site during March 1998 (**Fig. 1.4**). Samples were collected from this site until December 1998, when the site had to be abandoned at owners request.

Background Site

Little St. George Island, also referred to as Cape St. George, was once part of St. George Island. In 1954, Cape St. George was separated from the larger island by the Corps of Engineers to build a navigable channel to the Gulf, now called Bob Sikes Cut. In 1977, the State of Florida purchased Little St. George Island under the Environmentally Endangered Lands Program and created a state preserve. Due to the island's status, there has been no development, thus the groundwater nutrient concentrations have had no influence from wastewater systems. Two multi-level samplers were installed on the island, one within 1 km of the east end of the island and the other approximately 5 km west of the east end. The stratigraphies at these well locations are almost identical to the experimental sites. Concentrations of nutrients from these background well sites are considered natural background levels.

Methods

Sample Collection

Monthly measurements of hydrographic, chemical, and biological variables were made from September 1997 to May 1999, April 1998 to December 1998, and April 1998 to March 1999 at the SP, BL, and JA field sites, respectively. Water samples were collected in 125 mL acid washed polypropylene bottles. Samples for nutrient analyses

were filtered (0.45 μm) in the field and were stored on ice in the dark until analysis, typically performed within 24 hours.

Analytical Determination of Nutrients

Nutrient concentrations were determined by standard methods. Nitrite, ammonium, reactive phosphate, total phosphate, and silicate were quantified colormetrically using a spectrophotometer. Nitrate and total nitrogen were analyzed by vanadium (III) reduction with chemiluminescence detection.

Total Nitrogen, Nitrate and Nitrite. A procedure involving vanadium reduction followed by chemiluminescence detection of NO_x was used for nitrate plus nitrite and total nitrogen analysis (Braman and Hendrix, 1989). Nitrate and nitrite are quickly reduced to nitric oxide in an acidic medium containing vanadium (III) at 80-90°C. The nitric oxide is then removed from the reaction solution by scrubbing with helium carrier gas and is detected by means of a chemiluminescence NOx analyzer. This method is very sensitive and requires less than 1 mL of sample. Samples analyzed for total nitrogen were first digested at 120°C for 30 minutes in the presence of persulfate (Pujo-Pay and Raimbault, 1994). The determination of nitrite in water is based on the conversion of nitrous acid to a highly colored azo dye. Nitrite is allowed to react with sulphanilamide in an acid solution. The resulting diazo compound reacts with N-(1-naphtyl)-ethylenediamene and forms a highly colored azo dye which is measured colormetrically (Stickland and Parsons, 1972). Nitrate can then be estimated by difference.

Ammonium. The technique used to quantify ammonium is a sensitive modification of the phenol-hypochlorite method as described by Strickland and Parsons

(1972). The water is treated in an alkaline citrate medium with hypochlorite and phenol in the presence of sodium nitroprusside which acts as a catalyst. The blue indophenol formed with ammonia is measured using a 1 cm cell.

Phosphate. Samples analyzed for reactive phosphate and total phosphate are allowed to react with a composite reagent containing molybdic acid, ascorbic acid, and trivalent antimony. The resulting heteropoly acid complex is reduced in situ to give a blue solution. The colored solution is then measured colorimetrically. Total phosphate samples are initially digested at 120°C for 30 minutes in the presence of persulfate.

Silicate. Samples are allowed to react with molybdate under conditions that result in the formation of silicomolybdate. A reducing compound containing metol-sulphite and oxalic acid is then added to the solution which reduces the silicomolybdate complex to give a blue compound (Strickland and Parsons, 1972).

Bacteriological

Ackuritlabs, Inc., located in Tallahassee, Florida performed bacteriological analyses. Samples were collected in 120 mL Nasco Whirl-Pak Thio-Bags. Each bag contains a nontoxic, nonnutritive pill impregnated with 10 mg sodium thiosulfate sterilized in the bag by the ethylene oxide process. Samples were analyzed within 30 hours of collection using standard methods. Total coliform, fecal coliform, and *E. Coli* require membrane filter procedure for counting (EPA methods 9222B, 9222D, and 9213D, respectively) and are confirmed using fermentation processes (EPA methods 9221B, 9221E, and 9221E, respectively).

Results and Discussion

Nutrient Dynamics

According to the U.S. Environmental Protection Agency's Office of Technology Assessment, the total amount of waste disposed of through septic systems in the U.S. is over one trillion gallons per year and the majority of this waste is discharged directly to the subsurface, which affects groundwater quality. On St. George Island, virtually all the homes and businesses have an onsite wastewater treatment and disposal system with a drainfield less than 1 meter above the shallow groundwater. Average groundwater velocities have been shown to be as high as 0.4 m day^{-1} using artificial tracers, and presumably are even greater during large rain events, with little dilution expected (Corbett et al., 1999). The weakly dispersive nature of the island's aquifer and the fairly rapid transport rates may make current minimum distance-to-surface water (~23 m) regulations for permitting wastewater systems inadequate for protecting local surface water quality against mobile contaminants. In order to evaluate the current setback distance of wastewater systems from surface waters, nutrient and bacteriological samples were monitored monthly downfield from both septic and aerobic wastewater systems. In addition, effluent was collected as it exited the OSTDS and entered the drainfield at least twice at each site (**Table 2.1**).

Routine sampling of the monitoring network demonstrated that the effluent plume could be easily distinguished in the field by measurement of the groundwater silicate concentration (**Fig. 2.1**). Using silicate as an indicator shows the wastewater plume at the SP site extending almost to surface waters with relatively little dilution during January

Table 2.1: Average nutrient concentrations in wastewater exiting the tank in μM.

Site	Wastewater System	Total Nitrogen μM	Ammonia μM	Total Phosphate μM	Silicate μM
SP Site	Septic	1950 ± 650	350 ± 200	190 ± 20	380 ± 40
BL Site	Septic	1440 ± 990	980 ± 430	260 ± 10	510 ± 20
JA Site	Aerobic	543 ± 230	790 ± 240	110 ± 20	420 ± 50

Table 2.1: Average nutrient concentrations in wastewater exiting the tank in mg L^{-1}.

Site	Wastewater System	Total Nitrogen mg L^{-1}	Ammonia mg L^{-1}	Total Phosphate mg L^{-1}	Silicate mg L^{-1}
SP Site	Septic	27.3 ± 9.1	4.9 ± 2.8	5.9 ± 0.6	10.7 ± 1.1
BL Site	Septic	20.2 ± 13.9	13.7 ± 6.0	8.1 ± 0.3	14.3 ± 0.6
JA Site	Aerobic	7.6 ± 3.2	11.4 ± 3.4	2.3 ± 0.6	11.8 ± 1.4

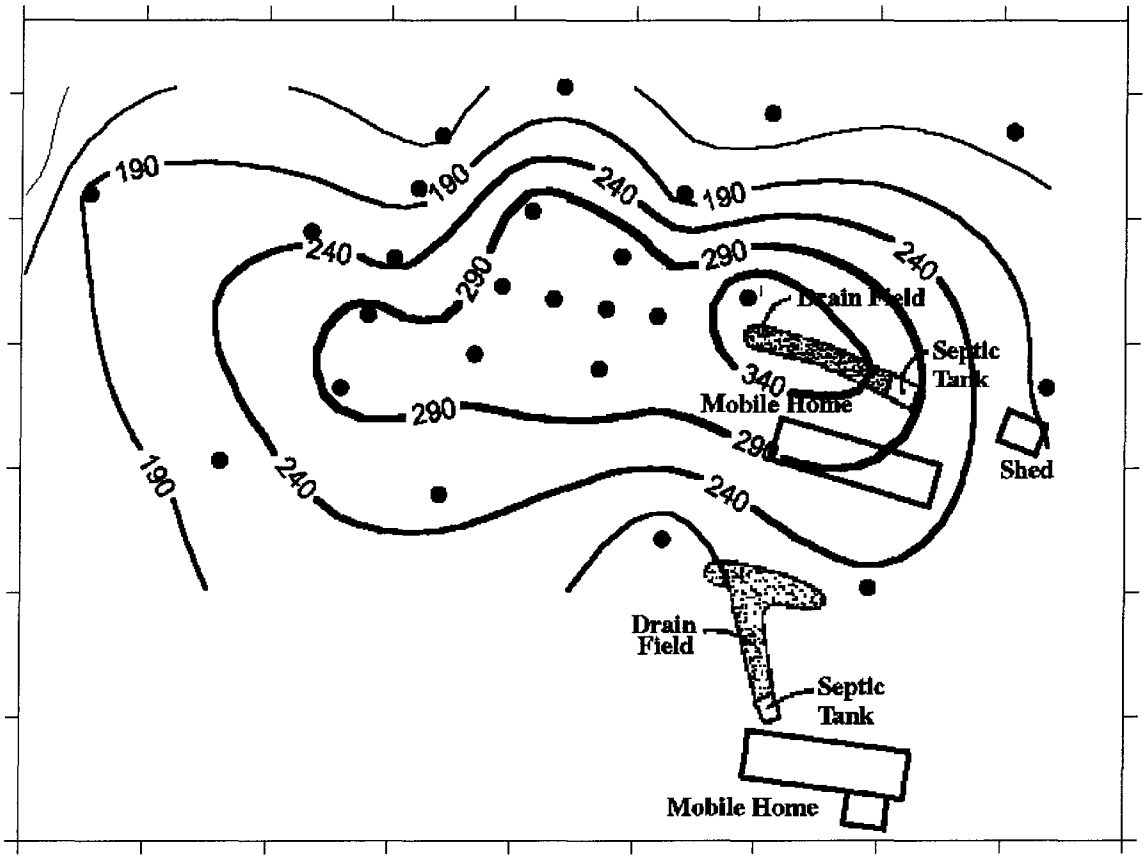


Figure 2.1: Map view of silicate concentration (μM) downgradient from the wastewater system at the SP site during January 1998. Silicate appears to act conservatively in the subsurface, thus mapping the wastewater plume.

1998. Silica serves as a natural tracer of wastewater due to the origin of the potable water for the island. St. George Island's drinking water is obtained from three deep wells (>150 m) on the mainland, which is pumped over to a large storage tank (570 m^3) on the island. The silicate concentration in the tap water averaged 410 μM (11.5 mg L^{-1}), ranging from 290 (8.1) to 510 (14.3) μM (mg L^{-1}) throughout the study period at all the experimental sites. Unimpacted groundwater collected from Little St. George Island had an average silicate concentration of 105 μM (2.9 mg L^{-1}), ranging from 40 (1.1) to 140 (3.9) μM (mg L^{-1}). The reactivity of silicate in this type of environment should be slight and the concentrations measured are at or near the saturation value for pure quartz (approximately 100 μM [2.8 mg L^{-1}]). The kinetics for dissolved silica precipitating to low-temperature quartz is so slow that it takes millions of years, much longer than the residence time of the groundwater. Therefore, silicate has been utilized as a conservative indicator of the wastewater plume in this study.

Nutrient concentrations in the subsurface varied considerably. However, general trends in the data were observed and these simplified trends were used for interpretation. For instance, the majority of the nitrogen species measured was either in the form of ammonia or organic nitrogen. Nitrate and nitrite represented less than 1.5% on average of the total amount of nitrogen in all the samples collected at the experimental sites. On the other hand, soluble-reactive phosphate averaged between 85% and 90% of the total phosphate measured. Based on these observations, trends for total nitrogen, ammonia, total phosphate, and silicate have been presented. Therefore, unless otherwise indicated, it was assumed assume that nitrate and nitrite are negligible and soluble-reactive phosphate is approximately equal to total phosphate.

Preferential removal of both phosphate and nitrogen relative to silicate is evident at the experimental sites (**Fig. 2.2 and 2.3**). At the SP site in January 1998, samples collected along the central transect from the drainfield to surface waters showed rapid attenuation of total nitrogen and total phosphate (**Fig. 2.2**). Ammonia showed a similar trend as total nitrogen. Silicate also showed a slight reduction in concentration, decreasing from 390 μM at the well closest to the drainfield (nearfield well) to 210 μM at the well closest to surface waters (farfield well). This reduction in concentration can be attributed to dilution, mixing with the surrounding silicate poor groundwater and surface water. Silicate had a fairly constant concentration of approximately 300 μM at the JA site in October 1998, indicating very little dilution of the wastewater (**Fig. 2.3 A**). However, just as at the SP site, nutrient concentrations were rapidly attenuated downfield from the drainfield relative to silicate (**Fig. 2.3 B**). Assuming the decrease in nutrient concentration was associated with dilution of nutrient-poor groundwater, a plot of silicate versus the nutrient of interest should fall along a linear mixing line if the nutrient was behaving conservatively. This line is drawn between two end points: (1) the groundwater concentration at the background sites; and (2) the concentration of wastewater measured flowing into the drainfield. It is evident from these plots that nitrogen and phosphorous species are distinctly non-conservative, decreasing in concentration due to some process other than dilution (**Fig. 2.4-2.6**). Although some samples fall along the conservative mixing line, a vast majority of the samples collected are much lower than would be expected assuming conservative behavior. Samples collected at the SP site may indicate ammonia being produced in the groundwater, since some of the samples fall above the conservative mixing line (**Fig. 2.4 B**). Interestingly,

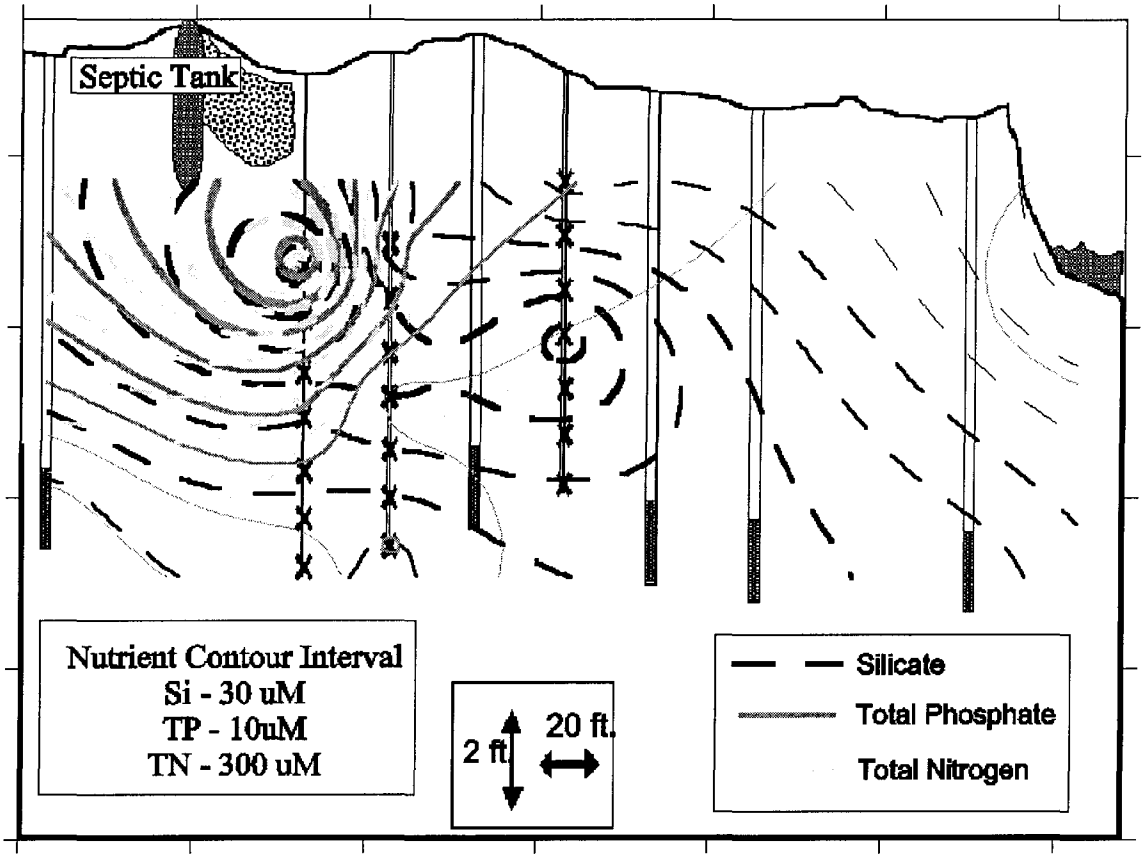
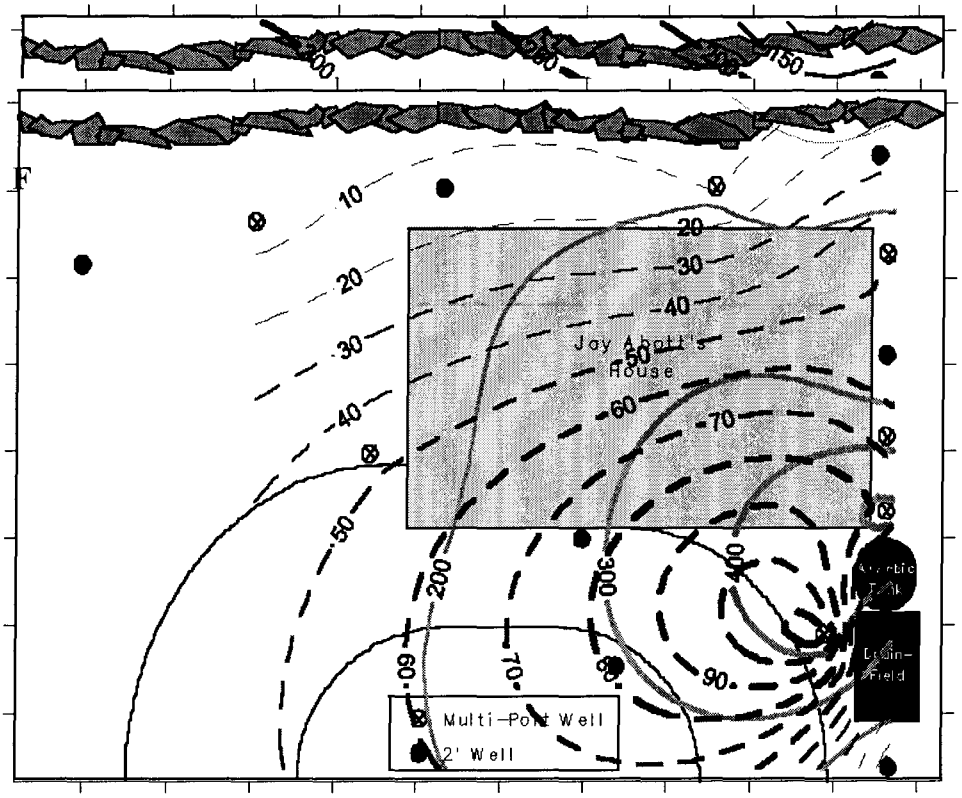


Figure 2.2: Cross sectional view of silicate, total phosphate and total nitrogen concentrations (μM) downgradient from the wastewater system at the SP site in January 1998. Silicate shows apparent conservative behavior within the wastewater plume, while total nitrogen and total phosphate display rapid removal.

A.

B.



igure 2.3: Silicate (**A**), total nitrogen (**B**; dashed line) and total phosphate concentrations (**B**; solid line) contoured for the JA site for October 1998. Silicate appears relatively constant throughout the site, while total nitrogen and total phosphate attenuate rapidly downgradient. Nutrient concentrations are in μM.

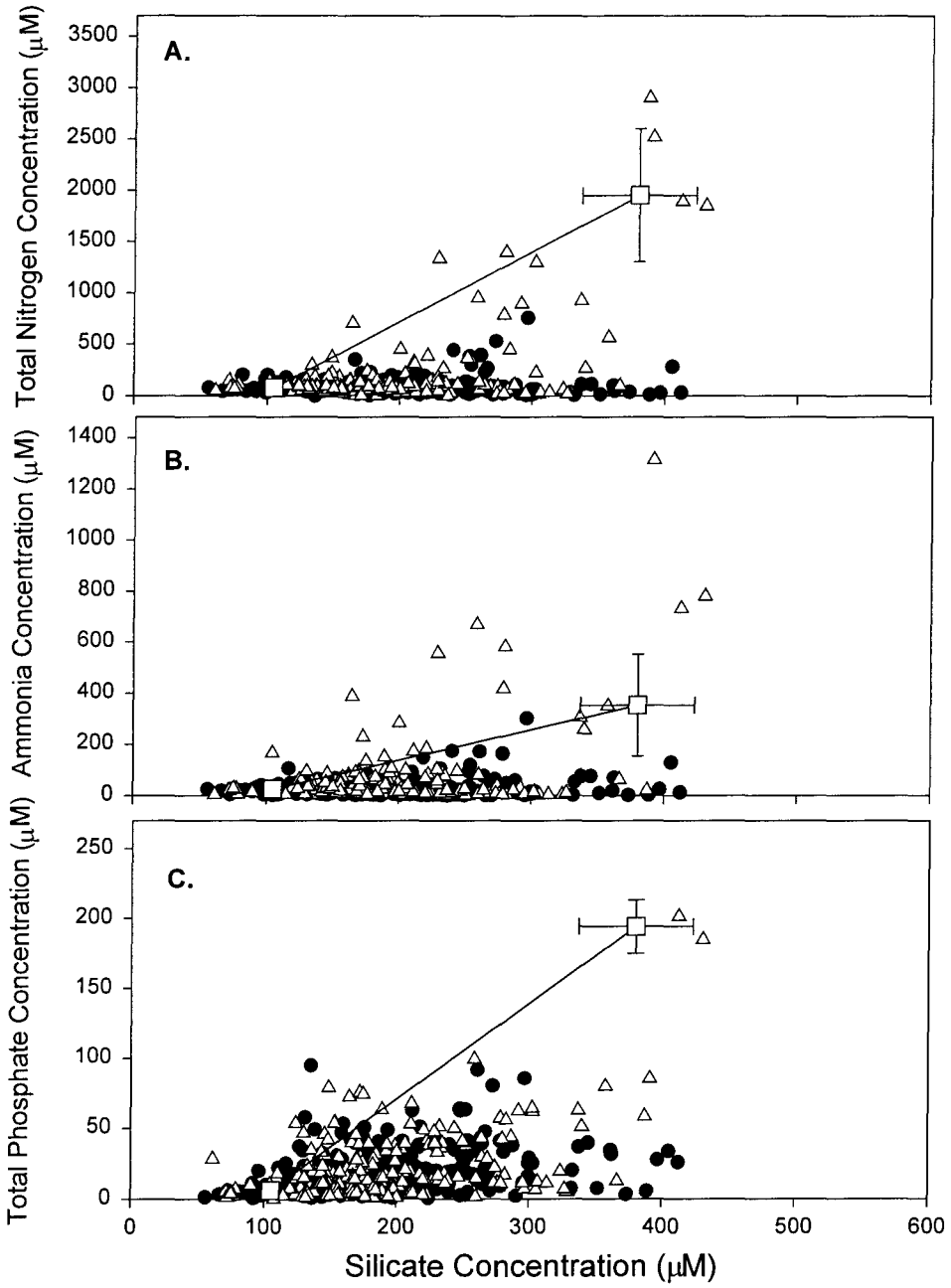


Figure 2.4: Samples collected from the SP site during periods of increased rainfall (open triangles) and low rainfall (closed circles). A conservative mixing line is drawn using the average background concentration at the control sites and the average concentration in the wastewater tanks (open square).

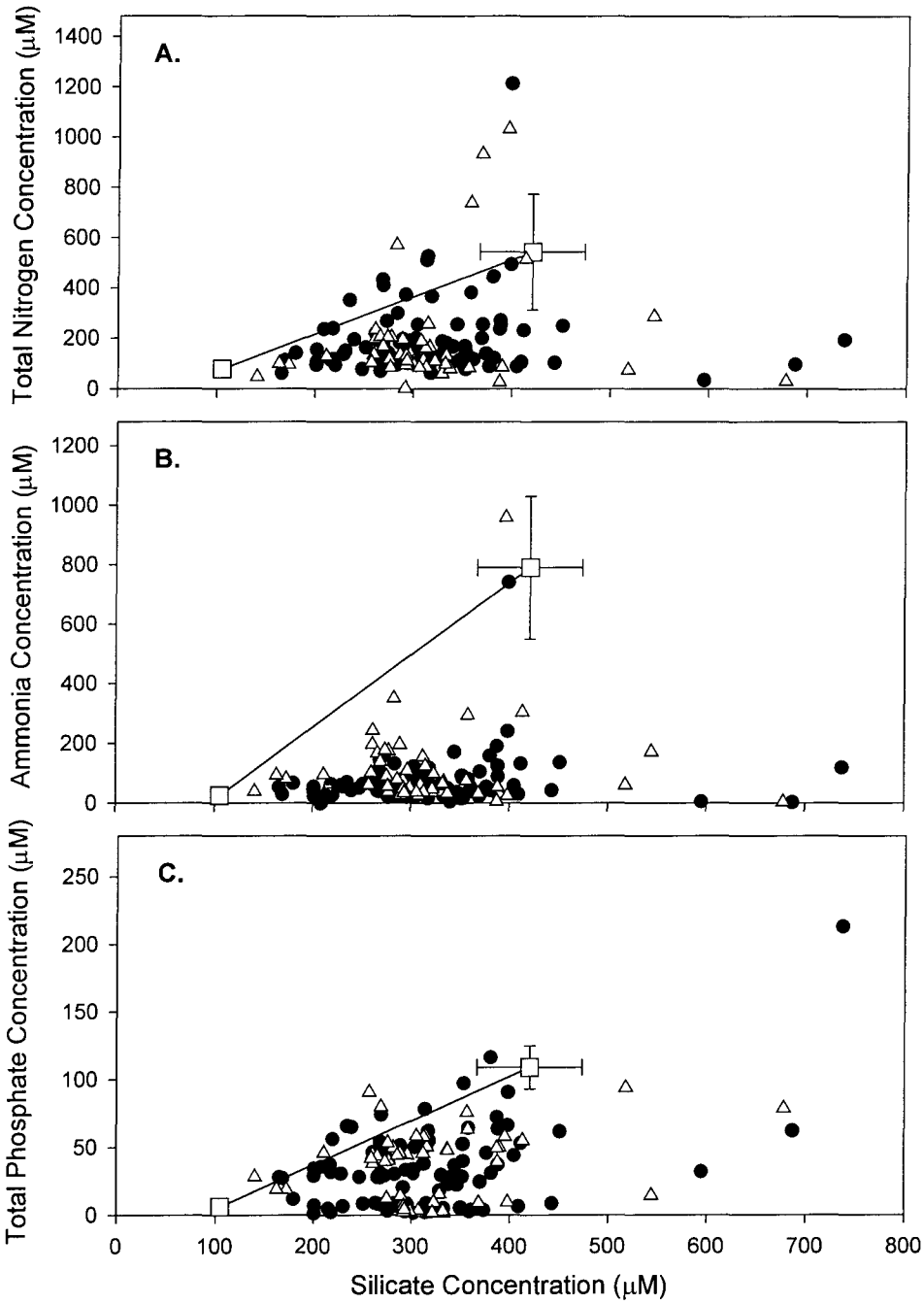


Figure 2.5: Samples collected from the JA site during periods of increased rainfall (open triangles) and low rainfall (closed circles). A conservative mixing line is drawn using the average background concentration at the control sites and the average concentration in the wastewater tanks (open square).

