APPENDIX A

SUPPLEMENTAL STUDIES

The Effect of Salinity and Light on Fecal Coliform Concentrations in Waters of Minter Watershed and Estuary

Introduction

The role of runoff in introducing fecal coliforms into streams has been studied in both Minter and Burley Watersheds. Loading studies have suggested a link between elevated FC levels in the estuary and both the duration of rainfall and FC loading in major tributaries.

The rate of fecal coliform die-off may have important implications for water quality downsteam and in the estuaries. Several interactive factors have been cited in the literature as affecting survivability. First, the dissolved salts in seawater are a factor. Second, the amount of sunlight has been shown to affect die-off. Fujioka, *et al.* (1981) observed during field experiments that the lethal effects of visible light penetrated clear saltwater to at least 3.3 m. These authors and others (Chojnowski, *et al.*, 1979; Hendricks and Morrison, 1967) found that the destructive effect of sunlight on fecal coliform bacteria is less rapid in saltwater than in fresh. Damage to fecal coliform due to sunlight, if not fatal, fosters predation by protozoans and bacteria on stream bottoms and in the water (McCambridge and McMeekin, 1981). The degree of damage by solar radiation varies among the different species of fecal coliform. *E. coli* is more sensitive than *Salmonella typhimurium*, *S. faecium*, *Enterobacter aerogenes*, or *Erwinia herbicola* (McCambridge and McMeekin, 1981). *Klebsiella pneumoniae* was less sensitive than *E. coli*.

It is important to understand how the interaction of light intensity and salinity affect fecal coliform levels in waters from the study area. The relative importance of sources along streams may decrease as the distance from each source to the estuary increases. Thus, there may be a theoretical point along each stream beyond which upstream sources may pose little risk to the estuary. The distance of the "safety point" from the estuary is a function of stream time of travel and the FC mortality rate.

Methods

Fecal coliform mortality experiments were conducted in August. Seed material for the experiments was unchlorinated primary effluent from LOTT Wastewater Treatment Plant in Olympia. The LOTT facility is a primary STP. About 2 liters of effluent were collected within several hours of the beginning of each experiment. Ten mL of seed was mixed with 15 liters of water in glass test aquaria. Two replicate aquaria were prepared for each experimental condition. All aquaria were placed in flowing water in raceways at the Minter Creek Salmon Hatchery and were completely exposed to skylight. The flowing water provided a means of controlling heat gain. The temperature of the flowing water was taken periodically during each experiment.

Light intensities were measured with a KAHLISCO underwater irradiance meter (Model No. 268WA310). Single samples were periodically taken from each aquarium for fecal coliform analysis using the membrane filter method. Each aquarium was stirred thoroughly with a plastic plate prior to grab-sampling. The plate was rinsed thoroughly with alcohol and de-ionized water before use. Samples were placed in a cooler and analyzed within one hour using a field filtration system and incubated for 24 hours in an aluminum block field incubator, both manufactured by Millipore Corporation.

Two fecal coliform experiments were conducted. The first tested the effects of salinity on the mortality of FC derived from human sewage. One pair of aquaria contained saltwater obtained from mid-Henderson Bay south of Minter Bay (about 28 ppt). Another pair contained freshwater from Minter Creek adjacent to the hatchery (0 ppt). The third pair contained an equal mixture of both types of water (about 14 ppt). LOTT seed was placed in all these tanks.

A second study tested the effects of reduced light intensity on fecal coliform survivability. One pair of tanks was exposed to open skylight; another pair was shaded with cloth to simulate shading by streambank vegetative canopy. Both pairs of tanks were seeded with LOTT effluent. An additional pair of tanks was similarly shaded, but contained 15 liters of undiluted Bear Creek water rather than water containing LOTT seed. This water was not seeded because it was obtained from a site known to be contaminated (BR 1.6; Figure 19) with fecal coliform from various animal sources and FC species acclimated to the stream environment. In this way, the behavior of FC derived from the two separate sources could be evaluated.

Light conditions beneath streambank canopy were measured along Minter Creek north of the hatchery during mid-day. The canopy consisted of tall cedar, alder, and maple. Cloud cover was 100 percent. Incident light energy under maximum canopy cover ranged from 2.5×10^2 to 4.1×10^2 uWatts/cm^{-2}. At a streamside clearing (about 40 percent open-sky exposure), values ranged from 1.2×10^4 to 1.5×10^4 uWatts/cm^{-2}. Incident light at the experimental site averaged 2.6×10^4 uWatts/cm^{-2}. Thus, incident light under maximum canopy was about one percent of that available at the totally exposed experimental site.

Several types of green cloth were tested for suitability as covers for experimental tanks. During the tests, early-morning cloud cover was 100 percent (0.87×10^4 uWatts/ cm^{-2}). The fabric which was selected reduced the light in the aquarium to 17 percent of ambient (0.15×10^4 uWatts/cm^{-2}). Under these conditions, the cloth covered the top and four sides. It was held in place by heavy black rubber straps.

Results and Discussion

During the first day of the salinity experiment, the sky was partly cloudy with cover ranging from 35 to 50 percent. On the second day, cloud cover was 100 percent. During the first-day morning of the shading effects experiment, cloud cover was complete. However, the clouds dissipated at noon and clear conditions prevailed during the remaining days of the experiment.

Light conditions varied with time of day and degree of cloud cover. During early-morning hours, complete cloud cover transmitted 0.9×10^4 uWatts/cm^{-2} of light, and clear skies transmitted 2.9×10^4 uWatts/cm^{-2}. Mid-day light readings showed 2.6×10^4 uWatts/cm^{-2} and 3.8×10^4 uWatts/cm^{-2} for cloudy skies and clear skies, respectively. During late afternoon under partly cloudy skies, available energy was 1.9×10^4 uWatts/cm^{-2}; under clear skies, 2.8×10^4 uWatts/cm^{-2}.

Early-morning water temperatures were about 12.3°C regardless of sky cover. During the day, water temperatures rose to a maximum of 13.4°C, 14.5°C, and 15.4°C under cloudy, partly cloudy, and clear conditions, respectively. These maxima occurred at about 1500.

The water flowing over the raceway bottom tended to pick up heat from the concrete bottom. At 1500 hours one afternoon, water temperatures were taken at several points for comparison. The temperature at the raceway inlet was 12.8°C. The water was drawn from an impoundment on Minter Creek about 300 meters upstream within forest canopy. The river temperature upon emergence from the forest was 13.0°C. The temperature rose to 13.2°C after passing over 100 meters of unshaded stream bed. On the other hand, the water at the end of the 25 meter raceway was 14.5°C; 1.7°C higher than the inlet.

Results of the first experiment are shown in Figure A1. Fecal coliform populations dropped very rapidly in each of the experimental tanks in all three salinity regimes. Densities of fecal coliforms fell below 10 percent of original numbers after only five hours. This mortality rate was far greater than that observed by CH_2M Hill (1981) at Willapa Bay. Their time to 90 percent reduction (T_{90}) for water of 24 ppt and 16 ppt were 72 hours and 104 hours, respectively. However, Fujioka, et al. (1981) obtained similar results. The difference in outcome may have been due to differences in experimental design, light intensity, or water turbidity.

The results of the second experiment (Figure A2) suggested that growth and reproduction occurred in shaded conditions. Fecal coliform in the unshaded tanks containing LOTT effluent displayed rapid, immediate die-off. Less than two percent of the original numbers were viable after 3.5 hours. However, fecal coliform populations in the shaded Bear Creek aquaria survived and increased in three days to nearly three times the initial population density. The population then dropped off markedly. Fecal coliforms in the shaded tanks seeded with LOTT effluent increased four-fold during two days. Eventually the population declined.

The final die-off may be an experimental artifact. Periphyton communities were observed on the inner surfaces of each aquarium after the experiments were completed. These communities may have competed with the fecal coliforms for nutrients which led ultimately to nutrient exhaustion. This outcome would not be likely in an open stream since there is periodic nutrient replenishment. On the other hand, the experimental die-off may be due to zooplankton feeding on fecal coliform. Predation in the stream would probably occur also except at different rates.

One might question the validity of these experiments by suggesting that the use of LOTT primary settlement effluent to represent the behavior of human fecal coliform from septic tanks (the major disposal method in the area) is not relevant, since bacterial populations may be different. Primary settlement and septic tanks perform similarly; they separate solids from liquid wastes, although on vastly different scales. Both systems have a wide range of treatment efficiencies. Hagedorn (1984) says the organic load and fecal bacterial populations from septic tanks are reduced only to a limited extent. Miescier and Cabelli (1982) report little or no discernible difference between primary settlement plant influent and effluent in the numbers of indicator bacteria organisms. On the other hand, Geldreich (1978) estimates 5

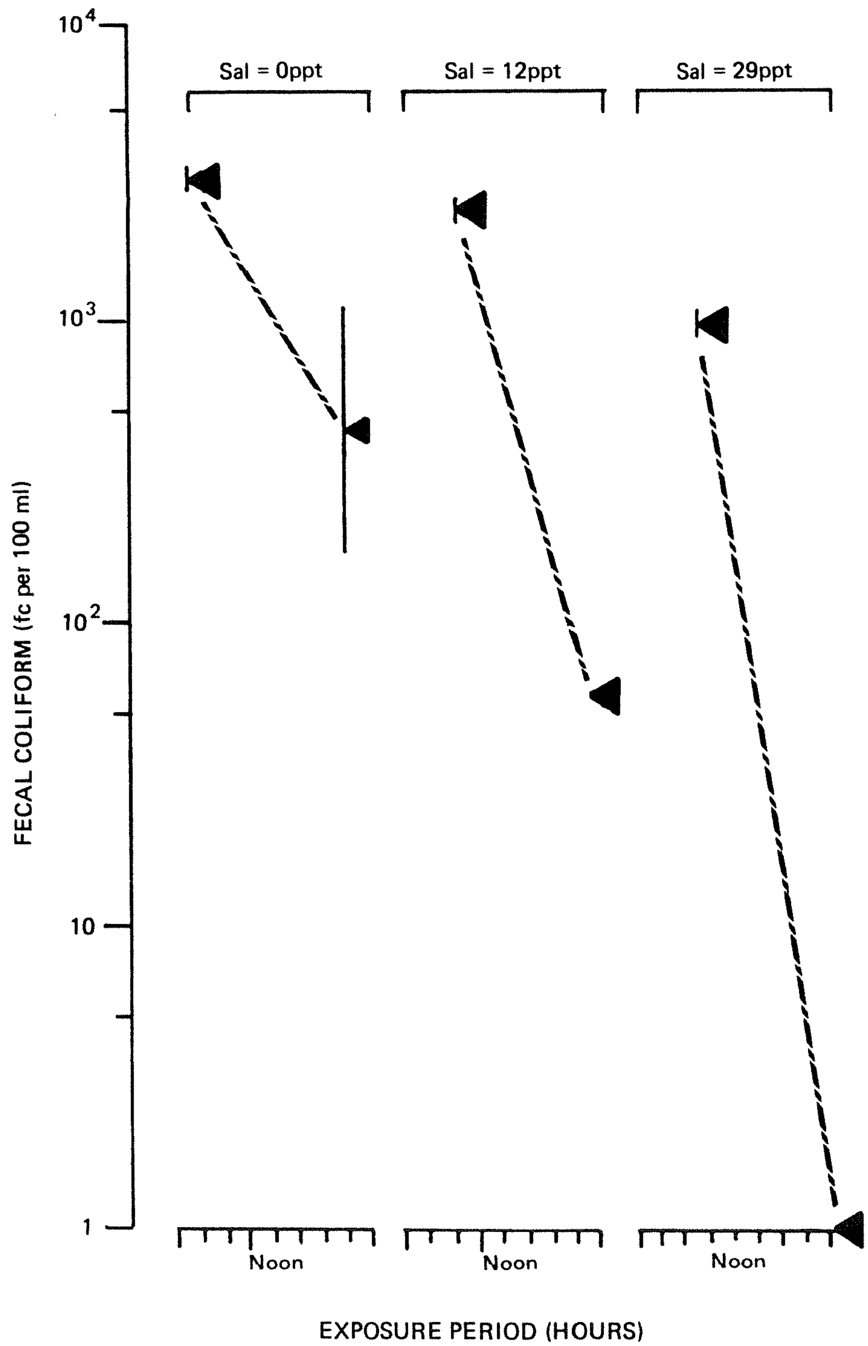

Figure A1. EFFECTS OF VARYING SALINITY ON FECAL COLIFORM DIE–OFF IN AQUARIA EXPOSED TO SKYLIGHT. (GEOMETRIC MEAN ± 1 SD; LOG–TRANSFORMED DATA; n = 2).

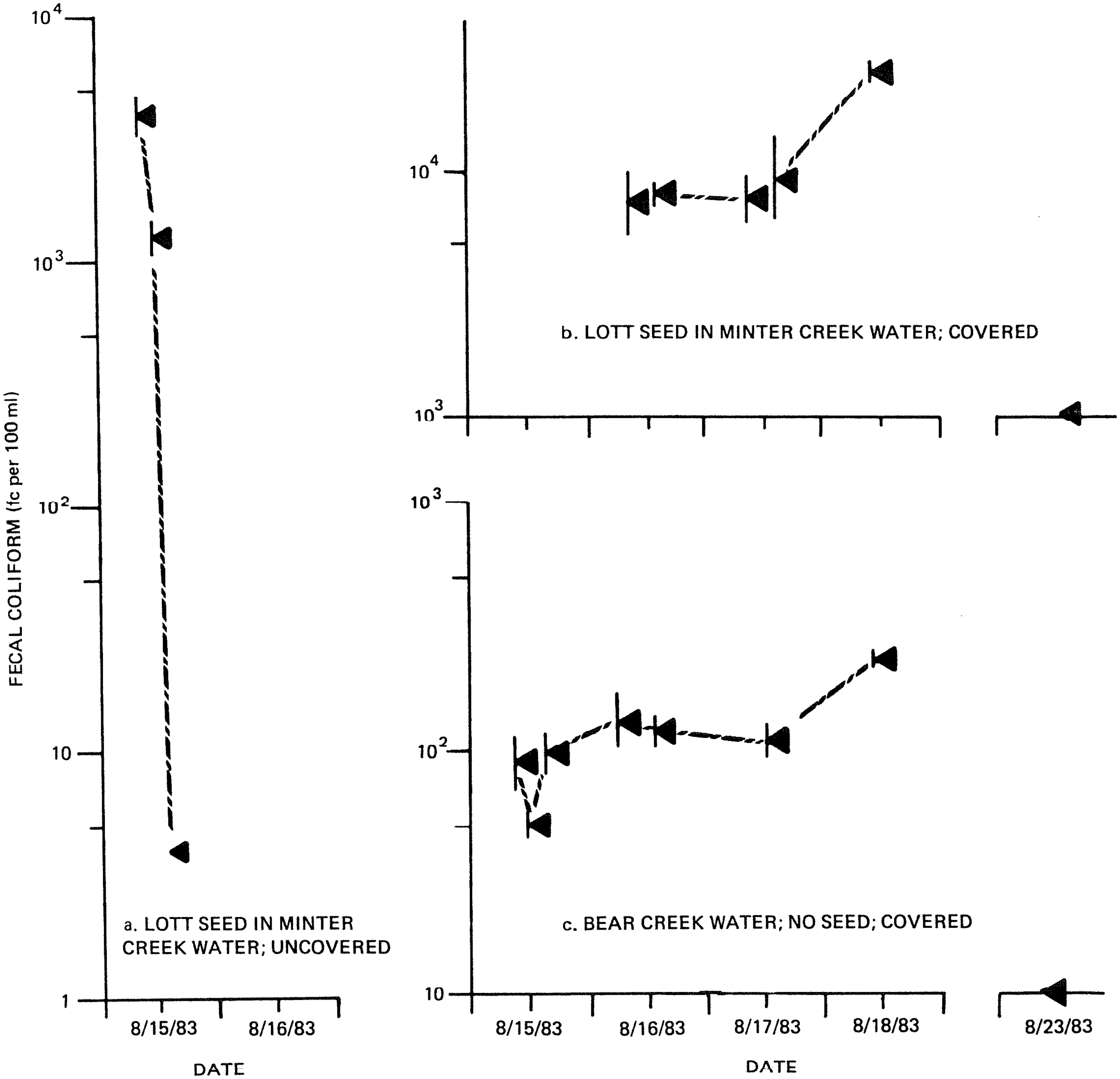

Figure A2. THE EFFECTS OF LIGHT INTENSITY ON FECAL COLIFORM DIE–OFF IN AQUARIA CONTAINING ARTIFICIALLY SEEDED AND NATURAL WATERS (GEOMETRIC MEAN ± 1 SD; LOG–TRANSFORMED DATA; n = 2).

to 40 percent reduction of bacterial flora in primary treatment while with careful operation and maintenance, septic systems (including soil treatment) remove 25 to 70 percent of the bacterial flora. Unfortunately, poor construction, little or no maintenance, overloading, and soils saturation result in no treatment. However, each treatment process produces effluents that only change the proportion of floral species without changing the species composition.

A second criticism is that the behavior of FC in the Bear Creek tanks is not typical of that of FC from treated effluent due to the presence of species that become acclimated to the stream environment, such as Klebsiella. That in fact was why we used Bear Creek water. However, the qualitative behavior of FC from both sources in shaded conditions is the same. Populations tend to be stable or increase for considerable periods of time. Fecal coliform die-off is significantly delayed.

In summary, there is some evidence that fecal coliforms not only survive but are capable of reproduction under stagnant shaded conditions. Large sections of streams in Minter and Burley Watersheds are shaded by vegetation. Many bogs and pools within shaded zones provide semi-stagnant conditions. It is therefore possible that bacterial regrowth may occur and FC that are exported downstream may remain viable while traveling through forested sections of the watershed for periods much longer than previously thought. Sediments may also protect fecal coliforms by providing habitat on the bottom and by reducing light penetration in the streams and estuary during rain events. In any case, it appears unlikely that a "safety point" exists on any tributary above which we can assume that contamination sources have no effect on the estuaries.

Time of Travel in Minter and Burley Creeks

Introduction

Die-off experiments conducted at the Minter Creek hatchery demonstrated that fecal coliforms are capable of surviving and reproducing for significant periods in shaded zones of streams ("The Effect of Salinity and Light," Appendix A). During a three-day experimental period, fecal coliform populations in the shade increased substantially in numbers above the initial concentration. At the same time, unshaded populations plummeted to less than ten percent of initial concentrations within several hours. These results suggest that stream travel time may be important in estimating the level of risk posed by upland sources on contamination in the estuaries when stream banks are shaded by overhanging trees and shrubs. If a discharge from a watershed source is carried downstream to the estuary before fecal coliform bacteria die-off, the source produces an effect on the estuary.

Methods

In order to estimate a maximum time of travel for any stream within each watershed, measurements were made along each mainstem creek; Minter Creek for Minter Watershed, and Burley Creek for Burley Watershed. Travel times were estimated by injection of a small volume of fluorescent dye into the creek, and detection of the dye during passage at a point downstream (Wilson, 1968; Kilpatrick, et al., 1970). Travel times were determined on a number of reaches and a total time estimated for each creek.

About 200 mLs of Rhodamine wt dye were dumped into the upper end of a creek reach. A Manning S-4040 portable discrete sampler was placed at the lower end. The sampler drew a 250 mL sample from the creek at equal time intervals. The samples were analyzed with a Turner Model 110 fluorometer, and dye concentrations calculated.

Results and Discussion

Figures A3 and A4 show the concentrations of dye passing each downstream sampling point plotted against the time after the dye was injected. Injection points and fluorometry sampling sites are shown on Figures 2 and 3. Stream stretches that have uniform, well-defined channels tend to produce tall, narrow graphs (Figure A3 a, c). Reaches that pass through bogs or break into a number of meandering channels produce short, wide graphs (Figure A3 b).

The mean travel time for the flow in a reach of a small stream can be estimated by the difference between the time of dye injection and the time the peak concentration occurs downstream. Minimum travel times are estimated by the elapsed difference between the time of injection and the time that dye is first detectable downstream. Maximum time of travel is the time difference between injection and the time that dye concentrations cease to be detectable. The overall time of travel for an entire stream is the sum of the travel times of the individual reaches (Table A1).

Time-of-travel studies were conducted from mid-October to early November. Twenty-four-hour rainfall each respective day of measurement ranged from zero to 0.50 inch. River flows were relative low during this period.

It took an average of 19 hours to travel the 4.6 miles of Burley Creek. Time of travel in the upper 1.5 miles of the creek was much longer than the lower reach; 11 hours and 8 hours, respectively. The broader graph and the delayed peak in the upper reach are due to a higher percentage of bogs that occur there.

The average total travel time for the main 4.1-mile stretch of Minter Creek was 37 hours. Minter Creek was divided into three sections and the travel time measured for each: the free-flowing, uppermost 0.7 mile; the next 1.4 miles of bog; and the lower 2 miles of free-flowing water. The bog zone was much slower than the rest of the creek, with an average travel time of 28 hours.

Neither Huge nor Unnamed Creeks in the Minter Watershed contain any sizeable bog areas. Both tributaries are shorter than Minter Creek and enter the mainstem below the large bog. Therefore, the travel time for these creeks is probably less than that for Minter Creek. In Burley Watershed, Purdy Creek has extensive reed marshes upstream. The travel time may approach that of Minter Creek. The travel time of Bear Creek is probably less than Burley Creek due to much shorter length.

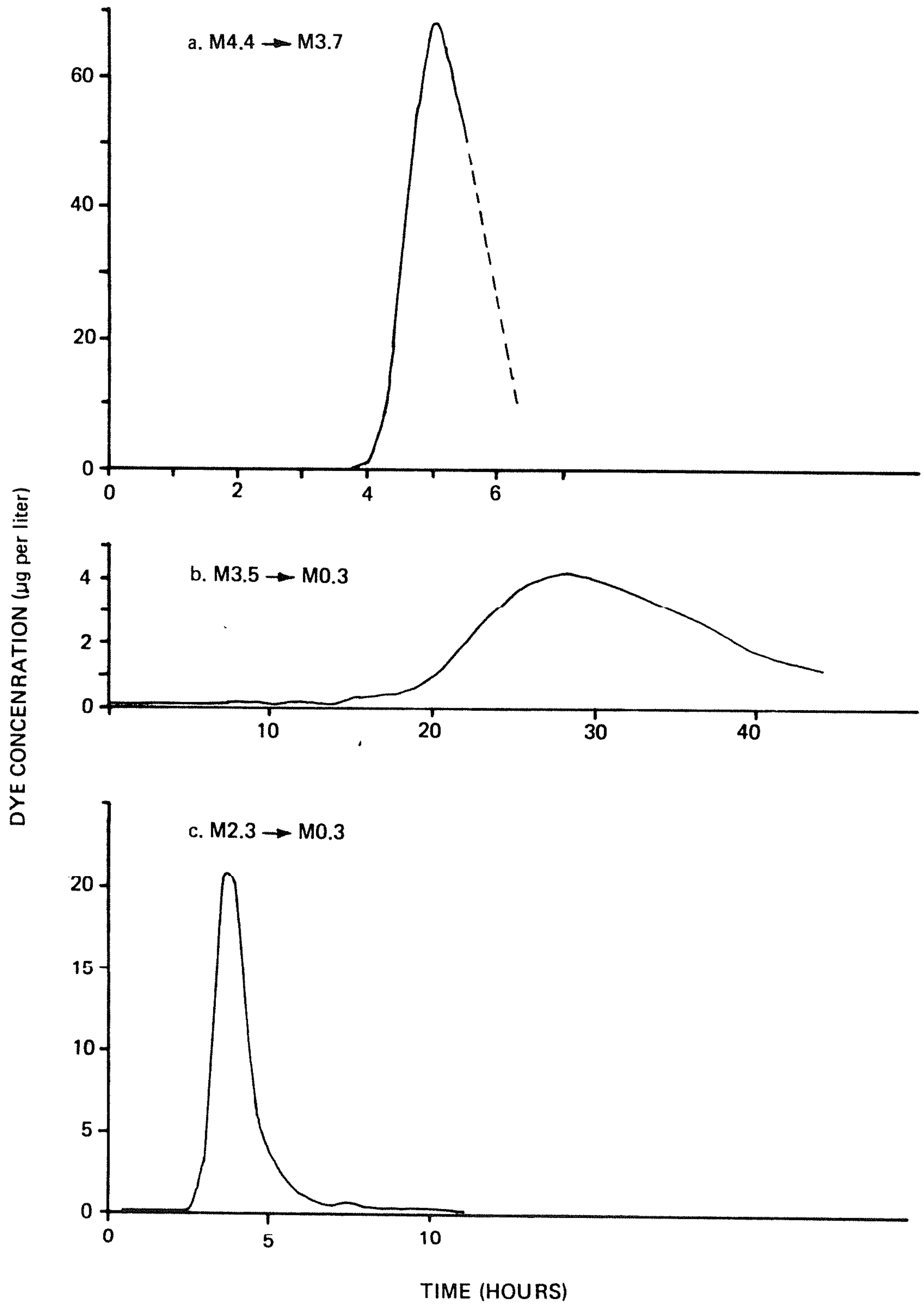

Figure A3. DYE CONCENTRATIONS AT THE LOWER END OF MINTER CREEK REACHES DURING TIME–OF–TRAVEL INVESTIGATIONS IN MID–OCTOBER 1983.

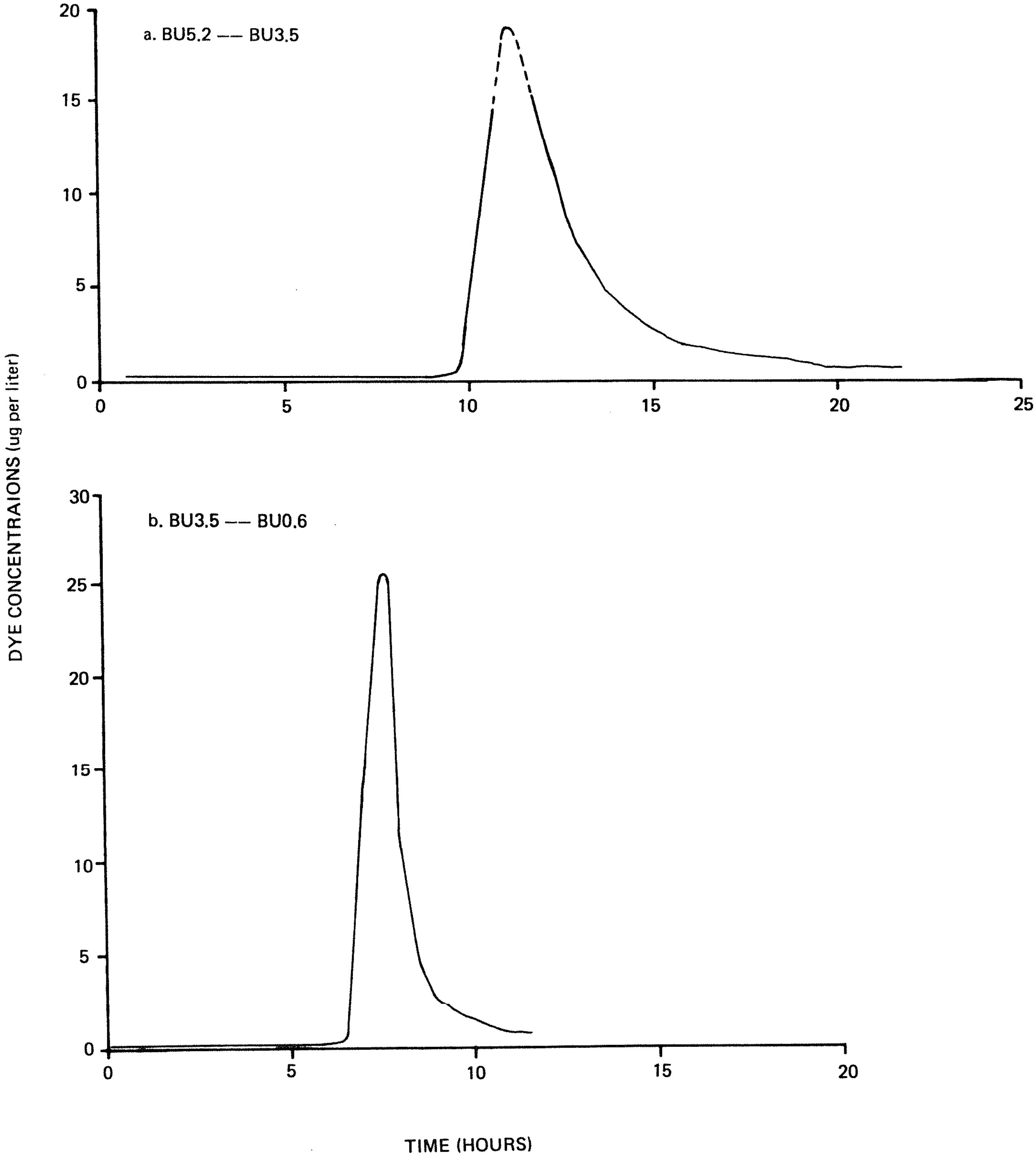

Figure A4. DYE CONCENTRATIONS AT THE LOWER END OF BURLEY CREEK REACHES DURING TIME–OF–TRAVEL INVESTIGATIONS IN NOVEMBER 1983.

