 to 17.7 ppt.
38	01/02/01	14:00	AR	1	B	6.8	34,200	20.7											
38	01/04/01	14:25	KT	1	T	6.6	24,600	14.4	9.0		9.0						N	0.46	
38	01/04/01	14:25	KT	1	B	6.6	27,800	16.7											
38	02/14/01	13:26	KT	0		6.7	45,700	28.4	5.0		5.0						S	0.61	
38	02/15/01	12:54	KT	0		3.6	38,300	23.1	48.0		40.0						N	0.76	
38	02/17/01	13:25	KT	1	T	3.8	32,500	19.5	0.8		0.8						S	0.76	
38	02/17/01	13:25	KT	1	B	4.1	37,300	22.6											
38	02/18/01	13:48	KT	0		6.5	45,900	28.6	2.0		2.0						S	0.76	
38	02/19/01	11:43	KT	0		5.8	39,200	23.9	5.0		0.8						N	0.61	
38	02/20/01	12:44	KT	1	T	6.6	42,600	26.3	3.0		3.0						N	0.76	
38	02/20/01	12:44	KT	1	B	6.6	45,500	28.2											
38	02/21/01	14:46	KT	0		7.5	46,400	29.0	1.0		1.0						N	0.76	
38	02/22/01	11:44	KT	0		7.7	46,500	29.2	0.8		0.8						N	0.76	
38	02/22/01	14:09	KT	0		8.0	45,000	28.1	0.8		0.8						N	0.61	
38	02/23/01	11:19	KT	0		7.2	46,100	28.8	8.0		0.8						S	0.61	
38	02/23/01	13:44	KT	0		7.5	46,400	29.0	3.0		3.0						S	0.76	
38	02/24/01	11:43	AR	1	T	7.2	45,300	28.2	0.8		0.8						ne	0.91	Clear water, 6" waves.
38	02/24/01	11:43	AR	1	B	7.4	46,600	29.1											Salinity changes gradually with depth.
38	02/25/01	13:12	KT	0		7.8	45,200	28.3	0.8		0.8						N	0.91	
38	02/26/01	11:01	KT	1	T	5.6	35,900	21.7	1.0		1.0						N	0.91	
38	02/26/01	11:01	KT	1	B	6.2	37,700	22.9											
38	02/26/01	13:47	KT	1	T	6.9	38,600	23.1	0.8		0.8						S	0.76	
38	02/26/01	13:47	KT	1	B	8.5	45,200	28.2											
38	02/27/01	14:09	KT	1	T	7.0	39,900	24.5	0.8		0.8						N	0.61	
38	02/27/01	14:09	KT	1	B	8.6	46,300	29.2											
38	02/28/01	10:27	KT	0		6.3	42,800	26.4	11.0		0.8						S	0.76	
39	10/17/00	12:04	KT	0		11.3	42,200	26.3	410.0		410.0						ne	0.61	Strong wind from south.
39	10/18/00	12:55	KT	1	T	11.6	43,500	27.3	11.0		11.0						N	0.91	
39	10/18/00	12:55	KT	1	B	11.4	44,400	27.9											
39	10/20/00	15:01	KT, SH	1	T	11.1	38,900	23.9	84.0		84.0						W	0.61	
39	10/20/00	15:01	KT, SH	1	B	10.8	45,100	28.4											
39	11/08/00	11:50	AR	1	T	8.3	34,600	21.0	4.0	*	4.0	*						0.76	Waves from north.
39	11/08/00	11:50	AR	1	B	8.4	35,700	21.7											
39	11/09/00	9:37	AR	1	T	8.6	44,700	27.9	6.0	*	6.0	*					ne	0.61	Salinity changes gradually with depth.
39	11/09/00	9:37	AR	1	B	8.8	45,000	28.1											
39	11/29/00	14:06	KT	1	T	7.6	41,900	25.8	54.0		54.0						SE	0.91	Flow from Portage Bay to Hale Passage.
39	11/29/00	14:06	KT	1	B	8.0	44,000	27.4											
39	11/30/00	15:09	KT, TM	0		8.2	44,700	27.8	8.0		8.0						S	0.91	Flow (plume) from Portage Bay to Hale Passage.
39	12/16/00	15:33	KT, LDD	0		6.2	45,400	28.2	6.0		6.0						S	0.76	Flow (plume) from Portage Bay to Hale Passage.