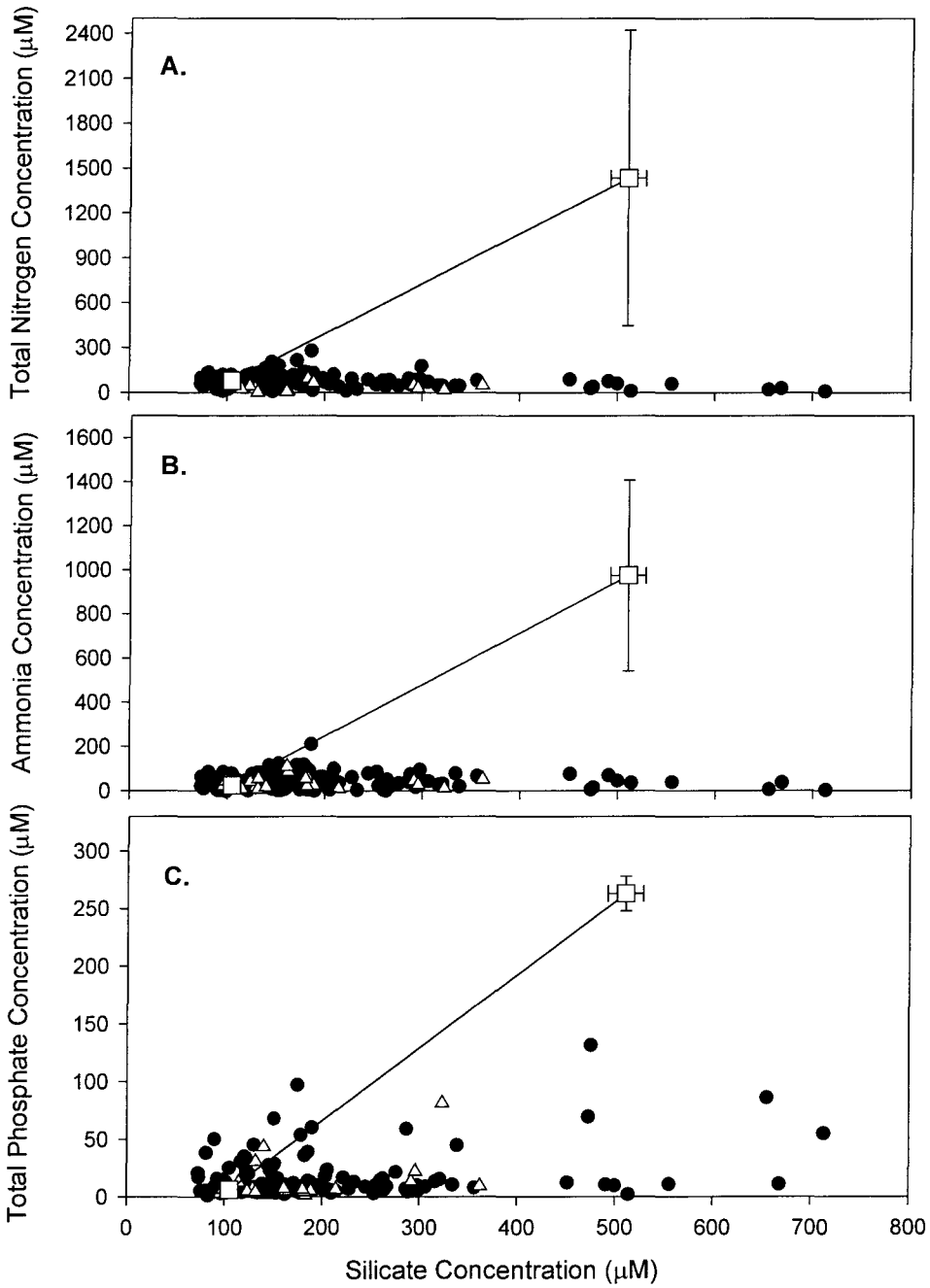


Figure 2.6: Samples collected from the BL site during periods of increased rainfall (open triangles) and low rainfall (closed circles). A conservative mixing line is drawn using the average background concentration at the control sites and the average concentration in the wastewater tanks (open square).

all of the ammonia samples that fall above this line occur during periods of increased rainfall (open triangles). Nutrients from samples collected at the JA site all appear to be attenuated relative to the conservative mixing line (**Fig. 2.5**), with little difference between periods of little and increased rain. The non-conservative mixing of nutrients is unquestionable at the BL site (**Fig. 2.6**). Nitrogen concentrations are reduced by over one order of magnitude in many cases. Phosphate concentrations at this site were rarely more than half of the observed concentration in the septic tank and typically reduced by almost one order of magnitude. Nutrient removal can be attributed to a variety of mechanisms including sorption, precipitation, denitrification and biological uptake.

A trend of decreasing nutrient concentration with distance from the drainfield is evident throughout the entire study period at both the SP and JA study sites (**Fig 2.7 and 2.8**). Nutrient concentrations at the BL site were low throughout the entire study site, although phosphate typically showed a slight increase in concentration closest to the drainfield (**Fig 2.9**). At both the SP and JA sites, the highest concentrations of total nitrogen, ammonia and phosphate were measured in the nearfield wells. Concentrations decreased exponentially downgradient from the drainfield, approaching values measured at the background sites. Silicate remained relatively constant throughout the study site and was rarely below 150 μM (4.2 mg L^{-1}) and 200 μM (5.6 mg L^{-1}) at the SP and JA sites, respectively. Samples collected during months of increased rainfall (open triangle) were separated from relatively dry months (closed circle) to evaluate potential differences due to the change in water table associated with increased rainfall. The highest concentrations of total nitrogen, ammonia and phosphate at the SP site were typically

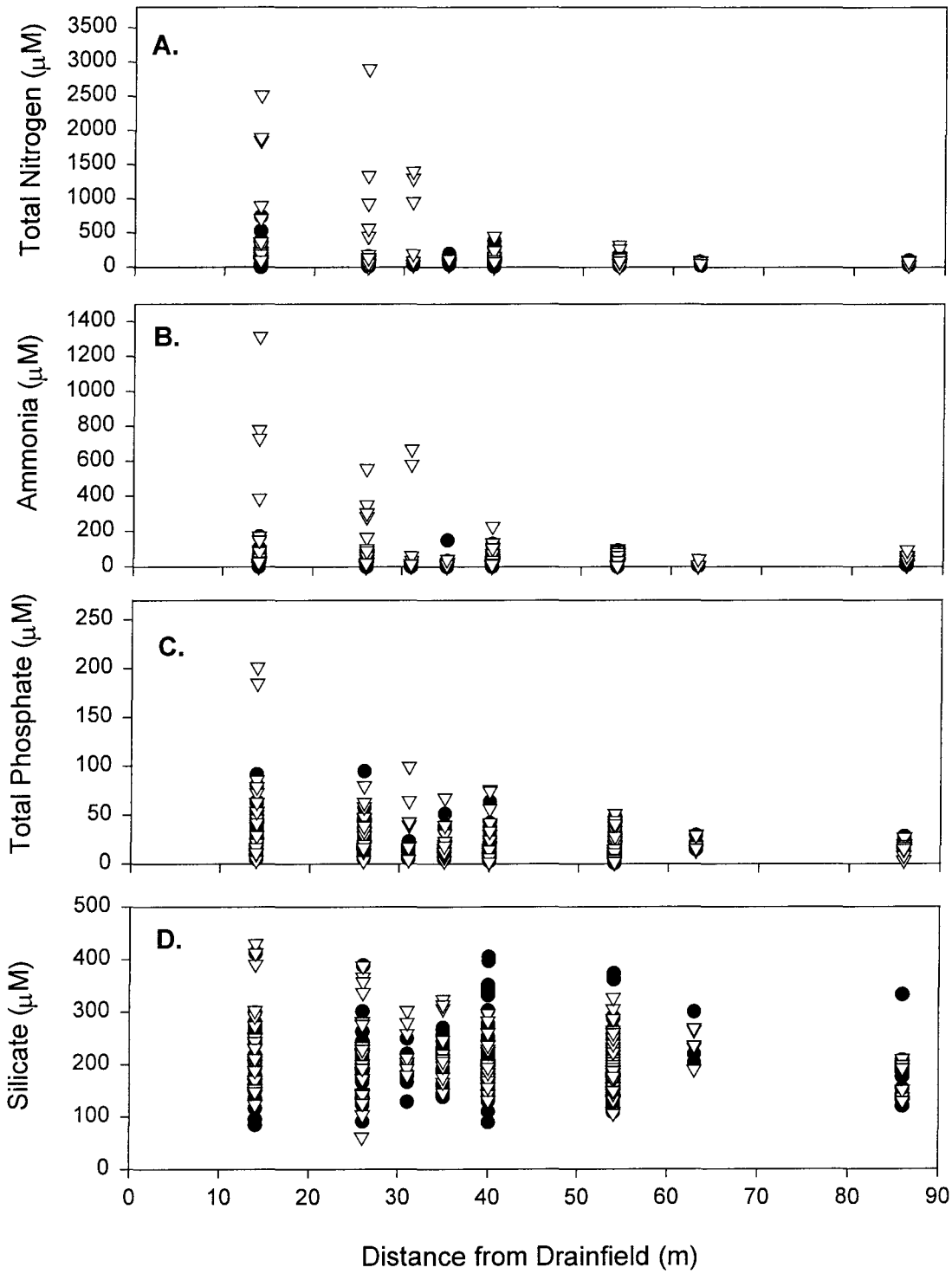


Figure 2.7: Samples collected from the SP site during periods of increased rainfall (open triangles) and low rainfall (closed circles) versus the distance from the wastewater tank. Silicate appears to be the only measured parameter that does not attenuate with distance.

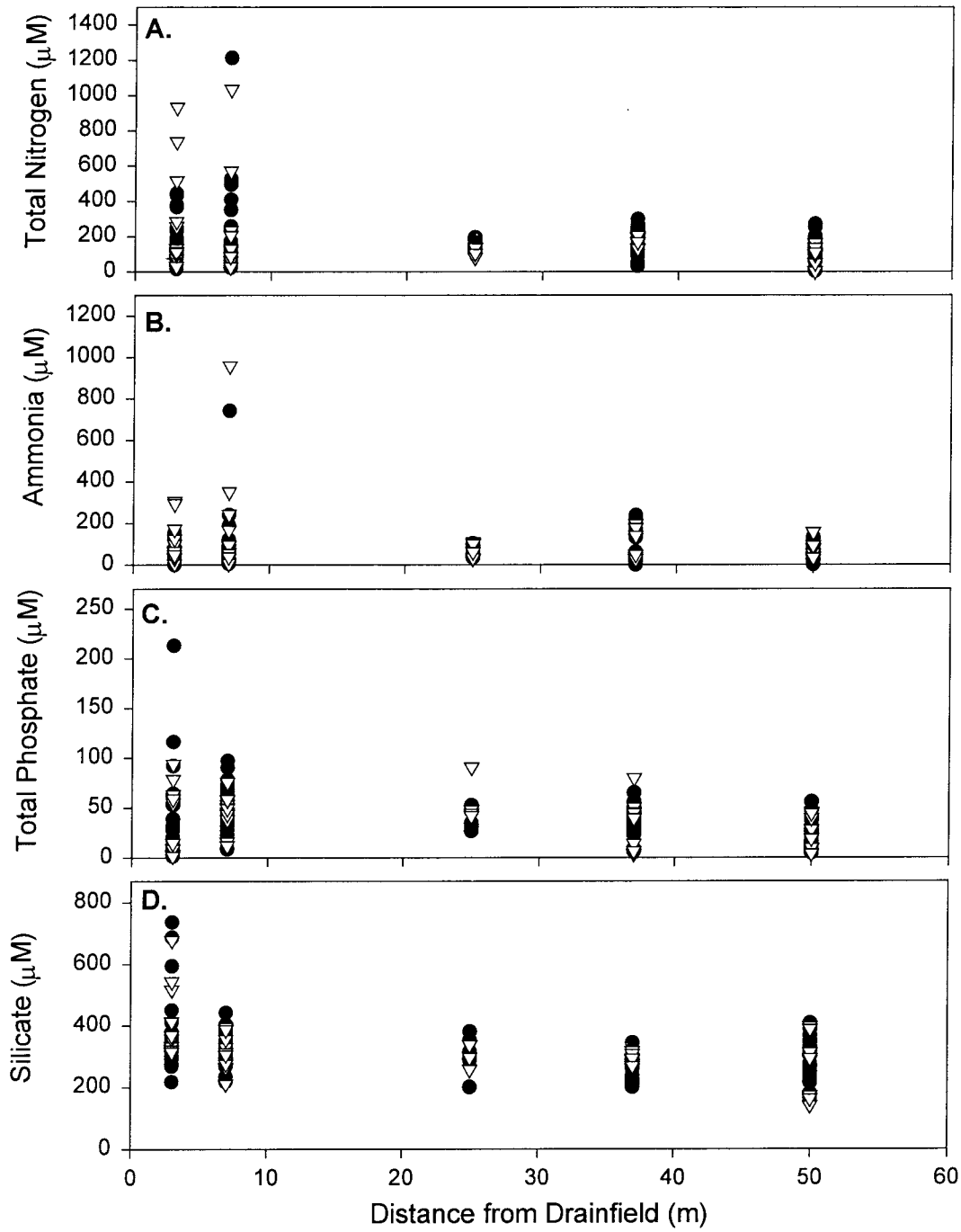


Figure 2.8: Samples collected from the JA site during periods of increased rainfall (open triangles) and low rainfall (closed circles) versus the distance from the wastewater tank. Silicate appears to be the only measured parameter that does not attenuate with distance.

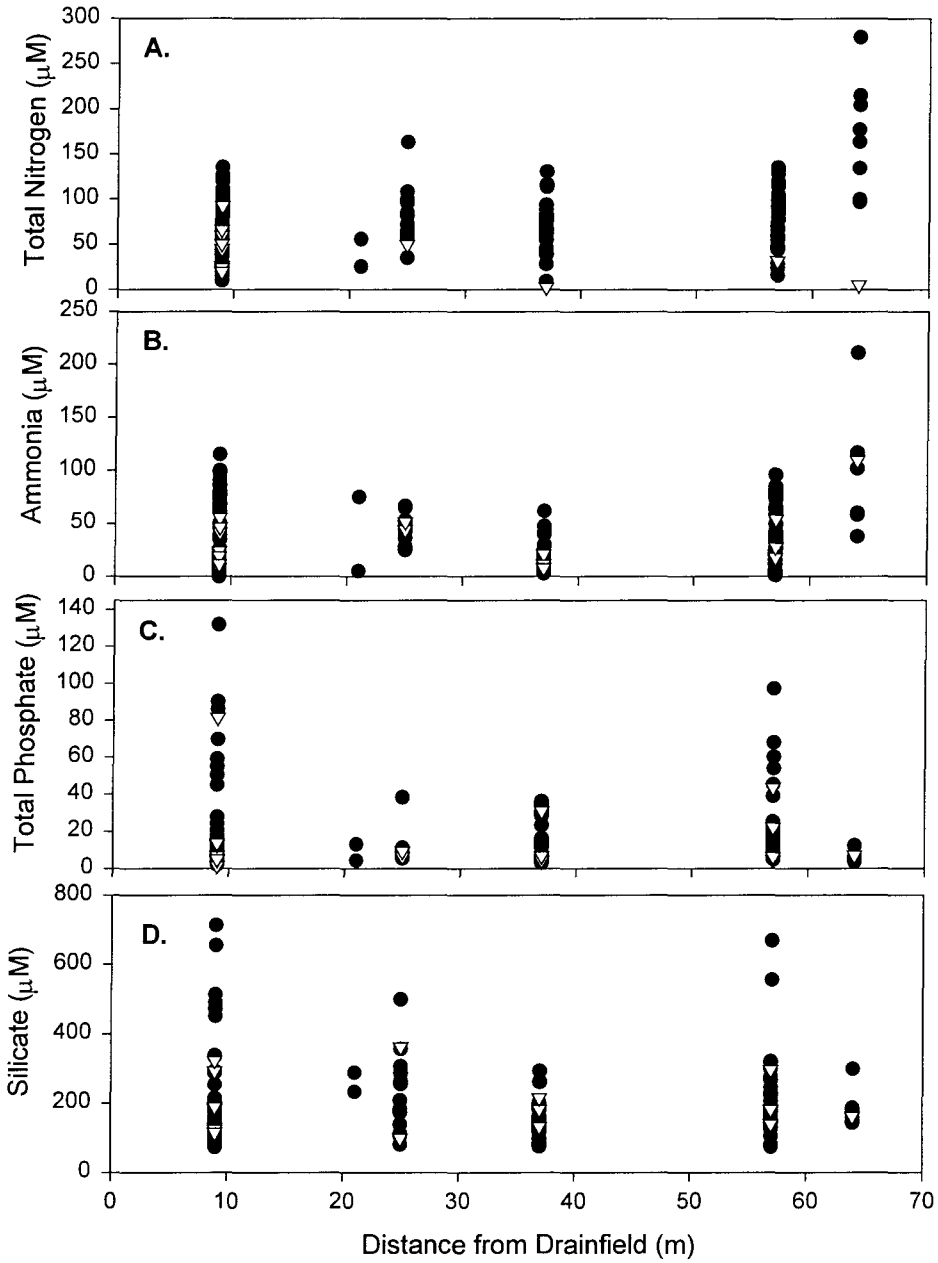


Figure 2.9: Samples collected from the BL site during periods of increased rainfall (open triangles) and low rainfall (closed circles) versus the distance from the wastewater tank. Most nutrients appear to be constant with distance. Note the difference in scale from previous figures.

observed during months with more rain in wells closer to the drainfield (**Fig. 2.7**). As the distance from the drainfield increases, little difference between varying amounts of rain can be identified. At the JA site, the differences in nutrient concentrations during varying amounts of rainfall are slight (**Fig. 2.8**). Higher concentrations near the drainfield were observed during months of both little and increased rainfall. Silicate concentrations varied very little over time and space, with slightly higher concentrations occasionally observed closest to the drainfield. Rainfall appeared to have little effect on silicate concentration throughout the study sites.

Since nearfield wells would have the most rapid response to rain events, nutrient concentrations and fecal coliform counts were plotted with rainfall over the course of the study period at all the sites (**Fig. 2.10**). Average nutrient concentrations and fecal coliform appear to follow the same trend as the rain events at the SP site (**Fig. 2.10 A**). In fact, each component was significantly correlated with rainfall with a p value less than 0.01 ($r>0.6$), except for total phosphate which was not as significant ($r=0.4$, $n=20$, $p=0.09$). The same correlation was not present at the JA site ($r<0.1$, $n=11$, $p>0.5$). Differences between the two sites are probably not associated with seasonal events, but rather due to differences in the type of wastewater treatment system (see below). Artificial tracer data also suggested increased groundwater flow velocities during periods of higher rainfall. Thus, elevated nutrient concentrations during these times result from more rapid transport leading to shorter residence time of the effluent in the drainfield and significantly less chemical and/or biological removal of nutrients from the effluent in the drainfield and aquifer. Therefore, wastewater is more likely to impact surface water bodies during extended periods of increased rainfall, assuming other factors remain the

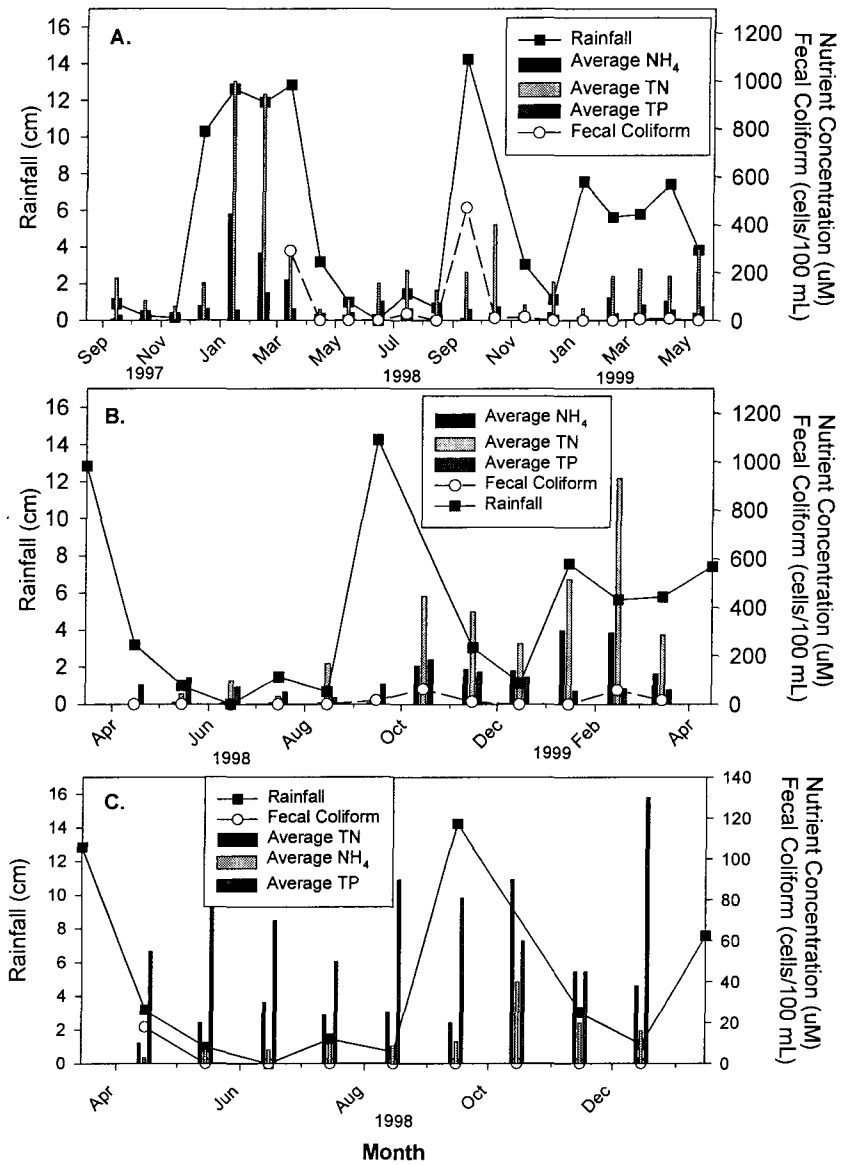


Figure 2.10: Average nutrient concentrations and fecal coliform counts for the nearfield well at the SP (**A**), JA (**B**), and BL (**C**) experimental field sites. The nutrient and fecal coliform measurements are statistically correlated at the SP site, but not at the JA or BL site.

same, i.e., volume of wastewater, nutrient content of effluent, residence time of wastewater in disposal tank, etc.

Samples collected from wells located nearfield and farfield were compared to those collected from the background site to evaluate changes in groundwater quality before discharge into surface waters (**Fig. 2.11 A and B**). Silicate concentrations at the experimental sites are much greater than those observed at the background locations. This indicates some influence from the wastewater at least as far as the furthest monitoring well. As with the silicate, total phosphate concentrations appear to be elevated above background levels in both near- and farfield wells. There is no statistical difference in the average phosphate concentrations of the three different experimental sites. In each case, total phosphate concentration decreased by approximately half the amount of the nearfield well over the distance of the well field. The largest differences in the two well locations can be seen in the total nitrogen and ammonia. Nitrogen concentrations are elevated above background at the SP and JA nearfield wells. At the BL site, total nitrogen and ammonia are within the uncertainty of the background site at both nearfield and farfield wells, indicating rapid removal of nitrogen in the drainfield and/or groundwater (see below). The farfield well at the JA site is the only one that appears to be above the background nitrogen levels, although the data is still within $\pm 2\ \sigma$ uncertainty. Samples collected from surface waters are within the uncertainties for all the nutrients presented from both background and experimental sites. This is more likely due to a large dilution relative to the groundwater discharge, rather than complete removal of the nutrients that were elevated in the farfield wells.

