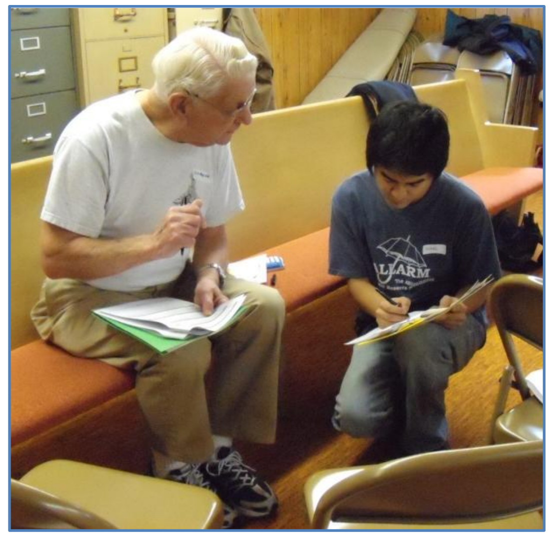
Alliance for Aquatic Resource Monitoring

Data Interpretation

January 2010

Background on ALLARM

The Alliance for Aquatic Resource Monitoring (ALLARM) is a project of the Environmental Studies Department at Dickinson College. Since its founding in 1986, ALLARM has become a nationally recognized technical and programmatic support center for community organizations interested in watershed assessment, protection, and restoration. ALLARM's program goals are to:



1) Enhance local action for the protection and restoration of Pennsylvania watersheds by empowering communities with scientific knowledge and tools to implement watershed assessments;
2) Provide Dickinson College students with opportunities to participate in community-based participatory research thereby enhancing the quality of undergraduate science education; and
3) Be the leader in volunteer monitoring in Pennsylvania and a national model for college-community partnerships.

Through the work of student and professional staff, ALLARM offers comprehensive services to enable groups to use critical scientific tools to enhance environmental quality and fully participate in community decision-making. The program staff includes a Director, an Assistant Director, a faculty Science Director, and 12-14 undergraduate student staff.

For more information about ALLARM, please visit: www.dickinson.edu/ALLARM.

Project funding provided by the Foundation for Pennsylvania Watersheds.

Foundation for Pennsylvania Watersheds

Background on the Virtual Watershed

What is a virtual watershed?

A virtual watershed is a fabricated watershed based on real aquatic trends and qualities.

What is the purpose of a virtual watershed?

The purpose of the virtual watershed exercise is to learn about the watershed and determine what the water quality values collected each month actually mean. The water quality data for College Creek are based off a true dataset, but have been manipulated to produce deliberate trends between values and elements of the watershed including land use, geology, and discharges as well as seasonality. The goal of the exercise is to learn how to identify these trends and understand how and why they occur. Once those skills are developed, it will be easier to identify and understand trends within a true data set where relationships are often less obvious.

How do you use the virtual watershed exercise?

The virtual watershed exercise contains three main parts:

1) Questions – used to discover the trends and relationships between the water quality values and other elements of the watershed – ultimately finding the story in the data
2) Water quality data – raw, summarized, and graphical forms
3) Watershed maps – site locations, land use, geology, and discharge locations

Items to note:

The virtual watershed contains deliberate errors in the data set (i.e. a pH value of 16) to signify the need to double-check values when recording and entering values into a database. The errors often go undetected until the data are looked at and analyzed at a closer level.

COLLEGE CREEK WATER QUALITY DATA INTERPRETATION SESSION

Section I: Findings/Observations

A. Using Raw Data and Maps

- As you answer the questions, bear in mind the acceptable ranges for chemical indicators. For some results, high values are "worse" (e.g. nitrate). For others, low values are "worse" (e.g. pH or dissolved oxygen).

- In general, how do you expect the chemical indicators to respond as pollution or some other negative alteration of College Creek increases?

Indicator	Increase	Decrease
Alkalinity		
Dissolved Oxygen		
Fecal Coliform		
Macroinvertebrates		
Nitrate		
pH		
Temperature		
Total Suspended Solids		

- You will now analyze the raw data on College Creek. If working in a group setting, each group will answer questions for flow, macroinvertebrates, fecal coliform, and three specific indicators, as indicated below. Otherwise, you should look at the parameters of interest. Record your answers in **Table 1** for each studied parameter under the appropriate question number at the top of the table.

Group 1: Alkalinity, Fecal Coliform, Dissolved Oxygen, Nitrate

Group 2: Fecal Coliform, pH, Temperature, Total Suspended Solids

- At the end of the session, the groups will combine their data to review the relationships between indicators, and discuss the overall health of College Creek.

Flow:

1. During which month was flow consistently the highest? ______________________________
2. During which month was flow consistently the lowest? ______________________________
3. Which site has the most variation in flow over the year? _____________________________
4. Which site has the highest flow during the year? ____________________________________
5. Referring your answer to question 4, what is the position of that site in relation to other sites in the study area? ____

Macroinvertebrates:

1. Which site has the **highest** EPT richness? ____
2. Which site has the **lowest** EPT richness? ____
3. Which site has the **highest** total richness? ____
4. Which site has the **lowest** total richness? ____
6. Referring your answer to question 1, what is the predominant land use at that site?

____

7. Referring your answer to question 2, what is the predominant land use at that site?

____

Alkalinity/Dissolved Oxygen/pH:

1. What is the **lowest** recorded value at any site?
2. Which site has the **lowest** recorded value?
3. Which month has the **lowest** recorded value?
4. Which site consistently has the **lowest** recorded values?
5. Which site consistently has the **highest** recorded values?
6. Referring your answer to question 2, what is the predominant land use at that site?
7. Referring your answer to question 5, what is the predominant land use at that site?

Bacteria/Nitrate/Phosphate/Temperature/Total Suspended Solids:

1. What is the **highest** recorded value at any site?
2. Which site has the **highest** recorded value?
3. Which month has the **highest** recorded value?
4. Which site consistently has the **highest** recorded values?
5. Which site consistently has the **lowest** recorded values?
6. Referring your answer to question 2, what is the predominant land use at that site?
7. Referring your answer to question 5, what is the predominant land use at that site?

Table 1. Using Raw Data

	1	2	3	4	5	6	7
Alkalinity							
Dissolved Oxygen							
Fecal Coliform							
Nitrate							
pH							
Temperature							
TSS							

B. Using Summarized Data

Answer the questions using the statistical summaries tables and box-and-whisker graphs for the same indicators as you did before. Record your results in Table 2.

1. Which site has the greatest range (max – min)?
2. Which site has the greatest IQ range?
3. Does the IQ range of these two sites (if different) overlap?
4. Based on the Box-and-Whisker graphs, which sites are most **different** from each other?
5. Based on the Box-and-Whisker graphs, which sites are most **similar** from each other?
6. Which site has the **highest** median?
7. Which site has the **lowest** median?
8. Does the IQ range of these two sites overlap?

Table 2. Using Summarized Data

	1	2	3	4	5	6	7	8
Alkalinity								
Dissolved Oxygen								
Fecal Coliform								
Nitrate								
pH								
Temperature								
TSS								

Section II: Interpretation

Use all of the tables, maps, and graphs as needed.

1. What may explain the difference in values for your indicators between sites?

2. Are there seasonal patterns in the data? What may explain this?

3. Can any meaningful upstream to downstream comparisons be made between sites?

4. What is the relationship between your indicators and flow?

Section III: Looking at all of the Data Together

Use the information presented by other teams to answer the following questions.

1. How are the indicators related to one another? How do they affect each other?

2. Does flow seem to have an effect on water quality indicators? If so, how?

3. Do any data suggest that point sources may be impacting the stream? If so, which indicators?

4. Do any data suggest that non-point source pollution may be impacting the stream? If so, which indicators?

5. Overall, what would you say about the health of the College Creek Watershed?

6. If this was your watershed, what are some ways to improve the condition of the stream and raise awareness in the community?