39	12/17/00	12:20	KT	0		6.5	46,400	28.9	2.0		2.0						N	0.91	No visible plume (from Porage Bay).
39	12/18/00	13:11	KT	1	T	5.5	40,200	24.5	27.0		27.0						N	0.91	Current from Hale Passage to Portage Bay.
39	12/18/00	13:11	KT	1	B	6.0	42,400	26.3											
39	12/19/00	14:20	KT	0		7.0	45,800	28.6	6.0		0.8						N	0.61	Current from Hale Passage to Portage Bay.
39	12/20/00	13:40	KT	0		7.0	46,400	29.0	4.0		4.0						N	0.76	Current from Hale Passage to Portage Bay.
39	12/21/00	11:51	KT	1	T	5.4	40,400	24.7	120.0		120.0						S	0.61	Current from Portage Bay to Hale Passage.
39	12/21/00	11:51	KT	1	B	6.1	43,800	27.1											
39	12/21/00	14:24	KT	0		7.0	45,400	28.3	26.0		26.0						S	0.61	
39	12/27/00	12:14	KT	0		7.6	45,500	28.4	4.0		4.0						N	0.46	
39	12/27/00	15:22	KT	0		7.6	45,600	28.5	55.0		55.0						N	0.61	
39	01/02/01	13:43	AR	1	T	7.7	44,500	27.6	0.8		0.8							0.76	Slow flow from Hale Passge to Portage Bay.
39	01/02/01	13:43	AR	1	B	7.7	45,400	28.3											
39	01/04/01	15:27	KT	0		7.6	45,000	28.0	3.0		0.8						ne	0.46	Current from Portage Bay to Hale Passage.
39	02/14/01	13:45	KT	0		6.8	46,300	28.9	28.0		22.0						S	0.46	
39	02/15/01	13:25	KT	0		6.1	47,100	29.4	3.0		3.0						N	0.46	
39	02/17/01	13:40	KT	0		5.9	44,700	27.7	0.8		0.8						N	0.91	Current from Hale Passage to Portage Bay, no visible plume.
39	02/18/01	14:09	KT	0		6.7	46,200	28.7	1.0		0.8						N	0.91	
39	02/19/01	12:05	KT	0		7.2	46,800	29.3	0.8		0.8						S	0.91	No visible plume.
39	02/20/01	13:01	KT	0		7.6	45,500	28.4	0.8		0.8							0.61	
39	02/21/01	15:24	KT	0		8.0	46,800	29.3	0.8		0.8						N	0.76	No visible plume.
39	02/22/01	12:00	KT	0		8.2	47,100	29.5	1.0		1.0						N	0.91	No visible plume.
39	02/22/01	14:29	KT	0		8.7	46,900	29.4	0.8		0.8						N	0.91	No visible plume.
39	02/23/01	11:39	KT	0		7.2	47,000	29.4	7.0		7.0						S	0.61	Flow (plume) from Portage Bay to Hale Passage.
39	02/23/01	14:01	KT	0		7.6	46,500	29.0	400.0		400.0						S	0.76	Flow (plume) from Portage Bay to Hale Passage.
39	02/24/01	12:04	AR	0		7.3	47,100	29.4	23.0		23.0							0.76	Water going slowly from Hale Passage to Portage Bay, wind from the north.
39	02/25/01	13:24	KT	0		8.1	46,500	29.1	0.8		0.8						N	0.76	No visible plume.
39	02/26/01	11:21	KT	0		7.4	46,400	29.0	0.8		0.8						N	0.61	No visible plume.
39	02/26/01	14:12	KT	0		8.5	46,700	29.3	0.8		0.8						N	0.76	No plume.
39	02/27/01	15:22	KT	0		8.5	46,800	29.3	3.0		3.0							0.61	
39	02/28/01	10:44	KT	0		6.8	46,600	29.1	4.0		4.0						S	0.91	Flow (plume) from Portage Bay to Hale Passage.