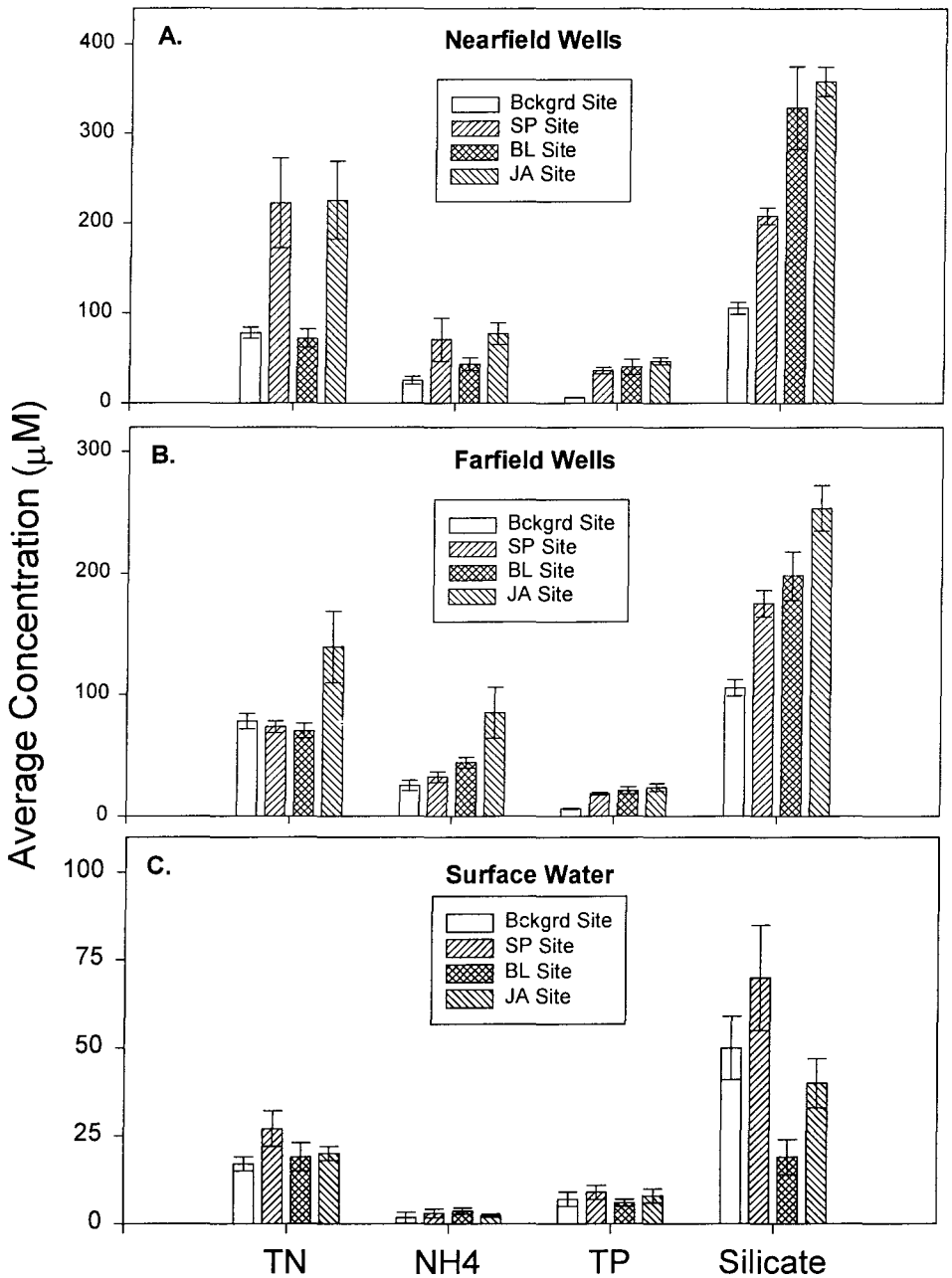


Figure 2.11: Summary of the average nutrient concentrations from experimental and background sites. Wells selected were closest to the drainfield (nearfield) and closest to surface waters (farfield). Surface water samples were collected directly offshore of farfield well. Errors represent one standard deviation around the mean. Note the difference in scales.

Although there is no statistical difference between the total phosphate concentrations in nearfield wells at all experimental sites, there is a statistical difference between BL and the other two sites for total nitrogen and ammonia (**Fig 2.11**). It was originally thought that the JA site would have the lowest nutrient concentrations in the effluent, and thus the surrounding groundwater, since the system has an aerobic treatment system. Aerobic wastewater treatment systems provide a higher level of treatment relative to septic systems (National Small Flows Clearinghouse, 1996). However, the differences observed in the nitrogen species may be attributed to the design of the septic system at the BL site. The septic system and drainfield is raised approximately 1 m above the natural ground surface, allowing the wastewater to spend more time in the vadose zone and preventing inundation of surface waters during large storm events. In a typical septic system, the soil in and directly beneath the drainfield acts as the final treatment step, acting as a biological filter. As the wastewater percolates to the groundwater below, the filtration process and organisms in the soil work together to remove toxins, bacteria, viruses, nutrients, and other pollutants from the wastewater. Raising the drainfield above the natural level by as little as 1 m has apparently reduced the total nitrogen and ammonia concentrations in the nearfield wells to less than 5% of that measured exiting the septic system without a noticeable increase in nitrate or nitrite. In addition, the average total nitrogen concentration observed in the nearfield well is within the uncertainty of the background concentration, while the ammonia is less than 50% higher than the background concentration measured on Little St. George Island. The nearfield wells at the other two sites had very similar nitrogen concentrations, approximately 2-3 times greater than the observed concentrations at the BL site. The

reduction of nitrogen in the drainfield may be attributed to the loss of nitrogen by denitrification or potentially assimilated by bacteria for additional biomass. The exact mechanism for the nitrogen loss cannot be clearly defined using the available data.

Although the aerobic tank on the JA site did not appear to significantly reduce nutrient levels below the traditional septic system, the tank was not working properly throughout the last half of monthly monitoring (Sept. 1998 – Feb. 1999). In early September, Hurricane Georges passed directly over the island, dumping over 5 inches of rain on the island in less than 24 hours. A tidal surge associated with the storm brought water levels high enough to inundate the wastewater system on the JA site. The pump that controlled aeration for the system was destroyed during the storm, along with other property damage. Due to circumstances beyond control, the wastewater system was not properly fixed until late February 1999. As a result, post-hurricane differences in nutrient concentrations are evident in the nearfield wells due to the change in oxygen conditions in the wastewater system (**Fig. 2.12**). The wastewater system probably shifted to anoxic conditions soon after the hurricane, converting the aerobic wastewater treatment system functionally to a septic system. Total nitrogen, ammonia and total phosphate concentrations increased significantly starting in October 1998 and remained elevated, relative to samples collected prior to the hurricane, throughout the study. Total nitrogen concentrations increased more than 40 times of that prior to the storm, while ammonia and total phosphate increased approximately 7 and 2 times, respectively. In fact, total nitrogen and ammonia in the nearfield well, analyzed before the hurricane, were approximately equal to concentrations measured at the background sites. Silicate concentrations remained fairly constant throughout the entire study period, moving

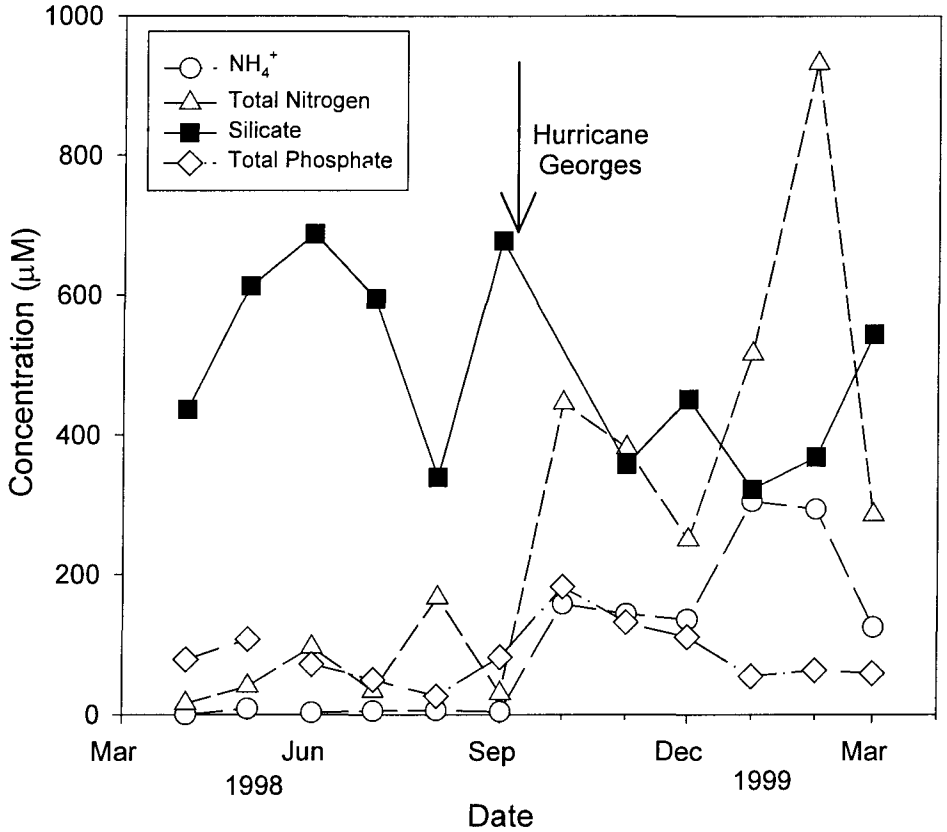


Figure 2.12: Nutrient concentrations measured at the nearfield well at the JA site throughout the study period. Notice the dramatic change in all nutrient concentrations, except silicate, after September 1998. This change is associated with damage to the aerobic system caused by Hurricane Georges which passed directly over the island.

around the mean of 490 ± 42 μM (13.8 ± 1.2 mg L^{-1}). The silicate concentrations indicate little change in the use of the wastewater system. In addition, the homeowner did not indicate any changes in daily activities during this period of time. Therefore, any change in nutrient concentration is assumed to be due to the disruption in the aeration of the wastewater system.

The increase in nutrient concentrations in the nearfield wells could also be attributed to either the inefficiency of anaerobic conditions in reducing the nutrient load before discharge or due to the wastewater tank, which when shifted to anaerobic conditions could not provide the necessary treatment. For instance, if the aerobic tank was slightly smaller than that of a typical septic system required for the size of the household, the residence time of the wastewater in the tank would be shorter. During aerobic conditions, this reduction in residence time does not pose a problem. However, the wastewater may not be properly treated during a period of time when the tank shifts to anaerobic conditions.

The other explanation infers that anaerobic conditions are less effective than aerobic. All residents on St. George Island are currently required to replace any malfunctioning septic system with an aerobic wastewater tank. This was instituted because aerobic systems provide a higher level of treatment, allowing a reduction in drainfield size, and therefore, help to better protect valuable water resources (National Small Flows Clearinghouse, 1996). However, prior to this study there was very little available data supporting this policy on St. George Island or on any other barrier island. Assuming the size of the wastewater tank on the JA site is suitable for anaerobic

conditions, the change in the level of oxygen in the system offers direct evidence toward the benefits of treating wastewater aerobically before release to the environment.

Nutrient Fluxes to Surface Waters

Annual groundwater nutrient contributions to Apalachicola Bay were calculated with estimates of groundwater flow and the groundwater nutrient concentrations at the point of discharge. Corbett et al. (1999) estimated the total amount of groundwater discharging into the bay from the island to be between 3-12 X 10^6 m^3 yr^{-1}. This discharge was estimated from two independent techniques: (1) a mass balance approach which accounted for sources and sinks to the surficial aquifer, assuming 50% of the water discharges into the bay; and (2) groundwater velocity measurements obtained through tracer experiments at two locations on the island and an estimate of the aquifer thickness and length.

Estimating the groundwater nutrient concentration at the point of discharge is typically difficult due to chemical and biological alterations during transit. It is apparent that the nutrient concentrations are significantly reduced as surface waters are approached (**Fig. 2.7-2.8**). As an upper limit of total nitrogen and phosphate concentrations, we used the average of the two wells closest to the surface waters at the JA site (**Fig. 2.8**, 37m and 50m). Total nitrogen and phosphate concentrations observed in these wells over the study period averaged 141 ± 8 and 25 ± 2 μM (2.0 ± 0.1 and 0.8 ± 0.1 mg L^{-1}), respectively. Average concentrations at the other two sites were similar but slightly lower. As a lower limit, we measured nutrient concentrations of interstitial waters directly offshore at all three experimental sites using a "peeper", a close interval

porewater sampling device (Hesslein, 1976). The lowest interstitial total nitrogen concentration was 30 μM (0.4 mg L^{-1}), observed at the BL site. The lowest interstitial total phosphate concentration was 9 μM (0.3 mg L^{-1}), observed at the JA site. A summary of the data used to estimate the nutrient fluxes to the bay is presented in **Table 2.2**.

The total nitrogen flux into Apalachicola Bay ranged between 0.3 and 6.5 mmoles m^{-2} yr^{-1} (3.3 and 78 mg m^{-2} yr^{-1}), accounting for the entire area of the bay, while the total phosphate flux ranged between 0.1 and 1.2 mmoles m^{-2} yr^{-1} (3.1 and 37.2 mg m^{-2} yr^{-1}). Although these nutrient fluxes are a minor fraction that the river provides annually, this is not surprising considering the size of the river and its associated drainage basin. In addition, the nutrient concentrations in the groundwater at the point of discharge at all the experimental sites were approximately equal to or lower than the concentrations at the background sites. Although it is fortunate that these systems remove nutrients effectively, it potentially provides a more conservative estimate of the nutrient contribution to the estuary than intended. Many bar-built estuaries do not have a large river draining directly into the estuary, providing an exuberant amount of nutrients. Ecosystems without a significant source of direct discharge would be more susceptible to alterations in the groundwater input and associated contaminants.

Bacteriological

Total coliforms were typically present in all wells collected each quarter at the background sites (**Table A.15**). Samples collected had total coliforms present as high as 17,000 cells per 100 mL. Fecal coliforms and *E. Coli* were only detected at the

Table 2.2: Estimates of nutrient flux into Apalachicola Bay and the parameters used to calculate them.

	Minimum	Maximum
Groundwater flux (m^3 yr^{-1})	3×10^6	12×10^6
Total Nitrogen Concentration (μM)	30	140
(mg L^{-1})	0.4	1.7
Total Phosphate Concentration (μM)	9	25
(mg L^{-1})	0.3	0.8
Total Nitrogen Flux[1]	0.3	6.5
(mmoles m^{-2} yr^{-1})		
(mg m^{-2} yr^{-1})	3.6	78
Total Phosphate Flux[1]	0.1	1.2
(mmoles m^{-2} yr^{-1})		
(mg m^{-2} yr^{-1})	3.1	37.2

[1]Flux is based on the entire area of Apalachicola Bay (260km^2).

background sites during October 1998, after the passage of Hurricane Georges. The bacteria measured at the background sites must be animal in origin, since there is no human impact on the island.

Total coliforms were also present from majority of the wells sampled from the experimental sites (**Table A.16 – A.18**). Due to the ubiquitous nature of total coliform, further statistical analysis was not performed. Fecal Coliform and *E. Coli* only showed a significant trend with rainfall at the SP site (**Fig. 10**). Fecal coliform and *E. Coli* samples were typically below detection at all sites, indicating rapid attenuation after exiting the OSTDS. E. Coli collected from the effluent exiting the septic system at the SP site were as high as 117,000 cells per 100 mL. Samples collected from the closest monitoring well during the same sampling period had *E. Coli* counts below detection. Surface water samples from experimental sites were not statistically different than the background sites. Bacteria from the OSTDS systems does not appear to have a significant impact on the groundwaters or surface waters relative to the background sites.

OSDS Setback Distance in Sand Aquifers

The State of Florida requires all wastewater systems to be set back approximately 23 m (75 ft) from the mean high tide. Since 1992, all wastewater systems installed or replaced on St. George Island have been aerobic treatment units. It is evident from the data presented here that the aerobic tank is more efficient in removing nutrients than septic systems. However, the setback distance could not be addressed directly, since each of the sites had an OSTDS setback greater than regulations require. It is possible, though,

that the change in nutrient concentrations with distance from the OSTDS (**Fig. 2.7-2.8**) may provide some useful information.

The BL site showed little evidence of change in the nutrient concentrations with distance. As previously noted, the concentrations were already near background levels at the nearfield wells. The SP and JA sites had wells installed 26 and 25 meters from the OSDS, respectively. The total nitrogen concentrations observed in these wells were not significantly different from those further away from the wastewater system. The average total phosphate concentrations observed at the regulation distance were twice as high as those in the farfield wells. Assuming this was near the point of discharge, approximately two times more phosphate would enter surface waters than the above estimate. Although the potential impacts were not assessed, increasing the current setback distance to 50-75 meters may provide enough of a buffering zone to reduce the majority of the nutrients from the wastewater system to background levels.

Summary

Nutrient concentrations monitored downgradient from wastewater disposal systems show significant attenuation before discharge into surface waters. This may suggest that current setback restrictions are adequate at the sites monitored. Silicate was used as a natural conservative tracer, providing insight to the extent of the wastewater plume. Total nitrogen, ammonia, and total phosphate were all attenuated rapidly relative to silicate, indicating very little transport of these nutrients to surface waters.

Nutrient results indicate that the most efficient system would be an aerobic system that was raised above the natural land elevation. A dramatic change in the groundwater

nutrient content was measured at the JA site when the aerobic system malfunctioned, allowing the tank to go anoxic. Both nitrogen and phosphate concentrations more than doubled after this system shifted to anaerobic conditions. However, the septic system at the BL site was raised above the natural ground surface by approximately 1 meter. This raised bed provides additional time and material for the wastewater to filter through before reaching the water table. Although there was little difference in phosphate concentrations at this site, total nitrogen and ammonia were significantly reduced throughout the study site relative to the other sites. Therefore, developing an aerobic system that is raised by as little as 1 m from the natural ground surface on St. George Island would provide the most efficient means for removing contaminants from the wastewater before it is introduced to the groundwater.

Estimates of the total nitrogen flux into Apalachicola Bay from groundwater originating on St. George Island ranged between 0.3 and 6.5 mmoles m^{-2} yr^{-1}. The total phosphate flux ranged between 0.1 and 1.2 mmoles m^{-2} yr^{-1}. This is a conservative estimate since the sites monitored efficiently removed the nutrients before discharge into surface waters. Wastewater systems installed closer to surface waters, as the law allows, may provide substantially more nutrients to surface waters, especially during large rain events.

ACKNOWLEDGEMENTS

This project was funded by the U.S. Environmental Protection Agency, Gulf of Mexico Program, through cooperative agreement No. C MX820886-01-1. This project was supported under an agreement with the Florida Department of Health by funds through Contract No. C0005. The authors wish to thank members of the Research Review and Advisory Committee for their review comments on the final report. In particular, thanks are due to Kevin M. Sherman for his support throughout the project.

We would also like to thank Bo Tapnell, Scott Powell, Greg Smith, Trevor Popp, and Roger Wong for assistance in fieldwork. We would also like to thank the National Park Service on St. George Island, Jay Abbott, and B.L. Cosey for allowing the use of their property to install wells for this research. Lee Edmiston and Chip Bailey at the Apalacicola Natioanl Estuarine Research Reserve provided the use of their equipment and boats and assistance in the field when ever necessary.

Literature Cited

Bitton, G. and C.P. Gerba, 1984. Groundwater Pollution Microbiology. John Wiley and Sons, Inc. New York. 137 pp.

Boggs, J.M., S.C. Young, H.F. Hemond, L. Richardson and M.E. Schaefer, 1988. Evaluation of tracer sampling devices for the macrodispersion experiment. Tennessee Valley Authority, EA-5816.

Bokuniewicz, H, 1980. Groundwater seepage into Great South Bay, New York. Estuarine and Coastal Marine Science, 10, 437-444.

Braman, R.S. and S.A. Hendrix, 1989. Nanogram nitrite and nitrate determination in environmental and biological materials by vanadium (III) reduction with chemiluminescence detection. Anal. Chem. 61, 2715-2718.

Capone, D.G. and M.F. Bautista, 1985. A groundwater source of nitrate in nearshore marine sediments. Nature, 313, 214-216.

Capone, D.G. and J.M. Slater, 1990. Interannual patterns of water table height and groundwater derived nitrate in nearshore sediments. Biogeochemistry, 10, 277-288.

Carr, P.A. and G.S. Van Der Kamp, 1969. Determining aquifer characteristics by the Tidal Method. Water Resources Res. 5, 1023-1031.

Clark, J.F., R. Wanninkhof, P. Schlosser and H.J. Simpson, 1994. Gas exchange rates in the tidal Hudson river using a dual tracer technique. Tellus, 46B, 274-285.

D'Elia, C.F., J.G. Sanders and W.R. Boynton, 1986. Nutrient enrichment studies in a coastal plain estuary: Phytoplankton growth in large-scale continuous cultures. Canad. J. Fish. Aquat. Sci. 43, 397-406.

Domenico, P.A. and F.W. Schwartz, 1990. Physical and Chemical Hydrogeology. John Wiley and Sons, Inc. New York. 824 pp.

Duley, J.W., 1987. Water tracing using a scanning spectrofluorometer for detection of fluorescent dyes. In: Environmental problems in karst terranes and their solution, proceedings, National Water Well Association, Dublin, Ohio, 389-405.

Enright, R.V., 1990. Relating the effects of oceanic tidal loading of a confined aquifer in Sarasota County, Florida, to fluctuations in well-water levels. Masters Thesis, Florida State University, Department of Geology.

Ferris, J.G., 1963. Methods of determining permeability, transmissivity and drawdown. U.S. Geol. Surv. Water Supply Paper 1536-I.

Frick, E.A., G.R. Buell and E.E. Hopkins, 1996. Nutrient sources and analysis of nutrient water-quality data, Apalachicola-Chattahoochee-Flint River basin, Georgia, Alabama, and Florida, 1972-1990. USGS. Water-Resource Investigations Report, 96-4101. Atlanta, Ga.

Fried, J.J. 1975. Groundwater Pollution. Elsevier, New York, 330 pp.

Fu, J-M. and J.W. Winchester, 1994. Sources of nitrogen in three watersheds of northern Florida, USA: Mainly atmospheric deposition. Geochim. Cosmochim. Acta 58, 1581-1590.

Fulmer, J.M., 1997. Nutrient enrichment and nutrient input to Apalachicola Bay, Florida. MSc. Thesis, Florida State University.

Grabedian, S.P., D.R. LeBlanc, L.W. Gelhar and M.A. Celia, 1991. Large-scale natural gradient tracer test in sand and gravel, Cape Cod, Massachusetts: 2. Analysis of spatial moments for a non-reactive tracer. Water Resour. Res. 27, 911-924.

Gaspar, E., 1987. Modern trends in tracer hydrology, vols I and II. CRC Press, Inc., Boca Raton, Florida.

Gelhar, L.W., A Mantogluo, C. Welty and K.R. Rehfeldt, 1985. A review of field-scale physical solute transport processes in saturated and unsaturated porous media, Final Proj. Rep. EPRI EA-4190, Elec. Power Res. Inst., Palo Alto, Calif.

Johannes, R.E., 1980. The ecological significance of the submarine discharge of groundwater. Mar. Ecol. Prog. Ser. 3: 365-373.

Knopman, D.S. and C.I. Voss, 1991. Sampling design for groundwater solute trasport: Tests of methods and analysis of Cape Cod tracer test data. Water Resour. Res. 27, 925-949.

Lapointe, B.E. and J. O'Connell, 1989. Nutrient-enhanced growth of *Cladophora prolifera* in brackish tidal marshes of Chesapeake Bay. Estuarine Coast. Shelf Sci., 21, 45-55.

Lapointe, B.E., J.D. O'Connell and G.S. Garrett, 1990. Nutrient couplings between on-site sewage disposal systems, groundwaters, and nearshore surface waters of the Florida Keys. Biogeochemistry, 10, 289-307.

LeBlanc, D.R., S.P. Garbedian, K.M. Hess, L.W. Gelhar, R.D. Quadri, K.G. Stollenwerk and W.W. Wood, 1991. Large-scale natural gradient tracer test in sand and gravel, Cape Cod, Massachusetts: Experimental design and observed tracer movement. Water Resour. Res. 27, 896-910.

Ledwell, J.R. A.J. Watson and C.S. Law, 1993. Evidence for slow mixing across the pycnocline from an open-ocean tracer-release experiment. Nature, 364, 701-703.

Lee, D.R., J.A. Cherry and J.F. Pickens, 1980. Groundwater transport of a salt tracer through a sandy lakebed. Limnol. Oceanogr. 25, 45-61.

Livingston, R.J., 1984. The Ecology of the Apalachicola Bay system: An estuarine profile. U.S. Dept. of the Interior, Fish and Wildlife Service, FWS/OSB-82/05.

MacIntyre, S., R. Wanninkhof and J.P. Chanton, 1995. Trace gas exchange in freshwater and coastal marine systems: Flux across the air water interface. In *Methods in Ecology: Trace Gases*, P. Matson and R. Harriss (eds.), Blackwell Scientific.

Mas-Pla, J., T.C. Yeh, J.F. McCarthy and T.M. Williams, 1992. A forced gradient tracer experiment in a coastal sandy aquifer, Georgetown Site, South Carolina. Groundwater 30, 958-964.

Millham, N.P. and B.L. Howes, 1995. A comparison of methods to determine K in a shallow coastal aquifer. Groundwater 33, 49-57.

Mortazavi, B., R.L. Iverson, W. Huang, G.F. Lewis and J.M. Caffrey, 1999a. Nitrogen budget of Apalachicola Bay: a bar-built, subtropical estuary in the northeastern Gulf of Mexico. Submitted to Mar. Ecol. Prog. Ser.

Mortazavi, B., R.L. Iverson, W.M. Landing and W. Huang, 1999b. Phosphorous budget of Apalachicola Bay: a river dominated estuary in the northeastern Gulf of Mexico. Submitted to Mar. Ecol. Prog. Ser.