Group 1 Raw Data:

Alkalinity (ppm)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	100.5	94.3	89.2	91.5	79.6	100.8	92.4	103.4	80.2	117.1	105.3	95.5
Urban	CC 2	34.2	30.5	25.2	27.2	10.2	35.2	37.5	40.2	43.5	42.5	39.8	36.5
Urban	CC 3	25.3	15.2	12.3	14.2	7.9	20.7	25.4	30.2	45.2	42.5	40.2	32.1
Ag	EB 1	102.1	95.2	94.3	96.5	80.5	100.2	104.2	110.3	132.3	122.5	115.4	105.3
Ag	SB 1	50.4	40.1	38.7	40.6	16.5	42.8	50.1	54.7	60.3	66.5	62.7	55.9
Forest	WB 1	15.2	12.2	10.2	12.2	5.3	18.2	19.4	120.2	25.4	21.3	19.5	18.4

Dissolved Oxygen (ppm)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	13.8	12.9	12.3	11.6	10.8	10.8	11.1	8.5	10.2	10.9	11.5	12.3
Urban	CC 2	11.4	10.6	10.2	9.2	8.1	6.9	6.7	5.6	5.5	8.6	10.5	11.0
Urban	CC 3	8.2	7.5	7.3	6.9	5.0	4.2	4.5	4.0	6.0	7.2	8.6	9.3
Ag	EB 1	12.9	12.7	11.5	11.0	9.5	8.2	7.1	5.2	5.2	8.6	10.0	11.5
Ag	SB 1	11.8	11.2	10.5	10.0	3.0	5.8	5.9	5.0	5.2	8.2	9.8	10.9
Forest	WB 1	14.0	13.0	12.8	12.0	11.6	11.2	10.8	10.8	11.1	11.9	12.6	12.8

Nitrate (ppm)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	5.7	6.6	6.4	6.4	6.0	6.7	6.7	6.7	6.8	6.8	6.8	6.7
Urban	CC 2	5.6	5.7	5.9	4.0	4.9	6.0	5.7	5.2	4.1	5.0	5.6	6.2
Urban	CC 3	5.4	4.9	4.8	2.0	2.3	5.3	4.3	3.3	2.3	3.8	4.4	5.1
Ag	EB 1	6.9	8.7	10.3	10.5	17.2	11.5	9.8	7.7	8.8	7.7	7.3	7.1
Ag	SB 1	5.8	6.9	8.1	8.4	8.5	8.6	9.4	10.5	8.4	7.3	7.1	6.8
Forest	WB 1	0.0	0.4	0.3	0.1	0.1	0.2	0.1	0.1	1.5	0.0	0.1	0.0

Group 2 Raw Data:

pH (pH units)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	7.4	7.5	7.3	7.4	7.4	7.6	7.6	7.7	7.5	7.6	7.6	7.5
Urban	CC 2	6.4	6.4	6.2	6.2	5.8	6.5	6.5	6.5	6.6	6.6	6.6	6.5
Urban	CC 3	6.4	6.3	6.3	6.4	5.9	6.4	6.4	6.5	6.7	6.6	6.6	6.4
Ag	EB 1	7.8	7.7	7.7	7.7	7.7	7.7	7.8	7.8	8.0	8.0	7.9	7.8
Ag	SB 1	6.7	6.6	6.4	6.4	5.9	6.8	6.8	6.9	6.9	6.9	16.8	6.8
Forest	WB 1	5.5	5.5	5.4	5.5	5.0	5.7	5.7	5.7	5.8	5.7	5.6	5.6

Temperature (°F)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	36.0	37.0	41.0	42.0	48.0	51.0	52.0	53.0	48.0	45.0	42.0	37.0
Urban	CC 2	46.0	50.0	53.0	62.0	74.0	81.0	81.0	80.0	68.0	65.0	52.0	47.0
Urban	CC 3	50.0	55.0	62.0	70.0	77.0	86.0	86.0	85.0	81.0	71.0	62.0	53.0
Ag	EB 1	36.0	37.0	40.0	42.0	48.0	53.0	53.0	54.0	49.0	45.0	43.0	37.0
Ag	SB 1	37.0	39.0	45.0	52.0	54.0	58.0	61.0	63.0	58.0	55.0	44.0	40.0
Forest	WB 1	33.0	35.0	36.0	38.0	41.0	42.0	43.0	42.0	42.0	38.0	35.0	34.0

Total Suspended Solids (ppm)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	45.4	55.3	62.2	58.5	146.7	36.5	25.3	161.6	23.1	23.6	35.1	42.6
Urban	CC 2	101.2	109.8	114.3	111.0	177.4	75.6	13.8	17.8	11.2	14.9	63.7	89.4
Urban	CC 3	133.8	158.2	185.6	178.3	456.3	125.6	100.3	50.2	56.3	62.3	103.2	135.2
Ag	EB 1	39.5	43.4	56.8	49.2	84.6	33.8	21.9	70.2	22.4	23.2	28.5	32.1
Ag	SB 1	52.2	152.3	189.3	175.2	365.2	85.6	25.6	20.8	19.8	25.4	75.8	125.6
Forest	WB 1	9.3	9.9	10.4	10.0	13.3	7.8	0.0	0.0	0.0	0.0	6.7	9.6

Raw Data and Statistical Summaries – College Creek Case Study

Alkalinity (ppm)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	100.5	94.3	89.2	91.5	79.6	100.8	92.4	103.4	80.2	117.1	105.3	95.5
Urban	CC 2	34.2	30.5	25.2	27.2	10.2	35.2	37.5	40.2	43.5	42.5	39.8	36.5
Urban	CC 3	25.3	15.2	12.3	14.2	7.9	20.7	25.4	30.2	45.2	42.5	40.2	32.1
Ag	EB 1	102.1	95.2	94.3	96.5	80.5	100.2	104.2	110.3	132.3	122.5	115.4	105.3
Ag	SB 1	50.4	40.1	38.7	40.6	16.5	42.8	50.1	54.7	60.3	66.5	62.7	55.9
Forest	WB 1	15.2	12.2	10.2	12.2	5.3	18.2	19.4	120.2	25.4	21.3	19.5	18.4

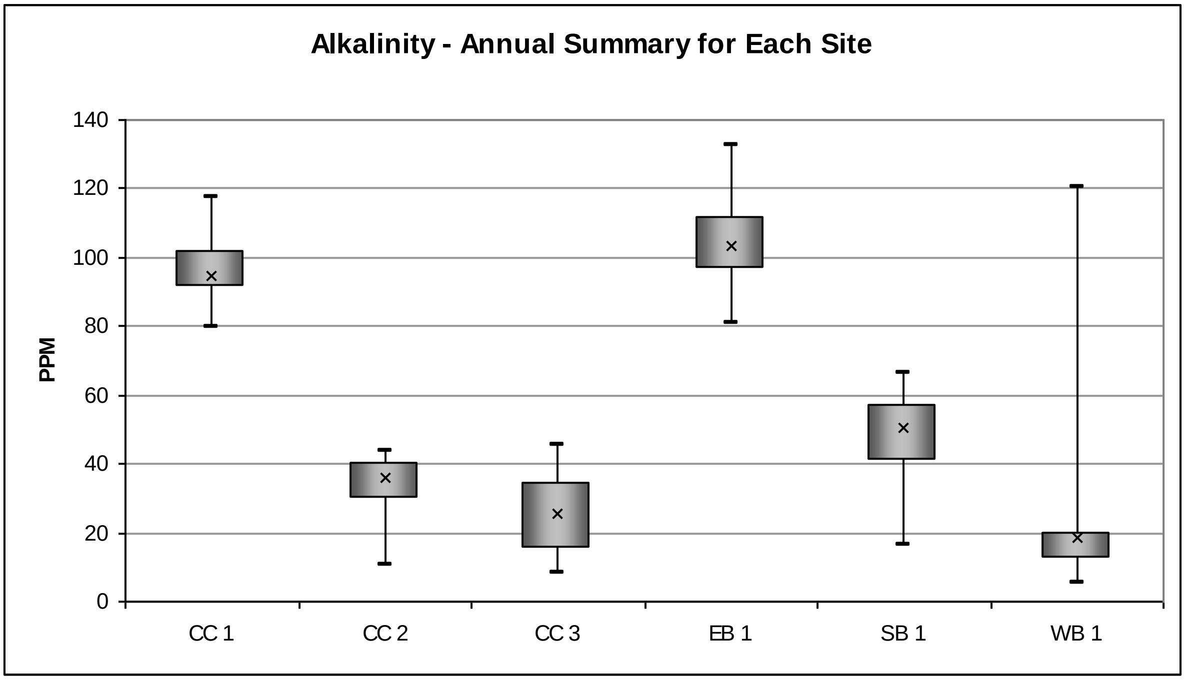
Alkalinity (ppm) – Annual Summary for Each Site