Lummi Indian Reservation Hermosa Beach Fecal Coliform Study, Fall 2000 to Winter 2001

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DATA NOT VERIFIED AND NOT STANDARDIZED

Sample Site Number	Date (mm/dd/yy)	Time (24 hrs)	Sampler	Stratified? 0 = No 1 = Yes	If Strat., Sample Depth	Probe Water Temp (C)	Conductivity (micromhos/cm)	Salinity (ppt)	Fecal Coliform (col./100 ml)	Nt	E. Coli. (col./100 ml)	Nt	Fecal Coliform Loading (col./sec)	Numeric Flow Rate (cfs)	Descriptive Flow Rate (cfs)	Flow Method	Flow Direction (from)	Depth (m)	Comments
41	11/30/00	13:23	KT, TM	0		7.6	29,200	17.3	440.0		440.0						ne	0.45	
41	01/04/01	13:47	KT	1	T	7.2	403	0.0	10.0	*	10.0	*					ne		
41	01/04/01	13:47	KT	1	B	7.2	23,200	12.7											Lower strata in seaweed at bottom of catch basin.
41	02/21/01	14:00	KT	1	T	5.7	340	0.0	0.8		0.8						ne		
41	02/21/01	14:00	KT	1	B	4.9	9,600	4.9											Lower strata in seaweed at bottom of catch basin.
41	02/27/01	13:18	KT	1	T	4.1	6,600	3.3	1.8		1.8						ne		
41	02/27/01	13:18	KT	1	B	3.8	15,000	8.3											Lower strata in seaweed at bottom of catch basin.
42	11/30/00	13:18	KT, TM	0		7.8	41,800	25.9	11.0		11.0						S	0.61	
42	01/04/01	13:43	KT	0		6.6	26,700	15.7	35.0		35.0						N	0.46	
42	02/21/01	13:51	KT	0		7.1	46,500	29.0	0.8		0.8						S	0.61	
42	02/27/01	13:10	KT	1	T	6.2	39,700	24.3	0.8		0.8						N	0.91	
42	02/27/01	13:10	KT	1	B	8.5	44,200	27.9											
43	11/30/00	13:41	KT, TM	0		8.0	186	0.0	2.0	*	2.0	*					ne	0.07	
43	01/04/01	14:07	KT	0		7.2	322	0.0	1.0		1.0						ne	0.09	
43	02/21/01	14:30	KT	0		6.1	416	0.0	0.8		0.8						ne	0.06	
43	02/27/01	13:36	KT	0		5.9	474	0.0	0.8		0.8						ne	0.07	
44	11/30/00	13:36	KT, TM	0		7.9	42,400	26.2	7.0		7.0						S	0.91	
44	01/04/01	13:58	KT	0		6.6	27,000	15.9	25.0		25.0						N	0.30	
44	02/21/01	14:22	KT	0		7.2	46,500	29.1	0.8		0.8						S	0.76	
44	02/27/01	13:27	KT	1	T	6.8	40,200	24.6	1.0		1.0						S	0.61	
44	02/27/01	13:27	KT	1	B	8.2	44,800	28.0											
45	11/30/00	14:37	KT, TM	1	T	8.3	31,700	21.7	41.0		41.0		11.6	0.001	<<<0.0022	VIS		0.10	
45	11/30/00	14:37	KT, TM	1	B	8.2	38,600	23.6											
45	01/04/01	14:47	KT	0		7.0	245	0.0	260.0		260.0		11,630.5	0.158		NB	ds	0.05	
45	02/21/01	15:05	KT	0		6.2	235	0.0	2.0	*	2.0	*					ds	0.03	
45	02/27/01	14:56	KT	0		5.6	246	0.0	4.0	*	4.0	*							
46	11/30/00	14:28	KT, TM	0		8.2	44,500	27.7	4.0		4.0						S	0.46	
46	01/04/01	14:43	KT	0		6.6	23,200	13.5	16.0		16.0						N	0.30	
46	02/21/01	15:02	KT	0		7.5	46,500	29.0	6.0		6.0						N	0.61	
46	02/27/01	14:48	KT	1	T	8.6	41,400	25.6	0.8		0.8						W	0.46	
46	02/27/01	14:48	KT	1	B	8.4	43,700	27.2											
47	11/30/00	14:58	KT, TM	0		8.5	32,600	19.7	140.0		140.0						ne	0.15	
47	01/04/01	15:16	KT	0		7.1		6.2	170.0		170.0						ne	0.20	Conductivity too variable to record.