National Small Flows Clearinghouse, 1996. Home aerobic wastewater treatment: An alternative to septic systems. Pipeline, 7, 1-8.

Nixon, S.W., 1992. Nutrient dynamics and the productivity of coastal marine waters. In: R. Halwagy, D. Clayton, and M. Behbehani (eds.). The Marine Environment and Pollution. The Alden Press, Oxford. Pp. 97-115.

Nixon, S.W., 1992. Quantifying the relationship between nitrogen input and the productivity of marine ecosystems. Proceedings of the Advanced Marine Technical Conference. 5, 57-83.

Pickens, J.F. and G.E. Grisak, 1981. Scale-dependent dispersion in a stratified granular aquifer. Water Resour. Res. 17, 1191-1211.

Pickens, J.F., J.A. Cherry, G.E. Grisak, W.F. Merritt and B.A. Risto, 1978. A multilevel device for groundwater sampling and piezometric monitoring. Groundwater 16, 322-327.

Porter, B., 1985. The relationship between Apalachicola Bay water quality and septic system installations in the coastal zone, with applications to other estuaries. Dept. of Natural Resources. Shellfish Environmental Assessment Section.

Porter, B and R.L. Thompson, 1986. Preliminary study describing the movement of a conservative tracer in groundwater on St. George Island adjacent to Apalachicola Bay. Dept. of Natural Resources. Shellfish Environmental Assessment Section.

Pujo-Pay, M. and P. Raimbault, 1994. Improvement of the wet-oxidation procedure for simultaneous determination of particulate organic nitrogen and phosphorous collected on filters. Mar. Ecol. Prog. Ser. 105, 203-207.

Quinlan, J.F., 1989. Groundwater monitoring in karst terrains: Recommended protocols and implicit assumptions. U.S. Environmental Protection Agency, Las Vegas, EPA/600/x-89/050.

Reich, C.D., 1993. Groundwater flow at Long Key, Florida Keys: A dye tracer study. Ms. Sc. Thesis, University of South Florida.

Robertson, W.D., J.A. Cherry and E.A. Sudicky, 1991. Groundwater Contamination from two small septic systems on sand aquifers. Groundwater 29, 82-92.

Schultz, G. and C. Ruppel, 1999. Mapping and monitoring of the spatio-temporal variation in a tidally forced coastal aquifer system. EOS, May, 1999.

Smart, P.L. and I.M.S. Laidlaw, 1977. An evaluation of some fluorescent dyes for water tracing. Water Resour. Res. 13, 15-33.

Smart, P.L., 1984. A review of toxicity of twelve fluorescent dyes used for water tracing. NSS Bulletin 46, 21-33.

Stickland and Parsons, 1972. A Practical Handbook of Seawater Analysis. Ottawa, Fisheries Research Board of Canada, 310 p.

Theis, C.V., 1963. Hydrologic phenomena affecting the use of tracers in timing groundwater flow. In Radioisotopes in Hydrology, IAEA, pp. 193-206.

Upstill-Goddard, R.C., A.J. Watson, P.S. Liss and M.I. Liddicoat, 1990. Gas transfer velocites in lakes measured with SF_6. Tellus 42B, 364-377.

Upstill-Goddard, R.C., A.J. Watson, J. Wood and M.I. Liddicoat, 1991. SF_6 and He^3 as sea-water tracers: deployment techniques and continuous underway analysis for SF_6. Anal. Chim. Acta 249, 555-562.

Upstill-Goddard, R.C. and C.S. Wilking, 1995. The potential of SF_6 as a geothermal tracer. Water Res. 29, 1065-1068.

Vacher, H.L., 1988. Dupuit-Ghyben-Herzberg analysis of strip-island lenses. Geol. Soc. Am. Bull. 100, 580-591.

Valiela, I., J.M. Teal, S. Volkmann, D. Shafer and E.J. Carpenter, 1978. Nutrient and particulate fluxes in a salt marsh ecosystem: Tidal exchanges and inputs by precipitation and groundwater. Limnol. Oceanogr. 23, 798-812.

Valiela, I. and J.M. Teal, 1979. The nitrogen budget of a salt marsh ecosystem. Nature 280, 652-656.

Valiela, I., J. Costa, K. Foreman, J.M. Teal, B. Howes and D. Aubrey, 1990. Transport of water-borne nutrients from watersheds and their effects on coastal waters. Biogeochemistry 10, 177-198.

Van der Veer, P., 1977. Analytical solution for steady interface flow in a coastal aquifer involving a phreatic surface with precipitation. J. Hydrol. 34, 1-11.

Wanninkhof, R., J.R. Ledwell and W.S. Broecker, 1985. Gas exchange - wind speed relationship measured with sulfur hexafluoride on a lake. Science 227, 1224-1226.

Wanninkhof, R., J.R. Ledwell, W.S. Broecker and M. Hamilton, 1987. Gas exchange on Mono Lake and Crowley Lake, California. Jour. Geophys. Res. 92, 14567-14580.

Wanninkhof, R., J.R. Ledwell and A.J. Watson. 1991. Analysis of sulfur hexafluoride in seawater. J. Geophysical Research 96:C5, 8733-8740.

Watson A.J., R.C. Upstill-Goddard and P.S. Liss, 1991. Gas exchange in rough and stormy seas measured with a dual tracer technique. Nature 349, 145-147.

Webb, K.L. and Eldridge, 1987. Nutrient limitation studies in a coastal plain estuary: Seasonal and salinity effects. EOS 68, 1689.

Weiskel, P.K. and B.L. Howes, 1992. Differential transport of sewage-derived nitrogen and phosphorous through a coastal watershed. Env. Sci. Technol. 26, 352-360.

Wilson R.D. and D.M. Mackay, 1993. The use of SF_6 as a conservative tracer in a saturated sandy media. Groundwater, 31, 719-724.

Zou, S. and A. Parr, 1994. Two-dimensional dispersivity estimation using tracer experiment data. Groundwater 32, 367-373.

Table A.11: Nutrient samples collected from groundwaters and surface waters at the SP Site on St. George Island between September, 1997 and May, 1999. Samples were analyzed for Ammonium (NH_4^+), Nitrite (NO_2), nitrate + nitrite (NN), Total Nitrogen (TN), soluble reactive phosphate (PO_4), Total Phosphate (TP) and Silicate (Si). All nutrient concentrations are reported in μM.

Sample Name	Date	NH_4^+	NO_2	NN	TN	PO_4	TP	Si
1	9/1/97	18.0	0.1	0.1	76.2	14.0	13.8	
1 Fld. Dup.	9/1/97	18.9	0.2	BD	76.2	12.3	12.3	
2	9/1/97	20.8	0.7	BD	124.0	22.7	24.1	
3	9/1/97	4.0	0.2	BD	26.7	5.1	4.7	
4	9/1/97	11.2	1.4	0.1	180.3	7.4	7.5	
5	9/1/97	4.1	BD	0.1	143.8	8.9	8.2	
5 Unfiltered	9/1/97	3.9	BD	0.1	127.6	7.8	8.4	
6	9/1/97	22.1	0.3	0.1	56.7	1.4	2.2	
7	9/1/97	8.7	BD	0.1	74.1	16.2	16.7	
8	9/1/97	11.3	BD	BD	78.1	16.4	18.9	
9	9/1/97	13.1	-0.0	0.1	61.6	22.5	21.3	
10	9/1/97	108.6	0.3	0.2	310.8	30.7	39.1	
11	9/1/97	131.9	BD	0.1	837.9	37.6	34.9	
12	9/1/97	5.8	BD	0.1	91.5	20.9	20.5	
12 Fld. Dup.	9/1/97	6.0	0.2	0.1	86.0	19.6	19.6	
12 Unfiltered	9/1/97	5.4	0.1	0.1	92.9	20.5	20.4	
13-3	9/1/97	15.9	0.2	1.0	139.7	8.0	9.0	
13-5	9/1/97	7.4	0.8	0.5	251.6	16.7	16.7	
14-1	9/1/97	12.5	0.2	0.1	36.5	9.6	10.0	
14-2	9/1/97	10.0	0.1	0.1	41.3	11.8	13.2	
14-2 Unfiltered	9/1/97	8.7	BD	0.3	53.0	15.5	14.1	
14-3	9/1/97	6.9	0.2	0.2	106.6	14.5	14.0	
14-4	9/1/97	6.8	0.0	0.3	54.5	50.6	45.5	
14-5	9/1/97	0.2	8.3	129.5	143.2	39.2	35.1	
14-5 Unfiltered	9/1/97	0.0	8.2	107.2	132.3	39.2	36.0	
14-6	9/1/97	9.2	0.3	36.2	121.7	21.7	22.2	
14-7	9/1/97	0.8	22.5	622.6	740.5	9.7	11.3	
15-1	9/1/97	16.9	0.1	0.2	114.8	23.8	28.5	
15-1 Fld. Dup.	9/1/97	16.9	0.1	0.1	114.7	27.8	26.4	
15-6	9/1/97	6.7	0.1	0.1	93.0	11.2	13.9	
16-2	9/1/97	51.8	0.1	0.0	77.3	7.3	8.5	
16-2 Fld. Dup.	9/1/97	46.1	0.0	1.6	0.0	7.6	9.0	

Table A.11 cont.

17-1	9/1/97	17.8	BD	0.1	64.8	11.7	13.7	
17-5	9/1/97	8.4	BD	0.1	47.0	11.1	11.7	
18-1	9/1/97	2.8	BD	BD	150.8	21.5	21.2	
18-6	9/1/97	3.2	BD	0.1	18.9	6.9	6.1	
19-2	9/1/97	32.1	0.1	0.1	58.2	5.3	7.3	
19-6	9/1/97	6.3	0.1	0.1	44.0	12.7	12.4	
20-1	9/1/97	30.5	0.2	0.1	66.7	6.4	6.0	
20-2	9/1/97	31.2	0.1	0.1	69.7	5.5	6.5	
20-3	9/1/97	41.2	0.1	0.1	79.1	5.9	6.2	
20-4	9/1/97	28.8	0.0	0.1	69.2	3.1	4.0	
20-5	9/1/97	24.7	0.2	0.1	70.2	2.3	2.8	
20-6	9/1/97	25.3	0.1	0.1	66.0	2.0	2.2	
20-7	9/1/97	23.7	0.3	BD	62.2	1.7	2.2	
9 Lab Dup.	9/1/97	13.1	BD	0.3	48.6	20.4	21.9	
10 Lab Dup.	9/1/97	41.9	0.1	0.5	317.0	31.3	38.8	
12 Lab Dup.	9/1/97	5.6	BD	0.2	84.0	17.5	21.0	
Fld Blank #2	9/1/97	BD	BD	0.1	BD	BD	BD	
Fld. Blank #1	9/1/97	BD	BD	0.3	BD	BD	BD	
Surface	9/1/97	0.4	BD	1.0	25.6	0.3	6.3	
Surface Unfiltered	9/1/97	0.7	BD	0.3	27.2	0.2	6.1	
1	10/1/97	17.4	0.3	0.3	52.2	7.2	8.6	148.6
2	10/1/97	14.3	BD	0.2	106.2	26.9	27.5	141.5
3	10/1/97	3.2	BD	0.3	27.0	3.5	3.5	166.7
4	10/1/97	7.2	1.1	0.5	171.5	6.9	8.0	98.7
5	10/1/97	4.0	BD	0.5	107.6	5.1	5.6	98.3
5 Fld. Dup.	10/1/97	1.6	0.1	0.2	128.7	6.3	6.9	104.8
6	10/1/97	14.3	0.0	0.1	106.1	1.2	1.6	107.2
7	10/1/97	8.2	BD	0.1	51.8	16.1	17.2	202.9
7 Fld. Dup.	10/1/97	7.8	BD	0.5	53.0	15.1	17.6	203.6
8	10/1/97	9.4	BD	0.5	60.1	19.1	21.0	200.4
9	10/1/97	10.0	BD	0.2	46.8	27.9	27.8	189.4
10	10/1/97	105.7	BD	0.1	95.2	43.9	40.8	231.1
11	10/1/97	129.0	BD	0.1	722.3	54.6	46.9	254.0
13-3	10/1/97	10.6	0.1	0.3	122.0	7.8	9.8	163.6
13-6	10/1/97	7.2	BD	0.4	143.6	18.3	22.2	185.3
13-9	10/1/97	6.7	BD	0.4	68.2	12.9	15.0	185.2
13-11	10/1/97	5.5	BD	0.3	46.8	11.7	13.2	196.7
14-1	10/1/97	8.7	BD	0.1	92.5	12.5	11.4	209.1

Table A.11 cont.

14-3	10/1/97	4.8	BD	0.2	53.3	11.0	14.0	209.0
14-5	10/1/97	10.5	BD	0.1	132.6	61.5	53.4	159.8
14-7	10/1/97	1.9	0.2	1.7	51.9	15.8	19.1	238.7
15-1	10/1/97	13.6	0.2	0.2	115.7	35.2	34.3	129.0
15-3	10/1/97	18.1	BD	0.2	64.8	19.7	21.7	222.0
15-5	10/1/97	10.2	BD	0.1	70.2	10.6	13.3	223.9
15-7	10/1/97	4.6	0.1	0.1	90.3	14.5	17.6	241.8
16-1	10/1/97	24.5	BD	0.1	96.9	6.8	10.8	239.6
16-2	10/1/97	19.0	BD	0.1	73.1	7.3	11.0	158.8
16-2 Fld. Dup.	10/1/97	17.4	BD	BD	71.8	7.4	10.5	157.3
16-4	10/1/97	14.7	BD	0.1	76.0	30.8	32.3	143.8
17-1	10/1/97	11.7	BD	0.1	75.8	13.2	17.4	188.4
17-3	10/1/97	10.3	BD	0.1	63.2	15.9	18.7	225.1
17-5	10/1/97	5.2	BD	0.1	61.3	12.7	14.5	228.0
17-7	10/1/97	4.8	0.2	0.1	84.5	36.0	35.0	244.1
18-1	10/1/97	5.5	0.3	0.2	140.1	21.4	23.3	178.3
18-3	10/1/97	3.0	BD	0.2	64.3	16.0	18.7	221.8
18-5	10/1/97	4.0	BD	0.1	38.4	9.0	10.3	217.5
18-7	10/1/97	3.4	BD	0.1	12.6	8.0	8.6	238.1
Surface	10/1/97	0.4	BD	0.2	15.6	1.3	13.5	28.4
Tap	10/1/97	0.3	BD	2.1	8.6	1.3	1.4	334.7
Septic	10/1/97	124.2	BD	3.0	2906.7	196.0	54.3	348.4
14-3 Lab Dup.	10/1/97	5.2	BD	BD	56.2	10.0	14.0	206.5
15-7 Lab Dup.	10/1/97	4.1	0.2	BD	91.0	16.0	17.4	238.1
18-1 Lab Dup.	10/1/97	4.9	0.4	BD	143.1	20.1	22.9	180.0
Fld. Blank #1	10/1/97	BD	0.2	0.1	0.9	1.1	1.0	0.1
Fld Blank #2	10/1/97	BD	0.2	0.1	1.2	1.2	1.0	BD
1	11/1/97	34.1	0.0	0.5	52.8	4.5	5.9	151.7
2	11/1/97	25.4	0.2	0.4	138.8	27.5	29.4	192.5
3	11/1/97	5.8	0.2	0.2	43.8	1.8	5.0	173.1
4	11/1/97	18.8	1.1	0.2	178.9	6.8	7.1	113.5
5	11/1/97	6.0	0.3	0.2	129.2	4.6	4.4	107.1
6	11/1/97	7.6	0.2	0.5	108.7	1.0	BD	149.1
7	11/1/97	3.5	0.0	0.5	30.3	9.9	12.4	180.9
8	11/1/97	11.1	0.1	0.3	62.0	14.0	19.3	200.0
9	11/1/97	15.3	0.1	0.1	56.2	21.8	24.0	200.3
10	11/1/97	174.3	0.2	0.1	444.0	39.0	38.6	240.2
11	11/1/97	157.8	0.1	0.1	866.7	43.4	36.1	280.5

Table A.11 cont.

11 Fld Dup	11/1/97	156.7	0.2	0.1	843.0	42.7	45.1	274.3
13-6	11/1/97	6.8	0.3	0.2	157.5	19.7	25.2	188.4
13-11	11/1/97	7.3	BD	0.1	36.9	10.2	12.7	205.4
13-13	11/1/97	13.2	0.8	0.1	157.0	7.5	10.9	142.2
14-1	11/1/97	19.6	0.2	0.1	44.3	8.9	BD	214.2
14-4	11/1/97	23.4	0.2	BD	66.3	41.2	28.5	158.7
14-7	11/1/97	8.7	BD	0.1	63.6	41.9	39.3	264.7
15-1	11/1/97	15.4	0.6	0.1	155.5	31.7	37.0	126.4
15-4	11/1/97	22.7	0.4	0.1	94.9	16.0	19.9	244.8
15-7	11/1/97	8.8	0.0	0.1	60.2	16.1	19.7	241.3
17-1	11/1/97	13.7	0.4	0.1	131.2	11.9	17.0	193.2
17-4	11/1/97	13.3	BD	0.1	47.3	10.3	13.0	190.7
17-7	11/1/97	2.7	BD	0.1	97.2	32.4	37.9	216.7
21-1	11/1/97	43.7	BD	0.1	80.5	22.9	22.2	146.3
21-4	11/1/97	153.8	BD	0.1	738.9	47.3	40.1	176.3
21-7	11/1/97	56.2	BD	0.1	2316.5	102.1	75.0	262.9
25-1	11/1/97	35.1	0.2	0.0	80.4	9.1	15.1	154.1
25-4	11/1/97	16.8	0.5	0.1	176.6	28.5	30.6	198.5
25-7	11/1/97	4.2	0.1	0.1	140.4	34.1	37.4	230.3
B1-1	11/1/97	14.9	0.1	0.1	108.8	6.4	8.8	95.0
B1-4	11/1/97	BD	0.5	0.1	183.7	13.3	15.3	68.5
B1-7	11/1/97	BD	BD	0.1	88.2	4.1	5.4	81.5
B2-1	11/1/97	52.1	BD	0.1	102.0	4.2	4.3	146.1
B2-4	11/1/97	40.1	BD	0.2	92.5	2.8	3.7	141.1
B2-4 Fld Dup	11/1/97	47.4	BD	0.1	100.9	2.9	3.7	131.4
B2-7	11/1/97	BD	1.6	0.1	165.3	7.1	5.1	108.4
Surface	11/1/97	1.0	BD	1.0	14.3	1.4	1.1	37.0
4 Lab Dup.	11/1/97	34.8	1.6	0.1	204.5	6.8	7.2	99.7
14-1 Lab Dup.	11/1/97	38.2	0.1	0.1	47.2	9.6	10.9	179.1
25-7 Lab Dup.	11/1/97	4.1	0.2	0.1	145.5	33.4	34.0	200.9
Fld. Blank #1	11/1/97	0.4	BD	BD	-7.2	1.4	0.7	0.5
Fld Blank #2	11/1/97	BD	BD	BD	-7.2	1.5	0.5	0.5
1	12/1/97	50.7	BD	0.1	38.7	4.3	9.3	159.0
2	12/1/97	20.3	BD	0.1	85.5	31.0	33.2	198.2
3	12/1/97	1.5	0.2	0.1	55.9	2.4	4.4	201.0
4	12/1/97	19.3	1.1	0.1	115.8	3.8	7.4	108.5
5	12/1/97	10.6	0.6	0.2	75.1	2.9	6.2	97.3
6	12/1/97	4.1	BD	0.3	103.6	2.0	2.3	158.1

Table A.11 cont.

7	12/1/97	0.2	BD	0.3	44.1	7.5	12.2	236.7
8	12/1/97	6.3	BD	0.2	39.9	13.0	20.5	219.9
9	12/1/97	12.2	0.0	0.2	45.7	21.3	24.3	206.5
9 dup	12/1/97	12.2	0.0	0.3	44.6	17.0	23.3	208.4
10	12/1/97	75.7	0.4	0.2	230.0	35.5	43.4	263.9
11	12/1/97	302.4	0.1	0.2	1114.4	58.1	59.7	326.8
13-3	12/1/97	12.8	1.7	0.2	120.0	12.2	17.4	156.0
13-6	12/1/97	7.4	0.5	0.2	72.0	13.7	24.2	204.6
13-9	12/1/97	8.3	BD	0.1	30.7	8.2	12.8	214.2
14-1	12/1/97	12.1	0.1	0.1	45.3	6.9	13.5	203.0
14-3	12/1/97	40.0	0.0	0.1	60.0	17.5	26.4	193.8
14-5	12/1/97	171.9	0.7	104.7	392.8	85.3	91.5	260.9
14-7	12/1/97	17.1	10.6	58.1	123.0	62.7	62.6	248.4
14-7 dup	12/1/97	6.2	10.7	60.0	122.7	62.0	63.7	247.9
15-1	12/1/97	11.3	2.3	0.1	116.3	34.5	49.1	138.1
15-3	12/1/97	19.4	0.5	0.2	63.2	11.4	19.9	227.9
15-5	12/1/97	14.4	0.8	0.1	89.6	9.9	18.7	212.4
15-7	12/1/97	7.6	0.6	0.1	52.3	8.8	18.3	219.6
16-1	12/1/97	21.2	0.2	0.1	92.4	2.8	10.5	265.3
16-1 dup	12/1/97	16.8	0.1	0.1	91.4	2.9	10.6	270.4
16-4	12/1/97	BD	0.3	0.1	101.9	45.0	46.9	158.3
16-5	12/1/97	301.7	0.2	0.1	759.4	79.1	85.7	296.5
17-1	12/1/97	12.7	0.8	0.0	66.1	9.7	17.0	211.2
17-3	12/1/97	8.0	0.1	0.0	41.3	12.8	18.3	254.4
17-5	12/1/97	11.7	0.2	0.0	39.9	16.3	21.8	266.8
17-7	12/1/97	1.5	0.3	0.0	79.9	38.4	39.3	233.8
18-1	12/1/97	19.0	0.2	0.0	37.3	8.9	14.0	164.4
18-1 dup	12/1/97	19.1	0.4	0.0	37.3	8.4	13.1	166.0
18-4	12/1/97	1.5	0.1	0.0	10.1	6.7	11.7	295.5
18-7	12/1/97	BD	0.1	0.1	13.9	10.2	16.1	299.4
19-1	12/1/97	51.2	0.1	0.1	66.5	4.6	11.2	176.4
19-4	12/1/97	34.7	0.1	0.1	51.9	6.5	12.8	190.2
19-7	12/1/97	21.0	0.2	0.1	41.1	7.0	14.2	232.3
20-1	12/1/97	33.8	0.1	0.1	51.2	3.6	19.4	159.6
20-4	12/1/97	31.4	0.1	0.1	52.3	1.8	-0.4	147.1
20-7	12/1/97	18.2	0.4	0.1	54.9	0.9	2.2	141.9
21-1	12/1/97	51.7	0.1	0.1	64.7	20.6	23.6	157.4
21-4	12/1/97	323.9	0.1	0.2	944.6	50.4	50.2	212.1

Table A.11 cont.

21-7	12/1/97	393.7	BD	0.1	1133.3	46.9	53.0	318.1
22-1	12/1/97	24.5	0.2	0.1	51.3	4.8	9.7	144.2
22-1 dup	12/1/97	27.0	0.1	0.1	51.6	4.6	8.3	139.5
22-4	12/1/97	2.5	BD	0.3	8.1	4.5	7.6	332.0
22-7	12/1/97	3.9	0.1	0.1	BD	8.9	15.2	223.2
23-1	12/1/97	91.6	BD	0.1	105.9	8.7	15.4	209.6
23-3	12/1/97	55.1	BD	0.1	69.7	22.9	24.2	179.3
23-5	12/1/97	72.0	0.1	0.2	98.1	52.8	48.5	173.5
23-7	12/1/97	406.8	0.1	0.1	2595.6	103.2	115.8	270.4
23-7 dup	12/1/97	400.6	0.1	0.1	2595.4	106.3	155.1	270.5
24-1	12/1/97	46.5	BD	0.1	69.9	3.8	3.7	174.1
24-4	12/1/97	9.4	0.2	0.1	47.8	16.4	14.5	160.6
24-7	12/1/97	4.7	0.2	BD	57.0	9.6	12.3	226.2
25-1	12/1/97	45.8	0.1	BD	73.1	6.5	8.3	150.0
25-4	12/1/97	30.3	0.7	BD	120.1	23.9	30.0	211.1
25-7	12/1/97	3.7	0.5	0.1	92.6	54.0	47.6	267.2
Tap water	12/1/97	BD	0.1	2.0	11.5	BD	BD	384.8
Surface	12/1/97	1.6	0.1	10.6	24.9	BD	0.3	88.4
Septic	12/1/97	178.3	0.4	0.5	2206.4	264.2	207.3	409.1
BLK 1	12/1/97	BD	BD	0.1	0.5	0.2	0.1	0.3
BLK 2	12/1/97	BD	BD	0.1	0.0	BD	BD	BD
13-6 lab dup	12/1/97	10.9	0.5	0.1	74.4	17.7	20.1	203.4
11 lab dup	12/1/97	311.2	0.2	0.1	1084.8	61.9	62.6	327.9
17-3 lab dup	12/1/97	16.1	0.1	0.1	45.4	14.6	17.6	257.9
20-4 lab dup	12/1/97	31.3	0.1	0.1	56.6	2.9	3.2	148.6
23-5 lab dup	12/1/97	70.0	0.1	0.2	101.3	54.7	43.8	174.6
1	1/1/98	23.5	0.3	0.5	49.1	8.0	10.0	158.3
2	1/1/98	10.3	0.6	0.2	112.9	43.4	36.2	233.7
3	1/1/98	1.8	0.7	0.1	67.3	3.5	4.3	175.1
3 dup	1/1/98	1.9	0.8	0.2	66.8	2.8	4.3	173.6
4	1/1/98	21.0	1.8	0.0	114.8	4.7	5.7	121.1
5	1/1/98	17.2	1.8	0.4	142.1	3.4	6.1	101.7
6	1/1/98	6.4	2.4	0.7	121.6	3.9	1.8	160.2
7	1/1/98	-0.2	0.3	0.1	46.5	12.1	13.2	226.7
8	1/1/98	1.1	0.5	0.3	90.8	13.1	13.2	231.7
8 dup	1/1/98	1.6	0.9	0.4	93.5	14.0	18.0	236.1
9	1/1/98	8.4	0.6	0.2	84.3	14.4	19.6	210.2
11	1/1/98	607.1	0.6	0.2	930.2	74.5	48.5	337.2

Table A.11 cont.

