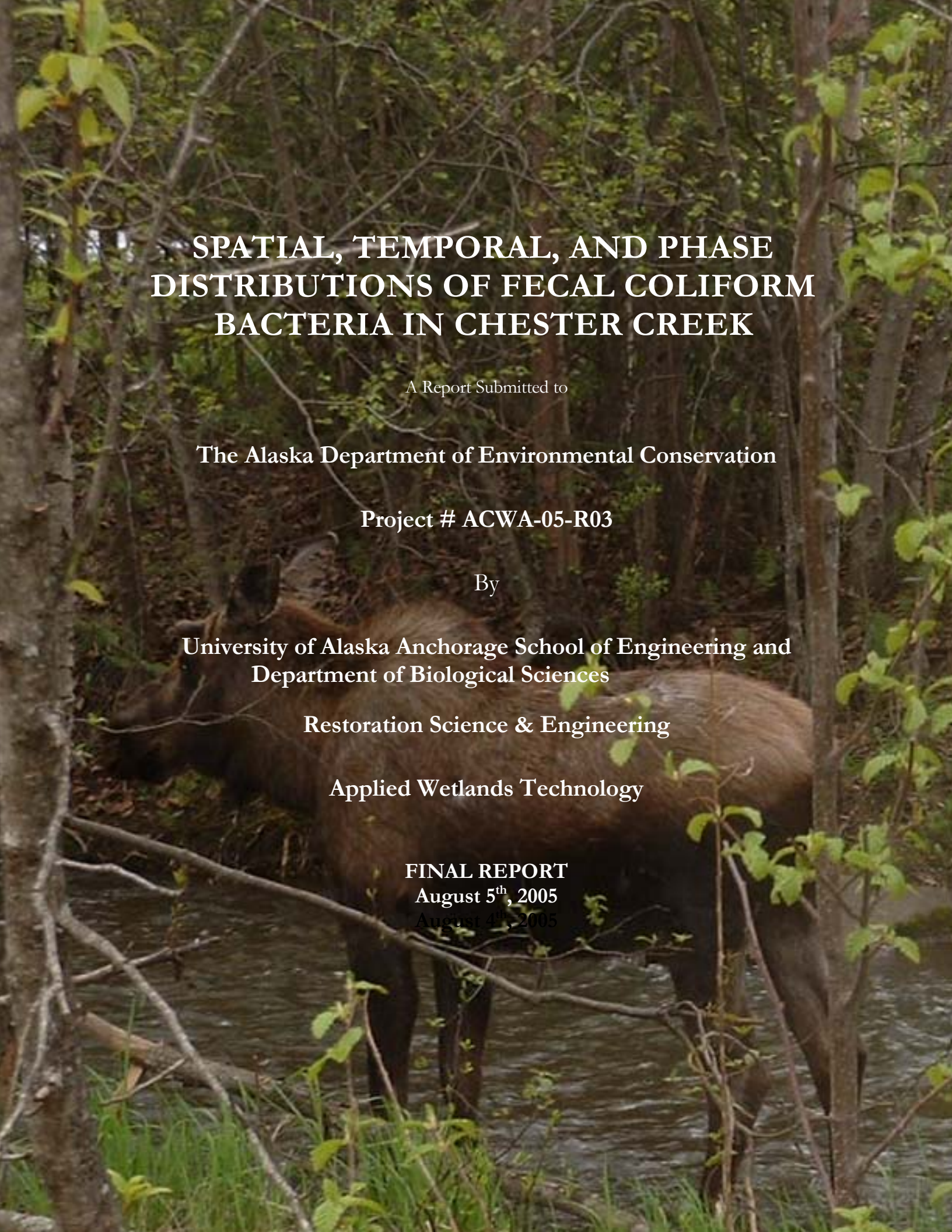

SPATIAL, TEMPORAL, AND PHASE DISTRIBUTIONS OF FECAL COLIFORM BACTERIA IN CHESTER CREEK

A Report Submitted to

The Alaska Department of Environmental Conservation

Project # ACWA-05-R03

By

University of Alaska Anchorage School of Engineering and Department of Biological Sciences

Restoration Science & Engineering

Applied Wetlands Technology

FINAL REPORT
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1. INTRODUCTION

This project represents a collaborative effort designed to better understand spatial, temporal and phase distributions of fecal coliform (FC) bacteria in Chester Creek, Anchorage, Alaska. Historical and field data were evaluated to identify correlations between fecal coliform bacteria populations and a wide variety of other parameters including flow, temperature, pH, conductivity, turbidity, and total suspended solids. These measurements were intended to aid in defining a conceptual model that would help characterize the geographical origin and dynamics of the FC bacteria in Chester Creek. The results reported here are anticipated to promote an appropriate mitigation strategy that will aid in the recovery of Chester Creek from fecal coliform contamination.

A primary goal of this project was to provide defensible compliance data through weekly FC sampling. This goal was accomplished, and the results are detailed in the report. A secondary goal was to investigate the relative FC loadings contributed by a list of potential sources, and to provide recommendations regarding the mitigation of the load. Potential sources specifically targeted by the Alaska Department of Environmental Conservation (ADEC) for further investigation include 1) Leaking Sewers, 2) Leaking Septic Systems, 3) Domestic Pets, 4) Wildlife, and 5) Outdoor Human Activity. To put into perspective the possible contribution of these and other sources, a list of typical fecal coliform densities associated with warm blooded animals and waste streams is presented in Table 1 below:

Table 1. Typical Fecal Coliform Densities Observed in Animal Feces and Waste Streams

Feces/Waste Stream	Fecal Coliform (Density/gm)	Unit Discharge (lbs. feces/day)
Human	1.3×10^7	0.35
Cats	7.9×10^6	0.15
Dogs	2.3×10^7	0.32
Rats	1.6×10^5	0.08
Cows	2.3×10^5	15.4
Ducks	3.3×10^7	0.15
Waterfowl	3.3×10^7	0.18-0.35
Raw Sewage	6.4×10^6	n/a
Combined Sewer Overflow	$10^4 - 10^6$	n/a
Failed Septic Systems	$10^4 - 10^6$	n/a
Urban Stormwater Runoff	2.0×10^4	n/a
Forest Runoff	$10^1 - 10^2$	n/a

*Adapted from Schueler and Holland (2000), "Microbes in Urban Watersheds: Sources, Concentrations and Pathways." **The Practice of Watershed Protection**, Center for Watershed Protection, Elliot City, MD.

With regard to the identification of potential sources, the original sampling strategy was designed to geographically isolate potential sources by measuring FC concentrations upstream and downstream of potential source areas. After several months of work, however, it was determined that the observed variability in the stream FC concentrations confounded efforts to isolate sources in this fashion. Consequently, the experimental design was modified in late 2004 to reflect a more mechanistic approach in which the pathways that lead to non-point source loading were investigated. From the data collected regarding the non-point source pathways, inferences regarding the possible contributions of the five listed potential sources were made.

2. MATERIALS AND METHODS

2.1 Field Measurements and Laboratory Techniques

Please refer to the Quality Assurance Project Plan as well as the Laboratory Standard Operating Procedures documents located in the Appendix for a detailed description of the laboratory methods.

2.2 Experimental Design

As a first step in the experimental design process, the research team conducted a literature review in order to collect and summarize the pertinent work that has been completed regarding FCs in Chester Creek and elsewhere. This literature review is included in Appendix A. Some key findings from the literature are as follows:

- Much of the available raw data for FCs is inconsistent, and quite often there are limited metadata available to provide a contextual framework for the results. In the studies for which there were reliable data available, the measurements were collected relatively infrequently or at very few sampling locations along Chester Creek itself. Consequently, while it is possible to make broad assertions regarding general FC trends in the creek from historical data, there are many issues regarding Chester Creek FC dynamics about which the historical record contains insufficient data to address.

- Previous data indicates that fecal coliform concentrations increase with downstream distance. The data also suggests that FC populations are present in the fine sediments. During high flow conditions fine sediments can be resuspended and mobilized downstream, and thus sediment transport could provide a mechanism for increases in FC populations due to in-stream storage in small sedimentations zones.

The experimental design was conceived through a collaborative effort between the project team, the ADEC project managers, and a committee of watershed researchers convened at the outset of the project. The final design incorporated the stated needs of the ADEC, the information gathered during the literature review, and the information gleaned from field measurements obtained during the early months of the project.

The sampling regimen included weekly sampling events at five base sites covering the length of the stream. At these five sites, parameters measured included FCs, flow/stage (at three of the five), total suspended solids, pH, conductivity, temperature and turbidity. In addition, numerous intermittent characterization studies and a short-term survivability study were completed to address specific issues regarding FC distribution, sources, and temporal dynamics. The sampling strategy for each intermittent sampling event was dependant upon the question being addressed. Additional information regarding the characterization studies and survivability study are outlined in Appendix D.

Maps of the creek on the following pages provide the weekly sampling locations as well as the intermittent sampling locations. The site maps are followed by Table 2, which provides additional site information, site nomenclature, and information regarding the purpose of the sampling events. Table 2 is followed by a descriptive overview of the weekly sampling events as well as the intermittent characterizations studies.

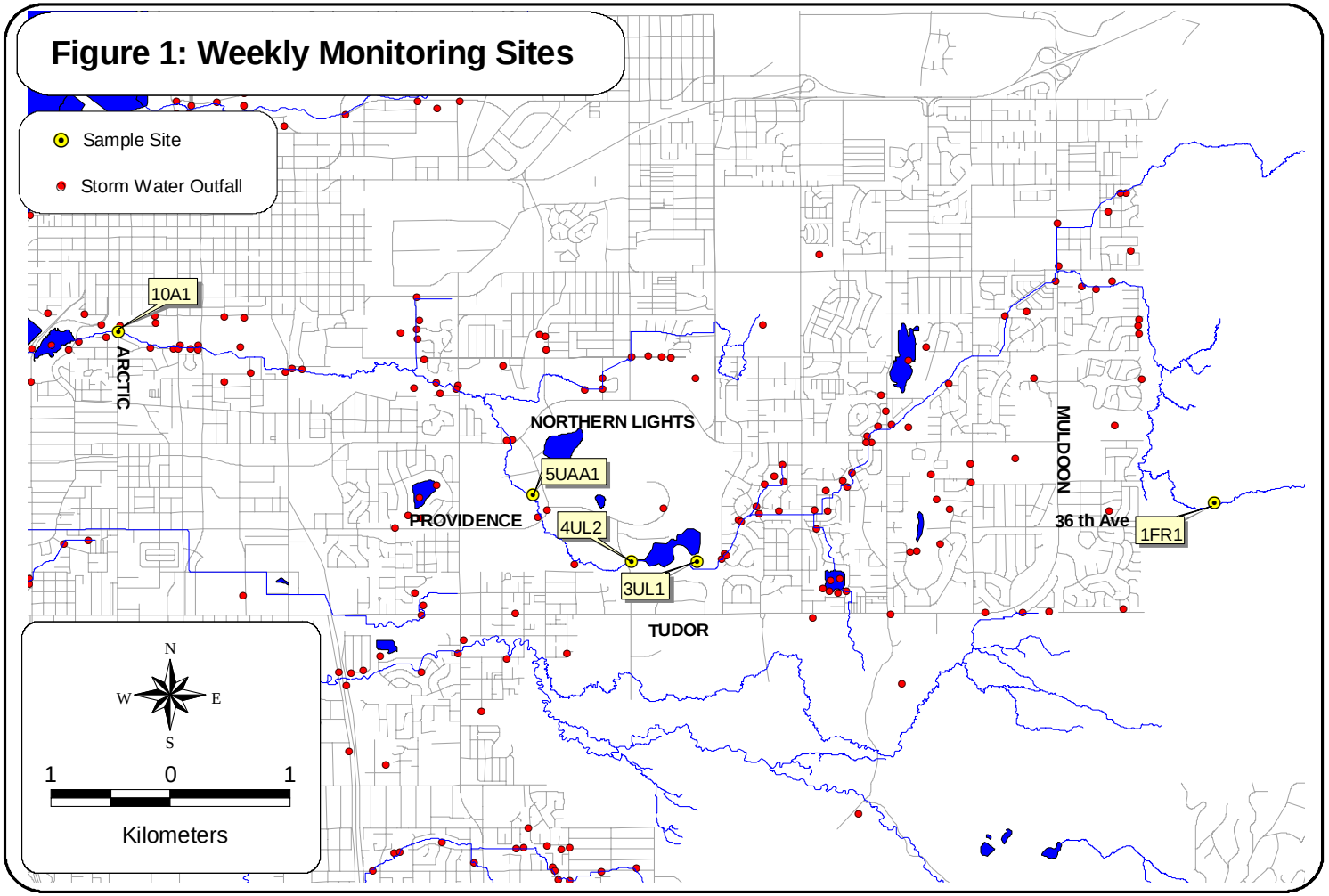
Figure 1: Weekly Monitoring Sites
Sample Site
Storm Water Outfall
10A1
ARCTIC
NORTHERN LIGHTS
5UAA1
PROVIDENCE
4UL2
3UL1
TUDOR
MULDOON
36 th Ave
1FR1
N
W
E
S
1
0
1
Kilometers

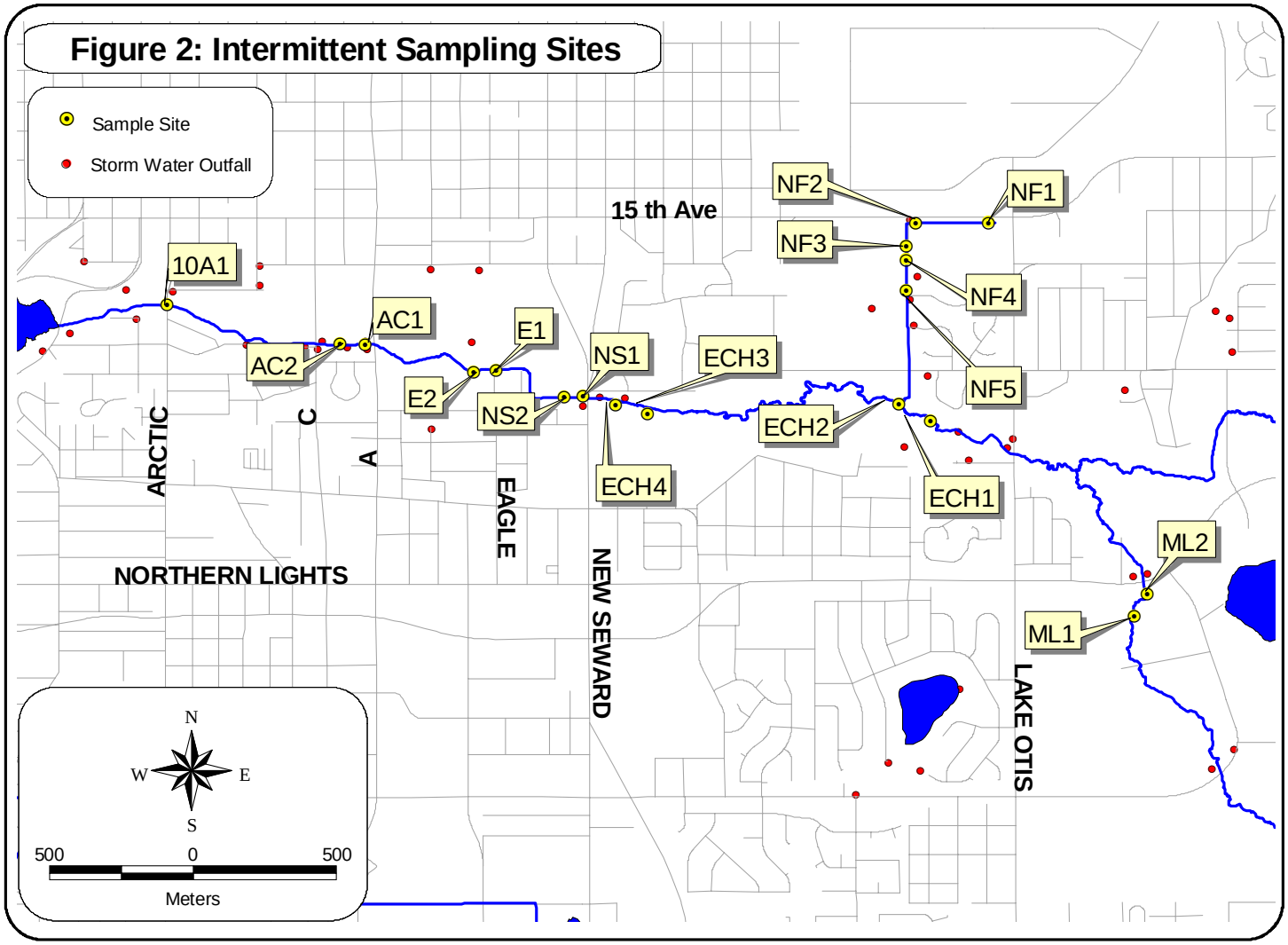
Figure 2: Intermittent Sampling Sites
Sample Site
Storm Water Outfall
15 th Ave
10A1
AC1
AC2
E1
E2
NS1
NS2
ECH3
ECH4
ECH2
ECH1
NF1
NF2
NF3
NF4
NF5
ML1
ML2
ARCTIC
C
A
EAGLE
NEW SEWARD
LAKE OTIS
NORTHERN LIGHTS
N
W
E
S
500
0
500
Meters

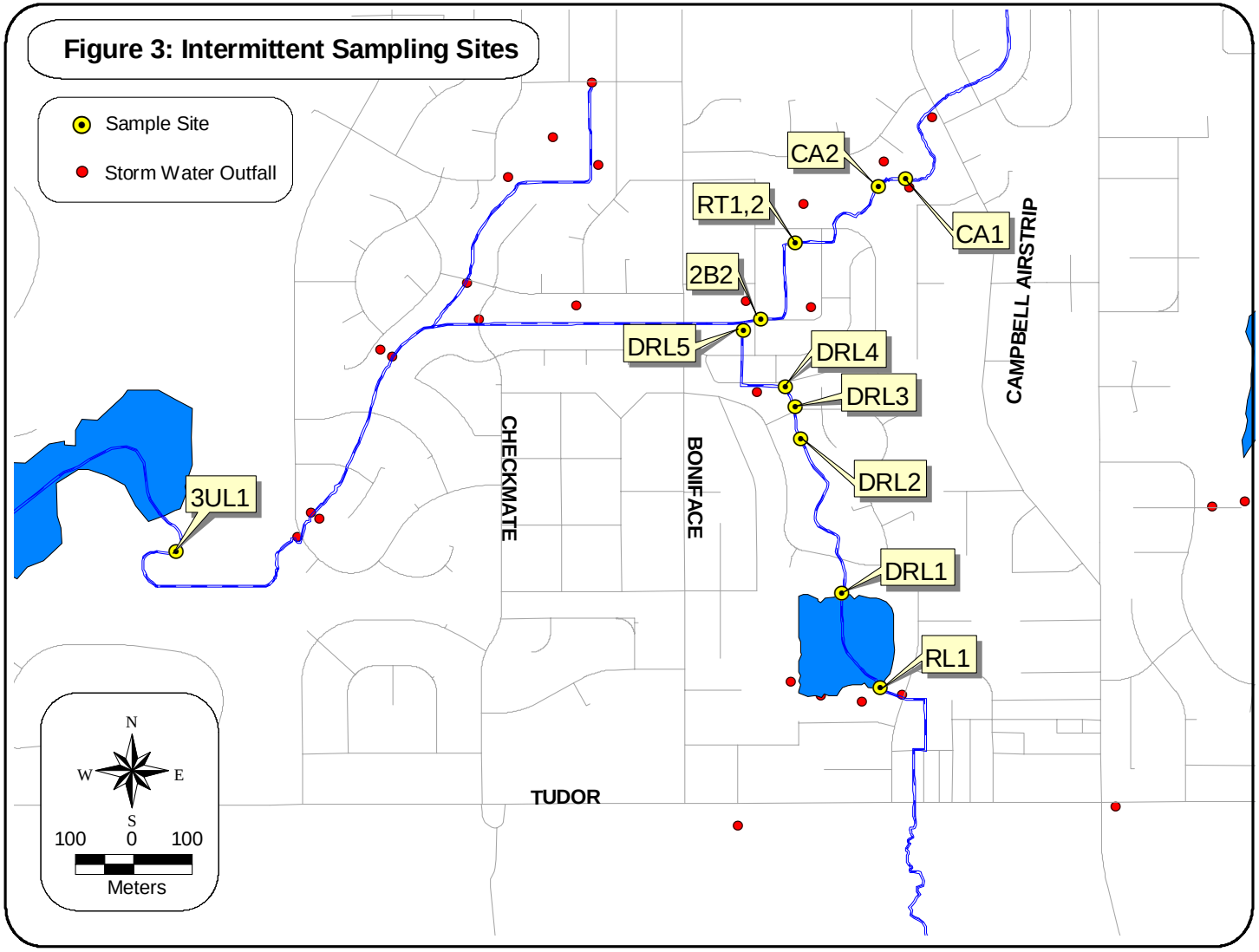
Figure 3: Intermittent Sampling Sites
Sample Site
Storm Water Outfall
CA2
RT1,2
CA1
2B2
DRL5
DRL4
DRL3
DRL2
DRL1
RL1
3UL1
CAMPBELL AIRSTRIP
CHECKMATE
BONIFACE
TUDOR
N
W
E
S
100
0
100
Meters

Table 2. Site Nomenclature and Descriptions

Site Nomenclature	Brief Site Description
1FR1	"Pristine" location sited upstream of Bulldog Trail bridge on Fort Richardson Army Base
2B1	At Riviera Terrace Trailer Park behind the mailboxes
2B2	Immediately downstream of 2B1, upstream of DRL5 outlet.
3UL1	Inlet into University Lake
4UL2	Outlet of University Lake
5UAA1	Under the spine on the campus of UAA behind the School of Engineering
6ECH1	Upstream of North Fork Confluence with the South Fork
7ECH2	Downstream of North Fork Confluence
8ECH3	Channelized zone 100m east of New Seward Highway
9ECH4	Immediately upstream of Culvert under New Seward Hwy.
10A1	USGS gauge location just downstream of culvert under Arctic, and Valley of the Moon Park
NF1	Culvert at Lake Otis and 15th Avenue
NF2	Upstream of culvert under Sitka St.
NF3	Upstream of entrance of snowmelt water from Municipality snow disposal site
NF4	Downstream of entrance of Municipality snow disposal site
RL1	Culvert at entrance to Reflection Lake
DRL1	Outlet of Reflection Lake
DRL2	Approximately 100m downstream of the outfall
DRL3	An additional site downstream of numerous duck and moose populations on the upstream side of a small settling pond
DRL4	Downstream side of a small sedimentation basin located between two houses where the stream enters the culvert
DRL5	Culvert outfall into the main channel which is located at Riviera Terrace
AC1	Upstream of storm water outfall located between A and C streets
AC2	Storm drain located between A and C streets
E1	Upstream of Storm Drain located at the end of Eagle street off of Fireweed.
E2	Storm water outfall located at the end of Eagle St. off of Fireweed
NS1	Storm water pipe located above the culvert on the west side of the New Seward Hwy.
NS2	Down stream of culvert and storm water outfall on west side of the New

Site Nomenclature	Brief Site Description
	Seward Hwy.
CA1	Upstream of Sewer Crossing near Campbell Airstrip Rd.
CA2	Downstream of Sewer Line Crossing near Campbell Airstrip Rd.
BGW1	Groundwater sample taken at 2B1
BGW2	Groundwater sample taken at 2B2
CAGW1	Groundwater sample taken at CA1
CAGW2	Groundwater sample taken at CA2
RT1	Sedimentation zone upstream of Post Office Boxes in Riviera Terrace. Samples taken with no disturbance of the sediments
RT2	Sedimentation zone described above with disturbance of the sediments
ML1	Upstream of possible Septic Influence near Mallard Lane and the UAA campus
ML2	Downstream of possible septic influence near Mallard Lane

- *Stream Monitoring/Weekly Sampling:* Field data were collected from July 2004 to June 2005 to monitor FC impacts on Chester Creek at five sites on a weekly basis. Three sites were sampled beginning July 2004, while sampling at the remaining two sites did not begin until November 2004. The two sites immediately upstream and downstream of University Lake were added after a revision in the original work plan.

- *Characterization Study - Short-Term Fecal Coliform Variability*: Data were collected at the outset of the project to assess the variability inherent in the FC laboratory tests as well as the short-term variability of FC concentrations in the stream.

- *Characterization Study - Sewer/Septic Sources:* Samples were obtained in order to evaluate FC concentrations in areas of the stream where sewer and/or septic influences were deemed most likely to occur. Parameters measured included pH, temperature, conductivity, NH_4, and FC in surface and groundwaters up and

downstream of sewer line crossings. The selected sewer crossings were located in areas where groundwater upwelling was thought to occur. This groundwater upwelling could potentially serve as a transport pathway for sewage to enter the stream. For the septic tank study, samples were obtained up and downstream of an active septic tank close to the creek.

- *Characterization Study - Reflection Lake Fork:* Reflection Lake and the channel leading to Chester Creek were chosen as suitable sites for closer scrutiny based upon its limited number of inputs, the large population of waterfowl located there, and the existence of a small detention basin near the outfall to Chester Creek. Sampling efforts at this location were focused upon characterizing the impacts of sedimentation-type Best Management Practices (BMPs) as well as providing insight into the influences of waterfowl.

- *Characterization Study - North Fork Sampling:* FC concentrations in the North Fork of Chester Creek are potentially influenced by a large congregation of waterfowl, numerous storm drains, a snow disposal site, sewer line crossings, and an adjacent landfill. Consequently, team members sampled the North Fork on several occasions in an attempt to elucidate whether one or a combination of these factors influenced the FC concentrations in the stream.

- *Characterization Study - Survivability of E. coli:* In order to better understand the temporal dynamics of FC bacteria in Chester Creek, a laboratory study was conducted to investigate the survivability of *Escherichia coli* (*E. coli*) bacteria in water column and sediment samples at 16 ºC and 4 ºC. These temperatures were assumed to be typical of Chester Creek water during the summer and winter months, respectively. Specific strains of *E. coli* cultured from Chester Creek were utilized for this study rather than the broader category of FC as a whole because the enumeration method used for the study required the use of pure cultures for quality control purposes. After inoculation with a known density of *E. coli*, sample microcosms were incubated at the indicated temperatures in either sterilized or non-sterilized aliquots of Chester Creek water. The concentrations of living bacteria were then measured at given time intervals, thus providing some indication of the survivability of representative FC bacteria in Chester Creek.

3. RESULTS AND DISCUSSION

This chapter contains the condensed results of experiments carried out between July 2004 and June 2005. Results include weekly sampling results at the five baseline sites as well as results from the intermittent characterization studies. Raw results and detailed information regarding the intermittent studies are presented in the Appendix. Data presented here are organized with respect to the studies under which they were obtained.

3.1 Overall Range of FC Concentrations

A summary of the FC data observed during this study is provided in Table 3 below. The table presents the minimum, maximum, and average FC concentrations, as well as the total number of samples collected at each individual sampling site:

Table 3: Data Summary

Site	# Samples	dates	Min FC/100mL	Max FC/100mL	Avg. FC/100mL
1FR1 (Ft. Richardson)	128	7/14/2004-6/29/2005	0	128	11
2B1	2	3/3/2005	0	3	2
2B2	14	3/3/2005-3/22/2005	0	1	1
3UL1 (University Lake Inlet)	102	11/10/2004-6/29/2005	0	284	62
4UL2 (University Lake Outlet)	101	11/10/2004-6/29/2005	0	76	31
5UAA1 (UAA)	179	7/9/2004-6/29/2005	2	378	45
6ECH1	25	8/18/2004-10/1/2004	10	226	84
7ECH2	25	8/18/2004-10/1/2004	2	120	49
8ECH3	19	8/18/2004	55	109	80

Site	# Samples	dates	Min FC/100mL	Max FC/100mL	Avg. FC/100mL
9ECH4	19	8/18/2004	7	131	68
10A1 (Arctic Blvd.)	162	7/14/2004-6/29/2005	0	279	45
NF1	18	3/9/2005-5/26/2005	0	≈1620	411
NF2	6	5/21/2005-5/26/2005	0	3	1
NF3	6	5/21/2005-5/26/2005	0	2	1
NF4	12	3/9/2005-5/26/2005	0	≈2000	400
RL1	3	6/16/2005	28	48	37
DRL1	6	3/22/2005-6/16/2005	7	20	12
DRL2	3	3/14/2005	10	45	23
DRL3	12	3/14/2005-6/16/2005	0	35	8
DRL4	9	3/22/2005-6/16/2005	7	85	30
DRL5	12	3/14/2005-3/22/2005	4	2140	465
AC1	9	8/9/2004-10/1/2004	33	220	111
AC2	9	8/9/2004-10/1/2004	0	1	0
E1	9	9/24/2004-10/1/2004	74	186	122
E2	9	9/24/2004-10/1/2004	30	78	55
NS1	6	10/1/2004	52	166	115
NS2	6	10/1/2004	6	40	114
CA1	2	3/3/2005	0	4	2
CA2	2	3/3/2005	0	14	7
BGW1	3	3/3/2005	0	0	0
BGW2	3	3/3/2005	0	0	0
CAGW1	3	3/3/2005	0	0	0

Site	# Samples	dates	Min FC/100mL	Max FC/100mL	Avg. FC/100mL
CAGW2	3	3/3/2005	0	0	0
RT1	7	10/15/2004	0	0	0
RT2	7	10/15/2004	0	2	0
ML1	1	6/16/2005			4
ML2	1	6/16/2005			11

As indicated in Table 3, the maximum FC concentrations observed at the majority of sites were on the order of 10^1 - 10^2. In three instances, however, FC concentrations reached higher than 10^3. These extremely high values were observed in the vicinity of Reflection Lake and the North Fork, and were all obtained during the spring snowmelt in early March, 2005.

3.2 Weekly Sampling Results

Site-by-site weekly sampling results for all measured parameters are presented in Figures 4 - 8. Descriptive statistics for all parameters measured at weekly sampling locations are provided in Appendix E. It should be noted that the FC values depicted in Figures 4 – 8 represent individual measurements at each site on each sampling day. Although the raw data and transfer log located in Appendices H and I demonstrate that three samples were actually analyzed per sampling event at each location, only one of those three was selected to represent the event's recordable value. The procedure used for selecting the most representative value is located in the QAPP (Appendix B). A table indicating the recordable values for all parameters measured is located in Appendix E.

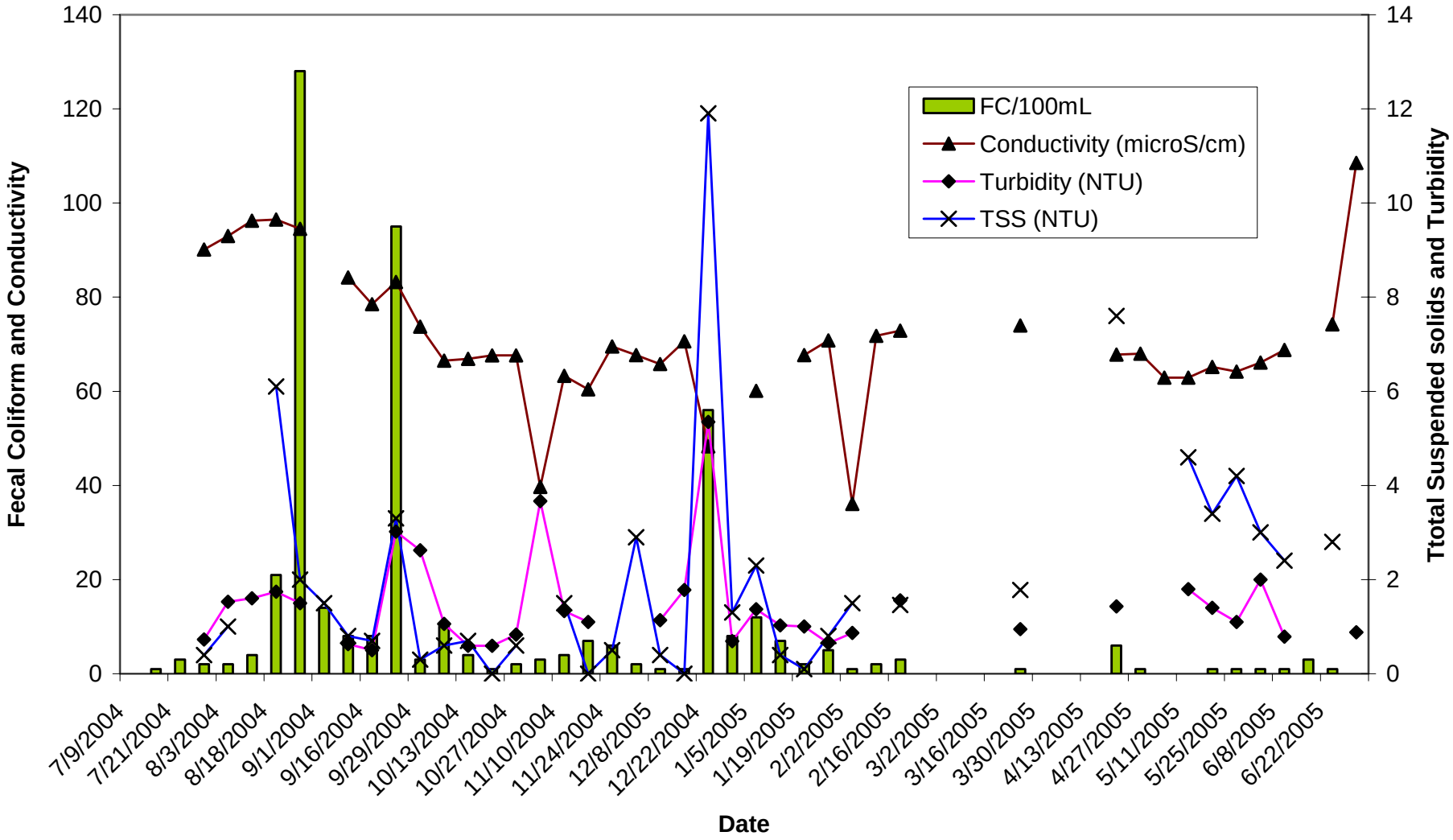

Figure 4a: Weekly Data from Ft. Richardson

University of Alaska Anchorage

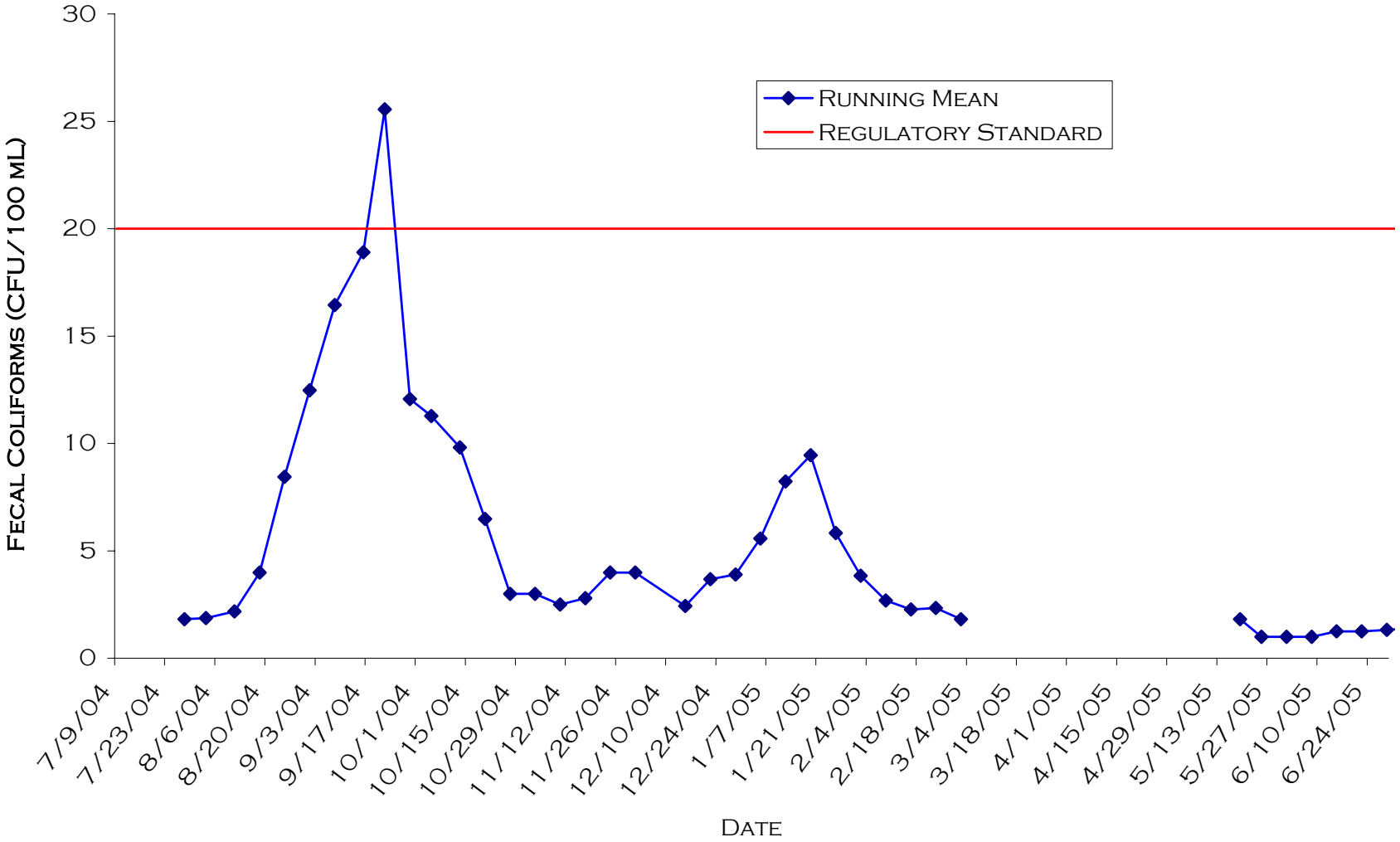

Figure 4b: Ft. Richardson Running Geometric Mean (30-Day)

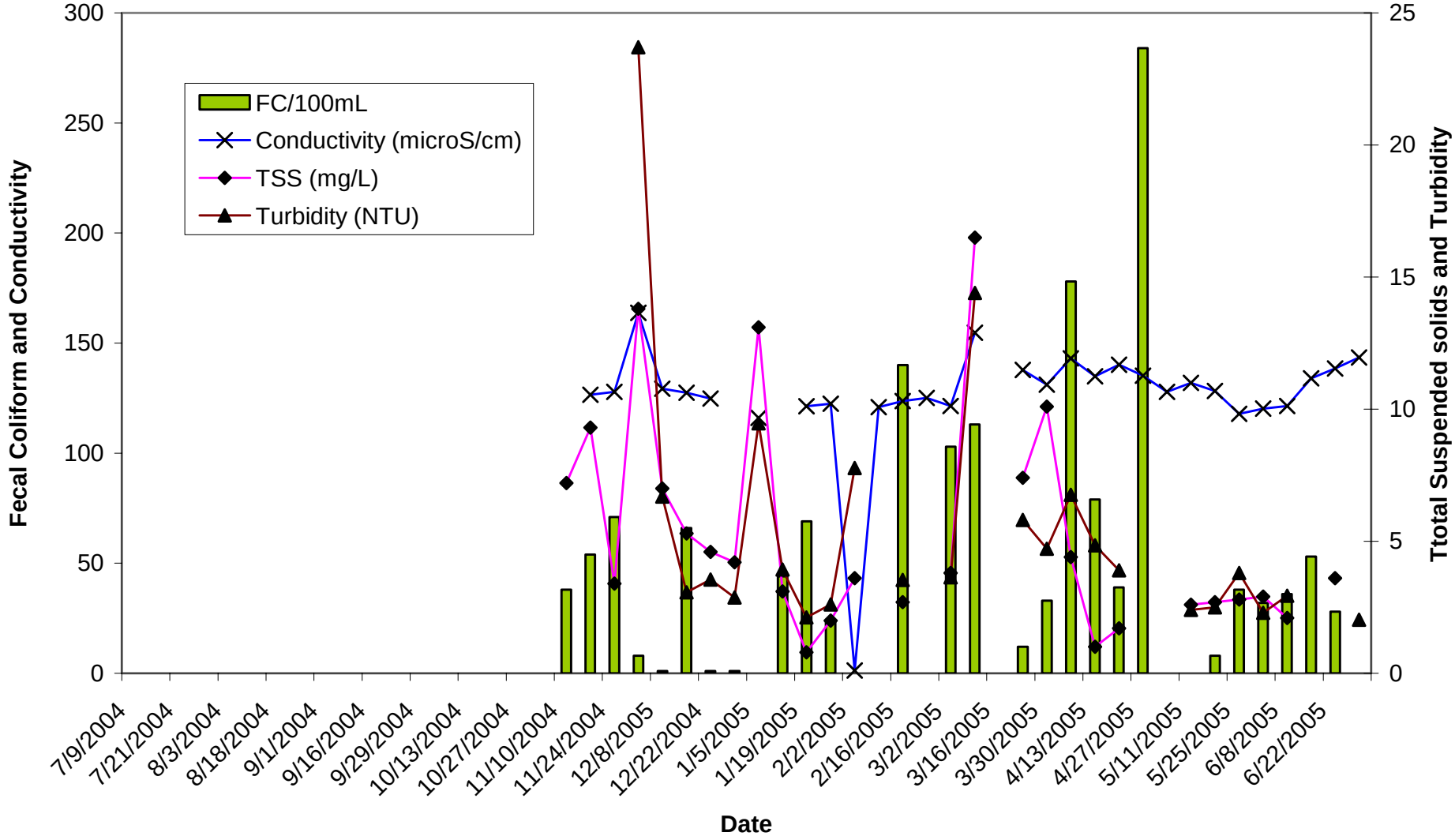

Figure 5a: Weekly Data from University Lake Inlet

University of Alaska Anchorage

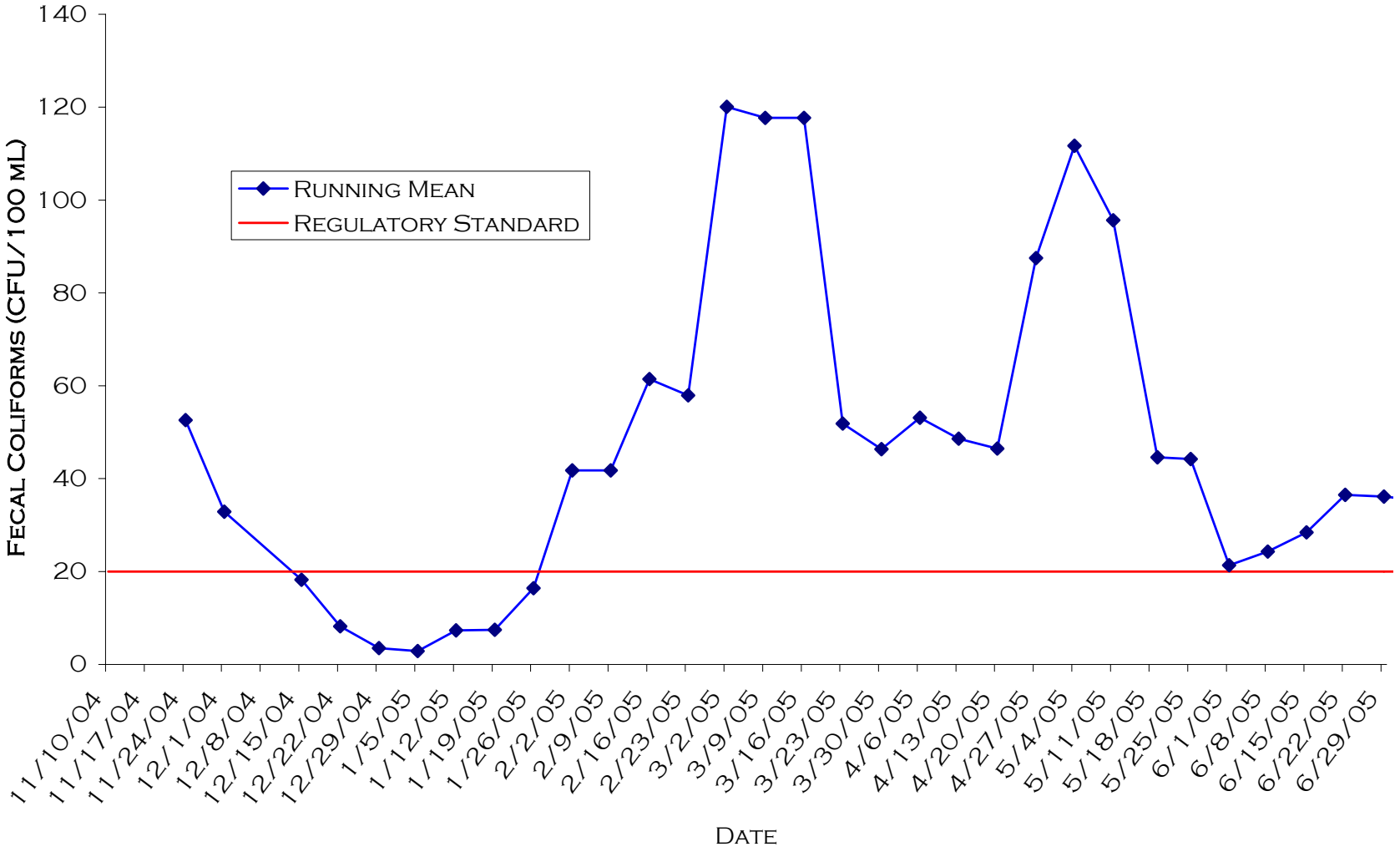

Figure 5b: University Lake Inlet Running Geometric Mean (30-Day)