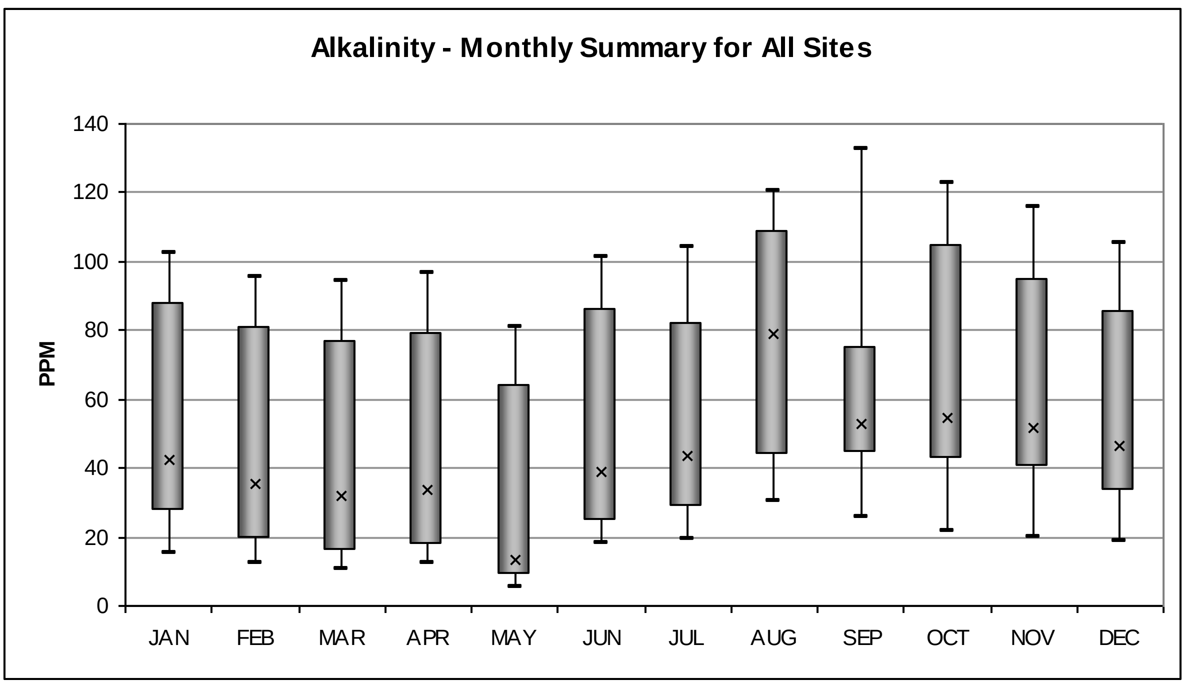
LAND USE	SITE	Average	Min	25th	Median	75th	Max	Range	IQ Range
Ag	CC 1	95.8	79.6	90.9	94.9	101.5	117.1	37.5	10.5
Urban	CC 2	33.5	10.2	29.7	35.9	39.9	43.5	33.3	10.2
Urban	CC 3	25.9	7.9	15.0	25.4	34.1	45.2	37.3	19.2
Ag	EB 1	104.9	80.5	96.2	103.2	111.6	132.3	51.8	15.4
Ag	SB 1	48.3	16.5	40.5	50.3	57.0	66.5	50.0	16.5
Forest	WB 1	24.8	5.3	12.2	18.3	20.0	120.2	114.9	7.8

Alkalinity (ppm) – Monthly Summary for All Sites

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average	54.6	47.9	45.0	47.0	33.3	53.0	54.8	76.5	64.5	68.7	63.8	57.3
Min	15.2	12.2	10.2	12.2	5.3	18.2	19.4	30.2	25.4	21.3	19.5	18.4
25th	27.5	19.0	15.5	17.5	8.5	24.3	28.4	43.8	43.9	42.5	39.9	33.2
Median	42.3	35.3	32.0	33.9	13.4	39.0	43.8	79.1	52.8	54.5	51.5	46.2
75th	88.0	80.8	76.6	78.8	63.8	85.9	81.8	108.6	75.2	104.5	94.7	85.6
Max	102.1	95.2	94.3	96.5	80.5	100.8	104.2	120.2	132.3	122.5	115.4	105.3

Alkalinity Graphs – College Creek Case Study





Raw Data and Statistical Summaries – College Creek Case Study

Dissolved Oxygen (ppm)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	13.8	12.9	12.3	11.6	10.8	10.8	11.1	8.5	10.2	10.9	11.5	12.3
Urban	CC 2	11.4	10.6	10.2	9.2	8.1	6.9	6.7	5.6	5.5	8.6	10.5	11.0
Urban	CC 3	8.2	7.5	7.3	6.9	5.0	4.2	4.5	4.0	6.0	7.2	8.6	9.3
Ag	EB 1	12.9	12.7	11.5	11.0	9.5	8.2	7.1	5.2	5.2	8.6	10.0	11.5
Ag	SB 1	11.8	11.2	10.5	10.0	3.0	5.8	5.9	5.0	5.2	8.2	9.8	10.9
Forest	WB 1	14.0	13.0	12.8	12.0	11.6	11.2	10.8	10.8	11.1	11.9	12.6	12.8

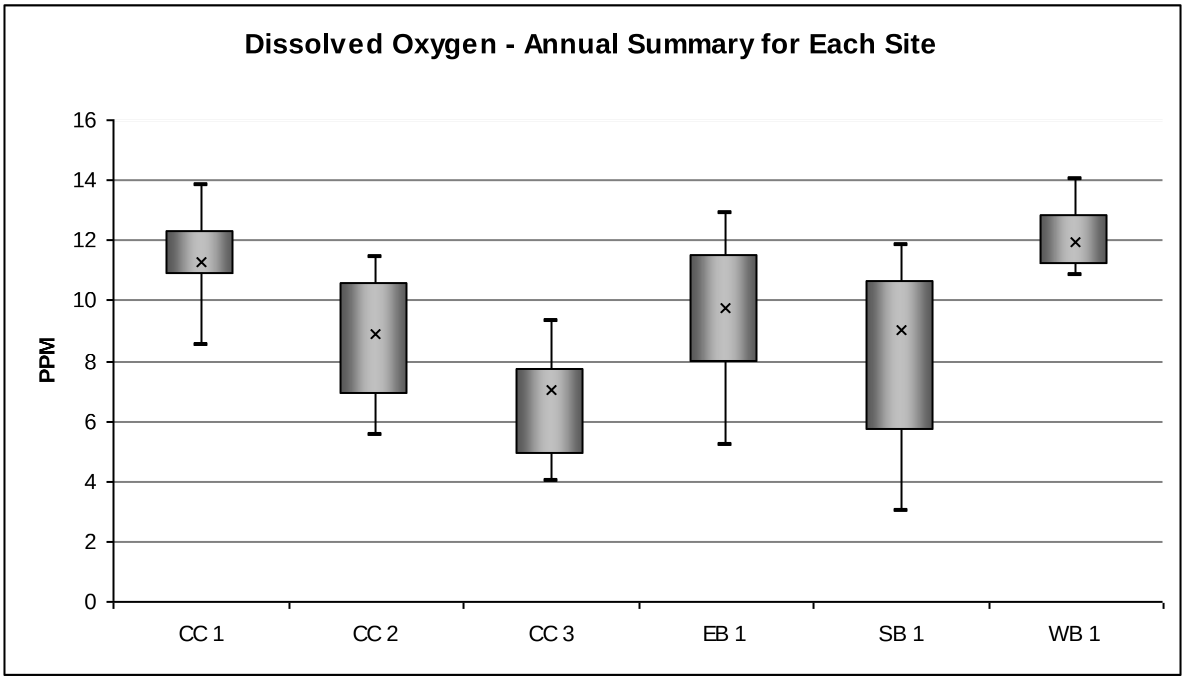
Dissolved Oxygen (ppm) – Annual Summary for Each Site

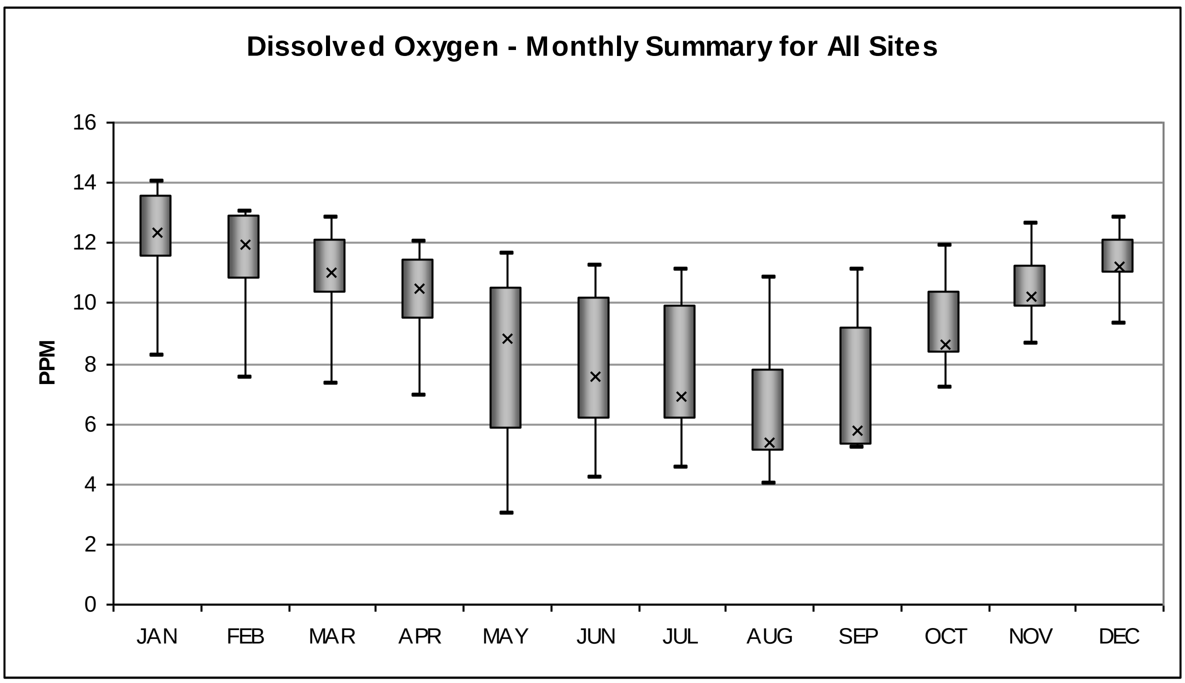
LAND USE	SITE	Average	Min	25th	Median	75th	Max	Range	IQ Range
Ag	CC 1	11.4	8.5	10.8	11.3	12.3	13.8	5.3	1.5
Urban	CC 2	8.7	5.5	6.9	8.9	10.5	11.4	5.9	3.7
Urban	CC 3	6.6	4.0	4.9	7.1	7.7	9.3	5.3	2.8
Ag	EB 1	9.5	5.2	7.9	9.8	11.5	12.9	7.7	3.6
Ag	SB 1	8.1	3.0	5.7	9.0	10.6	11.8	8.8	5.0
Forest	WB 1	12.1	10.8	11.2	12.0	12.8	14.0	3.2	1.6