Table A1. Estimated time of travel for the mainstem streams in Minter and Burley/Purdy Watersheds.

Reach	Travel Time (hours) Minimum	Mean	Maximum
Minter Creek			
(a) M 4.4 to M 3.7	3.5	5.0	*
(b) M 3.7 to M 2.3	14.0	28.0	44.0
(c) M 2.3 to M 0.3	2.5	3.7	11.0**
Sum	20.0	36.7	--
Burley Creek			
(a) Bu 5.2 to Bu 3.5	9.7	11.2	21.7
(b) Bu 3.5 to Bu 0.6	6.5	7.7	11.5**
Sum	16.2	18.9	33.2

*Insufficient data; sampling period too short.
**Estimated; sampling period too short.

Time of travel decreases during winter high-flow conditions. Discharge and time of travel are usually inversely related (Singleton and Joy, 1982). A slight increase in discharge will greatly reduce travel times. If a straight logarithmic relationship between discharge and time of travel exists, then the travel times for both Burley and Minter Creeks may be about six to seven hours during the mid-November high-flow period. The effects of shorter travel time, increased sediment, and decreased solar radiation during the winter would decrease fecal coliform die-off and allow more net loading to the estuaries. On the other hand, reduced salinities and temperatures along with increased turbidity during the rainy season cause reduced feeding by oysters. This may result in low oyster tissue coliform levels in winter.

In summary, it is highly unlikely that any point or non-point source in either watershed can be excluded as a contributor to contamination in the estuaries, given the probability for fecal coliform survival for extended periods and the relatively short travel times of streams.

Bacterial Speciation in Stream Water and Sediments

Introduction

Fecal coliforms in water were used in the Minter/Burley project as the primary indication of the presence of human (or other animal) wastes in water. This was done to be compatible with water quality criteria used by DSHS and FDA shellfish sanitation programs and WDOE.

Fecal coliforms are an ecologically heterogeneous group of micro-organisms, only some of which are consistently and exclusively associated with fecal wastes (Cabelli, 1978). The fecal coliform group is composed mainly of Escherichia coli (normally an intestinal organism) and Klebsiella spp., some of which are intestinal, but many others of which are free-living in soil and on plants (Linton, 1971). Klebsiella spp. have been recovered in large numbers from industrial wastes that are rich in carbohydrates (pulp mills, textile plants, and municipal sewage), although they haven't been consistently recovered from human feces (Cabelli, 1978).

The fecal coliform group is a subset of the larger coliform group. It includes a few human enteric pathogens such as Salmonella typhi (typhoid fever), Vibrio cholerae (cholera), and Shigella sp. (dysentery). Other pathogens are not included. However, coliforms such as Klebsiella, Enterobacter, and Serratia are also residents of soil and water (Gaudy and Gaudy, 1980). Enteric coliforms do not generally cause disease while in the intestinal tract. However, they can cause disease outside the gut and are now regarded to be the predominant causes of illnesses among isolated groups and hospitalized persons (McCarty, 1973).

The reason for applying a standard to shellfish-growing areas is that under average conditions, a reasonably constant ratio exists between indicator organisms and pathogens. Thus, an acceptable chance of illness caused by pathogens can be related to an indicator bacteria concentration. This assumption holds reasonably well for surface waters in which large municipal discharges occur. But as the relative size of sources decreases, the ratio of indicator to pathogen becomes increasingly uncertain (Cabelli, 1978).

Since 1900, 90 percent of shellfish-related illneses have been due to typhoid fever, gastro-enteritis of unknown cause, and infectious hepititus. A water quality standard based on the total coliform group was established in 1938-1941 to curb shellfish-associated typhoid fever outbreaks. These outbreaks steadily declined until the last one occurred in 1956 (Cabelli, 1978).

However, other enteric disorders were not curbed. In 1974, the current fecal coliform standard was instituted after studies established a reasonably accurate relationship between fecal and total coliforms. Fecal coliforms were adopted because they are thought to more accurately relate to pathogens specific to warm-blooded animals. However, in some cases, the Klebsiella component in fecal coliform analysis may produce errors of interpretation. For this reason, there is growing interest in adopting a water quality standard based on E. coli densities, since E. coli is a specific intestinal resident. In Europe, many countries have guidelines and standards based on E. coli densities (Cabelli, 1978). Yet, such a move is bound to be controversial since the die-off rate of E. coli in nature may be faster than many feces-associated pathogens, particularly viruses.

Bacterial speciation sampling was performed on freshwater streams in Minter and Burley Watersheds. One goal of the effort was to survey the numbers of enteric bacteria present and to detect a consistent presence of pathogens. Additionally, an effort was needed to estimate the percentage of Klebsiella spp. expected in fecal coliform results generally.

Methods

Samples were taken at a number of sites along streams in both watersheds (Figures 2 and 3). The samples were plated out on EMB, total coliform or fecal coliform media. A maximum of ten colonies were subjected to speciation tests. If the total number of colonies was less than ten, all colonies were tested. The API20E procedure (ANALYTAB Products, Division of Ayerst Labs, Inc., Plainview, NY) was used for speciation.

A set of water samples was taken on August 15, 1983 for initial screening. Sediment samples were taken on September 26. The sediment sampling procedure is discussed elsewhere ("Streambed Sediment as a Reservoir...," Appendix A). Additional water samples were collected on October 18 to provide an estimated percentage of each species present. Each sampling was preceded by extended dry periods. No major rain events occurred between samplings. A final semi-quantitative sampling was performed on January 9, 1984. Speciation for these samples was confined to fecal coliform only in order to determine the relationship between E. coli and Klebsiella spp. The sampling was performed following a long dry period, as before. However, several major rain events and a period of bitterly cold weather separated the January sampling from the others.

The January 9 samples were also used to determine concentrations of fecal streptococci. These were used to calculate FC:FS ratios (Geldreich, et al., 1968; Feachem, 1975).

Results and Discussion

Thirteen species of enteric bacteria were isolated from all stations in both watersheds. These and some clinical and ecological facts are summarized in Table A2. One species, Pseudomonas sp., is a non-coliform type. One coliform bacteria species can be considered pathogenic (Salmonella paratyphi A). It was found on one occasion at BR 0.0. Although the bacterium is of sanitary significance (i.e., derived largely from human wastes), it was detected only once in four samplings (Tables A3 and A4). However, its detection in Bear Creek which had other documented problems gives more evidence that a detailed sanitary survey be conducted in the Bear Creek basin.

Escherichia coli. was present in water samples at all sampling points, including several undeveloped sites (V 0.0, X 0.2). E. coli. made up the major composition of enteric bacterial flora in 13 of 15 samples taken from all 11 sites (Table A4). So E. coli. contamination is detectable in water at all points regardless of the degree and intensity of land use.

Klebsiella sp. was present with E. coli. in water samples at all sites except UN 0.0 on August 15 and September 26 (Table A-5). Species composition was estimated on October 18 and January 9 water samples. On October 18, Klebsiella was present with E. coli. at BU 0.3 and BU 0.6 only. At BU 0.3, Klebsiella represented about 27 percent of the flora, and E. coli. 60 percent. Klebsiella represented about 31 percent of the fecal coliform component (Klebsiella plus E. coli.). At BU 4.3, one-third of the fecal coliform (the only bacterial group present) was Klebsiella. On January 9, Klebsiella was present at BU 0.6 only, and amounted to 86 percent of the fecal coliform group. Klebsiella sp. was absent at all other sites on those dates.

The distribution of E. coli. and Klebsiella sp. was somewhat different in sediments. Eight sites were sampled on September 26. E. coli. was present at three sites (BR 1.2, Horizon Drive, and X 0.2). Klebsiella sp. was present at four sites (M 0.3, M 1.6, M 4.6, and BR 0.0). The two species did not occur together at any point.

Bacterial species diversity seems variable in time and sample sites. Water samples taken on August 15 showed maximum diversity at P 0.1 (five identified plus other species). Sediment samples (September 26) showed maximum diversity at Horizon Drive. On October 18, maximum diversity occurred at BU 0.3 (six species), BU 0.6 (four species), and BR 0.0 (four species).

In summary, there was no discernible pattern in species composition for any particular site. Species diversity appeared to be time-dependent. The relationship between E. coli. and Klebsiella sp. was also highly variable among sampling dates and sites, and seems to be associated more with environmental variability than land use. E. coli. seems to be a cosmopolitan species in water while E. coli. and Klebsiella seem to share similar distribution in sediments.

Selective surviability of Klebsiella may mean higher concentrations in sediments. During heavy rainfall and runoff, Klebsiella may be a more significant component of fecal coliform loading than during dry periods due

Table A2. Some characteristics of coliform and other species found in water and sediment samples from Minter and Burley/Purdy Watersheds.

Classification (Truant, 1974)	Origin and Ecology	Clinical Significance
Gram-negative, Facultatively anaerobic Rods (Coliforms)		
Family Enterobacteriaceae		
Escherichia coli	Found in intestines of humans and other warm-blooded animals; constitutes by far the greatest proportion of bacteria (Linton, 1971). E. coli survives only briefly outside the intestines.	Certain strains can cause serious diarrhea, especially in infants (McCarty, 1973). Important indicator of fecal pollution.
Citrobacter freundii	Infrequently recovered from feces of "normal" individuals at relatively low densities; has been recovered in large numbers from municipal sewage wastes (Cabelli, 1978).	Has been recovered from urinary tract infections and various septic processes (McCarty, 1973).
Salmonella paratyphi A	Salmonella sp. is commonly found in soil and water and animal gut, dairy products, and sewage (McCarty, 1973). Present sporadically and in low numbers in surface waters; no realistic guidelines relate Salmonella species densities in surface waters to disease (Cabelli, 1978).	S. paratyphi A causes enteric fevers in man (Linton, 1971) that are usually milder than "thyphoid fever" caused by S. typhi (McCarty, 1973). May cause chronic illnesses in other animals and birds. Other animals may be symptomless carriers (Linton, 1971).
Arizona sp (formerly Salmonella arizonae	Arizona sp. is commonly found in cold-blooded animals, but has been isolated from fowl and domestic animals and occur in dried egg powder and other foods (McCarty, 1973).	Associated with salmonellosis-like diseases; i.e., gastroenteritis and enteric fevers.
Enterobacter cloacae E. agglomerans	Enterobacter spp., like Klebsiella, have been recovered in large numbers from sewage and industrial discharges rich in carbohydrates; they are not consistently recovered from human feces (Cabelli, 1978).	Enterobacter spp. are opportunistic pathogens and cause secondary infections in hospitalized patients; associated with serious urinary tract and pulmonary infections (McCarty, 1973).
Klebsiella pneumoniae K. oxytoca	Klebsiella spp. have been recovered in large numbers from industrial wstes rich in carbohydrates (pulp mills, textile plants) and sewage; they cannot be recovered consistently from human feces (Cabelli, 1978). Many sp are saprophytes and plant parasites (Linton, 1971).	K. pneumoniae is found in five to ten percent of healthy people in the respiratory tract and feces. The organism causes three percent of all acute bacterial pneumonias. It can cause serious kidney and respiratory infections in hospitalized patients (McCarty, 1973).
Serratia liquefaciens	Serratia sp. is considered to be an opportunistic pathogen which in nature lives on dead or decaying organic material (McCarty, 1973).	Serratia sp., once considered a harmless saprophyte, has been found to cause serious urinary and pulmonary infections in hospital patients (McCarty, 1973).
Yersinia ruckeri	Relatively newly described, thought to be a pathogen of fish (Steve Waegent, FDA, personal communication); causes red-mouth disease in rainbow trout (Jim Staley, Ph.D., Univ. of Wash., Dept. of Microbiol., personal communication).	Y. ruckeri has not been associated with any human health issue to date (Steve Waegent, FDA, personal communication). This organism is not to be confused with several other Yersinia species that are attributed to plague and other illnesses in humans and other animals.
Family Vibrionaceae		
Aeromonas sp. (hydrophila?)	Found in natural waters and soil (McCarty, 1973); many species are pathogens to reptiles and fish (Linton, 1971). A. hydrophila is consistently present in sewage in large numbers, but infrequently present in human feces in relatively low numbers (Cabelli, 1978).	A. hydrophila has been cited as an agent in wound infections (Cabelli, 1978).
Gram-negative, Aerobic Rods and Cocci		
Family Pseudomonadaceae		
Pseudomonas sp.	Many species found in soil, fresh- and saltwater (Linton, 1971). P. Aerugenosa, like A. hydrophila, is consistently present in sewage in large numbers, but are relatively rare in feces from normal individuals (Cabelli, 1978).	Known to cause "swimmers ear." High densities in surface waters presumably because of a nearby sewage source. P. sp. may present a hazard to high-risk persons.

Table A3. Numbers and percent composition of enteric bacteria species in water samples from Minter and Burley/Purdy watersheds.

Station / Species		Minter Watershed: M 1.3 A[1]	M 1.3 B[2]	M 4.4 A	M 4.4 B	UN 0.0 A	UN 0.0 B	UN 0.3 A	UN 0.3 B	UN 2.0 A	UN 2.0 B	Burley/Purdy Watersheds: BU 0.3 A1	BU 0.3 B2	BU 0.6 A	BU 0.6 B	BU 4.3 A	BU 4.3 B	BU 5.2 A	BU 5.2 B	X 0.2 A	X 0.2 B	BR 0.0 A	BR 0.0 B
(Coliform bacteria)																							
Family Enterobacteriaceae																							
Escherichia coli	n[3]	2	*[5]	1	*	**[6]	10	**	9	5	9	9	**[6]	7	1	2	10	4	**	2	**	3	10
	(%)[4]	(100)		(100)			(100)		(90)	(100)	(90)	(60)		(70)	(14)	(67)	(100)	(100)		(100)		(43)	(100)
Salmonella paratyphi A	N																					1[7]	
	(%)																					(14)	
Enterobacter cloacae	N											1		1								1	
	(%)											(7)		(10)								(14)	
E. agglumerans	N											1		1									
	(%)											(7)		(10)									
E. sp.	N																						
	(%)																						
Klebsiella pneumoniae	N											2			3	1							
	(%)											(13)			(43)	(33)							
K. oxytoca	N											1											
	(%)											(7)											
K. sp.	N								1		1	1		1	3							2	
	(%)								(10)		(10)	(7)		(10)	(43)							(28)	
Other	N																						
	(%)																						
Number of species		1	--	1	--	--	1	--	2	1	2	6	--	4	3	2	1	1	--	1	--	4	1
Number of colonies identified		2	--	1	--	--	10	--	10	5	10	15	--	10	7	3	10	4	--	2	--	7	10
FC per station (1/9/84)		--	10	--	3	--	22	--	11	--	17	--	--	--	18	--	19	--	--	--		--	28

[1]A - Samples taken on 10/18/83; speciation done on colonies taken from total coliform and fecal coliform plates.

[2]B - Samples taken on 1/9/84; speciation done on fecal coliform plates only.

[3]n - Number of colonies.

[4](%) - Percent of identified colonies.

[5]* - FC count deemed too low for speciation.

[6]** - Not sampled.

[7] - Good likelihood, but low-sensitive identification.

Table A4. Enteric bacteria species in water and sediment samples from Minter and Burley/Purdy watersheds.

Classification/Station	Minter Watershed																Burley/Purdy Watershed													
	M 0.3		M 1.3		M 1.6		M 4.4		M 4.6		UN 0.0		UN 0.3		H 0.1		BU 0.6		X 0.2		Horizon Drive		BR 0.0		BR 1.2		P 0.1		V 0.0	
	W[1]	S[2]	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W	S
(Coliforms)																														
Family Enterobacteriaceae																														
Escherichia coli	n/s[3]		X[4]	n/s	n/s		X	n/s	n/s		X	n/s	n/s		X	n/s	X	n/s	X	X	n/s	X	X		n/s	X	X	n/s	X	n/s
Citrobacter freundii																						X					X			
C. sp.																						X								
Enterobacter cloacae														X																
E. agglumerans											X											X							X	
E. sp.																						X								
Klebsiella pneumoniae		X				X				X					X		X		X				X	X			X		X	
K. oxytoca																			X				X				X			
K. sp.			X				X								X															
Serratia liquefaciens		X																												
Yersinia ruckeri														X																
Arizona sp.											X																			
Family Vibrionaceae																														
Aeromonas sp. (*hydrophila*)											X																X			
(Non-coliforms)																														
Family Pseudomonadaceae																														
Pseudomonas sp.																			X											
Other unidentifiable species (due to mixed cultures)			X				X				X				X		X		X				X				X		X	
Number of Species (identified)	--	2	2	--	--	1	2	--	--	1	4	--	--	2	3	--	2	--	3	1	--	5	2	1	--	1	5	--	3	--

[1]W = water (8/15/83)
[2]S = sediment (9/26/83)
[3]n/s = not sampled
[4]X = present

to release of bacteria entrained in high flow. Under these conditions, a specific analysis for E. coli. may be more representative of the presence of fresh waste than the fecal coliform analysis.

Fecal Coliform:Fecal Strep Ratios. Several authors have reported the utility of FC:FS ratios in identification of the source of animal wastes as human or non-human (Geldrich and Kenner, 1969). The species of fecal streptococci in humans difers from those of livestock. An FC:FS ratio of less than 0.7 may be indicative of contamination from domesticated farm animals, while a ratio exceeding 4 indicates a human source. However, because of unequal rates of bacterial die-off, FC:FS ratios change in such a way that the ratio is valid only during the initial 24-hour period.

Feachem (1975) made use of the unequal die-off rates to show that if a series of FC:FS ratios is obtained over time, an estimate of age of the fecal contaminant is possible. A predominantly human source would have a high ratio (initially >4) which would decrease, whereas a non-human source should exhibit an initially low ratio (<0.7) which would increase. This method is useful, however, only if the waste stream receives no additional wastes over the period of study.

The conformity of the ratios to expected values in a body of water receiving wastes from mixed human and non-human sources would be difficult to predict. The value would be between 0.7 and 4.0 depending upon the relative population proportions. The interpretation of FC:FS ratios obtained under field conditions would require extensive knowledge of numerous uncontrolled factors such as land-use, population distribution, flow rates, and hydrologic characteristics of the area under study.

Table A5 summarizes FC:FS results. They suggest strong evidence of agricultural effects regardless of land use, the absence of pasture-derived runoff and lack of significant livestock at a number of points. The results appear to be contrary to common sense.

These data contrast sharply with results from Clark and Determan (1981) and Furfari and Carr (1981) at approximately the same sites. In Clark and Determan, conditions were warm and relatively dry; in Furfari and Carr (1981), cool and rainy. Their data point to mixtures of human and animal pollution. Furfari and Carr (1982) noted that the ratios did not show consistent relationships. In general, the use of FC:FS ratios did not serve to separate effects of human waste and animal pasturage. Jackson and Glendening (1982) noted similar lack of consistency in their detailed survey of sources in Tillamook Bay, Oregon, watershed.

Streambed Sediment as a Reservoir of Fecal Coliforms

Introduction

Rain-event sampling conducted during the Minter/Burley investigation showed that increased rainfall and subsequent elevation in stream flow result in dramatic jumps in fecal coliform levels. Stream turbidity and the quantity of suspended material also increase. The fecal coliform levels may be explained largely by entrainment of livestock wastes by runoff from streamside

Table A5. FC:FS ratios determined from water samples taken from Minter and Burley/Purdy Watershed streams on January 9, 1984.

Station	Land Use	FC/100 mL	FS/100 mL	FC:FS	FC:FS[1]	FC:FS[2]
M 1.3	Mixed residential, pasturage	10	115	0.09		1.9
M 4.4	Mixed residential, forest	3	168	0.02		
UN 0.0	Residential, forest	13	293	0.04		
UN 0.3	Commercial, residential	13	380	0.03		
UN 2.0	Extensive pasturage	21	684	0.03		
BU 0.6	Mixed residential, pasturage	18	83	0.22	0.70	1.3
BU 4.3	Pasturage, residential, wetland	19	212	0.09	1.54	
X 0.2	Forested, undeveloped	1	84	0.01		
BR 0.0	Residential, forested	28	193	0.15		1.0

[1]August 26, 1981 (Clark and Determan, 1981).
[2]January, 1981 (Furfari and Carr, 1981).

grazing areas. However, McDonald, et al. (1982) showed that a ten-fold elevation in fecal coliform levels could be induced in a stream without runoff of any sort simply by releasing water from an upstream reservoir. The added flow resulted in the disturbance of streambed material and entrainment of sediment-associated fecal coliform. Matson, et al. (1978) constructed a model which described the reduction of sediment-bound microorganisms and related increases in water-borne microorganisms during a rapid increase in river discharge.

Sediments provide substrate for fecal coliform bacteria and allow them to survive and perhaps reproduce. In order to quantify this phenomenon in this case, sediment-disturbance studies were conducted and sediment samples taken at a number of points on the Minter/Burley streams.

Methods

Study sites were chosen based on past data and land-use characteristics (Figures 2 and 3). Sediment disturbance experiments were conducted on September 20, 1983. Rainfall during the previous three days was 0.57 inch. River flows were relatively low. Each experiment was performed in the following manner: First, an initial set of two replicate water samples was taken for FC(MF) analysis. The sediments were then systematically disturbed at a point roughly seven meters upstream. A second set of samples was taken after the cloud of turbid water reached the sampling point. A sample for turbidity and suspended material was also taken. (No turbidity and solids samples were taken during initial sampling. Rather, these variables were assumed to be the same as those taken the previous day during routine background sampling.)

Samples of sediments were taken six days later. Only trace rainfall had fallen during the interval. A sampler was made from a 250 mL polyethylene sample bottle with the bottom removed. The sampler without the cap was pressed bottom-first into the streambed to a depth of 2 cm (± 0.5 cm). The cap was replaced, and a flat plate slid beneath the lower end of the sampler. The sampler was then removed. Water that was trapped in the bottle was decanted through the top, and the sediment was dropped through the bottom into pre-sterilized whirl-top bags. Three subsamples were composited for each site. The samples were placed on ice and returned to the laboratory.

Results and Discussion

The results of sampling are shown in Figure A5 and Table A6. Nearly half of the sites initially violated Part 1 of the state water quality standard (BU 0.6, M 1.6, BR 0.0, M 4.2). Two more sites violated the standard after the sediments were disturbed (UN 0.3, Horizon Drive). Significant increases were noted at five of nine sites (BR 0.0, UN 0.3, M 4.6, HORIZON DR., X 0.2) and a presumed increase at one other (M 1.6).

Disturbance at several other sites did not result in significant increases (BU 0.6, M 4.2, M 0.3). Prior to disturbance, two of these sites had violation-level initial FC densities (BU 0.6, M 4.2); the other (M 0.3) had moderately high levels.

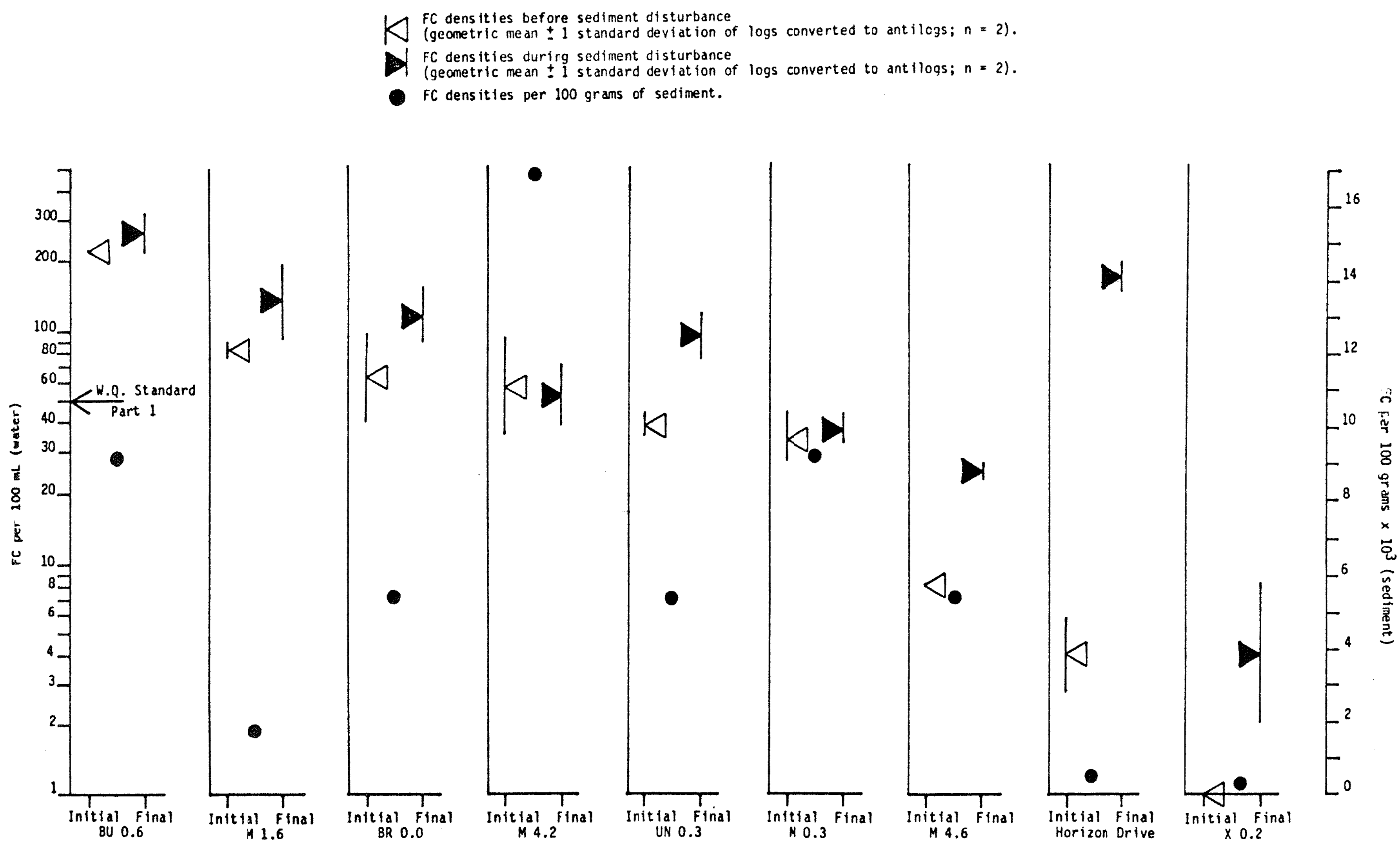

Figure A5. RESULTS OF SEDIMENT DISTURBANCE STUDIES CONDUCTED IN TRIBUTARIES IN MINTER AND BURLEY/PURDY WATERSHEDS. STATIONS ARE RANKED ACCORDING TO DESCENDING INITIAL FC CONCENTRATIONS.

Table A6. Results for stations ranked according to sediment fecal coliform release characteristics.