University of Alaska Anchorage

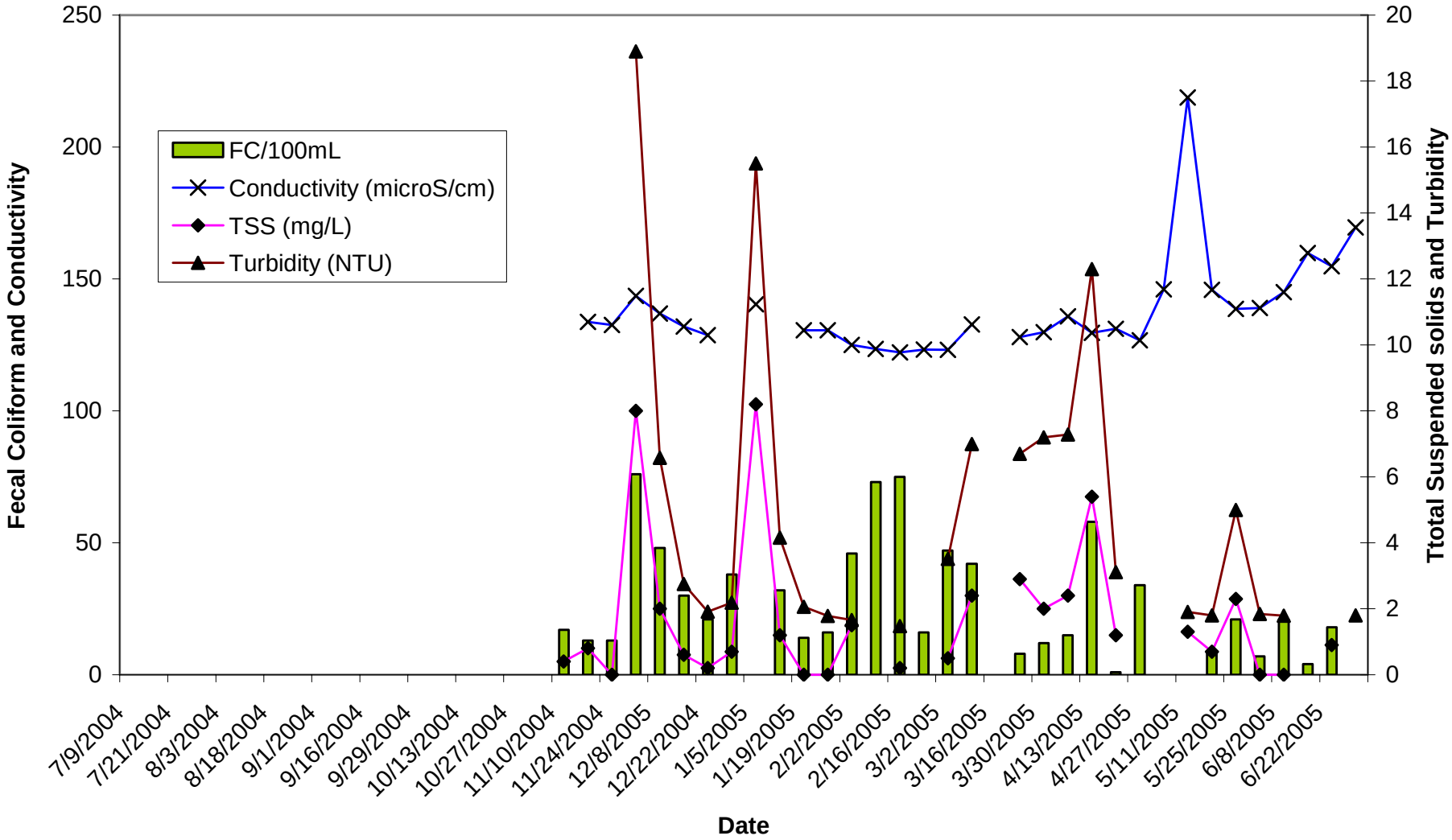

Figure 6a: Weekly Data from University Lake Outlet

University of Alaska Anchorage

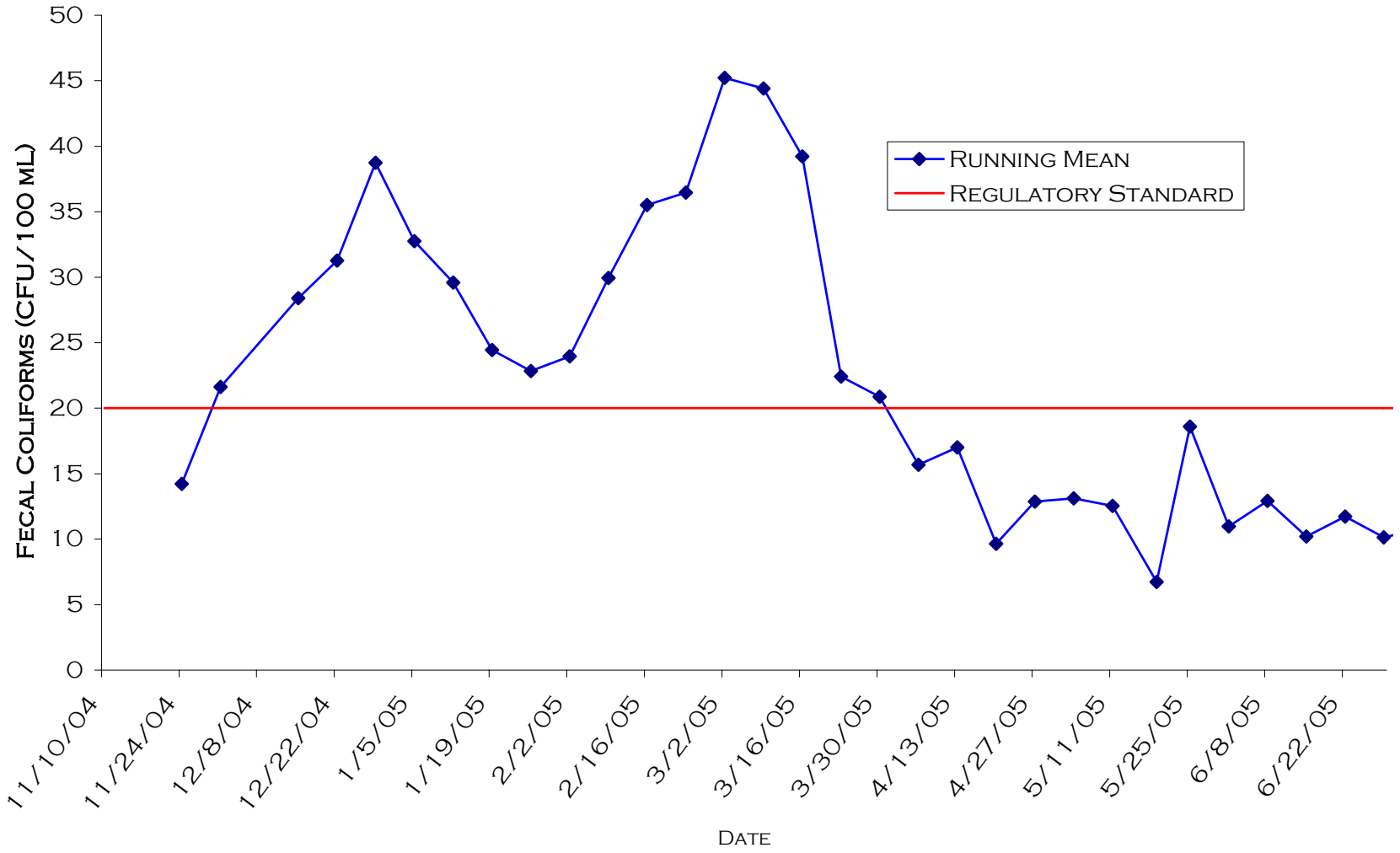

Figure 6b: University Lake Outlet Running Geometric Mean (30-Day)

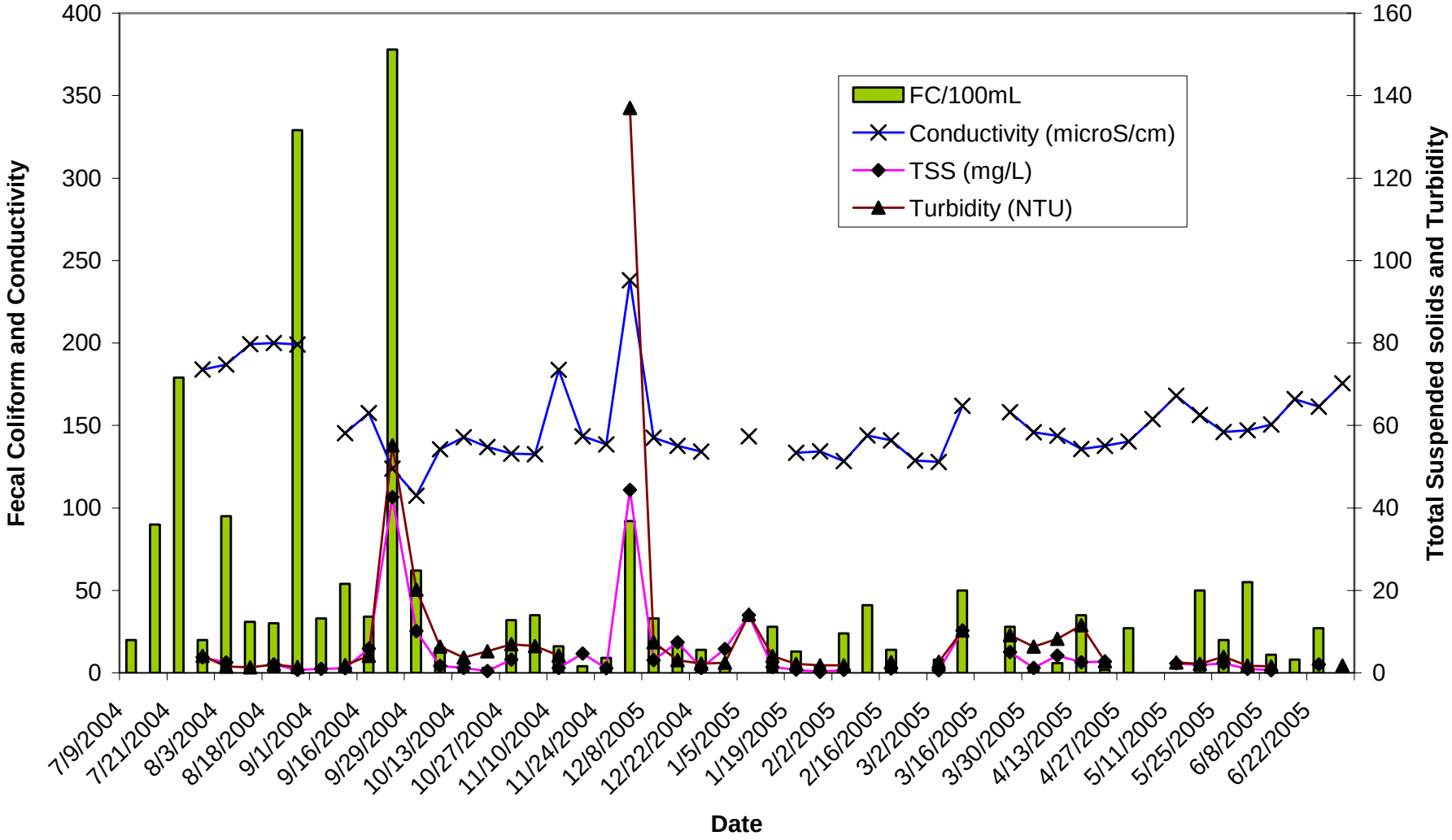

Figure 7a: Weekly Data from UAA

University of Alaska Anchorage

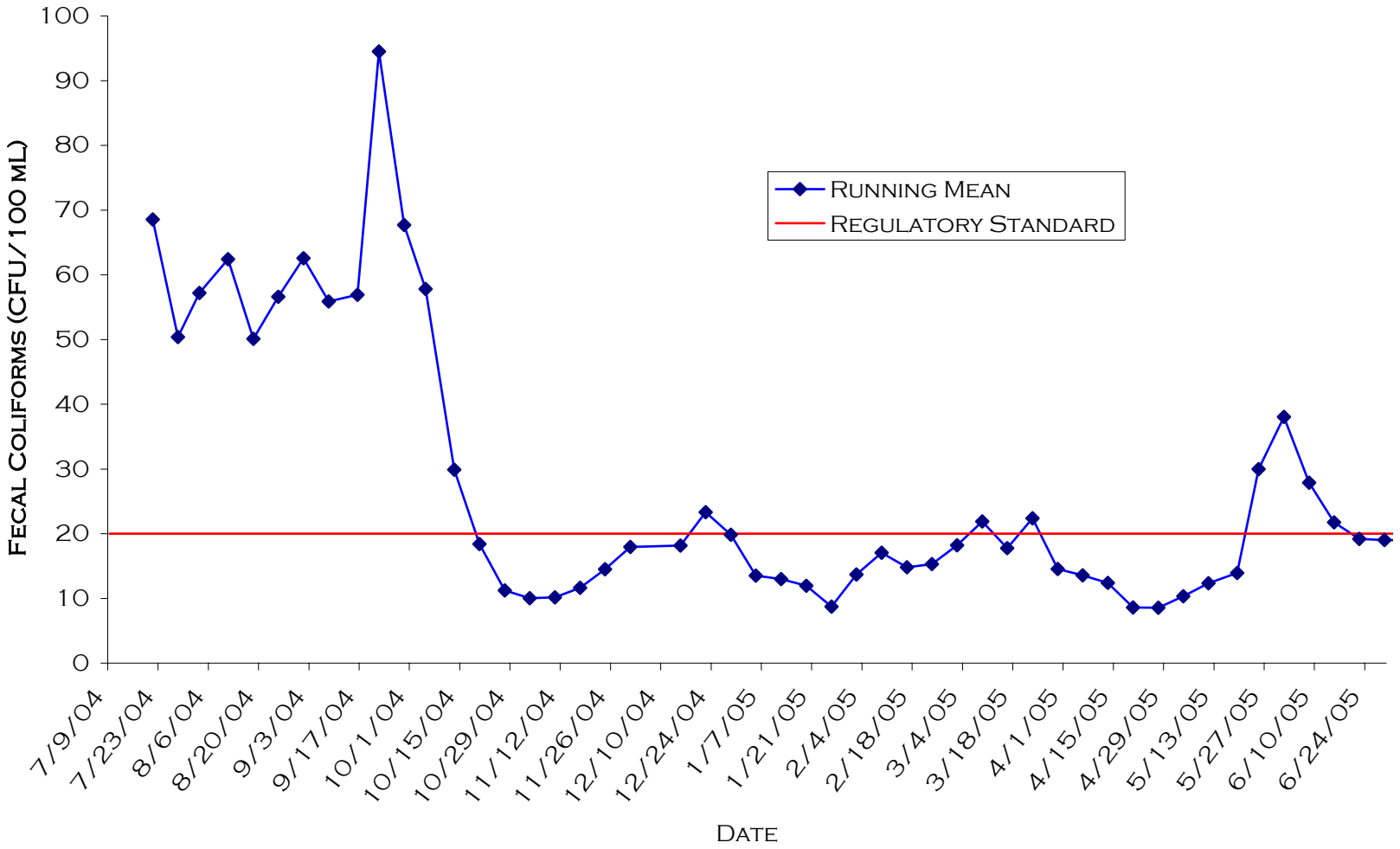

Figure 7b: UAA Running Geometric Mean (30-Day)

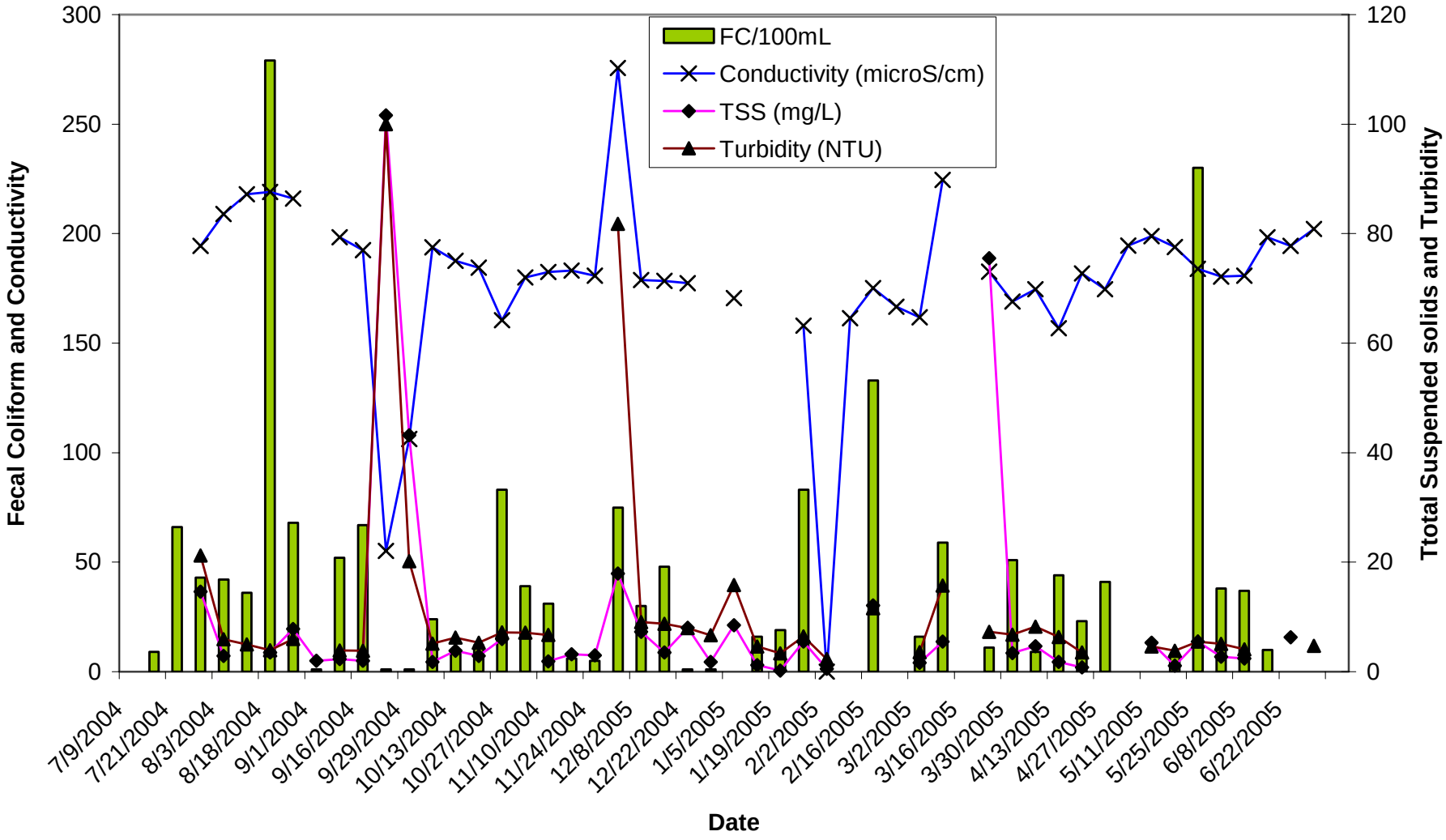

Figure 8a: Weekly Data from Arctic Blvd.

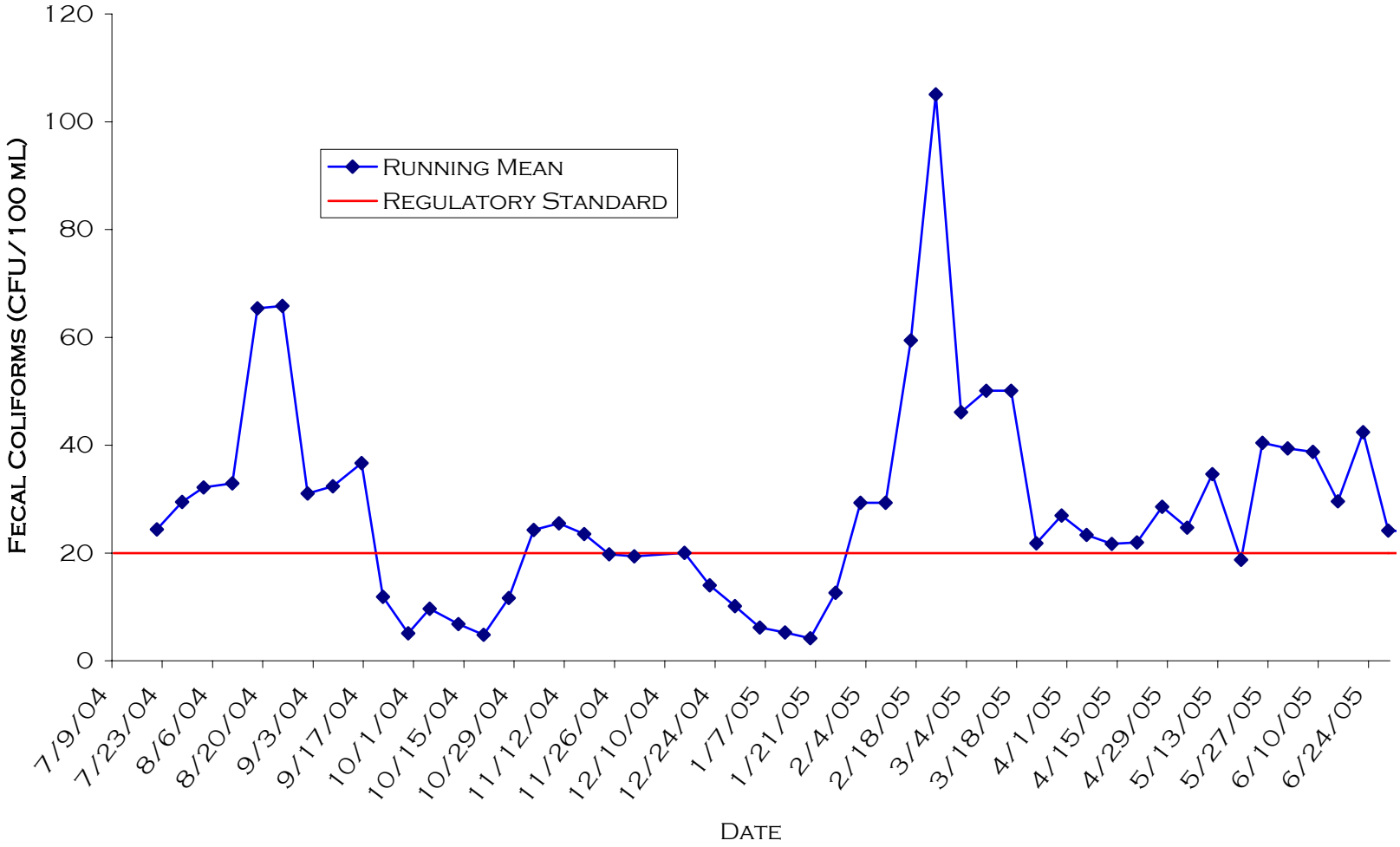

Figure 8b: Arctic Blvd. Running Geometric Mean (30-Day)

3.2.1 Regulatory Compliance Indicated by Weekly Samples

The data represented in Figures 4-8 can be used as a measure of regulatory compliance for the FC standard. In Alaska, water quality standards are listed in accordance with the intended use of the waterbody. As most of Alaska's fresh surface waters are expected to be in compliance for all uses, the relevant water quality standard for any given parameter is taken to be the most stringent standard over all use classifications. The relevant standard for FC bacteria in Chester Creek is the standard associated with drinking water sources (Category Ai). This standard stipulates that the geometric mean of FC samples obtained within a 30-day period may not exceed 20 CFU/100mL. This standard is represented by the red line in Figures 4b – 8b. In addition, no more than 10% of the samples obtained over a 30-day period may exceed 40 CFU/100mL. As no more than 5 samples were obtained at any given site over a 30-day period during the weekly sampling events, any sample resulting in more than 40 CFU/100mL therefore represented an exceedance of the standard. Regulatory compliance data associated with the weekly sampling effort is reported in Table 4 below:

Table 4: Summary of Site-by-Site Regulatory Compliance

Site	Exceedances of Standard	Number of Relevant Observations*	Percent Exceedances Standard	Exceedances of Standard	Number of Relevant Observations	Percent Exceedances of Standard
	Geometric Mean < 20 CFU/100mL (30-day)			90% of Samples < 40 CFU/100mL (30-day)		
1FR1	1	39	3%	3	41	7%
3UL1	24	32	75%	12	26	46%
4UL2	18	32	56%	17	29	59%
5UAA1	20	50	40%	12	46	26%
10A1	34	50	68%	8	42	19%

* The geometric means were based upon all of the recordable weekly observations made at a given site within any 30-day period. In most instances, five weekly observations were used to calculate the geometric mean. No 30-day geometric means were calculated using less than three weekly measurements.

The data in Figure 4 and Table 4 indicate that the "pristine" site, Ft. Richardson, only once exceeded the 20 CFU/100mL geometric mean standard and only three times exceeded the 40 CFU/100mL spike standard. One of those three spikes was associated with a mid-winter melt period, while the other two occurred during the period of autumn rains. It should be noted, however, that sampling was not performed at Ft. Richardson during much of the spring melt period due to military activities on the base. Given the observation of the spike during the mid-winter melting event, it appears likely that the spring melt period produced a spike in FC concentrations as well.

Although the Ft. Richardson site did not often exceed the FC standard, the fact that it exceeded the standard even a few times is worthy of note. There is no permanent human habitation upstream of the site, nor are there any stormwater outfalls, high concentrations of domestic animals, paved surfaces, or any other indicators of intrusive human activity. Consequently, the data indicate that wild animals in this pristine area likely caused the intermittent degradation of water quality.

With regard to the remainder of the sites, the data in Figures 4-8 and Table 4 appear to follow the expected pattern. It was previously known that sites within the urbanized sections of Chester Creek frequently exceed the water quality standards, and the results from this study support those previous findings. In general, the standards were exceeded most frequently during the autumn rainy period and during the spring snowmelt.

A notable exception to the autumn/spring trend was observed at the University Lake Outlet (Figure 6), where the exceedances tended to occur during the winter rather than the spring. Samples were not collected during the autumn at this location. It is possible that this effect was caused by a lag imposed by the mixing conditions and large holding time associate with the lake, but this hypothesis has not been tested. If such a lag were to occur, however, this would indicate that FC bacteria were able to survive outside of their host organisms over a period of months.

3.2.2 Correlations Between Water Quality Parameters

In addition to FC, weekly sampling events entailed measurements of total suspended solids (TSS—mg/L), turbidity (NTU), conductivity (µS/cm), pH, water temperature (°C), and stage (ft). Stage data were subsequently converted to flow (cfs) through the establishment of rating curves at three sites.

One goal of the study was to examine the relationships between these water quality parameters in an effort to discern whether they were measurably related to FC concentrations. It was suggested that if such relationships were easily discernable, then they might provide insight into FC dynamics and potential mitigation strategies.

The linear correlation coefficients between each of the water quality parameters measured at the weekly sites are depicted in Table 5 on the following page. These correlations were assessed on a site-by-site basis because it was reasoned that the relationships may vary between sites. In Table 5, coefficients greater than or less than approximately 0.30 and -0.30, respectively, were deemed to be noteworthy.

Although the correlations in Table 5 provide some insight into the relationship between parameters, the assumption of normality could potentially yield misleading results for non-normal data. Consequently, the relationships between parameters were also assessed on a non-parametric basis, and the results of this evaluation are depicted in Table 6. Correlation coefficients resulting from the Spearman's Rank Correlation Test (Table 6) are not dependant upon the assumption of normality, and may therefore be more appropriate for the samples collected in the study. Due to the constraints of the test, however, analysis was limited to the sample days for which all seven parameters were successfully measured. This effectively reduced the sample size compared to the linear correlation analysis.

Table 5: Linear Correlation Coefficients Between Water Quality Parameters

		FC	TSS	Turbid.	Cond.	pH	Temp.	Flow
Fort Richardson	FC	1.00						
	TSS	0.31	1.00					
	Turbid.	0.40	0.71	1.00				
	Cond.	0.27	-0.18	-0.28	1.00			
	pH	-0.02	0.00	-0.14	-0.32	1.00		
	Temp.	0.14	0.11	-0.13	0.67	-0.34	1.00	
	Flow	-0.26	0.06	0.38	-0.66	0.25	-0.23	1.00
		FC	TSS	Turbid.	Cond.	pH	Temp.	
University Lake Inlet	FC	1.00						
	TSS	-0.02	1.00					
	Turbid.	0.02	0.79	1.00				
	Cond.	0.11	0.27	0.19	1.00			
	pH	0.07	-0.07	0.02	-0.44	1.00		
	Temp.	0.10	-0.22	-0.24	0.27	-0.10	1.00	
		FC	TSS	Turbid.	Cond.	pH	Temp.	
University Lake Outlet	FC	1.00						
	TSS	0.51	1.00					
	Turbid.	0.46	0.97	1.00				
	Cond.	-0.34	0.04	-0.09	1.00			
	pH	-0.26	-0.26	-0.33	0.48	1.00		
	Temp.	-0.35	-0.15	-0.22	0.64	0.72	1.00	
		FC	TSS	Turbid.	Cond.	pH	Temp.	Flow
University Alaska Anchorage	FC	1.00						
	TSS	0.56	1.00					
	Turbid.	0.34	0.90	1.00				
	Cond.	0.18	0.26	0.38	1.00			
	pH	-0.22	-0.34	-0.19	0.12	1.00		
	Temp.	0.31	0.00	-0.06	0.58	0.03	1.00	
	Flow	-0.12	0.24	0.25	-0.19	0.03	0.00	1.00
		FC	TSS	Turbid.	Cond.	pH	Temp.	Flow
Arctic Blvd.	FC	1.00						
	TSS	-0.15	1.00					
	Turbid.	-0.08	0.67	1.00				
	Cond.	0.27	-0.36	-0.13	1.00			
	pH	0.14	-0.66	-0.59	0.47	1.00		
	Temp.	0.26	0.03	-0.02	0.35	0.23	1.00	
	Flow	-0.28	0.67	0.67	-0.71	-0.76	-0.19	1.00

*Correlation coefficients greater than or less than 0.030 and -0.030, respectively, are highlighted.

T*able 6: Spearman's Rank Correlation Coefficients Between Water Quality Parameters*

		FC	TSS	Turbid.	Cond.	pH	Temp.
Fort Richardson	TSS	0.04					
		0.879					
	Turbid.	0.17	0.47				
		0.496	0.044				
	Cond.	0.43	0.10	0.14			
		0.070	0.683	0.560			
	pH	-0.16	0.25	0.15	-0.35		
		0.512	0.309	0.534	0.140		
	Temp.	-0.01	0.47	0.38	0.60	0.04	
		0.970	0.042	0.106	0.006	0.886	
	Flow	-0.65	-0.02	-0.11	-0.70	0.25	-0.15
		0.003	0.943	0.646	0.001	0.299	0.555
		FC	TSS	Turbid.	Cond.	pH	Temp.
University Alaska Anchorage	TSS	0.39					
		0.041					
	Turbid.	0.08	0.68				
		0.674	0.000				
	Cond.	0.29	0.09	-0.24			
		0.133	0.668	0.213			
	pH	-0.11	-0.30	-0.33	0.24		
		0.589	0.119	0.087	0.217		
	Temp.	0.49	0.04	-0.31	0.48	-0.10	
		0.008	0.852	0.107	0.010	0.599	
	Flow	0.06	0.24	0.41	-0.31	-0.07	0.08
		0.782	0.212	0.029	0.108	0.718	0.691
		FC	TSS	Turbid.	Cond.	pH	Temp.
Arctic Blvd.	TSS	0.12					
		0.556					
	Turbid.	-0.01	0.83				
		0.944	0.000				
	Cond.	0.29	-0.08	-0.20			
		0.132	0.696	0.299			
	pH	0.17	-0.35	-0.51	0.27		
		0.384	0.065	0.005	0.161		
	Temp.	0.04	-0.02	-0.31	0.50	0.19	
		0.849	0.906	0.111	0.007	0.328	
	Flow	-0.44	0.13	0.34	-0.42	-0.31	-0.19
		0.018	0.518	0.079	0.026	0.114	0.324

* The top value in each cell contains the Spearman's Rank Correlation Coefficient. The bottom value contains the associated p-value. Correlation coefficients having associated p-values ≤ 0.05 are considered to represent significant correlations.

Correlations coefficients like those depicted in Tables 5 and 6 range from -1 to 1. Values close to the extreme ends represent strong correlations, whereas values close to zero represent no correlation. As evidenced in Tables 5 and 6, turbidity and TSS demonstrated a relatively strong positive correlation to each other at all of the sampling sties through both evaluation methods. This was not surprising, however, as the parameters are known to be related. Nonetheless, the values calculated for this relationship can serve as a benchmark to provide insight into the relative strengths of other correlations. The correlations most relevant to this study are the correlations between FC bacteria and the other six water quality parameters. It is these relationships that will be the focus of this discussion.

FC appeared to be somewhat correlated to turbidity in the linear test (3 of 5 sites), but this relationship was not borne out at the three sites evaluated via the Spearman test. Similar values were noted for the relationship between FC and TSS, although there was a single significant weak correlation observed in the Spearman test. These results were somewhat surprising, as it was expected that water found to be high in turbidity and/or TSS would most often be high in FC bacteria as well. As exemplified in Figures 4a-8a, however, this was not always the rule. As a consequence, mitigation measures designed to reduce the turbidity or TSS loading may have some impact upon FC populations, but based upon these results, one would not expect such measures to completely resolve the problem.

Based upon the literature review, it was anticipated that a relatively strong positive correlation would be observed between FC concentration and temperature. It was thought that higher FC values observed during the summer months would correlate with higher stream temperatures. Again, this initial assumption was not well supported by the results. The strongest linear correlation was in fact the negative correlation observed at the University Lake outlet. This could be explained, however, by the notion that higher autumn FC inputs to the lake actually exited the lake during the winter after some

amount of lag time. Nonetheless, it should be noted that the University Lake inlet and outlet sampling did not begin until November 2004, so the results are not necessarily comparable to the other three sites in this regard. An alternative explanation is that the waterfowl tended to congregate in the channeled areas of the lake during the wintertime due to the lack of ice near the inlet and outlet. Although the seasonality of FC concentrations at sites other than the lake are only intermittently supported by the correlation coefficients (e.g., UAA), an examination of the geometric means with respect to seasonality in Figures 4b-8b supports the notion that FCs tend to peak in the late summer / fall, drop off in the colder season, and pick back up again in the spring.

Neither conductivity nor pH appeared to be strongly related to FC concentrations at any of the sites. Although conductivity was observed to demonstrate a weakly negative linear correlation at the University Lake outlet site, there did not appear to be any demonstrable trend in these data.

Perhaps the most interesting trend observed in the correlation data was the trend relating FC to flow. Flow (in cubic feet per second) was calculated as a function of stage, and it was originally assumed that high, fast-moving waters would scour the sediments as well as the banks and carry a high concentration of FC bacteria. The results of the correlations presented here, however, indicate that higher FC concentrations were associated with lower flows. Although the linear correlations relating flow to FC depicted in Table 5 were all insignificant by the standards utilized in this report, it is notable that they were all found to be negative numbers. Moreover, the non-parametric analysis depicted in Table 6 indicates a significant negative correlation between flow and FC at two of the three sites assessed. The third site (UAA) resulted in no correlation at all.

The most likely explanation for this apparent FC-flow phenomenon is related to the seasonality of the precipitation observed in the area. While higher FC concentrations did

indeed appear to be associated with higher flows at the outset of the autumn rains (see raw stage data in the Appendix), the high FC concentrations in the ensuring weeks tended to abate, while the heavy flows did not. Consequently, after the FCs previously stored in the sediments and/or drainage basins surrounding the creek were flushed out at the onset of the rain in August and September, the heavy flows observed over a longer period later in the autumn carried relatively low FC loads, thus contributing to the negative correlation. This explanation would be consistent with the notion that the relatively light early and mid summer rains corresponded with accumulation of FCs in the creek, but did not contribute significantly to the creek flow. It should be noted that this correlation does not consider the effect of winter flows, as flow data was generally not gathered during the winter months due to ice cover at the gauges.

3.2.3 Spatial Variation Between Sites

A major assumption directing the experimental design of this project was that FC bacteria would tend to accumulate from point or non-point sources as the stream waters flowed through the urban areas of Anchorage. Consequently, the FC concentrations would generally be highest near the mouth of the creek. In addition, the research team hoped to be able to measure this effect by sampling upstream and downstream of suspected contributing areas.

Boxplots of the weekly FC results arranged according to sampling location are provided in Figure 9. For comparative purposes, boxplots of weekly conductivity (reported as specific conductance in µS/cm) are included in Figure 9 as well. As the data are highly variable and not normally or log-normally distributed, these boxplots serve as a convenient approach for visual data evaluation.

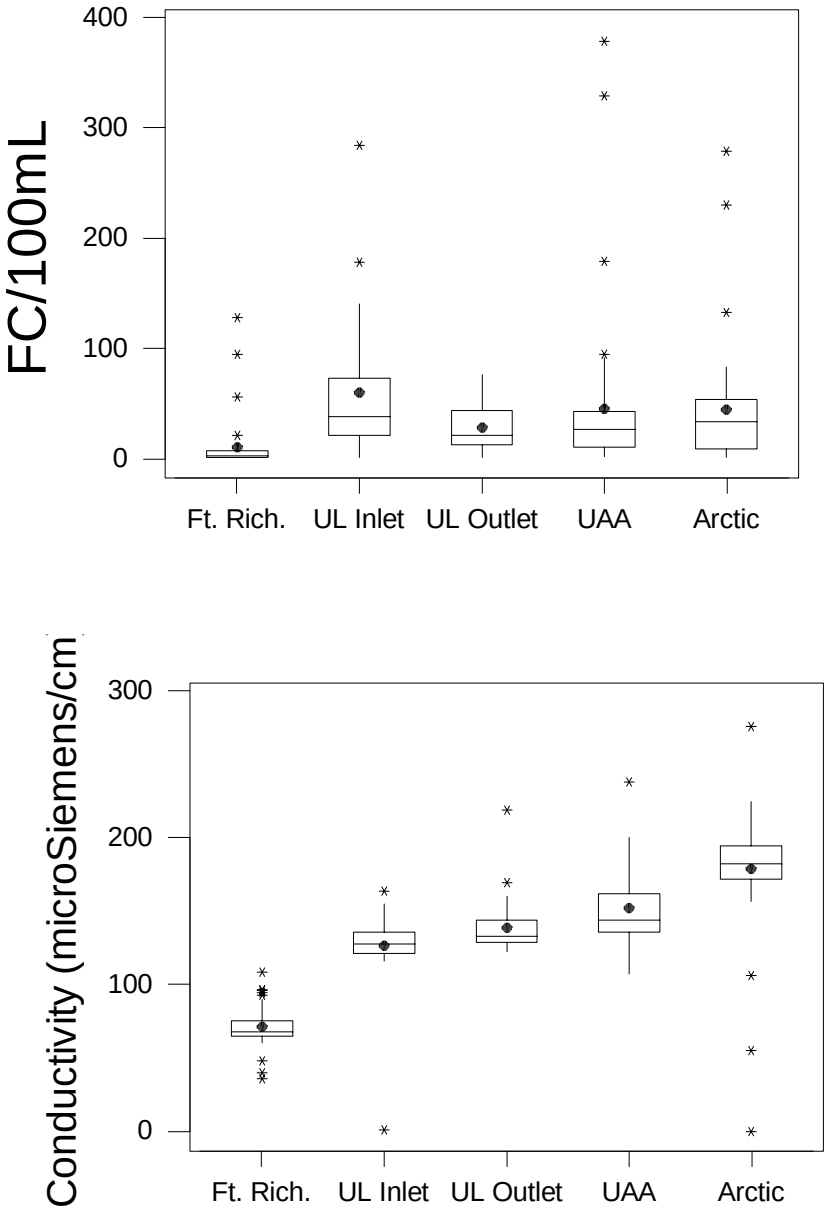

Figure 9: Boxplots of FC Bacteria and Conductivity from Upstream (Left) to Downstream (Right) Locations Along Chester Creek. Whiskers represent the range of data; boxes represent the 1st and 3rd quartiles; lines within the boxes represent the median; dots represent the means and stars represent outliers defined as more than 1.5 times the box height.

Based upon the boxplots depicted in Figure 9, there does not appear to be a discernable trend relating FC concentrations to downstream distance after the stream passed into the urbanized area. The Ft. Richardson site, however, did appear to exhibit lower FC concentrations, as evidenced by the box location as well as the mean and median values. Although the increased FC concentrations were likely associated with increased urbanization, the FC dynamics within the urbanized area remain unclear. The conductivity measurements, by comparison, did indeed appear to exhibit an upward trend relative to downstream distance. Conductivity clearly increased with downstream distance as the result of dissolved solids accumulating in the water column through the urbanized area. If the FC bacteria accumulated consistently in the water column and did not undergo any transformations or phase transfers during transit, it would be expected that the FC plot depicted in Figure 9 would resemble the conductivity plot depicted in the same figure.