13-3	1/1/98	19.9	3.0	0.2	120.7	11.9	16.1	175.4
13-8	1/1/98	7.8	0.3	0.2	54.5	9.0	11.5	198.4
13-14	1/1/98	-0.8	0.5	0.3	68.0	5.0	7.7	127.2
14-1	1/1/98	18.0	0.9	0.1	111.3	7.6	14.2	200.3
14-4	1/1/98	0.4	1.2	364.1	362.1	53.4	37.8	252.5
14-4 dup	1/1/98	1.3	1.3	361.2	363.9	54.7	39.8	250.7
14-7	1/1/98	1314.1	0.5	70.4	2515.2	70.9	85.3	390.7
15-1	1/1/98	16.8	1.4	0.2	135.5	28.2	31.8	184.6
15-4	1/1/98	4.5	0.6	0.1	62.0	11.8	17.2	281.6
15-7	1/1/98	0.2	0.6	0.2	112.8	59.0	42.1	223.5
16-2	1/1/98	52.3	0.3	0.3	75.1	6.7	8.9	155.3
16-5	1/1/98	256.5	0.3	0.1	271.3	75.0	50.9	340.0
17-1	1/1/98	17.6	0.5	0.1		13.9	15.5	246.6
17-4	1/1/98	3.3	0.4	0.2	61.2	16.7	19.7	323.6
17-7	1/1/98	BD	0.9	0.1	82.1	26.3	30.6	145.9
18-2	1/1/98	2.7	0.3	0.1	296.8	7.7	7.9	133.0
18-5	1/1/98	BD	0.3	0.1	24.6	3.7	5.3	329.6
19-2	1/1/98	65.6	0.3	0.1	79.2	4.1	10.0	179.7
19-5	1/1/98	51.5	0.3	0.1	65.7	6.9	10.4	165.2
20-2	1/1/98	37.7	0.5	0.1	64.9	3.9	6.4	156.1
20-5	1/1/98	27.9	0.6	0.0	58.3	1.6	2.0	130.4
21-2	1/1/98	60.9	0.5	0.1	132.1	47.4	39.9	166.1
21-5	1/1/98	428.2	0.4	0.0	1175.1	50.2	64.0	328.7
21-5 dup	1/1/98	388.6	0.4	0.1	1589.0	53.3	65.8	326.8
22-2	1/1/98	11.8	0.3	0.1	31.4	8.6	10.3	191.8
22-5	1/1/98	BD	0.3	0.1	21.5	6.1	7.1	296.3
23-2	1/1/98	99.8	0.2	0.0	115.5	11.6	14.9	189.4
23-5	1/1/98	60.7	0.4	0.0	89.8	60.3	38.9	171.5
24-2	1/1/98	9.6	0.4	0.1	42.1	9.4	11.6	144.6
24-5	1/1/98	3.1	0.4	0.2	16.5	6.2	6.6	305.2
25-2	1/1/98	59.0	1.0	0.2	872.2	27.2	28.6	208.7
25-5	1/1/98	21.6	0.9	0.2	823.8	45.5	31.9	301.6
BLK post	1/1/98	BD	0.3	0.1	0.6	0.2	0.1	4.1
BLK post dup	1/1/98	BD	0.2	0.1	0.9	-0.2	-0.3	2.1
BLK pre	1/1/98	BD	0.2	0.2	2.2	-0.2	-0.1	2.3
10	1/1/98	76.1	1.5	0.2	211.3	32.7	35.0	203.7
Surface	1/1/98	0.8	0.4	3.6	22.4	0.2	5.6	51.2
18-5 dup	1/1/98	BD	0.3	0.1	23.1	3.9	5.3	328.0

Table A.11 cont.

11 lab dup	1/1/98	714.8	0.5	BD	1183.0	62.5	48.6	341.5
18-2 lab dup	1/1/98	2.7	0.3	BD	92.5	7.8	8.6	134.4
1	2/1/98	31.9	BD	0.1	44.2	8.9	8.9	174.0
2	2/1/98	184.1	0.1	0.1	389.8	49.0	49.0	220.6
3	2/1/98	4.7	0.3	0.1	92.0	7.8	7.8	150.6
4	2/1/98	24.1	0.7	0.0	96.7	6.8	6.8	137.4
5	2/1/98	26.2	0.8	0.1	110.2	3.0	3.0	123.5
6	2/1/98	8.0	BD	0.1	104.0	3.4	3.4	183.4
7	2/1/98	3.3	0.1	0.1	64.1	17.6	17.6	217.6
8	2/1/98	6.0	0.2	0.2	87.9	29.8	29.8	264.6
8 dup	2/1/98	7.7	BD	0.2	87.1	28.5	28.5	268.7
9	2/1/98	11.9	0.4	0.3	101.2	26.7	26.7	198.9
10	2/1/98	9.4	0.9	0.1	131.4	18.9	18.9	148.9
10 dup	2/1/98	9.5	1.0	0.1	141.3	17.8	17.8	151.9
11	2/1/98	605.6	BD	0.2	1133.9	90.1	90.1	357.7
12	2/1/98	3.9	BD	0.2	31.8	18.0	18.0	203.7
14-1	2/1/98	35.8	0.1	0.2	88.6	22.3	22.3	274.2
14-4	2/1/98	30.4	BD	6.3	894.0	62.5	62.5	291.8
14-7	2/1/98	780.4	0.1	0.4	1848.8	184.9	184.9	430.1
14-7 dup	2/1/98	731.9	0.1	0.1	1891.9	201.3	201.3	412.0
15-1	2/1/98	54.0	0.4	0.0	112.9	18.6	18.6	146.1
15-4	2/1/98	4.4	BD	0.0	43.1	11.3	11.3	276.2
15-7	2/1/98	4.0	BD	0.1	54.8	46.6	46.6	129.7
16-2	2/1/98	33.0	0.1	0.1	65.7	10.8	10.8	150.6
16-5	2/1/98	418.6	BD	0.1	787.0	57.4	57.4	278.5
17-1	2/1/98	11.5	BD	0.1	39.2	11.6	11.6	220.0
17-4	2/1/98	4.8	BD	0.1	34.7	12.2	12.2	306.5
17-4 dup	2/1/98	4.0	0.0	0.1	34.7	11.2	11.2	313.5
17-7	2/1/98	1.8	0.5	0.1	87.7	23.0	23.0	
18-2	2/1/98	7.0	BD	0.1	14.2	11.2	11.2	273.6
18-5	2/1/98	4.9	BD	0.2	27.1	11.0	11.0	278.7
18-5 dup	2/1/98	6.2	BD	0.2	25.3	11.4	11.4	295.1
19-2	2/1/98	83.5	0.0	0.2	27.6	13.1	13.1	221.9
19-5	2/1/98	66.8	BD	0.3	96.4	12.1	12.1	197.9
20-2	2/1/98	25.7	BD	0.1	75.2	8.0	8.0	172.8
20-5	2/1/98	6.1	BD	0.1	321.2	3.7	3.7	210.3
21-2	2/1/98	12.9	BD	0.1	153.2	38.4	38.4	224.5
21-5	2/1/98	BD	0.0	0.0	449.6	56.1	56.1	282.8

Table A.11 cont.

22-2	2/1/98	15.9	BD	0.1	23.1	11.4	11.4	238.1
22-5	2/1/98	5.3	0.1	0.2	57.2	14.6	14.6	260.1
23-2	2/1/98	99.2	BD	0.2	104.9	18.4	18.4	205.0
23-5	2/1/98	88.6	0.1	0.2	265.0	51.1	51.1	232.5
24-2	2/1/98	15.1	BD	0.2	25.8	9.7	9.7	158.0
24-5	2/1/98	10.4	BD	0.3	20.0	6.9	6.9	326.8
25-2	2/1/98	73.8	0.3	0.1	141.2	33.4	33.4	230.8
25-5	2/1/98	21.5	0.2	0.1	102.5	42.9	42.9	264.3
Surface	2/1/98	2.6	0.0	9.3	26.7	1.4	1.4	67.0
Pre-Blank	2/1/98	4.0	BD	0.1	2.1	1.5	1.5	0.0
Post-Blank	2/1/98	4.4	BD	0.1	2.4	0.7	0.7	0.0
11 lab dup	2/1/98	659.0	0.0	0.1	1133.3	101.8	101.8	369.6
20-5 lab dup	2/1/98	5.3	BD	0.1	148.8	3.3	3.3	223.0
25-5 lab dup	2/1/98	22.3	0.2	0.1	107.6	44.0	44.0	286.8
1	3/1/98	27.3	0.2	0.4	43.3	6.1	7.2	119.3
2	3/1/98	20.6	0.1	0.5	183.8	41.2	34.7	135.4
3	3/1/98	4.7	0.7	0.6	111.8	5.6	6.6	78.7
5	3/1/98	19.5	1.8	0.4	147.8	7.7	5.0	71.3
7	3/1/98	5.2	0.5	0.1	99.1	13.0	18.0	110.0
9	3/1/98	20.1	0.4	0.0	93.6	15.9	19.1	136.7
11	3/1/98	63.1	0.2	0.3	1260.4	57.1	60.2	233.7
14-1	3/1/98	28.9	0.1	BD	80.1	28.0	20.9	206.7
14-4	3/1/98	94.8	0.1	0.1	109.0	59.7	50.0	243.9
14-7	3/1/98	388.5	0.3	0.1	707.4	84.7	72.3	164.0
15-1	3/1/98	12.2	0.2	0.1	50.7	9.9	9.8	104.6
15-1 dup	3/1/98	166.1	0.3	0.1	33.7	8.8	10.3	104.1
15-4	3/1/98	6.5	0.2	0.0	24.5	5.2	3.3	220.4
15-7	3/1/98	4.3	0.4	0.1	51.0	37.6	28.2	61.4
20-2	3/1/98	22.2	0.4	0.1	44.1	5.6	5.6	106.2
20-5	3/1/98	10.0	1.0	0.1	135.8	4.0	1.8	130.1
20-5 dup	3/1/98	4.9	0.9	0.1	156.4	4.5	1.7	129.0
21-2	3/1/98	135.3	0.3	0.1	237.7	39.0	21.6	174.9
21-5	3/1/98	228.4	0.3	0.1	92.9	45.4	30.0	172.5
22-2	3/1/98	9.4	0.1	0.1	26.3	9.1	7.0	156.7
22-5	3/1/98	10.8	0.7	0.1	107.2	14.4	18.2	143.5
25-2	3/1/98	81.4	0.4	0.1	149.3	35.8	19.1	161.8
25-2 dup	3/1/98	74.7	0.3	0.2	148.5	33.8	21.4	162.4
25-5	3/1/98	26.6	0.6	0.1	106.0	38.0	23.8	167.7

Table A.11 cont.

Surface	3/1/98	2.4	0.3	15.8	31.6	5.6	3.4	49.8
Tap	3/1/98	0.1	0.1	1.8	9.5	0.3	0.2	273.6
Pre-Blank	3/1/98	0.8	0.1	0.3	11.6	0.6	BD	3.5
Post-Blank	3/1/98	BD	BD	0.3	BD	0.5	BD	1.4
SP-1	4/1/98	26.7	0.3	0.1	12.6	4.9	6.1	270.8
SP_2	4/1/98	165.0	0.3	0.1	90.9	40.2	41.4	278.2
SP-3	4/1/98	2.6	0.6	0.1	19.4	5.6	5.4	168.1
SP-4	4/1/98	22.7	0.7	0.1	22.3	3.3	2.6	196.4
SP-5	4/1/98	19.5	1.2	0.1	6.4	7.0	8.6	177.0
SP-6	4/1/98	93.9	BD	0.1	19.0	1.3	3.0	252.6
SP-7	4/1/98	4.8	0.8	0.1	18.6	12.4	21.0	214.3
SP-8	4/1/98	11.1	0.4	0.1	19.3	27.4	29.0	300.2
SP-9	4/1/98	53.0	0.2	0.2	30.4	14.6	20.3	332.8
SP-10	4/1/98	16.7	1.1	0.1	26.2	14.6	20.0	230.3
SP-11	4/1/98	712.4	0.0	0.2	850.2	11.1	44.3	535.7
SP-11dup	4/1/98	541.1	0.1	0.1	939.7	71.6	36.9	542.4
SP-12	4/1/98	0.3	0.2	0.2	35.4	17.8	22.8	249.7
SP-14-1	4/1/98	15.1	1.0	0.1	64.8	22.9	25.4	299.4
SP-14-4	4/1/98	12.4	0.7	0.1	32.2	17.8	26.0	412.3
SP-14-7	4/1/98	48.8	0.4	0.1	42.0	46.0	33.6	281.0
SP-15-1	4/1/98	7.5	0.4	0.1	24.3	11.2	14.0	301.3
SP-15-4	4/1/98	2.1	BD	0.1	10.0	4.9	5.5	388.7
SP-15-7	4/1/98	0.2	0.1	0.1	23.6	52.3	40.8	186.6
SP-20-2	4/1/98	31.8	0.4	0.1	25.2	4.8	5.2	239.5
SP-20-2dup	4/1/98	31.6	0.4	0.1	25.7	4.8	4.9	253.9
SP-20-5	4/1/98	11.0	0.5	0.1	27.7	2.4	2.5	290.5
SP-21-2	4/1/98	25.6	0.4	0.1	28.3	28.8	28.3	396.7
SP-21-5	4/1/98	128.7	0.3	0.1	283.1	46.3	33.9	405.1
SP-22-2	4/1/98	9.9	0.3	0.1	15.6	7.2	7.7	351.5
SP-22-5	4/1/98	1.1	0.8	0.1	60.0	14.7	20.8	270.5
SP-25-2	4/1/98	69.4	0.2	0.1	51.1	30.2	31.8	362.1
SP-25-5	4/1/98	1.8	0.5	0.1	37.5	33.0	3.2	373.3
SP-26-1	4/1/98	BD	0.1	0.1	0.2	35.1	BD	13.4
SP-surface	4/1/98	BD	12.2	6.8	19.4	1.6	0.6	69.4
SP-3	5/1/98	3.9	2.9	0.2	66.7	5.8	7.0	108.6
SP-5	5/1/98	14.5	3.8	0.4	75.1	7.8	8.5	147.0
SP-6	5/1/98	22.3	0.5	0.8	86.3	0.8	0.8	224.4

Table A.11 cont.

SP-7	5/1/98	4.1	4.0	0.6	65.4	20.6	26.7	251.2
SP-9	5/1/98	22.8	0.5	0.4	67.5	15.5	18.0	197.3
SP-14-1	5/1/98	22.1	1.4	0.1	63.0	18.2	22.5	215.6
SP-14-7	5/1/98	21.9	3.3	0.3	115.9	39.3	40.9	204.6
SP-15-1	5/1/98	13.9	1.0	0.1	63.0	13.3	17.3	263.2
SP-15-7	5/1/98	4.6	0.6	0.2	41.5	52.2	57.6	130.8
SP-20-2	5/1/98	39.1	0.4	0.1	56.4	5.6	5.2	212.1
SP-20-5	5/1/98	15.3	0.9	0.1	85.7	2.6	2.5	248.5
SP-21-2	5/1/98	16.4	BD	BD	64.4	21.2	25.6	302.8
SP-21-5	5/1/98	76.2	0.3	BD	113.3	44.8	37.4	337.6
SP-21-5-dup	5/1/98	77.2	0.4	BD	115.9	45.4	40.0	344.6
SP-22-2	5/1/98	11.4	0.4	BD	27.9	6.8	9.0	278.0
SP-22-5	5/1/98	4.6	0.9	1.2	72.9	14.8	17.8	268.9
SP-25-2	5/1/98	59.2	1.4	0.9	110.1	33.2	38.0	287.7
SP-25-5	5/1/98	18.9	1.7	0.8	101.7	30.3	34.7	361.6
SP-surface	5/1/98	24.2	0.1	1.1	17.5	1.3	3.4	52.7
SP 3	6/1/98	4.4	0.3	0.2	58.5	4.8	6.1	72.8
SP 5	6/1/98	12.2	1.1	0.2	144.7	7.3	10.0	101.3
SP 6	6/1/98	22.8	0.3	0.1	90.3	2.5	1.4	144.0
SP 7	6/1/98	3.3	0.1	0.2	95.4	16.4	22.7	181.0
SP 9	6/1/98	15.0	BD	0.1	77.5	12.5	17.5	141.9
SP 11	6/1/98	498.4	0.3	0.1	1157.4	62.3	68.2	335.4
SP 12	6/1/98	6.8	0.1	0.1	48.4	6.0	7.6	166.4
SP 14-1	6/1/98	22.0	0.1	0.1	79.2	18.3	15.6	217.9
SP 14-7	6/1/98	35.2	0.5	0.1	229.4	35.5	216.7	177.3
SP 15-1	6/1/98	27.6	0.0	BD	83.0	17.1	21.4	187.7
SP 15-7	6/1/98	2.6	0.1	BD	72.8	17.1	22.4	145.4
SP 20-2	6/1/98	41.5	0.1	BD	69.6	4.4	7.0	158.1
SP 20-5	6/1/98	15.3	0.4	BD	154.9	3.4	3.2	187.2
SP 21-2	6/1/98	14.3	0.2	BD	101.2	22.8	31.6	186.3
SP 21-5	6/1/98	37.1	BD	BD	380.9	51.2	63.3	252.3
SP 22-2	6/1/98	13.5	0.1	BD	67.6	7.2	9.1	201.0
SP 22-5	6/1/98	4.8	0.1	0.1	111.3	13.3	17.6	227.9
SP 22-5 dup	6/1/98	5.2	BD	0.1	111.7	13.4	17.2	219.3
SP 25-2	6/1/98	56.2	0.2	0.1	134.9	32.3	34.9	204.9
SP 25-5	6/1/98	22.0	0.3	BD	139.6	24.7	30.4	249.7
SP surface	6/1/98	1.0	BD	0.2	25.0	0.9	9.7	28.4

Table A.11 cont.

SP 3	7/1/98	9.9	0.3	0.1	37.0	4.3	5.6	98.9
SP 5	7/1/98	19.0	1.5	0.1	124.4	5.4	2.7	98.5
SP 6	7/1/98	30.4	0.4	0.3	98.2	1.2	2.9	149.5
SP 7	7/1/98	5.3	0.0	0.1	62.0	14.4	18.2	201.8
SP 9	7/1/98	49.4	0.1	0.0	81.2	18.8	20.0	176.7
SP 11	7/1/98	510.3	0.3	0.4	1072.0	79.2	60.2	336.9
SP 12	7/1/98	6.7	BD	0.2	39.4	6.8	5.4	183.2
SP 14-1	7/1/98	27.1	0.0	0.3	68.2	12.2	16.1	218.3
SP 14-7	7/1/98	26.9	0.0	0.9	352.8	45.9	42.0	165.6
SP 15-1	7/1/98	20.7	0.2	0.2	59.2	20.9	39.9	168.7
SP 15-7	7/1/98	3.8	BD	0.3	62.6	14.0	19.1	166.5
SP 20-2	7/1/98	49.5	0.1	0.0	62.9	3.7	6.8	159.1
SP 20-5	7/1/98	12.9	0.7	0.1	131.7	2.5	1.8	191.5
SP 21-2	7/1/98	17.3	0.4	0.1	89.2	37.7	37.7	177.4
SP 21-5	7/1/98	118.6	0.1	0.1	300.9	60.6	41.4	253.7
SP 22-2	7/1/98	18.8	0.2	0.1	64.8	8.6	10.1	208.9
SP 22-5	7/1/98	11.2	0.2	0.1	90.3	12.6	16.5	221.9
SP 25-2	7/1/98	65.4	0.7	0.2	116.0	36.2	31.5	206.0
SP 25-5	7/1/98	0.2	115.9	24.5	30.4	253.8		
SP surface	7/1/98	0.3	16.7	0.0	11.5	53.6		
SP 3	8/1/98	5.7	0.3	0.3	35.0	5.2	4.9	99.2
SP 5	8/1/98	10.8	1.0	BD	131.4	9.8	7.4	104.5
SP 6	8/1/98	28.8	0.2	1.4	130.4	2.1	0.7	136.2
SP 7	8/1/98	5.3	0.1	0.4	61.9	15.9	15.5	219.7
SP 9	8/1/98	42.8	0.1	0.2	95.7	17.1	21.3	185.0
SP 11	8/1/98	444.8	0.2	0.2	202.7	76.7	79.1	338.8
SP 12	8/1/98	9.5	0.1	0.2	38.1	4.8	6.6	220.3
SP 14-1	8/1/98	14.4	0.2	0.2	60.5	10.3	12.9	261.2
SP 14-7	8/1/98	18.2	0.7	0.1	195.7	44.8	48.8	193.4
SP 15-1	8/1/98	19.5	0.2	0.2	57.9	19.8	20.6	178.9
SP 15-7	8/1/98	7.1	0.0	0.2	44.4	14.7	15.5	201.3
SP 20-2	8/1/98	39.5	0.1	0.1	62.6	3.4	4.2	170.0
SP 20-5	8/1/98	14.0	BD	0.1	95.0	2.8	0.8	197.3
SP 25-2	8/1/98	51.6	0.2	BD	110.1	39.7	38.9	219.6
SP 25-5	8/1/98	16.1	0.4	0.2	113.6	33.5	34.2	260.1
SP surface	8/1/98	0.1	BD	0.4	13.3	0.2	1.0	10.5
SP 3	9/1/98	14.8	0.2	BD	32.0	1.7	0.1	107.6

Table A.11 cont.

SP 5	9/1/98	12.8	1.1	0.1	BD	7.1	9.8	89.6
SP 7	9/1/98	11.5	BD	0.1	28.4	10.9	13.4	238.7
SP 9	9/1/98	52.6	0.2	BD	30.5	17.5	3.4	192.5
SP 11	9/1/98	345.4	BD	0.1	37.6	80.2	78.6	309.5
SP 12	9/1/98	15.9	0.3	0.1	35.9	5.5	4.2	212.3
SP 14-1	9/1/98	10.6	15.5	0.2	BD	12.0	16.6	231.4
SP 14-7	9/1/98	9.5	15.8	21.9	224.6	59.5	61.8	302.5
SP 15-1	9/1/98	22.5	BD	0.1	44.2	16.1	18.6	143.4
SP 15-1 dup	9/1/98	23.1	BD	0.1	34.8	16.2	18.5	142.6
SP 15-7	9/1/98	8.3	BD	0.1	3.0	29.7	28.5	182.6
SP 20-2	9/1/98	50.7	BD	0.1	47.1	3.5	3.7	150.5
SP 20-5	9/1/98	17.6	0.8	0.1	BD	3.1	0.9	183.3
SP 21-2	9/1/98	19.9	0.0	0.2	BD	32.2	34.1	192.5
SP 21-5	9/1/98	43.5	BD	0.3	51.5	43.9	41.8	229.3
SP 22-2	9/1/98	21.3	0.1	0.4	2.9	7.4	11.2	236.5
SP 22-5	9/1/98	12.6	0.0	0.1	10.1	17.3	16.6	166.7
SP 25-2	9/1/98	46.4	0.4	0.3	BD	32.7	37.6	199.0
SP 25-5	9/1/98	26.1	0.4	0.1	BD	30.8	40.7	249.8
SP surface	9/1/98	2.6	BD	0.3	9.5	BD	2.5	18.2
SP 3	10/1/98	36.4	0.2	0.3	78.8	1.9	2.9	105.1
SP 5	10/1/98	17.4	0.9	0.4	200.6	6.1	5.2	81.1
SP 7	10/1/98	29.5	0.1	1.5	74.5	8.2	12.9	159.0
SP 9	10/1/98	22.3	BD	0.2	74.0	21.4	17.8	195.8
SP 11	10/1/98	45.5	0.6	0.1	557.3	62.5	59.2	258.5
SP 12	10/1/98	9.9	0.0	0.1	42.7	6.3	8.1	205.1
SP 14-1	10/1/98	0.6	7.6	67.9	268.3	16.0	17.9	266.0
SP 14-4	10/1/98	60.0	BD	1.6	233.3	71.1	62.6	212.0
SP 14-7	10/1/98	63.6	0.5	0.1	529.2	109.6	80.3	272.4
SP 15-1	10/1/98	12.6	0.3	0.2	45.8	10.6	12.2	180.3
SP 15-4	10/1/98	10.2	BD	0.2	32.4	6.5	8.0	206.3
SP 15-7	10/1/98	11.1	0.3	0.2	39.3	10.0	10.5	174.5
SP 17-2	10/1/98	4.3	BD	0.2	68.8	6.0	7.6	270.3
SP 17-6	10/1/98	3.3	BD	0.0	61.5	7.8	11.3	145.5
SP 20-2	10/1/98	64.2	0.0	0.3	85.9	4.2	5.2	155.8
SP 20-5	10/1/98	18.4	0.3	0.1	102.6	2.1	2.0	174.4
SP 21-2	10/1/98	8.9	BD	0.2	69.7	19.1	20.6	174.0
SP 21-5	10/1/98	18.3	BD	0.2	46.5	32.0	36.9	216.3

Table A.11 cont.