				Before Disturbance			After Disturbance				
Station	Land Use	Sediment Type	Q (cfs)	Turb.[2] (NTU)	TSS[2] (mg/L)	FC/100 mL (Geo. Mean)	Turb. (NTU)	TSS (mg/L)	FC/100 mL (Geo. Mean)	Release[3] Capacity	FC/100 gr (sediment)
Horizon Dr.	Residential Subdivision	Clay	0.3	--	--	4	57	140	166	1.46	460
M 0.3	Undeveloped downstream forest	Sand	26.0	2	5	33	5	10	36	0.54	9,200
X 0.2	Undeveloped upland forest (control station)	Silt	0.3	3	5	1	36	160	4	0.15	260
M 1.6	Agricultural; grazing	Silt, sand	11.3	2[4]	3[4]	83	11	58	132	0.08	1,180
BR 0.0	Residential; small-scale agriculture	Sand	4.0	4	5	62	36	200	115	0.04	5,400
BU 0.6	Residential; smallscale agriculture	Sand	19.5	4	6	219	30	200	263	0.03	9,200
UN 0.3	Commercial (restaurant, veterinary clinic)	Silt, sand	0.5	3[5]	2[5]	38	70	140	93	0.03	5,400
M 4.6	Residential subdivision (modular housing)	Silt	2.4	1[6]	<1[6]	8	62	130	24	0.02	5,400
M 4.2	Residential; small-scale agriculture	Silt, sand	2.4	1[6]	<1[6]	56	21	50	51	0.01	17,000
BR 1.6[1]	Residential; moderate-density grazing	Clay		2[7]	2[7]		--	--	--	--	>240,000

[1]BR 1.6 not ranked due to lack of data.

[2]Samples taken September 19, 1983.

[3]Release capacity is the ratio of FC/100 mL before disturbance to FC/100 mL after disturbance (both concentrations "normalized" by dividing by the concentration of suspended solids).

[4]Samples taken at M 1.3.

[5]Samples taken at UN 0.0.

[6]Samples taken at M 4.4.

[7]Samples taken at BR 1.8.

The most dramatic disturbance-induced increase occurred at Horizon Drive below a residential subdivision. FC densities jumped from 4 FC/100 mL before disturbance to 166 FC/100 mL during disturbance. The sediment concentration at this site was low (460 FC/100 g). Similarly, FC counts at X 0.2 (the undeveloped control site) increased significantly upon disturbance. Concentrations of FC in sediments were low at this site also (260 FC/100 mL). At these sites, the physical or chemical character of the sediment may foster FC release from the sediment with minimal disturbance. There may be a lack of affinity of FC for this sediment which would not allow FC buildup.

Site M 4.2 shows another extreme. The sediments show high FC concentrations (17,000/100 g) while disturbance shows no significant increase in FC. In this case, the affinity of the sediment for FC may make it difficult to dislodge them. This may also be the pattern for BU 0.6 and M 0.3, which have moderately high sediment concentrations. The remaining sites may represent intermediate cases.

The results of the sediment disturbance studies were "normalized" by dividing fecal coliform density by suspended solids concentration (B. Yake, WDOE, personal communication). The ratio of normalized fecal coliform density obtained after disturbance to that density obtained before is referred to as <u>sediment fecal coliform release capacity</u> (Table A6). The degree of FC contribution from the sediments appeared to be related to certain sediment physical or chemical characteristics such as particle size and adsorptive properties. In places where FC levels in sediment are low, FC release capacity may be highest. (Station M 0.3 appears to be an exception). Likewise, FC in sediment content may be high where release capacity is low. The data may reinforce the idea that a negative correlation may exist between FC densities in sediment and the capacity to release them upon disturbance. However our data are too few to prove this hypothesis.

Several other factors influence the accumulation or concentration of fecal coliforms in sediment, including stream velocity, FC loading from surrounding land, and content of organic matter. Nutrient availability and predation, which were not addressed here, also increase fecal coliform survival (Tate, 1978).

The highest sediment fecal coliform levels seemed to be in areas of combination small farm/residential land use. The sediment fecal coliform content was quite low at the E. Horizon Lane station which is downstream from a residential area with no farm animals. However, wide variation in FC densities occur due to the factors discussed previously. These factors tend to obscure effects due to different land-use practices.

An additional sediment sample was taken at BR 1.6. This is a large and nearly stagnant point in the stream below several large pastures that are heavily grazed. Serious water quality problems have been noted several times in this report and elsewhere (Furfari and Carr, 1982). Deep deposits of silt from nearby fields fill the stream. A sediment sample here had greater than 240,000 FC/100 g; in excess of 14 times that found at the next highest point (M 4.2) and 1,000 times that found at the control site (X 0.2). The fine silts are easily transported downstream and probably account for much of the fecal coliform loading from Bear Creek during rain events. Additional loading may be due to the failure of septic systems downstream caused by flooding of the silt-choked stream.

In summary, sediment disturbance studies demonstrated that during periods of heavy rain and increased stream flow, a significant fraction of the observed fecal coliform loads may be derived from streambed sediments. The size of the fraction may be related to a number of factors including the character of the sediment, the degree of rainfall, and the magnitude of the source along the stream bank. During lighter rains when runoff is low, the proportion of load due to streambed entrainment may be larger than that due to runoff. In any case, streambeds may tend to amplify the effects of point- and non-point sources and thus serve as highly sensitive indicators of general conditions in the watershed. However, streambed entrainment of FC tends to obscure detection of individual sources.

The Effects of Ground Water Intrusion on Water Quality in Minter Bay

Introduction

Waste disposal from shoreside residences and commercial buildings may contribute contamination in both Burley Lagoon and Minter Bay. Several obvious disposal system failures in Burley Lagoon were located by DSHS in past years. Corrections were made under order of the Pierce County Health Department. Recently, WDOE surveys in Purdy Creek isolated a failed system used by the shopping center at the mouth of Purdy Creek. The management is currently under order to replace the system.

Numerous studies have described the movement of dissolved materials through soils. Several studies specifically adressed ground-water flow into estuaries. The movement of bacteria such as fecal coliform (FC) through soils has been studied also. In view of the evidence in the field and the literature, specific studies were carried out in Minter Bay in order to evaluate this issue. First, an indirect assessment was performed to locate segments of the estuary where significant ground-water flow and FC loading were evident. Next, direct sampling of ground-water wells was carried out at a number of points around the estuary. Finally, fluorescent dye was injected into some disposal systems and intensive sampling for dye carried out over several days.

Because of time constraints, ground-water studies were confined to Minter Bay. They were not carried out in Burley Lagoon.

Methods

An indirect assessment of ground-water flow and FC loads was carried out on October 6, 1983 during low tide. Minter Bay was empty of marine water for an extended period, and Minter Creek flowed through the empty estuarine basin within a well-defined channel (Figure A6).

Sampling sites were placed at approximately equal intervals along the stream channel from head to mouth of the estuary. In this manner, Minter Bay was divided into five segments with sampling sites placed at boundaries. Replicate FC samples and a salinity sample were taken at each point. Stream flow was measured using a Marsh-McBirney flow meter. Replicate stream flow measurements at the Minter Creek input point (M 0.0) showed a three percent variation. Given the limited time available and an acceptable level of variation, single stream flow measurements were taken at the other sites.

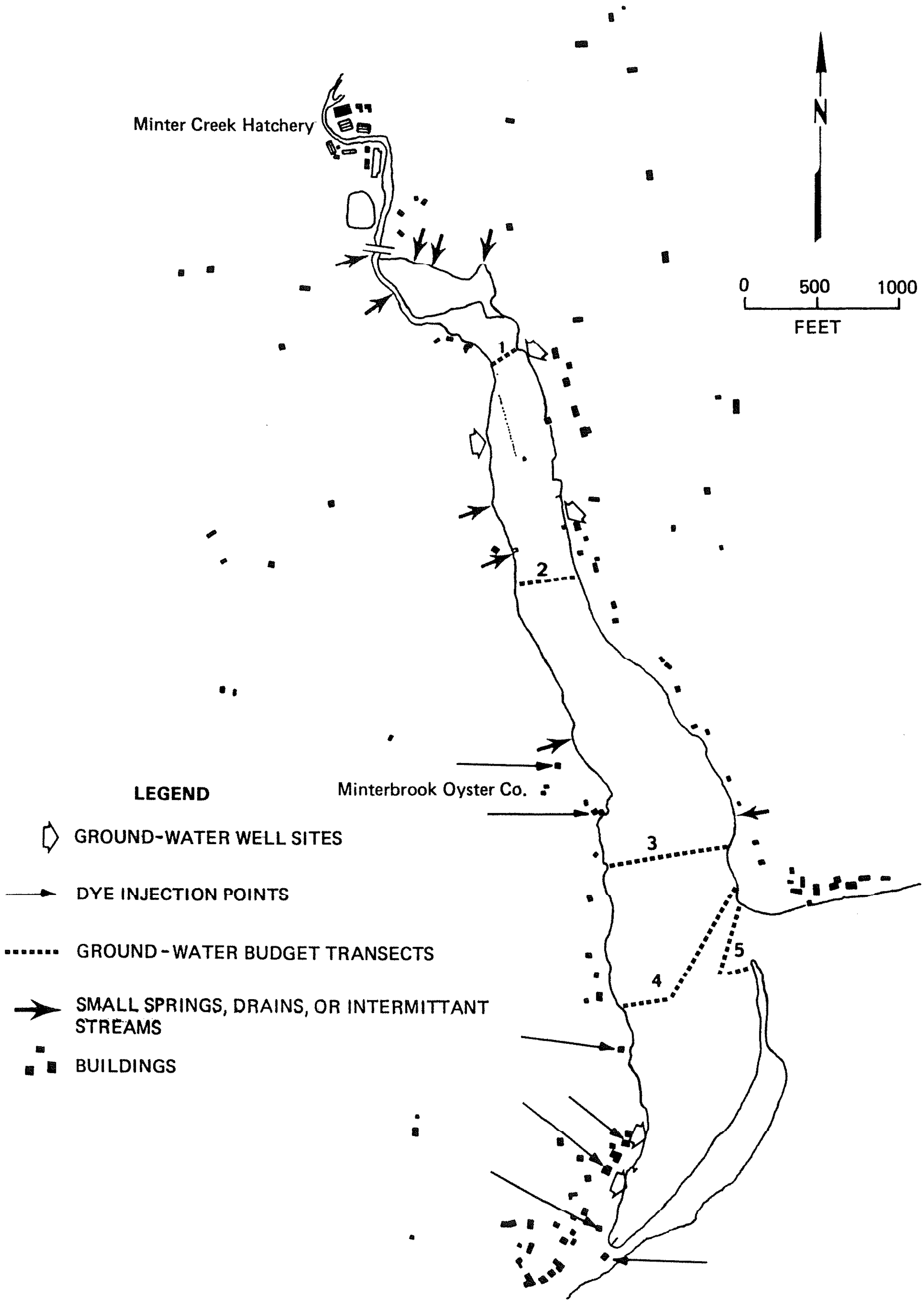

Figure A6. GROUND-WATER BUDGET TRANSECTS, GROUND-WATER SAMPLING SITES, AND RHODAMINE WT INJECTION POINTS IN MINTER BAY.

Shallow wells were used to sample ground waters around the perimeter of Minter Bay. Sites were selected to evaluate several land use classifications and their hydrological characteristics. Well casings were constructed from four-inch diameter PVC leaching field pipe, each about five feet long. Short horizontal slots were cut into the lower 2 1/2 feet of the pipe. Each set of three slots was spaced at intervals of 1/2 inch. Each adjacent set of slots was arranged to provide inflow from every direction. The well casings were placed into six-inch diameter holes bored with a hand auger. The top of the holes were placed above maximum high-tide level.

The bottom end of each pipe was sealed with plastic sheeting and electrical tape (seals showed no evidence of rupture when inspected after their recovery). Crushed, washed sand was placed around each casing and piled four inches above grade. An 18-inch diameter collar of plastic sheeting was placed around each casing and sealed with electrical tape to minimize surface contamination. The outer edges of the collar were buried. The casing extended 18 inches above grade, and the top was closed with a plastic litter bag with drawstrings when not being sampled.

Sampling was performed on January 19, 1984. A total of ten wells were installed. Three wells were located in deep sand and did not intersect ground water flow. These were abandoned. A fourth well showed evidence of contamination from standing water on the surface. Instead, samples were taken at a nearby spring which provides process water for the Minterbrook Oyster Company.

Samples taken included three replicates of FC, salinity, turbidity, and nutrients. Each well was evacuated twice with a battery-powered pump prior to sampling. Samples were drawn from the well into a large elbow flask by a Nalgene hand-operated vacuum pump. Samples were then decanted into regular sample bottles. All samples were stored on ice and returned to the laboratory for analysis. The flask and plastic sampling hose were then rinsed once with alcohol and twice with phosphate buffer water prior to taking the next sample.

We attempted to determine whether wastewater from individual septic systems found its way into Minter Bay. The buildings between the southwest corner of the estuary and the Minterbrook Oyster Company were selected as objects of study because our previous study indicated high rates of ground water intrusion in this area. Visits were made to residences directly fronting the beach. Dye was injected into the systems of six buildings (Figure 34). Six others were vacant or were only occasionally occupied. Four newer residences near the mid-point of the study area had disposal systems located upland as far as 600 feet away from the shoreline. (This means of disposal is required by recent Pierce County Health regulation.) Dye was injected into one of these systems.

About 200 mLs of Rhodamine B dye were poured into each water closet while it was flushing. The water closet was flushed several more times. The injection was done on the morning of January 19, 1984 during ebb tide. A continual watch was maintained throughout the day for visible evidence of dye. At high slack tide in the afternoon, 500 mL grab samples were taken in the shallows within six feet of the water's edge at numerous points along the southwest shoreline. An additional set of samples was taken the following afternoon during rising tide, estuary-wide.

All the samples were analyzed for the presence of fluorescent dye with a Turner Model 110 fluorometer. The instrument was corrected against background fluorescence with water collected in mid-Henderson Bay.

Results and Discussion

Data from the indirect assessment are shown in Table A7.

The study was conducted during an extended dry period. The total seven-day rainfall was 0.05 inch. Thus, contribution from the few small surface streams or surface runoff was minimal.

The salinity results (Table A7, column 1) were used to separate the fraction of stream flow due to ground water and Minter Creek from that due to the release of saltwater from bay sediments. The saltwater fraction (Column 2) was calculated as follows (Mills, et al., 1982):

$$f_{fi} = \frac{S_s - S_i}{S_s}$$

where:

f_{fi} = fraction of freshwater for segment "i"

S_s = salinity of local (Henderson Bay) water, o/oo

and

S_i = salinity for segment "i", o/oo

Finally:

$$f_{si} = 1 - f_{fi}$$

where:

f_{si} = fraction of saltwater for segment "i"

There is only a slight increase in total streamflow between Minter Creek mouth (M 0.0) and Transect 2 (Col. 3). The freshwater and saltwater components vary slightly. The saltwater component at Transect 2 (Col. 4) appears excessively large due to a probable salinity error. The freshwater component (Col. 5) is similarly an underestimate. The general trend is increasing flow for both components with increasing distance from M 0.0. The ground-water flow within each segment was estimated by subtracting the freshwater inflow from the freshwater outflow (Transect 2 was ignored). Groundwater flows (Col. 6) in Segments D and E are nearly five times greater than those in the northern end of the estuary.

Fecal coliform loads were calculated from total stream flow (Col. 3) and fecal coliform results (Col. 7) using Kittrell (1969). The net load generated within each segment was estimated by finding the difference between incoming and outgoing loads (Col. 9).

Table A7. Ground-water budget and fecal coliform loadings through segments of Minter Bay on October 6, 1983.

Segment	Sample Site	Salinity (o/oo)	Saltwater Fraction	Stream Flow (ft^3/sec) Total	Saltwater	Freshwater	Groundwater flow from Segment (ft^3/sec)	FC/100 mL $\bar{X} \pm S$ (n)	FC Load (FC/sec x 10^5)	Net Load Each Segment (FC/sec x 10^5)
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	M 0.0	.2	.01	21.46	0.01	21.45		13 ± 4(2)[1]	0.79	
A							(+) 0.03			0.67
	Transect 1	.2	.01	21.51	0.02	21.49		24 ± 1(2)	1.46	
B							-			0.49
	Transect 2	4.2	.14	21.54	3.02	18.25		32 ± 5(2)	1.95	
C							(+) 1.04			0.88
	Transect 3	1.0	.03	23.23	0.70	22.53		43 ± 20(2)	2.83	
D							(+) 2.38			-1.07
	Transect 4	1.2	.04	25.95	1.04	24.91		24 ± 5(2)	1.76	
E							(+) 2.34			-0.47
	Transect 5	6.5	.22	34.93	7.68	27.25		13(1)	1.29	
	Mid-bay Drainage	25.6	.87					<1		
	Henderson Bay (Stns. MES, BES)	29.5	1.0							

[1]Value obtained October 3, 1984.

[2]Value is the mean of samples taken during rising tide on October 10.

Fecal coliform loads are generated within each of the three northernmost segments. "Negative" loads occur in the two southern segments. This means that loads entering the two southern segments were being diluted. Overall, the sum load from all segments was 0.5 x 10^5 FC per second or about 63 percent that of Minter Creek inflow (0.79 x 10^5 FC per second).

An additional small stream was observed near the mouth of the estuary. The stream drained several large ponds on the south-central exposed bottom of the basin. Fecal coliform and salinity samples were taken (Table A7). The results indicated that the stream was nearly 90 percent seawater with negligible fecal coliforms. The results also suggest that ground-water input from the southeast shoreline is relatively unimportant.

The results of well sampling are shown in Table A8. Results from Minter Bay stations sampled during the last routine background monitoring on December 12, 1983, are also shown. The values in the estuary at that time may have reflected the influence of high watershed load due to heavy rainfall (three-day rainfall totaled 1.32 inches). Watershed effects during the well-sampling effort were minimal (three-day rainfall was zero).

All well samples showed high turbidity. The spring and surface water samples were far lower. The high turbdity in the wells may be an artifact of the method. EPA (1979) reports that turbidity may interfere with membrane-filter fecal coliform results due to the high probability of several fecal coliform(s) clumping to suspended matter which would underestimate the actual number. However, at very low concentrations, the probability of several fecal coliform attaching to the same particle is very small. Thus, the likelihood of serious error at the levels of turbidity we encountered is remote.

Upland ground waters do not appear to be an important direct source of fecal coliform bacteria. We have indirectly sampled ground water from several subsurface drains and emergent surface flows on several other occasions during the study. Those samples also showed FC levels to be within the standard. On the other hand, FC loads picked up by the creek as it passed through the first three segments of Minter Estuary were much higher than the load from Minter Creek. Fecal coliforms in this stretch may have been released from estuarine sediments by ground water flow.

Nutrients in the ground-water samples suggest two extremes. The Bernet and Yellow House wells show very low NO_3-N:NH_3-N ratios. High ammonia values may be due to ground-water contamination. On the other hand, a slight sulfide odor at the Barnet well, the high degree of soil saturation, and the slow recharge of the wells suggest that oxidation of nitrogen compounds may be retarded by lack of oxygen. The other wells show the opposite result. Ammonia levels are comparable to surface waters, but nitrate levels are generally higher. These other wells were characterized by sandy soils with moderate-to-rapid recharge of the well after draining.

The results of the dye injection effort are easily summarized. Close visual monitoring during the first day showed no evidence of immediate effluent breakthrough into Minter Bay. The two sets of samples taken after injection showed no fluorescence above background levels. Therefore, no discharge from septic tanks was detectable for a 36-hour period following injection.

Table A8. Results of ground-water sampling in Minter Bay.

Well No.	Location	FC per 100 mL $\bar{X} \pm S$ (n)	NO_3-N (mg/L)	NO_2-N (mg/L)	NH_3-N (mg/L)	O-PO_4-P (mg/L)	T-PO_4-P (mg/L)	Turb. (NTU)	Salinity (o/oo)	Soils and Recharge Characteristics
1	Bernet Residence; NE shoreline	<1 (3)	<0.01	<0.01	0.28	0.01	0.01	27	dl*	Sand overlying heavy clay; hardpan layer at one foot, recharge very slow
2	Yellow house; east side, mid-shore	<1 (3)	0.02	0.01	0.12	0.05	0.05	98	dl	Gravelly sandy loam with moderate permeability; recharge moderate
3	NW shore; undeveloped upland	<1 (3)	1.50	<0.01	0.03	0.02	0.06	48	dl	Loamy sand, well drained; recharge rapid
4	Minterbrook Oyster Co. spring; west side mid-shore	<1 (3)	1.10	<0.01	<0.01	0.03	0.04	4	dl	Refer 3, above; spring output large
5	Hershey Res.; SW shore	5 ± 3 (3)	1.40	<0.01	0.02	0.02	0.06	40	dl	Refer 3, above
6	Grey house; SW shore	<1 (3)	0.46	<0.01	0.03	0.06	0.07	23	dl	Refer 3, above
M 0.3	Minter Cr. above Hatchery	53 (1)	0.41	<0.01	0.01	<0.01	0.02	6	--	
MES	Mid-bay over oyster beds; sampled on ebb tide	26 ± 1 (2)** 49 ± 0 (2)**	0.39	<0.01	0.04	0.03	0.04	1	3.3	
MEX	Bay mouth; sampled on flood tide	2 ± 1 (2)** 3 + 1 (2)**	0.38	<0.01	0.03	0.06	0.06	1	25.9	

*"dl" means "detection limit."
**MPN analysis.

In summary, the net fecal coliform load carried out of Minter Bay on the survey day was about 63 percent in the Minter Creek input. Well sampling and dye injection does not indicate that ground water intrusion is an important source for fecal coliform loading into the estuary. The added load may be derived from estuarine sediments. On the other hand, the load from Minter Creek was relatively small; it was about 20 percent of the average load during the study (Table 3) and 3 percent of the highest load encountered (November 14, 1983, Appendix C). If the loads from ground-water intrusion or other estuarine sources remain relatively constant, their contribution to the total problem is probably small.

Distribution of Fecal Coliform Bacteria in Estuarine Water, Sediments, and Shellfish

Introduction

In late May and June, 1983, intensive sampling of surface waters, shellfish, and sediments was done in Burley Lagoon and Minter Bay. The purpose was three-fold. First, we wished to find how fecal concentrations at the routine mid-bay sampling sites (MES, BES) compared to shoreline values. Second, we wanted to learn the degree of variation of nearshore water quality and to see if this was associated with shoreline land-use practices. Third, we wished to detect a relationship, if any, between levels of fecal coliform in water and shellfish.

Methods

Sampling in the estuaries was carried out during a period of prolonged dryness. This was done in order to assure minimal influences from watershed sources and thus to detect the effects of sources within the estuary.

A map of each estuary was prepared by tracing building locations from color photographs obtained from the WDOE Shorelands Division onto a mylar sheet. Each shoreside building was noted on the map by physical description (paint color, etc.) during a preliminary survey. Each sampling site was located according to building locations. This method assured station location error to be no greater than 50 to 100 feet.

Single water samples were collected as close to the shoreline as possible. Shellfish were collected in the prescribed manner (APHA, 1970).

Sediment samples were obtained using a Petite Ponar grab sampler (WILDCO No. 1728-G40). The samples were taken from the sampler using a "cookie-cutter" device made from stainless steel. The device was rinsed with alcohol and de-ionized water between uses.

Procedures for analyses are described in Appendix B. Shellfish and sediment samples were analyzed by the most probably number (MPN) method. Water samples were analyzed with the membrane filter (MF) method. This method tends to underestimate the results in marine waters compared to the MPN method (page 14). However, due to limited laboratory capacity and the large number of samples required, MF analyses were run. Although absolute accuracy of the results is doubtful, the data were deemed useful to make spatial comparisons.

Results and Discussion

Water sampling in Minter Bay was done on May 18 and May 24 at high slack tide. Sediments and shellfish were sampled on June 7. Burley Lagoon water was sampled on June 8 and 9. Little or no rain fell during this time. Shellfish and sediment samples from Burley Lagoon were taken June 20. Several rain events occurred between June 9 and 20. The average daily rainfall was 0.18 inch. Maximum daily rainfall occurred on June 10 and 17 (0.52 inch and 0.26 inch, respectively). Thus the sediment and shellfish samples from Burley Lagoon may show the effects of periodic rain events that the water samples may not.

Results of sampling in Minter Bay are shown in Figures A7 and A8. The data show significant violations of both parts of the Water Quality Standards (Appendix B). The geometric mean (G.M.) of all samples was 43 FC/100 mL (n = 55). This is over three times the Part 1 standard (14 FC/100 mL). Fifty-eight percent exceeded 43 FC/100 mL (no more than 10 percent can exceed this value under Part 2 of the standards).

Fecal coliform densities along the shore north of the Minterbrook Oyster Company plant averaged 78 FC/100 mL (n = 16). Shoreline levels south of the plant averaged 19 FC/100 mL (n = 15). This may not be a true spatial difference because the samples were taken on different dates. The average fecal coliform level at mid-channel sites (the only ones taken on both days) was three times higher on May 18 than on May 24 (42 and 14 FC/100 mL, respectively).

The northeastern side of northern Minter Bay is lined with residences. The northwestern shore is undeveloped. At high slack tide, the geometric mean fecal coliform levels were almost indistinguishable, given the variability of the data (102 FC/100 mL, n = 9 on the east; 96 FC/100 mL, n = 9 on the west). Thus there appears to be little evidence that shoreside residences are generating localized contamination of the estuary.

An extremely high sample (450 FC/100 mL) was taken about 100 feet downstream (south of) the Minterbrook Oyster Company. The sample came from a plume of turbid water generated by a stream of washwater from the shucking house which intersected the ebbing current after flowing across 25 feet of beach. A sample taken immediately up-current was less than one-tenth as high. It is not clear whether the contamination came from the washwater itself or was derived from the beach over which it flowed.

Geometric mean shellfish and sediment samples in Minter Bay were 100 and 29 FC/100 g, respectively. The shellfish and sediment samples were generally lower in fecal coliform densities than would be expected considering the water quality. The highest level in shellfish was at the mouth of the estuary and at the northernmost sampling point.

It appears that the corner of the estuary south of the mouth and west of the spit may be somewhat isolated from watershed effects. Fecal coliform densities in both shellfish and water were lower here than elsewhere. Shoreline water quality in this area tended to be lower than elsewhere also (Figure A8) although they were still violation-level densities (G.M. = 19 FC/100 mL; n = 10). During a dispersion study, Rhodamine WT dye was injected in the northern end of the estuary at high slack tide. During the ebb, transects were run

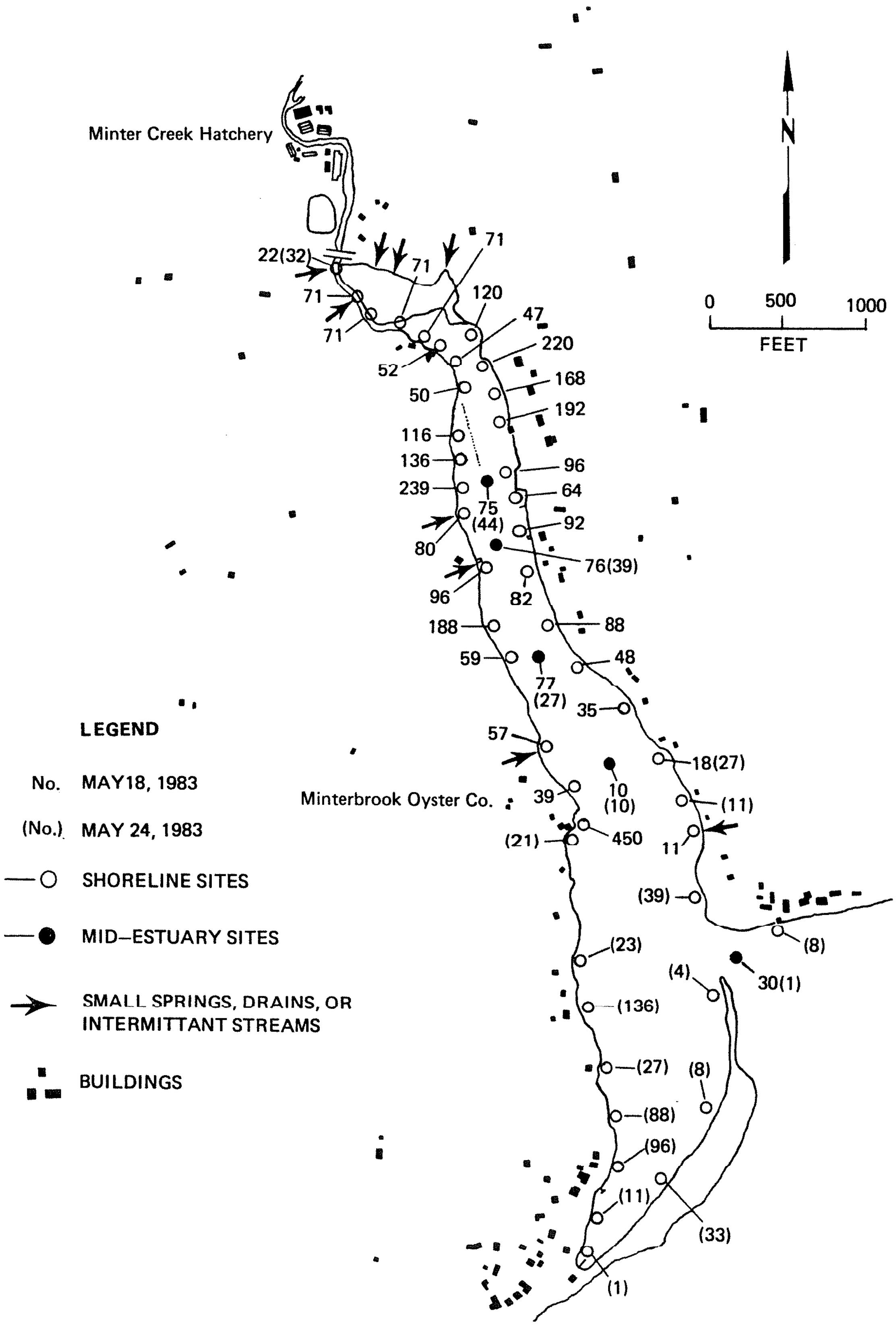

Figure A7. FECAL COLIFORM DENSITIES IN WATER (fc per 100 ml) IN MINTER BAY AT HIGH SLACK TIDE ON MAY 18 AND 24, 1983.