The high variability and lack of normality of the weekly FC data did not lend itself well to simple statistical hypothesis testing. Consequently, analyses such as the one described above were utilized to evaluate the impact of downstream distance on FC concentrations. Another such method entails the evaluation of adjacent sites over a set of simultaneous sampling events. It was reasoned that if the FCs were indeed accumulating with downstream distance, then for the majority of days sampled, concentrations at each site sampled should be higher than concentrations at the adjacent site upstream. Such an analysis would be expected to minimize variability related to season, flow, and weather. Results from this assessment are depicted in Figure 10:

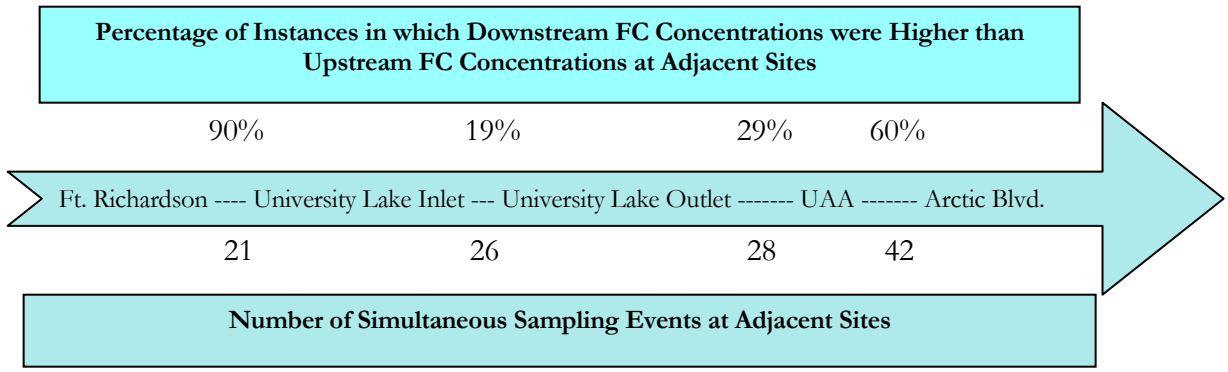

Figure 10: Frequency of Observed Downstream Increases in FC Concentrations Between Adjacent Sampling Locations

As evidenced in Figure 10, FC concentrations at University Lake inlet were higher than the FC concentrations at Ft. Richardson 90% of the time over a range of 21 simultaneous observations. By contrast, the concentrations at University Lake outlet were more often lower than at the inlet. Evaluation of the binomial probabilities of these trends occurring by chance indicates that the increasing trend after Ft. Richardson, the decreasing trend after the University Lake inlet, and the decreasing trend after the University Lake outlet were all significant at the 95% confidence level. The increase observed between UAA and Arctic was not statistically significant. Although this assessment does not provide an indication regarding the magnitude of the concentration change, it does indicate that the FC concentrations in the main channel exhibited somewhat regular fluctuations between geographic locations over the entire sampling period.

The observed increase between Ft. Richardson and University Lake inlet is readily explained by the increased urbanization between the two points. Moreover, the FC decrease observed between the University Lake inlet and outlet was likely the result of FC settling and/or mortality within the lake. The observed decrease between University Lake outlet and UAA is less clear, however, and warrants further investigation.

3.3 Short-Term Variability Study

A brief study was conducted at the project outset to evaluate whether the variability of FC in the stream over short periods of time was greater than the variability of the laboratory analysis itself. Stream samples were collected simultaneously to assess the laboratory test, and at five and fifteen minute intervals to assess short-term variability. One set of weekly samples (UAA site) collected at 7 day intervals was assessed for comparison. The results of this evaluation are presented in Table 7:

Table 7: Summary Statistics of Fecal Coliform Short-Term Variability Test

Test (n = 12)	Mean (CFU/100mL)	Standard Deviation (CFU/100mL)	Coeff. of Variation	Anderson-Darling p-Value
Simultaneous	20.9	4.2	0.20	0.54
5-Min Interval #1	148.2	41.8	0.28	0.69
5-Min Interval #2	85.7	14.5	0.17	0.55
15-Min Interval #1	58.3	35.0	0.60	0.09
15-Min Interval #2	62.7	35.1	0.56	0.42
15-Min Interval #3	84.5	16.6	0.20	0.50
15-Min Interval #4	68.7	31.6	0.46	0.38
7-Day Interval	107.7	123.9	1.15	0.00

As indicated in Table 7, the Anderson-Darling test for normality demonstrated that all of the short term sampling events could be assumed to represent normally distributed populations (p-value > 0.05). Consequently, it was concluded that the arithmetic mean of the non log-transformed results would serve as an adequate measure of central tendency.

The results from the simultaneous samples provided a reference measure of precision for the FC test in the laboratory. When the mean of the sample values was 21 CFU/100mL, the coefficient of variation (C_v = standard deviation divided by the mean) was found to be 0.20. Although this test was not repeated under conditions yielding a higher

concentration of fecal coliform bacteria, it was assumed that this value provided an adequate measure of relative precision over the lower range of values.

For the samples taken at 5-minute intervals, calculated C_v values ranged from 0.17 to 0.28. Thus, C_v from samples obtained at 5-minute intervals did not appear to be markedly different from the samples originating from a single grab sample. This indicated that under low-flow conditions, the stream had the capacity to achieve stability with regard to FC concentrations over durations as long as one hour. Consequently, grab samples taken from the stream were assumed to adequately represent the state of the stream over short durations. This assumption of short-term stability was instituted for all sampling events unless storm activity or other indicators of rapid change dictated otherwise.

The C_v values for the samples collected at 15-minute intervals ranged from 0.20 to 0.60. Consequently, it was concluded that over a longer sampling period (3 hours), the stream did not remain as stable with regard to FC concentrations, even when no recent precipitation had occurred and the flow appeared to be stable. Although this result was somewhat expected, it did provide some insight with regard to the method by which different locations in the stream could be measured for comparison to one another.

The above results indicated that multiple grab samples collected within a one-hour duration did not increase variability to a greater extent than was inherent in the laboratory analysis itself. Consequently, variability in samples collected for the purpose of site-by-site comparisons will likely be minimized by limiting the sampling duration to periods of one hour or less. As FC concentrations vary dramatically over the course of a season, sampling locations could best be compared with one another through the utilization of numerous short duration sampling events conducted over a range of flow and weather conditions.

3.4 Sewer-Septic Source Evaluation

One ancillary project goal was to evaluate the potential for leaking sanitary sewer lines or faulty septic systems to influence the FC loading in Chester Creek. In order to perform this evaluation, team members obtained maps of all the sewer lines and septic tanks with the watershed, performed field evaluations at every sewer line crossing across the creek, then performed follow-up FC sampling at sites deemed to have the highest potential for exhibiting a measurable impact.

The rationale behind this approach, as well as the maps themselves and results of the field reconnaissance survey are included in a letter report submitted by Restoration Science & Engineering entitled "UAA Fecal Coliform Study; Sewage Collection and Treatment Sources." The letter report, submitted to William Schnabel and dated March 2nd, 2005, is being submitted to the ADEC in its entirety along with this project report.

In brief, the letter report documented that while there are more than 45 sanitary sewer crossings beneath Chester Creek, there are only 11 active septic systems located within 500 feet of the creek. In the reconnaissance survey detailed in the report, no obvious surficial indications of leaking sewer lines or septic influence were observed. All septic locations adjoining the creek were inspected, and indicators of release of septic to the creek were not observed. Field personnel inspected 47 sewer crossing locations, 35 of which were subjected to detailed inspection and water quality sampling based upon accessibility. The remaining 12 sewer crossings were situated in sections of the creek that were completely frozen on the January 5 and 6, 2005 inspection date, or located in culvertized sections of the creek. With regard to sewer crossings, it was postulated that areas having significant groundwater channeling and upwelling from the sewer line burial trench represent the conceptual model most likely to result in sewage impacting surface waters. Consequently, follow-up testing was performed at two such locations.

On March 3rd, 2005, surface water samples were collected upstream and immediately downstream of the sewer crossings at each site, and analyzed for FC bacteria. In addition, a push point groundwater sampler and peristaltic pump were employed to collect samples directly from a depth of six inches beneath the streambed at both locations. Groundwater upwelling was detected at both sites via thermal sampling and direct observation. As with the surface water samples, streambed samples (groundwater) were collected upstream and immediately downstream of the sewer line crossings. These groundwater samples were then analyzed for FC bacteria and Ammonia-N. Results of these analyses are presented in Table 8.

Table 8: Results From Sewer Crossing Sampling

		Fecal Coliform (CFU/100/mL)				Ammonia-N (mg/L)	
		Surface Water		Groundwater		Groundwater	
		Up	Down	Up	Down	Up	Down
Riviera Terrace Trailer Court	Sample #1	6	0	0	0	< 0.1	< 0.1
	Sample #2	0	10	0	0	< 0.1	< 0.1
	Sample #3	--	--	0	0	--	< 0.1
Campbell Airstrip Road	Sample #1	14	0	0	0	< 0.1	0.263
	Sample #2	4	0	0	0	< 0.1	0.235
	Sample #3	--	--	0	0	< 0.1	0.170

As illustrated in Table 8, the surface water FC concentrations at both Riviera Terrace and Campbell Airstrip were relatively low. There were deemed to be no apparent differences in concentration between the upstream and downstream samples, given the variability of

the FC sampling method. None of the groundwater samples contained measurable FC concentrations, thereby indicating that the sewer crossings were not likely contributing to the stream FC load at that time.

It was notable that at the Campbell Airstrip Road site, Ammonia-N was detected in all three downstream groundwater samples, whereas no ammonia was detected in any of the upstream samples. As ammonia can serve as an indicator of sewage, it is therefore possible that these elevated ammonia levels were the result of sewage-impacted groundwater entering the stream at the crossing.

On a final follow-up sampling effort, the team sampled the creek upstream and downstream of a septic tank located within 500 feet of the stream. The sampling site was located in a relatively forested area of the stream directly behind Mallard Lane. On June 16th, 2005, the creek FC concentrations upstream and downstream of the lot were 4 and 11 CFU/100mL, respectively. These levels were deemed to be too low to warrant further study.

In summary, this evaluation appeared to support the notion that fecal coliform released from sewer crossings under Chester Creek were not a likely significant source of bacterial pollution. Likewise it did not appear that impacts from septic system discharges contributed to measured coliform concentrations. While the FC sampling effort at Campbell Airstrip Road detected no FC, the ammonia measured there did not allow us to completely rule out the possibility low-level FC inputs. Nonetheless, after evaluating the known sewer crossings and septic systems close to the creek, we inferred that at least for the known sites inspected, direct contribution of bacteria to the creek was of low potential. It is noted, however, that storm drains frequently accept groundwater via leakage, and storm drains (and culvertized sections of the Chester Creek) frequently traverse areas containing sewer lines and septic systems. The conditions observed indicate there may be some potential for such installations to intercept leaked sewage or septage, then transmit these localized releases to the creek via storm drain flow.

3.5 Reflection Lake Evaluation

During the course of sewer crossing sampling at Riviera Trailer Park, it was noted that FC concentrations appeared to be consistently higher at University Lake inlet than at the trailer park. Consequently, an investigation was performed to determine if a geographical source location could be identified between the trailer park and University Lake. This investigation is described in Figure 11 and the narrative that follows:

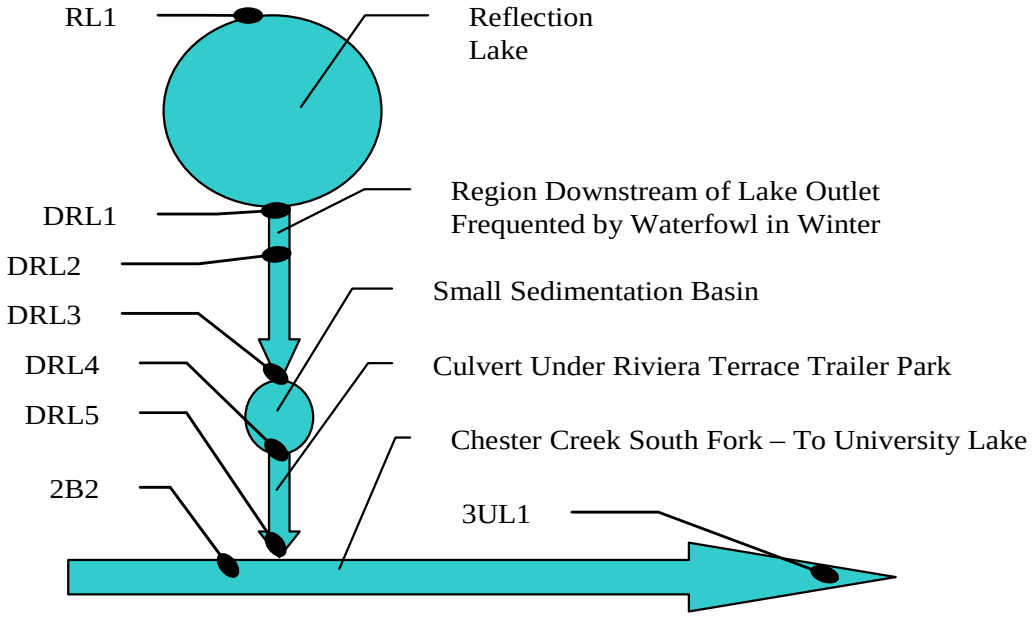

Figure 11: Schematic of Reflection Lake Sampling Sites

On 10 March 2005, FC samples collected at Riviera Terrace Trailer Court (2B2), the outfall from the Reflection Lake fork into Chester Creek (DRL5), and the University Lake inlet (3UL1) resulted in extremely high FC concentrations at the outfall and lake inlet (Table 9). Consequently, it was determined that the Reflection Lake fork was likely to be a heavy contributor to the FC load in Chester Creek during that period. At the time

of sampling, spring breakup had just begun, and it was assumed that the heavy loading was likely associated with meltwater entering the stream.

Table 9: Summary of Reflection Lake Fork Sampling Results

	Average Fecal Coliform Concentration (CFU/100mL)			
Site	**3/10/05**	**3/14/05**	**3/22/05**	**6/16/05**
RL1	--	--	--	37
2B2	83	240	33	--
DRL1	--	15	--	8
DRL2	--	23	--	--
DRL3	--	31	0	7
DRL4	--	--	23	69
DRL5	2140	305	23	--
3UL1	1140	--	--	--

As the FC counts originating from the fork were extremely high compared to the counts in Chester Creek itself, the sampling team returned to the site on March 14th for additional characterization. During this sampling event, the team attempted to isolate geographic locations on the fork that were believed to be potential source areas. DRL1 and DRL2 were located upstream and downstream, respectively, of a narrow channel immediately downstream of the lake outlet at which a high concentration of ducks were observed to frequent. DRL3 was located immediately upstream of a small sedimentation basin. The fork outlet (DRL5) and a Chester Creek (2B2) were sampled as well for background.

As illustrated in Table 9, the FC concentration at DRL5 was significantly higher than that observed at DRL3, thus indicating that the increase in FC occurred either in the sedimentation basin, or in the culvertized section directly downstream of the

sedimentation basin. Although there was evidence of recent duck habitation between DRL1 and DRL2, and recent moose activity between DRL2 and DRL3, this recent habitation did not lead to a measured difference in FC counts.

On March 22nd, the sampling team returned again to the site in an effort to discern whether the high FC counts originated in the sedimentation pond or in the culvertized section directly downstream. The results, presented in Table 9, indicated that while the FC concentration of the water entering the sedimentation basin was zero, the concentration leaving the basin was somewhat higher, and it did not increase within the culvert. Although this did indicate that the sedimentation basin acted as a source area, the concentrations were much lower than the FC levels measured during the previous sampling events.

On June 16th, 2005, the site was once again sampled in order to evaluate the summer FC dynamics. On this sampling event, the culvertized lake inlet was sampled (RL1) along with sites DRL1, DRL3, and DRL4. Results from this sampling event indicated that relatively low levels of FC were exiting the lake even though a large congregation of ducks and geese were observed at the site (Table 9). Indeed the FC concentration entering the lake was higher than the concentration exiting the lake. Moreover, the FC concentration once again appeared to increase as the water flowed through the shallow sedimentation basin.

Evaluation of these four sampling events taken as a whole indicates that the sedimentation basin located upstream of the fork outlet likely served as a significant FC source during breakup, and to a lesser extent, throughout the summer. Although the original source of the FCs may have been the waterfowl in the area, the FCs likely accumulated in the basin and became mobilized during periods of high flow. As the fork flowed openly through a densely-populated suburban neighborhood, it is quite possible that domestic animals as well as moose and waterfowl served as the original FC source.

3.6 North Fork Evaluation

Several sampling events were conducted on the Chester Creek's North Fork in an attempt to evaluate the impacts of the numerous potential FC sources in the vicinity. The reach of stream, located along the stretch between Lake Otis Blvd and Sitka Street (AWWU Map # SW1433), is potentially influenced by a landfill to the northwest, an adjacent sewer pipe, several stormwater outfalls, a large congregation of resident waterfowl, a residential condominium complex, an adjacent city park, and an adjacent municipal snow dump. Four locations along this reach were sampled over the course of four sampling events in spring and early summer 2005.

The first sampling event took place on March 9th, 2005, during the initial stages of the spring snowmelt. Six samples were collected at each of two locations along this reach, resulting in FC measurements too numerous to count (TNTC) for 11 of the 12 samples. The remaining sample, although officially TNTC according to the standard laboratory protocol, yielded a concentration approximated to be 1,620 CFU/100mL. It was assumed that the other 11 samples contained FC concentrations higher than that.

The team returned to the site on March 23rd, April 6th, and May 26th, 2005. The seven samples collected during these events ranged in concentration from 3 to 17 CFU/100mL. Due to the relatively low concentrations resulting from these efforts, it was determined that further warm weather evaluation at the site would not likely yield productive results.

This effort indicated that the North Fork was heavily impacted by FC during the spring snowmelt. Due to the large number of potential contributors, however, it was not possible to discern the individual influence of any single contributor through FC sampling alone. Indeed, FC concentrations in the water flowing into the reach from the culvertized region upstream were beyond the range of measurement (TNTC). Although this reach would serve well as a monitoring location in the future, the high number of potential influences located there would likely confound source isolation studies.

3.7 Survivability of E. coli

The survival of *E. coli* cultured from Chester Creek was evaluated over a period of weeks in the laboratory in order to provide an indication regarding the survivability of FC bacteria in the creek. A detailed description of the procedures used is provided in Appendix G. Although this study is ongoing, results to date are indicated in the figures below.

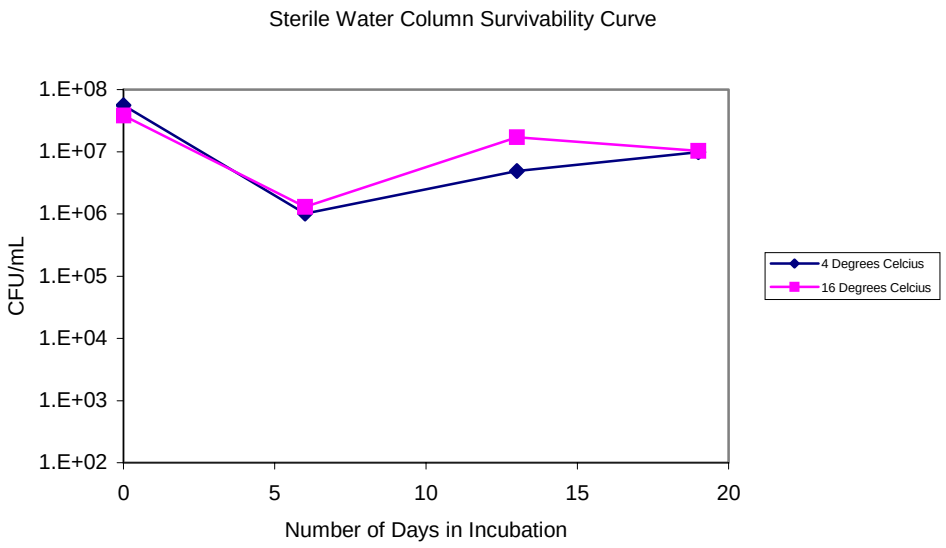

Figure 12. Sterile Water Survivability Curve

As indicated in Figure 12, the *E. coli* population was reduced by approximately one order of magnitude after a three week incubation period. Although the populations at both 4 °C and 15 °C did appear to decrease after the first week and then increase again thereafter, it was not determined whether this was an actual phenomenon or whether it was an artifact of laboratory error. Nonetheless, the results indicate that in sterilized Chester Creek water, the *E. coli* population did not decrease dramatically (several orders

of magnitude) during the initial three week period. These results can be compared with the results from the non-sterile incubation depicted in Figure 13 below:

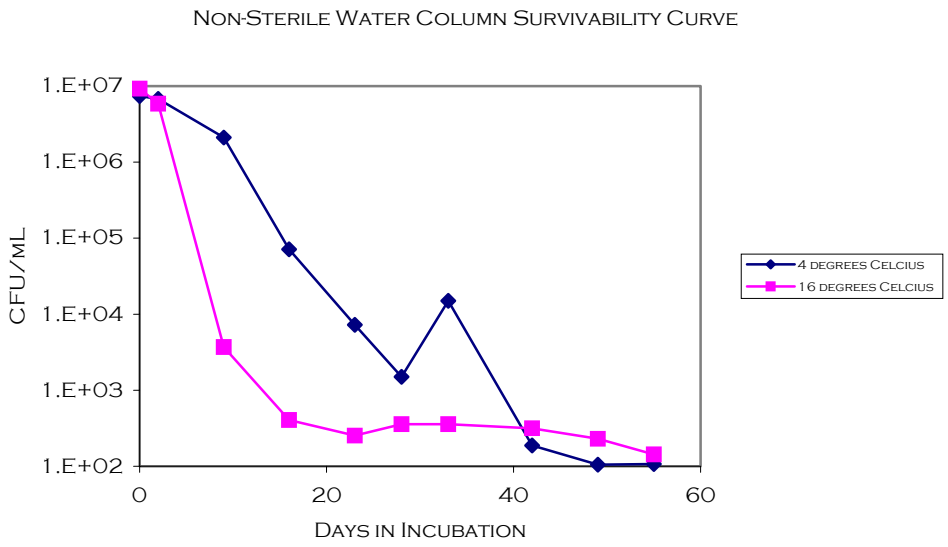

Figure 13. Non-Sterile Survivability Curve

As illustrated in Figure 13, the *E. coli* did not appear to survive as long under non-sterile conditions compared to sterile conditions. This result was expected, as non-sterile conditions would likely promote predation of the target bacteria. Moreover, *E. coli* at 4 °C appeared to survive longer than the same bacteria at 16 °C under non-sterile conditions. It is unclear whether this represents an increased survivability of *E. coli* itself under colder conditions, or rather represents a relative decrease in the survivability of bacterial predators at those same temperatures. Regardless, the results do indicate that the colder temperatures associated with winter conditions in the creek could extend the survivability of FC bacteria compared to summer conditions. It is also notable that the populations at both incubation temperatures tended to stabilize during the waning weeks

of the experiment. This indicates that the remnants of large FC spikes experienced during the late summer could potentially persist in the creek well into the winter months.

The survivability experiments detailed here were conducted in an effort to provide direction, but were not intended to provide quantitative survivability information. As the cultures evaluated in the laboratory were grown at significantly higher concentrations than would be observed in the creek, die-off rate data may not be directly applicable. As stated, these and similar studies are ongoing, and will be published as the results accumulate. Moreover, *in situ* survivability studies are planned for FY06, and it is anticipated that these will provide a higher degree of certainty regarding survivability in the natural state.

4. CONCLUSIONS

Based upon the observation that the highest concentrations of FC bacteria were measured during periods of relatively high input (spring snowmelt and autumn rains), we conclude that the majority of the FC bacteria in Chester Creek originally entered the creek via the storm drain system and/or overland flow. Some degree of loading likely occurred via direct deposition from waterfowl and other wildlife, but the relative quantity of this loading was difficult to discern without the use of microbial source tracking techniques. Once in the creek, the FC bacteria did not accumulate conservatively in the water column, but rather exhibited a more complicated dynamic resulting in varied reaches of net FC gain and net FC loss. While one component of this dynamic was likely related to the scour and deposition of particulate-bound FC, excessive FC concentrations were not always associated with excessive total suspended solids or turbidity measurements. Consequently, management measures designed to control total suspended solids or turbidity would not likely be universally effective at minimizing FC concentrations.

The in-stream FC measurements alone were not adequate for identifying non-point sources. While we were able to isolate a source area that produced extremely high FC inputs during the spring snowmelt, we were not able to discriminate the results with respect to the potential sources including 1) sewer, 2) septic, 3) domestic animals (dog), 4) wildlife (including waterfowl), or 5) outdoor human activity. As a consequence, we were forced to make inferences regarding those potential sources based primarily upon indirect measures.

Restoration Science & Engineering conducted an extensive study regarding the contributions of leaking sewers and faulty septic systems to the FC loading in the creek. This study, titled “UAA Fecal Coliform Study; Sewage Collection and Treatment Sources,” is being submitted along with this final report. The results indicated that sewers and septic systems in close proximity to the stream were not likely major

contributors of FC at the locations and times when measurements or observations were made.

We did not identify domestic animals as an FC source through direct measurement. Given the FC densities and unit feces discharges described in Table 1, however, we believe that domestic pets, especially dogs, are a primary contributor of FC to the creek both through the storm drain system and through direct runoff. Indeed, we observed dog feces on or near the banks on numerous occasions during the course of the study. On one occasion, we observed evidence that an individual had collected a substantial amount of dog feces in a large container and dumped the entire contents onto the bank. A single gram of that material ($2.3x10^7$ CFU/g) thoroughly mixed would be sufficient to raise more than 15,000 gallons of creek water above the not-to-exceed threshold of 40 CFU/100mL.

Similar to domestic animals, the contributions to FC in the creek due to wildlife could not be well quantified by the methods utilized. Nonetheless feces deposited by moose, waterfowl, and other wild animals were observed throughout the watershed. It is assumed that the contribution due to moose and other wild land mammals was low compared to domestic pets due to the evidence of high moose activity combined with low levels of FCs observed at the Ft. Richardson site. Although moose clearly exerted some impact upon FC levels in Chester Creek (on one occasion, we observed a moose defecating directly into the urbanized region of the stream), the moose population in the lower section of the watershed is much lower than the dog population. We are less certain with regard to the impact of waterfowl. Although we attempted to measure FC concentration gradients across regions densely populated by ducks, no such concentration gradients were observed to exist through the methods used. Due to their dense populations in and around the lower reaches of the stream itself as well as the numbers of FC reportedly produced by waterfowl (Table 1), however, we assume that they likely contribute a substantial amount of loading.

We conclude that direct human deposit was not a primary contributor to the Chester Creek FC load over the period studied. Although we occasionally observed evidence of outdoor human habitation, we did not observe evidence of waste pits or identifiably human fecal matter. In comparison to the number of dogs observed in or near Chester Creek's waters, the number of indigent people observed was negligible.

With regard to the water quality standards, we conclude that it may not be feasible for the urbanized sections of Chester Creek to ever fully meet the current level of compliance. At Ft. Richardson, the "pristine" baseline site utilized in the study, the monthly mean standard was exceeded once, and the not-to-exceed standard was surpassed on three occasions. Considering the density of human and animal activity in the lower Chester Creek watershed, it is inevitable that the creek will experience a higher degree of FC loading in the urbanized region compared to the pristine site. Although it will clearly benefit human and environmental health to reduce the FC loading as much as possible, we consider the current standards to be unattainable in the lower watershed.

Based upon our evaluation of the sedimentation basin located near Reflection Lake, it does not appear that such in-stream BMPs will effectively minimize the impacts of FCs on a year-round basis. Although shallow basins such as the one studied could potentially reduce the water column FC concentrations during periods of low flow, resuspension of the accumulated sediment during periods of high flow will likely increase the FC loading for portions of the year. As the survivability study appeared to indicate that FCs can survive for long periods of time outside of the host organism, shallow sedimentation basins may do no more than alter the temporal dynamics of water column FC concentrations.

Based upon the information gathered in this report, we conclude that the types of BMPs most likely to minimize the impact of FCs on Chester Creek will involve public policy, education, outreach, and enforcement. Such programs could include advertisements or articles in local news sources explaining the importance of cleaning up pet wastes and other coliform-containing solid wastes, and providing information detailing how irresponsible waste management can lead to decreased water quality. In addition, the free provision of heavy-duty bags or boxes for pet waste disposal at critical times such as immediately prior to spring snowmelt would likely serve to both increase public awareness and encourage reluctant pet owners to clean up their yards. Such an effort would likely be bolstered by regulations compelling the use of lidded plastic cans for curbside solid waste pickup.

5. RECOMMENDATIONS

Regulatory Standard: It is recommended that the ADEC review the designated uses of Chester Creek and consider reclassification under 18 AAC 70.230. Due to combined impacts from the heavily urbanized area through which it flows, Chester Creek is not likely to ever achieve year-round compliance with the current standard regarding FC bacteria. As Chester Creek is not used as a drinking water source, the second most stringent classification (contact recreation) may be sufficient to ensure human and environmental health.

Source Identification: It is recommended that chemical or biological source tracking techniques be employed to assess the relative FC loading originating from a list of potential host organisms. Potential host organisms include humans, domestic animals, waterfowl, moose, beaver, and others. Such an evaluation would provide the ADEC with valuable information relating FC concentrations in Chester Creek to their potential impacts upon human health. This, in turn, would aid in the consideration of management decisions.

Compliance Monitoring: It is recommended that a long-term program of regular compliance monitoring be instituted for Chester Creek. Due to the temporal variability observed in the creek during the course of this project, we believe that consistent sampling over long periods at relatively few sites would produce more useful information than short-term or excessively frequent sampling performed at a higher number of sites. In order to optimize the amount of useful information provided by the sampling budget, it is recommended that FC samples be collected at two locations along the creek on a bi-weekly basis into the indefinite future. Two sites recommended for consideration as long-term monitoring sites include the inlet to University Lake (3UL1) and the monitoring station adjacent to Arctic Blvd. (10A1). The trends in FC concentration observed at these two sites appeared to be consistent with Chester Creek trends reported

in the literature, and it is assumed that these two sites will prove to be sufficient general indicators of creek conditions in the future. It is important that such sampling be performed by qualified personnel in order to ensure that the results are consistently accurate. Moreover, it is recommended that this sampling be continued indefinitely in order to allow creek managers to adequately monitor the impacts of long-term management strategies.

BMP Strategies: In localized regions, the use of structural BMPs may be appropriate to reduce the levels of FC entering the creek. Greenbelt areas of high dog activity, for example, could be improved through the installation of filtration berms designed to route water under a vegetated surface through sand or filter rock. Such infiltration mechanisms could also be used at storm drain outlets found to be consistently high in FC concentration. Based upon the information gathered in this report, however, we recommend that watershed managers focus most of their mitigation efforts upon public education, outreach, and enforcement. Results of this study indicate that the majority of FC loading in Chester Creek originates from improper disposal of pet feces and other human-associated wastes. Only after the notion of clean surface water is instilled as a value in the aggregate community mind will the FC concentrations in Chester Creek fall to acceptable levels.

APPENDIX A.

Literature Review

Review of Spatial, Temporal and Phase distribution of Fecal Coliform Bacteria Studies on Chester Creek Anchorage, Alaska and Similar Studies Conducted Nationwide

APPENDIX A.

Literature Review

Review of Spatial, Temporal and Phase distribution of Fecal Coliform Bacteria Studies on Chester Creek Anchorage, Alaska and Similar Studies Conducted Nationwide

Abstract

This literature review is intended to provide the reader with current and historical research information regarding the study of fecal coliform bacteria concentrations in streams. Most of this review will provide specific information on Chester Creek in Anchorage, Alaska. Results indicate that more studies are required to aid in defining the distributions and dynamics of fecal coliform bacteria populations in Chester Creek, in order to answer questions regarding sediment resuspension of fecal coliform (FC) bacteria, source-tracking, and remediation processes appropriate for the creek. Weekly Monitoring and characterization studies are required to better understand the Fecal Coliform Bacteria in Chester Creek

Introduction

Fecal coliform bacteria are organisms that live in the intestines of warm-blooded animals. They can also live outside the body in animal feces, soils, and water. Chester Creek is on the 303(d) impairment list in Alaska for fecal coliform bacteria that indicates it is receiving fecal matter from some source or multiple sources (EPA, 2004). The primary sources of fecal coliform bacteria populations in streams are wastewater discharges, failing septic or sewer systems, and animal waste due to direct contact or storm water runoff (Chapra, 1997). Urbanization often increases the amount of fecal coliform (FC) bacteria found in a stream due to an increased proportion of impervious surfaces in combination with a higher concentration of potential inputs. Increased land area devoted to impervious surfaces leads to increased runoff, and consequent decreases in infiltration of stormwater runoff into soils(WA. Dept. of Ecology, 2004). In Anchorage it is estimated that storm water runoff contains approximately 10^2 to 10^3 FC/100 ml during snowmelt events and about 10^3 to 10^4 FC/100 ml during the rainy season throughout urbanized areas and (#) stormwater outfalls into Chester Creek (MOA, 2003).

Wildlife and domestic animals living near a stream can also contribute to FC populations in a stream (WA. Dept. of Ecology, 2004 and Chapra, 1997). Table 1 shows the amount of fecal coliform bacteria that are produced daily by representative warm-blooded animals.

Table 1

Animal	**FC x 10^6/capita day**
Human	2000
Duck	11,000
Dog	5000

*****Information found in this table is taken directly from EPA publications and Chapra (1997).

Because fecal coliform bacteria are living organisms, they are not simply deposited in the water, then subsequently observed downstream in representative numbers. In favorable conditions they will multiply, and in unfavorable conditions they will die off. This makes fecal coliform bacteria counts difficult to predict. For example if a failing septic or raw sewer line were responsible for fecal coliform in the stream, during cold winter months the incoming populations would die off due to the cold-water temperatures, resulting in a misrepresentation of the actual incoming population (WA Dept. of Ecology, 2004).

Survival and die-off rates are important in considering the interpretation of FC counts from stream samples. Factors that impact FC bacteria survival rates include the ability to thrive in the streambed sediments, winter survival of a portion of the total population, and the die off due to exposure to ultraviolet radiation (WA. Dept. of Ecology, 2004 and EPA, 1972). These impediments led project planners to implement characterization studies to narrow in on short-term dynamics during snowmelt, precipitation events, and dry-weather effects of waterfowl, wildlife, and recreational human and animal activity.

Nationwide Studies

Numerous studies have been conducted regarding microbial source tracking, microbial indicators and methods, identifying non-point sources of microbial contamination, and impacts of sediment reservoirs on fecal coliform water quality standards (Francy et al, 2000, McFeters and Stuart, 1972, Scott et al, 2002, Crabill et al, 1999 and Davies et al 1995). Land use has been sited as having the most impact on bacterial indicators in streams (Francy 2000). Many studies are moving away from fecal coliform tests, and

moving towards *E. coli* and *C. perfingens* as water quality monitoring standards for presence of fecal matter. Other studies document the use of source tracking in conjunction with FC counts to differentiate human vs. animal (Brion and Lingireddy 1999, Jagals et al, 1995, and Francy et al 2000). Once it has been determined whether the sources are human, animal or a combination of both, additional experiments can be performed to differentiate which animals are the major contributors. This is often done by complicated and expensive genotypic analysis (Scott et.al, 2002), although less expensive methods such as antibiotic resistance analysis are yielding promising results as well (Whitlock et al, 2002).

Another method of distinguishing human and animal fecal sources is the fecal coliform to streptococci ratios (FC/FS). This ratio becomes unreliable if the fecal contamination is not fresh, or if FS are less than 100cfu/100mL (Brion and Lingireddy, 1999). Human specific chemical sterols as well as other bile materials can also be used as indicators of human sewage, but such analyses are expensive and technically complex (Brion and Lingireddy, 1999).

Rapid detection of fecal coliforms in surface water via analyses that require 6 hour incubation periods (as opposed to 24 hour incubation periods) have been shown to be a viable option, but have not been approved as standard methods by the EPA and other governing bodies (Berg and Fiksdal, 1988).

Identifying particular sources of fecal coliform populations is a daunting task due to the non-point source of contamination, and survival of FC in freshwater sediments (Davies et al, 1995 and Brion and Lingireddy, 1999). One approach to remedy the complications of non-point source modeling for a FC model is to use Monte Carlo Analysis in field parameters to estimate long-term values that can be used for model calibration due to the short-term nature of the data available (Benaman and Shoemaker, 2004). Another modeling technique is to build a neural network that will bring together the data collected and interprets short-term trends for a long-term model (Brion and Lingireddy, 1999).

Water Quality Studies on Chester Creek Anchorage, Alaska

A number of organizations have conducted water quality studies on Chester Creek over the past twenty years. This review will address each organization and its associated research by sections below.

Anchorage Waterways Council

The Anchorage Waterways Council began a volunteer monitoring program in the late nineties to address water quality issues in Anchorage streams. Most data is available online (at least recent years) as well as in a few publications available in the local libraries. Most of the data collected has been deemed unreliable due to the methods used especially in regards to *E. Coli* bacteria. The incubation technique (a cardboard box) was found to have high temperature fluctuations, which would result in unreliable *E. Coli* counts. The information gathered could be useful if the parameters measured were taken

using consistent and proven techniques. Determining data reliability would involve acquiring all meta-data documentation as well as quality assurance and quality control documentation for each volunteer and sampling event.

Measurements taken by the volunteer program included; turbidity, conductivity, temperature, DO, total coliform, E. coli, pH, phosphate and nitrate. Not all sites have available data. Sites with available data show that data was taken irregularly every couple months, and varied site to site. Therefore, we will not present all the results here. The sites generally used are found below.

Nomenclature used: MF-Middle Fork of Chester Creek
NF-North Fork of Chester Creek

1) MF @ Arca Drive
2) NF @ Sitka Street
3) East of Muldoon
4) Tudor Center
5) Westchester Lagoon
6) East of Arctic

The data obtained for four of the six sites are shown below taken in 1999-2000 showing total coliform and *E. coli*. For each parameter, a 1 ml sample was taken and analyzed, as well as a 5 ml sample. The samples were taken monthly over the course of one year then a mean, min., max., and standard deviation were found. The results of each parameter and sample size are shown below.

Table 2 a,b,c,d

2 a. Westchester Lagoon

cfu/100 ml	N	Mean	Min	Max	Standard Deviation
1ml Coliform	18	183	0	700	233
5ml Coliform	18	98	0	380	140
1ml *E. coli*	18	11	0	100	32
5ml *E. coli*	18	17	0	60	19

2 b. East of Arctic

cfu/100 ml	N	Mean	Median	Min	Max	Standard Deviation
1ml Coliform	15	1526	700	0	6300	1896
5ml Coliform	15	729	740	60	1380	490
1ml *E. coli*	15	140	0	0	700	206
5ml *E. coli*	15	117	40	0	520	151

2 c. Tudor Center

cfu/100 ml	N	Mean	Median	Min	Max	Standard Deviation
1ml Coliform	12	3566	3450	200	6800	2205
5ml Coliform	12	2228	2240	160	4480	1213
1ml *E. coli*	12	616	100	0	3800	1164
5ml *E. coli*	12	441	60	0	2560	823

2 d. East of Muldoon

cfu/100 ml	N	Mean	Median	Min.	Max.	Standard Deviation
1ml Coliform	21	352	0	0	6600	1433

5ml Coliform	21	103	20	0	1120	275
1ml *E. coli*	21	23	0	0	200	53
5ml *E. coli*	21	18	0	0	100	27

The total coliform and *E. Coli* measured by the volunteers shows a high variability in one-year worth of samples, again emphasizing the need for short-term experimental studies. The standard deviation exceeds the mean at all sites for both *E. coli* and total coliform. The standard method for statistical analysis of coliform forming units per 100 ml is to calculate the geometric mean as opposed to the arithmetic mean (seen on the table above), and then perform statistical analysis reducing the variability seen here (EPA, 2004).

USGS

USGS has conducted many studies over the years with regards to fecal coliform indicator bacteria, urban runoff in Chester Creek, and water quality of Anchorage streams. In the past, USGS installed three gauging stations along Chester Creek, which are no longer in use. The data obtained online contains three sites listed below.

1) Chester Creek at Arctic Blvd.
2) South Branch of South Fork at Boniface Parkway.
3) Chester Creek at Tank Trail in Fort Richardson Air Force Base.

The information currently available online does not include the Tank Trail site. The other two sites have data available for sediment percent fines, phosphorous, dissolved nitrogen, nitrogen, nitrogen as ammonia, and organic nitrogen.

The Journal of the American Water Resources Association published a paper written by Frenzel and Couvillion of the USGS in Anchorage, Alaska titled " Fecal Indicator Bacteria in Streams Along a Gradient of Residential Development" in 2002. This paper indicated that fecal-indicator bacteria concentrations were higher in the summer than in the winter, and that areas served by sewer systems contained significantly higher levels of FC bacteria than in areas served by septic systems.

The Frenzel and Couvillion paper also states that areas of Chester Creek do not freeze during winter months and provide areas for waterfowl to congregate year-round. Fecal-indicator-bacteria concentrations were compared with population density categories, sewer and septic areas, and seasons. There was extreme variability found in short term segments, which led to a possible explanation of waterfowl during winter months as the possible source during these sampling events. Flushing of sediment particles into the stream were noted as a possible cause of increased FC that were not associated with human or animal inputs.

Areas along Chester Creek containing finer grained streambed sediments were cited as places that provide a favorable habitat for FC bacteria, and literature indicates that bacteria in stream beds can survive for several months and be resuspended when the

stream bed is disturbed or flows become high enough (Davies 1995 and McDonald et al. 1982).

Overall, the source of high concentrations of FC bacteria could not be determined from the data taken for this study. Many possible explanations were provided: water fowl (especially in the lagoon areas at the end of Chester Creek), storm sewers that drain directly into the basin, and throughout the stream, and finally raw sewer systems surrounding the creek and watershed.

Table 3 and Table 4 provide some of the data collected for this project regarding only Chester Creek in the year 2000.

The three sites in the table are as follows

CH1-S. Branch of S. Fork at Tank Trail
CH2-S. Branch of S. Fork at Boniface Parkway
CH3-Arctic Boulevard

Table 3

Location	Range of FC cfu/100 mL
CH1	1-7
CH2	90-2500
CH3	58-1500

The short-term variability study was conducted at CH3 indicating afternoon peaks of FC counts. (TNTC means Too Numerous To Count.) The results are given in Table 4.

Table 4

Fecal Coliforms (cfu/100mL)

Date	Time			
11/16/00	1:00 pm	3500	3400	TNTC
11/16/00	5:00 pm	60	60	130
11/17/00	11:30 am	70	87	110
11/17/00	2:40 pm	4000	4000	3900

In 1987 a Water-Resources Investigations Report 86-4312, was prepared with the Municipality of Anchorage titled " Quantity and Quality of Urban Runoff from the Chester Creek Basin Anchorage, Alaska". The information is fairly dated, the North Fork had not yet been channelized, and numerous storm water outfalls along the north fork were not yet in place.

The 1987 Report sited residential areas as the primary source of fecal coliform bacteria due to the high values found at the Arctic Blvd site. Comparison of suspended sediment and fecal coliforms were not conducted in this study. The highest concentrations of suspended sediment and fecal coliform concentrations were found during snowmelt periods. Non-point sources were identified as the source for these elevated levels. During base flow conditions fecal coliform bacteria did not meet water quality standards at the time of this study. Particular sources were not identified.

Municipality of Anchorage

The raw data for fecal coliform bacteria studies conducted by the municipality is buried in archived documents. Watershed Management Services provided a report including these studies titled “Fecal Coliform in Anchorage streams; Sources and Transport Processes” in 2003.

Storm water runoff is indicated as the major source of fecal coliform contamination in Anchorage area streams. The primary fecal source in runoff is thought to be domestic animals in residential areas. The municipality also states that FC stored in fine streambed sediments are important factors that contribute to elevated levels in the streams during high flow periods. The source of FC in the sediments is thought to come from lawn runoff, which contains animal feces, that attaches to sediment in gutters during storm events and is eventually transported to the creek.