Dissolved Oxygen (ppm) – Monthly Summary for All Sites

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average	12.0	11.3	10.8	10.1	8.0	7.9	7.7	6.5	7.2	9.2	10.5	11.3
Min	8.2	7.5	7.3	6.9	3.0	4.2	4.5	4.0	5.2	7.2	8.6	9.3
25^{th}	11.5	10.8	10.3	9.4	5.8	6.1	6.1	5.1	5.3	8.3	9.9	10.9
Median	12.4	12.0	11.0	10.5	8.8	7.6	6.9	5.4	5.8	8.6	10.3	11.3
75^{th}	13.6	12.9	12.1	11.5	10.5	10.2	9.9	7.8	9.2	10.3	11.3	12.1
Max	14.0	13.0	12.8	12.0	11.6	11.2	11.1	10.8	11.1	11.9	12.6	12.8

Dissolved Oxygen Graphs – College Creek Case Study





Raw Data and Statistical Summaries – College Creek Case Study

Fecal Coliform (col/100 mL)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	10.0	10.0	25.0	35.0	60.0	70.0	90.0	105.0	110.0	90.0	40.0	30.0
Urban	CC 2	5.0	5.0	15.0	20.0	35.0	50.0	70.0	90.0	90.0	60.0	40.0	15.0
Urban	CC 3	60.0	80.0	80.0	120.0	190.0	250.0	300.0	310.0	320.0	170.0	120.0	90.0
Ag	EB 1	2.0	2.0	7.0	10.0	20.0	35.0	50.0	60.0	60.0	40.0	30.0	10.0
Ag	SB 1	40.0	40.0	60.0	100.0	140.0	160.0	180.0	210.0	200.0	200.0	140.0	80.0
Forest	WB 1	0.0	0.0	0.0	2.0	2.0	4.0	4.0	4.0	4.0	2.0	0.0	0.0

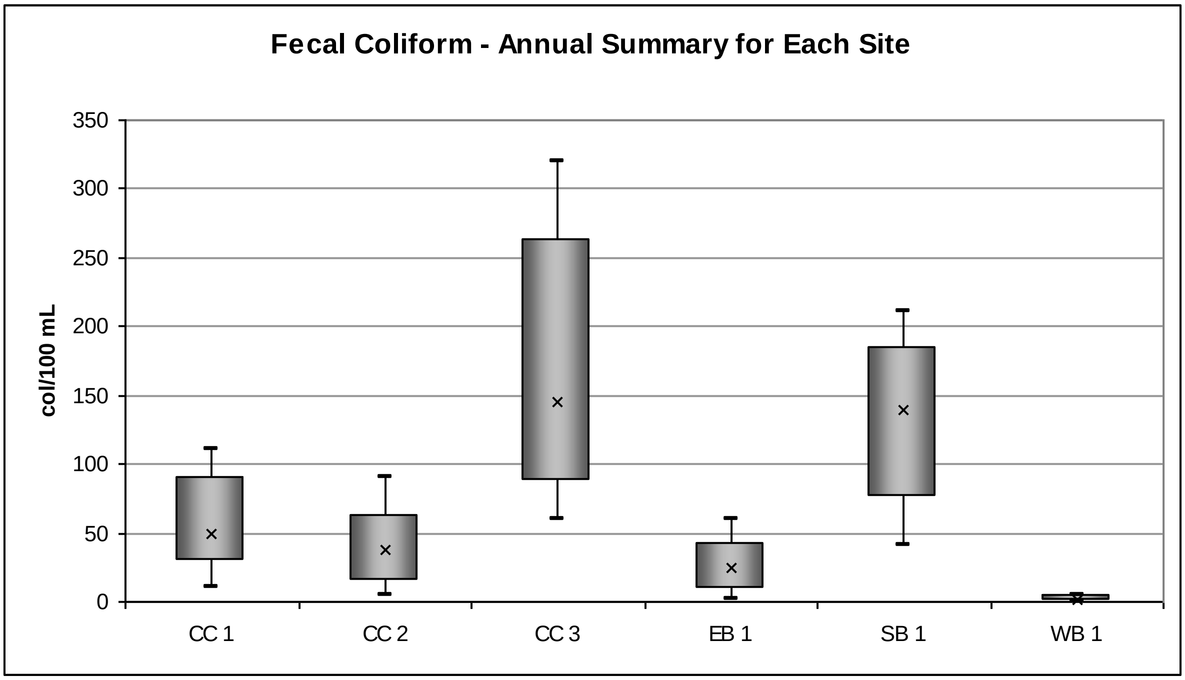
Fecal Coliform (col/100 mL) – Annual Summary for Each Site

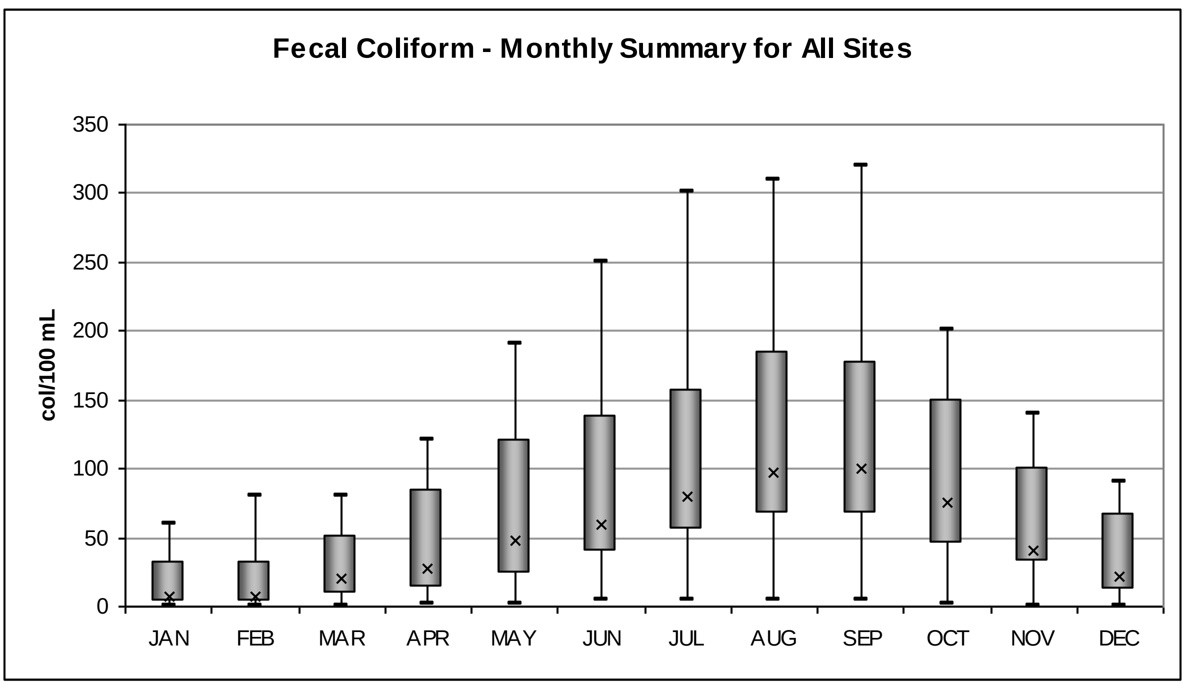
LAND USE	SITE	Average	Min	25th	Median	75th	Max	Range	IQ Range
Ag	CC 1	56.3	10.0	28.8	50.0	90.0	110.0	100.0	61.3
Urban	CC 2	41.3	5.0	15.0	37.5	62.5	90.0	85.0	47.5
Urban	CC 3	174.2	60.0	87.5	145.0	262.5	320.0	260.0	175.0
Ag	EB 1	27.2	2.0	9.3	25.0	42.5	60.0	58.0	33.3
Ag	SB 1	129.2	40.0	75.0	140.0	185.0	210.0	170.0	110.0
Forest	WB 1	1.8	0.0	0.0	2.0	4.0	4.0	4.0	4.0