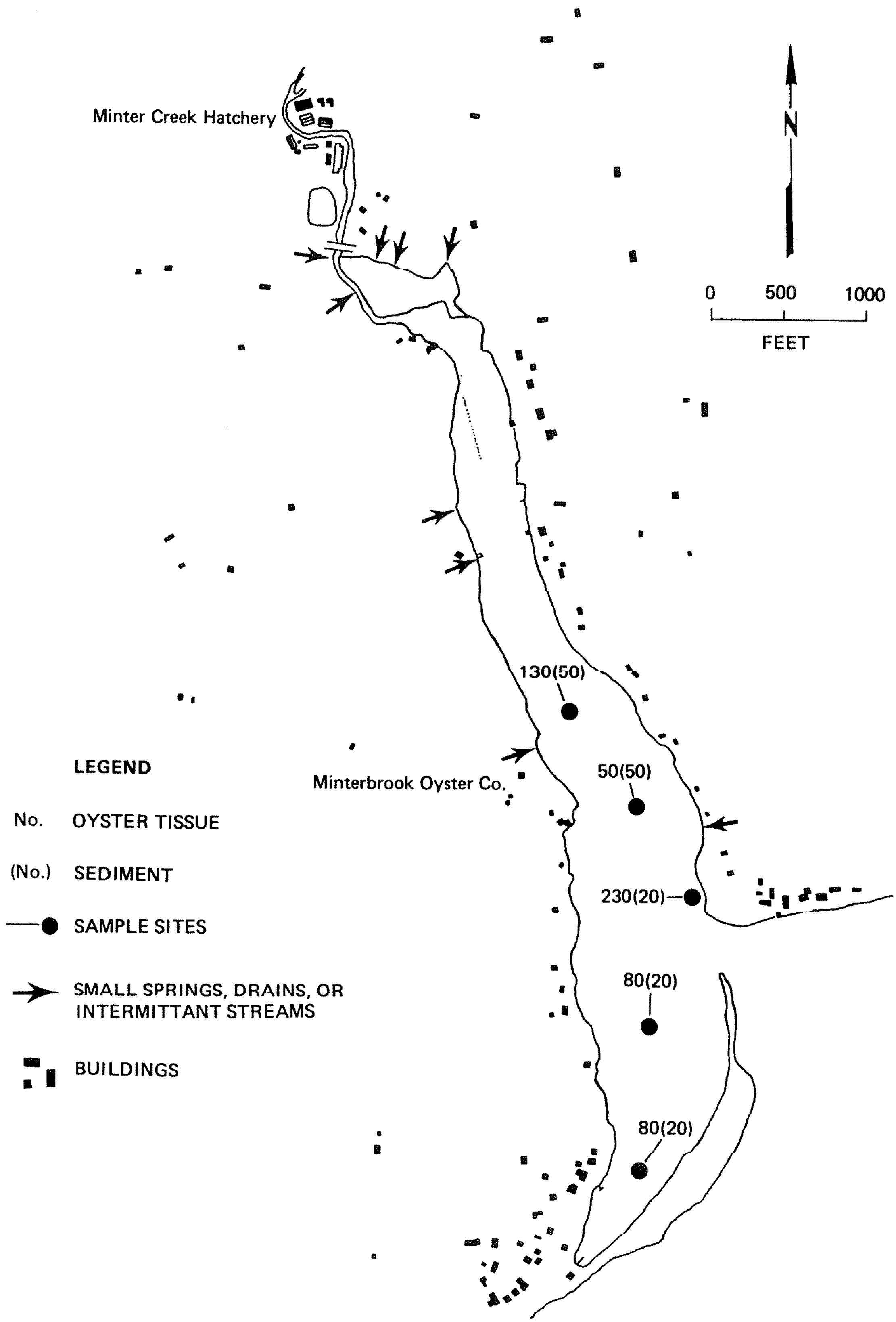

Figure A8. FECAL COLIFORM DENSITIES IN SEDIMENTS AND OYSTER TISSUE (fc per 100 g) IN MINTER BAY ON JUNE 6 AND 7, 1983.

across the estuary, including the southeastern corner. There was no evidence that dye entered the south corner of the estuary on the ebb flow. However, this corner and the rest of the estuary probably receives incoming tidal exchange contaminated by Minter Bay waters during previous tide cycles.

Results of sampling in Burley Lagoon are shown in Figures A9 and A10. The geometric mean of all samples was 24 FC/100 mL (n = 52), and 38 percent of the samples exceeded 43 FC/100 mL. Although these results were above the limits imposed by the standards, they were better than those found in Minter Bay. The samples taken at mid-lagoon sites averaged 8 FC/100 mL (n = 9). Like Minter Bay, Burley Lagoon mid-bay sites were far less contaminated than shoreline sites.

Considering the degree of variation in the data, there was no provable difference between fecal coliform levels north of the mid-estuary island (taken June 8) and south of there (taken June 9).

The highest levels of fecal coliform were in the Purdy Creek mouth area (G.M. = 66 FC/100 mL; n = 5) and around Burley Village at the north end (G.M. = 62 FC/100 mL; n = 3). The lowest shoreline values were associated with an undeveloped section in the northwest corner (G.M. = 13 FC/100 mL; n = 7). The eastern, more heavily developed shoreline (excluding Purdy Creek mouth) had a higher average (37 FC/100 mL; n = 16) than did the less densely settled western shore (23 FC/100 mL; n = 16). However, this difference is probably not significant given the variability of the data.

The geometric mean of shellfish and sediments samples in Burley Lagoon were 79 and 93 FC/100 g, respectively. Mean sediment values were somewhat higher here than in Minter Bay, while shellfish densities were slightly lower. As in the Minter Bay case, the values were lower than expected, given the water quality. This may be because the shellfish and sediment samples were located at mid-bay sites rather than close to shore. Mid-bay water samples are more apropriate for comparisons. If the present water and shellfish standards are an estimate of contamination potential, then shellfish can accumulate 230 FC/100 g of tissue if fecal coliform in water are 14/100 mL. This "accumulation ratio" (Vasconcelos, et al., 1969) is 16.4:1. In Minter Bay, the ratio of mean fecal coliform levels in shellfish to those in water (mid-bay locations, May 24 only) was 100:14 or 7.14. In Burley Lagoon, the rato was 79:8 or 9.9. It appears that the shellfish were underconcentated with fecal coliform relative to fecal coliform in the overlying water. However, because of water quality alone in Minter Bay and Burley Lagoon, neither estuary complied with the regulatory requirements for shellfish-growing areas. None of the shellfish samples exceeded marketability standard, and the geometric means of all samples were well within it.

In summary, shoreline water quality was lower than mid-estuary water quality in each estuary. The results from Minter Bay cannot explain differences between developed and undeveloped sections of shoreline. The small volume of the estuary, the closeness of differing shoreline uses, and the energy of tidal action, may have resulted in broad overlap of shoreline effects. On the other hand, the results from Burley Lagoon suggest slight differences among differing intensities of shoreline use. The case is rather weak, however, due to the variability of data.

There appears to be a zone of minimum watershed effect in the southern corner of Minter Bay south of the entrance and west of the spit. This zone may be worthy of consideration for re-opening to shellfish harvest at least part of the year.

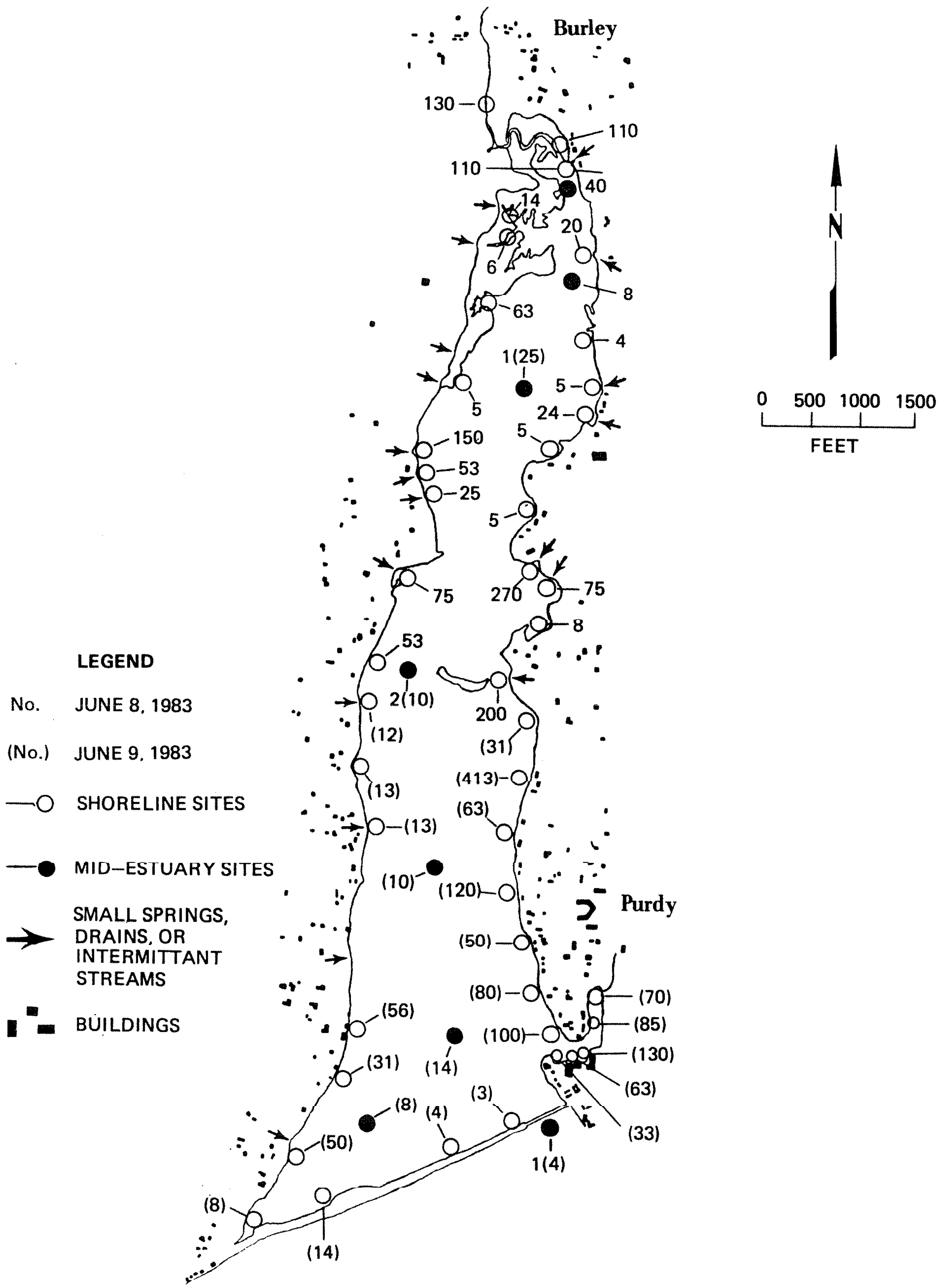

Figure A9. FECAL COLIFORM DENSITIES IN WATER (fc per 100 ml) IN BURLEY LAGOON AT HIGH SLACK TIDE ON JUNE 8 AND 9, 1983.

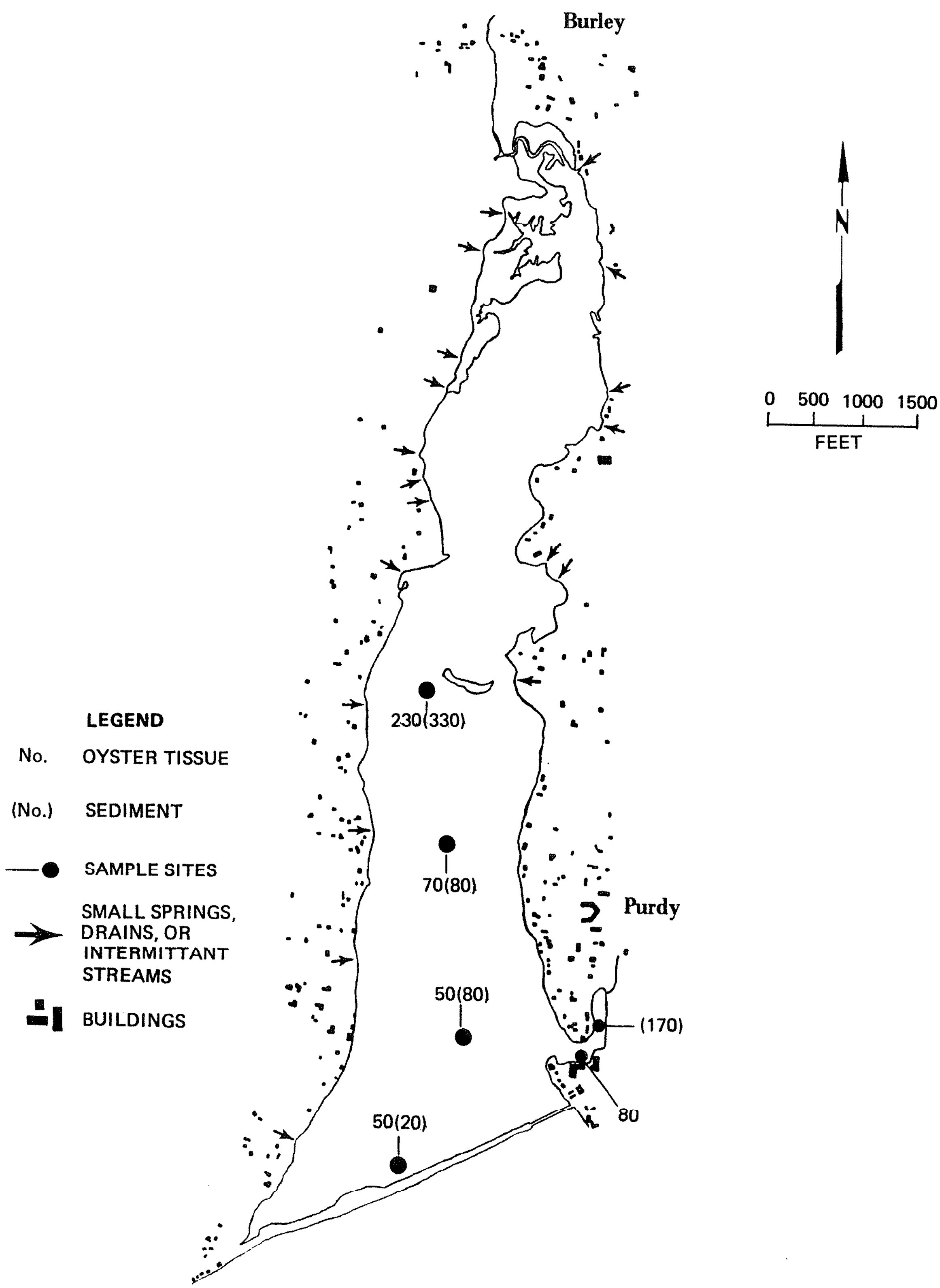

Figure A10. FECAL COLIFORM DENSITIES IN SEDIMENTS AND OYSTER TISSUE (fc per 100 g) IN BURLEY LAGOON ON JUNE 20, 1983.

A Tool for Predicting Fecal Coliform Concentrations in Estuaries During Rain Events

Increased fecal coliform loadings to marine receiving waters are directly related to rainfall events. A method to predict the degree of loading during any given rain event would be useful to determine the concentrations of coliforms to which shellfish growing areas are exposed.

Salinity measurements can be used as an indicator of the amount of freshwater/saltwater mixing in estuarine systems. A surface freshwater layer develops where streams discharge into shallow marine waters. This layer is thicker during rain events due to increased runoff. The freshwater layer can be identified at any time using salinity profiles taken at mid-estuary stations in both Minter Bay and Burley Lagoon.

For the mid-bay sites in both estuaries, depth-averaged salinity values and 24-hour rainfall measurements from study data were compared using a least squares regression method (Mendenhall, 1979). These two variables were found to be significantly correlated for both Minter Bay and Burley Lagoon (r = 0.82 and 0.76, respectively).

Fecal coliform concentrations can be related to salinity in the estuaries due to dilution of fecal coliforms to stream water by saltwater. Coliforms should decline at a predictable rate as freshwaters mix with greater amounts of saltwater, since incoming saltwater has lower fecal coliform counts. Fecal coliform concentrations for the saltwater mixture may then be predicted by using salinity measurements and known fecal coliform levels in freshwater and saltwater.

Using the freshwater fecal coliform count as a starting point (no dilution) and incoming saltwater (completely diluted) as an end point, the freshwaters were hypothetically mixed with saltwater. The following expression was used for the analysis (from Mills, et al., 1982):

$$F_s = \frac{S_a}{S_s} \qquad F_f = \frac{S_s - S_a}{S_s}$$

where F_f = Fraction of freshwater
S_a = Salinity of mix (S o/oo)
S_s = Salinity of incoming saltwater (S o/oo)
F_s = Fraction of saltwater

The expected fecal coliform in the freshwater/saltwater mix was then determined by:

$$C_{mix} = F_f(C_f) + F_s(C_s)$$

where C_f = Coliform count for pure freshwater (incoming streams FC/100 mL)
C_s = Coliform count for incoming saltwater (measured at mouth FC/100 mL)
F_f and F_s = Shown above

This procedure was carried out for both Minter and Burley estuaries using fixed end points and theoretical fecal coliform values for all sampling dates, including rain events where data were available (Table A9).

Table A9. Use of a predictive model to estimate fecal coliform from depth-averaged salinity in Minter Bay and Burley Lagoon.

Minter Bay					Burley Lagoon				
Sampling Date (month/day)	Average Salinity (S o/oo) (Z = 0.5m)	24-hour Rainfall (inches)	FC per 100 mL Predicted	FC per 100 mL Observed[1]	Sampling Date (month/day)	Average Salinity (S o.oo) (Z = 0.75m)	24-hour Rainfall (inches)	FC per 100 mL Predicted	FC per 100 mL Observed*
1/10**	0.37	1.40	34	88	1/11	21.1	0.02	23	15
1/17	17.6	0.10	17	5	1/17	26.3	0.01	≤7***	5
1/18	18.8	0.30	15	15	2/07	22.8	0.09	16	21
2/08	25.7	0	8	9	2/21	24.6	0	9	8
2/09**	6.3	1.17	28	122	3/07**	19.3	0.43	30	71
2/09**	6.9	1.17	28	234	3/08**	19.4	0.85	29	278
2/10**	14.2	0.42	20	104	3/09**	17.7	1.68	36	223
2/22	11.2	0.48	23	14	3/21	26.8	0	≤7***	3
4/05	10.8	0	24	20	4/04	24.2	0.09	11	2
4/20	13.9	0	20	17	4/18	25.9	0	4	7
6/01	18.7	0.01	15	225	5/02	25.0	0	8	6
6/13	26.7	0	7	56	5/31	25.4	0.01	6	51
6/27	26.9	0	7	46	6/13	27.2	0	≤7***	28
7/25	21.8	0.05	12	59	6/27	29.2	0	≤7***	9
8/08	18.7	0	15	ND	7/11	27.1	0	≤7***	29
9/06	22.8	0	11	62	7/25	27.1	0.05	≤7***	44
12/12	16.5	0.04	18	49	8/08	28.7	0	≤7***	27
					9/06	26.9	0	≤7***	15
					12/12	23.2	0.26	14	36

[1]Surface sample only (usually expected to be more variable than subsurface).

*Subsurface sampling data (one sample at 15 cm).
**Storm event.
***Minimum incoming saltwater concentration.

During rain events, incoming freshwater streams reduced salinity sharply. Since salinity measurements were taken at mid-bay, predicted values may actually underestimate the effects of freshwater in the nearshore areas where oyster beds are located. Predicted values were correspondingly high during heavy rainfall periods. These results coincide with fecal coliform data taken during the FC loading studies discussed earlier in this report.

Observed fecal coliform values were generally higher during the rain event and the latter half of the study period than by the model. In the case of rain events, the surface sample taken may overestimate the fecal coliform level averaged throughout the depth of the freshwater layer. The reason of the time-anomoly may be due to seasonal factors such as regrowth or increased survivability during warm weather.

The Effects of the Purdy Landfill on Fecal Coliform Levels in Nearby Streams

Introduction

A rain-event survey was conducted near Purdy Landfill on March 26, 1985. The purpose of the study was to: (1) measure fecal coliform levels in surface runoff from the landfill, (2) trace the route of landfill runoff into nearby ditches and streams, and, if this occurred, (3) rank fecal coliform loads due to the landfill to watershed loads as a whole.

Setting

The entrance to the Purdy Landfill lies on 144th Street Northwest (Purdy-Crescent Road) 0.8 mile east of Purdy, Washington (Figure A11). The landfill is located on top of a ridge running NNE to SSW.

The landfill covers about 15 acres. Solid waste is dumped into a disposal pit two acres in area. Access to the pit is on the northwest side. The remaining sides are vertical walls 15 to 30 feet high. The bottom of the pit lies about 15 feet below the level of the pit access point. The southern half of the remaining area is an elevated "final cover" terrace. Steep banks mark the landfill perimeter to the south and west. Water tends to pond on the terrace during rainfall. The water is drained into the adjacent forest through several plastic corrugated pipes. Water also runs westward over the ground from the pit access point.

There is no evidence that runoff travels farther than 50 to 100 feet before sinking into the ground. A field reconnaissance revealed no channels, ditches, or streams that could carry surface flow beyond the forest which surrounds the landfill on all sides. Soils in the area are either Indianola loamy sand (6 to 15 percent slopes) with good percolation or Harstene gravelly sandy loam (6 to 15 percent slope) with a relatively impermeable hardpan (Plate 4).

The Purdy Landfill lies on the boundary between two drainage basins because of its ridge-top location. To the east and south, an unnamed tributary system ultimately discharges into Henderson Bay.

The small stream located east of the landfill flows southward past two residences, a pond, and pasturage. The stream is joined at 144th Street NW by an

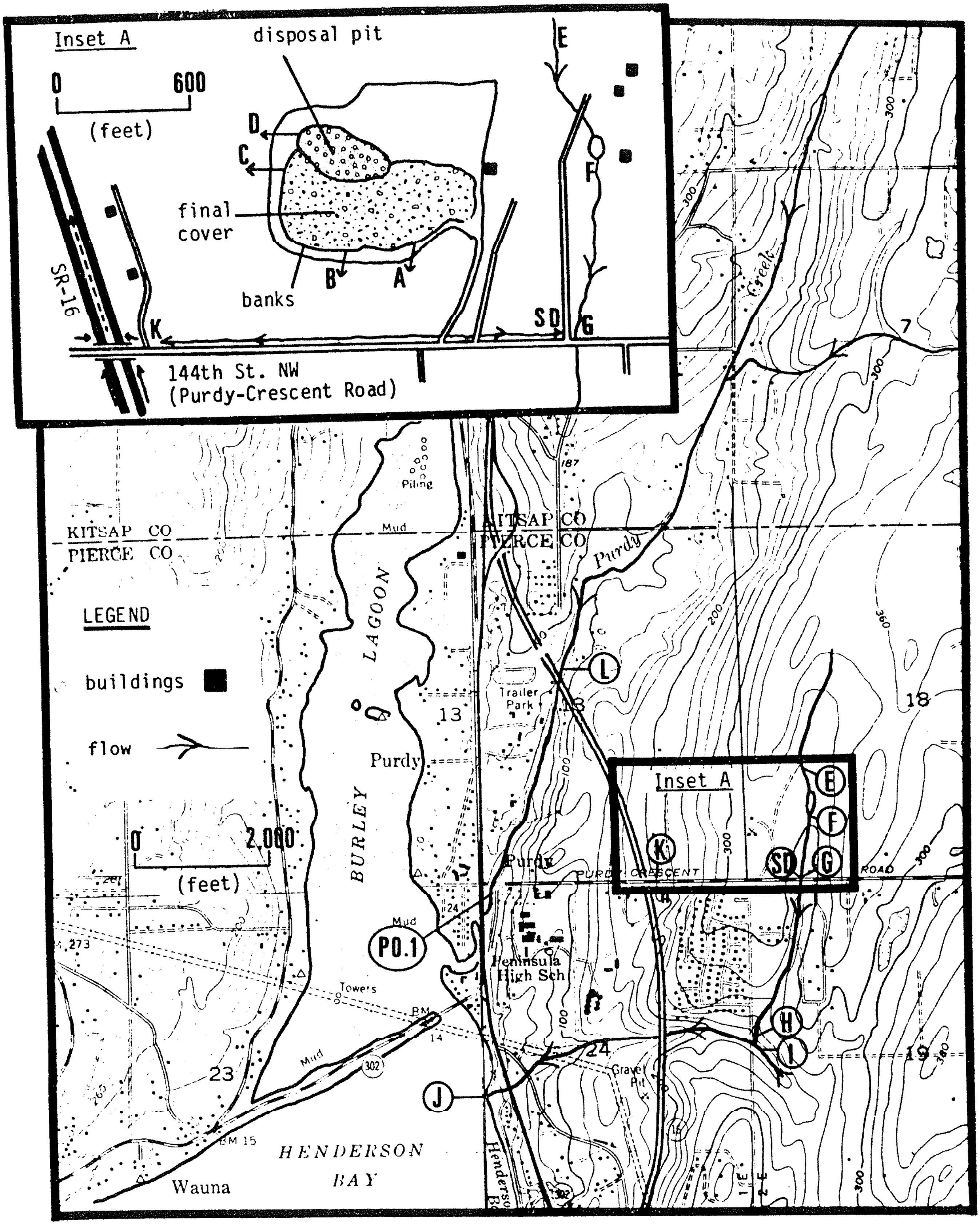

Figure A11. PURDY LANDFILL AND BURLEY LAGOON SHOWING WATER SAMPLING SITES ON MARCH 26, 1985.

intermittant flow which originates near the landfill access road, and flows east along the north side of 144th Street NW. The combined flow passes under the road and through a housing development. It joins a small tributary flowing from the east at a point about 0.5 mile south of 144th Street NW. From here, the creek flows west to Henderson Bay about a mile away.

Purdy Basin lies downslope to the west and north. The ditch on the north side of 144th Street NW carries intermittant drainage from near the landfill entrance westward toward State Route (SR) 16. The flow drops down onto the shoulder of SR 16 and enters the storm drain system. Storm water is carried northward under the median strip, and is discharged into Purdy Creek on the northeast side of the highway. Purdy Creek eventually flows into Burley Lagoon.

Methods

Fecal coliform samples were taken at 14 sites (Figure A11). Single samples of landfill runoff were analyzed using the multiple-tube, most-probable-number (MPN) method because of high turbidity. Membrane filter (MF) analyses were done on replicate samples from the other sites (APHA, 1980). Flow measurements were made at selected sites, and fecal coliform loads were calculated based on the method of Kittrell (1969).