SP 22-2	10/1/98	34.7	0.1	0.1	95.8	6.7	8.4	225.6
SP 22-5	10/1/98	15.3	0.1	0.4	73.1	13.4	13.8	155.2
SP 25-2	10/1/98	53.2	0.6	0.2	117.7	36.2	35.0	174.7
SP 25-5	10/1/98	38.9	0.4	0.1	102.1	26.9	28.5	172.5
SP surface	10/1/98	5.8	0.6	0.4	28.7	0.7	9.3	31.8
SP 3	11/1/98	29.7	BD	BD	69.9	1.6	0.7	92.0
SP 5	11/1/98	25.3	0.6	BD	80.6	2.5	1.2	56.1
SP 7	11/1/98	7.2	BD	BD	59.3	9.6	11.4	122.7
SP 9	11/1/98	48.7	BD	0.2	92.5	17.5	16.1	132.7
SP 11	11/1/98	186.7	0.8	0.8	517.4	49.7	27.5	179.5
SP 12	11/1/98	9.2	0.1	0.3	42.8	18.0	13.0	128.8
SP 14-1	11/1/98	21.7	BD	0.3	47.0	8.6	5.0	84.4
SP 14-4	11/1/98	105.5	BD	0.2	136.9	39.9	25.0	116.3
SP 14-7	11/1/98	40.6	0.2	0.3	79.4	29.7	20.0	95.9
SP 15-1	11/1/98	23.9	BD	0.2	46.8	11.3	10.9	91.0
SP 15-4 dup	11/1/98	12.6	BD	0.3	41.5	9.0	10.4	138.5
SP 15-7	11/1/98	10.1	BD	0.3	41.8	9.0	94.8	134.9
SP 17-2	11/1/98	9.1	0.4	0.0	56.1	17.7	11.8	138.2
SP 17-6	11/1/98	11.1	BD	0.1	46.0	5.4	4.7	163.8
SP 20-2	11/1/98	75.6	BD	0.1	42.1	14.5	15.9	129.8
SP 20-5	11/1/98	45.0	0.5	BD	114.2	3.7	7.2	108.9
SP 21-2	11/1/98	15.7	BD	BD	68.8	1.1	2.7	89.6
SP 21-5	11/1/98	7.1	BD	BD	54.1	23.2	22.2	110.6
SP 22-2	11/1/98	21.7	BD	0.1	47.1	22.2	16.0	136.5
SP 22-5	11/1/98	19.2	0.1	0.3	81.1	9.8	11.8	142.8
SP 25-2	11/1/98	62.5	0.1	0.2	77.2	10.9	13.4	138.1
SP 25-5	11/1/98	48.4	BD	BD	122.2	21.8	15.0	117.8
SP surface	11/1/98	3.5	BD	0.1	98.9	17.6	21.0	116.9
SP 3	12/1/98	27.2	0.2	0.5	44.5	1.7	2.0	130.4
SP 5	12/1/98	22.4	1.0	0.4	78.5	2.9	3.1	77.6
SP 7	12/1/98	7.9	BD	0.3	85.1	8.1	12.3	170.5
SP 9	12/1/98	65.4	0.3	1.2	97.4	12.8	15.3	154.0
SP 11	12/1/98	225.8	1.0	0.0	451.4	66.5	48.3	255.6
SP 12	12/1/98	20.4	0.3	0.1	52.2	16.0	16.6	177.3
SP 14-1	12/1/98	48.8	BD	4.6	98.1	6.2	9.2	149.6
SP 14-4	12/1/98	84.4	0.6	0.4	203.0	3.7	50.7	175.6
SP 14-7	12/1/98	16.4	1.6	BD	221.4	42.1	42.9	170.4

Table A.11 cont.

SP 15-1	12/1/98	34.7	0.1	0.1	55.1	8.8	10.0	187.5
SP 15-4	12/1/98	23.4	0.2	0.4	51.4	9.0	9.7	200.1
SP 15-7	12/1/98	13.8	BD	0.2	62.3	24.9	30.1	183.3
SP 17-2	12/1/98	8.8	BD	0.2	47.7	7.4	7.2	230.9
SP 17-6	12/1/98	14.5	0.2	0.2	59.1	15.0	16.6	187.3
SP 20-2	12/1/98	70.1	0.7	BD	100.0	6.2	8.1	158.1
SP 20-5	12/1/98	32.0	0.5	BD	102.9	2.2	3.5	188.9
SP 21-2	12/1/98	29.3	BD	0.1	48.0	20.9	23.3	129.8
SP 21-5	12/1/98	13.3	BD	0.1	42.3	19.7	20.0	186.2
SP 22-2	12/1/98	26.9	BD	BD	42.2	18.4	19.7	184.4
SP 22-5	12/1/98	16.7	0.3	BD	66.7	6.9	7.9	168.3
SP 25-2	12/1/98	56.7	0.3	BD	63.8	12.6	15.6	193.8
SP 25-5	12/1/98	38.2	0.1	0.1	91.5	26.7	30.7	155.1
SP surface	12/1/98	7.9	0.2	0.1	62.9	18.6	22.6	156.6
SP 3	1/1/99	4.7	BD	0.2	58.1	2.7	2.2	194.4
SP 5	1/1/99	25.1	0.2	0.2	75.3	3.0	2.1	77.4
SP 7	1/1/99	10.7	BD	0.3	52.9	11.6	5.2	193.9
SP 9	1/1/99	62.2	BD	0.3	91.2	15.0	8.0	151.0
SP 11	1/1/99	285.3	BD	0.6	509.9	47.7	52.9	263.8
SP 12	1/1/99	35.7	BD	0.1	85.3	26.2	16.9	191.7
SP 14-1	1/1/99	21.0	BD	0.1	70.9	7.6	3.6	164.5
SP 14-4	1/1/99	94.9	0.8	0.2	144.8	56.0	45.6	169.3
SP 14-7	1/1/99	7.5	2.9	0.3	BD	37.6	28.9	169.8
SP 15-1	1/1/99	62.4	0.0	0.2	96.7	20.5	12.8	366.1
SP 15-4	1/1/99	69.7	0.1	0.1	110.5	23.4	14.0	219.6
SP 15-7	1/1/99	282.7	0.5	0.1	448.6	42.1	33.4	200.0
SP 17-2	1/1/99	11.2	BD	0.2	42.4	6.4	3.1	220.2
SP 17-6	1/1/99	18.4	BD	0.3	59.8	13.5	7.3	166.2
SP 20-2	1/1/99	89.1	0.1	0.0	111.6	6.2	4.5	169.1
SP 20-2 dup	1/1/99	89.9	BD	0.1	112.3	6.3	4.4	166.9
SP 20-5	1/1/99	54.6	0.2	0.1	86.4	0.8	2.2	147.6
SP 21-2	1/1/99	22.9	BD	0.2	55.7	24.3	15.5	162.6
SP 21-5	1/1/99	33.0	BD	0.2	66.1	19.8	11.7	188.5
SP 22-2	1/1/99	24.5	BD	0.2	30.7	9.0	4.2	196.2
SP 22-5	1/1/99	18.1	BD	0.1	35.7	11.5	5.5	189.0
SP 25-2	1/1/99	70.8	BD	0.1	46.7	28.2	19.4	157.1
SP 25-5	1/1/99	44.5	0.0	BD	44.7	25.4	14.1	166.5
SP surface	1/1/99	3.1	BD	0.2	9.1	0.1	7.9	21.8

Table A.11 cont.

SP 3	2/1/99	36.8	0.0	0.1	90.4	3.3	4.2	132.5
SP 5	2/1/99	24.2	0.5	BD	90.1	3.0	4.5	74.3
SP 7	2/1/99	9.1	BD	0.1	51.7	10.6	13.3	184.5
SP 9	2/1/99	36.9	BD	0.4	86.2	13.4	19.1	127.7
SP 11	2/1/99	196.9	BD	0.3	786.7	52.6	50.1	261.2
SP 12	2/1/99	61.1	0.1	0.1	193.0	33.6	39.3	179.0
SP 14-1	2/1/99	20.5	BD	0.0	72.3	6.7	10.7	148.4
SP-14-1dup	2/1/99	20.8	BD	0.1	73.0	8.2	11.1	154.4
SP-14-4	2/1/99	47.4	0.8	0.1	184.1	66.1	53.7	153.7
SP-14-7	2/1/99	173.0	0.7	BD	307.8	54.2	53.0	211.0
SP-15-1	2/1/99	41.6	0.0	0.4	86.8	13.0	15.9	186.8
SP-15-4	2/1/99	76.4	BD	0.1	120.2	34.8	39.5	234.5
SP-15-7	2/1/99	557.0	0.4	0.1	1335.3	226.9	40.7	228.9
SP-17-2	2/1/99	15.6	BD	BD	56.4	6.7	8.9	197.8
SP-17-5	2/1/99	20.5	BD	0.2	75.9	12.2	15.9	175.7
SP-20-2	2/1/99	58.3	0.1	0.1	92.2	5.1	9.3	155.1
SP-20-5	2/1/99	58.5	BD	0.1	86.9	1.2	4.8	137.5
SP 21-2	2/1/99	27.2	BD	0.2	60.4	25.2	29.9	156.4
SP 21-5	2/1/99	72.7	BD	0.2	215.3	19.1	24.2	182.0
SP 22-2	2/1/99	29.3	BD	0.2	64.6	5.5	8.6	201.6
SP 22-5	2/1/99	8.5	BD	0.1	66.2	10.5	13.3	178.0
SP 25-2	2/1/99	54.4	BD	0.1	67.5	19.2	23.1	144.0
SP 25-5	2/1/99	39.8	BD	0.1	92.6	22.1	25.9	174.2
SP surface	2/1/99	BD	BD	11.0	25.2	0.3	12.0	63.9
SP 3	3/1/99	7.0	0.6	1.2	149.0	7.4	8.4	182.6
SP 5	3/1/99	20.5	0.4	1.2	76.6	2.8	1.1	72.3
SP 7	3/1/99	7.5	BD	1.0	60.3	10.4	14.8	188.3
SP 9	3/1/99	35.7	BD	0.8	83.5	8.2	16.9	129.9
SP 11	3/1/99	394.0	0.3	1.1	617.9	51.7	84.8	266.6
SP 12	3/1/99	668.5	0.0	1.0	950.6	58.3	99.2	258.7
SP 14-1	3/1/99	14.1	BD	1.0	63.8	7.7	10.1	141.9
SP-14-4	3/1/99	32.9	1.0	0.8	216.8	52.9	78.6	148.2
SP-14-7	3/1/99	-5.9	3.8	0.8	BD	31.6	53.5	152.9
SP-15-1	3/1/99	69.2	BD	0.7	105.7	13.3	19.9	172.6
SP-15-4	3/1/99	102.0	0.1	0.9	181.1	20.5	47.7	228.7
SP-15-7	3/1/99	350.3	BD	81.8	566.3	35.9	79.8	357.4
SP-17-2	3/1/99	25.6	0.0	0.7	75.9	8.9	12.0	204.5
SP-17-5	3/1/99	12.3	0.1	0.7	89.3	37.3	67.4	211.1

Table A.11 cont.

SP-20-2	3/1/99	44.9	1.9	0.8	88.1	6.6	10.9	156.7
SP-20-5	3/1/99	52.2	0.1	0.7	86.5	1.9	2.6	133.8
SP 21-2	3/1/99	26.5	0.0	0.7	38.7	19.9	33.1	143.0
SP 21-5	3/1/99	21.4	0.2	0.6	59.6	31.7	75.7	171.8
SP 21-5 dup	3/1/99	22.2	0.2	0.8	59.1	32.8	74.3	174.4
SP 22-2	3/1/99	20.0	0.1	0.7	62.8	5.5	7.1	197.6
SP 22-5	3/1/99	15.7	0.1	0.6	82.6	9.4	14.3	168.3
SP 25-2	3/1/99	41.2	BD	0.7	54.0	14.8	23.2	132.4
SP 25-5	3/1/99	37.9	0.1	0.7	91.7	17.1	27.8	169.9
SP surface	3/1/99	0.9	BD	1.0	17.6	0.9	16.3	28.1
SP 3	4/1/99	9.5	0.6	0.0	92.8	4.2	6.6	152.7
SP 3 dup	4/1/99	47.9	0.5	0.1	85.7	4.6	6.6	155.6
SP 5	4/1/99	28.0	0.2	0.2	68.9	2.4	3.7	75.4
SP 6	4/1/99	4.5	1.3	0.3	105.2	2.7	2.3	114.8
SP 7	4/1/99	24.5	0.1	0.2	68.0	12.1	14.9	187.8
SP 8	4/1/99	42.7	0.1	0.3	52.4	11.8	15.1	189.8
SP 9	4/1/99	61.8	0.1	0.2	82.8	9.2	14.2	124.4
SP 11	4/1/99	463.3	0.2	0.2	778.5	51.8	54.6	255.5
SP 12	4/1/99	14.3	0.1	205.8	1294.7	59.9	64.3	302.2
SP 14-1	4/1/99	31.2	0.0	0.2	60.6	7.2	11.3	145.6
SP-14-4	4/1/99	85.4	0.8	0.1	185.0	46.7	45.6	145.4
SP-14-7	4/1/99	24.9	2.3	0.4	367.2	41.0	41.7	148.0
SP-15-1	4/1/99	58.8	0.1	0.2	54.7	13.3	16.4	125.8
SP-15-4	4/1/99	57.0	0.3	0.1	137.9	38.1	39.4	229.0
SP-15-4 dup	4/1/99	88.6	0.3	0.1	136.2	36.1	38.5	192.6
SP-15-7	4/1/99	20.8	4.9	837.9	2898.5	69.6	58.3	387.3
SP-17-2	4/1/99	13.4	0.2	0.6	77.9	14.5	18.1	197.1
SP-17-5	4/1/99	41.9	0.4	0.2	117.3	32.7	39.3	206.6
SP-20-2	4/1/99	50.4	0.6	0.5	94.0	5.0	11.0	144.1
SP-20-5	4/1/99	37.4	0.9	3.5	6.8	3.2	4.9	170.8
SP 21-2	4/1/99	34.8	0.1	0.3	64.3	18.4	1.2	131.3
SP 21-5	4/1/99	19.1	0.1	0.0	71.2	34.6	3.1	155.9
SP 21-5 dup	4/1/99	15.2	0.2	0.3	69.2	34.0	6.3	184.1
SP 22-2	4/1/99	15.1	0.0	0.1	61.1	5.2	1.1	200.3
SP 22-5	4/1/99	106.9	0.2	0.2	79.5	13.4	1.8	194.1
SP 23-1	4/1/99	79.7	0.1	0.3	133.4	10.8	1.7	260.1
SP 23-5	4/1/99	62.5	0.1	0.4	132.2	31.4	4.6	169.9
SP 25-2	4/1/99	33.5	0.2	0.2	72.4	13.2	2.0	150.0

Table A.11 cont.

SP 25-5	4/1/99	5.1	0.3	0.5	88.9	16.2	1.9	176.3
SP surface	4/1/99	4.9	0.1	0.6	20.1	0.9	0.7	34.7
BLK	4/1/99	49.7	0.1	0.3	10.3	0.9	1.0	11.8
SP-9 labdup	4/1/99	93.7	0.1	0.1	85.6	10.7	15.0	129.8
SP 3	5/1/99	5.7	1.9	2.7	43.7	5.6	8.6	141.2
SP 5	5/1/99	18.8	0.3	0.1	48.0	2.2	3.4	66.6
SP 6	5/1/99	28.8	1.7	0.1	66.7	2.5	3.2	121.4
SP 7	5/1/99	5.1	BD	0.1	46.8	11.2	17.1	168.4
Sp 8	5/1/99	6.6	BD	0.1	44.1	10.4	14.4	203.2
SP 9	5/1/99	16.7	0.1	0.1	60.3	9.9	17.2	120.5
SP 11	5/1/99	616.5	0.2	0.2	951.9	40.0	46.4	230.6
SP 12	5/1/99	582.1	13.7	1781.1	1395.7	45.1	42.5	279.7
SP 14-1	5/1/99	15.3	0.1	0.5	1.9	6.6	9.6	135.8
SP-14-4	5/1/99	27.0	0.7	0.6	95.5	39.4	53.3	123.6
SP-14-7	5/1/99	150.4	1.6	0.4	35.1	48.2	63.1	188.8
SP-15-1	5/1/99	50.5	0.2	0.7	71.3	12.7	17.5	122.9
SP-15-4	5/1/99	40.0	0.1	0.5	64.7	19.7	29.4	172.5
SP-15-7	5/1/99	305.5	0.1	315.3	931.0	70.9	62.7	336.9
SP-17-2	5/1/99	33.1	0.2	0.4	74.7	12.1	18.4	159.1
SP-17-5	5/1/99	150.2	0.1	0.3	196.8	34.9	51.1	218.2
SP-20-2	5/1/99	53.5	0.5	0.4	79.6	5.3	11.3	147.1
SP-20-5	5/1/99	59.3	0.5	0.6	80.3	2.6	5.5	141.2
SP 21-2	5/1/99	61.1	0.0	0.3	83.5	17.6	24.2	146.7
SP 21-5	5/1/99	60.0	0.2	0.1	88.4	30.4	38.3	185.4
SP 22-2	5/1/99	14.1	0.1	0.3	48.2	4.2	8.1	194.9
SP 22-5	5/1/99	6.7	BD	0.9	83.7	11.8	20.4	218.1
SP 22-5 dup	5/1/99	8.1	0.4	0.4	79.0	11.0	21.8	222.4
SP 25-2	5/1/99	64.2	0.1	0.4	80.3	10.2	19.2	151.0
SP 25-5	5/1/99	38.5	0.1	0.6	79.4	18.1	28.3	174.9
SP surface	5/1/99	BD	0.1	0.3	10.3	0.9	13.8	13.0
SP 7 labdup	5/1/99	5.6	0.0	13.2	51.6	0.9	17.7	171.9
SP 20-5 lab dup	5/1/99	59.9	0.2	BD	92.8	0.9	5.1	143.7

Table A.12: Nutrient samples collected from groundwaters and surface waters at the BL Site on St. George Island between April, 1998 and December, 1998. Samples were analyzed for Ammonium (NH_4^+), Nitrite (NO_2), nitrate + nitrite (NN), Total Nitrogen (TN), soluble reactive phosphate (PO_4), Total Phosphate (TP) and Silicate (Si). All nutrient concentrations are reported in μM.

Sample Name	Date	NH4+	NO2	NN	TN	PO4	TP	Si
BL-2-2	4/1/98	53.4	0.3	0.1	94.6	4.0	4.0	186.0
BL-2-2dup	4/1/98	52.6	0.3	0.1	47.5	4.1	3.5	177.4
BL-2-6	4/1/98	95.0	0.1	0.1	58.4	5.5	5.7	297.5
BL-3-1	4/1/98	87.2	0.2	0.1	55.4	3.8	3.1	253.3
BL-3-4	4/1/98	17.0	0.2	0.1	19.0	6.8	7.9	135.5
BL-3-7	4/1/98	BD	0.1	0.1	11.0	9.8	10.8	95.5
BL-4-1	4/1/98	38.6	0.5	0.1	43.8	5.2	5.5	214.5
BL-4-4	4/1/98	3.2	0.4	0.1	15.3	5.5	6.4	187.7
BL-4-7	4/1/98	26.3	0.6	0.1	38.9	11.0	13.9	185.7
BL-5-1	4/1/98	78.2	0.1	0.1	44.2	10.6	10.5	334.0
BL-5-4	4/1/98	35.5	0.2	0.1	11.2	3.8	2.1	513.8
BL-5-7	4/1/98	3.0	0.1	0.1	10.2	105.4	55.1	713.1
BL-6-2	4/1/98	75.4	0.5	0.1	56.0	BD	4.5	287.9
BL-6-6	4/1/98	5.3	0.2	0.1	25.9	11.9	13.1	233.2
BL-7	4/1/98	24.8	1.3	0.2	61.2	9.5	10.1	255.0
BL-8	4/1/98	49.4	0.3	0.1	35.4	11.0	9.9	813.3
BL-9-1	4/1/98	14.2	0.5	0.1	39.3	5.9	7.2	10.0
BL-9-4	4/1/98	2.8	1.0	0.2	45.6	16.4	16.3	262.7
BL-9-7	4/1/98	BD	0.1	0.1	9.3	23.9	23.4	146.6
BL-13-2	4/1/98	58.6	0.2	0.1	47.0	7.5	7.7	177.5
BL-13-6	4/1/98	1.3	0.1	0.1	58.9	124.0	60.3	189.3
BL-14-2	4/1/98	37.4	0.3	0.1	28.7	12.5	11.2	668.4
BL-14-6	4/1/98	BD	0.2	0.1	16.1	17.3	17.2	222.1
BL-16-1	4/1/98	BD	0.2	0.2	BD	2.8	0.4	9.7
BL-surface	4/1/98	BD	0.2	0.3	5.6	2.7	7.5	18.0
BL-2-2	5/1/98	27.7	2.3	0.2	82.0	4.6	4.1	143.9
BL-2-6	5/1/98	118.0	1.2	0.1	139.3	8.3	8.3	178.1
BL-3-1	5/1/98	99.1	1.1	0.5	121.8	3.2	3.1	209.5
BL-3-7	5/1/98	3.9	0.3	0.5	27.8	1.3	15.1	98.8
BL-4-1	5/1/98	36.3	1.4	0.8	78.0	5.2	5.8	157.3
BL-4-7	5/1/98	3.0	2.3	0.6	82.0	10.1	16.3	154.7
BL-5-1	5/1/98	68.2	0.3	0.7	86.5	9.7	9.8	292.6

Table A.12 cont.

BL-5-7	5/1/98	6.6	BD	0.8	19.7	103.9	86.2	655.1
BL-7	5/1/98	28.4	3.1	0.8	84.4	6.9	7.7	183.6
BL-8	5/1/98	45.0	0.4	0.5	60.2	9.1	9.6	500.0
BL-9-1	5/1/98	17.5	24.1	0.5	61.8	4.8	5.7	293.3
BL-9-4	5/1/98	6.7	3.2	0.5	83.5	12.5	14.7	260.1
BL-9-7	5/1/98	3.8	0.2	0.0	28.4	26.3	28.4	151.3
BL-13-2	5/1/98	63.3	2.0	0.7	95.9	7.6	6.5	139.6
BL-13-6	5/1/98	6.0	6.2	0.5	91.8	85.9	97.2	174.3
BL-14-2	5/1/98	39.4	1.0	0.3	58.7	11.0	11.0	555.7
BL-14-6	5/1/98	4.7	1.4	0.2	55.0	17.6	23.6	205.3
BL-15	5/1/98	60.2	1.9	0.0	97.0	38.6	3.7	158.9
BL-15-dup	5/1/98	58.4	2.2	0.4	99.5	5.3	4.1	148.5
BL-surface	5/1/98	3.8	0.2	4.2	11.8	1.8	6.4	34.7
BL 2-2	6/1/98	38.4	0.3	0.5	105.7	4.3	4.6	90.1
BL 2-6	6/1/98	38.7	0.1	0.2	91.3	4.5	6.0	109.7
BL 3-1	6/1/98	100.1	BD	0.1	135.4	3.5	3.5	152.6
BL 3-5	6/1/98	4.9	BD	0.2	27.9	11.7	9.2	89.9
BL 3-7	6/1/98	3.4	BD	0.2	39.1	13.1	16.1	92.6
BL 4-1	6/1/98	35.2	0.3	0.1	102.0	5.7	6.3	97.6
BL 4-7	6/1/98	1.9	0.4	0.1	91.3	11.3	17.3	121.2
BL 5-1	6/1/98	61.9	BD	0.1	94.2	10.3	9.8	198.0
BL 5-1 DUP	6/1/98	62.9	BD	0.1	92.1	10.6	10.1	195.6
BL 5-7	6/1/98	6.7	BD	BD	30.0	69.8	69.7	472.5
BL 7	6/1/98	36.4	0.1	1.5	163.4	8.1	11.3	138.4
BL 8	6/1/98	43.6	BD	0.1	72.3	10.4	8.9	306.2
BL 9-1	6/1/98	19.9	BD	0.1	78.6	5.2	6.3	191.1
BL 9-4	6/1/98	5.6	0.4	0.1	130.4	6.6	13.1	188.1
BL 9-7	6/1/98	4.9	0.2	0.1	82.7	29.1	34.4	121.3
BL 13-2	6/1/98	77.4	0.5	0.0	119.5	6.2	6.5	104.3
BL 13-6	6/1/98	11.9	2.2	0.1	24.1	49.4	68.0	150.3
BL 14-2	6/1/98	49.7	0.4	0.1	89.8	10.0	10.1	298.1
BL 14-6	6/1/98	BD	0.1	0.1	75.7	17.5	19.5	149.2
BL 15	6/1/98	114.7	0.4	0.0	163.8	9.0	6.2	142.7
BLsurface	6/1/98	3.7	0.0	0.4	28.2	1.7	11.0	5.0
BL 2-2	7/1/98	35.2	0.5	0.2	77.5	3.7	5.0	89.6
BL 2-6	7/1/98	69.7	0.0	0.2	69.3	5.0	6.3	134.9
BL 3-1	7/1/98	115.3	BD	0.3	106.2	3.2	4.7	174.5
BL 3-5	7/1/98	14.6	BD	0.4	24.5	8.2	8.6	142.6

Table A.12 cont.