Fecal Coliform (col/100 mL) – Monthly Summary for All Sites

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average	19.5	22.8	31.2	47.8	74.5	94.8	115.7	129.8	130.7	93.7	61.7	37.5
Min	0.0	0.0	0.0	2.0	2.0	4.0	4.0	4.0	4.0	2.0	0.0	0.0
25th	2.8	2.8	9.0	12.5	23.8	38.8	55.0	67.5	67.5	45.0	32.5	11.3
Median	7.5	7.5	20.0	27.5	47.5	60.0	80.0	97.5	100.0	75.0	40.0	22.5
75th	32.5	32.5	51.3	83.8	120.0	137.5	157.5	183.8	177.5	150.0	100.0	67.5
Max	60.0	80.0	80.0	120.0	190.0	250.0	300.0	310.0	320.0	200.0	140.0	90.0

Fecal Coliform Graphs – College Creek Case Study





Raw Data and Statistical Summaries – College Creek Case Study

Flow (cfs)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	49.3	56.2	92.5	68.7	150.0	33.6	19.1	18.7	18.3	21.5	43.4	62.9
Urban	CC 2	1129.4	1197.6	2046.8	1857.3	2103.4	1001.5	445.7	216.3	121.8	149.9	637.9	1118.4
Urban	CC 3	2000.1	2506.1	4007.5	3204.7	5801.9	5007.4	703.2	406.5	405.8	501.6	1002.5	1901.6
Ag	EB 1	203.0	248.0	423.0	366.0	467.0	180.0	61.0	43.0	39.0	46.0	114.0	203.0
Ag	SB 1	220.5	310.4	420.1	360.8	540.3	210.6	80..4	50.2	40.1	60.8	110.5	210.6
Forest	WB 1	20.3	32.1	39.6	35.4	73.4	17.8	5.1	4.8	4.6	5.7	12.0	12.1

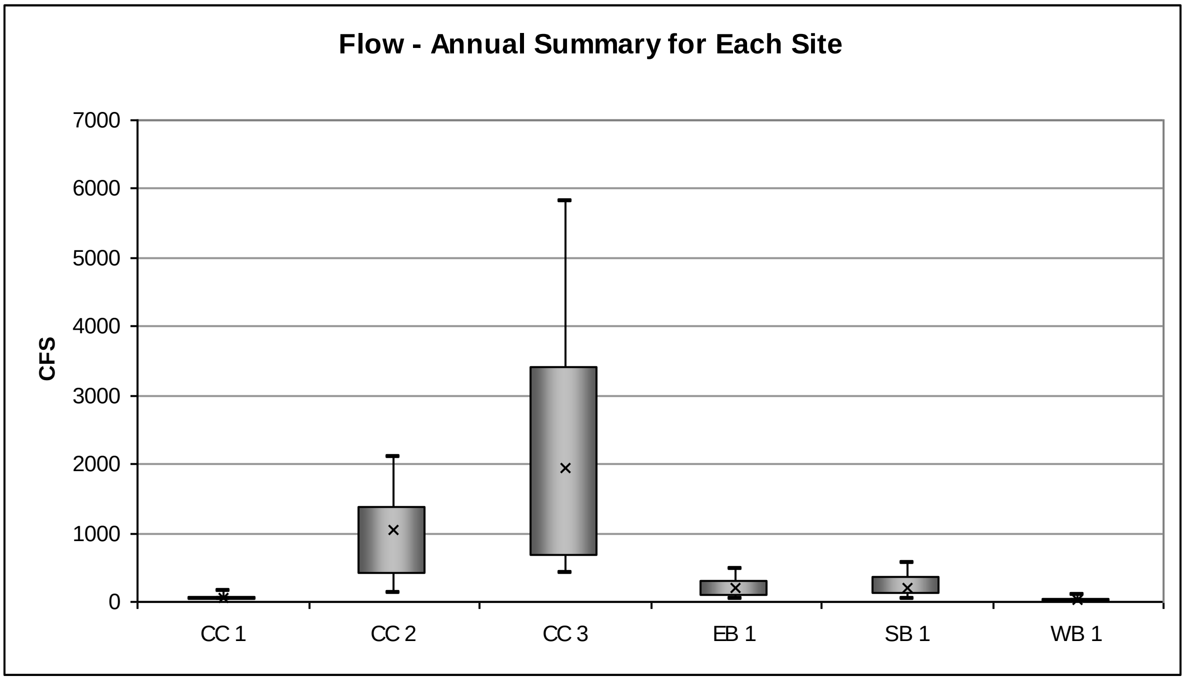
Flow (cfs) – Annual Summary for Each Site

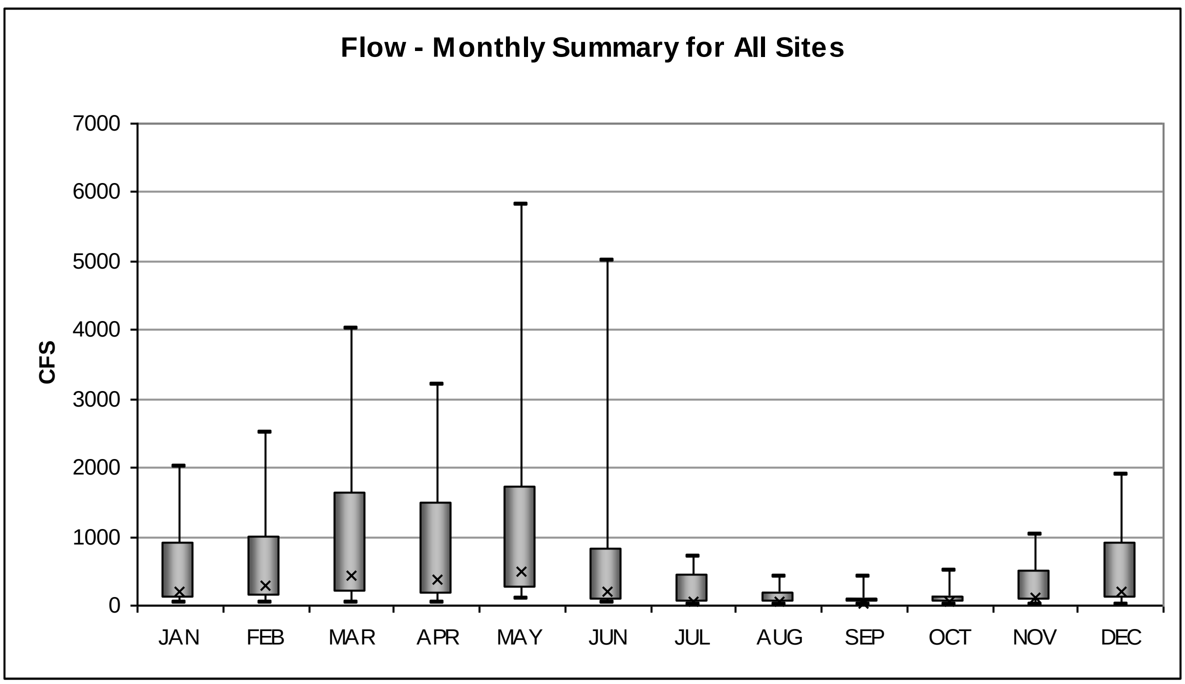
LAND USE	SITE	Average	Min	25th	Median	75th	Max	Range	IQ Range
Ag	CC 1	52.9	18.3	20.9	46.4	64.4	150.0	131.7	43.5
Urban	CC 2	1002.2	121.8	388.4	1060.0	1362.5	2103.4	1981.6	974.2
Urban	CC 3	2287.4	405.8	652.8	1950.9	3405.4	5801.9	5396.1	2752.6
Ag	EB 1	199.4	39.0	57.3	191.5	277.5	467.0	428.0	220.3
Ag	SB 1	230.4	40.1	85.7	210.6	335.6	540.3	500.2	250.0
Forest	WB 1	21.9	4.6	5.6	15.0	32.9	73.4	68.8	27.4

Flow (cfs) – Monthly Summary for All Sites

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average	603.8	725.1	1171.6	982.2	1522.7	1075.2	246.8	123.3	104.9	130.9	320.1	584.8
Min	20.3	32.1	39.6	35.4	73.4	17.8	5.1	4.8	4.6	5.7	12.0	12.1
25th	87.7	104.2	174.4	141.7	229.3	70.2	19.1	24.8	23.5	27.6	60.2	97.9
Median	211.8	279.2	421.6	363.4	503.7	195.3	61.0	46.6	39.6	53.4	112.3	206.8
75th	902.2	975.8	1640.9	1484.5	1712.6	803.8	445.7	174.8	101.4	127.6	506.9	891.5
Max	2000.1	2506.1	4007.5	3204.7	5801.9	5007.4	703.2	406.5	405.8	501.6	1002.5	1901.6