At streamflow gauging sites, temperature was taken with a thermometer (range: 0 to 32°C). Conductivity (umhos/cm) was measured with a Beckman Solu Bridge field conductivity meter adjusted for temperature.

Daily rainfall data were obtained from workers at the Minter Creek Department of Fisheries Salmon Hatchery.

Results

Rainfall totaled 0.6 inch on March 26, 1985. From March 20 through March 26, daily rainfall averaged 0.39 inch. Maximum 24-hour totals occurred on March 22 (0.82 inch) and March 23 (0.69 inch). Soils in the region appeared to be saturated. Standing water was visible in pastures and open spaces.

Fecal coliform densities, stream flows, FC loads, and field observations are shown in Table A10, together with a description of each sampling site. Relative loads are shown as a percentage of the load leaving Purdy Watershed (site P 0.1).

<u>Landfill Site</u> - Samples taken near the landfill disposal pit (sites C and D) were an order of magnitude higher than samples from the "final cover" terrace (samples A and B). The reason may be due in part to the presence of thousands of gulls and crows that stay close to the margins of the disposal pit. Few birds were seen on the remaining "final cover" area. The birds likely feed on the solid waste. There is little evidence that the waste is routinely covered with earth, which is the usual practice in landfill management.

Table A10. Results from a survey of the Purdy Landfill and nearby drainages and streams.

Site No.	Site Description	Fecal Coliform (FC/100 mL)[a]	Flow (cfs)	FC load (FC/sec)	Relative Contribution (percent)[b]	Temp. (°C)	Conductivity (umhos/cm)
A	Pipe draining upper surface of "final cover" in southeast corner of landfill	9000(1)	--	--	--	--	--
B	As above; farther west along south wall	11,000(1)	--	--	--	--	--
C	Over-the-ground drainage from off-loading zone on west side of landfill	>240,000(1)	--	--	--	--	--
D	As in A, B, above; from upper surface immediately soth of D, above	>240,000(1)	--	--	--	--	--
E	Creek upstream of landfill and several small pastures	8 ± 0(2)	--	--	--	--	--
F	Creek east of landfill and downstream of pond and pastures	10 ± 3(2)	--	--	--	--	--
G	Creek southest of landfill at 144th Street NW	8 ± 1(2)	0.23	520	0.2	6.3	38
SD	Culvert draining roadside runoff along north side of 144th Street NW	33(1)	0.02*	190	0.1	5.2	13
H	Creek above confluence with tributary from east; downstream of residential area	12 ± 1(2)	0.45	1,540	0.5	4.8	38
I	East tributary; above confluence with North Creek; limited development observed; boggy	50 ± 2(2)	0.10	1,420	0.4	6.0	46
J	Creek mouth, Henderson Bay	29 ± 0(2)	0.33	2,720	0.8	6.2	83[c]
K	Drainage ditch along north side of 144th Street NW	915 ± 35(2)	0.01	2,600	0.8	6.4	34
L	Purdy Creek east of SR 16	84 ± 23(2)	10.46	250,000	74.7	5.6	65
P0.1	Purdy Creek; routine sampling site during Minter/Burley/Purdy study	88 ± 16(2)	13.36	335,000	100	5.8	71

[a]Results shown as x ± s(n).

[b]Loads relative to that observed at P0.1.

[c]High value may be due to presence of sea salts in sediments.

*Estimate.

Henderson Bay Drainage - The small creek (sites E, F, and G) was not seriously contaminated from either the landfill or the two small farms alongside the creek. The roadside drainage (site SD) entering the creek near site G had somewhat higher fecal coliform levels, but not higher than expected in roadside runoff. The residential development farther downstream did not contribute significant levels of fecal bacteria to the creek, either (site H). Indeed, the highest level of fecal coliforms encountered along this creek came from the small east tributary draining a boggy, undeveloped area (site I).

Purdy Creek Drainage - The drainage from the roadside ditch at site K carried the highest concentrations of fecal coliforms (FC) encountered during the survey excluding the landfill itself. The FC load at Site K was nearly 14 times greater than the load carried into the eastern creek from the same ditch (Site SD). The conductivity at Site K was over twice as high as that at Site SD (34 and 13 umhos/cm, respectively). According to the contours on Figure 1, Site K lies about 100 feet lower in elevation than the landfill disposal pit. Site SD lies at the same or slightly higher elevation than the pit. There were no grazing animals, buildings, or other potential FC sources visible along 144th Street NW between Sites K and SD. We located no ditches, ravines, or creeks carrying runoff from the landfill to the roadside ditch over the ground. These facts suggest that ground-water movement from the landfill may be finding its way into the drainage ditch. The presence of a subsurface hardpan may facilitate this movement. The ultimate fate of this drainage is Purdy Creek and Burley Lagoon through the SR 16 storm drain.

Fecal coliform levels in Purdy Creek violated the Class AA freshwater quality standard (see page 11) at both Sites L and PO.1. FC concentrations were similar at both sites. However the streamflow at PO.1 was substantially higher. Thus, nearly 25 percent additional FC load was added between the two sites.

This outcome was different than that noted for this stretch of Purdy Creek during a previous rain-event survey in December 1983 (see page 96). At that time, there was no downstream increase in load. However, 24-hour rainfall was slight (0.1 inch) and runoff minimal.

Discussion

During wet-weather conditions of the survey, the fecal coliform load from the roadside drain at 144th Street NW (Site K) accounted for one percent of the total load in the Purdy Creek basin (PO.1). This represents three percent of the total load added between Site L and PO.1 on Purdy Creek (Table A10). This is a small but measurable component of the load generated within the Purdy Watershed. It was estimated that Purdy Watershed accounted for 18 percent of the load entering Burley Lagoon from the three main creeks in the Burley/Purdy Watershed (see page 63). If the quality of the drainage in the ditch is due to contaminated ground water from the landfill, then an estimate of the effect of Purdy Landfill on Burley Lagoon would be one percent of 18 percent or 0.18 percent.

Conclusions

The Purdy Landfill lies mostly in Purdy Watershed which drains into Burley Lagoon. A remaining part lies in a watershed draining into Henderson Bay.

The landfill is surrounded by forest on all sides. There is no evidence of surface runoff from the landfill reaching drains.

Runoff from Purdy Landfill contains very high concentrations of fecal coliform. This runoff ultimately sinks into the earth within 50 to 100 feet of the edge of the forest buffer. The highest concentrations were observed from areas surrounding the disposal pit. This may be due to the large populations of gulls and crows that feed on material dumped into the landfill. Routine covering of the waste in the pit may substantially reduce the numbers of foraging birds and the level of fecal coliform in runoff.

The drainage from the ditch on the north side of 144th Street NW entering Purdy Creek via the SR 16 storm drain system is equivalent to one percent of the Purdy Watershed load and 0.18 percent of the total load from both Burley and Purdy Creeks. If we assume that the source of fecal coliform contamination in this ditch is ground water from the Purdy Landfill, the influence on local streams and Burley Lagoon is relatively slight.

APPENDIX B

WATER QUALITY PARAMETERS USED IN THE MINTER/BURLEY/PURDY WATERSHEDS STUDY

Parameter	Method	Reason for Sampling	Water Quality Standard (Class AA)
Fecal Coliform in Water (FC/100 mL)	APHA, 1980	Indicator of presence of sewage wastes from humans and other animals.	Not to exceed a geometric mean of 14 FC per 100 mL; not more than 10 percent of samples to exceed 43 FC/100 mL. (marine) Not to exceed a geometric mean of 50 FC per 100 mL; not more than 10 percent of samples to exceed 100 FC/100 mL. (freshwater)
Fecal Coliform in Shellfish (FC/100 gr)	Houser (1965); Hunt, *et al.* (1976)	Indicator of presence of sewage wastes from humans and other animals in marketable shellfish. DSHS shellfish sanitation program applies this standard to commercial harvesters and public shellfish collection areas.	Not to exceed 230 colonies per 100 gr tissue (FDA and DSHS marketability criteria).
% KES (KES*/FC) *Klebsiella, Enterobacter Serriata group	APHA (1980)	*Klebsiella pneumoniae* are used as an indicator of waste discharge from certain pulp mill processees, and may show evidence of decomposition of organic matter from swamps and bogs.	N.A.
Temperature (°C)	Thermometer and temperature function on Kahlsico model RS5-3 induction salinometer	Used with salinity to determine water density; temperature also affects gas solubility and rates of biological processes.	Not to exceed 16°C (freshwater) or 13°C (marine water) due to human activities.
Salinity (o/oo)	Kahlsico Model RS5-3 induction salinometer or Beckman laboratory induction salinometer	Used to trace passage of freshwater through marine waters: affects mixing rates and density distribution in water column and solubility of dissolved oxygen.	In brackish waters of estuaries, where the fresh and marine water quality criteria differ within the same classification, the criteria shall be interpolated on the basis of salinity; except that the marine water quality criteria shall apply for fecal coliform organisms when the salinity is 10 parts per thousand or greater.
pH (S.U.)	Reference electrode pH meter	pH affects the carbonic acid-carbon dioxide balance in water. Freshwaer streams draining swamps, bogs, and reducing zones tend to have low pH (more acid).	Within range of 6.5 to 8.5 (freshwater) or 7.0 to 8.5 (marine water) with a man-caused variation within a range of less than 0.2 unit.
Total Non-filterable residue or total suspended solids (mg/L)	APHA (1980)	Estimate the erosion potential from drainage areas. Also, determine the effect on aquatic system as a result of reduced light for photosynthesis of plants and the adverse effects to aquatic organisms such as reduction of food availability, reduction of growth rate, prevention of successful early development.	No standard.
Stream flows (cfs)	Buchanan & Somers (1969)	Used with FC to calculate fecal coliform loads using the method of Kittrell (1969)	No standard.
Nutrients (mg/L) NO_3-N; NO_2-N; NH_3-N; O-PO_4-P; T-PO_4-P	APHA (1980); EPA (1979)	Inorganic nutrients are readily available for assimilation by marine plants. Excessive levels with abundant light may lead to massive algae production at the expense of other plants and animals. Ammonia (NH_3-N) is an immediate byproduct of the breakdown of urine and therefore may be useful to trace animal wastes in water.	No numerical standard.
Fluorescent Dye (ug/L)	Turner fluorometer (Model 110)	Used as a ground- or surface water movement tracer and measure of dilution and mixing processes downstream from the point of injection.	N.A.

Parameter	Method	Reason for Sampling	Water Quality Standard (Class AA)
Rainfall (inches/day)	National Weather Service Rain Gage at Minter Creek Hatchery	During heavy rainfall, runoff occurs and stream flows increase.	N.A.
Bird Counts (individuals)	Total number of birds and names of species recorded from replicate counts during a half-hour period at two sites in southern end of each estuary	Taken to test the idea that large numbers of resident or migratory birds in the estuary may cause FC levels in the water to increase.	N.A.
Turbidity (NTU)	Hach Ratio Turbidimeter	Measures water column transparency, light availability, and is an estimate of suspended material in water column. Sufficient light is essential to marine plant growth. Excessive suspended material may stress bottom-dwelling plants and animals by interference in filter feeding, and by light reduction, or smothering. Turbidity is a function of quantity and light-scattering characteristics of the suspended material.	Not to exceed 5 NTU over background if background is 50 NTU or less or have more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU.
Specific Conductivity (umhos/cm-1)	Beckman Laboratory Conductivity Bridge	Can be used as a tracer to estimate the quantity of pollutants in freshwaters from sources such as septic tanks, storm water, etc.	No standard.

APPENDIX C

WATER QUALITY DATA

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UN2.0 UNNAMED CREEK UPSTREAM

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/01/10	1015		11.4	7.8	114	5.8	2.0							2	1.62	2.55	6.72	32174
83/01/18	1410		4.1	8.3	16J	6.0	4.0							1	0.30	0.30	0.30	1649
83/02/08	1129		0.6	7.0	3J	6.3	3.0		0.85	0.01	0.04	0.02	0.02	1	0.09	0.39	0.39	44
83/02/22	1155		4.1	9.4	29	6.2	4.0		0.54	0.01	0.04	0.02	0.04	2	0.43	0.73	3.04	2945
83/03/22	1145		2.3	10.0	2K	6.6	2.0	80	0.85	0.01K	0.04	0.02	0.04	2	0.16	0.16	0.16	114
83/04/05	1015		2.4	8.5	4J	6.4	2.0	78	0.78	0.01K	0.03	0.02	0.04	1	0.00	0.09	2.17	236
83/04/20	0950		1.3	10.3	52	6.7	2.0	88	0.72	0.01K	0.02	0.02	0.03	3	0.00	0.00	0.00	1662
83/05/03	0955		1.0	9.5	35	6.8	1.0	89	0.76	0.01K	0.02	0.02	0.03	1K	0.00	0.00	0.00	861
83/05/17	1450		1.2	11.5	41	6.7	1.0	80	0.62	0.01	0.02	0.01	0.03	4	0.00	0.00	0.41	1210
83/06/01	1350		0.7		140	6.6	1.0	97	0.72	0.01	0.03	0.02	0.03	2	0.00	0.00	0.00	2547
83/06/13	0935		0.6	11.0	60	6.7	2.0	100	0.73	0.01K	0.02	0.02	0.04	1K	0.00	0.56	1.08	914
83/06/27	0845		0.3	10.8	46	6.6	1.0	101	0.76	0.01K	0.01K	0.02	0.04	4	0.00	0.00	0.23	441
83/07/11	1150		0.4	12.4	95	7.2	2.0	104	0.64	0.01	0.02	0.02	0.02	4	0.00	0.11	0.61	1445
83/07/25	1145		0.5		134	7.0	1.0	107	0.78	0.01K	0.03	0.02	0.02	1K	0.05	0.05	0.05	1647
83/08/08	1120		0.4	12.6	84	7.1	2.0	104	0.72	0.01	0.03	0.03	0.03	1K	0.00	0.00	0.00	991
83/08/22	1240		1.0	11.6	89	7.0	2.0	107	0.81	0.01	0.02	0.03	0.04	4	0.00	0.00	0.00	2341
83/09/06	1145		0.7	10.8	120	7.1	1.0	105	0.60	0.02	0.02	0.04	0.04	2	0.00	0.02	0.70	2065
83/09/19	1110		1.0	9.3	3	7.3	3.0	92	0.53	0.01K	0.01K	0.01	0.02	2	0.32	0.57	0.57	78
83/10/03	1720		0.6	7.5	360	7.0	1.0	106	0.73	0.01K	0.01K	0.03	0.04	3	0.00	0.00	0.00	5399
83/10/17	1350		0.7	10.3	1150	7.0	1.0	110	0.83	0.01K	0.01K		0.02	2	0.28	0.28	0.28	21485
83/10/31	1100		0.7	10.0	82	6.9	4.0	96	0.67	0.01K	0.04	0.03	0.04	3	0.37	0.61	0.66	1532
83/11/15	1110		4.3	10.2	141	6.1	4.0	69	0.98	0.02	0.06	0.04	0.06	2	1.14	2.35	3.72	13078
83/11/28	1350		1.5	9.3	14	6.5	4.0		0.86	0.01K	0.08	0.02	0.02	2	0.92	1.20	3.90	527
83/12/12	1200		2.4	7.1	51	6.4	8.0	76	0.96	0.01K	0.06	0.02	0.03	1K	0.02	1.32	3.09	3099

UN0.0 UNNAMED CR AT CONFL W/ MINTR CR

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/01/10	1045		19.9	7.8	78	6.0	7.0							12		2.55	6.72	38294
83/01/18	1050		4.3	7.9	15J	6.3	6.0							4	0.30	0.30	0.30	1599
83/02/08	1145		2.1	6.0	6J	6.8	3.0		0.68	0.01	0.03	0.01	0.05	5	0.09	0.39	0.39	312
83/02/22	1215		6.6	9.5	7J	6.7	6.0		0.67	0.02	0.06	0.02	0.03	10	0.43	0.73	3.02	1146
83/03/22	1200		4.2	8.9	3K	7.0	6.0	72	0.64	0.01K	0.04	0.03	0.07	6	0.16	0.16	0.16	310
83/04/05	1025		3.4	7.6	60	6.8	4.0	70	0.64	0.01K	0.02	0.02	0.04	4	0.00	0.09	2.17	5016
83/04/20	1025		2.4	10.4	63	6.9	4.0	81	0.62	0.01K	0.02	0.02	0.04	8	0.00	0.00	0.00	3717
83/05/03	1007		1.8	9.8	23J	6.9	2.0	81	0.66	0.01K	0.01	0.01	0.03	2	0.00	0.00	0.00	1018
83/05/17	1500		2.1	10.6	28	6.8	3.0	84	0.58	0.01	0.01K	0.01	0.02	6	0.00	0.00	0.41	1466
83/06/01	1400		1.4		68	6.6	3.0	90	0.71	0.01	0.01	0.02	0.04	4	0.00	0.00	0.00	2340
83/06/13	0950		1.3	11.7	69	6.7	3.0	90	0.61	0.01K	0.02	0.01	0.02	2	0.00	0.56	1.08	2357
83/06/27	0900		0.9	12.3	370	6.7	2.0	93	0.67	0.01K	0.01K	0.02	0.04	4	0.00	0.00	0.23	8551
83/07/11	1200		1.0	12.8	355	7.7	4.0	106	0.16	0.01K	0.04	0.03	0.04	7	0.00	0.11	0.61	8990
83/07/25	1200		0.9	12.3	173	7.3	3.0	98	0.70	0.01K	0.01	0.02	0.02	2	0.05	0.05	0.05	3871
83/08/08	1145		0.4	13.7	78	7.3	3.0	95	0.66	0.01	0.02	0.02	0.02	2	0.00	0.00	0.00	768
83/08/22	1310		0.4	13.0	290	7.7	6.0	95	0.68	0.01	0.01K	0.02	0.04	9	0.00	0.00	0.00	3351
83/09/06	1200		0.8	11.9	59	7.3	3.0	97	0.60	0.01	0.01K	0.02	0.03	4	0.00	0.02	0.70	1204
83/09/19	1110		1.0	9.3	54	7.3	3.0	92	0.53	0.01K	0.01K	0.01	0.02	2	0.32	0.57	0.57	1328
83/10/03	1100		0.7	8.0	14	7.2	2.0	99	0.61	0.01K	0.01K	0.01K	0.02	3	0.00	0.00	0.00	262
83/10/17	0940		0.5	9.3	28	7.2	4.0	101	0.66	0.01K	0.01K	0.01	0.02	9	0.28	0.28	0.28	406
83/10/31	1235		1.0	10.4	30	7.3	2.0	92	0.48	0.01K	0.01	0.01K	0.02	4	0.37	0.61	0.66	737
83/11/15	1313		5.4	10.0	144	6.8	6.0	63	0.70	0.02	0.01	0.02	0.04	10	1.14	2.35	3.72	19188
83/11/29	1425		2.1	6.7	99	7.2	2.0		0.78	0.01K	0.04	0.03	0.02	2	0.00	0.41	2.28	5114
83/12/13	1155		9.4		120	7.0	6.0		0.70	0.01K	0.05	0.02	0.03	8	0.92	1.20	3.90	27969

H3.5 HUGE CREEK UPSTREAM

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/01/10	0835		7.9	7.0	11J	6.0	2.0							1		2.55	6.72	2150
83/01/18	1310		1.2	6.8	2J	6.1	2.0							2	0.30	0.30	0.30	63
83/02/08	1018		0.3	5.5	2J	5.8	1.0		0.08	0.01K	0.01	0.01	0.02	1	0.09	0.39	0.39	19
83/02/22	1025		2.9	7.6	4J	5.7	1.0		0.03	0.01K	0.01	0.01K	0.01	1K	0.43	0.73	3.02	294
83/03/22	1024		0.8	8.3	1J	6.2	2.0	34	0.04	0.01K	0.02	0.01K	0.01	1K	0.16	0.16	0.16	22
83/04/05	0935		1.0	7.4	0K	6.1	1.0	22	0.04	0.01K	0.01	0.01K	0.01	1K	0.00	0.09	2.17	24
83/04/20	0910		0.2	9.4	1K	6.2	1.0	27	0.02	0.01K	0.01	0.01K	0.01	1	0.00	0.00	0.00	6
83/05/03	0900		0.1	8.4	1K	6.4	1.0	28	0.02	0.01K	0.01	0.01K	0.01K	1	0.00	0.00	0.00	3
83/05/17	1130		0.1	9.7	1J	6.2	1.0	29	0.04	0.01K	0.01K	0.01K	0.01	3	0.00	0.00	0.41	3
83/06/01	1310		0.0		630J	6.1	1.0	35	0.05	0.01K	0.02	0.01K	0.02	1	0.00	0.00	0.00	619
83/06/13	0905		0.0	11.4	105	6.7	3.0	30	0.06	0.01K	0.05	0.01K	0.01	1K	0.00	0.56	1.08	104
83/06/27	0800		0.0	11.2	9J	6.3	1.0	33	0.04	0.01K	0.02	0.01K	0.02	2	0.00	0.00	0.23	7
83/07/11	1110		0.0		32	6.5	1.0	36	0.02	0.01K	0.02	0.01K	0.02	2	0.00	0.11	0.61	16
83/07/25	1110		0.0	12.6	1849	6.2	2.0	38	0.04	0.01K	0.04	0.01K	0.01	1K	0.05	0.05	0.05	907
83/08/08	1030		0.0	14.4	18	6.3	4.0	38	0.03	0.01K	0.03	0.01K	0.02	2	0.00	0.00	0.00	4
83/08/22	1200		0.0	14.4	3	6.2	1.0	37	0.04	0.01K	0.04	0.01	0.03	4	0.00	0.00	0.00	1
83/09/06	1105		0.0	12.3	15	6.6	2.0	45	0.04	0.01K	0.02	0.01K	0.01	2	0.00	0.02	0.70	4
83/09/19	1020		0.0	9.0	3	6.5	2.0	36	0.03	0.01K	0.02	0.01K	0.01	1	0.32	0.57	0.57	1
83/10/03	1505		0.0	8.0	1	6.2	1.0	41	0.02	0.01K	0.01	0.01K	0.02	3	0.00	0.00	0.00	0
83/10/17	1420		0.0	9.0	5	6.4	1.0	43	0.01K	0.01K	0.01K	0.01K	0.02	2	0.28	0.28	0.28	1
83/10/31	1145		0.0	9.7	2	6.3	2.0	46	0.01	0.01K	0.01K	0.01K	0.01	2	0.37	0.41	0.66	1
83/11/14	1203		5.2	9.6	6	6.2	2.0	25	0.20	0.01K	0.01K	0.01K	0.01	1	1.14	2.35	3.72	776
83/11/28	1430		1.5	7.8	1J	6.3	2.0		0.12	0.01K	0.01K	0.01K	0.01K	1K	0.05	0.42	2.29	38
83/12/12	1120		2.1	5.7	12J	6.9	2.0	22	0.15	0.01K	0.02	0.01K	0.01	1	0.02	1.32	3.09	619

HO.1 HUGE CR ABOVE CONFL W/ MINTER CR

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/01/10	1125		82.0	7.5	14J	6.2	3.0							11	1.62	2.55	6.72	28224
83/01/18	1115		19.0	7.7	25	6.4	2.0							3	0.30	0.30	0.30	11678
83/02/08	1202		12.0	6.1	9J	6.9	2.0		0.18	0.01K	0.01	0.01	0.03	2	0.09	0.39	0.39	2650
83/02/22	1340		38.2	8.6	16J	7.0	2.0		0.31	0.01K	0.01K	0.01K	0.02	3	0.43	0.73	3.02	15026
83/03/22	1214		17.4	9.0	6J	7.1	2.0	56	0.14	0.01K	0.02	0.01	0.02	1	0.16	0.16	0.16	2566
83/04/05	1040		18.8	7.6	16J	6.9	2.0	51	0.13	0.01K	0.02	0.02	0.02	2	0.00	0.09	2.17	7394
83/04/20	1005		10.8	9.6	8J	7.0	3.0	64	0.12	0.01K	0.01	0.02	0.02	3	0.00	0.00	0.00	2124
83/05/03	1040		9.3	9.1	21	7.1	2.0	73	0.12	0.01K	0.01K	0.01	0.02	1K	0.00	0.00	0.00	4795
83/05/17	1350		9.3	9.7	98J	6.9	2.0	71	0.12	0.01K	0.01K	0.01	0.02	11	0.00	0.00	0.41	22406
83/06/01	1245		8.0		145	6.7	2.0	73	0.14	0.01K	0.01K	0.01	0.02	4	0.00	0.00	0.00	28512
83/06/13	0850		7.5	10.8	69	6.6	1.0	85	0.12	0.01K	0.01	0.02	0.02	3	0.00	0.56	1.08	12715
83/06/27	0730		5.1	10.6	125	6.8	2.0	74	0.14	0.01K	0.01K	0.02	0.02	1K	0.00	0.00	0.23	15797
83/07/11	1040		6.4	11.4	59	7.7	2.0	76	0.12	0.01K	0.01K	0.02	0.02	1K	0.00	0.11	0.61	9341
83/07/25	1035		6.4	10.9	278	7.6	2.0	76	0.14	0.01K	0.01	0.02	0.02	1K	0.05	0.05	0.05	44014
83/08/08	1000		5.6	11.8	48	7.7	3.0	76	0.13	0.01K	0.01K	0.02	0.02	1	0.00	0.00	0.00	6703
83/08/22	0855		6.4	11.6	59	7.6	1.0	78	0.15	0.01K	0.01	0.01	0.03	4	0.00	0.00	0.00	9341
83/09/06	1045		6.7	10.6	30	7.7	1.0	77	0.14	0.01K	0.01K	0.02	0.02	3	0.00	0.02	0.70	4942
83/09/19	0950		7.5	8.4	21	7.5	1.0	75	0.16	0.01K	0.01K	0.01K	0.01	2	0.32	0.57	0.57	3874
83/10/03	1500		6.6	7.4	7	7.6	1.0	80	0.11	0.01K	0.01K	0.01K	0.03	3	0.00	0.00	0.00	1143
83/10/17	1505		5.1	9.5	27	7.6	1.0	80	0.10	0.01K	0.01K	0.02	0.02	2	0.28	0.28	0.28	3413
83/10/31	1255		8.2	9.8	21	7.4	1.0	77	0.13	0.01K	0.01K	0.01K	0.02	1	0.37	0.61	0.66	4234
83/11/15	1250		25.7	9.5	70	7.2	4.0	65	0.60	0.01	0.01	0.01	0.02	8	1.14	2.35	3.72	44228
83/11/29	1400		18.1	6.8	9	7.5	2.0		0.26	0.01K	0.01	0.01K	0.01	1	0.00	0.41	2.28	4003
83/12/13	1145		51.4	6.7	41	7.3	4.0	34	0.28	0.01K	0.02	0.01K	0.02	7	0.92	1.20	3.90	51811