The municipality of Anchorage (MOA) notes that there is a late summer and early fall decline in FC concentrations which is typically the rainy season in Anchorage. The municipality believes that this suggests storm water runoff is not the only contributor to elevated FC levels in the streams. The mechanism suggested by the city is a sediment resuspension theory, which has yet to be validated. The resuspension theory is supported in the literature (Kidd 1987 and McDonald et al 1982).

FC concentrations stored in the streambed sediments have seasonal buildup and experience a seasonal depletion due to higher stream water velocities (MOA, 2003). The

recharge of the stream sediment occurs in the late fall coinciding with lower flows, and consistent storm water inputs. In the beginning of the rainy season, 'pulses' of fecal coliform concentrations should be found due to the resuspension of these scoured sediments in the streambed, according to the MOA (MOA, 2003).

Raw data to support these theories are not provided in the report, and available data is limited according to this report. The municipality indicates that a particular source cannot be determined given the data available.

UAA/ENRI

ENRI ran two stations on Chester creek and has data available for five months in 1999 including some physical data such as discharge, water and air temp, pH, DO and conductivity. Khrys Duddleston (a microbiology professor at UAA) has had students collect *E. coli* and total coliform data for one year. The nine UAA sites used by the Environmental and Natural Resources Institute (ENRI) and UAA students have been personally referenced.

Duddleston's students collected data from June through October in 2003. The data UAA students have collected has not yet been analyzed for significance and the information has not been published or made available to the general public.

UAA student data are shown below giving the geometric mean of cfu/100mL on a given day covering all nine sites along the whole stretch of the creek as well as the standard deviation.

Table 5 a. and b.

5 a. E. Coli

Sampling Date	Geometric Mean	Standard Deviation
16-Jun	1.75	0.3
27-Jun	1.72	0.2
31-Jul	1.74	0.4
18-Aug	2	0.2
18-Sept	1.75	0.4
19-Oct	1.62	0.2

5 b. Total Coliform

Sampling Date	Geometric Mean	Standard Deviation
16-Jun	2.26	0.7
27-Jun	2.79	0.8
31-Jul	2.87	0.5
18-Aug	3.17	0.6
18-Sept	3.13	0.8
19-Oct	2.61	0.8

Discussion

Nationwide studies were primarily conducted in areas where the land use is agricultural, residential or a combination of the two (Brion and Lingireddy, 1999 and Benaman and Shoemaker, 2004). Chester Creek is unique in the respect that there is no agricultural land use within the watershed that could be sited as a major contributor to fecal coliform contamination. Many segments of the stream are surrounded by significant riparian zones, which are used recreationally year-round. The riparian zones offer habitat for moose, rodents and waterfowl year-round regardless of the inner-city location. Highly residential and commercial regions surround the riparian zones. Drainage area and land-use of the Chester Creek watershed is quite large and diverse making similar studies nationwide difficult for a direct comparison.

Water Quality studies performed locally on Chester Creek indicate a need for reduction of variability in the measurements, and additional data to better identify sources for future remediation. Short-term intensive sampling events may provide data with less variability, but USGS found that short-term sampling events did not decrease variability. The caveat here is the Frenzel and Couvillion short-term sampling event took place over two days, and contained only four samples.

Conclusion

This literature review has led to a restructuring of the original work-plan where weekly samples would have been taken throughout the entire span of the creek. Historically studies done in this manner have led to inconclusive findings due to the high variability and sediment storage and resuspension theories of fecal coliforms. The revised strategy

will implement characterization studies to capture dynamics on a smaller scale throughout the year to add to a larger stream-span model. The characterization studies are intended to provide some illumination of wildlife and waterfowl, septic/sewer, human activity, and domestic animal contributions to fecal coliform contamination in Chester Creek, as well as illuminate persistence of fecal coliform bactera once it enters the stream, or is deposited into the sediment.

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APPENDIX B.

Quality Assurance Project Plan

APPENDIX B.

Quality Assurance Project Plan (QAPP)

Several changes have taken place since the revisal of the QAPP used in the Appendix here. This QAPP represents the original work plan, and should be regarded as such. It is not a record of what occurred throughout the study period.

University of Alaska Anchorage

A2. Table of Contents

A3. Distribution List

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A4. Project/Task Organization

The University of Alaska Anchorage School of Engineering has received a grant to assess the spatial, temporal and phase distributions of fecal coliform (FC) bacteria in Chester Creek. Potential sources suggested by the ADEC include1) Sewers, 2) Septic Systems, 3) Domestic Animals (dogs), 4) Wild Animals (including waterfowl), and 5) Outdoor Human Activity (not including sewer/septic). Tasks to be performed include seven substudies over the course of one full year designed to assess FC dynamics in Chester Creek. Creek waters will be sampled during storm events, snowmelt, base flow conditions, and dry weather events. A final report will be submitted at the end of the year in July 2005. Quarterly reports will be produced quarterly throughout the year. Duties and responsibilities for completing these tasks are described below.

UAA School of Engineering / Department of Biological Sciences

- Bill Schnabel (School of Engineering) is the Project Director. He will provide overall review and direction for the project.
- Khrys Duddleston (Department of Biological Sciences) is the Analytical Coordinator. She will train and oversee project team members in the proper laboratory procedures for fecal coliform and associated analyses. Additionally, Khrys will aid in data interpretation.

- Tammie Wilson is the primary graduate student on the project and will conduct the sampling and experimental fieldwork. She will produce the deliverables, data reports and interpretation.
- Graham Stahnke is the second graduate student to aid in all fieldwork tasks.

Restoration Science and Engineering

- David Nyman is an environmental consultant who will contribute to field sampling events, instrumentation, and aid in project coordination and data interpretation.
- Craig McCauley is another consultant who will aid in field sampling and provide technical and interpretative support.

Applied Wetlands Technology

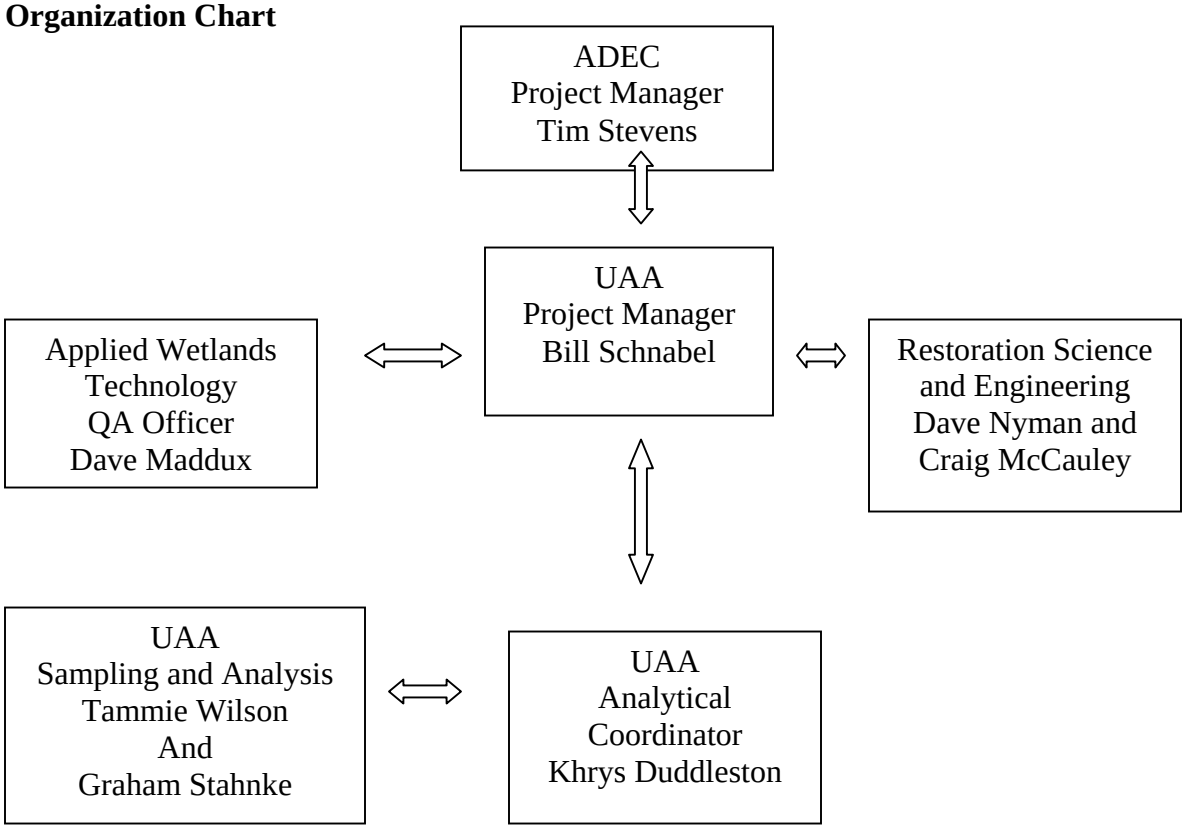
- Dave Maddux is the Quality Assurance Officer. He will be responsible for QA/QC of all data, as well as provide technical and interpretative support.

The project laboratory and analysis will be conducted at UAA School of Engineering and/or Department of Biological Sciences. Tammie Wilson will be the contact for this portion of the project

ADEC Staff

- ADEC Project Manager is Tim Stevens. Tim will be the primary contact for technical questions or other questions related to the project.

Organization Chart



A5. Problem Definition and Background

The purpose of this project is to investigate the spatial, temporal and phase distribution of fecal coliform bacteria in Chester creek, in support of the Fecal Coliform Total Maximum Daily Load (TMDL) being developed for Chester Creek. It is anticipated that through a better understanding of the dynamics associated with the highly variable FC levels currently observed in the creek, this

research will enhance future monitoring and/or mitigation efforts. Hypothesized nonpoint sources are as follows; sewer, septic, outdoor human activities, wildlife, and domestic animals.

As a first step in the experimental design process, the research team conducted a literature review in order to collect and summarize the pertinent work that has been completed regarding fecal coliforms in Chester Creek. The goal of this action was to allow the research team to develop an experimental strategy that would build upon the results of previous research. Although the complete literature review will be included in the FY04 report, some of the key findings are as follows:

Fecal coliform bacteria studies have been conducted on Chester Creek several times throughout the last twenty years by a number of organizations. The Municipality of Anchorage produced a report regarding Anchorage area streams and their associated fecal coliform bacteria in 2001. In the late nineties, the Anchorage Waterways Council initiated a volunteer program in which fecal indicator bacteria in Chester Creek (and others) were measured and reported. Additionally, the USGS has performed several studies on local streams and fecal-indicator bacteria.

Much of the available raw data for FCs is somewhat inconsistent, and quite often there are limited metadata available to provide a contextual framework for the results. In the studies for which there are reliable data available, the measurements were collected relatively infrequently or at very few sampling locations along Chester Creek itself. Consequently, while it is possible to make broad assertions

regarding general FC trends in the creek from historical data, there are myriad issues regarding Chester Creek FC dynamics about which the historical record contains insufficient data to address.

A primary issue not addressed in the historical records regards the short-term variability of FC concentrations under varying flow conditions. Quantification of short-term variability is critical to the proper interpretation of long-term trends, and this issue will be revisited consistently throughout the present study. Previous data does indicate that fecal coliform concentrations increase with downstream distance. The data also suggest that fecal coliform bacterial populations are present in the fine sediments. During high flow conditions such sediments are resuspended and mobilized downstream, and thus could provide a mechanism for in-stream storage and transport of FCs. This theory of resuspension has not been adequately tested up to this point, and of the seven substudies to be conducted, a few will attempt to examine this in greater detail.

The sampling regimen on this project includes three base sites covering the length of the stream at which measurements will be taken weekly for FCs, flow/stage, and turbidity. There will also be six additional substudies that will attempt to address specific issues regarding FC distribution, sources, and temporal dynamics during particular weather events. The sampling regimen for each substudy will vary based on the question being addressed. A full discussion of the proposed substudies is outlined in sections A6 and B1.

A6. Project/Task Description

The proposed work elements to meet the project objectives are summarized below. The summary for each work element includes deliverables, and a schedule.

Field Data Collection

Data will be collected from July 1, 2004 to June 30, 2005 to monitor fecal coliform (FC) impacts on Chester Creek, including seasonal sampling events to assess FC impacts from stormwater, melt water, base flow, and other potential sources on the creek. Additional parameters to be collected include turbidity, total suspended solids, pH, specific conductance, temperature and stage. Additional sampling dates and sampling sites may be utilized to further investigate FC dynamics at the discretion of the Project Manager. A detailed description of the sampling program is provided in Section B1, Sampling Process. See also a site location table (Table 2). Data collected will be submitted in the quarterly reports and raw data will be submitted by the ADEC regulations as stated in the grant application.

Quarterly Reports

Quarterly reports will be delivered quarterly throughout the sampling period. Each report will include results of data analysis to date, association with weather conditions, sites visited in the previous month, training, literature review, and any other activities conducted throughout the month.

Deliverable: Quarterly Reports

Schedule: Due Oct 15th 2004, Jan 15th 2005, April 15th 2005.

Draft Final Report

The 2004-2005 Draft Report will include the complete sampling results from the 2004-2005 sampling season. Samples will be analyzed and compared to state pollutant standards as described in the sampling plan. The Draft Report will be submitted on July 15, 2005 for review by ADEC. The Draft report will include the results from the quarterly reports and analyze the complete data set for the project. Data will be used to address a series of questions that will help to manage fecal coliform inputs to Chester Creek:

- What sources are contributing fecal coliform bacteria?
- Where and when are fecal coliform levels the highest?
- What is the relationship between FCs and TSS/turbidity, and can that relationship be exploited for mitigation purposes?

Deliverable: Draft Final Report

Schedule: completed by July 15th, 2005.

Final Report

A Final Report will be prepared following ADEC review of the Draft Final Report and will incorporate comments from that review. Photographic records and the project database will be submitted with the Final Report.

It is anticipated that the Final Report (as well as the Quarterly Reports) will be utilized by ADEC staff and other agencies in the formulation of management decisions regarding Chester Creek. Additionally, it is expected that the results contained in the Final Report will be utilized by this research team and other interested entities for the development of future projects designed to minimize pathogenic risk in Alaska's waterways.

Deliverable: Final Report

Schedule: Completed by July 31, 2005.

A7. Data Quality Objectives and Criteria for Measurement of Data

Project Data Quality Objectives

The overall objective of this study is to gain a better understanding of the sources and dynamics of FCs flowing through Chester Creek. In order to achieve this, the research team must first be able to quantify anticipated variability of FC counts under relatively stable flow conditions. Only through an explicit understanding of what is "normal" can deviations, and hence discrete impacts, be detected. The research team will attempt to quantify this variability through a series of tests in which replicate samples will be collected over varying time scales and flow regimes at pre-determined points in the stream. In so doing, baseline variability will be determined under various conditions, and data points located outside the expected range of variability can be considered to be the result of the sources or influences being tested. In addition, duplicate samples will be periodically collected to ensure that the FC analysis itself provides results within the defined range of variability.

Detection limits for the analytical methods must be comparable to the levels of concern

in order to meet data quality objectives. The levels of concern used for this project are

the water quality criteria in 18 ACC 70 for fecal coliform bacteria. A summary of the parameters, the analytical methods used for determining the concentration and

their associated reporting units, instrument or method specifications, and calibration methods are detailed in Table 1:

Table 1. Analytes and Methods

Water Quality Parameter	Method	Instrument or Equipment	Range	Units	Sensitivity	Completeness	Precision	Accuracy	Holding Time	Calibration Method	Calibration Frequency
Fecal Coliform	SM 9222D	sterile bench, vacuum filtration, incubator, microscope	ND - TNTC	col/100mL	Dependant upon Dilution 100mL-1 50mL-2	966 - 20% proposed	< 20% RPD of log-transformed values	--	6 hours	--	--
Turbidity	EPA 180.1 modified	Hach® Model 2100P Portable Turbidimeter Instrument	0-9.99 NTU; 0-99.9 NTU; 0-1000 NTU	NTU	0.01 at lowest range; 0.1 at middle range; 1 at highest range	Approx 150 proposed	±1% of reading or 0.01 NTU, whichever is greater	±2% plus stray light	48 hours	4-point (<0.1 NTU, 20 NTU, 200 NTU and 800 NTU)	prior to each sampling event
pH	EPA 150.1 modified	Hach® sension156 pH probe	2.00-19.99	pH units	Instrument Drift: <40uV/^{o}C	Approx 150 proposed	±0.2 units	±0.2 mV or ±0.15% of mV reading - whichever is greater	field	3-point (pH = 4.01, 7.00 and 10.00 @ 25^{o}C)	prior to each sampling event
Specific Conductance	EPA 120.1 modified	Hach® sension156 conductivity probe	0-19.99 uS/cm; 20-199.9 uS/cm; 200-1999uS/cm; 2-19.99 mS/cm; 20-199.9 mS/cm	uS/cm or mS/cm	0.07 uS/cm	Approx 150 proposed	< 10% RPD	±0.5% of range	field	1-point (1413 uS/cm or 0.01M KCl solution)	prior to each sampling event
Temperature	EPA 170.1	Hach® sension156	-10.0-110^{o}C	^{o}C	0.1 C	Approx 150 proposed	< 10% RPD	±0.3^{o}C from 0-70oC; ±1.0^{o}C from 70-110^{o}C	field	Manufacturer Calibration	--
Total Suspended Solids	SM 2540D	vacuum filtraton and microbalance	Gravimetric	mg/L	2 mg/L	Approx 150 proposed	< 20% RPD	To be Determined	7 days	--	--

Criteria for Measurement of Data

Criteria for Measurements of Data are the performance criteria: accuracy, precision, comparability, representativeness and completeness of the tests. These criteria must be met to ensure that the data are verifiable and that project quality objectives are met.

Our objectives for accuracy, precision, comparability, representativeness and completeness are summarized in this section. Our contracted laboratory is the University of Alaska Anchorage, Environmental Engineering Division water quality lab.

Accuracy

Accuracy is a measure of confidence that describes how close a measurement is to its

"true" value. Methods to ensure accuracy of field measurements include instrument calibration and maintenance procedures discussed in Section B7 and B8 of this QAPP. Sample handling procedures are also discussed in Section B3 and review of these procedures for verification of data is included in Section D.

Precision

Precision is the degree of agreement among repeated measurements of the same

characteristic, or parameter, and gives information about the consistency of methods.

Precision is expressed in terms of the relative percent difference (RPD) between two

measurements (A and B).

Field and lab precision will be measured by collecting field duplicate

samples. One duplicate QC sample will be collected on each sample event date.

UAA will ensure laboratory precision by comparing the analysis of laboratory duplicate samples.

Representativeness

Representativeness is the extent to which measurements actually represent the true environmental condition. Representativeness of data collected is part of the sampling

program developed by ADEC and outlined in the sampling plan. The locations of the

sampling sites are based on the consensus of the Technical Advisory Committee (TAC) from sites in Chester Creek. The storm water locations were chosen because they are located in areas where multiple activities may be contributing to the fecal coliform and other pollutant concentrations.

We will ensure the representativeness of the data by recording weather conditions

throughout the sampling season, using consistent sampling methods and ensuring quality during sample collection, handling and transport (see Sections B2 and B3).

Comparability

Comparability is the degree to which data can be compared directly to similar studies.

Standardized sampling and analytical methods and units of reporting with comparable

sensitivity will be used to ensure comparability. Analytical sample analysis will be performed following EPA-approved procedures by the UAA water quality lab. The methods used for this sampling program will be compared to field sample collection methods employed by previous investigators.

Completeness

Completeness is the comparison between the amounts of usable data collected versus

the amount of data called for in the sampling plan. We will determine completeness by comparing sampling and analyses completed with the requirements in the sampling plan.

A8. Training and Certifications

Sampling personnel are trained in sampling methods, sample handling, sample transport, and field laboratory measurements. Personnel analyzing and reporting data will be qualified to conduct these tasks per their experience with fecal coliform sampling at various sites on Chester Creek and/or 18 ACC 70 water quality criteria.

Field instrumentation and sampling training was conducted at UAA on June 28th, 2004. Craig McCauley conducted the training session. In attendance were Bill Schnabel, Graham Stahnke, Tammie Wilson, Dave Maddux, and Craig McCauley. Laboratory training is scheduled to occur on July 6th. Khrys Duddleston will conduct the training. Training documentation will be made available upon request.

A9. Documents and Records

As described in Section A6, reports will include three quarterly reports, one draft final report, and one final report. In addition to any written report, data collected for this project will be provided electronically to the DEC via a 3.5" diskette, CD-ROM, FTP site, or e-mail Zip file. Both the original application file and a comma delimited text file will be provided. The text file will be an ASCII (text) file with fields separated by commas (comma delimited; often "CVS") text enclosed in quotes. Spaces are not permitted between fields. Blank lines are not permitted in the file. All dates must be formatted as MM-DD-YYYY.

Field notebooks will be completed during all field activities. Any modifications to the notebook text will be made by crossing out errors, initialing, and then adding

the corrected information. These notebooks will be copied upon completion of each sampling event, and included in the appendix of the final report. No data sheets other than the field notebooks will be utilized in the field. Copies of the field notebooks will be included as an appendix to the final report.

Laboratory data results will be recorded on laboratory data sheets, bench sheets and/or in

laboratory logbooks for each sampling event. These records as well as control charts,

equipment maintenance logbooks, calibration and quality control logs (e.g. logs describing preparation and use of standard solutions), chemical MSDSs and/or all other associated information will be maintained at the laboratory for a period of at least one year following the completion of the project.

Any procedural or equipment problems will be recorded in the field notebooks. Any deviation from this Quality Assurance Project Plan will also be noted in the field notebooks. Data results returned to ADEC will include information on field and/or laboratory QA/QC problems and corrective actions.

Training records and data review records will be kept on file at UAA and will

be available on request by ADEC. All sample analysis records and documents will be maintained at UAA during the project period and will be available to the ADEC for inspection at any time. If requested, UAA will provide copies of all project-

related records to the ADEC at the conclusion of the project. Unlike commercial laboratories, UAA research laboratories do not normally follow a systematic method of record retention/archival following the conclusion of projects. Although the PI will indeed retain these records on his own accord, it is recommended that the ADEC collect and store all project records at the conclusion of this project.

B. Data Generation and Acquisition

B1: Sampling Process and Design

Overview

The original sampling plan was modified as a result of meetings between the research team and the ADEC held in October and November 2004. The original sampling plan is retained in its entirety in the appendix for reference. Both the original and the modified sampling plans are organized into discrete substudies; however the modified plan incorporates elements of different original substudies into new categories (as well as adds new sections). In order to avoid confusion, the modified sampling plan circumvents the use of numbered substudies altogether and simply notates the sampling activities in descriptive terms. In order to gain a better understanding of the activities described in the modified plan, it is recommended that the reader examine the original plan first.

Current Completion Status

As of 11/24/04 inclusive, there have been 305 fecal coliform samples collected as part of this project. The current sampling plan calls for 966 fecal coliform samples between July 1st 2004 and June 30th 2005.

Weekly Samples

The weekly sampling events are designed to provide a consistent, defendable, record of fecal coliform levels at various sites along the creek. In recognition of the need to collect such data, the number of weekly sampling sites has been increased from three to five sites per sampling event. The additional sites are located at the inlet and outlet of University Lake. As University Lake is so large relative to the size of the creek, we predict that the water quality will change during the long holding time, and it is important to collect data from these sites to better understand both the upper and lower reaches of the creek. Weekly sampling at five sites entails the enumeration of 15 samples per week. As 35 weekly sampling events are planned after 11/24/04, weekly sampling will entail the enumeration of 525 additional fecal coliform samples.

Survivability in the Water Column

In order to predict the survivability of fecal coliforms in the water column, microcosms will be set up in the laboratory under controlled conditions and enumerated at specified time intervals. To carry this out, a large sample will be obtained from the creek and transported to the lab in a sterile container. The sample will then be continuously stirred and aliquoted into autoclaved 250 mL Erlenmeyer flasks (100 mL sample per flask). One set of flasks will then be immediately enumerated for fecal coliforms according to the standard membrane filter protocol. The remaining flasks will be covered with a sterile semi-permeable membrane ($\leq$ 0.45 μm filter) and stored in the cold room. Sets of flasks will then be retrieved from the cold room at various intervals and

enumerated as above. One control flask from each group will be utilized for measuring pH and DO at each time interval. During sample storage (prior to enumeration), one set of samples will be stored at approximately 2 °C and one set of samples will be stored at approximately 15 °C to simulate winter and summer stream temperatures respectively. It is anticipated that this experiment will require at least fifty fecal coliform samples.

Sediment Survivability (In Lab)

In order to predict the survivability of fecal coliforms in stream sediments, microcosms will be set up in the laboratory similar to those used in the water column survivability experiment. Approximately 4 kg (wet weight) of sediment will be retrieved from the stream and transported to the lab in a sterile container. The sediment will be homogenized and aliquoted (100 g each) into autoclaved 250 mL Erlenmeyer flasks. A large volume (approx 4 L) of stream water will then be autoclaved, cooled, and added to the flasks (100 mL per flask). One set of flasks will then be immediately shaken, sonicated for thirty seconds, and allowed to settle for ten minutes. After settling, the supernatant will be enumerated for fecal coliform following the standard membrane filter technique. The remaining flasks will be covered with a sterile semi-permeable membrane ($\leq$ 0.45 μm) and stored in the cold room. Sets of flasks will then be retrieved from the cold room at various intervals, shaken, sonicated, and enumerated as above. One control flask from each group will be utilized for measuring pH and DO at each time interval. Additionally, homogenized sediment from the original sample will be subjected to sieve analysis to provide particle size information on the sample. During sample storage (prior to enumeration), one set of samples will be stored at approximately 2 °C and one set of samples will be stored at approximately 15 °C to simulate winter and summer stream temperatures respectively.

The sites for the collection of the sediments will be determined by assessing known areas of fine sediment deposition. Possible source areas include Eastchester Park or the within the trailer park

located directly to the east of Boniface. It is anticipated that this experiment will require at least fifty fecal coliform samples.

Field Sediment and Water Column Association

Equally spaced transects will be determined at each site, where sampling of the water column will occur. At this transect an analysis of the sediment at intervals from the bank will aid in comparing the concentrations of FC in the sediments to the concentrations found in the water column, across a cross section of the stream. The sampling will be conducted on a seasonal basis, specifically spring break-up which is thought to be a time when loading of FC into the stream is occurring.

The sites for this study will be determined by the amount and quality of the sediments found near the bank. Ideally, we would like to use sites that have fine silty or sandy sediments along the cross section rather than rocky or coarse pebbles. It is anticipated that this experiment will require at least forty fecal coliform samples.

Other Influences

On December 8th and 9th, team members performed a reconnaissance survey of sites along Chester Creek potentially impacted by sewer or septic seepage. Observations were taken regarding the stream temperature, pH, conductivity, specific conductance, salinity sediment temperature (6 to 18 inches below the sediment surface), and stream dimensions. In addition, visual or sensory observations were taken with regard to algae growth, groundwater seeps, erosion pathways, odors, the presence of deleterious materials, the presence of wildlife or indigent people, evidence of groundwater upwellings or any other anomalies that could be indicative

of sewer/septic seepage. Based upon the results of that survey, the team will revisit at least four of those sites for further consideration. Several sites were shown to have groundwater upwelling in areas near sewer crossings. At these sites, fecal coliform samples will be taken in the stream as well as within the sediments to indicate whether the FC counts are higher than control sites directly upstream. In addition, two sites were found to harbor large populations of waterfowl. Samples will be taken upstream and downstream of the waterfowl areas to indicate the level of FC contribution. Specific sampling locations (GIS coordinates) will be provided in following reports. Information relating to other influences (e.g., sewer/septic, waterfowl, indigent people, etc.) will be collected throughout the remainder of the project, as new evidence arises. All such influences will be described/discussed in the interim and final reports as necessary.

B2. Sampling Methods

FC samples will be collected from the stream through the use of a sampling rod (or tube, in the case of the automated samplers) being placed into the center of streamflow at each sampling location. At least two people will be scheduled to participate in each sampling event, with the exception of the weekly baseline samples described in Substudy #1. Samples will be collected in accordance with established sampling procedures as outlined by Standard Methods, sections 1060 A, B and C. All samples will be collected in pre-sterilized containers. All samples

will be collected below the surface as a grab sample by submerging the sample containers in the creek flow to collect the sample.

To ensure sample integrity, specific sampling and documentation procedures will be followed. This process will include labeling containers with indelible ink prior to sampling, extensive sample and site information recording (including site meta data, e.g. weather conditions), and appropriate sample handling. All samples will be immediately placed on gel ice after sampling and will remain chilled to 4°C during transportation to the laboratory. Holding times for each sample analysis type will be met according to Table 3. Any modifications to the holding time requirement will be made only after approval by the ADEC. Sample documentation procedures will include field notebooks and sample labels. No chain-of-custody forms will be used, as the samples will not change custody between collection and analysis. Specific information such as site identification, sample identification numbers, sampling observations and sample collection time and date will be recorded in field notebooks. Additionally, photo documentation will be collected during sampling events. Prior to, and after each sampling event, all field meter probes will be rinsed with de-ionized water.

Unique sample IDs will be based on the following format: site #, mmddyy-0000 (24-hour time) plus a sub ID used if required to indicate a special sampling event. Sample labels will include the sample ID, date sampled, time sampled, sampler initials, analysis and any special instructions to the laboratory.

See Figure 1 for a map of the sampling locations and specific sampling site numbers. Sample sites are numbered from the upstream to downstream sample locations for each sampling date (see Table 2). A letter will be appended to the sample site number at sample sites where multiple samples are collected at different depths (e.g. 1 a, 1 b, and 1 c).

The equipment required for sample analysis, as described in Table 1, are available in the Water Quality Laboratory managed by the UAA School of Engineering. Bill Schnabel, the UAA Project Manager, will be responsible for correcting problems observed in the field and the associated with sampling and sample handling.

B3. Sample Handling and Custody

Individual samples for analysis will be placed in the appropriate pre-cleaned sample containers as shown in Table 3. To ensure sample integrity, specific sampling and documentation procedures will be followed. These procedures will include labeling containers prior to sampling, extensive sample and site information recording, and appropriate sample handling. Sample and site information will be recorded in the field notebooks. Quality control samples or additional sample volume for laboratory QC will be collected as appropriate and are discussed in more detail in B5. All samples will be immediately placed in coolers and packed with gel ice after sampling and will remain chilled to 4°C during transportation to the UAA testing facilities. In cases where the ISCO autosamplers are utilized, the autosamplers will

be packed with cold gel ice for the duration of the sampling event. Samples will be retrieved at least once per day to facilitate analytical holding times.

Table 3. Analyte Description

Analyte	Matrix	Container	Preservative	Holding time
Fecal coliform	water	100 ml	-	6 hours
TSS	water	1000 ml	-	7 days
Turbidity	water	250 ml	-	48 hours

Sample documentation procedures will include project field notebooks and sample labels. Specific information such as site identification, sample identification numbers, sampling observations and sample collection time and date will be recorded in field notebooks. Additionally, photographic documentation will be collected. All sampling information from field notebooks will be transferred to a Transfer Log, to be maintained by the Project Manager. The Transfer Log will be utilized as a master list encompassing all of the samples or water quality parameters taken over the course of the project. This log will be maintained on an electronic spreadsheet program. An example of the Transfer Log is attached in the appendix.

B4. Analytical Methods

Laboratory analyses will take place in the Water Quality Laboratory, University of Alaska Anchorage. As this research facility is utilized for a wide variety of projects, there is no specific Quality Management Plan in place to cover all projects. Nonetheless, the laboratory will follow the QA/QC guidelines specified in SM 9020 for microbial analyses on this project. Any modifications to this procedure will be

noted and recorded in the Final Report and other appropriate documents. Water quality analytical methods used throughout this project will follow Standard Methods procedures, specifically 9222 for fecal coliform. All other water quality-testing methods will follow the appropriate Standard Methods (or other EPA-approved) protocol. All water quality analysis used for this program are EPA-approved and can be found in Table 1. Khrys Duddleston, the project Analytical Coordinator, will be responsible for correcting problems observed in the laboratory.

B5. Quality Control

Quality control activities in the field will include adherence to documented procedures

and the comprehensive documentation of sample collection information included in the

field notebooks. To insure quality control for sample collection and analysis the analyst and sampler are one in the same. The samples will not change hands upon transport to lab for analysis, therefore chain-of-custody forms will not be utilized.

Analytical methods in use on the program have been approved and documented by EPA. These methods will be used as project-specific protocols to document and guide analytical procedures. Adherence to these documented procedures will ensure that analytical results are properly obtained and reported.

Quality control activities in the field will consist of the following items:

Adherence to documented procedures in this QAPP, cross-checking of field measurements and recording to ensure consistency and accuracy and comprehensive documentation of field observations, sample collection and sample identification information. Internal laboratory quality control checks will include the use of quality control samples such as procedural (or method) blanks, laboratory control blanks, and duplicates as specified in the EPA approved analytical procedures.

In addition to laboratory QC samples, multiple field quality control samples will also be collected. One field duplicate sample will be collected during each sampling date and sent to the lab to test for precision of analytical procedures. A trip blank will be submitted to the lab during each sampling event to ensure that equipment handling and transport procedures do not introduce contamination.

Results from quality control samples allow the assessment of quality assurance parameters such as accuracy and precision of the data. Any data falling outside the acceptable criteria as defined in the methods will be appropriately investigated and qualified as described in Section D2. The equations utilized to calculate accuracy and precision are as follows:

$$Accuracy = \frac{Measured\ value}{True\ value} \text{ x } 100$$

$$\text{Precision} = \frac{(A-B)}{((A+B)/2)} \text{ x } 100$$

The primary parameters to be tested in the lab are fecal coliform bacteria and total suspend solids. All other parameters such as dissolved oxygen, conductivity and pH will be conducted in the field at the discretion of the project manager and field technicians. Please refer to Section B-1 Overview for further elucidation. The sampling frequency for quality control samples are listed in Table 4:

Table 4.

Quality Control Sample	Frequency
Method Blanks	1 per batch
Laboratory control sample/Laboratory control sample duplicate	1 per batch
Field duplicate	1 per sampling date
Trip blank	1 per sampling date
Decontamination sample	1 per 4 weeks
Method sample	1 per 4 weeks

Regardless of the number of samples collected during a field trip, at least one replicate will be collected for FC and TSS. All other parameters will have duplicate readings taken in the field and recorded in the field notebook.

B6. Instrument Equipment Testing. Inspection and Maintenance

Field equipment used for collection, measurement and testing will be subject to strict

program of control, calibration, adjustment and maintenance. Routine maintenance of the sampler will be conducted prior to each sampling event. Maintenance of field equipment will include a visual inspection that all parts are present, attached correctly and devoid of any obvious contamination.

Water quality parameters including pH, conductivity, turbidity and temperature

will be measured in the field during each sampling event. Routine maintenance on the field equipment will be conducted according to schedules described in the manual provided by the manufacturer and recorded in the field notebook. Any deviations from this procedure will be documented, and will only occur if the project Quality Assurance Officer concurs that the deviations will increase the overall project integrity.

Copies of the manufacturer equipment manuals for the Hach® Sension156 for measuring pH, conductivity and turbidity and the Hach® Model 2100P Portable Turbidimeter Instrument for measuring turbidity are attached in Appendix A. Replacement parts and accessories and ordering information for the Hach® sension156 are summarized from pages 83 to 87 of the equipment manual. Pages 72 to 74 of the Hach® Model 2100P Portable Turbidimeter Instrument equipment manual summarize replacement parts and accessories and ordering information. Additionally, as the UAA Water Quality Laboratory has two identical sets of the HACH equipment described for this study, replacement parts (or equipment) will be available at the laboratory.

B7. Instrument/Equipment Calibration and Frequency

Care will be taken to ensure that the field equipment used for field measurements is calibrated and adjusted prior to each sampling event using calibration methods provide by the equipment manufacturer.

Calibration frequency, methods and standard solutions are summarized in Table 1. All calibration measurements including the lot number of the calibration solution, if appropriate, and expiration date will be recorded on the appropriate field forms or in field

logbooks and will be available for review by ADEC upon request.

B8. Inspection/Acceptance of Supplies and Consumables

All buffer solutions used for field instrument calibration will be checked for expiration

date, sufficient quantity, and discoloration. Qualified field staff will check all field equipment and supplies that are required for this project to ensure their technical specifications before use. Evaluation criteria that will be used are listed below:

- Ensuring that equipment and supplies have been cleaned if they are reusable or

  are sterile if they are packaged.

- Equipment is in serviceable condition and the appropriate procedures have been taken if equipment or supplies were shipped.

- Cooler temperature will be maintained at 4 ± 2 °C.

- The UAA lab prior to field mobilization will provide coolers, gel ice, a water trip blank, and sample containers. Extra sample containers will be available in the event re-sampling becomes necessary.

B9. Non-Direct Measurements

Non-direct measurements collected for this project include: weather data, stage, and maps.

Weather data will be obtained from National Oceanic and Atmospheric Associations (NOAA) National Weather Service (NWS) website for Anchorage, Alaska weather data. USGS gauging station data can be downloaded from the USGS Water Resources website for *historical* flow data. Anchorage Waterways Council is providing stage data from the web. (Stage and/or flow data will also be directly measured at specific locations by this research team as described in Section B1). The Municipality of Anchorage has provided GIS data for all maps, watershed characteristics and land use data.

B10. Data Management

Data obtained during sampling activities will be entered into field notebooks, and then transferred to the Transfer Log as noted in B3. The Quality Assurance Officer will review the field notebooks and Transfer Log to ensure that no mistakes are made in the transfer of data. All analytical results will be reviewed by the Analytical Coordinator, Quality Assurance Officer, and Project Management. Any inconsistencies found will be corrected, and a notation will be made in the final report. Quarterly reports, the draft final report, and the final report will be written as a collaborative effort by the research team. The Project Manager and the Quality Assurance manager will review all reports prior to submission.

All data collected for the project will be entered into STORET via the SIM-D database program in accordance with DEC guidelines and training. Data also will be entered into the CIIMS database.

C. Assessment and Oversight

C1. Assessments and Response Actions

Project assessment will primarily be conducted through the preparation of quarterly reports for DEC by the project manager. The project manager will review all data sheets and entered data to ensure that all entered data is complete.

Should the sampling staff, laboratory personnel or Quality Assurance Officer find errors
in sampling or analysis, the Quality Assurance Officer will notify the Project Manager
and the party responsible for the error or deficiency and recommend methods for correcting the deficiency. The responsible party will then take action to correct the problem and will report corrections to the QA Officer and Project Manager.

The Quality Assurance Officer will review the QA/QC procedures used for the sampling
and analytical program. Procedures for this review are included in Section D2 to meet
the data quality criteria specified in **A7**. The Quality Assurance Officer will report these
assessment records in the FY05 Quarterly Report and in the Draft and Final Reports.

C2. Reports to Management

Project assessment will primarily be conducted through the preparation of quarterly reports for the ADEC by the Project Manager. The Project Manager will review all data sheets and entered data to make sure that data collection is complete.

Sampling results will be summarized in the Quarterly Reports and in the Draft and Final Reports completed for this project. These reports will include the results of project assessments listed above. Reports will also update the status of the project relative to the schedule and tasks of the work plan. Any QA problems will be identified and reported in the quarterly reports. The final report will contain a project evaluation including recommendations for future work if needed. All of the individuals listed on the Distribution List at the beginning of the document will receive a copy of the Final Report.

D. Data Validation and Usability

D1. Data Review. Validation & Verification Requirements

As the UAA Water Quality Laboratory is primarily a research laboratory, there is no specific QA program applicable to every project. Consequently, analytical results for this project will be reviewed and validated in accordance with Standard Methods Part 9020 A-C. Any modifications to this procedure will be noted in the laboratory notebook. This procedure will serve as the laboratory QA program for the purposes of this project. The Project Manager and Quality Control officer will conduct data review and validation of all primary and secondary project samples, including their associated quality control duplicates and laboratory quality control samples.

A review of sample handling and analytical and field data for completeness, accuracy, holding time compliance, and quality control (QC) sample frequency compliance will be performed on a monthly basis.

Evaluation of laboratory blank samples

- Evaluation of the accuracy and precision of field duplicate samples, and laboratory control samples.

- Assignment of data qualifiers, when necessary, to reflect limitations identified in the data assessment process.

D2. Validation and Verification Methods

The following procedures will be used to determine if data meets the data quality objectives and criteria specified in Section A7. If data QA/QC procedures do not meet the specified criteria, the Quality Assurance Officer will review all field and laboratory records to determine the cause. If equipment failures are limiting the usability of the data, calibration and maintenance procedures will be reviewed and changed as needed.

If sampling or analytical procedures are causing the failures, methods will be reviewed to resolve the errors. Any changes or modifications to quality control procedures will be approved by ADEC prior to inclusion in the QAPP.

Review of Sample Handling

Proper sample handling techniques are required to ensure sample integrity. During data review, the sample handling procedures identified below are evaluated to determine potential effects on data quality.

- Review of field sample collection and preservation procedures to determine whether they were completed in accordance to the requirements specified by the analytical methods.
- Review of sample holding times between sample collection, extraction, and analysis (see Table 3 in Section B3).
- Review of sample conditions upon receipt at the UAA laboratory.
- Review of Quality Assurance/Quality Control (QA/QC) Samples. Specific procedures for review of QA/QC samples are included in the sections below.

Laboratory Blank Samples

Laboratory blank samples (method and instrument blanks) are laboratory-prepared, analyte-free samples used to detect the introduction of contamination or other artifacts into the laboratory sample handling and analytical process. These blanks play an especially important role in sampling programs involving trace-level analyses or analytes that are common solvents found in a laboratory. None of the analytes of concern for this project are common laboratory contaminants. If a

contaminant is discovered in the analytical sample at less than five times the concentration it is found in the laboratory blank, it will be considered a laboratory contaminant. Otherwise, it will be reported as an environmental contaminant.

Laboratory Control Samples

Laboratory control samples are used to assess analytical performance under a given set of standard conditions. Synthetic samples, containing some or all of the analytes of interest, are prepared at known concentrations independently from calibration standards, and analyzed along with batch samples. Due to the difficulties inherent in obtaining live fecal coliform standards at specified concentrations, these laboratory control samples will not be completed for this study.

Field Duplicate Samples

Field duplicate samples will be collected simultaneously with a primary project sample.

Duplicates are treated in the same manner as the primary sample during all phases of sample collection, handling, and analysis. Duplicate sample results are used to assess precision, including variability associated with both the laboratory analysis and the sample collection process (i.e., QC purposes). One duplicate field sample will be collected and submitted to the laboratory during each sampling date for this program.

Analytical results will be reviewed for agreement with each other or their respective reporting limits and evaluated for comparability. Estimated results quantified below the reporting limit and qualified with a "J" flag are not considered significant for the purpose of data agreement. The comparison between project and field duplicate sample results should meet the criteria for each method listed in Table 4.

Reporting Limits

The reporting limits are the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory conditions. For many

analytes, the reporting limit analyte concentration is selected by the laboratory as the lowest non-zero standard in the calibration curve. Sample reporting limits vary based on sample matrix and dilution of the samples during analysis.

Data Qualification

Qualifiers will be applied to QC samples when acceptance criteria are not met and corrective action is not performed or is unsuccessful. These same qualifiers will be applied to the associated sample data, as defined below:

Qualifier Description

J The analyte was positively identified, the quantization is estimation.

U The analyte was analyzed for, but not detected. The associated numerical value is at or below the method detection limit (MDL).