Flow Graphs – College Creek Case Study





Raw Data and Statistical Summaries – College Creek Case Study

Nitrate (ppm)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	5.7	6.6	6.4	6.4	6.0	6.7	6.7	6.7	6.8	6.8	6.8	6.7
Urban	CC 2	5.6	5.7	5.9	4.0	4.9	6.0	5.7	5.2	4.1	5.0	5.6	6.2
Urban	CC 3	5.4	4.9	4.8	2.0	2.3	5.3	4.3	3.3	2.3	3.8	4.4	5.1
Ag	EB 1	6.9	8.7	10.3	10.5	17.2	11.5	9.8	7.7	8.8	7.7	7.3	7.1
Ag	SB 1	5.8	6.9	8.1	8.4	8.5	8.6	9.4	10.5	8.4	7.3	7.1	6.8
Forest	WB 1	0.0	0.4	0.3	0.1	0.1	0.2	0.1	0.1	1.5	0.0	0.1	0.0

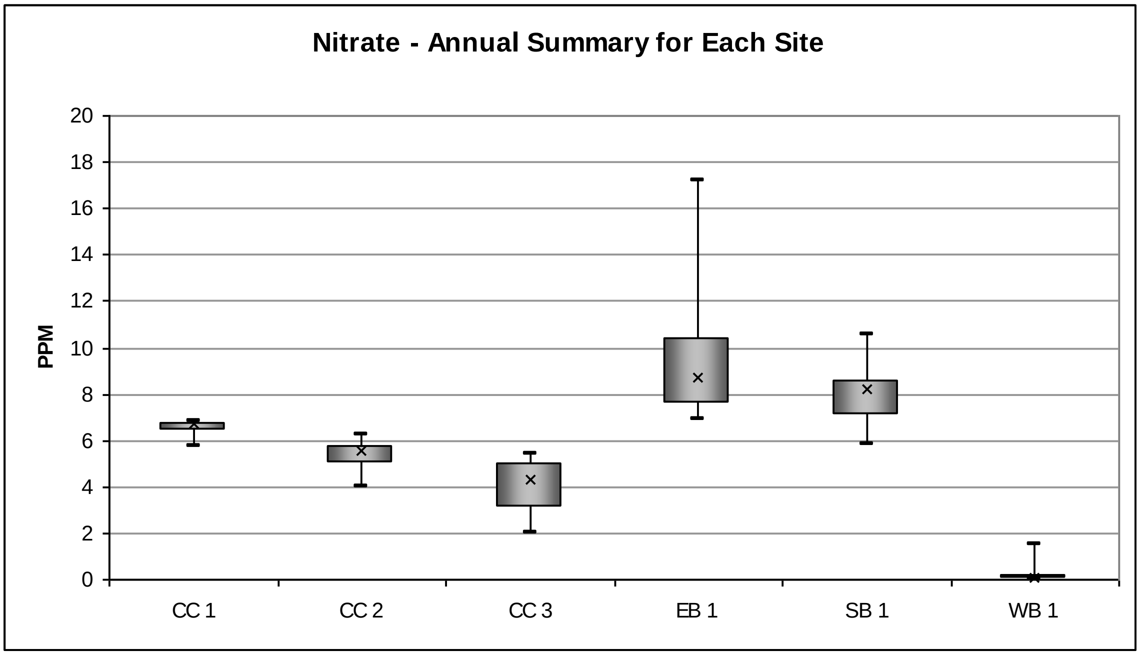
Nitrate (ppm) – Annual Summary for Each Site

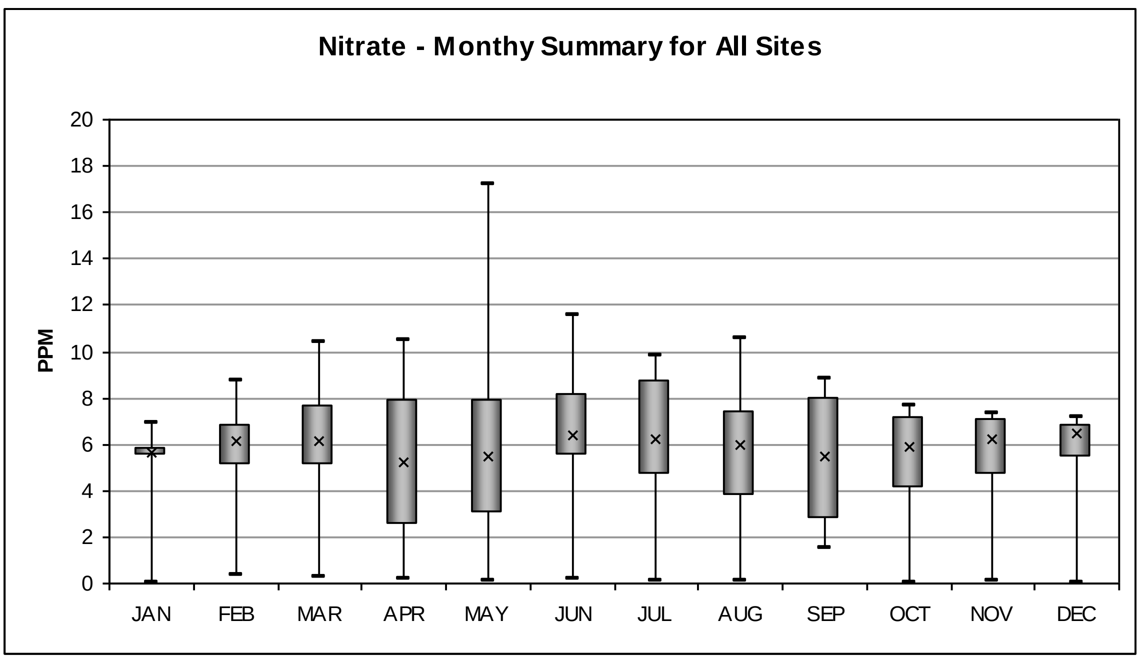
LAND USE	SITE	Average	Min	25th	Median	75th	Max	Range	IQ Range
Ag	CC 1	6.5	5.7	6.4	6.7	6.7	6.8	1.1	0.3
Urban	CC 2	5.3	4.0	5.0	5.6	5.8	6.2	2.2	0.8
Urban	CC 3	4.0	2.0	3.1	4.3	5.0	5.4	3.4	1.9
Ag	EB 1	9.4	6.9	7.6	8.7	10.4	17.2	10.3	2.8
Ag	SB 1	8.0	5.8	7.1	8.3	8.5	10.5	4.7	1.5
Forest	WB 1	0.2	0.0	0.0	0.1	0.2	1.5	1.5	0.1

Nitrate (ppm) – Monthly Summary for All Sites

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average	4.9	5.5	6.0	5.2	6.5	6.4	6.0	5.6	5.3	5.1	5.2	5.3
Min	0.0	0.4	0.3	0.1	0.1	0.2	0.1	0.1	1.5	0.0	0.1	0.0
25th	5.5	5.1	5.1	2.5	3.0	5.4	4.7	3.8	2.8	4.1	4.7	5.4
Median	5.7	6.2	6.2	5.2	5.5	6.4	6.2	6.0	5.5	5.9	6.2	6.5
75th	5.8	6.8	7.7	7.9	7.9	8.1	8.7	7.4	8.0	7.2	7.0	6.8
Max	6.9	8.7	10.3	10.5	17.2	11.5	9.8	10.5	8.8	7.7	7.3	7.1

Nitrate Graphs – College Creek Case Study





Raw Data and Statistical Summaries – College Creek Case Study

pH (pH units)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	7.4	7.5	7.3	7.4	7.4	7.6	7.6	7.7	7.5	7.6	7.6	7.5
Urban	CC 2	6.4	6.4	6.2	6.2	5.8	6.5	6.5	6.5	6.6	6.6	6.6	6.5
Urban	CC 3	6.4	6.3	6.3	6.4	5.9	6.4	6.4	6.5	6.7	6.6	6.6	6.4
Ag	EB 1	7.8	7.7	7.7	7.7	7.7	7.7	7.8	7.8	8.0	8.0	7.9	7.8
Ag	SB 1	6.7	6.6	6.4	6.4	5.9	6.8	6.8	6.9	6.9	6.9	16.8	6.8
Forest	WB 1	5.5	5.5	5.4	5.5	5.0	5.7	5.7	5.7	5.8	5.7	5.6	5.6