M4.4 MINTER CREEK U.STREAM

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/01/10	0945		22.8	7.3	46	6.0	2.0							1	1.62	2.55	6.72	25785
83/01/18	1340		8.0	7.0	4J	6.0	2.0							1	0.30	0.30	0.30	795
83/02/08	1046		3.4	5.3	4	6.4	1.0		0.26	0.01K	0.01	0.01	0.03	1	0.09	0.39	0.39	337
83/02/22	1100		13.4	8.0	34	6.4	2.0		0.18	0.01K	0.01	0.01K	0.02	2	0.43	0.73	3.02	11259
83/03/22	1127		7.1	8.1	72J	6.9	2.0	51	0.22	0.01K	0.04	0.01	0.02	2	0.16	0.16	0.16	12568
83/04/05	0955		7.5	6.6	5J	6.7	2.0	49	0.22	0.01K	0.01	0.01K	0.02	2	0.00	0.09	2.17	922
83/04/20	0930		5.2	9.4	1J	6.9	3.0	58	0.22	0.01K	0.01	0.01K	0.02	3	0.00	0.00	0.00	128
83/05/03	0925		3.1	8.5	2J	7.1	1.0	59	0.22	0.01K	0.02	0.01K	0.02	1	0.00	0.00	0.00	153
83/05/17	1430		3.7	9.0	3J	6.8	1.0	60	0.18	0.01K	0.01K	0.01K	0.02	5	0.00	0.00	0.41	274
83/06/01	1330		2.3		14J	6.6	3.0	65	0.18	0.01K	0.01	0.01K	0.02	3	0.00	0.00	0.00	792
83/06/13	0915		3.0	10.7	34	6.8	3.0	66	0.16	0.01K	0.01	0.01K	0.02	1	0.00	0.56	1.08	2506
83/06/27	0820		1.9	10.8	8J	6.6	2.0	69	0.15	0.01K	0.01	0.01	0.02	1	0.00	0.00	0.23	374
83/07/11	1125		1.5	11.8	6	7.5	2.0	73	0.12	0.01K	0.02	0.01K	0.02	1	0.00	0.11	0.61	230
83/07/25	1125		1.4	11.6	74				0.12	0.01K	0.02	0.01	0.02		0.05	0.05	0.05	2678
83/08/08	1030		1.8	14.0	22	7.4	1.0	75	0.11	0.01K	0.01	0.01K	0.02	1K	0.00	0.00	0.00	994
83/08/22	1220		0.5	11.8	23	7.3	2.0	78	0.11	0.01K	0.01K	0.01	0.03	20	0.00	0.00	0.00	317
83/09/06	1120		2.6	10.9	20	7.4	2.0	75	0.09	0.01K	0.01K	0.01	0.02	1	0.00	0.02	0.70	1282
83/09/19	1040		2.4	8.5	37	7.3	1.0	68	0.14	0.01K	0.01	0.01K	0.02	1K	0.32	0.57	0.57	2189
83/10/03	1520		1.7	7.7	2	7.3	1.0	75	0.06	0.01K	0.01K	0.01K	0.02	2	0.00	0.00	0.00	86
83/10/17	1350		1.2	9.0	2	7.3	1.0	3	0.04	0.01K	0.01K	0.01K	0.01	3	0.28	0.00	0.00	60
83/10/31	1120		2.3	9.5	10	7.1	1.0	70	0.34	0.01K	0.01K	0.01K	0.01	1	0.37	0.61	0.66	576
83/11/15	1135		7.3	9.5	86	6.5	2.0	43	0.46	0.01K	0.01K	0.01K	0.01K	3	1.14	2.35	3.72	15624
83/11/28	1410		6.0	7.6	3J	6.9	2.0		0.18	0.01K	0.02	0.01K	0.01	1	0.05	0.42	2.29	45
83/12/12	1140		8.2	5.8	5J	6.9	4.0	44	0.25	0.01K	0.02	0.01K	0.01	1	0.02	1.32	3.09	1008

M1.3 MINTER CREEK NEAR MOUTH

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/01/10	1145		66.1	7.8	88	6.3	8.0							17	1.62	2.55	6.72	143000
83/01/18	1120		29.0	7.6	21J	6.4	4.0							4	0.30	0.30	0.30	14998
83/02/08	1214		18.2	6.0	16J	6.9	3.0		0.28	0.01	0.01	0.02	0.03	4	0.09	0.39	0.39	7174
83/02/22	1420		31.8	9.0	40	7.0	4.0		0.28	0.01K	0.01	0.01	0.02	7	0.43	0.73	3.02	31271
83/03/22	1225		20.4	9.6	54	7.1	2.0	63	0.23	0.01K	0.04	0.01	0.02	5	0.16	0.16	0.16	27082
83/04/05	1045		30.6	8.3	12J	6.9	2.0	61	0.23	0.01K	0.01	0.01	0.03	1	0.00	0.09	2.17	9029
83/04/20	1010		18.7	11.4	23	7.1	3.0	70	0.14	0.01K	0.01	0.01	0.03	6	0.00	0.00	0.00	10574
83/05/03	1025		15.1	10.7	33J	7.0	2.0	70	0.15	0.01K	0.02	0.01	0.02	3	0.00	0.00	0.00	12250
83/05/17	1400		13.3	11.0	59J	6.7	1.0	71	0.14	0.01K	0.01K	0.01	0.02	5	0.00	0.00	0.41	19292
83/06/01	1255		9.5		345	6.6	2.0	78	0.16	0.01K	0.01	0.01	0.02	5	0.00	0.00	0.00	80575
83/06/13	0845		10.2	13.0	390	6.7	2.0	76	0.17	0.01K	0.01	0.01K	0.02	4	0.00	0.56	1.08	97798
83/06/27	0740		14.2	13.1	54	6.8	3.0	80	0.14	0.01K	0.01K	0.01	0.02	4	0.00	0.00	0.23	18851
83/07/11	1045		9.3	13.5	56	7.6	3.0	84	0.16	0.01K	0.02	0.01	0.02	3	0.00	0.11	0.61	12817
83/07/25	1050		9.0	13.3	810	7.5	4.0	85	0.16	0.01K	0.01	0.02	0.02	5	0.05	0.05	0.05	180010
83/08/08	1010		6.8	14.4	97	7.6	3.0	84	0.16	0.01K	0.01K	0.02	0.03	2	0.00	0.00	0.00	16430
83/08/22	1135		5.9	13.9	1350	7.5	3.0	86	0.14	0.01K	0.01K	0.02	0.03	8	0.00	0.00	0.00	197470
83/09/06	1035		8.5	12.3	74	7.6	3.0	84	0.15	0.01K	0.01K	0.02	0.02	3	0.00	0.02	0.70	15627
83/09/19	0940		11.2	9.4	160	7.5	2.0	79	0.17	0.01K	0.01K	0.01	0.02	3	0.32	0.57	0.57	44253
83/10/03	1440		8.7	8.5	99	7.5	2.0	84	0.15	0.01K	0.01K	0.01	0.02	2	0.00	0.00	0.00	21370
83/10/17	1455		8.4	10.2	130	7.4	1.0	85	0.14	0.01K	0.01K	0.01K	0.02	4	0.28	0.28	0.28	27070
83/10/31	1245		10.5	9.8	40	7.5	2.0	83	0.16	0.01K	0.01K	0.01K	0.02	2	0.37	0.61	0.66	10355
83/11/15	1240		40.9	9.6	100	7.0	6.0	60	0.61	0.01	0.01	0.02	0.02	11	1.14	2.35	3.72	100740
83/11/29	1405		15.7	7.0	4J	7.3	3.0		0.44	0.01K	0.02	0.01	0.02	1K	0.00	0.41	2.28	1544
83/12/13	1130		46.4	6.5	53	6.9	4.0	50	0.44	0.01K	0.02	0.01K	0.02	6	0.92	1.20	3.90	60562

M0.0 MINTER CREEK MOUTH

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/01/10	1245		168.6	7.9	48	6.4	10.0							18	1.62	2.55	6.72	198950
83/01/18	1200		52.0	7.6	42	6.3	5.0							6	0.30	0.30	0.30	53693
83/02/08	1630		34.0	6.7	12J	6.8	4.0		0.27	0.01K	0.13	0.04	0.07	8	0.09	0.39	0.39	10051
83/02/22	1430		49.7	9.1	24	7.1	5.0		0.24	0.01	0.02	0.02	0.02	14	0.48	0.73	3.02	29372
83/03/22	1445		28.9	9.3	24	7.0	2.0	65	0.22	0.01K	0.08	0.03	0.06	5	0.16	0.16	0.16	17052
83/04/05	1225		57.6	9.6	16J	6.5	4.0	63	0.22	0.01K	0.06	0.03	0.05	4	0.00	0.09	2.17	22657
83/04/20	1335		44.4	11.4	12		5.0	77	0.18	0.01K	0.12	0.03	0.05	4	0.00	0.00	0.00	13098
83/05/03	1330		33.0	10.6	28	7.1	2.0	75	0.18	0.01K	0.06	0.04	0.05	1	0.00	0.00	0.00	22716
83/05/17	1520		34.6	10.7	23J	7.0	1.0	77	0.16	0.01K	0.01	0.04	0.04	4	0.00	0.00	0.41	19564
83/06/01	1415		27.9		78	6.7	1.0	81	0.18	0.01K	0.10	0.04	0.04	4	0.00	0.00	0.00	53700
83/06/13	1000		26.0	11.6	117	6.7	3.0	88	0.18	0.01K	0.09	0.03	0.04	2	0.00	0.56	1.08	74786
83/06/27	0915		22.7	11.6	65	6.7	2.0	89	0.16	0.01K	0.06	0.04	0.04	2	0.00	0.00	0.23	36274
83/07/11	1220		11.3	12.5	41	7.4	2.0	100	0.62	0.01K	0.02	0.01	0.02	3	0.00	0.11	0.61	11398
83/07/25	1215		11.6	11.7	323	7.6	4.0	93	0.18	0.01K	0.03	0.03	0.04	2	0.05	0.05	0.05	92114
83/08/08	1225		11.0	13.6	55	7.6	1.0	94	0.16	0.01K	0.04	0.03	0.04	1	0.00	0.00	0.00	14874
83/08/22	1225		12.1	13.4	52	7.5	3.0	90	0.16	0.01K	0.70	0.04	0.05	6	0.00	0.00	0.00	15558
83/09/06	1210		21.6	11.6	46	7.5	2.0	92	0.14	0.01K	0.08	0.04	0.04	3	0.00	0.02	0.70	24461
83/09/19	1210		25.9	9.4	69	7.4	2.0	85	0.16	0.01K	0.07	0.03	0.04	5	0.32	0.57	0.57	44087
83/10/03	1030		22.0	7.2	13	7.3	2.0	91	0.15	0.01K	0.08	0.04	0.06	4	0.00	0.00	0.00	70502
83/10/17	0911		13.6	9.3	40	7.3	2.0	91	0.17	0.01K	0.08	0.04	0.04	6	0.28	0.28	0.28	13424
83/10/31	1200		19.8	9.7	52	7.3	2.0	89	0.16	0.01K	0.08	0.03	0.04	4	0.37	0.61	0.66	25414
83/11/14	1015		84.7	9.6	120	6.9	4.0	63	0.62	0.01	0.06	0.02	0.04	10	1.14	2.35	3.72	255980
83/11/29	1025		41.1	6.8	4J	7.3	2.0		0.44	0.01K	0.02	0.01	0.02	1K	0.00	0.41	2.28	4042
83/12/13	0935		107.3	6.8	53	7.2	6.0		0.41	0.01K	0.01	0.01K	0.02	8	0.92	1.20	3.90	139860

MES MINTER BAY AT MIDBAY

DATE FROM TO	TIME	DEPTH METERS	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	70305 SALINITY CONDUCTVY g/l	31615 FECAL COLIFORM /100mlMPN	31640 FEC COLI SHELLFISH MPN/100g	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	84067 BIRD COUNT NUMBER
83/01/11	1451		7.3	64	6.4	6.0							7	0.0	88J	1300		2.55	6.72	
83/01/17	2150		6.2	3J	7.4	2.0							5	0.1	5J	230	0.00	0.00	0.02	
83/01/18	1233		6.5	10J										7.2	15J		0.30	0.30	0.30	
83/02/08	1600		5.9	6J	7.5	3.0		0.30	0.01	0.05	0.03	0.06	5	24.5	9J	20	0.09	0.39	0.39	
83/02/15	1300															40	0.34	1.09	4.14	
83/02/22	1507		6.5	9J	7.2	2.0		0.25	0.01K	0.03	0.02	0.02	1	2.1	14J	68	0.41	0.73	3.02	613
83/02/28	1200															63	0.03	0.26	2.30	
83/03/22	1420		10.4	41	8.1	3.0	25200	0.07	0.01K	0.09	0.04	0.06	2	21.0	62	130	0.16	0.16	0.16	301
83/04/05	1320		11.3	13J	7.8	2.0	4310	0.22	0.01K	0.06	0.03	0.05	4	0.8	20	80	0.00	0.09	2.17	226
83/04/20	1305		11.6	13	7.1	2.0	5280	0.18	0.01K	0.08	0.03	0.08	3	3.2	17	11	0.00	0.00	0.00	220
83/05/03	1250		10.9	50J	7.3	4.0	9730	0.18	0.01K	0.06	0.03	0.05	2	7.3	78	5	0.00	0.00	0.00	406
83/05/17	1030		12.5	24J	7.7	3.0	13300	0.12	0.01K	0.06	0.02	0.03	12	10.1	53	80	0.00	0.00	0.41	66
83/06/01	1145		11.5	120	7.0	3.0	4110	0.20	0.01K	0.16	0.04	0.06	4	2.8	225	110	0.00	0.00	0.00	30
83/06/13	0620		12.9	15	8.0	2.0	28200	0.14	0.01K	0.07	0.02	0.04	1	20.3	56	50	0.00	0.56	1.08	62
83/06/27	0600		11.8	30	8.0	2.0	28500	0.04	0.01K	0.02	0.04	0.04	5	24.8	46	20	0.00	0.00	0.23	50
83/07/11	0910		15.7	78	7.9	2.0	30000	0.07	0.01K	0.03	0.02	0.05	6	26.9	101	130	0.11	0.11	0.61	
83/07/25	0755		12.6	42	8.0	2.0	31700	0.15	0.01K	0.04	0.02	0.02	1	11.0	59J	20	0.05	0.05	0.05	86
83/08/08	0800				7.6	2.0		0.11	0.01K	0.03	0.03	0.04	2	9.9		230	0.00	0.00	0.00	
83/08/22	0800		18.1	125	8.1	7.0	37200	0.42	0.01K	0.04	0.03	0.05	15	27.2	94	35	0.00	0.00	0.00	507
83/09/06	0730		10.4	48	7.8	5.0		0.12	0.01K	0.05	0.04	0.04	5	13.2	62	2400	0.00	0.02	0.70	154
83/09/19	0830		12.4	59	7.7	7.0		0.09	0.01K	0.05	0.04	0.06	21	28.1	130	790	0.32	0.57	0.57	191
83/10/03	1740		11.3	7	7.8	5.0		0.14	0.01	0.02	0.06	0.09	11	29.6	9	230	0.00	0.00	0.00	320
83/10/17	1735		13.1	34	7.8	1.0	5770	0.16	0.01K	0.08	0.04	0.04	1K	3.0	33	330	0.28	0.28	0.28	466
83/10/31	1540		12.6	33	7.7	2.0	13900	0.20	0.01K	0.08	0.04	0.07	4	24.4	20	230	0.37	0.61	0.66	
83/11/15	1340		10.5	145	7.1	6.0	1370	0.42	0.01	0.06	0.02	0.02	2	0.9	206	170	1.16	2.35	3.72	475
83/11/29	1450		8.0	7J	7.7	2.0		0.37	0.01K	0.06	0.05	0.04	1K	20.6	14	460	0.00	0.41	2.28	443
83/12/12	1410		5.7	24	7.4	1.0		0.39	0.01K	0.04	0.03	0.04	1	3.3	49	460	0.02	1.32	3.09	757

MEX MINTER BAY AT MOUTH

DATE FROM TO	TIME	DEPTH METERS	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	70305 SALINITY CONDUCTVY g/l	31615 FECAL COLIFORM /100mlMPN	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES
83/01/10	1315		8.2	75	6.6	7.0							6	0.6	103J	1.62	2.55	6.72
83/01/17	1700		6.8	4J	7.8	2.0							13	27.6	6J	0.00	0.00	0.02
83/02/08	0931		5.9	3J	7.6	1.0		0.30	0.01	0.03	0.05	0.05	5	23.4	5J	0.09	0.39	0.39
83/02/22	0940		7.6	17J	6.8	2.0		0.25	0.01K	0.03	0.02	0.02	1	7.6	25J	0.48	0.73	3.02
83/03/22	0940		8.2	23	8.1	2.0	22100	0.17	0.01K	0.11	0.03	0.04	3	5.9	52	0.16	0.16	0.16
83/04/05	0900		6.7	14J	7.7	2.0	17000	0.16	0.01K	0.08	0.04	0.05	2	12.6	28	0.00	0.09	2.17
83/04/20	0830		11.9	1J	8.5	4.0	30300	0.01K	0.01K	0.01	0.02	0.04	10	26.8	2	0.00	0.00	0.00
83/05/03	0810		8.4	8J	8.2	2.0	25800	0.04	0.01K	0.04	0.04	0.04	3	17.1	26	0.00	0.00	0.00
83/05/17	0930		12.3	31	7.7	1.0	10800	0.15	0.01K	0.10	0.04	0.07	6	14.6	53J	0.00	0.00	0.41
83/06/13	0555		14.4	1K	8.0	5.0	31800	0.01K	0.01K	0.02	0.02	0.04	4	26.9	2K	0.00	0.56	1.08
83/06/27	0545		14.9	35	8.0	4.0	27900	0.02	0.01K	0.01	0.02	0.04	7	28.7	41	0.00	0.00	0.23
83/07/11	1715		15.4	1	8.3	4.0	39500	0.01K	0.01K	0.01K	0.02	0.04	8	27.7	2	0.00	0.11	0.61
83/07/25	1700		17.3	1	8.3	1.0	43100	0.01K	0.01K	0.01K	0.02	0.04	3	22.0	2J	0.05	0.05	0.05
83/08/08	1645		15.4	2	8.2	2.0		0.01K	0.01K	0.01K	0.03	0.04	6	28.7	1	0.00	0.00	0.00
83/08/22	1740		19.2	5	8.3	4.0	39600	0.01K	0.01K	0.01K	0.02	0.04	9	29.3	25	0.00	0.00	0.00
83/09/06	1640		14.5	3	8.1	2.0		0.03	0.01K	0.01K	0.02	0.06	7	27.9	3	0.00	0.02	0.70
83/09/19	1640		14.7	1K	8.1	1.0		0.04	0.01K	0.01	0.04	0.06	6	29.5	2K	0.32	0.57	0.57
83/10/03	1220		11.1	1K	7.9	6.0	40900	0.14	0.01K	0.01	0.06	0.09	9	29.5	2K	0.00	0.00	0.00
83/10/17	1200		13.1	2	8.1	2.0	41400	0.04	0.01K	0.02	0.03	0.05	10	29.7	4	0.28	0.28	0.28
83/10/31	1005		12.6	6	7.7	1.0	40300	0.22	0.01	0.08	0.06	0.07	4	29.9	10	0.66	0.61	0.37
83/11/15	0940		11.6	5	7.7	9.0	41200	0.32	0.01	0.02	0.04	0.04	12	29.7	3	1.14	2.35	3.72
83/11/28	1000		12.3	3J	7.8	3.0		0.34	0.01K	0.02	0.06	0.06	3	27.6	5	0.05	0.42	2.30
83/12/12	1005		8.2	2K	7.7	1.0		0.38	0.01K	0.03	0.06	0.06	5	25.9	3	0.02	1.32	3.09

BR1.8 BEAR CREEK UPSTREAM

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/02/21	1345		1.5		4J		4.0		0.15	0.01K	0.03	0.01K	0.01	3	0.00	0.66	2.88	153
83/03/21	1135		1.5	11.5	2J	6.6	2.0	30	0.05	0.01K	0.04	0.01	0.02	2	0.00	0.00	0.26	73
83/04/04	0935		1.3	8.7	4J	6.5	2.0	28	0.05	0.01K	0.03	0.01K	0.04	1	0.00	0.68	2.92	128
83/04/18	1410		0.3	15.5	50	6.6	2.0	32	0.05	0.01K	0.03	0.01K	0.01	1	0.00	0.00	0.00	455
83/05/02	0935		0.1	11.5	17J	6.4	5.0	38						12	0.00	0.00	0.02	50
83/05/16	1515		0.1	12.6	78J	6.8	2.0	40	0.10	0.01K	0.04	0.01K	0.02	4	0.00	0.41	0.41	210
83/05/31	1415		0.1		2800J	6.7	3.0	77	0.01	0.01K	0.02	0.01	0.03	3	0.00	0.00	0.00	11703
83/06/13	1340		0.0	22.4	160	7.4	4.0	72	0.01K	0.01K	0.02	0.01K	0.02	2	0.00	0.56	1.08	157
83/06/27	1300		0.0	21.8	205	7.5	2.0	77	0.01K	0.01K	0.01	0.01	0.02	2	0.00	0.00	0.23	101
83/07/11	1425		0.0	16.3	64	7.0	4.0	63	0.04	0.01K	0.04	0.01	0.04	1K	0.00	0.11	0.61	32
83/07/25	1505		0.0	15.5	5250	6.9	4.0	76	0.05	0.01K	0.04	0.01	0.01	2	0.05	0.05	0.05	3872
83/08/08	1500		0.0	21.0	89	7.5	3.0	77	0.01K	0.01K	0.01K	0.01K	0.02	6	0.00	0.00	0.00	88
83/09/06	1345		0.0	11.6	55	6.5	1.0	63	0.04	0.01K	0.01	0.01K	0.02	3	0.00	0.02	0.70	40
83/09/19	1325		0.0	11.0	82	6.9	2.0	65	0.01	0.01K	0.01	0.01K	0.02	2	0.32	0.57	0.57	81
83/10/03	1540		0.0	8.7	6	6.5	1.0	67	0.02	0.01K	0.02	0.01	0.03	5	0.00	0.00	0.00	0
83/10/17	1515		0.0	10.8	7	7.0	2.0	73	0.01K	0.01K	0.01	0.01	0.02	1	0.28	0.28	0.28	14
83/10/31	1340		0.0	10.8	85	6.8	5.0	69	0.01K	0.01K	0.02	0.01K	0.03	1K	0.37	0.61	0.66	189
83/11/14	1205		0.2	8.8	51	6.7	3.0	48	0.46	0.01K	0.02	0.01K	0.02	1	0.76	1.31	2.66	325
83/11/28	1340		0.0	7.7	6J	6.8	4.0	49	0.27	0.01K	0.04	0.01	0.02	1K	0.05	0.42	2.29	10
83/12/13	1320		0.4	6.8	14	6.8	3.0		0.40	0.01K	0.02	0.01K	0.02	1	0.92	1.20	3.90	156

BR0.0 BEAR CR AT CONFL WITH BURLEY CR

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/02/21	1312		14.3	8.3	55		4.0		0.05	0.01	0.02	0.03	0.03	9	0.00	0.66	2.88	19390
83/03/07	1100		9.3	9.3	631	7.2	21.0	83	0.44	0.01K	0.05	0.04	0.11	34	0.43	0.94	1.59	145510
83/03/21	1150		7.9	10.1	40	7.0	8.0	73	0.40	0.01K	0.02	0.02	0.05	13	0.00	0.00	0.26	7749
83/04/04	0945		9.0	7.5	76J	7.0	4.0	76	0.42	0.01K	0.02	0.02	0.04	6	0.00	0.68	2.92	16816
83/04/18	1358		6.2	11.9	7J	7.2	3.0	86	0.37	0.01K	0.01	0.02	0.04	4	0.00	0.00	0.00	1067
83/05/02	0950		2.8	9.8	23	3.1	4.0	91						4	0.00	0.00	0.02	1582
83/05/16	1525		6.2	10.7	130J	6.9	8.0	81	0.33	0.01K	0.02	0.02	0.02	13	0.00	0.41	0.41	19816
83/05/31	1430		5.1		160J	6.8	4.0	96	0.34	0.01K	0.01	0.03	0.04	7	0.00	0.00	0.00	20061
83/06/13	1350		4.6	12.6	550J	7.7	14.0	96	0.32	0.01K	0.02	0.04	0.06	30	0.00	0.56	1.08	62199
83/06/27	1250		3.5	12.3	68	7.7	5.0	91	0.30	0.01K	0.01	0.04	0.04	8	0.00	0.00	0.23	5969
83/07/11	1430		3.8	12.6	118	7.8	4.0	88	0.24	0.01K	0.01K	0.04	0.04	4	0.00	0.11	0.61	11169
83/07/25	1520		2.6	12.1	703	8.0	7.0	101	0.30	0.01K	0.02	0.04	0.04	11	0.05	0.05	0.05	46318
83/08/08	1515		3.5	13.6	200	7.8	3.0	97	0.30	0.01K	0.01K	0.04	0.04	4	0.00	0.00	0.00	17356
83/08/22	1430		1.7	12.9	13	7.6	5.0	88	0.29	0.01K	0.01K	0.03	0.04	9	0.00	0.00	0.00	569
83/09/06	1330		3.5	11.6	44	7.7	5.0	91	0.30	0.01K	0.01K	0.04	0.04	8	0.00	0.02	0.70	3797
83/09/19	1330		3.9	10.3	460	8.1	4.0	86	0.28	0.01K	0.01K	0.04	0.04	5	0.32	0.57	0.57	44896
83/10/03	1545		3.7	8.4	7	7.6	2.0	87	0.25	0.01K	0.01K	0.04	0.04	6	0.00	0.00	0.00	646
83/10/17	1525		4.2	10.2	46	7.7	3.0	102	0.26	0.01K	0.01	0.03	0.04	4	0.28	0.28	0.28	4838
83/10/31	1345		4.4	10.3	620	7.5	2.0	100	0.24	0.01K	0.01K	0.04	0.04	4	0.37	0.61	0.66	68134
83/11/14	1325		12.4	9.7	866	7.7	9.0	76	0.77	0.01	0.10	0.06	0.08	14	0.76	1.31	2.66	265700
83/11/29	1330		4.8	7.5	12J	7.6	3.0	79	0.60	0.01K	0.06	0.04	0.03	3	0.00	0.41	2.28	1434
83/12/13	1330		13.0	7.9	150	7.2	10.0		0.82	0.01K	0.06	0.03	0.03	8	0.92	1.20	3.90	47976

BU0.3 BURLEY CREEK MOUTH

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/01/11	1350		29.7	7.9	36	6.5	3.0							8		1.86	5.90	26356
83/01/17	1015		14.2	7.8	64	6.4	4.0							8		0.00	0.02	22343
83/02/07	1100		12.2	6.4	89	8.0	3.0		0.40	0.01	0.02	0.03	0.05	6	0.09	0.39	0.39	26803
83/02/21	1400		48.2	8.8	184		5.0		0.45	0.01	0.01	0.02	0.02	10	0.00	0.66	2.88	218240
83/03/21	1210		29.7	9.9	25	7.0	3.0	79	0.42	0.01K	0.08	0.02	0.05	6	0.00	0.00	0.26	18253
83/04/04	1010		16.4	7.5	205	7.0	3.0	77	0.42	0.01K	0.02	0.02	0.05	6	0.00	0.68	2.92	82653
83/04/18	1335		30.4	11.6	69	7.3	4.0	87	0.36	0.01K	0.01	0.02	0.04	4	0.00	0.00	0.00	51568
83/05/02	1020		21.2	9.8	72	7.4	3.0	88						6	0.00	0.00	0.02	37526
83/05/16	1550		18.4	10.4	155	6.9	3.0	90	0.30	0.01K	0.02	0.02	0.04	10	0.00	0.41	0.41	70115
83/05/31	1505		18.2		210	6.9	4.0	93	0.31	0.01K	0.01	0.03	0.04	8	0.00	0.00	0.00	93961
83/06/13	1415		16.9	12.8	210	7.6	5.0	91	0.30	0.01K	0.01	0.03	0.04	9	0.00	0.56	1.08	87251
83/06/27	1310		10.0	12.3	50	7.8	3.0	93	0.29	0.01K	0.02	0.06	0.08	4	0.00	0.00	0.23	12292
83/07/11	1455		17.0	13.0	130	7.8	3.0	99	0.26	0.01K	0.01	0.04	0.04	3	0.00	0.11	0.61	54331
83/07/25	1550		25.0	12.4	400L	7.4	150.0	94	0.32	0.01K	0.05		0.02	290	0.05	0.05	0.05	246140
83/08/08	1540		16.4	14.2	175	7.8	2.0	96	0.28	0.01K	0.01K	0.04	0.05	5	0.00	0.00	0.00	70644
83/08/22	1455		16.7	13.1	47	7.6	3.0	96	0.29	0.01K	0.01K	0.40	0.50	7	0.00	0.00	0.00	19365
83/09/06	1405		16.3	11.7	51	7.7	4.0	98	0.26	0.01K	0.01K	0.04	0.04	7	0.00	0.02	0.70	20537
83/09/19	1400		12.9	10.4	170	7.7	4.0	93	0.24	0.01K	0.01K	0.03	0.04	7	0.32	0.57	0.57	54289
83/10/03	1610		90.0	8.4	37	7.4	3.0	98	0.25	0.01	0.01K	0.04	0.04	7	0.00	0.00	0.00	81867
83/10/17	1540		19.8	10.3	94	7.6	3.0	100	0.25	0.01K	0.01K	0.02	0.03	4	0.28	0.28	0.28	45896
83/10/31	1445		24.9	10.4	254	6.9	4.0	97	3.31	0.01K	0.01	0.02	0.03	4	0.37	0.61	0.66	155860
83/11/14	1400		42.3	9.2	384	7.3	10.0	80	0.56	0.01K	0.04	0.04	0.06	20	0.76	1.31	2.66	400180
83/11/29	1240		16.6	7.2	18J	7.6	3.0	88	0.53	0.01K	0.03	0.04	0.04	2	0.00	0.41	2.28	7345
83/12/13	1400		47.0	6.8	68	7.1	7.0		0.64	0.01K	0.02	0.02	0.04	10	0.92	1.20	3.90	78706