BL 3-7	7/1/98	11.3	BD	0.1	24.2	10.3	13.3	101.3
BL 4-1	7/1/98	50.6	0.1	0.1	76.7	4.6	7.5	129.0
BL 4-7	7/1/98	7.4	0.1	0.2	68.9	14.4	17.7	203.6
BL 5-1	7/1/98	69.5	0.1	0.4	76.6	9.1	10.5	491.0
BL 5-7	7/1/98	9.6	BD	0.2	23.6	75.0	50.3	89.0
BL 7	7/1/98	50.0	0.3	0.3	95.8	4.9	7.1	286.1
BL 8	7/1/98	53.4	0.2	0.2	56.3	10.0	9.7	172.8
BL 9-1	7/1/98	27.8	0.3	0.2	69.5	5.7	7.1	200.0
BL 9-4	7/1/98	8.2	0.2	0.2	93.6	7.8	11.2	158.7
BL 9-7	7/1/98	6.4	0.5	0.1	116.5	36.3	35.4	119.8
BL 13-2	7/1/98	96.3	1.5	0.2	117.1	9.6	7.2	168.2
BL 13-6	7/1/98	25.7	3.6	0.1	59.5	56.9	50.6	0.0
BL 14-2	7/1/98	20.5	0.8	0.1	83.6	8.7	9.4	266.4
BL 14-2 dup	7/1/98	78.9	0.7	0.1	87.7	7.9	8.9	244.7
BL 14-6	7/1/98	32.5	0.1	0.2	44.4	13.8	15.5	320.8
BL 15	7/1/98	211.1	1.2	0.3	279.5	6.2	12.6	185.9
BLsurface	7/1/98	4.0	0.2	1.2	16.0	0.9	11.7	11.3
BL 2-2	8/1/98	22.5	0.4	0.3	73.0	3.8	3.6	100.8
BL 2-6	8/1/98	56.5	0.1	BD	83.7	4.3	4.7	163.6
BL 3-1	8/1/98	91.3	0.1	0.1	127.1	3.3	3.2	184.0
BL 3-5	8/1/98	39.9	0.2	0.3	74.3	7.0	7.0	191.7
BL 3-7	8/1/98	7.9	0.0	0.3	24.9	8.7	9.6	6.9
BL 4-1	8/1/98	37.3	0.1	BD	72.5	4.6	5.4	6.8
BL 4-7	8/1/98	4.3	0.1	BD	41.7	13.6	14.4	7.6
BL 5-1	8/1/98	50.5	0.2	BD	74.3	8.3	9.4	6.7
BL 5-1 DUP	8/1/98	50.0	0.2	BD	76.8	8.0	9.7	6.3
BL 5-7	8/1/98	8.5	BD	BD	25.4	82.4	90.2	8.4
BL 7	8/1/98	44.6	0.1	0.0	98.6	5.2	6.0	8.7
BL 8	8/1/98	41.4	BD	BD	65.4	7.2	8.3	4.2
BL 9-1	8/1/98	21.2	0.3	BD	81.0	4.8	6.2	7.6
BL 9-7	8/1/98	6.2	0.6	0.1	113.7	35.3	36.3	181.8
BL 13-2	8/1/98	75.3	2.0	0.1	128.1	6.1	5.7	125.4
BL 13-6	8/1/98	24.5	2.8	0.1	105.5	54.9	54.0	177.8
BL 14-2	8/1/98	63.0	1.0	0.1	94.0	7.9	7.3	227.8
BL 14-6	8/1/98	27.8	0.2	BD	46.3	12.5	13.5	316.3
BL 15	8/1/98	37.9	0.9	BD	204.7	5.7	6.7	145.0
BLsurface	8/1/98	7.7	0.4	3.7	26.4	-0.1	1.3	53.1
BL 2-2	9/1/98	22.3	0.2	BD	BD	3.0	3.5	95.7

Table A.12 cont.

BL 2-6	9/1/98	86.5	BD	0.2	12.4	3.7	5.2	162.7
BL 3-1	9/1/98	55.6	BD	BD	92.3	1.9	1.5	182.9
BL 3-5	9/1/98	23.7	BD	0.1	59.7	4.3	4.6	187.3
BL 3-5 dup	9/1/98	23.7	BD	0.1	66.2	4.4	5.2	188.8
BL 3-7	9/1/98	18.8	BD	0.1	26.0	5.6	6.9	129.1
BL 4-1	9/1/98	41.6	BD	0.1	44.7	3.8	5.1	123.5
BL 4-7	9/1/98	7.9	BD	0.1	24.0	10.0	12.8	114.7
BL 5-1	9/1/98	46.3	BD	0.1	50.5	11.1	13.8	291.7
BL 5-7	9/1/98	11.4	BD	0.1	19.7	85.2	81.4	322.8
BL 7	9/1/98	44.4	0.6	0.1	BD	5.3	6.6	98.5
BL 8	9/1/98	51.6	0.0	0.1	49.7	7.5	9.3	362.2
BL 9-1	9/1/98	21.0	BD	0.1	BD	3.8	4.3	181.8
BL 9-4	9/1/98	11.7	BD	0.1	BD	6.6	6.7	214.4
BL 9-7	9/1/98	8.1	BD	0.1	2.7	34.1	31.0	131.4
BL 13-2	9/1/98	54.0	1.8	0.2	BD	5.6	4.4	131.8
BL 13-6	9/1/98	17.9	0.9	BD	BD	47.0	43.6	139.6
BL 14-2	9/1/98	54.3	1.3	0.1	BD	8.5	6.5	180.5
BL 14-6	9/1/98	28.1	BD	0.1	32.2	21.5	22.3	295.9
BL 15	9/1/98	109.8	0.5	0.1	5.3	7.0	7.0	161.3
BL surface	9/1/98	4.5	0.1	1.1	11.0	0.0	3.4	15.3
BL 2-2	10/1/98	124.1	0.2	0.0	179.8	4.2	5.6	152.7
BL 2-6	10/1/98	54.4	0.3	0.2	93.5	6.9	5.6	190.2
BL 3-1	10/1/98	74.6	BD	0.1	97.0	2.4	2.5	161.9
BL 3-5	10/1/98	98.2	BD	0.2	111.4	3.9	4.4	156.9
BL 3-7	10/1/98	9.9	0.1	0.2	36.6	5.8	6.4	118.7
BL 4-1	10/1/98	46.1	BD	0.3	71.7	4.1	5.3	132.7
BL 4-7	10/1/98	8.8	0.1	0.1	57.1	20.8	24.2	122.1
BL 5-1	10/1/98	76.4	BD	0.0	88.6	12.9	12.4	451.5
BL 5-7	10/1/98	40.1	0.9	0.1	92.5	67.9	59.2	286.2
BL 7	10/1/98	46.4	0.1	0.1	95.9	4.3	6.0	111.7
BL 8	10/1/98	66.8	0.1	0.1	81.8	7.6	7.8	356.3
BL 9-1	10/1/98	30.3	BD	0.3	79.5	4.8	5.2	182.1
BL 9-4	10/1/98	16.2	BD	0.2	65.3	5.6	6.7	161.1
BL 9-7	10/1/98	9.7	BD	0.1	55.2	28.6	30.2	122.5
BL 13-2	10/1/98	82.3	1.8	0.2	133.0	7.6	5.2	131.4
BL 13-6	10/1/98	15.9	0.5	0.3	98.9	33.8	45.4	129.5
BL 14-2	10/1/98	36.9	0.3	0.3	79.6	9.1	10.6	162.3
BL 14-6	10/1/98	20.8	BD	0.1	48.4	35.4	39.2	185.2

Table A.12 cont.

BL 15	10/1/98	117.0	1.1	0.1	215.4	2.8	12.0	170.9
BL surface	10/1/98	BD	BD	0.0	44.5	BD	-0.0	8.8
BL 2-2	11/1/98	69.9	0.2	0.1	107.4	2.8	1.4	82.7
BL 2-6	11/1/98	63.0	0.4	0.5	101.2	4.2	4.7	106.6
BL 3-1	11/1/98	85.5	0.2	0.2	120.1	2.7	4.0	95.6
BL 3-5	11/1/98	66.5	BD	0.1	93.1	3.1	3.9	96.6
BL 3-5 dup	11/1/98	0.0	BD	0.2	94.2	3.0	3.8	99.3
BL 3-7	11/1/98	16.7	BD	0.2	55.7	3.6	6.0	93.6
BL 4-1	11/1/98	72.8	BD	0.7	104.2	3.4	5.7	81.4
BL 4-7	11/1/98	22.0	BD	0.3	62.5	20.1	20.9	73.1
BL 5-1	11/1/98	38.0	0.1	0.0	67.9	7.6	9.9	182.2
BL 5-7	11/1/98	20.3	BD	0.2	43.8	83.4	45.1	337.9
BL 7	11/1/98	46.9	0.0	0.7	108.1	4.8	38.5	80.7
BL 8	11/1/98	66.0	0.0	0.4	85.3	6.0	6.2	207.9
BL 9-1	11/1/98	39.8	BD	0.0	88.8	0.8	4.3	84.7
BL 9-4	11/1/98	11.8	BD	0.3	40.3	4.2	5.5	75.6
BL 9-7	11/1/98	42.0	BD	0.1	75.2	19.0	3.1	96.1
BL 13-2	11/1/98	85.2	1.6	0.2	135.3	5.5	4.9	80.6
BL 13-6	11/1/98	64.4	0.3	0.3	98.9	20.6	17.4	73.6
BL 14-2	11/1/98	26.9	BD	0.0	60.6	9.0	10.8	159.0
BL 14-6	11/1/98	42.6	BD	0.1	69.8	24.2	20.3	124.7
BL 15	11/1/98	BD	1.8	0.5	177.2	4.0	5.9	298.9
BL surface	11/1/98	0.7	BD	1.3	16.2	0.2	8.0	5.6
BL 2-2	12/1/98	54.3	1.0	0.3	79.3	5.2	4.6	130.0
BL 2-6	12/1/98	52.7	1.1	0.2	105.6	6.3	5.6	179.2
BL 3-1	12/1/98	80.6	0.6	0.1	108.5	3.5	3.8	134.2
BL 3-5	12/1/98	46.0	BD	0.1	83.5	4.0	4.2	118.3
BL 3-5 dup	12/1/98	46.1	BD	0.2	87.3	3.8	4.2	117.6
BL 3-7	12/1/98	16.6	0.1	0.1	108.4	5.9	9.4	153.0
BL 4-1	12/1/98	36.2	0.4	0.1	61.4	4.2	6.3	110.2
BL 4-7	12/1/98	11.3	0.5	0.2	94.5	21.3	27.8	144.9
BL 5-1	12/1/98	35.0	0.4	0.1	63.2	6.7	7.8	129.1
BL 5-7	12/1/98	15.6	BD	0.1	37.8	114.3	131.9	475.1
BL 7	12/1/98	65.0	0.7	0.8	99.9	5.7	5.5	105.2
BL 8	12/1/98	52.3	0.5	0.3	71.8	7.2	6.5	263.8
BL 9-1	12/1/98	62.1	BD	0.2	66.8	4.0	4.1	138.3
BL 9-4	12/1/98	47.9	0.2	0.4	59.8	5.7	6.8	129.7
BL 9-7	12/1/98	12.8	0.1	0.1	39.2	28.9	31.0	116.3

Table A.12 cont.

BL 13-2	12/1/98	73.6	0.7	0.2	114.1	5.2	6.4	155.6
BL 13-6	12/1/98	65.9	0.5	0.1	101.2	22.5	25.4	104.8
BL 14-2	12/1/98	37.6	1.3	0.1	65.6	7.0	8.4	130.8
BL 14-6	12/1/98	34.5	0.1	0.2	46.4	19.7	21.8	275.7
BL 15	12/1/98	102.2	1.6	0.1	134.4	5.9	5.3	181.4
BL surface	12/1/98	1.1	0.1	1.8	9.7	0.9	5.5	16.5

Table A.13: Nutrient samples collected from groundwaters and surface waters at the JA Site on St. George Island between April, 1998 and March, 1999. Samples were analyzed for Ammonium (NH_4^+), Nitrite (NO_2), nitrate + nitrite (NN), Total Nitrogen (TN), soluble reactive phosphate (PO_4), Total Phosphate (TP) and Silicate (Si). All nutrient concentrations are reported in μM.

Sample Name	Date	NH4+	NO2	NN	TN	PO4	TP	Si
JA-1	4/1/98	37.8	0.0	0.2	47.6	3.9	3.0	476.3
JA-1dup	4/1/98	39.0	BD	0.1	42.8	2.7	3.1	456.5
JA-2-1	4/1/98	26.7	BD	0.0	84.2	3.0	2.6	447.4
JA-2-4	4/1/98	59.7	0.2	0.0	38.8	10.6	11.7	469.4
JA-2-7	4/1/98	0.2	0.2	0.1	16.1	79.2	39.0	436.4
JA-4-1	4/1/98	26.3	BD	0.1	30.4	8.8	9.7	506.0
JA-4-4	4/1/98	9.8	BD	0.1	23.5	53.9	23.8	547.4
JA-4-7	4/1/98	112.2	0.2	0.1	259.4	61.5	57.4	587.1
JA-7	4/1/98	103.7	0.3	0.0	129.3	54.3	26.6	509.4
JA-8-1	4/1/98	238.7	BD	0.1	52.6	33.3	28.0	469.0
JA-8-4	4/1/98	140.6	0.3	0.1	251.7	57.4	26.8	443.9
JA-8-7	4/1/98	12.8	0.4	0.1	33.3	24.7	23.1	128.7
JA-10-1	4/1/98	73.3	0.7	0.1	157.8	9.0	9.3	414.4
JA-10-4	4/1/98	540.6	0.4	BD	747.5	7.0	34.5	508.9
JA-10-7	4/1/98	29.9	0.4	BD	65.8	16.3	16.1	155.4
JA-12-1	4/1/98	24.0	1.0	0.1	4.4	7.8	5.4	572.9
JA-12-4	4/1/98	13.7	0.9	0.1	15.7		12.4	427.4
JA-12-7	4/1/98	1.6	BD	0.1	176.7	46.1	47.4	42.5
JA-14-2	4/1/98	18.2	BD	0.1	88.1	8.3	8.5	411.4
JA-14-6	4/1/98	41.0	0.9	BD	156.8	61.1	33.4	403.6
JA-surface	4/1/98	3.1	0.3	4.4	20.4	4.0	4.8	56.1
JA-1	5/1/98	37.3	2.3	0.6	83.7	4.4	2.1	412.7
JA-2-1	5/1/98	25.4	2.2	0.5	70.7	4.5	2.3	353.8
JA-2-4	5/1/98	48.5	1.3	0.6	75.7	9.4	11.4	383.4
JA-2-7	5/1/98	8.4	0.5	0.3	40.6	107.9	92.2	612.7
JA-4-1	5/1/98	35.0	2.2	0.7	80.9	8.0	8.7	508.9
JA-4-4	5/1/98	6.2	BD	0.8	34.6	51.8	45.0	442.8
JA-4-7	5/1/98	115.1	0.1	0.5	171.1	83.6	68.7	622.2
JA-7	5/1/98	96.2	1.3	0.7	118.3	51.8	46.6	457.2
JA-8-4	5/1/98	213.3	0.7	0.6	113.5	57.3	41.4	386.7
JA-10-1	5/1/98	70.2	3.8	0.6	124.2	8.0	8.4	352.8
JA-10-1-dup	5/1/98	71.1	3.8	0.3	127.5	7.8	8.4	359.3

Table A.13 cont.

JA-10-7	5/1/98	20.4	2.0	0.5	58.1	18.1	25.7	189.5
JA-12-1	5/1/98	25.2	11.1	0.5	BD	8.3	5.6	509.7
JA-12-7	5/1/98	134.7	8.0	0.3	161.0	42.3	40.2	568.4
JA-14-2	5/1/98	22.3	8.8	0.5	31.8	9.9	8.7	379.2
JA-14-6	5/1/98	38.7	3.4	0.5	134.2	62.0	56.3	360.8
JA-surface	5/1/98	2.8	0.8	34.5	16.2	2.0	5.2	62.3
JA-blank	5/1/98	2.3	0.8	0.3	BD	2.1	0.9	42.3
JA 1	6/1/98	40.5	0.3	0.1	139.0	5.0	3.6	373.3
JA 2-1	6/1/98	25.2	0.9	0.1	116.7	5.1	3.1	276.1
JA 2-4	6/1/98	79.2	0.1	0.2	372.7	18.9	20.4	291.9
JA 2-7	6/1/98	3.0	BD	BD	96.5	71.9	62.3	687.3
JA 4-1	6/1/98	36.5	1.0	0.1	113.8	9.6	8.8	315.4
JA 4-4	6/1/98	17.0	BD	BD	64.0	65.3	62.2	317.2
JA 4-7	6/1/98	190.4	0.3	BD	237.2	74.5	72.2	387.1
JA 4-7 dup	6/1/98	89.4	0.2	BD	253.7	70.3	63.8	388.1
JA 7	6/1/98	96.8	BD	BD	137.9	48.4	51.2	315.4
JA 8-4	6/1/98	131.9	BD	0.1	299.3	65.8	30.3	283.4
JA 10-1	6/1/98	63.7	1.6	0.1	163.1	9.3	8.3	251.1
JA 10-7	6/1/98	27.6	0.9	0.1	94.4	41.5	56.1	219.9
JA 12-1	6/1/98	22.7	2.1	0.1	200.3	5.5	5.5	368.9
JA 12-7	6/1/98	105.2	1.2	0.1	254.8	38.1	24.6	369.8
JA 14-2	6/1/98	39.9	1.8	0.1	130.9	5.9	7.9	267.3
JA 14-6	6/1/98	43.3	1.2	0.1	195.2	52.7	65.2	239.2
JA surface	6/1/98	3.5	BD	0.2	25.3	2.6	9.7	8.6
JA 1	7/1/98	52.6	0.4	0.1	116.5	3.2	3.7	360.7
JA 2-A	7/1/98	36.1	1.2	0.2	91.6	4.2	3.0	315.7
JA 2-B	7/1/98	133.3	BD	0.1	232.6	79.6	52.9	411.4
JA 2-7	7/1/98	5.6	BD	0.1	34.1	50.3	32.1	594.6
JA 4-1	7/1/98	49.7	0.6	0.3	103.5	24.3	22.8	337.5
JA 4-4	7/1/98	58.1	BD	BD	90.5	71.7	44.0	404.4
JA 4-7	7/1/98	54.3	BD	0.1	88.8	78.0	45.8	376.4
JA 7	7/1/98	43.0	0.6	0.4	121.4	51.0	31.0	381.0
JA 8-4	7/1/98	171.3	0.1	0.1	255.0	55.5	36.7	344.0
JA 10-1	7/1/98	73.1	2.0	0.1	141.8	6.9	7.8	273.9
JA 10-7	7/1/98	51.6	0.5	0.1	77.4	43.0	28.2	247.1
JA 12-1	7/1/98	30.8	2.9	0.2	107.2	6.7	6.2	408.8
JA 12-7	7/1/98	91.8	1.2	BD	167.7	30.5	28.3	351.6
JA 14-2	7/1/98	31.5	3.0	0.3	96.0	9.6	8.6	282.9

Table A.13 cont.

JA 14-6	7/1/98	59.6	1.0	0.4	137.2	48.7	30.7	228.2
JA surface	7/1/98	4.3	BD	0.4	23.1	0.5	12.2	44.5
JA 1	8/1/98	38.2	0.3	BD	119.9	1.3	2.6	358.6
JA 2-A	8/1/98	36.2	BD	BD	122.4	1.7	3.1	762.7
JA 2-B	8/1/98	120.1	0.0	BD	193.8	198.1	213.4	737.1
JA 2-7	8/1/98	6.2	7.3	122.2	167.3	27.0	28.3	339.7
JA 4-1	8/1/98	43.2	0.7	0.3	103.3	7.9	8.7	442.8
JA 4-4	8/1/98	88.9	BD	0.1	142.8	91.3	97.3	352.8
JA 4-7	8/1/98	17.1	0.5	1.7	79.0	37.1	39.9	352.4
JA 7	8/1/98	84.7	0.3	BD	118.6	56.5	52.5	352.4
JA 8-4	8/1/98	62.1	0.1	BD	219.7	50.3	46.6	261.1
JA 10-1	8/1/98	56.2	BD	BD	150.8	5.6	6.6	230.1
JA 10-7	8/1/98	47.0	0.4	BD	98.6	40.6	41.0	276.6
JA 12-2	8/1/98	16.7	0.2	BD	97.7	9.7	5.4	349.8
JA 12-7	8/1/98	36.2	0.2	BD	114.1	21.4	22.5	346.4
JA 14-2	8/1/98	19.7	BD	BD	123.5	7.9	6.8	277.1
JA 14-6	8/1/98	45.1	0.1	BD	95.9	27.4	29.1	200.6
JA surface	8/1/98	1.2	BD	0.8	14.8	0.7	0.8	54.2
JA 1	9/1/98	39.4	0.5	0.1	BD	3.4	1.7	332.2
JA 2-1	9/1/98	36.1	1.9	0.1	BD	5.2	3.7	321.0
JA 2-4	9/1/98	61.9	BD	BD	74.4	93.3	94.0	517.5
JA 2-7	9/1/98	4.2	BD	BD	30.4	82.3	78.7	677.9
JA 4-1	9/1/98	59.3	BD	0.1	60.4	12.2	15.8	328.5
JA 4-4	9/1/98	76.0	BD	0.1	83.5	66.6	75.7	355.9
JA 4-7	9/1/98	32.0	BD	0.1	86.4	50.8	50.0	389.8
JA 7	9/1/98	30.2	BD	0.4	80.6	43.5	48.4	336.5
JA 7 dup	9/1/98	32.9	0.2	0.1	80.2	47.5	48.0	336.9
JA 8-4	9/1/98	128.8	BD	0.1	165.0	56.5	50.5	316.1
JA 10-1	9/1/98	76.5	1.8	0.2	1.9	6.6	9.3	291.9
JA 10-7	9/1/98	39.0	0.1	0.2	47.2	24.0	28.2	140.2
JA 12-1	9/1/98	25.1	1.1	0.2	BD	7.4	9.4	397.7
JA 12-7	9/1/98	54.3	2.9	0.1	BD	34.6	39.4	387.7
JA 14-2	9/1/98	26.9	3.0	0.1	BD	8.5	14.1	289.4
JA 14-6	9/1/98	37.8	0.7	0.1	BD	40.8	41.7	276.8
JA surface	9/1/98	2.5	BD	0.2	14.4	0.2	1.4	16.9
BL blank	9/1/98	BD	BD	0.3	BD	0.4	0.1	9.4
JA 1	10/1/98	54.5	1.0	0.2	115.1	3.9	2.3	314.2
JA 2-A	10/1/98	50.0	1.7	0.1	117.0	5.1	1.8	302.2

Table A.13 cont.

JA 2-B	10/1/98	118.5	BD	0.0	367.6	48.0	55.1	318.2
JA 2-7	10/1/98	158.1	1.6	0.1	445.7	182.8	116.3	38.1
JA 4-1	10/1/98	123.1	0.1	0.1	174.3	25.7	34.1	302.8
JA 4-4	10/1/98	74.6	1.1	BD	512.4	32.1	38.1	312.8
JA 4-7	10/1/98	111.2	BD	0.1	527.9	97.9	78.3	313.5
JA 7	10/1/98	53.7	0.9	0.1	195.0	43.5	51.3	288.9
JA 8-4	10/1/98	21.3	BD	0.3	254.3	46.8	50.4	303.7
JA 10-1	10/1/98	101.8	1.3	0.2	191.5	8.8	9.0	263.5
JA 10-7	10/1/98	29.7	1.1	0.1	112.1	23.4	27.3	168.5
JA 12-1	10/1/98	25.9	1.7	0.1	181.4	6.8	5.1	332.7
JA 12-7	10/1/98	125.1	4.3	0.3	270.6	39.5	37.3	388.0
JA 14-2	10/1/98	19.9	3.2	0.3	189.5	9.7	8.3	295.8
JA 14-2 dup	10/1/98	21.0	3.2	0.2	181.9	10.2	6.7	285.5
JA 14-6	10/1/98	45.6	1.3	0.4	140.6	48.9	47.5	273.7
JA surface	10/1/98	3.8	0.8	5.6	30.8	0.7	9.3	58.3
JA aerobic	10/1/98	553.9	0.1	0.1	315.2	126.1	12.6	381.6
JA 1	11/1/98	55.5	1.2	0.2	105.0	2.5	1.4	200.7
JA 2-A	11/1/98	53.8	1.1	0.4	117.7	3.6	2.1	217.8
JA 2-B	11/1/98	144.4	BD	0.3	434.1	48.1	54.1	268.4
JA 2-7	11/1/98	80.0	BD	0.2	381.6	132.0	64.3	358.0
JA 4-1	11/1/98	63.7	0.2	0.2	117.8	37.6	31.9	218.3
JA 4-4	11/1/98	69.5	0.1	0.2	351.9	118.5	65.9	234.6
JA 4-7	11/1/98	93.8	BD	BD	410.4	126.8	74.2	269.0
JA 7	11/1/98	36.2	0.9	BD	156.3	32.6	34.7	201.0
JA 8-4	11/1/98	0.0	BD	0.1	236.3	34.2	35.7	208.3
JA 8-4 dup	11/1/98	21.9	BD	0.1	239.1	31.9	37.5	217.3
JA 10-1	11/1/98	66.8	1.9	0.2	141.7	9.3	11.8	179.7
JA 10-7	11/1/98	53.9	BD	0.1	61.9	24.1	27.8	165.1
JA 12-1	11/1/98	35.8	1.9	BD	114.6	4.2	4.8	215.1
JA 12-7	11/1/98	104.7	5.5	BD	177.3	41.3	30.7	268.8
JA 14-2	11/1/98	23.4	4.1	BD	108.5	8.2	7.2	201.0
JA surface	11/1/98	0.5	BD	1.4	13.8	0.7	-0.0	10.5
JA 1	12/1/98	52.8	1.7	0.1	100.4	4.7	2.4	293.6
JA 2-A	12/1/98	60.3	1.8	0.0	115.3	3.6	2.9	319.7
JA 2-B	12/1/98	55.5	1.6	0.3	187.6	15.0	18.2	328.8
JA 2-7	12/1/98	136.3	0.3	0.4	250.1	111.0	61.7	451.0
JA 4-1	12/1/98	91.8	0.1	0.1	121.9	46.5	27.7	268.3
JA 4-4	12/1/98	741.7	0.0	0.3	1212.4	220.0	90.5	397.9

Table A.13 cont.