F The analyte was positively identified but the associated numerical value is below the reporting limit (RL).

R The data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.

B The analyte was found in an associated blank, as well as in the sample.

MA matrix effect was present.

H Analysis was performed outside of the recommended holding time.

Completeness

Completeness is calculated after the QC data have been evaluated, and the qualifiers have been applied to the sample data. Invalid results, broken or spilled samples, and samples that are unable to be analyzed for other reasons are included in the assessment of completeness. The criteria and calculation to determine completeness are provided in Section A7. If data cannot be qualified to meet completeness goals, UAA will consult with the ADEC Project Manager to determine if additional sampling should be performed to accomplish data quality objectives.

D3. Reconciliation with User Requirements

The Project Manager will review all data deliverables upon receipt from the lab. Laboratory results will be checked for data qualifiers entered by the lab to ensure that sample collection and preservation procedures were adequate and that laboratory analysis procedures met quality assurance objectives. Any outstanding issues will be addressed immediately with the lab and/or sampling staff to ensure that project quality assurance objectives are met.

The Project Manager and Quality Assurance Officer will review and validate the data during the quarterly reporting and final reporting stages. If there are any problems with quality sampling and analysis, these issues will be addressed immediately and methods will be modified to ensure that data quality objectives are being met. Modifications to monitoring will require notification to ADEC and subsequent edits to the approved QAPP.

The project results and associated variability, accuracy, precision, and completeness will be compared with project objectives. If results do not meet criteria establishes at the beginning of the project, this will be explicitly stated in the final report.

Appendix

Example of Transfer Log (To be maintained on an electronic spreadsheet)

Original Sampling Plan (Superseded in Section B1)

The sampling process is organized as a series of discrete substudies designed to isolate key processes related to FC dynamics in Chester Creek. It is anticipated that the collection of a relatively large number of samples over relatively short time intervals will increase the value of results, due to the increased temporal variability associated with long-term sampling strategies.

The primary water quality parameter to be collected during the course of this study is fecal coliform bacteria. FCs will be collected at every sampling event. In many instances, other water quality parameters including stage/flow, turbidity, pH, temperature, specific conductance, and TSS will be collected as well. Although these additional water quality parameters will be incorporated into the data interpretation and reports submitted to the ADEC, they will not be discussed in the following design report unless specifically integral to the substudies being described.

The number of samples to be collected, as depicted in this section, is significantly higher than the number of samples originally proposed in the ACWA Grant proposal (approximately 780 in the original proposal; approximately 966 in this workplan). Consequently, it is likely that some of the sampling efforts described in this workplan (approximately 20%) will be dropped from the schedule over the course of the contract period due to time constraints and lack of adequate funding.

Although it is predicted that some of the following substudies will be modified, it is not known yet which of the substudies will be impacted. This determination will be made only after results begin to accumulate, and the research team gains a better understanding with regard to which types of sampling strategies tend to yield the most useful results. In any event, modifications to the sampling design will be made only after consultation with the ADEC.

The temporal distribution, location, and total number of samples to be obtained over the course of the seven substudies are presented in Table 2. A map depicting the sampling locations is presented in Figure 1. A summary describing the justification and experimental procedure associated with each substudy follows the table and figure:

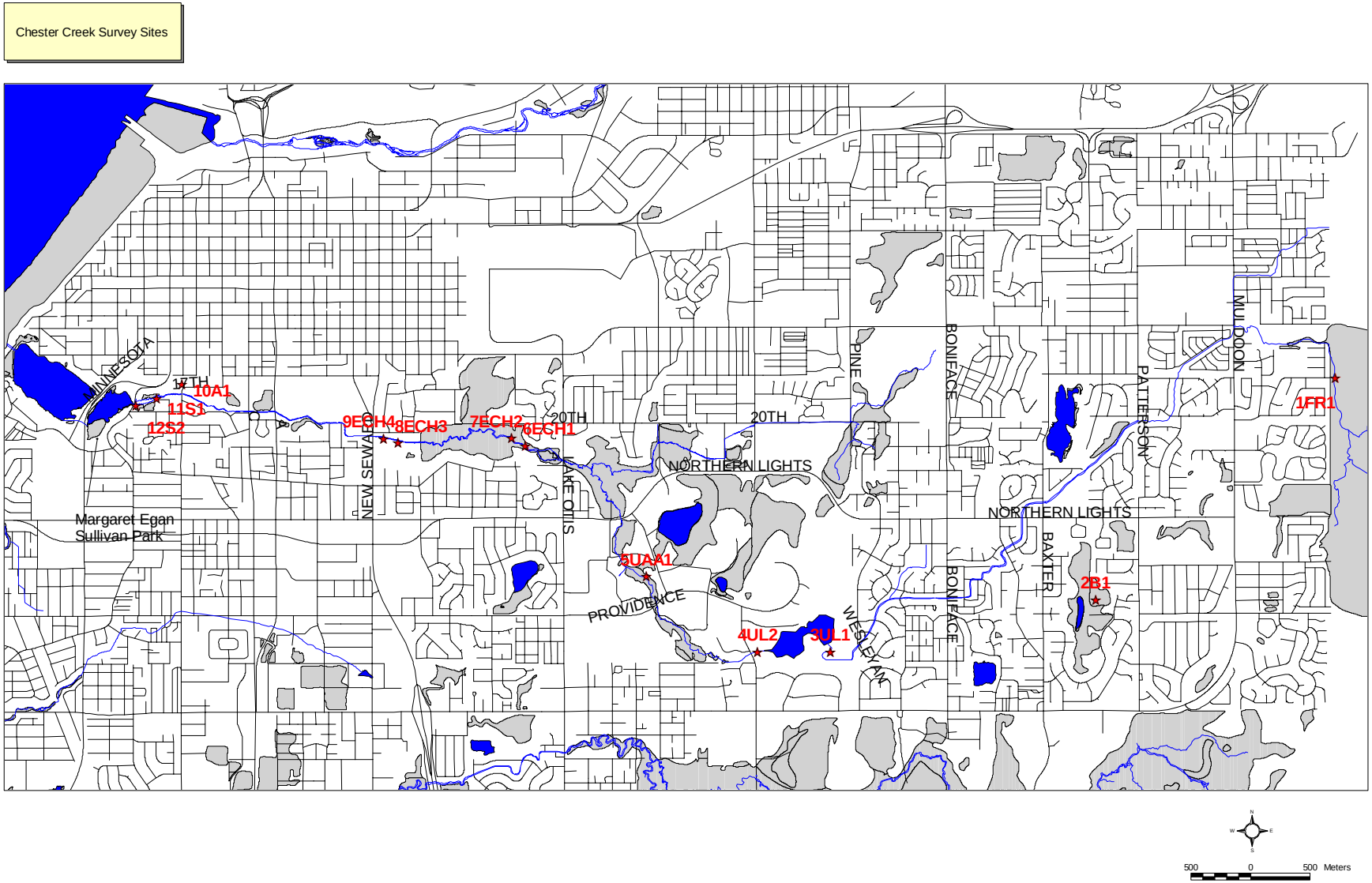
Table 2: Sampling Design

Substudy	Location	Samples	Total Time	Samples	Notes
1	5UAA1	10 simultaneous	1 test	10	Analytical variability, low flow conditions
1	5UAA1	10 simultaneous	1 test	10	Analytical variability, mid-range flow conditions
1	5UAA1	10 simultaneous	1 test	10	Analytical variability, high flow conditions
1	5UAA1	1 every 5 mins	1 hr	12	Very short term temporal variability, low flow
1	10A1	1 every 5 mins	1 hr	12	Very short term temporal variability, low flow
1	5UAA1	1 every 30 mins	24 hrs	48	Short term temporal variability, low flow
1	10A1	1 every 30 mins	24 hrs	48	Short term temporal variability, low flow
1	5UAA1	1 every week	1 year	52	Long-term temporal variability; variable flow
1	10A1	1 every week	1 year	52	Long-term temporal variability; variable flow
1	1FR1	1 every week	1 year	52	Long-term temporal variability; variable flow
2	6ECH1	1 every 15 mins	6 hours	24	Storm event
2	7ECH2	1 every 15 mins	6 hours	24	Storm event
2	8ECH3	1 every 15 mins	6 hours	24	Storm event
2	9ECH4	1 every 15 mins	6 hours	24	Storm event
2	6ECH1	1 every 15 mins	6 hours	24	Low flow conditions
2	7ECH2	1 every 15 mins	6 hours	24	Low flow conditions
2	8ECH3	1 every 15 mins	6 hours	24	Low flow conditions
2	9ECH4	1 every 15 mins	6 hours	24	Low flow conditions
2	6ECH1	1 every 3 hours	72 hours	24	Spring breakup
2	7ECH2	1 every 3 hours	72 hours	24	Spring breakup
2	8ECH3	1 every 3 hours	72 hours	24	Spring breakup
2	9ECH4	1 every 3 hours	72 hours	24	Spring breakup
3	1FR1	1 every hour	24 hours	24	Low flow conditions
3	1FR1	1 every hour	24 hours	24	Storm event
3	1FR1	1 every 3 hours	72 hours	24	Spring breakup
4	Upstream Sewer*	1 every hour	24 hours	24	Low flow conditions, winter
4	Downstream Sewer*	1 every hour	24 hours	24	Low flow conditions, winter
4	Upstream Septic*	1 every hour	24 hours	24	Low flow conditions, winter
4	Downstream Septic*	1 every hour	24 hours	24	Low flow conditions, winter
5	11S1	1 every 30 mins	12 hours	24	Low flow conditions, dry weather, birds present
5	11S2	1 every 30 mins	12 hours	24	Low flow conditions, dry weather, birds present
6	3UL1	1 every 3 hours	72 hours	24	Steady low flow conditions
6	4UL2	1 every 3 hours	72 hours	24	Steady low flow conditions
6	3UL1	1 every 3 hours	72 hours	24	Before, during, and after an intense storm event
6	4UL2	1 every 3 hours	72 hours	24	Before, during, and after an intense storm event
7	7ECH2	10 per test	3 tests	30	Low flow conditions
7	2B1	10 per test	3 tests	30	Low flow conditions

Adjacent similarly-shaded rows represent discrete sampling efforts.

*Sewer/Septic locations remain to be determined. **Total Samps:** **966**

Figure 1: Proposed Sampling Locations



Substudy #1: Analytical and Temporal Variability of FCs in Chester Creek

Justification: One objective of this substudy is to quantify the variability of the membrane filtration analysis itself over a range of FC concentrations. A second objective of this substudy is to help elucidate the temporal variability of FC concentrations under steady flow conditions over a variety of temporal scales. Such quantification of system variability is crucial, as it will aid in the understanding and interpretation of results from all of the substudies. The locations of the sampling sites were chosen both to represent three different reach types and to more fully assess conditions at varying downstream distances.

Experimental: In order to assess analytical variability, large grab samples will be obtained during periods of high and low anticipated FC conditions. Each large grab sample will be stirred continuously, and aliquoted into multiple subsamples, which will then be analyzed simultaneously using the standardized membrane filtration method. Variability within the subsamples will be quantified and subsequently considered during the interpretation of results from other substudies. This will be performed at 2 locations (5UAA1, 10A1). In order to assess temporal variability, multiple samples will be collected at predetermined locations (1FR1, 5UAA1, 10A1) under relatively steady flow conditions over time scales ranging from minutes to weeks. As above, results from these experiments will provide a contextual framework around which results from other focused studies can be interpreted. At a minimum, parameters to be measured include fecal coliforms and flow/stage.

Substudy #2: Urban Human/Wildlife Source Isolation

Justification: This substudy is designed to isolate a location where the combined impacts of outdoor human activity (not including sewer/septic) and wildlife could potentially be isolated as a contributing source of fecal coliform along Chester Creek. It is within a riparian zone along the Chester creek recreational trail where both humans and wildlife congregate in a relatively wooded environment. There are a relatively small number of natural outfalls, and the land use is predominantly residential in the surrounding sub watersheds. It is assumed that during dry, low flow periods, this reach is large and homogenous enough such that impacts from human or wildlife activity may potentially be detected and attributed to the source area. Conversely, during storm events, it is predicted that the influence of storm flow from the North Fork drainage basin will increase the baseline such that isolation of this source will be improbable. Nonetheless, during storm events, a comparison between the Hilstrand Pond outlet water and the water downstream of the North Fork confluence (as well as downstream of the western stormwater outfalls) will likely help to quantify the impacts of mixed residential runoff originating from piped storm drains. This area will also be utilized to assess the impact of meltwater during the spring breakup period. Confounding factors for this substudy include the contribution from the North Fork drainage basin, the influence of the waterfowl population in Hilstrand Pond, the potential for resuspension of polluted sediments, and the potential for contamination from nearby sewer lines. Attempts will be made during the experimental procedure and data interpretation to address these confounding factors.

Experimental: Samples will be collected near the Hilstrand Pond outlet (6ECH1), at a location just downstream of the North Fork/South Fork confluence (7ECH2), at a location on the west end of the park just upstream of two storm water outfalls (8ECH3), and at a location directly downstream of the same two outfalls (9ECH4). The reach between 7ECH2 and 8ECH3 contains no known constructed storm water outfalls, and represents one of the longest urbanized reaches of the creek for which this is the case. This substudy will be comprised of two six-hour sampling events and one 72-hour sampling event. The six-hour sampling events will take place during a period of storm activity and a period of low flow. The 72-hour event will take place during the spring breakup. During all sampling events, FCs, turbidity, and flow will be monitored. For the six-hour events, samples will be collected simultaneously at the four sampling

locations at fifteen minute intervals. During the 72-hour event, samples will be collected at three hour intervals.

Substudy #3: Wilderness Baseline Identification

Justification: This substudy is designed to examine the variability of the baseline FC levels resulting from wildlife inputs in a non-urbanized location. The sampling location will be on Ft. Richardson at a point upstream of any piped storm water outfalls in an area relatively devoid of urban impact (1FR1). It is assumed that if FCs are detected at this sampling location, then they will primarily be the result of wildlife impact. Furthermore, if FCs are detected in this area, then it can be assumed that wildlife and/or human activity in similar wooded areas within the MOA is likely to be a downstream source of FCs. The warm weather sampling will be conducted under both wet and dry conditions, and each sampling event will be conducted over a 24-hour interval. The sampling interval for this substudy is longer than for the similar experiment described in Substudy #2 primarily because it is assumed that the runoff events in this area will be relatively prolonged due to the lack of channelized or piped storm water conduits. A spring breakup sampling event will be performed for comparison to the spring sampling event described in Substudy #2. Furthermore, only one sampling location will be utilized in this study, as the study is designed to isolate the impacts of the uppermost reaches of Chester Creek.

Experimental: Samples will be collected at a single location on Ft. Richardson during consistent low flow conditions as well as during a storm event. The sampling rate will be one sample per hour for a period of 24 hours during each warm weather sampling event. The spring breakup sampling event will take place over a period of 72 hours, with a sampling interval of three hours.

Substudy #4: Sewer/Septic Source Isolation

Justification: This substudy is designed to isolate the potential contributions of FCs from sewer or septic discharges into Chester Creek. The study will be conducted under low flow conditions in an attempt to minimize the impact of storm water runoff. In this substudy, reaches containing a high number of 1) sewer line crossings, and 2) septic systems, will be sampled on the upstream and downstream end of the reaches in an attempt to assess the impacts of the sewer/septic influences. An attempt will be made to minimize the impacts of storm water and wildlife inputs by conducting the studies in residential locations during a period of low flow. It is anticipated that if sewer or septic systems are serving as a significant source of FCs, then they are likely doing so in a diffuse manner through the water table, or they are commingling with the water in the storm drain system. Consequently, it is relatively improbable that an actual sewer or septic source will be identified through this study. Nonetheless, the ramifications of sewer or septic systems serving as FC sources to Chester Creek are great enough to justify the cursory examination described in this substudy. An attempt will be made to select locations where, in our best professional judgment, the probability of detecting sewer and septic sources will be the greatest. Although the research team has begun this task by obtaining and examining a map of the MOA sewer system, it was determined that site selection for this substudy will also require some amount of preliminary FC sampling. This preliminary sampling will take place in Summer/Fall 04, and site selection will be completed prior to the winter sampling event.

Experimental: Samples will be collected once per hour over 24-hour intervals in order to encompass the full range of sewer/septic system use. Sampling events will take place at both a sewer and a septic location once during winter base flow conditions. The actual reaches to be sampled remain to be determined after consultation with the ADEC and other sources.

Substudy #5: Waterfowl Source Isolation

Justification: This substudy is designed to isolate waterfowl as a potential source of FCs in the creek. The primary confounding factor of this substudy is that waterfowl tend to congregate primarily in open ponds that could potentially serve as sinks for suspended particles and attached bacteria under low flow conditions, and sources under high flow conditions. Consequently, although it is assumed that waterfowl do indeed contribute FCs to the creek, it is not certain whether or when those FCs mobilize downstream. To minimize this confounding factor, a sampling location would be required that is large enough to attract a consistently high number of waterfowl, yet small enough such that the detention time of the basin is as small as possible. The basin just east of Spenard Road was selected as the location that best met the above criteria. Although the pond at Sitka Park was considered as an option for this substudy, the pond flows directly into a wetland, and no single outflow channel was identified at which samples could be collected. Additionally, although Hilstrand pond was considered as an option, numerous visual observations indicated that the waterfowl population in the Spenard Road basin is much higher than the Hilstrand Pond waterfowl population

Experimental: During a dry weather low-flow period, samples will be collected twice per hour over a 12-hour period, both at the upstream (11S1) and downstream (12S2) ends of the basin. A 12-hour duration was selected for this study to better accommodate the holding time of the basin while minimizing the temporal variability associated with longer-term sampling events.

Substudy #6: University Lake Dog Park Source Identification

Justification: The University Lake Dog Park may serve as a source of FCs to the Chester Creek drainage, although it is also possible that the lake itself may serve as a sedimentation basin to remove FCs attached to suspended solids from the water column. In order to assess this, the variability of the FC levels in the water as it leaves the lake will be assessed over 72-hour periods. If, as it expected, the water leaving the lake under steady low flow conditions has relatively low FC counts and low temporal variability compared to the upstream end, then it can be concluded that the lake is likely acting as a sink under low flow conditions. This assertion will not be decisively demonstrated, however, because the detention time of the basin is too

great to be able to perform an actual mass balance. The quasi-mass balance approach (assuming steady state based upon defined temporal variation on either end of the lake) is likely to be valid only after a relatively long period of dry, stable weather. During rain events, the variability at the inlet combined with the holding time of the lake would almost certainly render such an assessment meaningless. Consequently, the quasi-mass balance approach will be utilized only during a dry period. During a rain event, it would be instructive to quantify the temporal aspect of the FC levels exiting the lake as a response to the increased flow associated with the event. If the FC levels increased relatively soon after the initiation of the rain event, then that would support the notion that the FCs originated either in the lake sediments or in the park directly adjacent to the lake. Although the quasi-mass balance assessment will not be valid for the wet weather scenario, the upstream samples will still be taken in order to better characterize the longer-duration response of the creek to an intense storm event.

Experimental: During a long-term dry weather period, samples will be collected once every 3 hours for a 72-hour period on either end of the lake (3UL1, 4UL2). For the wet weather study, samples will be collected before, during, and after an intense storm event once every 3 hours over a period of at least 72 hours at either end of the lake. In both events, TSS as well as FCs will be assessed.

Substudy #7: Stream Sediment Source Isolation

Justification: It is possible that FCs associated with particulate matter are stored on the bottom of the creek and mobilized in response to high flow rates. Consequently, once FCs have entered the creek, the creek itself may be a source for the areas downstream. If this were demonstrated to be a significant dynamic, then BMPs could potentially be utilized to mitigate these impacts. Consequently, an experiment will be conducted to test whether fine sediments deposited after a storm event will contribute to FCs detected downstream.

Experimental: Two locations have been identified where sediments tend to accumulate during low flow conditions. One location is in Eastchester Park, near the sampling location described in Substudy #2 (7CH2). Another location is situated where the creek meanders through a mobile home community off of Boniface Parkway (2B1). In both locations, samples will be taken directly from the sediments during low flow conditions to test if the sediments contain significant fecal coliform levels. Additionally, the creek bottoms at both locations will be perturbed with a stirring device to encourage resuspension of deposited sediments. Immediately following the perturbation, water samples will be collected a short distance downstream to test if the disturbed sediments contribute to FC levels above a measured baseline. In addition to FC counts, TSS and/or turbidity will be measured as well. This test will be repeated at several spots in the vicinity of both sampling locations.

APPENDIX C.

Standard Operating Procedures: Laboratory

Spatial and temporal distributions of Fecal Coliform bacteria in Chester Creek

APPENDIX C.

Standard Operating Procedures: Laboratory

Spatial and temporal distributions of Fecal Coliform bacteria in Chester Creek

1.0 Personnel

1.1 Supervisor/Consultant

The consultants on this project regarding field and laboratory procedures are

Khrys Duddleston PhD
Analytical Coordinator
University of Alaska Anchorage
3211 Providence Drive
Anchorage, AK 99508
Phone: (907) 786-07752
E-mail:

Dave Maddux PhD
Project Quality Assurance Officer
Applied Wetlands Technology
PO Box 81091
Fairbanks, AK 99708
Phone: (907) 479-3847
E-mail: davemaddux@wetlandsoptions.com

1.2 Analysts

The lists of analysts trained to date are as follows. The project requires additional analysts, which will be properly trained to perform the duties required as specified with the certification guidelines of laboratory procedures regarding microbiological testing.

Tammie Wilson
University of Alaska Anchorage

3211 Providence Dr
Anchorage, AK 99508
Phone: (907) 786-1106
E-mail: astlw16@uaa.alaska.edu

Tammie has a Bachelor of Science in physics from Evergreen State College, Olympia Washington 2001. Currently she is working towards a master degree in environmental quality science form the university of Alaska Anchorage.

A specialized training session was conducted in June of 2004 regarding the laboratory procedures regarding the enumeration of fecal coliform bacteria in fresh water streams. This training session included instrumentation, field techniques, and laboratory procedures for the membrane filtration technique.

Graham Stahnke
University of Alaska Anchorage
3211 Providence Drive
Anchorage, AK 99508
Phone: (907) 786-1106
e-mail: g_stahnke@yahoo.com

Graham holds a bachelor of science in chemical engineering form the university of Montana. He is also currently working towards a master in environmental quality engineering form the university of Alaska anchorage.

Graham was also present at each training session held in June of 2004.

Additional training sessions will be held to accommodate the new analysts prior to any sampling or laboratory activity. Any changes in the analysts will be documented by adding the appropriate information to this form, and resending to the ADEC.

2.0 Laboratory facilities

The laboratory facilities are located on the first floor of the engineering building at The University of Alaska Anchorage. The lab has all the required equipment and cleanliness appropriate for this scope of work.

3.0 Laboratory Equipment and Supplies

3.1 pH Meter

Scale and Accuracy gradations for the pH probe must remain within+/-0.1 units. All buffer solutions are up to date, and thrown out if out-dated. Electrodes on the pH meter are maintained according to the manufacturers recommendations.

HACH sension 156 portable multiparameter Meter

YSI Model 63 #6350FT SN:03D0600AC

3.2 Balance

Mettler AE100, digits measure down to the ten-thousandths decimal place.

3.3 **Temperature Monitoring Devices**

Standard glass mercury thermometers are kept in the oven, incubator and fridge for routine checking. The YSI and HACH meters are used for field measurements of surface water temperature.

3.4 Incubator Unit

NAPCO E Series Model 303 Incubator. The incubator has two separate compartments. Only one side is used for the incubation of the fecal colonies.

3.5 Autoclave

Market Forge Sterilmatic Model STM-E B/M 95-2678

3.6 Hot Air Oven

Gallenkamp size ace oven BC EL 22-133/02

3.7 Conductivity Meter

Same as pH meter listed above. HACH and YSI multiparameter meters.

3.8 Refrigerator

Franklin Chef small refrigerator unit.

3.9 Membrane Filtration Equipment

Microcheck Filter Funnels #4710

3.10 Sample Containers

I-Chem, security snap Bact bottle sterile, 100mL fill line

3.11 Glassware and Plastic ware

Kontes Ultaware and Pyrex

4.0 General Laboratory Practices

Once the samples are collected in the field the hood for membrane filtration is turned on, and the samples are kept in the fridge until needed. There is a manifold to filter 3 samples at a time. Before the samples are taken out of the fridge the table surface is wiped with a 10% bleach solution.

After cleaning, three samples at a time will be processed according to microcheck filter funnel directions, and incubated for 24 hours, plus or minus two. Since varying volumes may be required, the volume filtered is noted in the lab notebook. After incubation the blue colonies are counted and recorded in the lab notebook.

If samples spill on the counter each spill is immediately cleaned with the bleach solution to prevent cross-contamination.

Total suspended solids are filtered using a 45 mm glass filter. The filters are dried in the oven and stored in the desiccators to cool before being weighed. The weights of each filter is noted in the lab notebook, and used to determine TSS in mg/L. The volume of water used to filter is also noted in the notebook. After each sample is filtered the

graduated cylinder used to measure and decant the sample is rinsed three times with distilled water and the kontes glass filter funnel is also rinsed. The samples are then dried in the oven overnight, and weighed after reaching room temperature in the desiccator.

4.1 Sterilization Procedures

All of the sample containers and membrane filtration units are pre-sterilized and stored in their original boxes until needed. The sampling containers and membrane filtration units are not reused.

Each sample is filtered under a hood to avoid contamination by particles traveling through the air. This hood is cleaned with a ten percent bleach solution before filtration of samples begins, and after the filtration of all samples is finished.

4.2 Sample Containers

Sample containers are disposed of after one use. They are EPA approved 100 mL I-Chem, security snap Bact bottle sterile sampling containers. They are shipped to the lab sterile from I-Chem and stored in the box in the laboratory shelves.

4.3 Reagent Grade Water

Distilled and DI water is produced on campus.

4.4 Glassware Washing

All glassware is washed using alconox and bottlebrushes after each use. Including the sample container for turbidity.

5.0 Analytical Methodology

Analytical procedures follow those outlined in the Standard Methods for the Examination of Water and Wastewater, 19th Edition.

5.1 General

General lab procedures include cleaning all surfaces after use, and maintaining disposal of garbage, autoclaving all bacteria plates before disposal, and all other general laboratory procedures for environmental analysis.

5.2 Membrane Filter Technique

We are using Microcheck Filter Funnels #4710 for the filtration of the samples. The growing media comes in one use sterile ampoules containing M-FC broth, fecal coliform with rosalic acid.

6.0 Sample Collection, Handling and Preservation

The samples are collected from the stream by dipping container about 6 inches below the water surface breaking the seal on the container waiting for the container to fill, and closing while still immersed in the water. The containers are then stored in cooler containing gel ice packs in order to maintain a temperature of 4 +/-2°C. After collection the samples are transported back to the lab by the collector and analyzed within the six-hour holding time specified in standard methods.

6.1 Sample Collector

Sample collectors are the same as the analysts. If additional samplers or analysts are to be used they will be trained appropriately and documented bye the primary investigator Bill Schnabel.

6.2 Sampling

All sampling is handled in the manner described above in section 6.1.

6.3 Sample Icing

Sample icing is also handled as described in section 6.1.

6.4 Sample Holding/Travel Time

Samples are never stored in the cooler over the six-hour holding time. If this does happen, the sample will be discarded. Travel time for samples does not exceed four hours on sampling days. If the sampling event requires longer than four hours in the field before the four hours is up the samples will be transported back to the label and analyzed mid-day.

6.5 Sample Information Form

Each sample is properly labeled before each field-sampling event prior to leaving the laboratory. The label will contain the date the sampling will take place, person sampling, parameter to be analyzed, sample number, and time taken (to be labeled in the field).

7.0 Quality Assurance

Each field sampling event a filed blank for fecal coliform and temperature will be taken in transport with all other samples to ensure the fecal samples are not causing cross-contamination, and the temperature has remained at 4+/-2°C.

8.0 Records and Data Reporting

Records are kept in a laboratory notebook, and a field notebook, that remain in the laboratory. The data is entered into an excel spreadsheet at a later time and all filed outings are also documented in a spreadsheet form.

8.1 Legal Defensibility

All records kept are maintained according to proper scientific standards, which will maintain credibility legally.

8.2 Maintenance of Records

The analysts listed in the beginning of this document maintain records.

8.3 Sampling Records

All sampling records are maintained in the field notebook, and transferred to an electronic form after the sampling date.

8.4 Analytical Records

Analytical records are kept in the laboratory notebook, which remains in the laboratory and maintained by the same two analysts.

8.5 Preventative Maintenance

9.0 Action Response to Laboratory Results

Presentations are given to a group of graduate students and faculty at The School of ‘Engineering on a regular basis. Quarterly reports are also written for the ADEC regarding laboratory results. In the en\vent that unusual results are displayed the analysts, and consultants hold regular meeting to discuss anything unusual, and maintain communication in regards to the results.

APPENDIX D.

Characterization Study Reports

1. **Variability**
2. **Reflection Lake Fork**
3. **Storm Drains**
4. **North Fork**
5. **Sewer/Septic**
6. **Survivability**

APPENDIX D.

Characterization Study Reports

7. **Variability**
8. **Reflection Lake Fork**
9. **Storm Drains**
10. **North Fork**
11. **Sewer/Septic**
12. **Survivability**

D 1.

Characterization Study Report: Variability Study

Purpose: Three separate variability studies were conducted to determine the variability of fecal coliform bacteria in Chester Creek; variability of the enumeration method, variability over one-hour, and variability over six-hours. During low-flow conditions over a 6-hour period and one-hour period, we investigated the variability in the water column by sampling at four locations in Eastchester Park every 15 minutes for 6-hours, and every 5 minutes for one-hour at two locations. The experiment for variability of the method involved taking a large grab sample, stirring continuously, and enumerating fecal coliform samples as fast as they could be processed.

Methods and Measurements: Every 15 min. over a 6 hour period, grab samples of FC were taken, making a total of 72 samples for the variability of the stream segment in Eastchester Park. In addition to FC, one measurement each of TSS, pH, conductivity, temperature and turbidity was taken during the 6-hour study. FC was the only parameter measured for the other two variability experiments. The methods for enumeration of FC and field measurements were taken according to the lab SOP and QAPP procedures outlined for this research project regarding spatial, temporal and phase distributions of fecal coliform bacteria in Chester Creek. The sampling events took place on the following dates: Variability of Method on July 10, 2004, One-hour variaibility on July 22, 2004, and six-hour variability on August 18, 2004.

The site descriptions are as follows; ECH1 upstream of North Fork confluence, ECH2 downstream of North Fork confluence, ECH3 just downstream of the end of the riparian zone were ECH1 and ECH2 are located, and ECH4 is downstream of 2 stormdrain outfalls without active groundwater flow.

Results: All of the raw data is presented below.

Table 1: Parameters /Measured
Field Samples

Site	pH	cond	turb	temp
ECH1	8.24	223.9	27.8	15.7
ECH2	8.23	223.2	39.7	15.7
ECH3	8.4	219	3.31	15.7
ECH4	8.4	220	4.55	15.7

Table 2
FC/100mL Every 15 Minutes

Site	Sample #	FC	Site	Sample #	FC
ECH1	1	153	ECH3	1	92
ECH1	2	172	ECH3	2	91

ECH1	3	128	ECH3	3	73
ECH1	4	91	ECH3	4	109
ECH1	5	113	ECH3	5	106
ECH1	6	56	ECH3	6	75
ECH1	7	57	ECH3	7	95
ECH1	8	45	ECH3	8	92
ECH1	9	34	ECH3	9	79
ECH1	10	15	ECH3	10	70
ECH1	11	43	ECH3	11	68
ECH1	12	49	ECH3	12	59
ECH1	13	50	ECH3	13	83
ECH1	14	19	ECH3	14	105
ECH1	15	38	ECH3	15	87
ECH1	16	14	ECH3	16	61
ECH1	17	10	ECH3	17	59
ECH1	18	57	ECH3	18	62
ECH1	19	73	ECH3	19	55
ECH2	1	0	ECH4	1	74
ECH2	2	-	ECH4	2	96
ECH2	3	102	ECH4	3	78
ECH2	4	120	ECH4	4	58
ECH2	5	105	ECH4	5	107
ECH2	6	57	ECH4	6	131
ECH2	7	68	ECH4	7	7
ECH2	8	67	ECH4	8	50
ECH2	9	24	ECH4	9	51
ECH2	10	9	ECH4	10	52
ECH2	11	16	ECH4	11	54
ECH2	12	48	ECH4	12	72
ECH2	13	68	ECH4	13	89
ECH2	14	68	ECH4	14	75
ECH2	15	71	ECH4	15	67
ECH2	16	108	ECH4	16	62
ECH2	17	80	ECH4	17	67
ECH2	18	75	ECH4	18	52
ECH2	19	75	ECH4	19	52

From this raw data we were able to create a histogram displaying the distribution of data during low-flow conditions over a six-hour period in Chart 1.

Chart 1

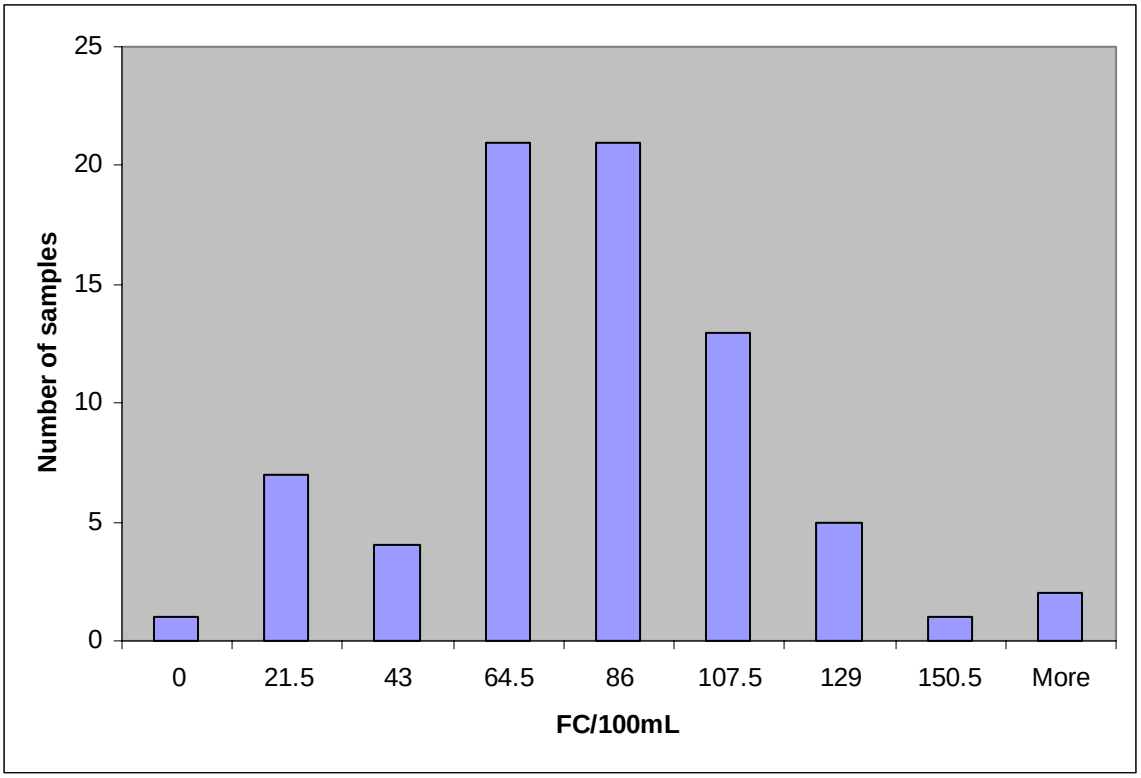


Table 3 Descriptive Statistics

Mean	69.24
Standard Error	3.812726
Median	68
Mode	68
Standard Deviation	33.01918
Sample Variance	1090.266
Kurtosis	0.787748
Skewness	0.347067
Range	172
Minimum	0
Maximum	172
Sum	5193
Count	75
Confidence Level(95.0%)	7.597023

Table 4: Temporal Variabiliy, One-hour

Site	Sample #	CFU/100mL
5UAA1	1	186
5UAA1	2	210
5UAA1	3	136

5UAA1	4	160
5UAA1	5	170
5UAA1	6	182
5UAA1	7	184
5UAA1	8	150
5UAA1	9	102
5UAA1	10	125
5UAA1	11	71
5UAA1	12	102
10A1	1	56
10A1	2	88
10A1	3	85
10A1	4	67
10A1	5	99
10A1	6	96
10A1	7	82
10A1	8	96
10A1	9	73
10A1	10	80
10A1	11	85
10A1	12	94

Table5: Variability of Method Results

Sample #	**FC/100mL**
1	24
2	20
3	15
4	23
5	22
6	25
7	20
8	20
9	22
10	15
11	20
12	16

Table 6 : Descriptive Statistics

Variability Study	**Site**	**Mean**	**Variance**	**Standard Deviation**
Method	5UAA1	21	11	4

One-hour	5UAA1	148	1746	42
One-hour	10A1	86	211	15

Discussion: The data above indicates that FC populations in the stream over a six-hour period are normally distributed. The Variance calculated for this data is quite high given the large sample volume, indicating values in the stream vary substantially within the 95% confidence interval. The higher numbers seen at the beginning of the sampling event may be due to a change in batch number of media used. The higher numbers may also be explained by the presence of some children rafting and playing upstream of ECH1.

Over a one-hour period, the sample variance is about the same as that for a six-hour period. It appears that the higher the FC population, the larger the sample variance. This could be skewing the results for variance over a one-hour period due to the higher FC populations on the data of the study at only one of the sites.

The variability of the method show the lowest sample variance. The lower sample variance may be due to the lower FC values present that day, if higher variances are an indication of higher FC counts coinciding with higher sample variance.

D 2.

Characterization Study Report: Reflection Lake Fork

Purpose: To obtain additional data regarding the inputs from outlet of Reflection Lake to where the culvert outfall into the main stream channel. In particular, to define a small area where FC levels appear to be low, then increase before the outfall into the main channel. These sampling events were initiated due to an observation that FC values at Riviera Terrace trailer park were consistently lower than the values found at the inlet to University Lake. Sampling events that took place on this fork included measurements upstream and downstream of the Reflection Lake where populations of geese and ducks have been spotted during low-flow conditions in the winter months. This initial sampling event led to several other sampling events to aid in identifying a geographical source location of FC.

Methods and Measurements: The parameters measured were FC. The first sampling event involved sampling at 3 locations. The first location was the culvert outfall into the main channel located between Riviera Terrace and University Lake inlet, named DRL5, the second site was positioned in the main channel upstream of the outfall (2B2), and the third was our weekly sampling location, 3UL1. Five sites were chosen for the second sampling event on this fork and are as follows; DRL1 the outlet of Reflection Lake, DRL2 approximately 100m downstream of the outfall, DRL3 an additional site downstream of numerous duck and moose populations on the upstream side of a small settling pond, and DRL5 as described above. The third sampling event included four sampling locations; 2B2, DRL5, DRL4 positioned on the downstream side of a small

sedimentation basin located between two houses where the stream enters the culvert, and DRL3 upstream of the small sediment basin. The fourth event included the inlet to Reflection Lake, RL1, and 3 downstream locations, DRL1, DRL3, and DRL4, Reflection Lake Outlet, and up and downstream of the small settling pond respectively.

The sites chosen on each sampling event depended on the question being asked. Initially, on the first sampling event on March 10, 2005 the purpose was to determine if the fork was a significant input into the stream. The samples taken on this day were during the first initial break-up of the season, and resulted in high numbers at DRL5. In the second sampling event on March 14, 2005, we increased our sampling sites to determine what segment of the fork may be responsible for the high numbers found four days previous. By the third sampling day March 22, 2005, the input location had been narrowed down to two possible locations: in the sediment basin, and/or the culvert between the outfall and the sediment basin. This required four sampling sites up and downstream of these possible inputs. An additional measurement was obtained after break-up on June 16, 2005 to verify the conclusions made from the previous results.

Results: Results of each sampling event are shown in Table 1, 2, 3, and 4.

Table 1
3/10/2005

Site	Sample #	FC/100mL
2B2	1	60
2B2	2	105
2B2	3	tntc
DRL5	1	2140
DRL5	2	tntc

DRL5	3	tntc
3UL1	1	1140
3UL1	2	tntc
3UL1	3	tntc

Table 2

3/14/2005

Site	sample #	FC/100mL
2B2	1	340
2B2	2	tntc
2B2	3	tntc
DRL5	1	400
DRL5	2	210
DRL5	3	tntc
DRL3	1	0
DRL3	2	35
DRL3	3	26
DRL2	1	10
DRL2	2	45
DRL2	3	14
DRL1	1	0
DRL1	2	10
DRL1	3	20

Table 3

3/22/2005

Site	sample #	FC/100mL
2B2	2	28
2B2	4	26
2B2	5	60
2B2	6	16
DRL5	1	50
DRL5	2	12
DRL5	4	4
DRL5	6	24
DRL4	2	28
DRL4	4	12
DRL4	6	28
DRL3	1	0
DRL3	2	0
DRL3	3	0
DRL3	4	2
DRL3	5	0
DRL3	6	0

Table 4
6/16/2005

Site	**Sample #**	FC/100mL
RL1	1	35
RL1	2	28
RL1	3	48
DRL1	1	5
DRL1	2	12
DRL1	3	7
DRL3	1	10
DRL3	2	8
DRL3	3	3
DRL4	1	55
DRL4	2	68
DRL4	3	85

Discussion: The results shown above show that the most likely source of high numbers found in the Reflection Lake Fork is the small sedimentation pond between DRL4 and DRL3. It is possible that FC's will accumulate in the pond, then consequently are flushed out during high flow conditions. This explains why FC populations decreased with each subsequent sampling event during springtime snowmelt. The first two occurred during high-flow initial snowmelt conditions, and populations consistently decreased throughout the spring season. Subsequent sampling events indicate that after all the snow is melted, the sediment basin is still a source of elevated fecal coliform levels, oand may be the cause of increased values on the upstream end of University Lake.

D 3.

Characterization Study Report: Storm Drains

Purpose: To obtain data regarding the FC inputs from a variety of storm drain outfalls after heavy rainfalls.

Methods and Measurements: The parameters measured during this experiment were FC, TSS, turbidity, conductivity, and temperature. Four locations were chosen for the measurements. The first was upstream of the North Fork confluence, and the North Fork in Eastchester Park (ECH1, ECH2). Second was a storm drain with groundwater recharge between A St. and C St (AC1, AC2). The third was located just west of the new Seward highway (NS1, NS2). And the fourth was located at the end of Eagle Drive off of fireweed Blvd (E1, E2). Samples were collected at Eagle on more than one occasion.

The sampling event occurred on October 1, 2004.

Results: The raw data are given in the tables below. The site nomenclature is as follows; ECH1 is upstream of the Confluence with North Fork, ECH2 is taken directly from the North Fork, NS1 was taken from the culvert that goes under the New Seward Highway, NS2 is the storm drain located right above the culvert, E1 is upstream of the stormdrain at the end of Eagle Rd. off of Fireweed, downstream of the New Seward Highway culvert, E2 is the storm drain at Eagle, AC1 is in between A St. and C St., the sample was taken directly under the A St. Bridge that runs over Chester Creeek, AC2 is the storm drain located just west of the A St. bridge.