BU5.2 BURLEY CREEK UPSTREAM

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/02/21	0955		2.1	6.4	21J	7.5	2.0	64	0.01	0.01	0.01K	0.01	0.03	1	0.00	0.66	2.88	1120
83/03/21	1026		1.6	8.3	1J	6.7	1.0	75	0.40	0.01K	0.02	0.02	0.02	1K	0.00	0.00	0.26	39
83/04/04	0830		1.7	6.5	7K	6.8	1.0	73	0.40	0.01K	0.02	0.01K	0.02	1	0.00	0.68	2.92	293
83/04/18	1135		1.5	10.2	2J	6.9	1.0	80	0.40	0.01K	0.01	0.01	0.01	2	0.00	0.00	0.00	73
83/05/02	0800		1.4	9.2	13J	6.7	1.0	83						1K	0.00	0.00	0.02	448
83/05/16	1405		1.4	9.7	2J	6.7	1.0	84	0.38	0.01K	0.01K	0.01	0.02	3	0.00	0.41	0.00	69
83/05/31	1320		1.2		6J	6.8	2.0	89	0.44	0.01K	0.01	0.01	0.02	1K	0.00	0.00	0.00	177
83/06/13	1230		0.8	11.3	20J	7.2	1.0	87	0.46	0.01K	0.01	0.01	0.02	1K	0.00	0.56	1.08	399
83/06/27	1145		0.8	10.9	10J	7.3	1.0	90	0.47	0.01K	0.01	0.02	0.02	2	0.00	0.00	0.23	219
83/07/11	1330		1.0	11.6	18	7.4	1.0	92	0.45	0.01K	0.02	0.02	0.02	6	0.00	0.11	0.61	474
83/07/25	1350		0.8	11.8	1284	7.0	5.0	87	0.33	0.01K	0.01K	0.02	0.02	2	0.05	0.05	0.05	25253
83/08/08	1400		1.0	12.1	39	7.3	1.0	96	0.53	0.01K	0.01K	0.02	0.02	2	0.00	0.00	0.00	1025
83/08/22	1520		0.7	11.8	25	7.2	2.0	97	0.57	0.01	0.01	0.01	0.04	4	0.00	0.00	0.00	485
83/09/06	1520		1.0	11.4	21	7.2	2.0	97	0.53	0.01K	0.01K	0.01	0.02	5	0.00	0.02	0.70	537
83/09/16	1435		0.8	9.8	18	7.2	1.0	89	0.44	0.01K	0.01K	0.02	0.02	1	0.32	0.57	0.57	339
83/10/03	1635		0.7	7.8	14	7.1	1.0	96	0.52	0.01K	0.01K	0.01	0.02	2	0.00	0.00	0.00	250
83/10/17	1630		0.4	9.7	6	7.2	1.0	95	0.58	0.01K	0.01K	0.01	0.02	2	0.28	0.28	0.28	68
83/10/31	1415		1.7	9.8	23	7.2	2.0	90	0.52	0.01K	0.01K	0.01	0.02	1	0.37	0.61	0.66	1001
83/11/14	1045		2.4	8.5	88	6.9	3.0	71	0.40	0.01K	0.02	0.01K	0.04	3	0.76	1.31	2.66	5387
83/11/28	1310		1.7	7.9	10J	6.9	4.0	71	0.48	0.01K	0.02	0.01	0.02	2	0.05	0.42	2.29	435
83/12/12	1245		3.2	6.2	25	7.4	3.0	61	0.46	0.01K	0.02	0.02	0.03	6	0.02	1.32	3.09	1967

XO.2 UNDEVELOPED TRIB TO BURLEY CREEK

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/02/21	0925		0.5	7.5	1J	7.3	1.0	66	0.17	0.01K	0.01K	0.01	0.02	4	0.00	0.66	2.88	14
83/03/07	0955		1.5		13J	7.1	4.0	65	0.20	0.01K	0.05	0.02	0.04	11	0.43	0.94	1.59	480
83/03/21	1011		0.9	8.6	1K	6.5	2.0	73	0.11	0.01K	0.10	0.04	0.10	5	0.00	0.00	0.26	23
83/04/04	0815		1.1	7.3	2J	6.9	2.0	72	0.12	0.01K	0.02	0.02	0.03	2	0.00	0.68	2.92	55
83/04/18	1125		0.8	9.8	0K	7.0	3.0	79	0.08	0.01K	0.01K	0.02	0.03	8	0.00	0.00	0.00	21
83/05/02	0745		0.7	9.3	2J	6.8	3.0	77						5	0.00	0.00	0.02	36
83/05/16	1355		0.5	9.6	1J	6.7	2.0	77	0.08	0.01K	0.01K	0.01	0.02	9	0.00	0.41	0.41	13
83/05/31	1305		0.6		11J	6.9	9.0	81	0.08	0.01K	0.01K	0.02	0.04	14	0.00	0.00	0.00	157
83/06/13	1220		0.5	10.9	5J	7.5	6.0	83	0.07	0.01K	0.01K	0.02	0.02	10	0.00	0.56	1.08	62
83/06/27	1130		0.4	10.7	2J	7.5	4.0	80	0.06	0.01K	0.01K	0.02	0.03	8	0.00	0.00	0.23	22
83/07/11	1320		0.4	11.2	3	7.6	3.0	81	0.04	0.01K	0.01K	0.02	0.03	10	0.00	0.11	0.61	30
83/07/25	1335		0.6	11.1	29	7.6	12.0	83	0.08	0.01K	0.01K	0.02	0.02	21	0.05	0.05	0.05	492
83/08/08	1330		0.2	12.0	5	7.6	4.0	81	0.06	0.01K	0.01K	0.02	0.03	6	0.00	0.00	0.00	36
83/08/22	1510		0.2	11.6	3J	7.4	4.0	86	0.06	0.01K	0.01K	0.02	0.04	10	0.00	0.00	0.00	14
83/09/06	1500		0.4	10.9	3	7.6	4.0	81	0.06	0.01K	0.01K	0.02	0.03	6	0.00	0.02	0.70	33
83/09/19	1420		0.2	10.0	2	7.6	3.0	79	0.08	0.01K	0.01K	0.02	0.02	5	0.32	0.57	0.57	13
83/10/03	1625		0.3	7.8	2	7.5	3.0	82	0.04	0.01K	0.01K	0.02	0.02	5	0.00	0.00	0.00	16
83/10/17	1620		0.8	9.8	1	7.4	4.0	80	0.04	0.01K	0.01K	0.02	0.02	8	0.28	0.28	0.28	20
83/10/31	1400		0.4	9.9	1	7.4	1.0	81	0.08	0.01K	0.01K	0.01	0.02	5	0.37	0.61	0.66	10
83/11/14	1030		1.7	9.3	1	7.3	3.0	77	0.48	0.01K	0.01K	0.01K	0.01K	3	0.76	1.31	2.66	43
83/11/28	1300		0.8	8.6	1K	7.1	3.0	74	0.33	0.01K	0.01K	0.02	0.05	2	0.05	0.42	2.29	20
83/12/12	1230		0.5	7.3	8J	7.0	3.0	70	0.35	0.01K	0.01	0.01K	0.02	8	0.02	1.32	3.09	107

BUO.6 BURLEY CR ABOVE BEAR CR CONFL

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/02/21	1330		37.2	8.8	370J		4.0		0.43	0.01	0.01	0.02	0.02	8	0.00	0.66	2.88	366440
83/03/07	1125		58.1	9.3	100	7.2	12.0	77	0.37	0.01K	0.03	0.04	0.08	18	0.43	0.94	1.59	142830
83/03/21	1200		35.6	9.9	17J	7.1	3.0	83	0.39	0.01K	0.02	0.02	0.05	3	0.00	0.00	0.26	14878
83/04/04	1000		39.4	7.3	46	7.1	4.0	82	0.38	0.01K	0.02	0.02	0.04	5	0.00	0.68	2.92	44556
83/04/18	1345		28.2	11.6	58	7.2	4.0	86	0.33	0.01K	0.01	0.02	0.04	4	0.00	0.00	0.00	40211
83/05/02	1000		22.5	9.8	89	7.3	2.0	89						3	0.00	0.00	0.02	49231
83/05/16	1500		26.4	10.2	62	6.9	3.0	93	0.26	0.01K	0.01	0.02	0.04	8	0.00	0.41	0.41	40239
83/05/31	1440		19.7		260	7.0	4.0	95	0.03	0.01K	0.01	0.03	0.04	7	0.00	0.00	0.00	125920
83/06/13	1400		18.7	12.6	145	7.7	3.0	93	0.27	0.01K	0.01K	0.04	0.04	7	0.00	0.56	1.08	66660
83/06/27	1235		15.6	12.2	62	7.8	2.0	96	0.27	0.01K	0.01	0.04	0.04	5	0.00	0.00	0.23	23779
83/07/11	1440		15.6	12.9	154	7.8	4.0	99	0.25	0.01K	0.01	0.06	0.04	3	0.00	0.11	0.61	59062
83/07/25	1540		22.4	12.2	2179	7.6	12.0	105	0.29	0.01K	0.01	0.06	0.06	25	0.05	0.05	0.05	1199900
83/08/08	1525		7.7	14.0	165	7.8	3.0	98	0.26	0.01K	0.01K	0.04	0.04	4	0.00	0.00	0.00	31396
83/08/22	1435		13.9	12.9	59	7.6	5.0	98	0.29	0.01K	0.01K	0.04	0.04	8	0.00	0.00	0.00	20235
83/09/06	1325		14.9	11.6	59	7.7	3.0	101	0.24	0.01K	0.01K	0.04	0.04	5	0.00	0.02	0.70	21714
83/09/19	1345		19.5	10.6	125	7.7	4.0	97	0.24	0.01K	0.01K	0.03	0.04	6	0.32	0.57	0.57	60110
83/10/03	1555		22.2	8.4	44	7.4	2.0	101	0.24	0.01K	0.01K	0.03	0.04	7	0.00	0.00	0.00	24047
83/10/17	1555		17.6	10.2	383	7.6	4.0	104	0.24	0.01K	0.01K	0.03	0.03	7	0.28	0.28	0.28	166370
83/10/31	1430		19.1	10.5	174	7.5	3.0	99	0.30	0.01K	0.02	0.03	0.04	3	0.37	0.61	0.66	82047
83/11/14	1335		56.3	9.2	198	7.3	5.0	82	0.51	0.01K	0.02	0.03	0.06	12	0.60	1.31	2.66	274050
83/11/29	1215		27.0	7.2	19	7.5	3.0	89	0.48	0.01K	0.03	0.03	0.03	1	0.00	0.41	2.28	12622
83/12/13	1345		56.8	7.7	58	7.2	6.0		0.58	0.01K	0.02	0.03	0.03	8	0.92	1.20	3.90	81049

P3.6 PURDY CREEK UPSTREAM

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/01/10	1045														1.62			
83/02/11	1055		0.3	8.1	2J	6.5	1.0	45	0.22	0.01K	0.02	0.01	0.01	1K	0.00	0.00	0.26	19
83/02/21	1015		0.6	7.1	3J	6.6	2.0	38	0.12	0.01K	0.01	0.01K	0.01	1	0.00	0.66	2.88	50
83/03/21	1055		0.4	8.1	2K	6.6	1.0	45	0.22	0.01K		0.01	0.01	1K	0.00	0.00	0.26	20
83/04/04	0845		0.4	6.6	1J	6.5	1.0	42	0.24	0.01K	0.02	0.01K	0.01	1K	0.00	0.68	2.92	10
83/04/18	1150		0.1	9.6	0K	6.7	2.0	46	0.14	0.01K	0.02	0.01K	0.01	1	0.00	0.00	0.00	3
83/05/02	0822		0.1	9.1	2J	6.7	2.0	47						1K	0.00	0.00	0.02	7
83/05/16	1420		0.1	9.7	2J	6.7	1.0	48	0.11	0.01K	0.01K	0.01K	0.01	4	0.00	0.41	0.41	9
83/05/31	1335		0.1		8J	6.7	3.0	51	0.10	0.01K	0.02	0.01K	0.02	3	0.00	0.00	0.00	23
83/06/13	1245		0.0	11.8	4J	7.1	6.0	52	0.09	0.01K	0.03	0.01K	0.02	6	0.00	0.56	1.08	4
83/06/27	1200		0.0	12.1	6J	7.2	13.0	52	0.08	0.01K	0.02	0.01	0.06	22	0.00	0.00	0.23	6
83/07/11	1345		0.1	12.6	8	7.2	4.0	54	0.07	0.01K	0.01	0.01K	0.02	4	0.00	0.11	0.61	22
83/07/25	1450		0.1	12.7	250	7.0	9.0	57	0.08	0.01K	0.01	0.01	0.03	17	0.05	0.05	0.05	677
83/08/08	1420		0.0	14.4	16	7.3	4.0	54	0.06	0.01K	0.01	0.01K	0.02	1	0.00	0.00	0.00	16
83/08/22	1535		0.0	13.7	28	7.1	4.0	57	0.06	0.01K	0.01	0.01	0.03	7	0.00	0.00	0.00	35
83/09/06	1425		0.0	12.5	28	7.1	4.0	57	0.06	0.01K	0.04	0.01K	0.02	4	0.00	0.02	0.70	42
83/09/19	1450		0.1	10.7	12	7.0	2.0	55	0.07	0.01K	0.01	0.01K	0.02	4	0.32	0.57	0.57	33
83/10/03	1650		0.0	8.3	4	7.1	5.0	59	0.04	0.01K	0.01K	0.01K	0.02	5	0.00	0.00	0.00	4
83/10/17	1650		0.0	9.7	4	7.2	3.0	60	0.04	0.01K	0.02	0.01K	0.01	6	0.28	0.28	0.28	7
83/10/31	1505		0.1	10.0	1	7.0	2.0	59	0.09	0.01K	0.02	0.01K	0.01	4	0.37	0.61	0.66	3
83/11/14	1100		0.4	9.0	4	6.5	2.0	48	0.62	0.01K	0.01	0.01K	0.01	4	0.76	1.31	2.66	48
83/11/28	1325		0.0	8.0	9J	6.5	3.0	47	0.74	0.01K	0.02	0.01K	0.02	2	0.05	0.42	2.29	17
83/12/13	1420		0.8	7.2	24	6.6	2.0	40	0.70	0.01K	0.02	0.01K	0.01	1J	0.92	1.20	3.90	520

V0.0 UNDEVELOPED TRIB TO PURDY CREEK

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/02/21	1030		1.5	7.7	3J	7.1	2.0	73	0.12	0.01K	0.02	0.02	0.02	2	0.00	0.66	2.88	117
83/03/07	1020		1.5		52	7.2	3.0	65	0.10	0.01K	0.03	0.03	0.09	4	0.43	0.94	1.59	2002
83/03/21	1105		1.7	9.1	1K	7.0	1.0	73	0.06	0.01K	0.04	0.02	0.03	2	0.00	0.00	0.26	42
83/04/04	0905		1.4	7.2	9J	7.1	1.0	70	0.06	0.01K	0.02	0.02	0.02	1	0.00	0.68	2.92	310
83/04/18	1200		1.3	10.0	0K	7.2	1.0	80	0.04	0.01K	0.02	0.03	0.05	2	0.00	0.00	0.00	32
83/05/02	0845		1.5	9.1	3J	7.1	2.0	78						1K	0.00	0.00	0.02	111
83/05/16	1435		1.1	9.7	2J	6.9	1.0	78	0.05	0.01K	0.01K	0.01	0.02	2	0.00	0.41	0.41	55
83/05/31	1350		0.8		38	6.9	1.0	84	0.05	0.01K	0.01	0.02	0.02	1K	0.00	0.00	0.00	812
83/06/13	1255		1.0	11.4	56	7.6	1.0	85	0.04	0.01K	0.01	0.02	0.02	1	0.00	0.56	1.08	1377
83/06/27	1210		0.6	10.8	3J	7.6	1.0	83	0.01	0.01K	0.01K	0.02	0.02	1K	0.00	0.00	0.23	48
83/07/11	1400		0.7	11.3	6	7.7	1.0	86	0.01	0.01K	0.02	0.02	0.03	4	0.00	0.11	0.61	106
83/07/25	1435		1.1	11.2	170	7.6	4.0	82	0.08	0.01K	0.01K	0.02	0.02	2	0.05	0.05	0.05	4723
83/08/08	1435		0.8	12.2	18	7.6	3.0	84	0.04	0.01K	0.01K	0.02	0.03	2	0.00	0.00	0.00	354
83/08/22	1355		0.6	11.9	5	7.5	2.0	86	0.03	0.01K	0.01	0.03	0.03	4	0.00	0.00	0.00	76
83/09/06	1435		0.7	10.5	10	7.6	1.0	85	0.02	0.01K	0.02	0.02	0.02	2	0.00	0.02	0.70	187
83/09/19	1505		0.6	10.2	3	7.6	1.0	83	0.04	0.01K	0.01K	0.02	0.02	1	0.32	0.57	0.57	48
83/10/03	1705		0.6	7.5	2	7.5	2.0	87	0.01K	0.01K	0.01K	0.02	0.03	3	0.00	0.00	0.00	29
83/10/17	1700		0.7	9.6	3	7.3	1.0	87	0.32	0.01K	0.01K	0.02	0.02	4	0.28	0.28	0.28	56
83/10/31	1515		0.7	9.7	1	7.5	1.0	85	0.01K	0.01K	0.01K	0.02	0.02	3	0.37	0.61	0.66	19
83/11/14	1115		1.4	8.7	6	7.2	2.0	74	0.15	0.01K	0.01K	0.01K	0.01K	2	0.76	1.31	2.66	209
83/11/29	1200		0.9	7.2	1J	7.4	2.0	76	0.08	0.01K	0.02	0.02	0.02	1K	0.00	0.41	2.28	22
83/12/13	1435		1.8	7.5	1J	7.3	2.0		0.14	0.01K	0.02	0.01K	0.02	2	0.92	1.20	3.90	45

P0.1 PURDY CREEK NEAR MOUTH

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	99901 FEC COLI LOADINGS CORRECTED
83/01/11	1443		19.5	7.5	122	6.4	3.5							5	0.02	1.86	5.90	58576
83/01/17	1900		10.6	7.2	14J	6.1	4.0							4	0.01	0.00	0.02	3652
83/02/07	1000		8.1	6.0	6	7.6	2.0		0.30	0.01	0.01	0.01	0.03	1	0.09	0.39	0.39	1201
83/02/21	1125		15.0	7.4	225J	7.2	3.0		0.32	0.01K	0.02	0.01K	0.02	4	0.00	0.66	[illegible]	83064
83/03/07	1030		20.1		105	7.2	4.0	57	0.27	0.01K	0.02	0.01	0.05	8	0.43	0.94	1.59	52118
83/03/21	1120		9.6	9.4	6J	6.9	4.0	66	0.20	0.01K	0.06	0.03	0.09	1	0.00	0.00	0.26	1416
83/04/04	0920		11.5	6.9	49J	7.0	3.0	63	0.22	0.01K	0.02	0.01K	0.02	2	0.00	0.68	2.92	13853
83/04/18	1420			11.9	9J		3.0	73	0.14	0.01K	0.01	0.01	0.02	3	0.00	[illegible]	0.00	
83/05/02	0900		5.0	9.9	94J	7.2	3.0	82						3	0.00	0.00	0.02	11555
83/05/16	1450		5.3	10.2	280J	6.8	2.0	83	0.16	0.01K	0.01	0.01	0.01	5	0.00	0.41	0.41	36484
83/05/31	1400		3.3		104J	7.0	3.0	93	0.20	0.01K	0.02	0.01	0.02	3	0.00	0.00	0.00	5437
83/06/13	1305		3.3	12.5	135J	7.5	2.0	89	0.16	0.01K	0.01	0.01	0.02	1K	[illegible]	0.56	1.08	10953
83/06/27	1225		2.4	12.4	240	7.6	1.0	94	0.14	0.01K	0.01	0.01	0.02	1K	0.00	[illegible]	0.23	14161
83/07/11	1410		2.2	13.3	701	7.7	3.0	101	0.12	0.01K	0.02	0.02	0.02	2	0.00	0.11	0.61	35465
83/07/25	1420		5.1	12.6	3246	7.6	4.0	91	0.16	0.01K	0.01	0.02	0.05	20	0.05	0.05	0.05	411770
83/08/08	1440		2.1	14.5	185	7.5	3.0	99	0.14	0.01K	0.01	0.02	0.03	1K	0.00	0.00	0.00	9642
83/08/22	1405		1.4	13.8	520	7.6	3.0	101	0.16	0.01K	0.01	0.02	0.03	3	0.00	[illegible]	0.00	19048
83/09/06	1450		2.2	12.2	265	7.6	2.0	99	0.14	0.01K	0.02	0.02	0.02	2	0.00	0.02	0.70	14359
83/09/19	1520		2.2	10.9	205	7.5	2.0	92	0.13	0.01K	0.01	0.01	0.02	3	0.32	0.57	0.57	11491
83/10/03	1150		1.8	8.5	290	7.6	1.0	98	0.10	0.01K	0.01K	0.01	[illegible]	3	0.00	0.00	0.00	13189
83/10/17	1035		1.9	9.6	860	7.4	3.0	99	0.12	0.01K	0.01K	0.02	0.02	6	0.28	0.28	0.28	[illegible]
83/10/31	1630		3.1	10.5	36	7.5	1.0	93	0.17	0.01K	0.01	0.01K	0.02	2	0.37	0.61	0.66	2762
83/11/14	1130		16.8	9.3	85	7.3	6.0	70	0.62	0.01	0.02	0.01K	0.01	5	0.76	1.31	2.66	35211
83/11/28	1115		7.3	6.6	31	7.3	3.0	72	0.44	0.01K	0.02	0.01	0.02	1	0.05	0.42	[illegible]	5564
83/12/13	1450		21.1	7.7	25	7.1	3.0		0.58	0.01K	0.02	0.01K	0.02	3	0.92	1.20	3.90	12969

BEX BURLEY LAGOON MOUTH

DATE FROM TO	TIME	DEPTH METERS	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	70305 SALINITY CONDUCTVY g/l	31615 FECAL COLIFORM /100mlMPN	31640 FEC COLI SHELLFISH MPN/100g	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES
83/01/11	1230		6.6	5J	7.6	4.0							4	21.9	8J		0.02	1.86	5.90
83/01/17	1618		7.2	4J	7.7	2.0							7	27.6	6J		0.00	0.00	0.02
83/02/07	0925		6.6	6J	7.9	1.0		0.32	0.01K	0.03	0.05	0.08	3	27.6	9J		0.09	0.39	0.39
83/02/21	0855		7.0	1J	7.8	1.0		0.30	0.01	0.01	0.05	0.05	4	27.0	2J		0.00	0.66	2.88
83/03/07	0920		7.6	1J	7.7	2.0	2660	0.34	0.01K	0.03	0.08	0.08	6	5.8	2J		0.43	0.94	1.59
83/03/21	0940		8.8	3J	8.0	2.0	28500	0.14	0.01K	0.08	0.04	0.06	4	25.5	4J		0.30	0.00	0.26
83/04/04	0745		8.1	9J	8.0	3.0	28800	0.09	0.01K	0.08	0.02	0.07	4	24.2	14		0.30	0.68	2.92
83/04/18	1645		11.2	4J	8.1	3.0	29500	0.12	0.01K	0.04	0.04	0.05	6	26.3	7	11	0.00	0.00	0.00
83/05/02	0714		11.2	4J										27.1	8		0.00	0.00	0.02
83/05/16	1630		14.2	8J	8.1	4.0	29700	0.01K	0.01K	0.01	0.02	0.07	12	25.6	23		0.00	0.41	0.41
83/05/31	1620		15.9	9J	8.0	4.0	30300	0.02	0.01K	0.05	0.02	0.06	13	25.7	17		0.00	0.00	0.00
83/06/13	0530		13.2	11	7.9	2.0	30800	0.02	0.01K	0.01	0.02	0.04	4	27.3	2K		0.00	0.56	1.08
83/06/27	0525		13.2	11	7.9	2.0	31000	0.01K	0.01K	0.01K	0.02	0.04	5	29.4	2K		0.00	0.00	0.23
83/07/11	1650		16.8	2	8.3	7.0	39300	0.01K	0.01K	0.01	0.03	0.04	21	27.8	5		0.00	0.11	0.61
83/07/25	1720		17.1	2	8.3	2.0	43400	0.01K	0.01K	0.01	0.02	0.04	14	27.5	3J		0.05	0.05	0.05
83/08/08	1730		16.6	15				0.01K	0.01K	0.01K	0.02	0.04		28.9	25		0.00	0.00	0.00
83/08/22	1715		20.5	15	8.3	3.0	39500	0.01K	0.01K	0.01K	0.02	0.05	7	28.9	25	20	0.00	0.00	0.00
83/09/06	1705		14.5	2	8.1	2.0		0.03	0.01K	0.01K	0.03	0.07	6	28.0	2		0.00	0.02	0.70
83/09/19	1500		14.2	2	7.7	2.0		0.16	0.01K	0.04	0.06	0.10	7	29.7	2K		0.32	0.57	0.57
83/10/03	1350		11.6	3	7.8	2.0	40900	0.17	0.01	0.02	0.06	0.10	5		3		0.00	0.00	0.00
83/10/17	1140		12.8	2	8.0	0.0	41400	0.08	0.01K	0.02	0.04	0.07	7	29.6	2		0.28	0.28	0.28
83/10/31	0905		12.5	5	7.7	3.0	40200	0.29	0.01	0.08	0.06	0.07	4	29.6	8		0.66	0.61	0.37
83/11/14	0915		11.0		7.8	3.0	38100	0.32	0.01	0.04	0.06	0.06	4	29.0	49		0.76	1.31	2.66
83/11/28	0935		9.8	1J	7.6	2.0		0.32	0.01K	0.02	0.05	0.07	4	28.8	2		0.05	0.42	2.30
83/12/12	0930		7.8	5J	7.6	1.0		0.37	0.01K	0.02	0.06	0.06	6	25.0	6		0.02	1.32	3.09