JA 4-7	12/1/98	240.7	0.1	0.2	494.5	103.2	66.3	397.9
JA 7	12/1/98	53.1	1.1	2.5	178.3	55.5	33.2	294.7
JA 8-4	12/1/98	159.8	0.1	0.3	268.3	46.1	29.0	272.5
JA 10-1	12/1/98	83.1	0.9	0.2	201.6	54.4	31.0	301.8
JA 10-7	12/1/98	41.9	0.3	0.3	71.9	37.7	28.0	265.9
JA 10-7 dup	12/1/98	43.2	0.1	0.2	70.6	35.3	28.6	266.1
JA 12-1	12/1/98	36.5	1.7	0.2	150.3	7.3	5.3	314.7
JA 12-7	12/1/98	62.4	1.3	0.2	149.6	24.6	29.7	330.5
JA 14-2	12/1/98	27.0	3.3	0.8	156.4	9.7	6.6	295.7
JA surface	12/1/98	BD	0.2	5.2	18.7	1.3	8.2	38.4
JA-1	1/1/99	62.4	0.1	0.2	112.7	2.3	2.1	309.8
JA-2A	1/1/99	71.3	0.6	1.7	131.2	5.4	2.8	332.8
JA-2B	1/1/99	305.5	0.1	0.1	515.7	89.3	54.8	413.1
JA-2-7	1/1/99	98.5	BD	1.2	113.8	14.3	9.5	322.7
JA-4-1	1/1/99	89.7	0.1	0.2	117.2	17.1	12.1	275.1
JA-4-4	1/1/99	958.8	BD	0.2	1032.2	80.0	57.7	395.1
JA-4-7	1/1/99	351.0	BD	0.2	571.4	49.8	49.7	282.0
JA-7	1/1/99	109.2	0.7	0.6	137.1	50.4	44.4	296.1
JA-8-4	1/1/99	195.8	BD	0.2	194.4	30.8	45.6	288.8
JA-8-4dup	1/1/99	196.0	BD	0.2	197.8	30.5	44.7	260.7
JA-10-1	1/1/99	155.7	0.1	0.3	161.1	34.8	45.7	312.1
JA-10-7	1/1/99	80.9	0.1	0.2	95.6	18.8	18.9	172.8
JA-14-2	1/1/99	26.7	2.7	0.4	189.8	8.2	3.7	307.4
JA surface	1/1/99	BD	0.0	0.4	18.5	0.2	8.3	31.2
JA-1	2/1/99	52.5	0.1	0.2	103.2	3.4	2.9	298.7
JA-2A	2/1/99	65.1	0.1	0.0	98.5	3.8	3.0	331.9
JA-2B	2/1/99	294.2	BD	0.2	737.6	84.9	63.3	357.6
JA-2-7	2/1/99	32.0	13.3	1033.9	932.1	2.2	9.0	368.3
JA-4-1	2/1/99	95.2	BD	2.0	129.4	48.7	45.9	210.9
JA-4-4	2/1/99	243.1	0.5	2.7	234.1	50.0	38.2	261.1
JA-4-7	2/1/99	166.9	0.1	9.4	206.6	41.6	43.7	265.7
JA-7	2/1/99	101.5	BD	0.5	135.8	48.6	41.9	259.3
JA-8-4	2/1/99	175.2	BD	0.4	204.0	38.0	40.2	277.3
JA-8-4dup	2/1/99	177.5	BD	0.6	204.1	42.7	39.5	273.6
JA-10-1	2/1/99	78.9	0.2	0.3	135.0	46.5	44.1	286.2
JA-10-7	2/1/99	93.0	BD	0.4	99.6	13.0	19.0	162.5
JA-14-2	2/1/99	48.0	BD	0.1	130.2	6.4	6.4	292.4
JA-surf	2/1/99	1.1	BD	19.5	35.5	0.3	5.7	87.2

Table A.13 cont.

JA-1	3/1/99	47.9	0.1	0.9	94.2	0.3	2.2	292.1
JA-2A	3/1/99	47.9	0.6	0.8	109.9	3.6	1.8	321.4
JA-2B	3/1/99	124.9	0.3	0.8	258.2	28.9	59.0	314.5
JA-2-7	3/1/99	172.0	0.1	1.1	285.9	10.6	14.5	544.0
JA-4-1	3/1/99	55.8	0.3	0.8	85.5	30.5	53.3	276.2
JA-4-4	3/1/99	6.8	BD	0.7	27.0	29.0	49.5	386.9
JA-4-7	3/1/99	38.6	0.1	1.3	86.6	27.0	57.8	312.8
JA-4-7 dup	3/1/99	38.4	0.1	1.2	86.6	31.2	58.5	305.7
JA-7	3/1/99	61.9	0.0	0.8	103.9	39.0	90.8	256.9
JA-8-4	3/1/99	139.7	0.1	0.8	168.6	38.5	79.8	268.7
JA-14-2	3/1/99	34.0	0.5	0.8	108.8	4.1	3.9	293.0
JA-surf	3/1/99	0.8	BD	0.6	13.4	0.9	17.1	15.9

Table A.14: Nutrient samples collected from groundwaters and surface waters at the Background Sites located on Little St. George Island between February, 1998 and May, 1999. Samples were collected on the western- (W) and eastern- (E) sides of the island. Samples were analyzed for Ammonium (NH_4^+), Nitrite (NO_2), nitrate + nitrite (NN), Total Nitrogen (TN), soluble reactive phosphate (PO_4), Total Phosphate (TP) and Silicate (Si). All nutrient concentrations are reported in μM.

Sample Name	Date	NH4+	NO2	NN	TN	PO4	TP	Si
W-1	Feb-98	107.3	0.1	0.1	121.9	7.6	7.6	147.3
W-1 dup	Feb-98	110.7	0.1	0.1	121.6	7.0	7.0	146.4
W-4	Feb-98	8.3	1.8	0.1	148.6	7.4	7.4	131.0
W-7	Feb-98	2.6	1.6	0.1	128.1	4.0	4.0	90.8
W-Surface	Feb-98	3.2	0.1	4.5	18.3	1.1	1.1	48.7
E-1	Feb-98	8.4	0.6	BD	79.6	9.5	9.5	94.8
E-4	Feb-98	3.3	1.2	BD	122.1	6.1	6.1	60.9
E-7	Feb-98	4.1	0.4	0.3	46.8	3.6	3.6	43.7
E-Surface	Feb-98	4.5	BD	1.2	15.4	1.1	1.1	34.7
Blk	May-98	BD	BD	0.2	0.6	0.2	1.4	107.8
E-surface	May-98	BD	BD	0.1	10.5	0.1	7.9	146.0
W-surface	May-98	BD	BD	0.3	19.3	0.1	6.5	222.8
E-1	May-98	32.5	BD	0.2	62.4	4.5	5.6	249.4
E-3	May-98	32.1	BD	0.3	62.0	4.5	5.8	195.9
E-7	May-98	BD	BD	0.1	61.6	2.8	2.3	214.1
W-1	May-98	53.4	BD	0.2	82.4	6.8	8.1	203.2
W-3	May-98	28.9	BD	0.1	58.2	3.1	4.0	261.4
W-7	May-98	BD	BD	0.1	8.0	5.4	3.9	129.9
E-1	Jul-98	40.6	0.3	0.2	66.6	6.2	7.1	96.3
E-4	Jul-98	34.5	0.7	0.4	62.5	5.4	6.9	122.1
E-7	Jul-98	1.9	0.2	0.0	60.1	2.9	4.7	66.2
W-1	Jul-98	69.9	0.5	0.4	92.7	5.1	8.9	128.8
W-4	Jul-98	21.9	0.4	0.3	124.3	1.7	2.3	158.7
W-7	Jul-98	0.7	3.2	0.2	88.4	7.5	6.3	116.7
W-surface	Jul-98	BD	BD	0.6	9.8	BD	BD	22.2
E-surface	Jul-98	BD	0.1	0.4	10.2	0.4	13.9	23.7
E surface	Oct-98	3.9	0.8	5.6	26.2	0.9	8.1	71.1
W surface	Oct-98	5.1	0.9	7.1	31.5	0.9	9.7	75.9
E-1	Oct-98	14.7	0.2	0.1	61.7	4.9	7.1	91.3
E-4	Oct-98	7.4	0.1	0.1	75.5	4.3	7.9	86.9
E-4 dup	Oct-98	8.8	BD	0.2	73.9	4.8	7.0	87.6

Table A.14 Cont.

E-7	Oct-98	3.9	0.2	0.1	40.1	2.1	4.3	90.8
W-1	Oct-98	56.8	BD	0.1	110.2	6.4	7.0	143.1
W-4	Oct-98	2.1	2.9	0.3	188.0	15.6	14.6	119.4
W-7	Oct-98	78.5	0.4	0.1	127.9	3.2	4.8	114.9
W-surf	Feb-99	BD	BD	2.6	13.3	0.2	15.3	26.0
E-surf	Feb-99	BD	0.0	5.7	19.8	0.2	10.7	41.3
W-1	Feb-99	BD	0.8	0.7	68.5	1.4	9.4	106.2
W-4	Feb-99	52.0	2.7	0.3	62.4	1.4	1.9	116.8
W-7	Feb-99	4.1	0.2	0.6	119.2	2.3	2.5	68.5
E-1	Feb-99	35.7	BD	0.2	66.9	4.4	6.2	91.5
E-1dup	Feb-99	35.0	0.1	0.1	68.1	5.1	6.6	93.3
E-4	Feb-99	30.9	BD	0.1	58.0	3.7	6.2	70.5
E-7	Feb-99	5.6	BD	0.1	33.4	1.6	2.8	36.3
W-1	May-99	31.7	1.0	0.5	67.8	7.9	12.6	111.2
W-4	May-99	13.1	1.1	0.4	53.8	4.6	7.2	143.2
W-7	May-99	4.2	0.8	0.4	59.6	2.6	3.7	68.0
W-Surface	May-99	BD	BD	0.3	17.5	0.8	9.9	9.1
E-1	May-99	38.6	0.1	0.7	66.6	4.1	6.1	95.5
E-4	May-99	24.5	BD	0.2	47.0	4.1	7.9	90.4
E-6	May-99	0.6	0.1	0.3	25.4	1.9	4.8	60.3
E-Surface	May-99	BD	0.1	1.2	12.7	0.9	7.2	15.4

Table A.15: Bacteriological samples collected from groundwaters and surface waters at the background sites between April, 1998 and May, 1999. All samples are reported as the number pf colonies per 100 mL.

Sample Name	Date	Total Coliform	E. Coli	Fecal Colifom
East 1	4/1/98	89	BD	
East 7	4/1/98	110	BD	
West 1	4/1/98	85	BD	
West 7	4/1/98	902	BD	
East 1	6/1/98	BD	BD	
East 7	6/1/98	1360	BD	
East Surface	6/1/98	6040	BD	
West 1	6/1/98	320	BD	
West 7	6/1/98	960	BD	
West Surface	6/1/98	10,100	BD	
East 7	7/1/98	140	BD	BD
West 4	7/1/98	BD	BD	BD
East 1	10/1/98	600	BD	BD
East 4	10/1/98	640	BD	BD
East 7	10/1/98	600	BD	BD
East Surface	10/1/98	7760	BD	4
West 1	10/1/98	5500	2	18
West 4	10/1/98	9340	BD	2
West 7	10/1/98	3760	BD	BD
West Surface	10/1/98	13,200	BD	34
East 1	2/1/99	BD	BD	BD
East 7	2/1/99	9120	BD	BD
West 1	2/1/99	BD	BD	BD
West 7	2/1/99	17,440	BD	BD
East 1	5/1/99	20	BD	BD
East 7	5/1/99	BD	BD	BD
East Surface	5/1/99	200	BD	BD
West 1	5/1/99	160	8	10
West 7	5/1/99	60	BD	BD
West Surface	5/1/99	80	2	2

Table A.16: Bacteriological samples collected from groundwaters and surface waters at the SP site between February, 1998 and May, 1999. All samples are reported as the number pf colonies per 100 mL.

Sample Name	Date	Total Coliform	E. Coli	Fecal Colifom
SP 1	2/1/98	1764	64	
SP 2	2/1/98	296	BD	
SP 3	2/1/98	195	BD	
SP 4	2/1/98	294	BD	
SP 5	2/1/98	824	BD	
SP 6	2/1/98	750	BD	
SP 7	2/1/98	1312	BD	
SP 8	2/1/98	1140	BD	
SP 9	2/1/98	1034	2	
SP 10	2/1/98	3504	82	
SP 11	2/1/98	180	BD	
SP 12	2/1/98	39	BD	
SP 14-4	2/1/98	240	BD	
SP 15-1	2/1/98	180	BD	
SP 15-7	2/1/98	BD	BD	
Blank	2/1/98	7	BD	
Surface Water	2/1/98	3960	60	
SP 3	3/1/98	260	BD	
SP 7	3/1/98	BD	BD	
SP 9	3/1/98	160	BD	
SP 14-1	3/1/98	BD	BD	
SP 14-4	3/1/98	BD	BD	
SP 14-7	3/1/98	2280	290	
SP 15-1	3/1/98	180	BD	
SP 15-7	3/1/98	BD	BD	
Blank	3/1/98	BD	BD	
Septic	3/1/98	>200,000	117,600	
SP 3	4/1/98	1340	42	
SP 6	4/1/98	780	BD	
SP 7	4/1/98	140	24	
SP 9	4/1/98	800	150	
SP 12	4/1/98	4480	BD	
SP 14-1	4/1/98	100	BD	
SP 14-7	4/1/98	320	BD	

Table A.16 Cont.

SP 15-1	4/1/98	BD	BD	
SP 15-7	4/1/98	220	BD	
Surface	4/1/98	1720	BD	
Blank	4/1/98	180	BD	
SP 14-1	5/1/98	BD	BD	
SP 14-7	5/1/98	BD	BD	
SP 15-1	5/1/98	BD	BD	
SP 12	6/1/98	250	BD	BD
SP 14-1	6/1/98	540	BD	BD
SP 14-7	6/1/98	100	BD	BD
SP 15-1	6/1/98	BD	BD	BD
Blank	6/1/98	12	BD	BD
SP 12	7/1/98	69,120	BD	26
SP 14-1	7/1/98	380	BD	BD
SP 14-7	7/1/98	60	BD	28
SP 15-1	7/1/98	1160	BD	BD
SP 14-1	8/1/98	40	BD	BD
SP 14-7	8/1/98	260	BD	BD
SP 15-1	8/1/98	340	BD	BD
SP 12	9/1/98	1780	BD	BD
SP 14-1	9/1/98	10	BD	BD
SP 14-7	9/1/98	1600	BD	24
SP 15-1	9/1/98	10	BD	BD
SP 15-7	9/1/98	8960	BD	470
SP 12	10/1/98	740	BD	BD
SP 14-1	10/1/98	140	BD	BD
SP 14-7	10/1/98	4560	BD	10
SP 15-1	10/1/98	80	BD	BD
SP 15-7	10/1/98	2560	BD	470
SP 12	11/1/98	2600	BD	10
SP 14-1	11/1/98	2020	BD	BD
SP 14-7	11/1/98	4960	BD	6
SP 15-1	11/1/98	500	BD	4
SP 15-7	11/1/98	120	BD	BD
Blank	11/1/98	180	BD	14
SP 12	12/1/98	220	BD	BD
SP 14-1	12/1/98	4880	BD	BD

Table A.16 Cont.

SP 14-7	12/1/98	560	BD	BD
SP 15-1	12/1/98	240	BD	BD
SP 15-7	12/1/98	260	BD	BD
Blank	12/1/98	160	BD	BD
SP 12	1/1/99	1360	BD	BD
SP 14-1	1/1/99	220	BD	BD
SP 14-7	1/1/99	60	BD	BD
SP 15-1	1/1/99	40	BD	BD
SP 15-7	1/1/99	40	BD	BD
SP 14-1	2/1/99	BD	BD	BD
SP 14-7	2/1/99	140	BD	BD
SP 15-1	2/1/99	40	BD	BD
SP 15-7	2/1/99	BD	BD	BD
SP 14-1	3/1/99	40	BD	BD
SP 14-7	3/1/99	260	BD	BD
SP 15-1	3/1/99	BD	BD	BD
SP 15-7	3/1/99	340	6	6
SP 14-1	4/1/99	140	8	8
SP 14-7	4/1/99	BD	BD	BD
SP 15-1	4/1/99	BD	BD	BD
SP 15-7	4/1/99	40	6	6
SP 14-1	5/1/99	BD	BD	BD
SP 14-7	5/1/99	BD	BD	BD
SP 15-1	5/1/99	60	BD	BD
SP 15-7	5/1/99	920	2	3
Blank	5/1/99	BD	BD	BD

Table A.17: Bacteriological samples collected from groundwaters and surface waters at the BL site between April, 1998 and December, 1998. All samples are reported as the number pf colonies per 100 mL.

Sample Name	Date	Total Coliform	E. Coli	Fecal Colifom
BL 2-2	4/1/98	3720	220	
BL 3-1	4/1/98	7040	4	
BL 3-7	4/1/98	2320	18	
BL 6-2	4/1/98	3200	106	
BL 6-6	4/1/98	3760	38	
BL 9-1	4/1/98	700	4	
BL 9-7	4/1/98	1520	BD	
Surface	4/1/98	5680	BD	
BL 3-1	5/1/98	80	BD	
BL 3-7	5/1/98	500	BD	
BL 2-2	6/1/98	480	BD	BD
BL 3-1	6/1/98	1420	BD	BD
BL 3-7	6/1/98	BD	BD	BD
BL 9-1	6/1/98	4000	BD	BD
BL 9-7	6/1/98	2940	BD	BD
Blank	6/1/98	8	BD	BD
BL 2-2	7/1/98	140	BD	BD
BL 3-1	7/1/98	1120	BD	BD
BL 3-7	7/1/98	40	BD	BD
BL 9-1	7/1/98	9590	BD	BD
BL 9-7	7/1/98	220	BD	34
BL 2-2	8/1/98	20	BD	BD
BL 3-1	8/1/98	40	BD	BD
BL 3-7	8/1/98	300	BD	BD
BL 9-1	8/1/98	100	BD	BD
BL 9-7	8/1/98	450	BD	BD
Blank	8/1/98	110	BD	BD
BL 2-2	9/1/98	40	BD	BD
BL 3-1	9/1/98	50	BD	BD
BL 3-7	9/1/98	230	BD	BD
BL 4-7	9/1/98	1550	BD	BD
BL 5-7	9/1/98	380	BD	BD
BL 9-1	9/1/98	140	BD	BD
BL 9-7	9/1/98	370	BD	BD

Table A.17 Cont.

BL 3-1	10/1/98	BD	BD	BD
BL 3-7	10/1/98	400	BD	BD
BL 4-7	10/1/98	1580	BD	BD
BL 5-7	10/1/98	35,360	BD	8
BL 2-2	11/1/98	BD	BD	BD
BL 3-1	11/1/98	BD	BD	BD
BL 3-7	11/1/98	1040	BD	BD
BL 4-7	11/1/98	760	BD	BD
BL 5-7	11/1/98	BD	BD	8
BL 9-1	11/1/98	360	BD	BD
BL 9-7	11/1/98	BD	BD	BD
BL 3-1	12/1/98	80	BD	BD
BL 3-7	12/1/98	100	BD	BD
BL 4-7	12/1/98	BD	BD	BD
BL 5-7	12/1/98	BD	BD	BD
BL 9-1	12/1/98	120	BD	BD
BL 9-7	12/1/98	460	BD	4

Table A.18: Bacteriological samples collected from groundwaters and surface waters at the JA site between April, 1998 and March, 1999. All samples are reported as the number pf colonies per 100 mL.

Sample Name	Date	Total Coliform	E. Coli	Fecal Colifom
JA 1	4/1/98	3840	22	
JA 2-1	4/1/98	160	BD	
JA 2-7	4/1/98	5680	60	
JA 4-4	4/1/98	7360	BD	
JA 10-1	4/1/98	60	BD	
Ja 10-7	4/1/98	3840	4	
Surface	4/1/98	7360	BD	
JA 2-7	5/1/98	2880	BD	
JA 2-1	5/1/98	BD	BD	
Blank	5/1/98	BD	BD	
JA 2-1	6/1/98	20	BD	BD
JA 2-7	6/1/98	100	BD	BD
JA 4-1	6/1/98	440	BD	BD
JA 4-7	6/1/98	700	BD	BD
JA 7	6/1/98	18,900	BD	BD
JA 8-4	6/1/98	1300	BD	BD
JA 2-1	7/1/98	180	BD	BD
JA 2-4	7/1/98	80	BD	BD
JA 2-7	7/1/98	80	BD	BD
JA 4-1	7/1/98	880	BD	BD
JA 4-7	7/1/98	3180	BD	BD
JA 7	7/1/98	3620	BD	BD
JA 2-1	8/1/98	60	BD	BD
JA 2-4	8/1/98	30	BD	BD
JA 2-7	8/1/98	310	BD	BD
JA 4-1	8/1/98	30	BD	BD
JA 4-7	8/1/98	910	BD	BD
JA 8-4	8/1/98	60	BD	BD
Blank	8/1/98	640	BD	BD
JA 2-1	9/1/98	BD	BD	BD
JA 2-4	9/1/98	10	BD	BD
JA 2-7	9/1/98	90	BD	BD
JA 4-1	9/1/98	110	BD	BD

Table A.18 Cont.

JA 4-7	9/1/98	1960	BD	16
JA 8-4	9/1/98	BD	BD	BD
Blank	9/1/98	BD	BD	BD
JA 2-1	10/1/98	BD	BD	BD
JA 2-4	10/1/98	BD	BD	BD
JA 2-7	10/1/98	820	BD	BD
JA 4-1	10/1/98	140	BD	BD
JA 4-7	10/1/98	3860	8	62
JA 8-4	10/1/98	40	BD	BD
Blank	10/1/98	180	BD	BD
JA 2-1	11/1/98	BD	BD	BD
JA 2-4	11/1/98	1360	BD	10
JA 2-7	11/1/98	3160	BD	4
JA 4-1	11/1/98	480	BD	BD
JA 4-7	11/1/98	640	BD	BD
JA 8-4	11/1/98	160	BD	BD
JA 2-1	12/1/98	BD	BD	BD
JA 2-4	12/1/98	160	BD	BD
JA 2-7	12/1/98	280	BD	BD
JA 4-1	12/1/98	60	BD	BD
JA 4-7	12/1/98	560	BD	BD
JA 8-4	12/1/98	180	BD	BD
JA 2-1	1/1/99	60	BD	BD
JA 2-4	1/1/99	100	BD	BD
JA 2-7	1/1/99	2200	BD	BD
JA 4-1	1/1/99	140	BD	BD
JA 4-7	1/1/99	660	BD	BD
JA 8-4	1/1/99	BD	BD	BD
JA 2-1	2/1/99	BD	BD	BD
JA 2-4	2/1/99	BD	BD	BD
JA 2-7	2/1/99	740	BD	BD
JA 4-1	2/1/99	360	BD	58
JA 4-7	2/1/99	380	BD	BD
JA 8-4	2/1/99	BD	BD	BD
JA 2-1	3/1/99	20	BD	BD
JA 2-4	3/1/99	220	BD	BD

Table A.18 Cont.

JA 2-7	3/1/99	120	BD	16
JA 4-1	3/1/99	260	2	BD
JA 4-7	3/1/99	440	6	10
Blank	3/1/99	BD	BD	BD

Table A.18: Bacteriological samples collected from groundwaters and surface waters at the background sites between April, 1998 and May, 1999. All samples are reported as the number pf colonies per 100 mL.

Sample Name	Date	Total Coliform	E. Coli	Fecal Colifom
East 1	4/1/98	89	BD	
East 7	4/1/98	110	BD	
West 1	4/1/98	85	BD	
West 7	4/1/98	902	BD	
East 1	6/1/98	BD	BD	
East 7	6/1/98	1360	BD	
East Surface	6/1/98	6040	BD	
West 1	6/1/98	320	BD	
West 7	6/1/98	960	BD	
West Surface	6/1/98	10,100	BD	
East 7	7/1/98	140	BD	BD
West 4	7/1/98	BD	BD	BD
East 1	10/1/98	600	BD	BD
East 4	10/1/98	640	BD	BD
East 7	10/1/98	600	BD	BD
East Surface	10/1/98	7760	BD	4
West 1	10/1/98	5500	2	18
West 4	10/1/98	9340	BD	2
West 7	10/1/98	3760	BD	BD
West Surface	10/1/98	13,200	BD	34
East 1	2/1/99	BD	BD	BD
East 7	2/1/99	9120	BD	BD
West 1	2/1/99	BD	BD	BD
West 7	2/1/99	17,440	BD	BD
East 1	5/1/99	20	BD	BD
East 7	5/1/99	BD	BD	BD
East Surface	5/1/99	200	BD	BD
West 1	5/1/99	160	8	10
West 7	5/1/99	60	BD	BD
West Surface	5/1/99	80	2	2