Table1
Field Samples

Site	Turbidity (NTU)	Temp (Celcius)	Conductivity (mS/cm)	TSS (mg/L)
ECH 1	15.2	4.8	115.8	6.2
ECH 2	14.4	7.4	254	9.4
NS1	10.7	5	121.5	4.2
NS2	264	8.3	289	36
E1	13.7	5.1	125.3	6.4
E2	5.4	8.9	325	0
AC1	12.2	5.2	128.3	6.9
AC2	135	8	371	28.9

Site	sample #	FC/100 mL	Site	sample #	FC/100 ml
ECH 1	1	40	NS1	1	120
ECH 1	2	200	NS1	2	156
ECH 1	3	226	NS1	3	166
ECH 1	4	102	NS1	4	52
ECH 1	5	126	NS1	5	120
ECH 1	6	198	NS1	6	78
ECH 2	1	2	NS2	1	40
ECH 2	2	4	NS2	2	20
ECH 2	3	34	NS2	3	6

Table2

Site	sample #	FC/100 ml	Site	sample #	FC/100 ml
ECH 2	4	14	NS2	4	100
ECH 2	5	12	NS2	5	27
ECH 2	6	6	NS2	6	26
E1	1	160	AC1	1	46
E1	2	90	AC1	2	152
E1	3	132	AC1	3	156
E1	4	186	AC1	4	160
E1	5	tntc	AC1	5	144
E1	6	104	AC1	6	190
E2	1	tntc	AC2	1	tntc
E2	2	68	AC2	2	tntc
E2	3	30	AC2	3	tntc
E2	4	58	AC2	4	tntc
E2	5	42	AC2	5	tntc
E2	6	50	AC2	6	tntc

The ‘tntc’ values represented in these tables are due to a plate that was too numerous to count and grew colonies that were not the typical color of blue for FC colonies.

Discussion: The results shown here indicate that the FC population sin the main stream channel following a large storm event are higher than those measured directly from the storm drain source. However, it appears that North Fork is a contributor following a storm event as well as the storm drains at Eagle, and the New Seward Hwy as indicated by the presence of bacteria in the water column at these location above the one-time standard 40 CFU/100mL.

D 4.

Characterization Study Report: North Fork

Purpose: To obtain additional data regarding FC inputs in the North Fork, which a large congregation of ducks inhabit during the winter months. In addition to the presence of winter waterfowl, evidence of moose, snow hares, and rodents inhabitation was found in the riparian area on the west side of the North Fork. Isolating for inputs by instream measurements is expected to be inconclusive due to the presence of wildlife, storm drains, the municipality snow disposal site, sewer crossing, and proximity of the Merril Field landfill, yet measurements were taken for the purpose of quantifying the FC populations seasonally present in the water column.

Methods and Measurements: The parameters measured were FC. Four sites were chosen for measurements. The first was located at the culvert where several storm drains enter the creek, as well as the spring, which feed the creek at this location (NF1). The second location was located before the ninety-degree bend (NF2), the third location was placed downstream of the snow disposal site outfall (NF3), and the fourth site was located downstream of the sedimentation zones and large congregations of ducks (NF4). This location is in the vicinity of a riparian area on the west side, and a road on the east side followed by residential lawns. The riparian area contained fecal evidence indicating the presence of snow hares, moose, magpies, and ducks.

The first sampling event on March 9, 2004, occurred during a snowmelt event, producing a significant amount of runoff from the road, and extremely turbid water conditions (with

the exception of NF4 downstream of the sedimentation zone). Following the initial sampling event, additional samples were taken on March 23, 2005, April 6, 2005, May 21, 2005, and May26, 2005.

Results: Raw data showing the results from all measurements are shown in the tables below organized by date of the sampling event.

Table 1

3/9/2005

Site	**Sample #**	**FC/100 mL**
NF1	1	≈1620
NF1	2	tntc
NF1	3	tntc
NF1	4	tntc
NF1	5	tntc
NF1	6	tntc
NF2	1	tntc
NF2	2	tntc
NF2	3	tntc
NF2	4	tntc
NF2	5	tntc
NF2	6	tntc

Table 2

3/23/2005

Site	**Sample #**	**FC/100 mL**
NF1	1	4
NF1	2	17

Table 3

4/6/2005

Site	Sample #	FC/100 mL
NF1	1	3

Table4

5/26/2005

Site	Sample #	FC/100 mL
NF1	1	4
NF2	1	3
NF3	1	2
NF4	1	3

Results show TNTC at NF1 and NF4 on the first day of sampling during initial snowmelt. An estimation of FC counts were approximately 1620 CFU/100mL. It was observed that low flows serve as sedimentation zones as the stream water appeared to be less turbid at NF4 than NF1. The consequent samples taken March 23, and April 6, showed a significant decrease in FC populations at the culvert, from approximately 1620CFU/100mL on March 9 to 3 CFU/100mL on April 6.

D 5.

Characterization Study Report: Groundwater and Surface Water at Sewer Crossings

Purpose: FC samples were taken in order to determine the influences present at specific sewer line crossings and active septic tanks located within 500 feet of chester creek in a groundwater seepage area.

Methods and Measurements: A groundwater sample was taken from the streambed by immersing a push point sampler PPX36, with a peristaltic pump attached into the sediment until groundwater was reached. The clean tubing used was flushed until the water ran clear and the samples could be captured. Between each sampling event the push point sampler was washed, rinsed, and bleached with a 10% bleach solution.

Restoration Science and Engineering (RSE) determined sewer line crossing locations. A full report was given on determination of these sites according to a risk assessment by RSE. Two locations were chosen and sampled on 3/3/ 2005, and a third was sampled on 6/16/2005.

Parameters measured include pH, temperature, conductivity, NH_4, and FC in both the surface water and groundwater up and downstream of the sewer line crossings. The first sewer line crossing was located off of Campbell Airstrip Road near Boniface and Northern Lights Blvd. The second was near Riviera Terrace off of Boniface. The third event did not include sampling of groundwater or NH_4, and was located near an active septic tank in the riparian area west of the University, noted here as Mallard Lane or ML1 and ML2 up and downstream of the active septic system respectively.

Results: The raw data are presented in Table 1 , 2 and 3 below. GWU indicates a sample taken from the groundwater upstream of the sewer line crossing, and GWD is a groundwater sample taken downstream of the sewer line crossing. At the same location the groundwater samples were taken, a surface water sample was taken as well, and is identified in the table as SWU (surface water upstream), and SWD (surface water downstream).

Table 1

Riviera Terrace Trailer Park

Site	**samp#**	**FC/100mL**
GWU	1	0
GWU	2	0
GWU	3	0
GWD	1	0
GWD	2	0
GWD	3	0
SWU	1	6
SWU	2	0
SWD	1	0
SWD	2	10

Table 2

Campbell Airstrip

Site	**Samp#**	**FC/100mL**
GWU	1	0
GWU	2	0
GWU	3	0
GWD	1	0
GWD	2	0
GWD	3	0
SWU	1	4
SWU	2	14
SWD	1	0
SWD	2	0

Table 3
6/16/2005

Site	Samp#	FC/100mL
ML1	1	4
ML2	1	11

Discussion: The samples taken at Riveria Terrace all turned out to be zeroes in the groundwater. However, the surface water samples taken upstream samples were 6 FC/100mL, and downstream zeroes again.

At Campbell Airstrip there were no elevated FC levels in the groundwater. The surface water samples and again upstream surface water had the most elevated FC levels.

Based on these results, there does not appear to be an influence at these sewer line crossings on FC levels in the groundwater or the surface water at these locations. However, there were elevated levels of Ammonium in the downstream samples from the groundwater at both locations where ammonium samples were taken.

The samples taken at Mallard lane, showed no significant results to warrant another sampling event in the area. Time of day is an important factor in capturing the inputs due to raw sewage seepage or influent from a septic system. All samples were taken in the afternoon when wastewater flows are usually relatively low dependent on typical usage in the area.

D 6.

Characterization Study Report: Protocol for Survivability Study

Purpose: To determine how long strains of E.Coli from Chester Creek survive in water and sediment at 4 degrees Celsius and 16 degrees Celsius. This experiment may also give an indication of the die-off rates associated with FC entering surface waters at these temperatures.

Collection and Incubation of Samples: The samples for the survivability study will be collected in different ways according to the particular experiment as stated in the categories below.

Water Samples

Dividing the experiment into two categories, the sterile experiment vs. the non-sterile experiment, will be starting protocol for FC survivability in the water column and sediment experiments. For the sterile experiment begins with a large 1000 ml grab sample taken from the stream at the UAA sampling site. The sample volume will be separated into six aliquots then autoclaved for incubation at 4 degrees Celsius and 16 degrees Celsius. During incubation the samples will be placed on a shaking table to mimic the oxygenation conditions that would normally be present in the stream due to turbulent flows. Alternately, the non-sterile samples will be taken as a grab sample, not sterilized and incubated in the same manner as the sterilized samples.

Survivability experiments will be performed first by inoculating the six samples with 4 isolated strains of E. Coli previously isolated from cultures found in Chester Creek. After

the initial inoculation the first enumeration of E.Coli and Entercocci will be performed, marking a day zero count then the remaining inoculated samples will be incubated until subsequent enumerations at the temperatures mentioned previously.

Enumeration of the bacteria over time will be done by dilution spread plate technique. The incubation times will depend on the results of the dilution spread plate technique. If the die-off is occurring rather quickly, we will enumerate more frequently, when the die-off rate begins to decrease enumerations can be done less frequently until the populations reach zero, or 3-months has expired.

Sediment Samples

Sediment samples will be treated much the same as the water samples with minor changes regarding collection and incubation. Sediment samples will be taken from the creek, and allowed to dry overnight. Additional water is required to keep the sediments completely submersed and that can be collected from the same location with a 1000mL container grab sample at the streambed surface.

A sterile and non-sterile experiment will also be performed at incubation temperatures the same as above. During incubation the sediment samples will not be shaken to ensure oxygenation. This is under the assumption that the reduced water level above the sediments and allowance of air into the samples, by not sealing the tops of the incubation containers, can mimic the oxygen reaching the samples in the stream to the conditions in the incubation chambers.

Dilution Spread Plate Technique

First the flask of sterile or non-sterile sample that has been inoculated with a known concentration of E.Coli or Enterococci will be removed from the incubation chamber and shaken well. After removing 0.5 mL from the flask with a sterile pipette, the flask is returned to its original location in the incubation chamber. The 0.5 mL sample that was removed from the sample flask will be transferred to a culture tube containing 4.5 mL of sterile saline buffer solution. Another 0.5 mL will be taken from that culture tube, transferred to another culture tube and so on until the original solution has been diluted about seven times. In other words the original 0.5 mL sample has been diluted to 1/10,000,000. Each dilution present in the culture tube will be spread onto plates containing EMB Agar and incubated for growth at 37 degrees Celsius for 24 hours and then counted.

The dilution spread plate technique will be similar for the enumeration of bacteria in the water and the sediment.

Countable plates will contain about 25-250 colonies per plate. The countable plates can be averaged to determine the original number present in the solution.

Inoculation

Both E. Coli and Enterococci strains will be added to a nutrient broth and incubated for 24 hours for harvest the following day. The bacteria growing in the broth will be transferred to a sterile container and centrifuged until a bacterial pellet is formed. The remaining solution can be decanted off. Sterile saline buffer is then added to the bacteria pellet and shaken until the pellet is dissolved. The solution is then measured for its optical density in a spectrophotometer and diluted until the optical density is found to equal one. This optical density is associated with a specific bacterial population that can now be applied to the sample. This known concentration is then added to the water and sediment samples, shaken, and put in its incubation location.

Results

Once the plates are counted the data can be collected and the survivability trend can be seen by plotting the FC population versus time starting at time zero through the end of the experiment. From this trend the line may be sectioned off to determine die-off rates at certain time intervals throughout the experiment.

APPENDIX E.

Weekly Monitoring Data Summary

APPENDIX E.

Weekly Monitoring Data Summary

Fort Richardson

Date	FC/100mL	pH	Cond. (mS/cm)	Flow (cfs)	Temp. (°C)	TSS (mg/L)	Turb. (NTU)
7/9/2004							
7/14/2004	1	7.6		4.999942	7.8		
7/21/2004	3	7.5		3.539794	8.3		
7/28/2004	2	7.2	90.1	4.281645	7.9	0.4	0.73
8/3/2004	2	7.2	93	2.772791	8.6	1	1.53
8/11/2004	4	7.6	96.2	1.978869	9		1.6
8/18/2004	21	7.7	96.5	1.978869	8.8	6.1	1.74
8/25/2004	128	7.9	94.5	1.156072	8	2	1.5
9/1/2004	14					1.5	
9/8/2004	8	7	84.2	2.772791	4.5	0.8	0.63
9/16/2004	8	7.1	78.5	2.772791	2.2	0.7	0.5
9/22/2004	95	7.3	83.2	4.999942	5	3.3	3.02
9/29/2004	3	7	73.7	6.371539	2.8	0.3	2.62
10/5/2004	10	7.7	66.5	11.15229	4	0.6	1.06
10/13/2004	4	7.65	66.9	10.04844	3.2	0.7	0.59
10/20/2004	1	7.81	67.6	7.664716	2.2	0	0.59
10/27/2004	2	7.86	67.6	7.027366	2.5	0.6	0.83
11/3/2004	3	7.8	39.7	22.38389	0.1		3.67
11/10/2004	4	7.63	63.3	5.696133	1.4	1.5	1.33
11/17/2004	7	7.7	60.4	3.539794	0.9	0	1.1
11/24/2004	6	7.89	69.5	3.539794	1.1	0.5	
12/1/2004	2	7.93	67.7	4.999942	2.2	2.9	
12/8/2005	1	7.59	65.8		0	0.4	1.14
12/15/2004	1	7.52	70.6		2.7	0	1.78
12/22/2004	56	7.5	48.3		0	11.9	5.35
12/29/2004	8					1.3	0.69
1/5/2005	12	7.88	60.1		0.4	2.3	1.37
1/12/2005	7	8.8			0	0.4	1.03
1/19/2005	2	7.82	67.7		0.2	0.1	1
1/26/2005	5	7.85	70.8		1.3	0.8	0.65
2/2/2005	1	8.01	36.1		0.87	1.5	0.87
2/9/2005	2	7.3	71.8		1.3		
2/16/2005	3	7.65	72.9		1.5	1.46	1.56

2/23/2005							
3/2/2005							
3/9/2005							
3/16/2005							
3/23/2005	1	8.03	74		0.8	1.78	0.95
3/30/2005							
4/6/2005							
4/13/2005							
4/20/2005	6	7.73	67.8	3.159543	2.5	7.6	1.43
4/27/2005	1	7.83	68	2.772791	3.6		
5/4/2005		7.95	62.9	8.284602	3.9		
5/11/2005		7.81	62.9	10.04844	4.6	4.6	1.8
5/19/2005	1	7.91	65.2	10.04844	5.1	3.4	1.4
5/25/2005	1	7.65	64.2	12.71321	4.9	4.2	1.1
6/1/2005	1	7.88	66.1	11.42004	5.1	3	2
6/8/2005	37	7.54	68.8	10.04844	5.4	2.4	0.79
6/15/2005	10						
6/22/2005		7.18	74.2	8.588291	15.4	2.8	
6/29/2005		7.87	108.5	7.027366	10.6		0.88

University Lake Inlet

Date	FC/100mL	pH	Cond. (mS/cm)	Flow (cfs)	Temp. (°C)	TSS (mg/L)
11/10/2004	38	7.2			7.68	2.1
11/17/2004	54	9.3		126.6	7.78	2.6
11/24/2004	71	3.4		127.8	7.96	2.1
12/1/2004	8	13.8	23.7	163.7	7.78	3.1
12/8/2005	1	7	6.69	129.3	7.71	1.1
12/15/2004	66	5.3	3.07	127.5	7.48	1.7
12/22/2004	1	4.6	3.55	124.9	7.7	1.8
12/29/2004	1	4.2	2.87			
1/5/2005	tntc	13.1	9.46	116.1	7.76	1.1
1/12/2005	44	3.1	3.93		8.25	0
1/19/2005	69	0.8	2.12	121.3	7.84	0.5
1/26/2005	24	2	2.61	122.5	7.8	0.9
2/2/2005	tntc	3.6	7.77	1.3	8.25	0
2/9/2005	75			120.9	7.79	1.4
2/16/2005	140	2.7	3.54	123.7	7.82	1.8
2/23/2005				125.1	8.12	2.2
3/2/2005	103	3.8	3.64	121.5	8.14	1.2
3/9/2005	113	16.5	14.4	154.7	7.94	2.7
3/16/2005						
3/23/2005	12	7.4	5.81	137.8	8.01	3.2
3/30/2005	33	10.1	4.72	131.1	7.86	1.5
4/6/2005	178	4.4	6.76	143.1	7.81	3.5

4/13/2005	79	1	4.85	135	7.59	2.8
4/20/2005	39	1.7	3.9	140.2	7.87	4.6
4/27/2005	284			135.2	7.84	10.2
5/4/2005				127.8	7.8	6
5/11/2005		2.6	2.4	131.9	7.88	7.8
5/19/2005	8	2.7	2.5	128.2	7.86	7.9
5/25/2005	38	2.8	3.8	117.9	7.76	7.8
6/1/2005	32	2.9	2.29	120.3	7.86	8.45
6/8/2005	36	2.1	2.94	121.4	7.83	7.4
6/15/2005	53			134	7.94	10.2
6/22/2005	28	3.6		138.5	7.82	16.7
6/29/2005			2.03	143.5	7.86	11.3

University Lake Outlet

Date	**FC/100mL**	**pH**	**Cond. (mS/cm)**	**Flow (cfs)**	**Temp. (°C)**	**TSS (mg/L)**
11/10/2004	17	0.4			7.68	1.6
11/17/2004	13	0.8		133.7	7.63	2.1
11/24/2004	13	0		132.5	7.76	9.2
12/1/2004	76	8	18.9	143.6	7.74	5.4
12/8/2005	48	2	6.58	136.9	7.74	1.4
12/15/2004	30	0.6	2.75	132	7.34	1.3
12/22/2004	21	0.2	1.91	128.7	7.6	1.5
12/29/2004	38	0.7	2.18			
1/5/2005	tntc	8.2	15.5	140.4	7.66	1.1
1/12/2005	32	1.2	4.16		7.84	0.6
1/19/2005	14	0	2.06	130.6	7.7	0.6
1/26/2005	16	0	1.78	130.6	7.72	1
2/2/2005	46	1.5	1.66	125	7.75	0.5
2/9/2005	73			123.5	7.71	0.5
2/16/2005	75	0.2	1.48	122.2	7.69	0.7
2/23/2005	16			123.2	7.89	1.2
3/2/2005	47	0.5	3.51	123.1	8.05	1.3
3/9/2005	42	2.4	7	132.7	7.85	1.6
3/16/2005						
3/23/2005	8	2.9	6.7	127.9	7.73	1.5
3/30/2005	12	2	7.2	129.8	7.69	1.7
4/6/2005	15	2.4	7.28	135.8	7.69	2.1
4/13/2005	58	5.4	12.3	129.6	7.46	2.9
4/20/2005	1	1.2	3.11	131.1	7.67	3.3
4/27/2005	34			126.8	7.54	5.6
5/4/2005				146.1	7.62	9.2
5/11/2005		1.3	1.9	218.8	7.95	11.1
5/19/2005	9	0.7	1.8	145.9	8.05	10.6
5/25/2005	21	2.3	5	138.6	7.79	12.3

6/1/2005	7	0	1.84	139	8.04	10.6
6/8/2005	21	0	1.79	145	8.03	15.4
6/15/2005	4			159.8	8.25	20.2
6/22/2005	18	0.9		154.8	8.11	16.9
6/29/2005			1.8	169.5	8.29	21.2

UAA

Date	**FC/100mL**	**pH**	**Cond. (mS/cm)**	**Flow (cfs)**	**Temp. (°C)**	**TSS (mg/L)**	**Turb. (NTU)**
7/9/2004	20					15.8	15.00779
7/14/2004	90				8	16.3	13.71338
7/21/2004	179				8.2	15.3	14.36693
7/28/2004	20	3.8	4.1	183.9	7.1	15.2	19.73059
8/3/2004	95	2.5	1.57	186.9	7.9	15.5	13.71338
8/11/2004	31		1.3	199.3	7.4	16.8	12.36612
8/18/2004	30	2	2.04	200	7.9	16	12.36612
8/25/2004	329	0.7	1.42	199.1	7.8	15.3	11.67129
9/1/2004	33	1					
9/8/2004	54	1.1	1.91	145.4	6.4	11	12.36612
9/16/2004	34	5.9	4.13	157.6	7.1	9	10.96151
9/22/2004	378	42.6	55.2	123.8	6.8	8.3	21.86058
9/29/2004	62	10.1	20.2	107.4	6.8	5.3	30.03999
10/5/2004	15	1.7	6.34	135.6	7.42	5.9	23.86139
10/13/2004	2	1.2	3.68	142.8	7.53	6	20.81277
10/20/2004	3	0.4	5.22	137	7.7	4.6	21.86058
10/27/2004	32	3.2	6.91	132.9	7.9	3.8	22.87614
11/3/2004	35		6.47	132.5	7.7	2.9	17.4536
11/10/2004	16	1.2	4.19	183.8	7.72	2.2	18.03775
11/17/2004	4	4.7		143.4	7.73	2.5	17.4536
11/24/2004	9	1.1		138.6	7.87	2.7	18.03775
12/1/2004	92	44.4	137	238	7.66	5.9	24.81808
12/8/2005	33	3.1	7.39	142.6	7.69	1.5	19.73059
12/15/2004	18	7.4	3.1	137.6	7.47	1.6	18.61173
12/22/2004	14	1.2	2.22	134.1	7.78	1.8	
12/29/2004	4	5.8	2.48				19.73059
1/5/2005	tntc	14	14.1	143.4	7.75	1.4	23.86139
1/12/2005	28	1.4	4.05		7.9	0.3	
1/19/2005	13	0.8	2.19	133.4	7.83	0.5	
1/26/2005	4	0.2	1.83	134.4	7.78	0.5	15.00779
2/2/2005	24	0.7	1.85	128.4	7.8	0.2	
2/9/2005	41			143.9	7.84	0.8	16.25335
2/16/2005	14	1.07	2.57	141	7.82	1	13.71338
2/23/2005				128.8	8.15	1.7	13.71338
3/2/2005	8	0.6	2.68	127.8	8.15	1.3	13.04662
3/9/2005	50	10.3	10.3	162	7.97	2	16.25335

3/16/2005							
3/23/2005	28	5	9.13	158	7.86	2.3	17.4536
3/30/2005	4	1.2	6.33	145.9	7.91	2.1	17.4536
4/6/2005	6	4.2	8.27	143.7	7.79	2.7	18.61173
4/13/2005	35	2.6	11.5	135.7	7.62	3.4	24.81808
4/20/2005	2	2.7	2.79	137.7	7.84	4.1	23.37244
4/27/2005	27			140.2	7.78	6.9	29.22505
5/4/2005				153.9	7.73	9.2	27.09507
5/11/2005		2.3	2.5	168	8.06	11.5	26.65206
5/19/2005	50	1.9	2.2	156.3	8.09	11.2	25.74781
5/25/2005	20	2.3	3.9	146.1	7.89	10.8	27.5322
6/1/2005	55	1	1.72	147	7.99	10.6	27.5322
6/8/2005	11	0.6	1.52	150.6	7.99	11.5	
6/15/2005	8			166	8.1	20.6	26.65206
6/22/2005	27	2		161.4	7.96	13.9	
6/29/2005			1.75	175.5	8.13	20.2	24.81808

Arctic

Date	FC/100mL	pH	Cond. (mS/cm)	Flow (cfs)	Temp. (°C)	TSS (mg/L)	Turb. (NTU)
7/9/2004							
7/14/2004	9				8.5	13.8	40
7/21/2004	66				8.2	14.3	39
7/28/2004	43	14.6	21.2	194.4	7.2	14.2	49
8/3/2004	42	2.9	5.91	209	8.3	14	39
8/11/2004	36		4.98	218	8.1	14.3	38
8/18/2004	279	3.5	3.93	219	8	14	38
8/25/2004	68	7.8	5.96	216	8.1	13.2	35
9/1/2004	1	2					
9/8/2004	52	2.3	3.88	198.4	7.6	9.2	45
9/16/2004	67	2	3.84	192.5	7.5	7.3	39
9/22/2004	1	101.6	100	55.2	6	8.3	160
9/29/2004	1	43.2	20.2	106.2	6.2	5.1	127
10/5/2004	24	1.8	5.11	193.7	7.52	6.5	71
10/13/2004	9	3.8	6.26	187.6	7.7	6.1	70
10/20/2004	12	2.9	5.29	184.5	7.75	4.9	72
10/27/2004	83	6	7.18	160.5	7.96	4.5	72
11/3/2004	39		7.15	180	7.77	2.7	59
11/10/2004	31	1.9	6.71	182.5	7.81	2.9	67
11/17/2004	6	3.2		183.1	7.71	2.8	59
11/24/2004	5	3		180.8	7.92	2.5	58
12/1/2004	75	17.9	81.8	275.6	7.82	3.5	75
12/8/2005	30	7.3	9.04	178.8	7.61	3.3	67
12/15/2004	48	3.5	8.77	178.4	7.53	1.9	

12/22/2004		1	8	7.98	177.4	7.81	2.3	
12/29/2004		1	1.8	6.65				
1/5/2005	tntc		8.5	15.8	170.6	7.76	1.2	71
1/12/2005		16	1.2	4.63		8.02	0	
1/19/2005		19	0.2	3.34		7.89	0	
1/26/2005		83	5.5	6.43	158	7.77	0	52
2/2/2005	tntc		0.5	2.28	0	7.95	0	
2/9/2005	tntc				161.4	7.8	0	
2/16/2005		133	12.1	11.6	175.2	7.68	1.4	52
2/23/2005					166.6	8.15	1.9	45
3/2/2005		16	1.6	3.57	161.8	8.12	0.7	47
3/9/2005		59	5.5	15.7	224.5	7.89	2.9	49
3/16/2005								
3/23/2005		11	75.5	7.29	182.6	7.94	3.4	53
3/30/2005		51	3.4	6.76	169	7.74	1.3	56
4/6/2005		9	4.64	8.24	174.6	7.71	3.1	57
4/13/2005		44	1.8	6.33	156.8	7.72	3.1	70
4/20/2005		23	0.8	3.5	181.8	8.17	6.6	66
4/27/2005		41			174.6	7.89	6.7	76
5/4/2005					194.6	7.81	8.5	68
5/11/2005			5.3	4.6	198.9	8.1	10.2	65
5/19/2005		7	1.1	3.8	193.9	8.33	11.3	65
5/25/2005		230	5.5	5.5	183.9	7.98	12.4	65
6/1/2005		38	2.7	5.06	180.4	7.99	10.6	65
6/8/2005		37	2.4	4.07	180.8	7.97	10.6	64
6/15/2005		10			198.4	8.41	13.8	65
6/22/2005	tntc		6.3		194.4	8.15	17	58
6/29/2005				4.69	202.2	8.1	14.1	58

*'tntc' indicate samples were too numerous to count, all cells left blank indicate the samples or measurements were not taken or not valid.

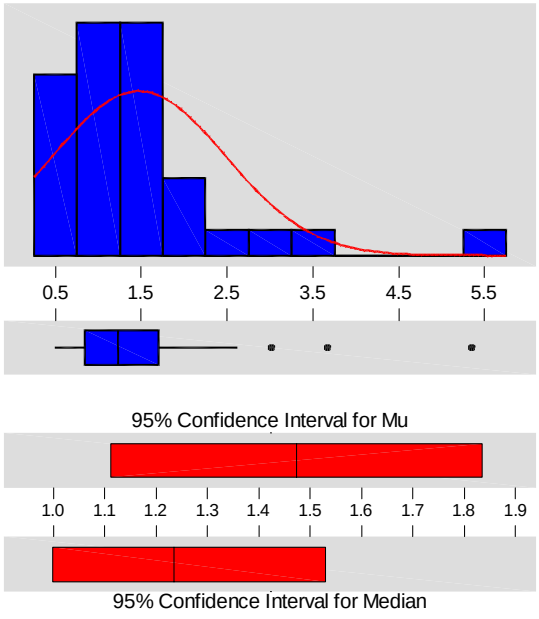
APPENDIX F.

Descriptive Statistics: All Sites, All Parameters

Figure 1: Descriptive Statistics, Fort Rich, Turbidity

Fort Rich

Descriptive Statistics



Variable: turb (NTU)

Anderson-Darling Normality Test	
A-Squared:	2.181
P-Value:	0.000
Mean	1.47375
StDev	1.00438
Variance	1.00879
Skewness	2.33890
Kurtosis	6.72415
N	32
Minimum	0.50000
1st Quartile	0.84000
Median	1.23500
3rd Quartile	1.70500
Maximum	5.35000
95% Confidence Interval for Mu	
1.11163	1.83587
95% Confidence Interval for Sigma	
0.80522	1.33531
95% Confidence Interval for Median	
0.99992	1.53005

Figure 2: Fort Rich, pH

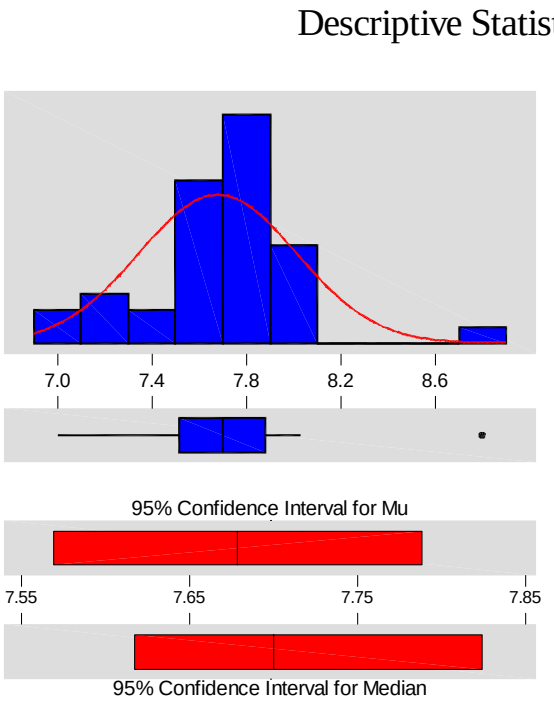
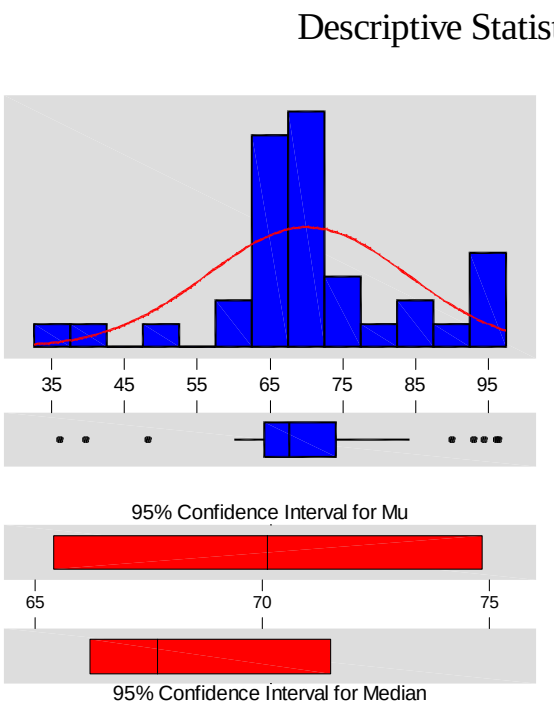


Figure 3: Fort Rich, conductivity



Variable: cond(mS/cm)

Anderson-Darling Normality Test

A-Squared:	1.319
P-Value:	0.002
Mean	70.1229
StDev	13.7504
Variance	189.075
Skewness	-6.4E-02
Kurtosis	0.897409
N	35
Minimum	36.1000
1st Quartile	64.2000
Median	67.7000
3rd Quartile	74.0000
Maximum	96.5000

95% Confidence Interval for Mu

65.3994 74.8463

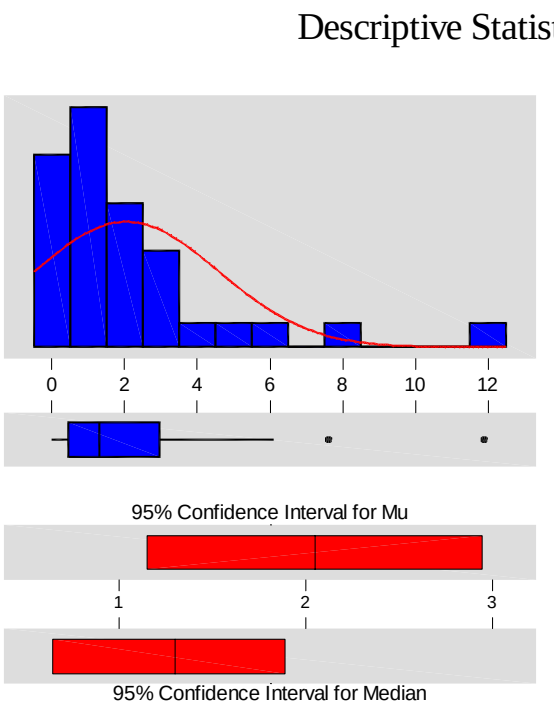
95% Confidence Interval for Sigma

11.1224 18.0159

95% Confidence Interval for Median

66.2219 71.4953

Figure 4: Fort Rich, TSS



Variable: TSS(mg/L)

Anderson-Darling Normality Test

A-Squared:	2.664
P-Value:	0.000
Mean	2.04970
StDev	2.52759
Variance	6.38870
Skewness	2.37447
Kurtosis	6.70097
N	33
Minimum	0.0000
1st Quartile	0.4500
Median	1.3000
3rd Quartile	2.9500
Maximum	11.9000

95% Confidence Interval for Mu

1.1535	2.9459

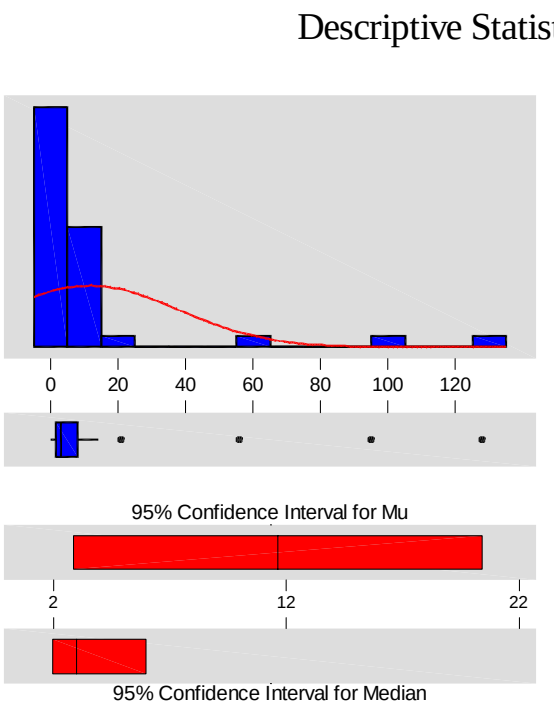
95% Confidence Interval for Sigma

2.0327	3.3432

95% Confidence Interval for Median

0.6497	1.8906

Figure 5: Fort Rich, FC



Variable: FC

Anderson-Darling Normality Test

A-Squared:	8.200
P-Value:	0.000
Mean	11.6486
StDev	26.3019
Variance	691.790
Skewness	3.58154
Kurtosis	12.8930
N	37
Minimum	0.000
1st Quartile	1.500
Median	3.000
3rd Quartile	8.000
Maximum	128.000

95% Confidence Interval for Mu

2.879	20.418

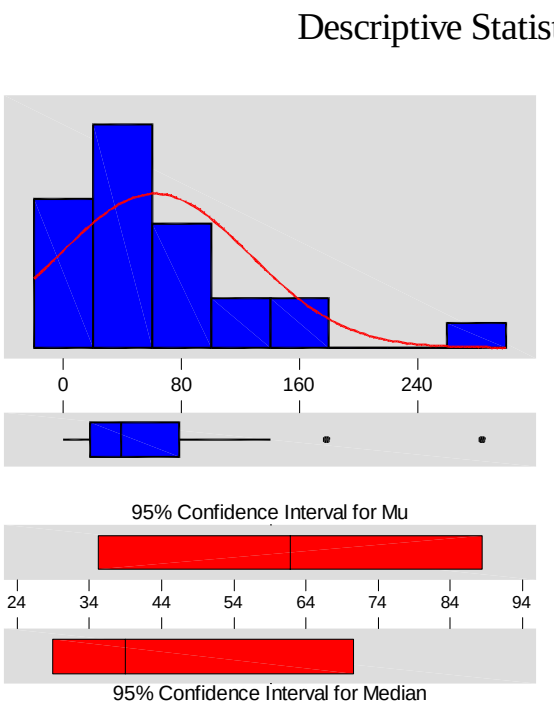
95% Confidence Interval for Sigma

21.389	34.165

95% Confidence Interval for Median

2.000	6.000

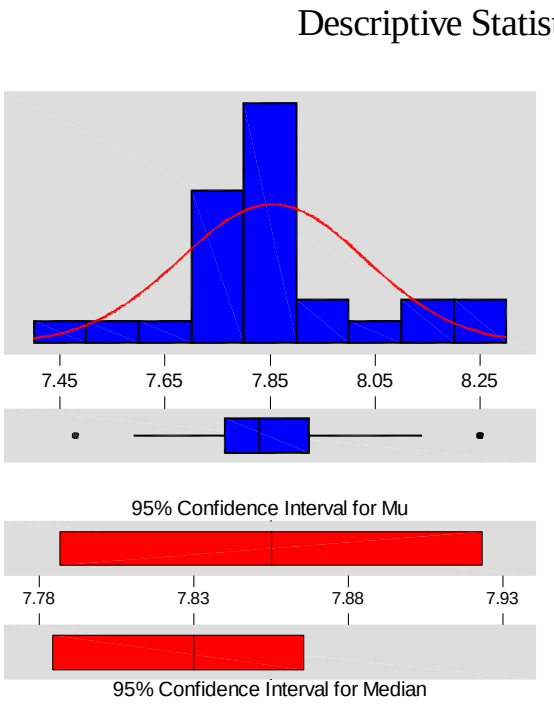
Figure 6: University Lake Inlet, FC



Variable: FC_1

Anderson-Darling Normality Test	
A-Squared:	1.372
P-Value:	0.001
Mean	61.8400
StDev	64.4526
Variance	4154.14
Skewness	2.01364
Kurtosis	5.07534
N	25
Minimum	0.000
1st Quartile	18.000
Median	39.000
3rd Quartile	78.500
Maximum	284.000
95% Confidence Interval for Mu	
35.235	88.445
95% Confidence Interval for Sigma	
50.326	89.663
95% Confidence Interval for Median	
28.991	70.604

Figure 7: University Lake Inlet, pH



Variable: pH

Anderson-Darling Normality Test

A-Squared:	0.917
P-Value:	0.017
Mean	7.85500
StDev	0.17602
Variance	3.10E-02
Skewness	0.612573
Kurtosis	0.872441
N	28
Minimum	7.48000
1st Quartile	7.76500
Median	7.83000
3rd Quartile	7.92500
Maximum	8.25000

95% Confidence Interval for Mu

7.78675	7.92325

95% Confidence Interval for Sigma

0.13916	0.23958

95% Confidence Interval for Median

7.78448	7.86552

Figure 8: University Lake Inlet, Conductivity

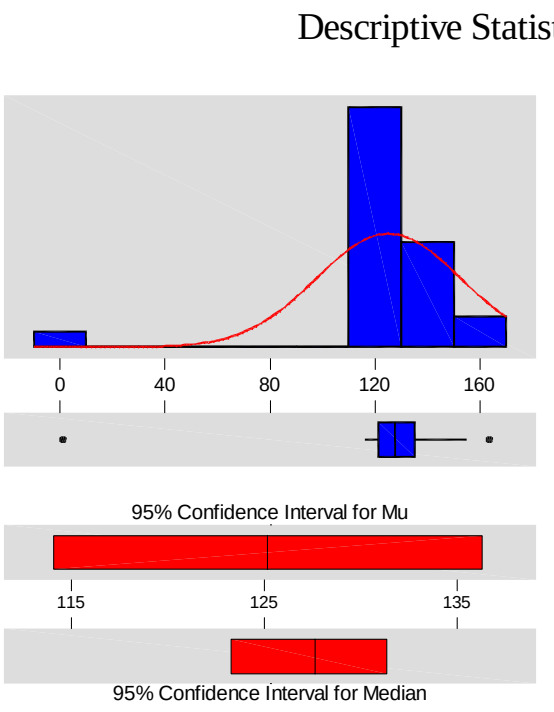
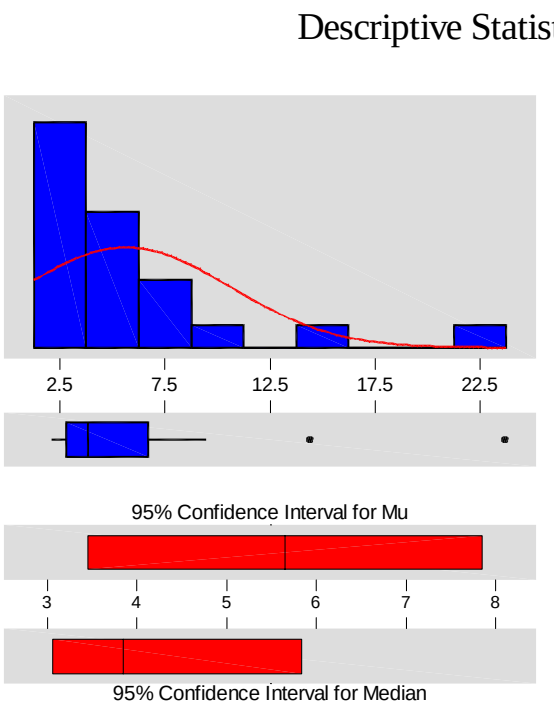


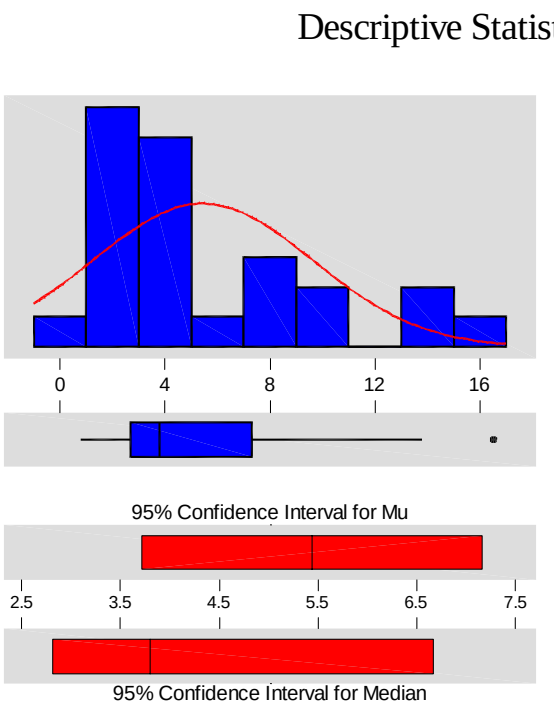
Figure 9: University Lake Inlet, Turbidity



Variable: Turb (NTU)

Anderson-Darling Normality Test	
A-Squared:	2.506
P-Value:	0.000
Mean	5.65364
StDev	4.95420
Variance	24.5441
Skewness	2.73682
Kurtosis	8.40397
N	22
Minimum	2.1200
1st Quartile	2.8050
Median	3.8500
3rd Quartile	6.7075
Maximum	23.7000
95% Confidence Interval for Mu	
3.4571	7.8502
95% Confidence Interval for Sigma	
3.8115	7.0799
95% Confidence Interval for Median	
3.0645	5.8340