BES BURLEY LAGOON MIDBAY

DATE FROM TO	TIME	DEPTH METERS	00010 WATER TEMP DEG-C	31616 FECAL COLIFORM /100ml MF	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00530 SOLIDS SUSPENDED mg/l	70305 SALINITY CONDUCTVY g/l	31615 FECAL COLIFORM /100mlMPN	31640 FEC COLI SHELLFISH MPN/100g	82553 RAINFALL in 1 DAY INCHES	82371 RAINFALL in 3 DAYS INCHES	82554 RAINFALL in 7 DAYS INCHES	84067 BIRD COUNT NUMBER
83/01/11	1125		6.6	10J	7.5	4.0							6	20.8	15J		0.02	1.86	5.90	
83/01/17	2250		7.1	3J	7.7	2.0							5	22.1	5J	230	0.00	0.00	0.02	
83/02/07	1657		6.1	14		2.0		0.32	0.01	0.05	0.04	0.10	4	11.2	21J	130	0.09	0.39	0.39	
83/02/21	1440		7.7	5J		3.0		0.26	0.01	0.05	0.04	0.06	8	24.3	8J	50	0.00	0.66	2.88	343
83/03/07	1545		8.8	51	7.6	5.0	1540	0.32	0.01K	0.04	0.05	0.05	5	12.2	71J	170J	0.43	0.94	1.59	
83/03/21	1415		9.7	2	8.1	2.0	28800	0.10	0.01K	0.06	0.04	0.06	1	26.4	3	70	0.00	0.00	0.00	528
83/04/04	1245		9.4	1K	8.0	2.0	27900	0.08	0.01K	0.08	0.02	0.05	6	22.2	2K	50	0.00	0.68	2.92	339
83/04/18	1220		11.6	4J	8.0	3.0	29500	0.12	0.01K	0.04	0.04	0.05	6	24.9	7	11	0.00	0.00	0.00	368
83/05/02	1245		12.3	3J		3.0	30200						2	24.6	6	130	0.00	0.00	0.02	148
83/05/16	1155		13.4	14J	7.9	5.0	30700	0.01K	0.01K	0.03	0.02	0.04	17	25.6	8	50	0.00	0.41	0.41	131
83/05/31	1230		16.0	24J	7.9	7.0	29400	0.04	0.01K	0.07	0.02	0.06	13	23.9	51	140	0.00	0.00	0.00	36
83/06/13	0725		14.5	18	8.1	5.0	30000	0.01K	0.01K	0.02	0.04	0.05	3	26.3	28	50	0.00	0.56	1.08	139
83/06/27	0635		12.4	8J	7.8	2.0	31400	0.06	0.01K	0.03	0.02	0.06	4	28.9	9	90	0.00	0.00	0.23	190
83/07/11	0935		16.6	17	8.0	10.0	39100	0.07	0.01K	0.03	0.02	0.05	24	26.9	27	80	0.00	0.11	0.61	
83/07/25	0830		16.5	31	8.1	2.0	41300	0.02	0.01K	0.04	0.02	0.04	1K	26.0	44J	230	0.05	0.05	0.05	109
83/08/08	0840			11	7.9	2.0		0.09	0.01	0.04	0.04	0.06	4	28.5	27	80	0.00	0.00	0.00	
83/08/22	0900		18.3	8	8.1	4.0	38900	0.01K	0.01K	0.03	0.03	0.05	12	28.5	5	20	0.00	0.00	0.00	158
83/09/06	0810		14.1	19	7.9	3.0		0.06	0.01K	0.05	0.03	0.06	6	26.4	15	130	0.00	0.02	0.70	642
83/09/19	0850		13.3	38	7.6	3.0		0.15	0.01K	0.06	0.04	0.06	7	28.5	59	440	0.32	0.57	0.57	381
83/10/03	1800		11.3	6	7.7	4.0		0.16	0.01	0.02	0.05	0.08	12	29.4	14	70	0.00	0.00	0.00	271
83/10/17	1750		13.1	1	8.0	3.0	41000	0.04	0.01K	0.06	0.03	0.05	11		2	230	0.28	0.28	0.28	560
83/10/31	1605		12.8	3	7.8	1.0	40100	0.20	0.01	0.08	0.05	0.06	1	29.6	5	230	0.37	0.61	0.66	
83/11/14	1340		11.0		7.7	3.0	38200	0.32	0.01	0.06	0.05	0.05	4	28.7	62		0.76	1.31	2.66	751
83/11/29	1530		9.8	2J	7.7	2.0							1	27.6	4	80	0.00	0.41	2.28	1040
83/12/12	1450		6.8	18J	7.5	2.0		0.39	0.01K	0.08	0.05	0.06	4	19.1	36	330	0.02	1.32	3.09	1050

APPENDIX D

STREAMWALK RESULTS

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MINTER WATERSHED

Huge Creek, RM	Vegetation	Houses in View	Animals Seen	Fecal Violation (>50 FC/100 mL)	Tributary or Drainage Discharge Sampled	Comments
H 3.5	Boggy clearcut w/vine maple & devil's club	1	No	No	Midstream in creek	Mucky bottom
H 3.25	Same as above	0	No	No	Same as above	Same as above
H 3.15	Same as above	0	No	Yes	Same as above	Stream more channelized than bog above Logging road crosses stream here; mucky bottom.
H 2.9	Same as above	0	No	No	Tributary	At Roland's farm two separate streams converge; gravel bottom.
H 2.7	Same as above	0	No	Yes	Midstream in creek	Beaver dam spillway sampled. No surface drainage; gravel bottom.
H 2.45	Pasture	Yes	No	Yes	Drainage from pasture on east side	First house downstream from N. Firdrone Drive Bridge
H 2.4	Forest	No data	No	Yes	Drainage from forested area on east side	
H 2.25	No data	No data	No	No	Midstream in creek above tributary	
H 2.2	No data	No data	No	Yes	Small stream entering on east side of creek	
H 2.1	Forested	No data	No	Yes	Small stream entering on west side, draining forested area	Road recently excavated in area
H 1.7	No data	No data	No	No	Midstream in creek	Followed path from logging road
H 1.5	No data	No data	No	No	Small stream draining bog on east side	
H 1.4	No data	No data	No	No	Large stream draining several acres of "homestead" on west side	
H 1.3	Pasture	No data	No	No	Drainage from pasture entering east side	Flow goes south under county line road and enters river from roadside ditch by br.
H 1.1	No data	No data	No	No	Midstream in creek	
H 0.7	No data	No data	No	No	Small trickle entering west side	
H 0.6	Wooded	Log cabin and several mobile homes	No	Yes	Midstream in creek	Area being developed. Downstream 1/4 mile, high bank with sparse development set back from stream.
H 0.5	No data	No data	No	No	Hill drainage off east bank	
H 0.3	No data	Some residences on west side	No	Yes	Midstream in creek below large grazing field on east side	East bank pasture. Mostly undeveloped woods west bank, some residences.
H 0.2	No data	Directly below H 0.2 house on west bank. Houses begin here and a few down to confluence with Minter Creek	No	Yes	Small creek draining fields on east side	Between H 0.2 and H 0.3 most of creek fenced, but a few spots where cows can enter.
H 0.0	No data	No data	No	No	Midstream in creek	Below farm

MINTER WATERSHED - (continued)

Minter Creek, RM	Vegetation	Houses in View	Animals Seen	Fecal Violation (50 FC/100 mL)	Tributary or Drainage Discharge Sampled	Comments
M 4.4	Wooded, boggy	See comments	No	No	Midstream in creek	Muddy bottom. Upstream 1/4 mile clearcut for development, power and roads 4/6/83; same area 4-5 mobile homes observed on 6/1/83. At least 10 mobile homes seen on 9/26/83 on very small lots (less than 1/4 acre). Somewhat wooded buffer.
M 4.37	Wooded, boggy	No	No	No	Tributary draining forested area about 3 inches deep, 2 1/2 feet wide enters on east side	
M 4.35	No data	One	No	No	Tributary flowing beside mobile home 50 feet from creek, 1 foot wide x 3 inches deep, enters on east side	
M 4.32	No data	One	No	No	Runoff rivulet just below mobile home, 1 foot wide x 2 inches deep, enters on east side	
M 4.27	Swampy	Yes	No	No	Runoff from swamp area at upstream home boundary	House has red shed and flagpole
M 4.23	No data	Yes	No	No	Small ditch behind house (6 inches wide x 1 inch deep), enters on east side	Water iron-colored
M 4.21	Swampy		No	No sample taken	Drainage from swampy area (2 feet x 3 inches)	
M 4.2	Pasture	Yes (more than one)	No	No	Runoff just below fish rearing ponds entering east side; drains pasture land	
M 4.17	No data	No	No	No	Creek sampled midstream	
M 4.15	No data	Yes	No	No sample taken	Small runoff ditch from below home, 100 ft. south of Minter Creek Rd. Runoff enters on west side.	
M 4.12	No data	Yes	No	No sample taken	Small runoff ditch next house down from M 3.05, enters west side.	
M 4.11	No data	No data	No	No sample taken	No sample taken	Swamp pond on east side. On west side park-like area with swing set 200 ft. inland.
M 4.10	No data	No data	No	No sample taken	Drainage ditch enters west side; runs by homes on hill, possibly draining large pond.	
M 4.00	Pasture	No data	No	No sample taken	Drainage enters west side (1 ft. x 2 in.) 100 ft. below swing set mentioned above. 200-yd.-wide pasture area.	Downstream on west side, farm lands w/2 pigs, 2 cows. Just above Pine Road, small farm w/30-50 chickens, ducks, geese, etc., near large pond which discharges into creek on east side.

MINTER WATERSHED - (continued)

Minter Creek, RM	Vegetation	Houses in View	Animals Seen	Fecal Violation (>50 FC/100 mL)	Tributary or Drainage Discharge Sampled	Comments
M 3.65	Swampy	Yes	5 sheep, 5 goats in corral w/creek access; 6 large geese; all on east side	No	Creek sampled midstream	
M 3.60	Very swampy bog; brush	No data	7 geese on west bank; 5 goats on east side	No	Creek sampled below farms.	Next 1/2 mile downstream of M 2.50 braided creek, very boggy. East braid runs near homes. West braid runs across fields and forests, no development.
M 3.1	Bog merging into forest.	0	No	No	Creek sampled reverting back to free-flowing water from bog.	
M 2.75	Forest	No data	No	No	Creek sampled midstream	End of bog, start of free flow again.
M 2.65	Alder swamp	No data	No	No	Small trickle draining alder swamp entering east side.	Abandoned wooden traffic bridge/road 100 feet downstream.
M 2.60	Steep ravine, alder/cedar forest on east side. West side dry, steep.	No data	No	No	Small stream draining steep forested ravine.	
M 2.45	East side clearcut (large area). Some pasture.	No data	No	No	Midstream in creek.	Site tagged with ribbon, can be reached from east end of the County Line Road.
M 2.35	Alders along cr., pasture behind	No data	No	No	Small stream flowing from north through alder stand.	Large truck canopy on north side.
	No data	Downstream, one house on south bank with barn-like building.	No	No sample taken	No sample taken	Downstream of M 2.35, no evidence of discharge.
M 2.25	No data	No data	No	No	Small stream entering cr. from north, 150 ft. east of 118th Avenue.	Fish fry seen.
M 2.20	Swampy	No data	No	No	Very small flow from north side, 100 yd. west of 118th Avenue, partly subsurface.	Fish fry observed. Small stream entering around same place on south side, draining pasture; no sample taken.
M 2.00	Pasture	No data	20 cows	No	Creek sampled midstream	Cattle not fenced from creek.
M 1.90	No data	No data	No	No	Creek samples below machinery house downstream from cow field.	Waterwheel in creek.
M 1.80	Pasture	3 houses adjacent to creek	5 ducks on east side	No	Small tributary entering on east side.	Between M 1.8 and M 1.65, 10-15 horses; no fencing from stream. Evidence of livestock in cr. throughout river channel on property.
M 1.65	Pasture	1 house on horse farm	2 horses	No	Stream sampled below horse farm.	Heavy bank erosion.
M 1.55	Pasture	No data	No	No	Creek sampled below br. crossing 118th Avenue.	
M 1.25	Pasture on west side	No data	No	No	Creek sampled just upstream of routine sampling station.	
M 1.1	Wooded banks	No data	No	No	Sample taken at bridge above confluence of Minter and Huge Creeks.	

MINTER WATERSHED - (continued)

Unnamed Creek, RM	Vegetation	Houses in View	Animals Seen	Fecal Violation (>50 FC/100 mL)	Tributary or Drainage Discharge Sampled	Comments
UN 2.15	Pasture, bog, w/ scattered woods	No data	No	No	Several drainages come together to form creek.	
UN 2.0	Wooded	No data	No	No	Midstream of creek.	
UN 1.9	No data	Several	2 cows	Yes	Midstream of creek.	Mobile home court SE of here.
UN 1.8	No data	Several	12 cows; 6 ducks	No	Midstream of creek.	Heavy bank erosion, concrete flow control and wooden barrier before creek crosses small road. Barnyard beside creek.
UN 1.0	Wooded	No data	No	No	Midstream of creek	Gravel bottom. Between UN 1.8 and UN 1.0 boggy area changing to woods, then thickets. A few residences with some pasture.
UN 0.9	Wooded	1 house on north bank	Poultry pen 50' from cr.	No	Sampled pool 40 yards below house on bank.	Gravel bottom. Below UN 0.9 red barn on south bank. Finer gravel to sandy mud bottom. Much clearing going on. Another house and dirt road crossing creek.
UN 0.65	No data	Houses visible	No	No	Sampled creek above several houses on south bank.	Fine gravel to sandy mud bottom.
UN 0.55	Wooded	Houses visible	No	No	Drain below house on south bank.	Well-walked trail on south bank. Cleared below UN 0.55.
UN 0.45	Cleared, grassy, commercial area	1 house between H 0.55 and 0.45	Chickens	No	Creek sampled upstream of restaurant.	
UN 0.35	Cleared, grassy, commercial area	No data	No	No	Creek sampled downstream from veterinary clinic.	White PVC pipe crosses stream in streambed. House few hundred yards from creek before 118th Avenue.
UN 0.2	No data	No data	No	Yes	Sampled creek at pump house below store.	After creek crosses 118th Aavenue, runs along Rt. 302, crosses 302 below Collins store.
UN 0.0	Swampy, wooded	2 houses upstream	No	Yes	Midstream in creek.	Stream crosses back under Rt. 302, enters Minter Creek just below UN 0.0.

BURLEY WATERSHED

Bear Creek

BR 1.8	Wooded	No	No	Yes	Creek sampled midstream.	Routine monitoring station on south side of Pine Road.
BR 1.7	Heavily grazed pasture	Yes	40 cattle on 10-acre plot, east side. Cattle also on west side. Ducks, chickens present, too.	Yes	Creek sampled, hardly moving.	Muck bottom, very brown, turbid; siltation and bank erosion very severe. House on northwest bank.
BR 1.6	Grassy, some trees	Yes	Ducks, geese, cows	Yes	Creek sampled below duck pond.	Heavy erosion, mucky bottom.

BURLEY WATERSHED - (continued)

Bear Creek, RM	Vegetation	Houses in View	Animals Seen	Fecal Violation (>50 FC/100 mL)	Tributary or Drainage Discharge Sampled	Comments
BR 1.5	Somewhat grassy, cleared	Yes	No	Yes	Creek sampled below cattle grazing area.	Erosion tapers off; gravel bottom. Some fencing from creek above here. Old septic tank box lies below BR 1.4, drains into creek. Stream appears to pick up much humic material in this area.
BR 1.35	No data	No data	No data	No	Sample taken from small tributary on west side.	
BR 1.25	No data	No data	No data	No	Tributary below BR 1.3, longer than above, draining same west side.	Between BR 1.1 and BR 1.05 banks on both sides abuot 50 feet high. Signs of spora dic humic loading.
BR 1.1	Brush	Yes	Sheep on northwest side w/ creek access	Yes	Creek sampled below A-frame house across from Jenkins' residence.	Two large drain pipes in creek (flowing). Several smaller pipes run through creek. Bank rip-rapped. Swampy area below BR 1.05.
BR 1.0	No data	No data	No	No	Sample taken from 1-inch pipe discharging from hose into pond on south side of river just west of BR 0.9.	Pond has bluish bottom.
BR 0.9	Swampy	No data	No	No	Creek sampled where road crosses creek.	Swampy area above.
BR 0.8	No data	No data	No	No	Very small flow from tributary on south side 75 feet downstream from BR 0.9.	
BR 0.75	No dta	Yes, on both sides of creek.	No	No	Creek sampled downstream of intake for a pond on east side.	
BR 0.7	No data	Yes	No	Yes	Discharge from domestic pond on east side mentioned above.	
BR 0.6	No data	Yes	No	Yes	Creek sampled below group of houses.	
BR 0.55	Clearcut	No data	No	No	Stream enters Bear Creek on east side w/about one-half the flow of the mainstem.	Clearcut area just downstream. Road leading to house trailer and camper in center of clearcut area.
BR 0.5	Grassy	One	Cattle, chickens above pond	No	Pond discharge near house w/sattelite TV dishes.	A few cattle penned above pond and house.
BR 0.3	No data	One	No	No	Stream sampled downstream of house with swimming pool on river.	
BR 0.25	Cleared	Several	No	No	Drainage from bank near suspected well house on west side.	Large cleared area on west side (10 to 15 acres).
BR 0.2	Thick alder woods	No data	No	No	Wide, shallow inflow, very low flow, sandy bottom (west side).	Fish fry present in small stream. Small creek downstream drains cedar stand not sampled (west side). Vegetation below changes back to alder with emerging ground water, not sampled.
BR 0.15	No data	No data	No	No	Drainage ditch entering north side of creek along Bethel-Burley Road.	
BR 0.06	No data	No data	No	No	Drainage ditch entering on south side of creek along Bethel-Burley Road.	
BR 0.05	No data	No data	No	No	3- to 4-inch pipe discharging directly into creek from north side, 100 ft.east of Bethel-Burley Road.	
BR 0.0	Grassy, cleared	Yes (several)	No	Yes	Routine monitoring station sampled midstream.	

BURLEY WATERSHED - (continued)

Burley Creek, RM	Vegetation	Houses in View	Animals Seen	Fecal Violation (>50 FC/100 mL)	Tributary or Drainage Discharge Sampled	Comments
BU 5.2	Cedar swamp w/ dense thickets	Yes	No	No	Midstream in creek.	No sources seen between BU 5.2 and BU 5.0 (about 1,000 ft. apart).
BU 5.0	Same as above	Yes (few)	No	No	Where creek crosses Spring Creek Road.	
BU 4.9	End of swamp, merging into pasture	Yes (few)	Evidence of cattle trodding through swamp.	No	Midstream in creek.	Large pasture below BU 4.8.
BU 4.5	Pasture; some swampy, brushy areas	Yes (one)	5 cows; 1 horse; 8 sheep	Yes	Creek sampled at lower end of pasture.	Pasture did not seem heavily grazed.
BU 4.4	Pasture	Yes	15 cows; 1 horse	Yes	Creek sampled at freeway.	Pasture seemed very moderately grazed.
BU 4.3	Forested, swampy w/dense underbrush similar to BU 5.2-BU 5.0.	Several close to creek	No data	Yes	Creek sampled just below Mullenix Road where two culverts cross road.	Short stretch with very steep banks, then flattens out. Garbage dumped high on bank.
BU 4.2	Swampy lowland, forested	No	No data	No	Spring-fed stream entering on east side.	Standing water and very small streams between BU 4.0 and BU 3.9.
BU 4.15	Alder swamp	No	No data	No	Typical small seep for this stretch on west. side.	Many small flows not large enough to sample coming from water-soaked depression on west side. Downstream between BU 3.85 and BU 3.75 lies log house on 5-acre clearing, east side. Access road to house house goes over creek.
BU 4.05	Vine maple; devil's club thickets	No data	No	Yes	2-foot wide inflow with sandy bottom entering west side.	Passage through this section extremely difficult.
BU 4.0	Alder-cedar forest	No data	No	No	Drainage ditch entering west side. Ditch along access road leading to house on east side of creek.	Bethel-Burley Road 100 yards west of sampling location. A similar inflow about 100 yards downstream entering west side, not sampled.
BU 3.9	Alder swamp, very wet	Several on top of hill, west side.	No	No	Flow coming from base of hill on west side.	
BU 3.7	Pasture	No data	1 horse	No	Drainage ditch running along Bethel-Burley Road entering on southwest side.	
BU 3.65	No data	No data	No	No	Small stream on west side of creek near mailbox #9534 on Bethel-Burley Road.	
BU 3.6	Grassy, cleared	One	No	No	Small seep like BU 3.65 below steep bank.	House lies on cleared area on top of steep bank.
BU 3.5	Pasture	Yes	Horses	Yes	Ditch entering creek immediately upstream of Holman Road on east side.	

Burley Creek, RM	Vegetation	Houses in View	Animals Seen	Fecal Violation (>50 FC/100 mL)	Tributary or Drainage Discharge Sampled	Comments
BU 3.45	Pasture	Yes	Horses & cows on both sides of creek.	No	Creek sampled just upstream of Holman Road.	
BU 3.35	Pasture	Yes	No data	Yes	Creek sampled 200 yards downstream from Holman Road.	Many small seeps enter-on right bank. Stream fenced above, but here evidence of heavy livestock usage. 1/2-inch PVC pipe in creek. Very silty bottom. For next 1/4 mile stream continues to pick up pasture runoff; silty bottom.
BU 3.25	No data	No data	No	No	Creek sampled.	
BU 2.8	Fairly dense alder forest	No data	No data	No	Tributary draining forested pasture on west side.	
BU 2.6	No data	No data	No	No	Burley Creek just above major tributary inflow.	Tributary inflow (Y 0.0) about 1/3 of Burley Cr. flow. Below here creek bottom more gravelly.
Y 0.2	Forested w/ houses above	No data	No	Yes	Tributary just above culvert under Rt. 16.	Water has organic appearance.
Y 0.15	No data	No data	No	Yes	Tributary 200 yards below cattle barn.	Above where sample taken tributary passes close to dairy barn and two houses. Heavily colored and foamy. Tributary appears to drain large fields between Burley Creek and Rt. 16.
Y 0.0	Pasture	No data	No	No	Mouth of tributary.	Tributary here drains pasture areas on north side. Bottom pea gravel.
BU 2.35	No data	One	No	No	Ditch on east bank at first house below drop-off point.	
BU 2.3	Alder forest	One	No	No	Ditch on east bank 1000 feet downstream of BU 2.25.	Numerous small rivulets entering between BU 2.25 and BU 2.2. Not sampled. Did not seem likely sources.
BU 2.2	No data	No data	No	No	Ditch on east bank.	Dilapidated pole and fiberglass structures near mouth of ditch.
BU 2.0	No data	One	A few cattle	Yes	Ditch by driveway crossing creek at brown house.	
BU 1.95	No data	No data	Horses	No	Pond outlet east side, 1-foot diameter metal pipe.	Red barn nearby.
BU 1.9	No data	One	Cows	Yes	Large ditch at cattle farm just above Burley-Olalla Rd. entering west side.	3-foot corrugated pipe under farm driveway.
BU 1.85	No data	No data	No	No	2-inch metal pipe entering east side below red barn with pond.	One tributary below cattle ranch, east side; not sampled.
BU 1.8	Forested	Yes	No	Yes	Creek sampled midstream.	

BURLEY WATERSHED - (continued)

Burley Creek, RM	Vegetation	Houses in View	Animals Seen	Fecal Violation (>50 FC/100 mL)	Tributary or Drainage Discharge Sampled	Comments
X 0.0	Forested	No	No	No	Major tributary	Undeveloped forest above here.
BU 1.2	Forested	Scattered houses	No	No	Spring drainage entering on east bank.	Forested between Burley-Olalla Rd. and Oak Road (1/4 mile downstream); gravelly bottom. 1/4 mile below Oak Rd. surveyors' stakes and fence cross road; cobble bottom. Some erosion in stretch starting 1/2 mile below Oak Rd. Banks vegetated. Large water-filled depressions visible from creek.
BU 0.9	No data	One house 50' from creek	2 goats	Yes	Creek sampled below residence on west side (red house).	
BU 0.8	Swampy	No data	No	No	Small tributary entering on east bank.	
BU 0.75	No data	Sparse housing	No data	No	Larger tributary entering on west bank.	
BU 0.70	No data	Yes	No	Yes	Large drainage from fields on west bank.	Several houses above BU 0.6 (routine monitoring station) lie directly on bank of creek. One mobile home within 15 feet of creek.
BU 0.65	No data	Yes	No data	Yes	Ditch entering creek above routine monitoring station BU 0.6.	
BU 0.6	Grassy on east side; vines on west side	Yes	Horse seen later in summer	Yes	Creek at routine mointoring station, just above confluence w/Bear Creek.	House on east bank; few others visible above. Bank erosion for next 1/4 mile. Drainfield pipe protruding from east bank.
BR 0.1	No data	Yes	No data	Yes	Creek on east side of Bethel-Burley Road.	
BR 0.0	No data	3 to 4	No data	Yes	Bear Creek on east side of Bethel-Burley Road blw wooden bridge just before Bear Creek flows into Burley Creek.	Also routine monitoring station.
BU 0.3	Pasture	Yes	No	No	Inflow on west side.	
BU 0.2	Swamp	Yes	2 horses; 10 cows	Yes	Ditch draining swampy area with cattle & 2 houses.	
BU 0.15	Marshland	No data	No data	No	Drainage from marshland, tidally influenced.	
BU 0.05	No data	No data	No data	Yes	Creek sampled, tidally influenced.	
Spring	No data	Yes	No data	Yes	Stream flowing under Bethel-Burley Road.	Neighbor claims stream spring-fed.

BURLEY WATERSHED - (continued)

Purdy Creek, RM	Vegetation	Houses in View	Animals Seen	Fecal Violation (>50 FC/100 mL)	Tributary or Drainage Discharge Sampled	Comments
P 3.6	No data	No data	No	No	Creek sampled midstream.	Sampled just above Burley-Ollala Road.
P 3.3	Pasture with few large trees	2 houses visible west side	See comments	Yes	Drainage into small pond with farm animals nearby on west side of creek.	Evidence of cattle in stream above pond. Pond has no surface outlet. Between P 3.3 and P 2.9 clearing and development on west side; 2 new homes visible; thickets on east side.
P 2.9	Devil's club; vine maple thickets	2 houses west side	See comments	No	Tributary stream enters on east side draining thick brush area.	Cattle grazing area just downstream of tributary.
P 2.3	No data	Yes	Chickens, ducks, other animals just upstream	Yes	Creek samples on south side of Nelson Road.	
P 2.2	Swampy	No data	No	Yes	Spring drainage through swampy area on west side.	Downstream of P 2.3 survey flags lined across creek; foot path west side running along creek, crossing and continuing along east side.
P 2.05	Pasture	Several just downstream	Yes	Yes	One of many area seeps from pasture on east side.	Livestock access in places, but mostly fenced on east side; 1 horse, 2 cows on west side; chicken coop downstream on west side.
V 0.0	Forest	1 or 2	No	No	Major tributary draining forested area.	Between P 1.8 and P 1.6 mostly thickets and small trees. A few houses above on east side.
P 1.7	Wooded	Yes	No	No	Creek sampled just downstream of major tributary input (V 0.0) which drains a mostly undeveloped forested area.	
P 1.6	Thickets	1 mobile home	Yes	No	Creek sampled below mobile home on west side.	Livestock tracks downstream of P 1.6. Shetland pony and 2 houses on west side.
P 1.3	Pasture	2 houses	Pony upstream; 100 chickens, geese on east side	No	Drainage entering east side from barnyard; undeveloped forest above barnyard.	
P 1.25	Pasture	Yes	Downstream of chickens, geese mentioned above.	No	Creek sampled midstream.	Sampling site below 160th Street. Paint shop, junkyard east of creek apparently associated with farm.
P 1.2	Clearing/farm	Yes	No data	No	Road ditch entering below 160th Street.	Clearing operation on east side. 5-acre farm on west side. Downstream from here recreational cabin lies on west bank below a logging operation. Another 7-acre farm lies farther downstream on west side w/at least 4 horses. Ditching in some of the latter field. Between P 1.2 and P 1.05 creek partially fences from fields.

BURLEY WATERSHED (continued)

Purdy Creek, RM	Vegetation	Houses in View	Animals Seen	Fecal Violation (>50 FC/100 mL)	Tributary or Drainage Discharge Sampled	Comments
P 1.05	No data	Yes	more than 4 horses	No	Taken in creek below small tributary on east side.	Larger tributary enters creek below P 1.05. House lies on bulkhead 50' from creek downstream of horse fields mentioned above. Driveway bridge crosses creek downstream. Small seep below driveway bridge drains field with horses. Below bridge two houses directly on west bank; 5-acre farm on east side. Wooded below to State Hwy. 16. Stream crosses under Rt. 16 in 2 culverts.
P 0.8	No data	Yes	No data	No	Culverts downstream of Rt. 16 sampled.	Downstream from culverts 2 private road bridges cross creek. At second bridge 2 water pipes cross creek and a black drain pipe emerges from bank, though not flowing. Iron-colored spring emerges from bank nearby.
P 0.5	Pasture	Yes (2)	None seen, but evidence of heavy grazing	No	Cistern overflow into creek through 3/4" black pipe sampled.	Humic substances apparent. Three spring seeps from banks. Access road crosses creek 300 yards below cistern pipe. Very mucky field. No animals observed, though good evidence of cattle or horse grazing. Mobile home above creek.
P 0.1	Wooded	No	2 deer	No	Stream sampled just upstream from Chevron gas station.	Stream wooded at sampling spot, but just downstream lies urban area. Gravel bars present above P 0.1.
2 drains in Purdy shopping area	Urban	Businesses; school	No	1-yes; 1-no	Urban drains.	

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