47	02/21/01	15:20	KT	0		8.2	181	0.0	2.0	*	2.0	*					ne	0.15	
47	02/27/01	15:14	KT	0		8.1	233	0.0	2.0	*	2.0	*					ne	0.15	
48	11/30/00	14:49	KT, TM	0		8.2	44,100	27.5	3.0		3.0						E	0.61	
48	01/04/01	15:09	KT	1	T	6.6	25,300	14.9	18.0		0.8						S	0.46	
48	01/04/01	15:09	KT	1	B	6.7	28,600	16.3											
48	02/21/01	15:15	KT	0		7.4	46,500	29.1	2.0		2.0						W	0.61	
48	02/27/01	15:08	KT	0		8.6	46,200	29.1	0.8		0.8						N	0.46	
60	11/30/00	12:50	KT, TM	0		7.6	40,600	25.0	16.0		16.0						S	0.61	
60	01/04/01	12:32	KT	0		6.4	20,100	11.6	170.0		170.0						N	0.46	
60	02/21/01	13:07	KT	1	T	7.6	45,600	26.2	0.8		0.8						S	0.15	Conductivity ranged from 45,100 to 46,100 uS/cm. Salinity ranged from 23.7 to 28.6 ppt.
60	02/21/01	13:07	KT	1	B	7.7	46,200	28.9											
60	02/27/01	12:31	KT	1	T	6.8	30,500	18.3	0.8		0.8				SWIFT	VIS	S	0.61	
60	02/27/01	12:31	KT	1	B	7.4	38,900	24.0											
61	11/30/00	12:45	KT, TM	DRY, NO FLOW									0.0	0		VIS			
61	01/04/01	12:36	KT	0		6.3	233	0.0	170.0		1.8		2,743.4	0.057		VOL	ds	0.10	
61	02/21/01	13:18	KT	0		5.8	107	0.0	12.0	*	12.0	*	149.5	0.044		VOL	ds	0.08	Majority of flow from south.
61	02/27/01	12:38	KT	0		6.2	110	0.0	1.8		1.8						ds	0.08	Majority of flow from south.
62	11/30/00	12:40	KT, TM	0		7.6	40,300	24.8	17.0		17.0						S	0.61	
62	01/04/01	12:20	KT	0		6.4	20,100	11.6	19.0		7.0						N	0.30	

Lummi Indian Reservation Hermosa Beach Fecal Coliform Study, Fall 2000 to Winter 2001

PRELIMINARY, SUBJECT TO REVISIONS

DATA NOT VERIFIED AND NOT STANDARDIZED

Sample Site Number	Date (mm/dd/yy)	Time (24 hrs)	Sampler	Stratified? 0 = No 1 = Yes	If Strat., Sample Depth	Probe Water Temp (C)	Conductivity (micromhos/cm)	Salinity (ppt)	Fecal Coliform (col./100 ml)	Nt	E. Coli. (col./100 ml)	Nt	Fecal Coliform Loading (col./sec)	Numeric Flow Rate (cfs)	Descriptive Flow Rate (cfs)	Flow Method	Flow Direction (from)	Depth (m)	Comments
62	02/21/01	12:48	KT	0		7.6	46,000	28.7	0.8		0.8						S	0.61	
62	02/27/01	12:16	KT	1	T	6.6	34,400	20.9	1.0		1.0				SWIFT	VIS	S	0.46	
62	02/27/01	12:16	KT	1	B	6.3	37,300	22.7											
63	11/30/00	12:35	KT, TM	DRY, NO FLOW									0.0	0		VIS			
63	01/04/01	12:24	KT	TOO SHALLOW TO SAMPLE															
63	02/21/01	12:56	KT	TOO SHALLOW TO SAMPLE															Very shallow puddle at culvert inlet.
63	02/27/01	12:22	KT	NO FLOW, SHALLOW PUDDLES									0.0	0		VIS			
64P	10/20/00	13:32	KT, SH	1	T	11.2	35,300	21.8	130.0		130.0						S	0.46	Sampled at new culvert immeadiately to north of 31.
64P	10/20/00	13:32	KT, SH	1	B	11.2	37,800	23.3											
64	10/20/00	13:40	KT, SH	1	T	11.2	34,900	21.4	100.0		100.0						S	0.46	Sampled new culvert north of Site 31.
64	10/20/00	13:40	KT, SH	1	B	11.2	38,700	24.0											
64	11/30/00	11:23	KT, TM	1	T	7.3	39,000	23.8	140.0		140.0						S	0.61	Salinity gradually changes with depth.