Figure 10: University Lake Inlet, TSS



Variable: TSS(mg/L)

Anderson-Darling Normality Test

A-Squared:	1.450
P-Value:	0.001
Mean	5.44000
StDev	4.18081
Variance	17.4792
Skewness	1.33078
Kurtosis	1.05936
N	25
Minimum	0.8000
1st Quartile	2.7000
Median	3.8000
3rd Quartile	7.3000
Maximum	16.5000

95% Confidence Interval for Mu

3.7142	7.1658

95% Confidence Interval for Sigma

3.2645	5.8161

95% Confidence Interval for Median

2.8198	6.6632

Figure 11: University Lake Outlet, pH

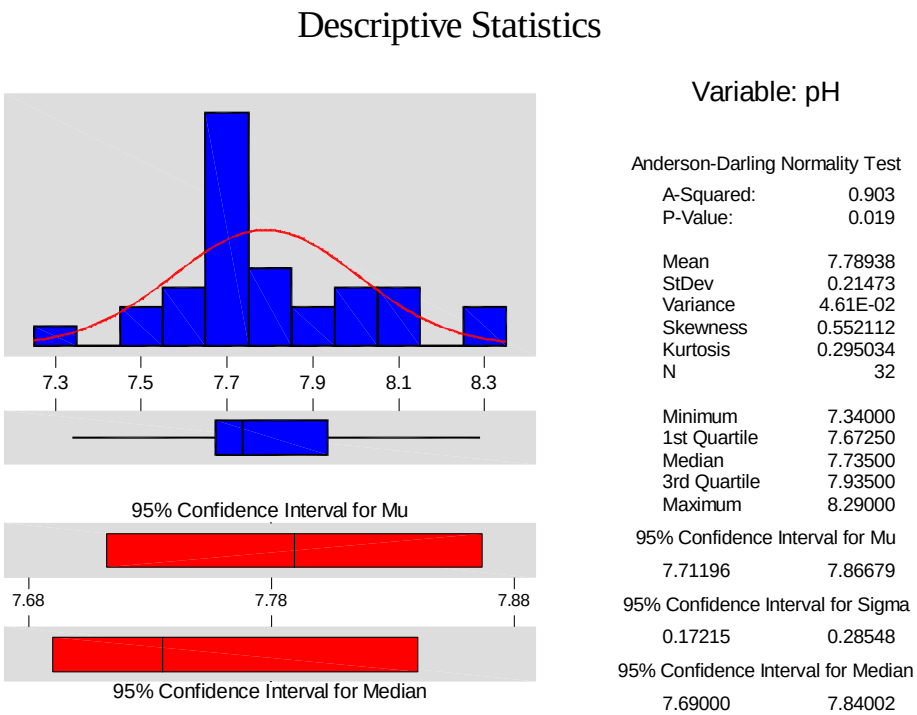


Figure 12: University Lake Outlet, Conductivity

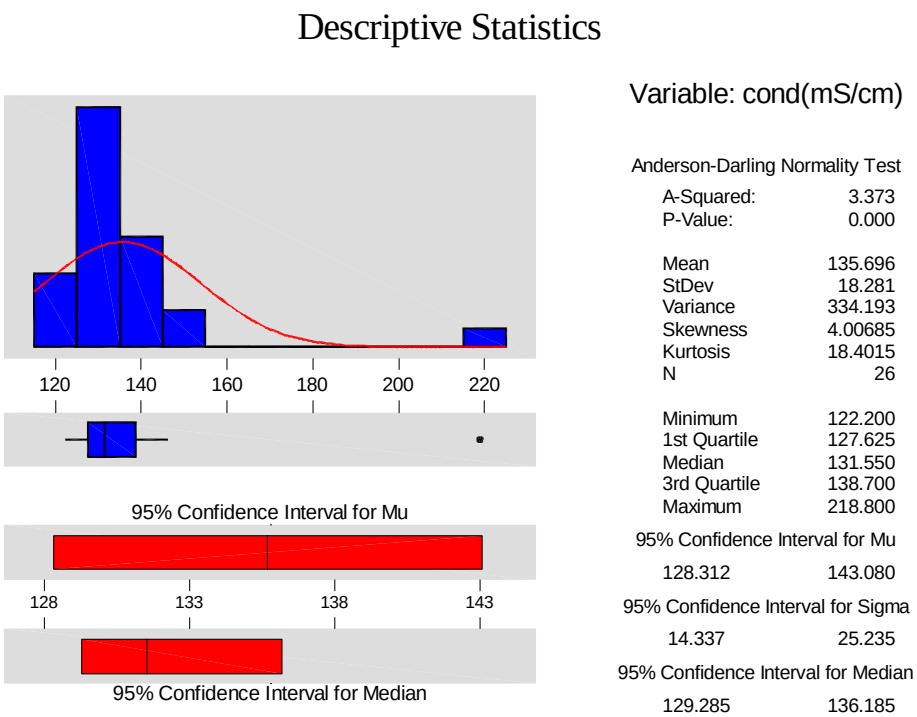
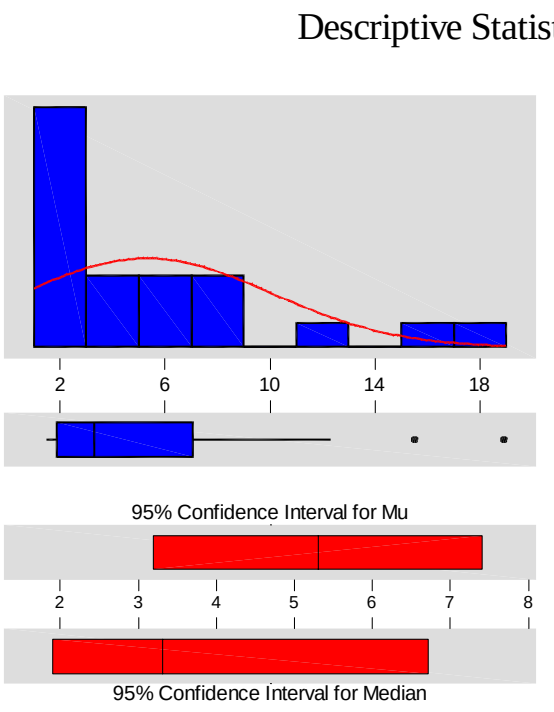


Figure 13: University Lake Outlet, Turbidity



Variable: Turb (NTU)

Anderson-Darling Normality Test

A-Squared:	1.839
P-Value:	0.000
Mean	5.30000
StDev	4.75920
Variance	22.6500
Skewness	1.71785
Kurtosis	2.55770
N	22
Minimum	1.4800
1st Quartile	1.8850
Median	3.3100
3rd Quartile	7.0500
Maximum	18.9000

95% Confidence Interval for Mu

3.1899	7.4101

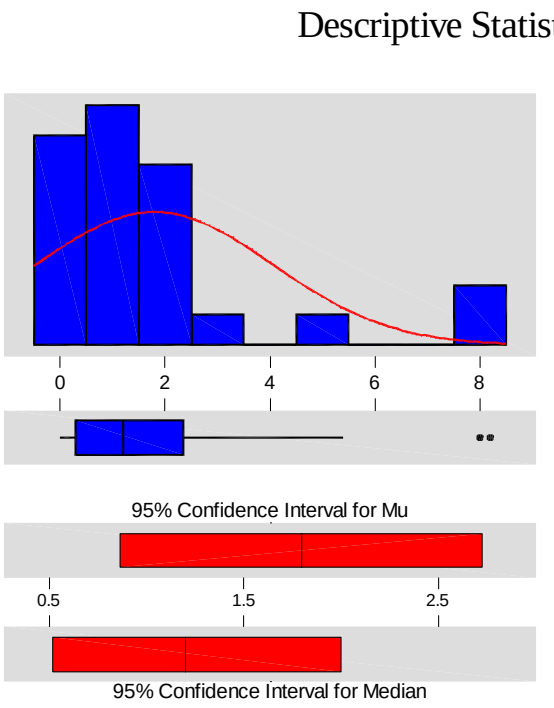
95% Confidence Interval for Sigma

3.6615	6.8012

95% Confidence Interval for Median

1.9097	6.7082

Figure 14: University Lake Outlet, TSS



Variable: TSS(mg/L)

Anderson-Darling Normality Test

A-Squared:	2.338
P-Value:	0.000
Mean	1.79600
StDev	2.25711
Variance	5.09457
Skewness	2.00105
Kurtosis	3.59935
N	25
Minimum	0.00000
1st Quartile	0.30000
Median	1.20000
3rd Quartile	2.35000
Maximum	8.20000

95% Confidence Interval for Mu

0.86431	2.72769

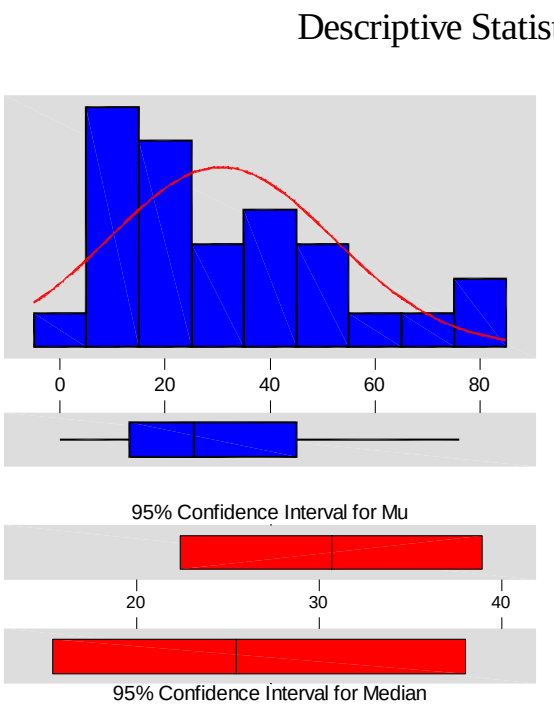
95% Confidence Interval for Sigma

1.76242	3.13999

95% Confidence Interval for Median

0.51981	2.00000

Figure 15: University Lake Outlet, FC



Variable: FC_1

Anderson-Darling Normality Test

A-Squared:	0.904
P-Value:	0.018

Mean	30.6786
StDev	21.3456
Variance	455.634
Skewness	0.802558
Kurtosis	-1.9E-01
N	28

Minimum	0.0000
1st Quartile	13.2500
Median	25.5000
3rd Quartile	45.0000
Maximum	76.0000

95% Confidence Interval for Mu

22.4016	38.9555

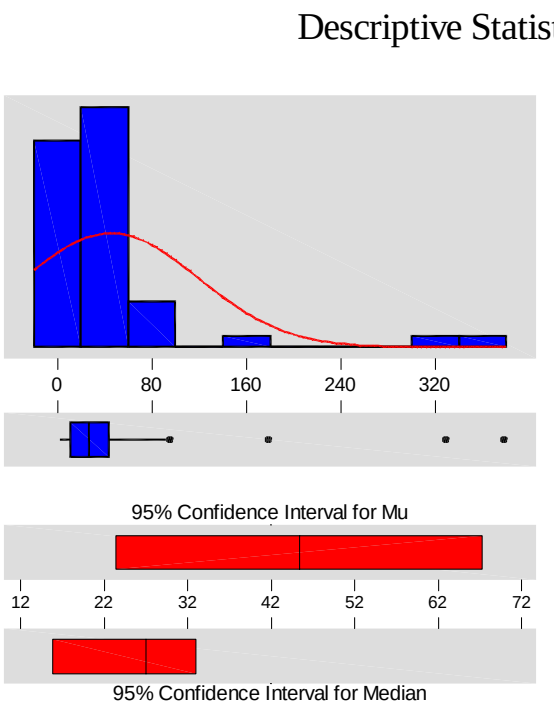
95% Confidence Interval for Sigma

16.8762	29.0542

95% Confidence Interval for Median

15.4483	38.0000

Figure 16: UAA, FC



Variable: FC_1

Anderson-Darling Normality Test	
A-Squared:	7.304
P-Value:	0.000
Mean	45.3696
StDev	73.9097
Variance	5462.64
Skewness	3.52627
Kurtosis	13.0308
N	46
Minimum	2.000
1st Quartile	10.500
Median	27.000
3rd Quartile	43.250
Maximum	378.000

95% Confidence Interval for Mu	
23.421	67.318

95% Confidence Interval for Sigma	
61.303	93.091

95% Confidence Interval for Median	
15.917	33.000

Figure 17: UAA, pH

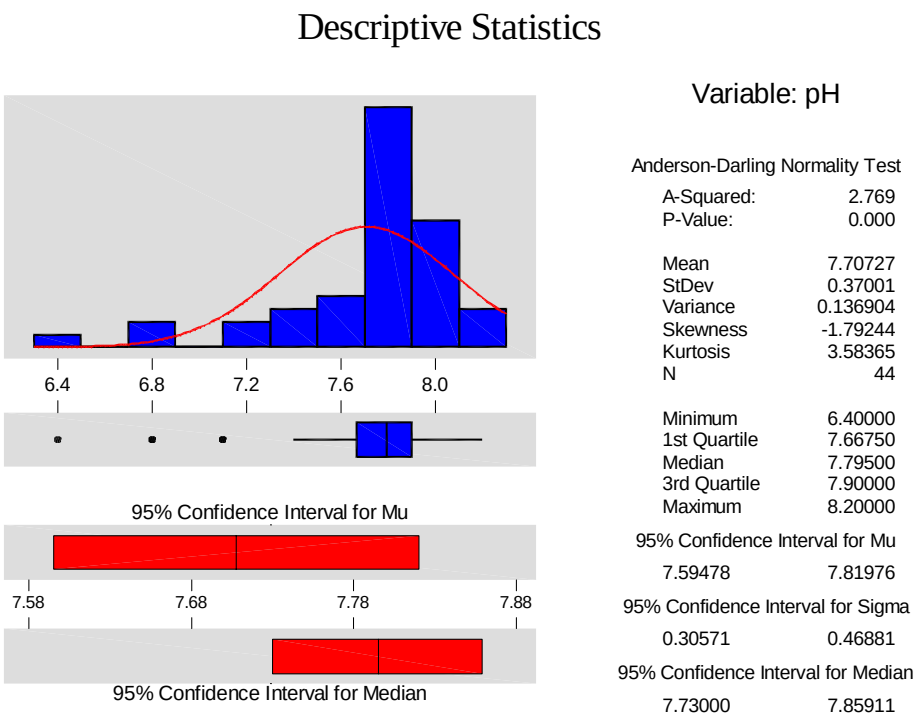


Figure 18: UAA, Conductivity

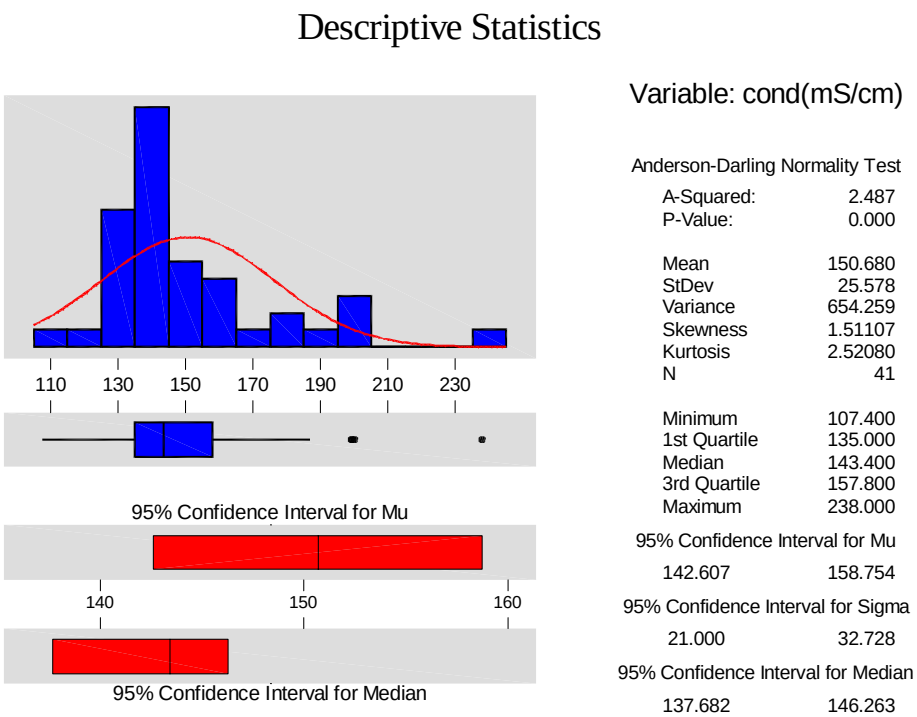


Figure 19: UAA, Turbidity

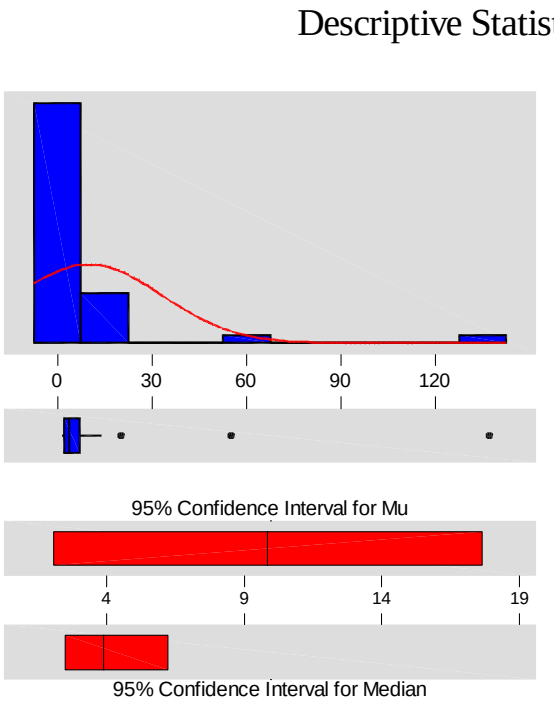
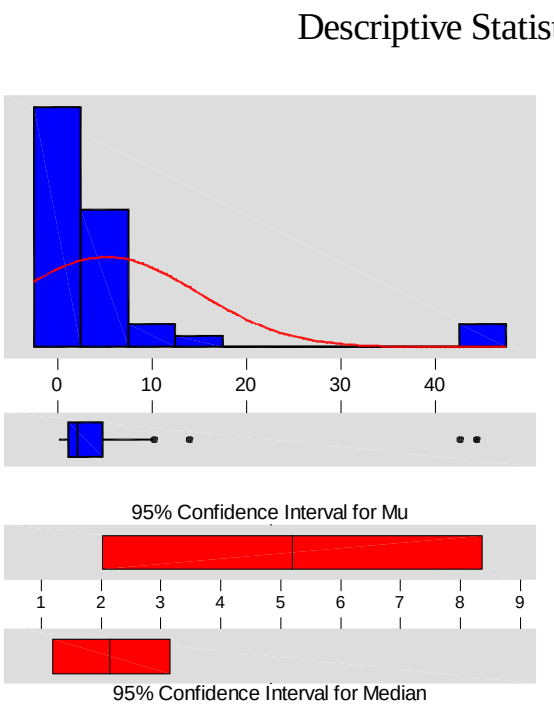


Figure 20: UAA, TSS



Variable: TSS(mg/L)

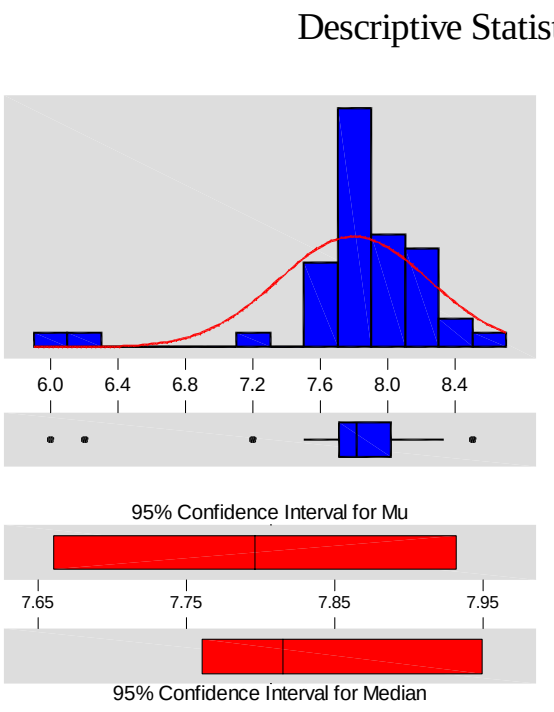
Anderson-Darling Normality Test	
A-Squared:	7.184
P-Value:	0.000
Mean	5.19395
StDev	9.64809
Variance	93.0856
Skewness	3.55943
Kurtosis	12.6405
N	38
Minimum	0.2000
1st Quartile	1.0925
Median	2.1500
3rd Quartile	4.7750
Maximum	44.4000

95% Confidence Interval for Mu	
2.0227	8.3652

95% Confidence Interval for Sigma	
7.8657	12.4822

95% Confidence Interval for Median	
1.2000	3.1420

Figure 21: Arctic, pH



Variable: pH

Anderson-Darling Normality Test

A-Squared:	2.929
P-Value:	0.000
Mean	7.79591
StDev	0.44747
Variance	0.200229
Skewness	-2.49986
Kurtosis	8.47501
N	44
Minimum	6.00000
1st Quartile	7.71000
Median	7.81500
3rd Quartile	8.01500
Maximum	8.50000

95% Confidence Interval for Mu

7.65987	7.93195

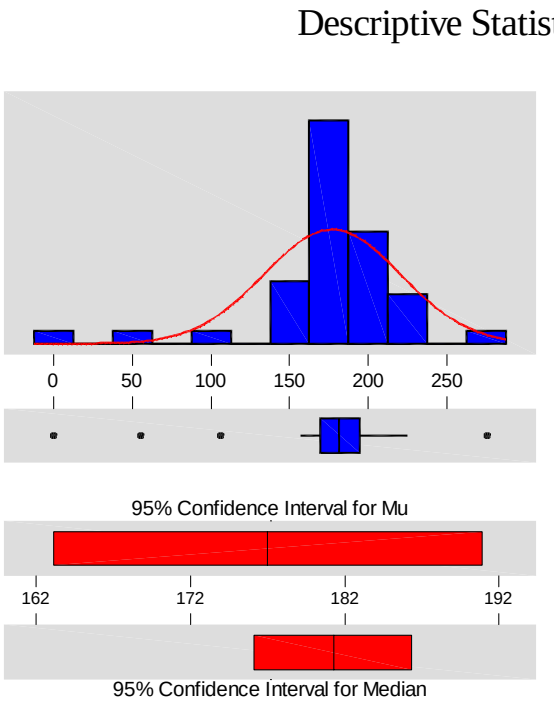
95% Confidence Interval for Sigma

0.36971	0.56696

95% Confidence Interval for Median

7.76045	7.94955

Figure 22: Arctic, Conductivity



Variable: cond(mS/cm)

Anderson-Darling Normality Test

A-Squared:	3.308
P-Value:	0.000
Mean	177.020
StDev	43.448
Variance	1887.74
Skewness	-2.10362
Kurtosis	7.98007
N	40
Minimum	0.000
1st Quartile	169.400
Median	181.300
3rd Quartile	194.275
Maximum	275.600

95% Confidence Interval for Mu

163.125	190.915

95% Confidence Interval for Sigma

35.591	55.789

95% Confidence Interval for Median

176.104	186.326

Figure 23: Arctic, Turbidity

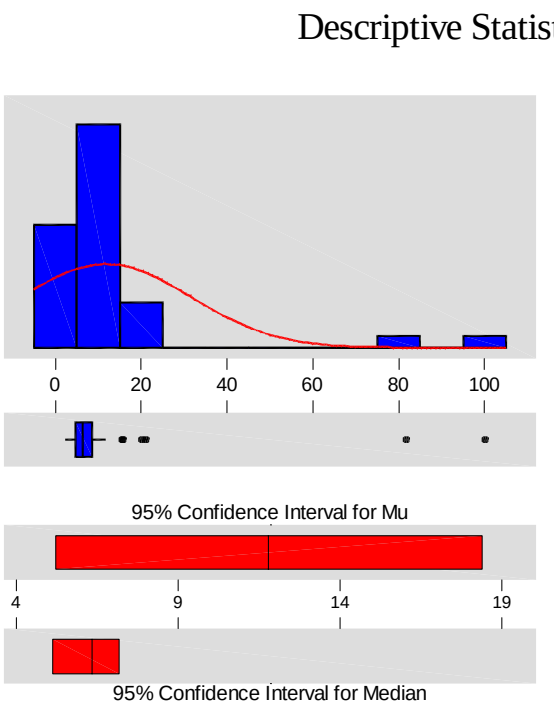


Figure 24: Arctic, TSS

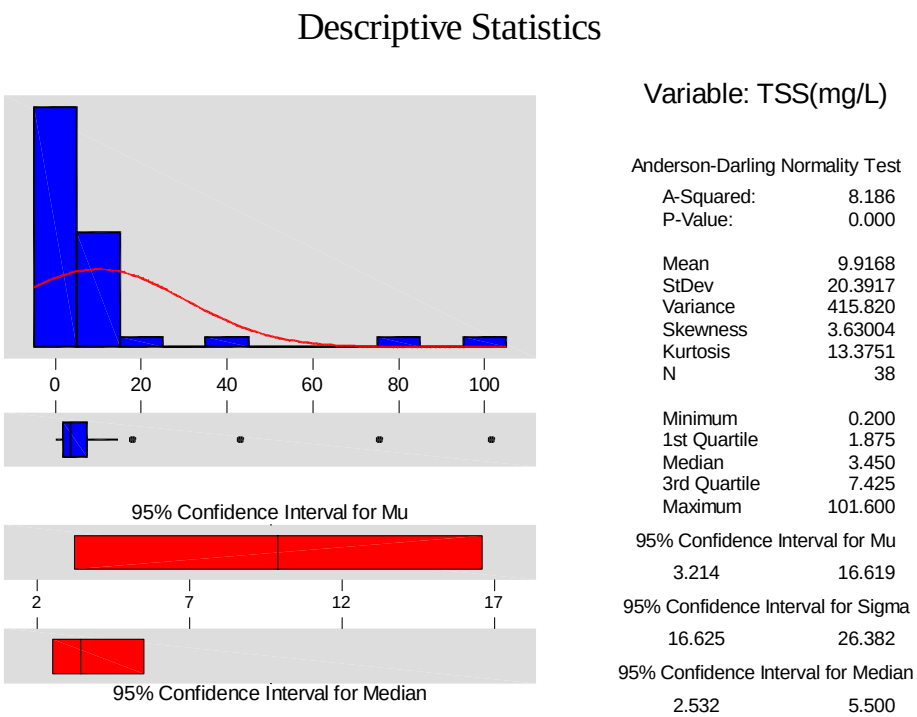
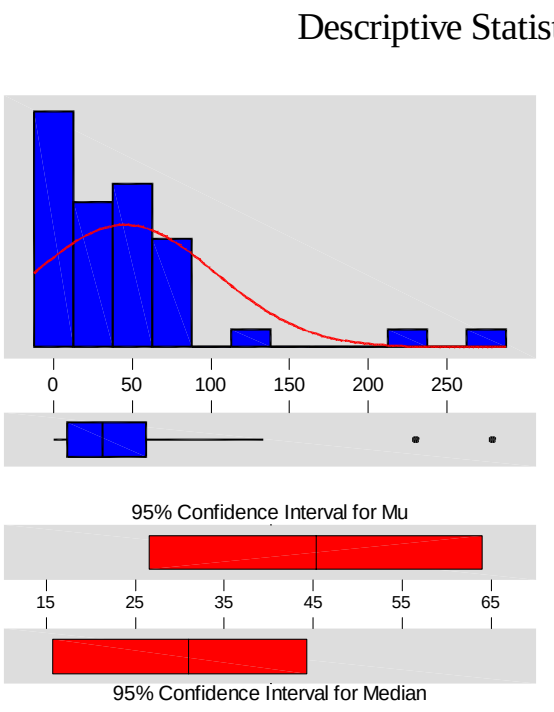


Figure 25: Arctic, FC



Variable: FC

Anderson-Darling Normality Test

A-Squared:	3.410
P-Value:	0.000
Mean	45.3077
StDev	57.7741
Variance	3337.85
Skewness	2.72498
Kurtosis	8.50172
N	39
Minimum	0.000
1st Quartile	9.000
Median	31.000
3rd Quartile	59.000
Maximum	279.000

95% Confidence Interval for Mu

26.579	64.036

95% Confidence Interval for Sigma

47.216	74.458

95% Confidence Interval for Median

15.767	44.233

APPENDIX G.

QA/QC Procedures and Results

Gas Test Results for Verifying FC Colonies

Purpose: To verify typical blue colonies as fecal or non-fecal coliform bacteria for quality control purposes. A variety of colony colors have been found on plates, these were also tested. Specifically, most of the tests performed were to determine if the pink colonies found on many of our FC plates were fecal coliform colonies.

Methods and Measurements: The methods used were according to those found in Standard Methods for the Examination of Water and Wastewater. Typical colonies of a particular color are picked from a single membrane filter and examined for the production of gas.

First Lauryl Tryptose Broth is inoculated with the picked colony and incubated at 35 degrees Celsius for 24 hours and checked for gas production. The same culture tube is incubated at the same temperature for an additional 24 hours to be checked for the production of gas. At this point, the colonies are transferred to EC broth and incubated at 35 degrees for 24 hours and checked for gas production. Those whom produce gas in both the Lauryl Tryptose Broth and EC Broth are a verified FC colony.

Results: A total of 49 tests were done on 3 typical blue, 24 pink from a countable plate, 17 pinks from a tntc plate, 2 yellow/green, and 5 yellow colonies. The results are below in Table 1.

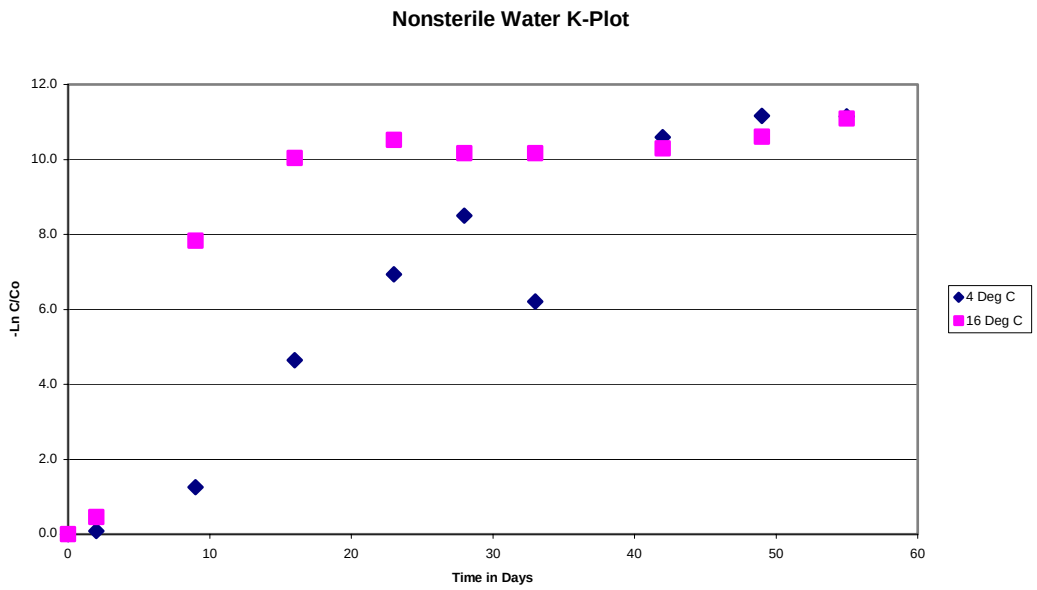
Table 1

Colony Color	Positive FC	Negative FC	**%FC**
Blue	3	0	100
Yellow	4	1	80
Yellow/Green	2	0	100
Pink on a Countable Plate	3	21	13
Pink on a tntc Plate	6	11	35

Discussion: Based on the results shown in Table One more tests should be done on yellow, yellow/green, and blue colonies to statistically validate % values found. From these results it is evident that pink colonies are not consisitently identified as fecal.

APPENDIX H.

Decay Rate Constant k Data Summary



Raw Data

Day #	4C ln C/C0	16C ln C/Co
0	0.00E+00	0.00E+00
2	8.46E-02	4.55E-01
9	1.26E+00	7.83E+00
16	4.65E+00	1.00E+01
23	6.93E+00	1.05E+01
28	8.50E+00	1.02E+01
33	6.20E+00	1.02E+01
42	1.06E+01	1.03E+01
49	1.12E+01	1.06E+01
55	1.11E+01	1.11E+01

Date 7/14/2004 Dry Weather

Field

Site	pH	Turb	temp	cond	Stage
1FR1	7.6	0.37	7.8	96.5	
5UAA1	8	1.31	16.3	211	
10A1	8.5	5.54	13.8	237	

FC

Site	Sample#	FC	Volume	FC/100 ml	Sample Name
1FR1	1	0	100	0	1FR1_WS1_071404
1FR1	2	0	100	0	1FR1_WS2_071404
1FR1	3	0	100	0	1FR1_WS3_071404
5UAA1	1	85	100	85	5UAA1_WS1_071404
5UAA1	2	100	100	100	5UAA1_WS2_071404
5UAA1	3	85	100	85	5UAA1_WS3_071404
10A1	1	5	100	5	10A1_WS1_071404
10A1	2	1	100	1	10A1_WS2_071404
10A1	3	20	100	20	10A1_WS3_071404
BLANK	1	0	100	0	BLANK_071404

Date 7/9/2004 Dry Weather

Field Samples

Site	pH	Turb. (NTU	Temp ©	Cond. (*mS*	Stage
5UAA1	7.74	1.81	18.3	318	

Fecal Coliform Colonies/100 ml

Site	Sample#	FC	Volume	FC/100 ml	Sample Name
5UAA1	1	24	100	24	5UAA1_WS1_070904
	2	20	100	20	5UAA1_WS2_070904
	3	15	100	15	5UAA1_WS3_070904

Date 7/21/2004 Dry weather

Field Samples

Site	pH	Turb	Temp	Cond	Stage
1FR1	7.5	0.75	8.3	98.3	0.6
5UAA1	8.2	1.23	15.3	212	0.51
10A1	8.2	5.18	14.3	237	2.02

Fecal Coliform

Site	sample #	FC	Filter Volur	FC/100ml	Sample Name
1FR1	1	0	100	0	1FR1_WS1_072104
1FR1	2	3	100	3	1FR1_WS2_072104
1FR1	3	2	100	2	1FR1_WS3_072104
5UAA1	1	166	100	166	5UAA1_WS1_072104
5UAA1	2	186	100	186	5UAA1_WS2_072104
5UAA1	3	184	100	184	5UAA1_WS3_072104
10A1	1	65	100	65	10A1_WS1_072104
10A1	2	67	100	67	10A1_WS2_072104
10A1	3	67	100	67	10A1_WS3_072104

Date 7/28/2004 rain showers during the night

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.2	0.73	7.9	90.1	0.62	0.4
5UAA1	7.1	4.1	15.2	183.9	0.6	3.8
10A1	7.2	21.2	14.2	194.4	2.16	14.6

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	2	100	2	1FR1_WS1_072804
1FR1	2	1	100	1	1FR1_WS2_072804
1FR1	3	0	100	0	1FR1_WS3_072804
5UAA1	1	4	20	20	5UAA1_WS1_072804
5UAA1	2	4	20	20	5UAA1_WS2_072804
5UAA1	3	4	20	20	5UAA1_WS3_072804

10A1	1	7	40	18	10A1_WS1_072804
10A1	2	24	42	57	10A1_WS2_072804
10A1	3	21	40	53	10A1_WS3_072804

Date 8/03/2004 Dry weather

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.2	1.53	8.6	93	0.58	1
5UAA1	7.9	1.57	15.5	186.9	0.5	2.5
10A1	8.3	5.91	14	209	2.02	2.9

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	0	100	0	1FR1_WS1_080304
1FR1	2	1	100	1	1FR1_WS2_080304
1FR1	3	3	100	3	1FR1_WS3_080304
5UAA1	1	23	20	115	5UAA1_WS1_080304
5UAA1	2	39	50	78	5UAA1_WS2_080304
5UAA1	3	91	100	91	5UAA1_WS3_080304
10A1	1	6	20	30	10A1_WS1_080304
10A1	2	25	50	50	10A1_WS2_080304
10A1	3	45	100	45	10A1_WS3_080304

Date 8/11/04 Dry weather

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.6	1.6	9	96.2	0.56	
5UAA1	7.4	1.3	16.8	199.3	0.48	
10A1	8.1	4.98	14.3	218	2	

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	6	100	6	1FR1_WS1_081104
1FR1	2	4	100	4	1FR1_WS2_081104
1FR1	3	3	100	3	1FR1_WS3_081104
5UAA1	1	20	40	50	5UAA1_WS1_081104
5UAA1	2	3	40	7.5	5UAA1_WS2_081104
5UAA1	3	14	40	35	5UAA1_WS3_081104
10A1	1	40	100	40	10A1_WS1_081104
10A1	2	34	100	34	10A1_WS2_081104
10A1	3	33	100	33	10A1_WS3_081104
BLANK		0	100	0	BLANK_081104

Date 8/18/04 Dry Weather

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.7	1.74	8.8	96.5	0.56	6.1
5UAA1	7.9	2.04	16	200	0.48	2
10A1	8	3.93	14	219	2	3.5

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	20	100	20	1FR1_WS1_081804
1FR1	2	20	100	20	1FR1_WS2_081804
1FR1	3	22	100	22	1FR1_WS3_081804
5UAA1	1	36	100	36	5UAA1_WS1_081804
5UAA1	2	22	100	22	5UAA1_WS2_081804
5UAA1	3	31	100	31	5UAA1_WS3_081804
10A1	1	228	100	228	10A1_WS1_081804
10A1	2	292	100	292	10A1_WS2_081804
10A1	3	316	100	316	10A1_WS3_081804
BLANK		0	100	0	BLANK_081804

Date 8/25/04 still dry weather

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.9	1.5	8	94.5	0.54	2
5UAA1	7.8	1.42	15.3	199.1	0.47	0.7
10A1	8.1	5.96	13.2	216	1.96	7.8

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	13	20	65	1FR1_WS1_082504
1FR1	2	86	50	172	1FR1_WS2_082504
1FR1	3	147	100	147	1FR1_WS3_082504
5UAA1	1	69	20	345	5UAA1_WS1_082504
5UAA1	2	183	50	366	5UAA1_WS2_082504
5UAA1	3	276	100	276	5UAA1_WS3_082504
10A1	1	7	20	35	10A1_WS1_082504
10A1	2	43	50	86	10A1_WS2_082504
10A1	3	83	100	83	10A1_WS3_082504
BLANK		0	100	0	Blank_082504

Date 9/1/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.3	0.92	7.8	92.8	0.59	1.5
5UAA1	6.3	2.57	13.1	160.9	0.53	1
10A1	7.6	3.43	12.2	200	2.18	2

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	6	20	30	1FR1_WS1_090104
1FR1	2	8	50	16	1FR1_WS2_090104
1FR1	3	12	100	12	1FR1_WS3_090104
5UAA1	1	6	20	30	5UAA1_WS1_090104
5UAA1	2	18	50	36	5UAA1_WS2_090104
5UAA1	3	34	100	34	5UAA1_WS3_090104
10A1	1	0	20	0	10A1_WS1_090104
10A1	2	0	50	0	10A1_WS2_090104
10A1	3	0	100	0	10A1_WS3_090104
BLANK		0	100	0	Blank_090104

Dater 9/8/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7	0.63	4.5	84.2	0.54	0.8
5UAA1	6.4	1.91	11	145.4	0.47	1.1
10A1	7.6	3.88	9.2	198.4	1.96	2.3

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	0	20	0	1FR1_WS1_090804
1FR1	2	5	50	10	1FR1_WS2_090804
1FR1	3	5	100	5	1FR1_WS3_090804
5UAA1	1	10	20	50	5UAA1_WS1_090804
5UAA1	2	30	50	60	5UAA1_WS2_090804
5UAA1	3	53	100	53	5UAA1_WS3_090804
10A1	1	11	20	55	10A1_WS1_090804
10A1	2	27	50	54	10A1_WS2_090804
10A1	3	46	100	46	10A1_WS3_090804
BLANK		0	100	0	Blank_090804

Date 9/16/2004 Dry and very cool weather. Mornings are frosty.