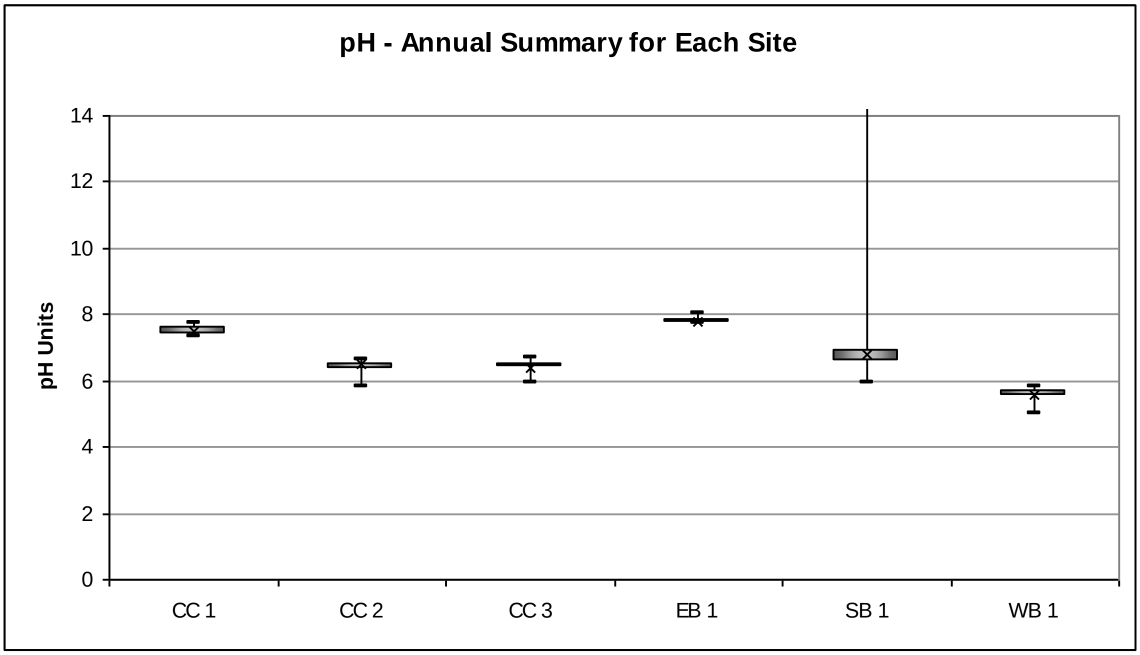
pH (pH units) – Annual Summary for Each Site

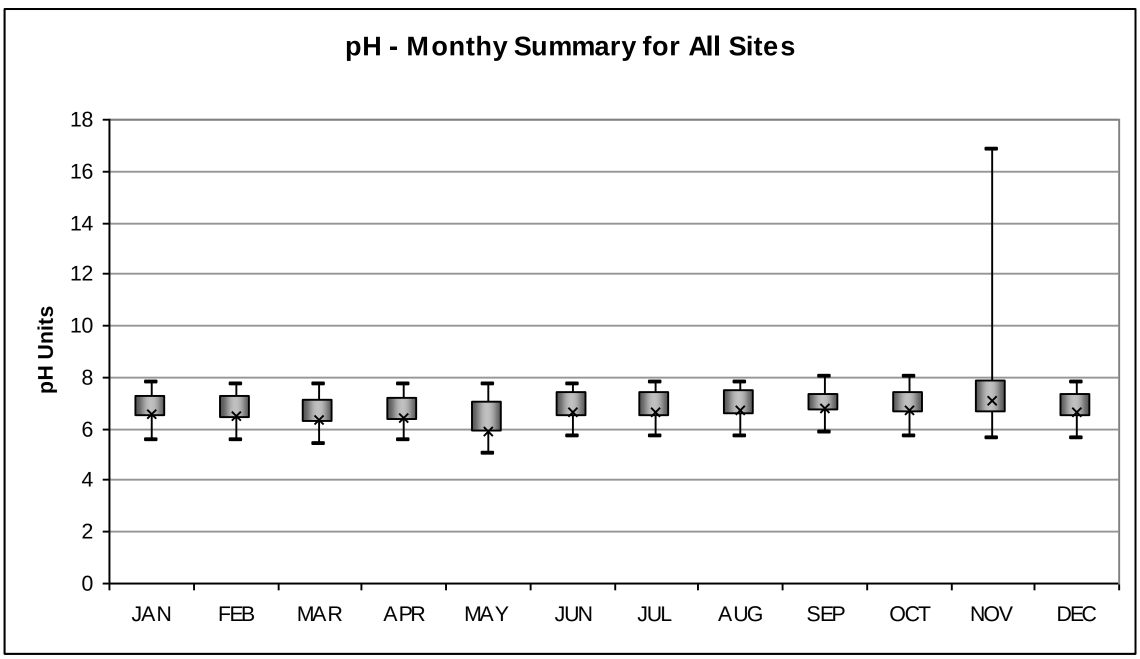
LAND USE	SITE	Average	Min	25th	Median	75th	Max	Range	IQ Range
Ag	CC 1	7.5	7.3	7.4	7.5	7.6	7.7	0.4	0.2
Urban	CC 2	6.4	5.8	6.4	6.5	6.5	6.6	0.8	0.2
Urban	CC 3	6.4	5.9	6.4	6.4	6.5	6.7	0.8	0.2
Ag	EB 1	7.8	7.7	7.7	7.8	7.8	8.0	0.3	0.1
Ag	SB 1	7.5	5.9	6.6	6.8	6.9	16.8	10.9	0.4
Forest	WB 1	5.6	5.0	5.5	5.6	5.7	5.8	0.8	0.2

pH (pH units) – Monthly Summary for All Sites

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average	6.7	6.7	6.6	6.6	6.3	6.8	6.8	6.9	6.9	6.9	8.5	6.8
Min	5.5	5.5	5.4	5.5	5.0	5.7	5.7	5.7	5.8	5.7	5.6	5.6
25th	6.4	6.3	6.2	6.3	5.8	6.4	6.4	6.5	6.6	6.6	6.6	6.4
Median	6.6	6.5	6.4	6.4	5.9	6.7	6.7	6.7	6.8	6.8	7.1	6.7
75th	7.2	7.3	7.1	7.2	7.0	7.4	7.4	7.5	7.4	7.4	7.8	7.3
Max	7.8	7.7	7.7	7.7	7.7	7.7	7.8	7.8	8.0	8.0	16.8	7.8

pH Graphs – College Creek Case Study





Raw Data and Statistical Summaries – College Creek Case Study

Temperature (°F)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	36.0	37.0	41.0	42.0	48.0	51.0	52.0	53.0	48.0	45.0	42.0	37.0
Urban	CC 2	46.0	50.0	53.0	62.0	74.0	81.0	81.0	80.0	68.0	65.0	52.0	47.0
Urban	CC 3	50.0	55.0	62.0	70.0	77.0	86.0	86.0	85.0	81.0	71.0	62.0	53.0
Ag	EB 1	36.0	37.0	40.0	42.0	48.0	53.0	53.0	54.0	49.0	45.0	43.0	37.0
Ag	SB 1	37.0	39.0	45.0	52.0	54.0	58.0	61.0	63.0	58.0	55.0	44.0	40.0
Forest	WB 1	33.0	35.0	36.0	38.0	41.0	42.0	43.0	42.0	42.0	38.0	35.0	34.0

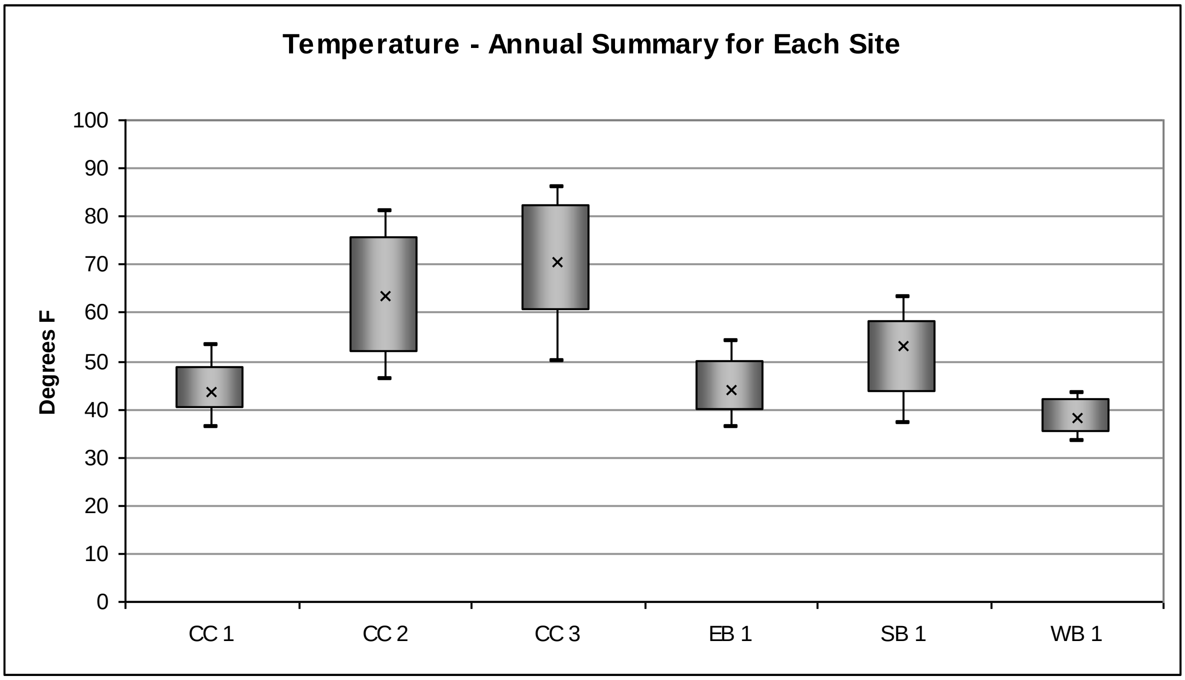
Temperature (°F) – Annual Summary for Each Site