64	11/30/00	11:23	KT, TM	1	B	7.4	39,600	24.3											
64	01/04/01	11:23	KT	0		6.1	20,200	11.6	32.0		0.8						N	0.46	
64	02/21/01	10:59	KT	1	T	7.5	43,600	27.1	1.0		1.0						S	0.15	
64	02/21/01	10:59	KT	1	B	7.0	44,900	27.9											
64	02/27/01	11:19	KT	1	T	5.5	38,000	23.0	0.8		0.8						N	0.46	
64	02/27/01	11:19	KT	1	B	6.2	40,500	25.1											
65	10/20/00	13:46	KT, SH	0		12.1	156	0.0	1,100.0		1,000.0		218.0	0.0007		VOL	ds		
65	11/30/00	11:20	KT, TM	DRY, NO FLOW									0.0	0		VIS			
65	01/04/01	11:29	KT	0		6.5	344	0.0	9.8		9.8						ne	0.02	
65	02/21/01	11:09	KT	0		7.1	345	0.0	1.8		1.8				VERY SLOW	VIS	ds	0.06	No flow at culvert outlet.
65	02/27/01	11:25	KT	0		6.8	556	0.0	1.8		1.8		0.0	0		VIS	ne	0.05	Stagnant water.
66	11/30/00	11:22	KT, TM	0		7.3	38,700	23.7	40.0		40.0						S	0.61	
66	01/04/01	11:06	KT	1	T	6.2	20,300	11.7	18.0		18.0		0.0	0		VIS	S	0.30	
66	01/04/01	11:06	KT	1	B	6.2	21,900	12.4											
66	02/21/01	10:40	KT	0		6.9	44,600	27.6	150.0		150.0						S	0.15	
66	02/27/01	11:04	KT	1	T	5.4	38,900	23.5	0.8		0.8						N	0.61	
66	02/27/01	11:04	KT	1	B	5.7	40,500	24.9											
67	11/30/00	11:10	KT, TM	DRY, NO FLOW															
67	01/04/01	11:12	KT	TOO SHALLOW TO SAMPLE															
67	02/21/01	10:43	KT	0		4.2	299	0.0	1.8		1.8		1.0	0.002		VOL	ds		
67	02/27/01	11:09	KT	0		4.5	319	0.0	1.8		1.8		0.5	0.001	<<<0.0022	VIS	ds		
68	11/30/00	10:33	KT, TM	0		7.3	38,100	23.3	30.0		30.0						S	0.46	
68	01/04/01	10:50	KT	1	T	6.2	21,700	12.6	24.0		0.8						N	0.76	
68	01/04/01	10:50	KT	1	B	6.5	34,500	20.9											
68	02/21/01	10:25	KT	0		7.2	45,200	28.1	15.0		15.0						S	0.31	
68	02/27/01	10:51	KT	1	T	5.1	38,600	23.5	1.0		1.0						S	0.61	
68	02/27/01	10:51	KT	1	B	5.5	40,500	24.8											
69	11/30/00	10:25	KT, TM	DRY, NO FLOW									0.0	0		VIS			
69	01/04/01	10:59	KT	0		6.5	242	0.0	28.0		28.0		7.9	0.001	<<<0.0022	VIS	ds	0.01	Very low water level.
69	02/21/01	10:03	KT	TOO SHALLOW TO SAMPLE															
69	02/27/01	10:55	KT	TOO SHALLOW TO SAMPLE															
70	11/30/00	10:18	KT, TM	0		7.3	38,800	23.8	20.0		20.0						S	0.46	Lots of debris along shore (seaweed/wood).
70	01/04/01	10:18	KT	1	T	6.1	20,000	11.5	27.0		27.0						N	0.46	
70	01/04/01	10:18	KT	1	B	6.1	21,300	12.4											
70	02/21/01	10:06	KT	0		7.3	42,100	26.4	0.8		0.8						N	0.14	Conductivity varied from 41,500 to 42,600 uS/cm. Salinity varied from 25.6 to 27.2 ppt.
70	02/27/01	10:29	KT	1	T	4.8	37,800	22.9	0.8		0.8						S	0.61	
70	02/27/01	10:29	KT	1	B	5.4	39,800	24.3											
71	11/30/00	10:15	KT, TM	DRY, NO FLOW									0.0	0		VIS			
71	01/04/01	10:28	KT	0		6.5	209	0.0	18.0	*	18.0	*	190.1	0.0373		VOL	ds	0.15	
71	02/21/01	10:11	KT	0		4.5	155	0.0	1.0		1.0		3.9	0.0136		VOL	ds	0.10	
71	02/27/01	10:38	KT	0		5.5	163	0.0	1.8		1.8		1.0	0.0019		VOL	ds	0.08	