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.1	0.5	2.2	78.5	0.58	0.7
5UAA1	7.1	4.13	9	157.6	0.46	5.9
10A1	7.5	3.84	7.3	192.5	2.02	2

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	0	20	0	1FR1_WS1_091604
1FR1	2	3	50	6	1FR1_WS2_091604
1FR1	3	9	100	9	1FR1_WS3_091604
5UAA1	1	8	20	40	5UAA1_WS1_091604
5UAA1	2	12	50	24	5UAA1_WS2_091604
5UAA1	3	37	100	37	5UAA1_WS3_091604
10A1	1	15	20	75	10A1_WS1_091604

10A1	2	38	50	76	10A1_WS2_091604
10A1	3	56	100	56	10A1_WS3_091604
BLANK		0	100	0	Blank_091604

Date 9/22/2004 Rain throughout the day of sampling, previous days clear and cold

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.3	3.02	5	83.2	0.64	3.3
5UAA1	6.8	55.2	8.3	123.8	0.64	42.6
10A1	6	100	8.3	55.2	3.4	101.6

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	17	20	85	1FR1_WS1_092204
1FR1	2	50	50	100	1FR1_WS2_092204
1FR1	3	79	80	99	1FR1_WS3_092204
5UAA1	1	87	20	435	5UAA1_WS1_092204
5UAA1	2	160	50	320	5UAA1_WS2_092204
5UAA1	3	TNTC	100	TNTC	5UAA1_WS3_092204
10A1	1	0	20	0	10A1_WS1_092204
10A1	2	0	50	0	10A1_WS2_092204
10A1	3	0	100	0	10A1_WS3_092204
BLANK		0	100	0	Blank_092204

Date 9/29/04 Rain during sampling..all locations.garbage @arctic, fish @FR, heavy flows all around. Lots of leaves

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7	2.62	2.8	73.7	0.68	0.3
5UAA1	6.8	20.2	5.3	107.4	0.82	4.4
10A1	6.2	20.2	5.1	106.2	3.08	17.7

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	0	20	0	1FR1_WS1_092904
1FR1	2	0	50	0	1FR1_WS2_092904
1FR1	3	3	100	3	1FR1_WS3_092904
5UAA1	1	18	20	90	5UAA1_WS1_092904
5UAA1	2	17	52	33	5UAA1_WS2_092904
5UAA1	3	0	100	0	5UAA1_WS3_092904
10A1	1	0	20	0	10A1_WS1_092904
10A1	2	0	50	0	10A1_WS2_092904
10A1	3	0	100	0	10A1_WS3_092904
BLANK		0	100	0	Blank_092904

Date 10/05/04

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.7	1.06	4	66.5	0.84	0.6
5UAA1	7.42	6.34	5.9	135.6	0.68	1.7
10A1	7.52	5.11	6.5	193.7	2.46	1.8

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	5	100	5	1FR1_WS1_100504
1FR1	2	3	50	6	1FR1_WS2_100504
1FR1	3	4	20	20	1FR1_WS3_100504
5UAA1	1	15	100	15	5UAA1_WS1_100504
5UAA1	2	10	50	20	5UAA1_WS2_100504
5UAA1	3	2	20	10	5UAA1_WS3_100504
10A1	1	32	100	32	10A1_WS1_100504
10A1	2	8	50	16	10A1_WS2_100504
10A1	3	0	20	0	10A1_WS3_100504
BLANK		0	100	0	Blank_100504

Date 10/13/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.65	0.59	3.2	66.9	0.8	0.7
5UAA1	7.53	3.68	6	142.8	0.62	1.2
10A1	7.7	6.26	6.1	187.6	2.44	3.8

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	1	22	5	1FR1_WS1_101304
1FR1	2	1	50	2	1FR1_WS2_101304
1FR1	3	5	100	5	1FR1_WS3_101304
5UAA1	1	0	20	0	5UAA1_WS1_101304
5UAA1	2	1	50	2	5UAA1_WS2_101304

5UAA1	3	0	100	0	5UAA1_WS3_101304
10A1	1	1	20	5	10A1_WS1_101304
10A1	2	9	50	18	10A1_WS2_101304
10A1	3	5	100	5	10A1_WS3_101304
BLANK		0	100		Blank_101304

Date 10/20/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.81	0.59	2.2	67.6	0.72	-
5UAA1	7.7	5.22	4.6	137	0.64	0.4
10A1	7.75	5.29	4.9	184.5	2.47	2.9

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	2	100	2	1FR1_WS1_102004
1FR1	2	1	100	1	1FR1_WS2_102004
1FR1	3	0	100	0	1FR1_WS3_102004
5UAA1	1	4	100	4	5UAA1_WS1_102004
5UAA1	2	2	71	3	5UAA1_WS2_102004
5UAA1	3	1	90	1	5UAA1_WS3_102004
10A1	1	5	100	5	10A1_WS1_102004
10A1	2	14	100	14	10A1_WS2_102004
10A1	3	18	100	18	10A1_WS3_102004
BLANK		0			Blank_102004

Date 10/27/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.86	0.83	2.5	67.6	0.7	0.6
5UAA1	7.9	6.91	3.8	132.9	0.66	3.2
10A1	7.96	7.18	4.5	160.5	2.47	6

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	2	100	2	1FR1_WS1_102704
1FR1	2	2	100	2	1FR1_WS2_102704
1FR1	not taken	-	-	-	1FR1_WS3_102704
5UAA1	1	29	100	29	5UAA1_WS1_102704
5UAA1	2	32	100	32	5UAA1_WS2_102704
5UAA1	3	36	100	36	5UAA1_WS3_102704
10A1	1	99	100	99	10A1_WS1_102704
10A1	2	67	100	67	10A1_WS2_102704
10A1	3	18	100	18	10A1_WS3_102704
BLANK		0	100	0	Blank_102704

Date 11/03/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.8	3.67	0.1	39.7	1.38	
5UAA1	7.7	6.47	2.9	132.5	0.56	-
10A1	7.77	7.15	2.7	180	2.3	-

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	2	100	2	1FR1_WS1_110304
1FR1	2	5	100	5	1FR1_WS2_110304
1FR1	3	2	100	2	1FR1_WS3_110304
5UAA1	1	35	100	35	5UAA1_WS1_110304
5UAA1	2	36	100	36	5UAA1_WS2_110304
5UAA1	3	34	100	34	5UAA1_WS3_110304
10A1	1	39	100	39	10A1_WS1_110304
10A1	2	38	100	38	10A1_WS2_110304
10A1	3	24	100	24	10A1_WS3_110304
BLANK		0	100	0	Blank_110304

Date 11/10/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.63	1.33	1.4	63.3	0.66	1.5
UL1	7.68	9.81	2.1	117.4	-	7.2
UL2	7.6	3.05	1.6	127.7	-	0.4
5UAA1	7.72	4.19	2.2	183.8	0.57	1.2
10A1	7.81	6.71	2.9	182.5	2.4	1.9

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	9	100	9	1FR1_WS1_111004
1FR1	2	1	100	1	1FR1_WS2_111004

1FR1	3	2	100	2	1FR1_WS3_111004
UL1	1	30	100	30	UL1_WS1_111004
UL1	2	49	100	49	UL1_WS2_111004
UL1	3	35	100	35	UL1_WS3_111004
UL2	1	18	100	18	UL2_WS1_111004
UL2	2	20	100	20	UL2_WS2_111004
UL2	3	14	100	14	UL2_WS3_111004
5UAA1	1	15	100	15	5UAA1_WS1_111004
5UAA1	2	21	100	21	5UAA1_WS2_111004
5UAA1	3	12	100	12	5UAA1_WS3_111004
10A1	1	27	100	27	10A1_WS1_111004
10A1	2	31	100	31	10A1_WS2_111004
10A1	3	34	100	34	10A1_WS3_111004
BLANK		0	100	0	Blank_111004

Date 11/17/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.7	1.1	0.9	60.4	0.6	
UL1	7.71		2.8	183.1	2.3	9.3
UL2	7.73		2.5	143.4	0.56	0.8
5UAA1	7.78		2.6	126.6		4.7
10A1	7.63		2.1	133.7		3.2

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	9	100	9	1FR1_WS1_111704
1FR1	2	9	100	9	1FR1_WS2_111704
1FR1	3	2	100	2	1FR1_WS3_111704
UL1	1	31	100	31	UL1_WS1_111704
UL1	2	75	100	75	UL1_WS2_111704
UL1	3	56	100	56	UL1_WS3_111704
UL2	1	7	100	7	UL2_WS1_111704
UL2	2	22	100	22	UL2_WS2_111704
UL2	3	11	100	11	UL2_WS3_111704
5UAA1	1	7	100	7	5UAA1_WS1_111704
5UAA1	2	2	100	2	5UAA1_WS2_111704
5UAA1	3	2	100	2	5UAA1_WS3_111704
10A1	1	2	100	2	10A1_WS1_111704
10A1	2	6	100	6	10A1_WS2_111704
10A1	3	9	100	9	10A1_WS3_111704
BLANK		0	100	0	Blank_111704

Date 11/24/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.89		1.1	69.5	0.6	0.5
UL1	7.96		2.1	127.8	N/A	3.4
UL2	7.76		9.2	132.5	N/A	N/V
5UAA1	7.87		2.7	138.6	0.57	1
10A1	7.92		2.5	180.8	2.29	3

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	4	100	4	1FR1_WS1_112404
1FR1	2	8	100	8	1FR1_WS2_112404
1FR1	3	7	100	7	1FR1_WS3_112404
UL1	1	68	100	68	UL1_WS1_112404
UL1	2	78	100	78	UL1_WS2_112404
UL1	3	67	100	67	UL1_WS3_112404
UL2	1	13	100	13	UL2_WS1_112404
UL2	2	12	100	12	UL2_WS2_112404
UL2	3	15	100	15	UL2_WS3_112404
5UAA1	1	9	100	9	5UAA1_WS1_112404
5UAA1	2	8	100	8	5UAA1_WS2_112404
5UAA1	3	10	100	10	5UAA1_WS3_112404
10A1	1	0	100	0	10A1_WS1_112404
10A1	2	2	100	2	10A1_WS2_112404
10A1	3	7	100	7	10A1_WS3_112404
BLANK		0	100	0	Blank_112404

Date 12/1/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.93		2.2	67.7	0.64	2.9
UL1	7.78	23.7	3.1	163.7		17.25
UL2	7.74	18.9	5.4	143.6		8
5UAA1	7.66	137	5.9	238	0.7	90.6
10A1	7.82	81.8	3.5	275.6	2.5	44.75

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name	Comments
1FR1	1	0	47	0	1FR1_WS1_120104	
1FR1	2	1	50	2	1FR1_WS2_120104	
1FR1	3	0	82	0	1FR1_WS3_120104	
UL1	1	0	20	0	UL1_WS1_120104	
UL1	2	2	50	4	UL1_WS2_120104	
UL1	3	11	100	11	UL1_WS3_120104	
UL2	1	8	20	40	UL2_WS1_120104	
UL2	2	47	50	94	UL2_WS2_120104	
UL2	3	95	100	95	UL2_WS3_120104	
5UAA1	1	17	20	85	5UAA1_WS1_120104	
5UAA1	2	57	50	114	5UAA1_WS2_120104	
5UAA1	3	76	100	76	5UAA1_WS3_120104	
10A1	1	10	20	50	10A1_WS1_120104	
10A1	2	40	50	80	10A1_WS2_120104	
10A1	3	95	100	95	10A1_WS3_120104	
BLANK		0	100	0	Blank_120104	

Date 12/8/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.59	1.14	0	65.8	N/A	0.4
UL1	7.71	6.69	1.1	129.3	N/A	7.2
UL2	7.74	6.58	1.4	136.9	N/A	2.1
5UAA1	7.69	7.39	1.5	142.6	0.6	3.1
10A1	7.61	9.04	3.3	178.8	2.4	7.3

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	1	100	1	1FR1_WS1_120804
1FR1	2	1	100	1	1FR1_WS2_120804
1FR1	3	0	100	0	1FR1_WS3_120804
UL1	1	0	100	0	UL1_WS1_120804
UL1	2	0	100	0	UL1_WS2_120804
UL1	3	0	100	0	UL1_WS3_120804
UL2	1	59	100	59	UL2_WS1_120804
UL2	2	TNTC	100	TNTC	UL2_WS2_120804
UL2	3	37	100	37	UL2_WS3_120804
5UAA1	1	12	100	12	5UAA1_WS1_120804
5UAA1	2	40	100	40	5UAA1_WS2_120804
5UAA1	3	47	100	47	5UAA1_WS3_120804
10A1	1	28	100	28	10A1_WS1_120804
10A1	2	19	100	29	10A1_WS2_120804
10A1	3	34	100	34	10A1_WS3_120804
BLANK		0	100	0	Blank_120804

Date 12/15/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.52	1.78	2.7	70.6	N/A	N/A
UL1	7.48	3.07	1.7	127.5	N/A	5.3
UL2	7.34	2.75	1.3	132	N/A	0.53
5UAA1	7.47	3.1	1.6	137.6	0.58	7.68
10A1	7.53	8.77	1.9	178.4	N/A	3.5

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	0	90	0	1FR1_WS1_121504
1FR1	2	0	100	0	1FR1_WS2_121504
1FR1	3	0	100	0	1FR1_WS3_121504
UL1	1	69	100	69	UL1_WS1_121504
UL1	2	76	100	76	UL1_WS2_121504
UL1	3	53	100	53	UL1_WS3_121504
UL2	1	37	95	39	UL2_WS1_121504
UL2	2	26	95	27	UL2_WS2_121504
UL2	3	23	100	23	UL2_WS3_121504
5UAA1	1	22	100	22	5UAA1_WS1_121504
5UAA1	2	13	100	13	5UAA1_WS2_121504
5UAA1	3	20	100	20	5UAA1_WS3_121504
10A1	1	48	100	48	10A1_WS1_121504
10A1	2	49	100	49	10A1_WS2_121504
10A1	3	46	100	46	10A1_WS3_121504
BLANK		0	100		Blank_121504

Date 12/22/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)

1FR1	7.5	5.35	0	48.3	N/A	11.9
UL1	7.7	3.55	1.8	124.9	N/A	4.6
UL2	7.6	1.91	1.5	128.7	N/A	0.2
5UAA1	7.78	2.22	1.8	134.1	N/A	1.2
10A1	7.81	7.98	2.3	177.4	N/A	8

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	59	100	59	1FR1_WS1_122204
1FR1	2	58	100	58	1FR1_WS2_122204
1FR1	3	51	100	51	1FR1_WS3_122204
UL1	1	0	100	0	UL1_WS1_122204
UL1	2	0	50	0	UL1_WS2_122204
UL1	3	0	100	0	UL1_WS3_122204
UL2	1	27	100	27	UL2_WS1_122204
UL2	2	14	100	14	UL2_WS2_122204
UL2	3	23	100	23	UL2_WS3_122204
5UAA1	1	20	100	20	5UAA1_WS1_122204
5UAA1	2	10	100	10	5UAA1_WS2_122204
5UAA1	3	13	100	13	5UAA1_WS3_122204
10A1	1	0	100	0	10A1_WS1_122204
10A1	2	0	100	0	10A1_WS2_122204
10A1	3	0	100	0	10A1_WS3_122204
BLANK		0	100	0	Blank_122204

Date 12/29/2004

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1						
UL1						
UL2						
5UAA1						
10A1						

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	11	100		1FR1_WS1_122904
1FR1	2	7	100		1FR1_WS2_122904
1FR1	3	7	100		1FR1_WS3_122904
UL1	1	0	100		UL1_WS1_122904
UL1	2	0	100		UL1_WS2_122904
UL1	3	0	100		UL1_WS3_122904
UL2	1	48	100		UL2_WS1_122904
UL2	2	31	100		UL2_WS2_122904
UL2	3	35	100		UL2_WS3_122904
5UAA1	1	1	100		5UAA1_WS1_122904
5UAA1	2	0	100		5UAA1_WS2_122904
5UAA1	3	7	100		5UAA1_WS3_122904
10A1	1	1	100		10A1_WS1_122904
10A1	2	0	100		10A1_WS2_122904
10A1	3	0	100		10A1_WS3_122904
BLANK		0	100		Blank_122904

Date 1/5/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.88	1.37	0.4	60.1		2.037
UL1	7.76	9.46	1.1	116.1		13.1
UL2	7.66	15.5	1.1	140.4		8.2
5UAA1	7.75	14.1	1.4	143.4	0.68	14
10A1	7.76	15.8	1.2	170.6	2.46	8.5

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml		Sample Name
1FR1	1	12	100	12		1FR1_WS1_010505
1FR1	2	10	100	10		1FR1_WS2_010505
1FR1	3	13	100	13		1FR1_WS3_010505
UL1	1	0	100	tntc		UL1_WS1_010505
UL1	2	0	70	tntc		UL1_WS2_010505
UL1	3	0	100	tntc		UL1_WS3_010505
UL2	1	0	100	tntc		UL2_WS1_010505
UL2	2	0	100	tntc		UL2_WS2_010505
UL2	3	0	100	tntc		UL2_WS3_010505
5UAA1	1	0	100	tntc		5UAA1_WS1_010505
5UAA1	2	0	100	tntc		5UAA1_WS2_010505
5UAA1	3	0	100	tntc		5UAA1_WS3_010505
10A1	1	0	100	tntc		10A1_WS1_010505
10A1	2	0	100	tntc		10A1_WS2_010505
10A1	3	0	100	tntc		10A1_WS3_010505
BLANK		0	100			Blank_010505

Date 1/12/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	8.8	1.03	0	3.2		0.4
UL1	8.25	3.93	0	0.4		3.1
UL2	7.84	4.16	0.6	0.5		1.2
5UAA1	7.9	4.05	0.3	0.9		1.4
10A1	8.02	4.63	0	0.9		1.2

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	8	100	8	1FR1_WS1_011205
1FR1	2	6	100	6	1FR1_WS2_011205
1FR1	3	6	100	6	1FR1_WS3_011205
UL1	1	55	100	55	UL1_WS1_011205
UL1	2	33	100	33	UL1_WS2_011205
UL1	3	0	100	tntc	UL1_WS3_011205
UL2	1	33	100	33	UL2_WS1_011205
UL2	2	30	100	30	UL2_WS2_011205
UL2	3	37	100	37	UL2_WS3_011205
5UAA1	1	25	100	25	5UAA1_WS1_011205
5UAA1	2	26	100	26	5UAA1_WS2_011205
5UAA1	3	32	100	32	5UAA1_WS3_011205
10A1	1	21	100	21	10A1_WS1_011205
10A1	2	14	100	14	10A1_WS2_011205
10A1	3	11	100	11	10A1_WS3_011205
BLANK		0	100	0	Blank_011205

Date1/19/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.82	1	0.2	67.7		
UL1	7.84	2.12	0.5	121.3		
UL2	7.7	2.06	0.6	130.6		
5UAA1	7.83	2.19	0.5	133.4		
10A1	7.89	3.34	0	8.1		

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	1	100	1	1FR1_WS1_011905
1FR1	2	2	100	2	1FR1_WS2_011905
1FR1	3	2	100	2	1FR1_WS3_011905
UL1	1	64	100	64	UL1_WS1_011905
UL1	2	93	100	93	UL1_WS2_011905
UL1	3	50	100	50	UL1_WS3_011905
UL2	1	3	73	4	UL2_WS1_011905
UL2	2	19	100	19	UL2_WS2_011905
UL2	3	20	100	20	UL2_WS3_011905
5UAA1	1	22	100	22	5UAA1_WS1_011905
5UAA1	2	8	100	8	5UAA1_WS2_011905
5UAA1	3	8	100	8	5UAA1_WS3_011905
10A1	1	19	100	19	10A1_WS1_011905
10A1	2	23	100	23	10A1_WS2_011905
10A1	3	16	100	16	10A1_WS3_011905
BLANK		0	100	0	Blank_011905

Date 1/26/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.85	0.65	1.3	70.8		0.8
UL1	7.8	2.61	0.9	122.5		2
UL2	7.72	1.78	1	130.6		
5UAA1	7.78	1.83	0.5	134.4	0.52	0.2
10A1	7.77	6.43	0	158	2.2	5.5

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	1	100	1	1FR1_WS1_012605
1FR1	2	0	100	0	1FR1_WS2_012605
1FR1	3	0	100	0	1FR1_WS3_012605
UL1	1	TNTC	100	tntc	UL1_WS1_012605
UL1	2	70	50	tntc	UL1_WS2_012605
UL1	3	26	20	26	UL1_WS3_012605
UL1	4	21	100	21	UL1_WS4_012605
UL2	1	18	100	18	UL2_WS1_012605
UL2	2	10	100	10	UL2_WS2_012605
UL2	3	19	100	19	UL2_WS3_012605
UL2	4	9	100	9	UL2_WS4_012605

5UAA1	1	1	50	2	5UAA1_WS1_012605
5UAA1	2	3	50	6	5UAA1_WS2_012605
5UAA1	3	1	20	5	5UAA1_WS3_012605
10A1	1	76	96	76	10A1_WS1_012605
10A1	2	85	100	85	10A1_WS2_012605
10A1	3	44	50	88	10A1_WS3_012605
blank		0	100	l	Blank_012605

Date 2/1/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1NF1	8.84		2.1	220		
2NF2	8.56		4.6	239.3		

Date 2/2/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	8.01	0.87	0	36.1		1.5
UL1	8.25	7.77	0	1.3		3.6
UL2	7.75	1.66	0.5	125		1.5
5UAA1	7.8	1.85	0.2	128.4		0.7
10A1	7.95	2.28	0	0		0.5

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml		Sample Name
1FR1	1	1	100	1		1FR1_WS1_020205
1FR1	2	0	100	0		1FR1_WS2_020205
1FR1	3	1	100	1		1FR1_WS3_020205
UL1	1	39	20	tntc		UL1_WS1_020205
UL1	2	0	50	tntc		UL1_WS2_020205
UL1	3	0	100	tntc		UL1_WS3_020205
UL2	1	9	20	45		UL2_WS1_020205
UL2	2	32	50	64		UL2_WS2_020205
UL2	3	29	100	29		UL2_WS3_020205
UL2	4	28	50	56		UL2_WS4_020205
5UAA1	1	10	20	50		5UAA1_WS1_020205
5UAA1	2	0	50	0		5UAA1_WS2_020205
5UAA1	3	5	100	5		5UAA1_WS3_020205
5UAA1	4	8	50	16		5UAA1_WS4_020205
10A1	1	4	20	20		10A1_WS1_020205
10A1	2	tntc	50	tntc		10A1_WS2_020205
10A1	3	0	100	tntc		10A1_WS3_020205
blank		0	100	0		Blank_020205

Date 2/9/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.3		1.3	71.8		
UL1	7.79		1.4	120.9		
UL2	7.71		0.5	123.5		
5UAA1	7.84		0.8	143.9	0.54	
10A1	7.8		0	161.4		

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml		Sample Name
1FR1	1	2	100	2		1FR1_WS1_020905
1FR1	2	0	100	0		1FR1_WS2_020905
1FR1	3	0	100	0		1FR1_WS3_020905
UL1	1	0	100	tntc		UL1_WS1_020905
UL1	2	0	50	tntc		UL1_WS2_020905
UL1	3	49	20	tntc		UL1_WS3_020905
UL2	1	60	100	tntc		UL2_WS1_020905
UL2	2	45	50	90		UL2_WS2_020905
UL2	3	15	20	75		UL2_WS3_020905
5UAA1	1	30	100	tntc		5UAA1_WS1_020905
5UAA1	2	31	50	62		5UAA1_WS2_020905
5UAA1	3	4	20	20		5UAA1_WS3_020905
10A1	1	0	100	tntc		10A1_WS1_020905
10A1	2	0	50	tntc		10A1_WS2_020905
10A1	3	98	20	tntc		10A1_WS3_020905
BLANK		0	100	0		Blank_020905

Date 2/16/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.65	1.56	1.5	72.9		1.46
UL1	7.82	3.54	1.8	123.7		2.7
UL2	7.69	1.48	0.7	122.2		0.2
5UAA1	7.82	2.57	1	141	0.5	1.07

10A1	7.68	11.6	1.4	175.2	2.2	12.1

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	1	100	1	1FR1_WS1_021605
1FR1	2	5	100	5	1FR1_WS2_021605
1FR1	3	4	100	4	1FR1_WS3_021605
UL1	1	7	5	140	UL1_WS1_021605
UL1	2	0	20	tntc	UL1_WS2_021605
UL1	3	0	50	tntc	UL1_WS3_021605
UL2	1	0	5	0	UL2_WS1_021605
UL2	2	0	20	0	UL2_WS2_021605
UL2	3	8	50	16	UL2_WS3_021605
5UAA1	1	0	5	0	5UAA1_WS1_021605
5UAA1	2	0	20	0	5UAA1_WS2_021605
5UAA1	3	7	50	14	5UAA1_WS3_021605
10A1	1	9	5	180	10A1_WS1_021605
10A1	2	17	20	85	10A1_WS2_021605
10A1	3	14	50	28	10A1_WS3_021605
BLANK		0	100	0	Blank_021605

Date 2/23/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1						
UL1	8.12		2.2	125.1		3.8
UL2	7.89		1.2	123.2		0.5
5UAA1	8.15		1.7	128.8	0.5	0.6
10A1	8.15		1.9	166.6	2.1	1.6

Date 3/2/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
UL1	8.14	3.64	1.2	121.5		3.8
UL2	8.05	3.51	1.3	123.1		0.5
5UAA1	8.15	2.68	1.3	127.8	0.49	0.6
10A1	8.12	3.57	0.7	161.8	2.14	1.6

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
UL1	1	5	5	100	UL1_WS1_022305
UL1	2	21	20	105	UL1_WS2_022305
UL1	3	tntc	50	tntc	UL1_WS3_022305
UL2	1	5	5	100	UL2_WS1_022305
UL2	2	2	20	10	UL2_WS2_022305
UL2	3	16	50	32	UL2_WS3_022305
5UAA1	1	0	5	0	5UAA1_WS1_022305
5UAA1	2	1	20	5	5UAA1_WS2_022305
5UAA1	3	5	50	10	5UAA1_WS3_022305
10A1	1	0	5	0	10A1_WS1_022305
10A1	2	4	20	20	10A1_WS2_022305
10A1	3	6	50	12	10A1_WS3_022305
BLANK		0	100	0	Blank_022305

Date 3/9/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
UL1	7.94	14.4	2.7	154.7		16.5
UL2	7.85	7	1.6	132.7		2.4
5UAA1	7.97	10.3	2	162	0.54	10.3
10A1	7.89	15.7	2.9	224.5	2.16	5.5

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
UL1	1	5	5	100	UL1_WS1_030905
UL1	2	29	20	145	UL1_WS2_030905
UL1	3	47	50	94	UL1_WS3_030905
UL2	1	1	5	20	UL2_WS1_030905
UL2	2	9	20	45	UL2_WS2_030905
UL2	3	30	50	60	UL2_WS3_030905
5UAA1	1	1	5	20	5UAA1_WS1_030905
5UAA1	2	20	20	100	5UAA1_WS2_030905
5UAA1	3	15	50	30	5UAA1_WS3_030905
10A1	1	2	5	40	10A1_WS1_030905
10A1	2	13	20	65	10A1_WS2_030905
10A1	3	36	50	72	10A1_WS3_030905
BLANK	1	0	100	0	Blank_030905

Date 3/23/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	8.03	0.95	0.8	74	0.48	1.78
UL1	8.01	5.81	3.2	137.8		7.4
UL2	7.73	6.7	1.5	127.9		2.9
5UAA1	7.86	9.13	2.3	158	0.56	5.8
NF1	7.13	113	4	253.8		5
10A1	7.94	7.29	3.4	182.6	2.24	75.5

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	0	20	0	1FR1_WS1_032305
1FR1	2	0	50	0	1FR1_WS2_032305
1FR1	3	0	100	0	1FR1_WS3_032305
3UL1	1	1	20	5	UL1_WS1_032305
3UL1	2	3	50	6	UL1_WS2_032305
3UL1	3	25	100	25	UL1_WS3_032305
4UL1	1	1	20	5	UL2_WS1_032305
4UL1	2	6	50	12	UL2_WS2_032305
4UL1	3	6	100	6	UL2_WS3_032305
5UAA1	1	5	20	25	5UAA1_WS1_032305
5UAA1	2	15	50	30	5UAA1_WS2_032305
5UAA1	3	29	100	29	5UAA1_WS3_032305
10A1	1	0	20	0	10A1_WS1_032305
10A1	2	2	50	4	10A1_WS2_032305
10A1	3	17	100	17	10A1_WS3_032305
NF1	1	6	20	30	NF1_WS1_032305
NF1	2	24	50	48	NF1_WS2_032305
NF1	3	23	100	23	NF1_WS3_032305
Blank	1	0	100	0	Blank_032305

Date 3/30/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
UL1	7.86	4.72	1.5	131.1		
UL2	7.69	7.2	1.7	129.8		
5UAA1	7.91	6.33	2.1	145.9	0.54	
10A1	7.74	6.76	1.3	169	2.26	

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
UL1	1	12	20	60	UL1_WS1_033005
UL1	2	15	50	30	UL1_WS2_033005
UL1	3	9	100	9	UL1_WS3_033005
UL2	1	0	20	0	UL2_WS1_033005
UL2	2	0	50	18	UL2_WS2_033005
UL2	3	5	100	5	UL2_WS3_033005
5UAA1	1	0	20	0	5UAA1_WS1_033005
5UAA1	2	2	50	4	5UAA1_WS2_033005
5UAA1	3	4	100	4	5UAA1_WS3_033005
10A1	1	12	20	60	10A1_WS1_033005
10A1	2	27	50	54	10A1_WS2_033005
10A1	3	39	100	39	10A1_WS3_033005
BLANK	1	0	100	0	Blank_033005

Date 4/6/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
UL1	7.81	6.76	3.5	143.1		4.4
UL2	7.69	7.28	2.1	135.8		2.4
5UAA1	7.79	8.27	2.7	143.7	0.58	4.2
10A1	7.71	8.24	3.1	174.6	2.27	4.64
NF1	7.56	17	4.3	209		13.14

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
UL1	1	35	20	195	UL1_WS1_040605
UL1	2	89	50	178	UL1_WS2_040605
UL1	3	160	100	160	UL1_WS3_040605
UL2	1	2	20	10	UL2_WS1_040605
UL2	2	13	50	26	UL2_WS2_040605
UL2	3	10	100	10	UL2_WS3_040605
5UAA1	1	1	20	5	5UAA1_WS1_040605
5UAA1	2	4	50	8	5UAA1_WS2_040605
5UAA1	3	5	100	5	5UAA1_WS3_040605
10A1	1	0	20	0	10A1_WS1_040605
10A1	2	0	50	0	10A1_WS2_040605
10A1	3	9	100	9	10A1_WS3_040605

NF1	1	0	20	0	NF1_WS1_040605
NF1	2	0	50	0	NF1_WS2_040605
NF1	3	3	100	3	NF1_WS3_040605
Blank		0	100	0	Blank_040605

Date 4/13/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
UL1	7.59	4.85	2.8	135		1
UL2	7.46	12.3	2.9	129.6		5.4
5UAA1	7.62	11.5	3.4	135.7	0.7	2.6
10A1	7.72	6.33	3.1	156.8	2.44	1.8

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
UL1	1	18	20	90	UL1_WS1_041305
UL1	2	34	50	68	UL1_WS2_041305
UL1	3	0	100	tntc	UL1_WS3_041305
UL2	1	10	20	50	UL2_WS1_041305
UL2	2	33	50	66	UL2_WS2_041305
UL2	3	4	100	tntc	UL2_WS3_041305
5UAA1	1	3	20	15	5UAA1_WS1_041305
5UAA1	2	1	50	2	5UAA1_WS2_041305
5UAA1	3	55	100	55	5UAA1_WS3_041305
10A1	1	5	20	50	10A1_WS1_041305
10A1	2	23	50	46	10A1_WS2_041305
10A1	3	37	100	37	10A1_WS3_041305
blank		0	100	0	Blank_041305

Date 4/20/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.73	1.43	2.5	67.8	0.59	7.6
UL1	7.87	3.9	4.6	140.2		1.7
UL2	7.67	3.11	3.3	131.1		1.2
5UAA1	7.84	2.79	4.1	137.7	0.67	2.7
10A1	8.17	3.5	6.6	181.8	2.39	0.8

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	2	20	10	1FR1_WS1_042005
1FR1	2	2	50	4	1FR1_WS2_042005
1FR1	3	5	100	5	1FR1_WS3_042005
3UL1	1	6	10	60	UL1_WS1_042005
3UL1	2	17	50	34	UL1_WS2_042005
3UL1	3	23	100	23	UL1_WS3_042005
4UL1	1	0	20	0	UL2_WS1_042005
4UL1	2	0	50	0	UL2_WS2_042005
4UL1	3	0	100	0	UL2_WS3_042005
5UAA1	1	0	20	0	5UAA1_WS1_042005
5UAA1	2	0	50	0	5UAA1_WS2_042005
5UAA1	3	2	100	2	5UAA1_WS3_042005
10A1	1	2	20	20	10A1_WS1_042005
10A1	2	7	50	14	10A1_WS2_042005
10A1	3	36	100	36	10A1_WS3_042005
blank		0	100	0	Blank_042005

Date 4/27/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.83		3.6	68	0.58	
UL1	7.84		10.2	135.2		
UL2	7.54		5.6	126.8		
5UAA1	7.78		6.9	140.2	0.8	
10A1	7.89		6.7	174.6	2.52	

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	0	100	0	1FR1_WS1_042005
1FR1	2	0	100	0	1FR1_WS2_042005
1FR1	3	0	100	0	1FR1_WS3_042005
3UL1	1	62	20	310	UL1_WS1_042005
3UL1	2	129	50	258	UL1_WS2_042005
3UL1	3	tntc	100	tntc	UL1_WS3_042005
4UL1	1	6	20	30	UL2_WS1_042005
4UL1	2	16	50	32	UL2_WS2_042005
4UL1	3	41	100	41	UL2_WS3_042005
5UAA1	1	5	20	25	5UAA1_WS1_042005
5UAA1	2	15	50	30	5UAA1_WS2_042005

5UAA1	3	26	100	26	5UAA1_WS3_042005
10A1	1	2	20	10	10A1_WS1_042005
10A1	2	6	50	12	10A1_WS2_042005
10A1	3	19	100	19	10A1_WS3_042005
blank		0	100	0	Blank_042005

Date 5/4/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.95		3.9	62.9	0.74	
UL1	7.8		6	127.8		
UL2	7.62		9.2	146.1		
5UAA1	7.73		9.2	153.9	0.75	
10A1	7.81		8.5	194.6	2.42	

Date 5/11/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.81	1.8	4.6	62.9	0.8	4.6
UL1	7.88	2.4	7.8	131.9		2.6
UL2	7.95	1.9	11.1	218.8		1.3
5UAA1	8.06	2.5	11.5	168.8	0.74	2.3
10A1	8.1	4.6	10.2	198.9	2	5.3

contamination of weekly samples FC occurred this week

Date 5/18/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.91	1.4	5.1	65.2	0.8	3.4
UL1	7.86	2.5	7.9	128.2		2.7
UL2	8.05	1.8	10.6	145.9		0.7
5UAA1	8.09	2.2	11.2	156.3	0.72	1.9
10A1	8.33	3.8	11.3	193.9	2	1.1

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	0	20	0	1FR1_WS1_051905
1FR1	2	0	50	0	1FR1_WS2_051905
1FR1	3	0	100	0	1FR1_WS3_051905
3UL1	1	2	20	10	UL1_WS1_051905
3UL1	2	3	50	6	UL1_WS2_051905
3UL1	3	8	100	8	UL1_WS3_051905
4UL1	1	1	20	5	UL2_WS1_051905
4UL1	2	3	50	6	UL2_WS2_051905
4UL1	3	17	100	17	UL2_WS3_051905
5UAA1	1	11	20	55	5UAA1_WS1_051905
5UAA1	2	21	50	42	5UAA1_WS2_051905
5UAA1	3	52	100	52	5UAA1_WS3_051905
10A1	1	2	20	10	10A1_WS1_051905
10A1	2	4	50	8	10A1_WS2_051905
10A1	3	3	100	3	10A1_WS3_051905
blank		0	100	0	Blank_051905

Date 5/25/2005

Field Samples

Site	pH	turb	temp	cond	stage	TSS (mg/L)
1FR1	7.65	1.1	4.9	64.2	0.9	
UL1	7.76	3.8	7.8	117.9		
UL2	7.79	5	12.3	138.6		
5UAA1	7.89	3.9	10.8	146.1	0.76	
10A1	7.98	5.5	12.4	183.9	2	

Fecal Coliform

Site	sample #	FC	Filter Vol.	FC/100 ml	Sample Name
1FR1	1	1	100	1	1FR1_WS1_052505
1FR1	2	1	100	1	1FR1_WS2_052505
1FR1	3	1	100	1	1FR1_WS3_052505
3UL1	1	7	20	35	UL1_WS1_052505
3UL1	2	21	50	42	UL1_WS2_052505
3UL1	3	37	100	37	UL1_WS3_052505
4UL1	1	0	20	0	UL2_WS1_052505
4UL1	2	12	50	24	UL2_WS2_052505
4UL1	3	17	100	17	UL2_WS3_052505
5UAA1	1	5	20	25	5UAA1_WS1_052505
5UAA1	2	5	50	10	5UAA1_WS2_052505
5UAA1	3	25	100	25	5UAA1_WS3_052505
10A1	1	57	20	285	10A1_WS1_052505
10A1	2	87	50	174	10A1_WS2_052505

10A1	3	tntc	100	tntc	10A1_WS3_052505
blank	0		100	0	Blank_052505

APPENDIX J.

Transfer Log

Date	Time	Sample ID	Site ID	Sample Type	Sampler	Method	Notes
7/9/2004	9:00 AM	#1-12	5UAA1	FC	Tammie	Grab	Also took turb, cond,temp, pH
7/14/2004	10:00 AM	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond,temp, pH
7/14/2004	11:00 AM	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond,temp, pH
7/14/2004	12:00 AM	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond,temp, pH
7/14/2004	10:00 AM	Blank	LAB	FC	Tammie		
7/21/2004	10:00 AM	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond,temp, pH
7/21/2004	1:00 PM	#1-3 and #1-12	5UAA1	FC	Tammie	Grab	Also took turb, cond,temp, pH
7/21/2004	3:00 PM	#1-3 and #1-12	10A1	FC	Tammie	Grab	Also took turb, cond,temp, pH
7/21/2004	10:00 AM	Blank	LAB	FC	Tammie		
7/28/2004	10:00 AM	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond,temp,pH and TSS
7/28/2004	11:00 AM	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
7/28/2004	12:00 PM	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
7/28/2004	10:00 AM	Blank	LAB	FC	Tammie		
8/4/2004	11:00AM	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
8/4/2004	12:00 PM	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
8/4/2004	12:30 PM	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
8/4/2004	10:00 AM	Blank	LAB	FC	Tammie		
8/9/2004	1:00 PM	#1-6	A street bridge	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
8/11/2004	11:00 AM	#1-3	1FR1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
8/11/2004	12:00 PM	#1-3	5UAA1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
8/11/2004	1:00 PM	#1-3	10A1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
8/11/2004	12:30-5:00 PM	#1-19	ECH1	FC	Craig	Grab	Also took turb, cond, temp, pH and TSS
8/11/2004	12:30-5:00 PM	#1-19	ECH2	FC	Craig	Grab	Also took turb, cond, temp, pH and TSS
8/11/2004	12:30-5:00 PM	#1-19	ECH3	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
8/11/2004	12:30-5:00 PM	#1-19	ECH4	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
8/18/2004	10:00	#1-3	1FR1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
8/18/2004	11:00	#1-3	5UAA1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
8/18/2004	12:00	#1-3	10A1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
8/25/2004	10:00	#1-3	1FR1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
8/25/2004	11:00	#1-3	5UAA1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
8/25/2004	12:00	#1-3	10A1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
9/1/2004	12:05	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/1/2004	2:35	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/1/2004	2:50	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/8/2004	10:00	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/8/2004	11:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/8/2004	12:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS

9/16/2004	11:00	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/16/2004	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/16/2004	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/22/2004	11:00	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/22/2004	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/22/2004	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/24/2004	12:00	#1-3	EA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/24/2004	12:00	#1-3	EA2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/24/2004	12:00	#1-3	EA3	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/29/2004	10:00	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/29/2004	11:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
9/29/2004	12:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/1/2004	11:00	#1-6	ECH1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/1/2004	11:30	#1-6	ECH2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/1/2004	12:00	#1-6	NS1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/1/2004	12:30	#1-6	NS2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/1/2004	1:00	#1-6	EA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/1/2004	1:30	#1-6	EA2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/1/2004	2:00	#1-6	AC1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/1/2004	2:30	#1-6	AC2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/6/2004	10:00	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/6/2004	11:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/6/2004	12:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/13/2004	10:00	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/13/2004	11:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/13/2004	12:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/15/2004	11:00	#1-7	NOD	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/15/2004	11:30	#1-7	W/D	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/20/2004	10:00	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/20/2004	11:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/20/2004	12:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
10/27/2004	10:00	#1-3	1FR1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
10/27/2004	11:00	#1-3	5UAA1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
10/27/2004	12:00	#1-3	10A1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
11/3/2004	10:00	#1-3	1FR1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
11/3/2004	11:00	#1-3	5UAA1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
11/3/2004	12:00	#1-3	10A1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
11/10/2004	10:00	#1-3	1FR1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
11/10/2004	1:00	#1-3	UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
11/10/2004	1:30	#1-3	UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
11/10/2004	1:45	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
11/10/2004	11:00	#1-3	10A1	FC	Graham	Grab	Also took turb, cond, temp, pH and TSS
11/24/2004	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
11/24/2004	11:00	#1-3	UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
11/24/2004	11:30	#1-3	UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
11/24/2004	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
11/24/2004	12:30	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/1/2004	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS

12/1/2004	11:00	#1-3	UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/1/2004	11:30	#1-3	UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/1/2004	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/1/2004	12:30	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/8/2004	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/8/2004	11:00	#1-3	UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/8/2004	11:30	#1-3	UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/8/2004	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/8/2004	12:30	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/15/2004	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/15/2004	11:00	#1-3	UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/15/2004	11:30	#1-3	UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/15/2004	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/15/2004	12:30	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/22/2004	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/22/2004	11:00	#1-3	UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/22/2004	11:30	#1-3	UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/22/2004	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/22/2004	12:30	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
12/29/2004	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turbidity
12/29/2004	11:00	#1-3	UL1	FC	Tammie	Grab	Also took turbidity
12/29/2004	11:30	#1-3	UL2	FC	Tammie	Grab	Also took turbidity
12/29/2004	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turbidity
12/29/2004	12:30	#1-3	10A1	FC	Tammie	Grab	Also took turbidity
1/5/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/5/2005	11:00	#1-3	UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/5/2005	11:30	#1-3	UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/5/2005	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/5/2005	12:30	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/6/2005	4:00	#1-3	5UAA1	FC	Tammie	Grab	
1/11/2005	11:00	#1-8	5UAA1	FC	Tammie	Grab	
1/12/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	
1/12/2005	11:00	#1-3	UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/12/2005	11:30	#1-3	UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/12/2005	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/12/2005	12:30	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/19/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/19/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/19/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/19/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/19/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/26/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/26/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/26/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/26/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
1/26/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/1/2005	10:30	#1-6	1NF1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/1/2005	11:00	#1-6	2NF2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS

2/2/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/2/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/2/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/2/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/2/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/9/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/9/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/9/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/9/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/9/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/16/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/16/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/16/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/16/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/16/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/23/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/23/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/23/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/23/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
2/23/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/2/2005	10:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/2/2005	11:30	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/2/2005	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/2/2005	12:30	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/3/2005	12:30	#1-3	CA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/3/2005	12:45	#1-3	CA2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/3/2005	1:30	#1-3	2B1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/3/2005	1:45	#1-3	2B2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/9/2005	10:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/9/2005	11:30	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/9/2005	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/9/2005	12:30	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/10/2005	11:15	#1-3	DRL4	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/10/2005	11:15	#1-3	2B2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/10/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/14/2005	10:30	#1-3	2B2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/14/2005	10:30	#1-3	DRL4	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/14/2005	10:45	#1-3	DRL3	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/14/2005	10:50	#1-3	DRL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/14/2005	10:55	#1-3	DRL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/22/2005	10:30	#1-6	2B2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/22/2005	10:45	#1-6	DRL5	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/22/2005	11:00	#1-6	DRL4	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/22/2005	11:15	#1-6	DRL3	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/23/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/23/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/23/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/23/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS

3/23/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/30/2005	10:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/30/2005	11:30	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/30/2005	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
3/30/2005	12:30	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/6/2005	10:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/6/2005	11:30	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/6/2005	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/6/2005	12:30	#1-3	NF1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/6/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/13/2005	10:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/13/2005	11:30	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/13/2005	12:00	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/13/2005	12:30	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/19/2005	11:15	#1	5UAA1	survivability	Tammie	Grab	sample was sterilzed for innoculation in lab of E.C
4/20/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/20/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/20/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/20/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/20/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/27/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/27/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/27/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/27/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
4/27/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/4/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/4/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/4/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/4/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/4/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/10/2005	11:20	#1	5UAA1	survivability	Tammie	Grab	non-sterile survivability inoculated with E.Coli
5/11/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/11/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/11/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/11/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/11/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/19/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/19/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/19/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/19/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/19/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/21/2005	11:20	#1-3	NF1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/21/2005	11:35	#1-3	NF2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/21/2005	11:45	#1-3	NF3	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/21/2005	11:55	#1-3	NF4	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/25/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/25/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/25/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS

5/25/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/25/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/26/2005	11:20	#1-3	NF1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/26/2005	11:35	#1-3	NF2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/26/2005	11:45	#1-3	NF3	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
5/26/2005	11:55	#1-3	NF4	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/1/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/1/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/1/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/1/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/1/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/8/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/8/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/8/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/8/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/8/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/15/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/15/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/15/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/15/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/16/2005	12:15	#1-2	RL	FC	Tammie	Grab	Also took cond, ph, and temp
6/16/2005	12:35	#1-2	DRL1	FC	Tammie	Grab	Also took cond, ph, and temp
6/16/2005	1:10	#1-3	DRL3	FC	Tammie	Grab	Also took cond, ph, and temp
6/16/2005	1:15	#1-3	DRL4	FC	Tammie	Grab	Also took cond, ph, and temp
6/22/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/22/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/22/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/22/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/22/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/29/2005	10:30	#1-3	1FR1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/29/2005	11:30	#1-3	3UL1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/29/2005	12:00	#1-3	4UL2	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/29/2005	12:30	#1-3	5UAA1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS
6/29/2005	1:00	#1-3	10A1	FC	Tammie	Grab	Also took turb, cond, temp, pH and TSS