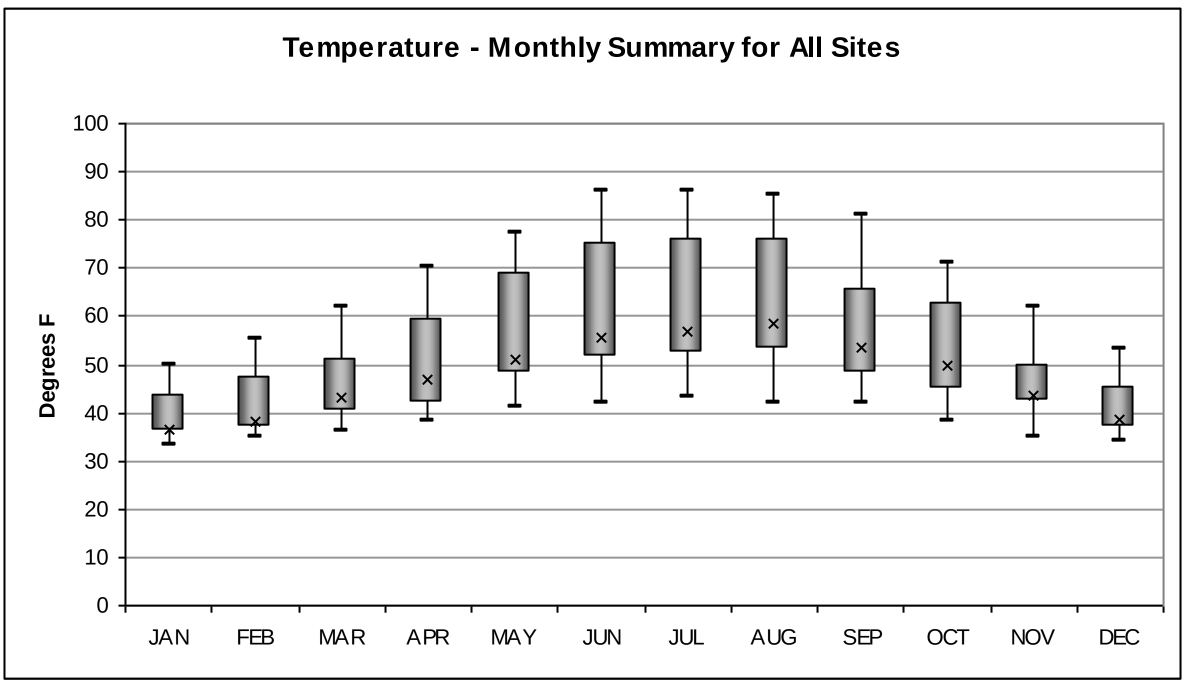
LAND USE	SITE	Average	Min	25th	Median	75th	Max	Range	IQ Range
Ag	CC 1	44.3	36.0	40.0	43.5	48.8	53.0	17.0	8.8
Urban	CC 2	63.3	46.0	51.5	63.5	75.5	81.0	35.0	24.0
Urban	CC 3	69.8	50.0	60.3	70.5	82.0	86.0	36.0	21.8
Ag	EB 1	44.8	36.0	39.3	44.0	50.0	54.0	18.0	10.8
Ag	SB 1	50.5	37.0	43.0	53.0	58.0	63.0	26.0	15.0
Forest	WB 1	38.3	33.0	35.0	38.0	42.0	43.0	10.0	7.0

Temperature (°F) – Monthly Summary for All Sites

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average	39.7	42.2	46.2	51.0	57.0	61.8	62.7	62.8	57.7	53.2	46.3	41.3
Min	33.0	35.0	36.0	38.0	41.0	42.0	43.0	42.0	42.0	38.0	35.0	34.0
25th	36.0	37.0	40.3	42.0	48.0	51.5	52.3	53.3	48.3	45.0	42.3	37.0
Median	36.5	38.0	43.0	47.0	51.0	55.5	57.0	58.5	53.5	50.0	43.5	38.5
75th	43.8	47.3	51.0	59.5	69.0	75.3	76.0	75.8	65.5	62.5	50.0	45.3
Max	50.0	55.0	62.0	70.0	77.0	86.0	86.0	85.0	81.0	71.0	62.0	53.0

Temperature Graphs – College Creek Case Study





Raw Data and Statistical Summaries – College Creek Case Study

Total Suspended Solids (ppm)

LAND USE	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Ag	CC 1	45.4	55.3	62.2	58.5	146.7	36.5	25.3	161.6	23.1	23.6	35.1	42.6
Urban	CC 2	101.2	109.8	114.3	111.0	177.4	75.6	13.8	17.8	11.2	14.9	63.7	89.4
Urban	CC 3	133.8	158.2	185.6	178.3	456.3	125.6	100.3	50.2	56.3	62.3	103.2	135.2
Ag	EB 1	39.5	43.4	56.8	49.2	84.6	33.8	21.9	70.2	22.4	23.2	28.5	32.1
Ag	SB 1	52.2	152.3	189.3	175.2	365.2	85.6	25.6	20.8	19.8	25.4	75.8	125.6
Forest	WB 1	9.3	9.9	10.4	10.0	13.3	7.8	0.0	0.0	0.0	0.0	6.7	9.6

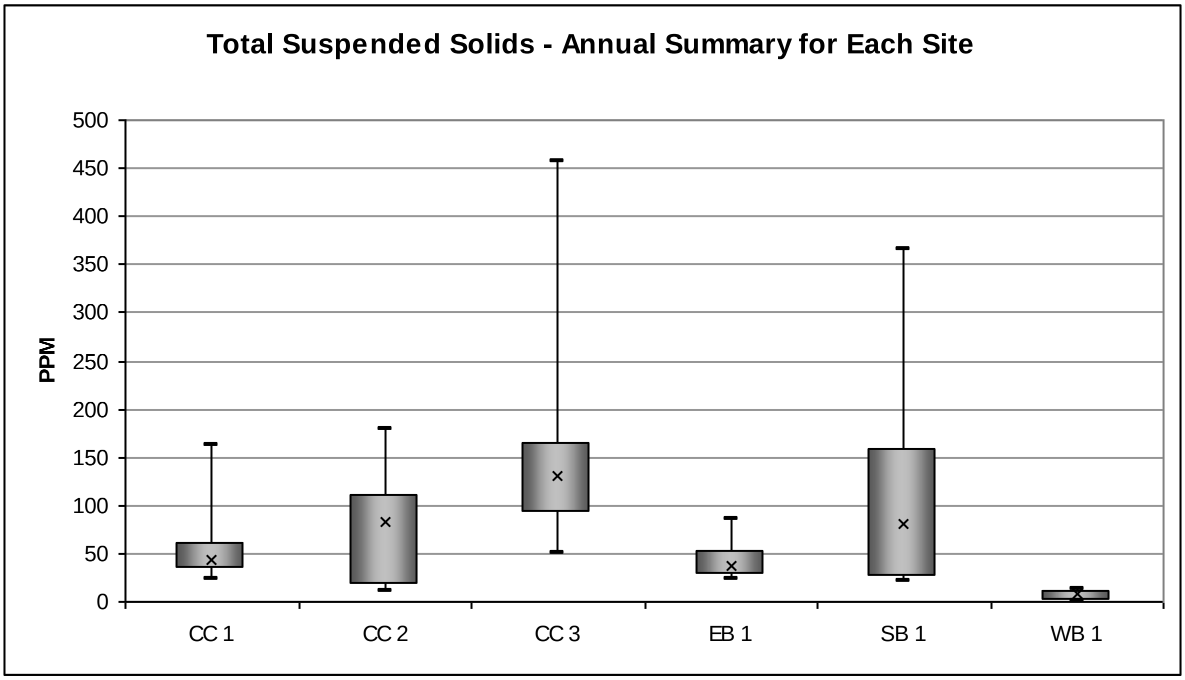
Total Suspended Solids (ppm) – Annual Summary for Each Site

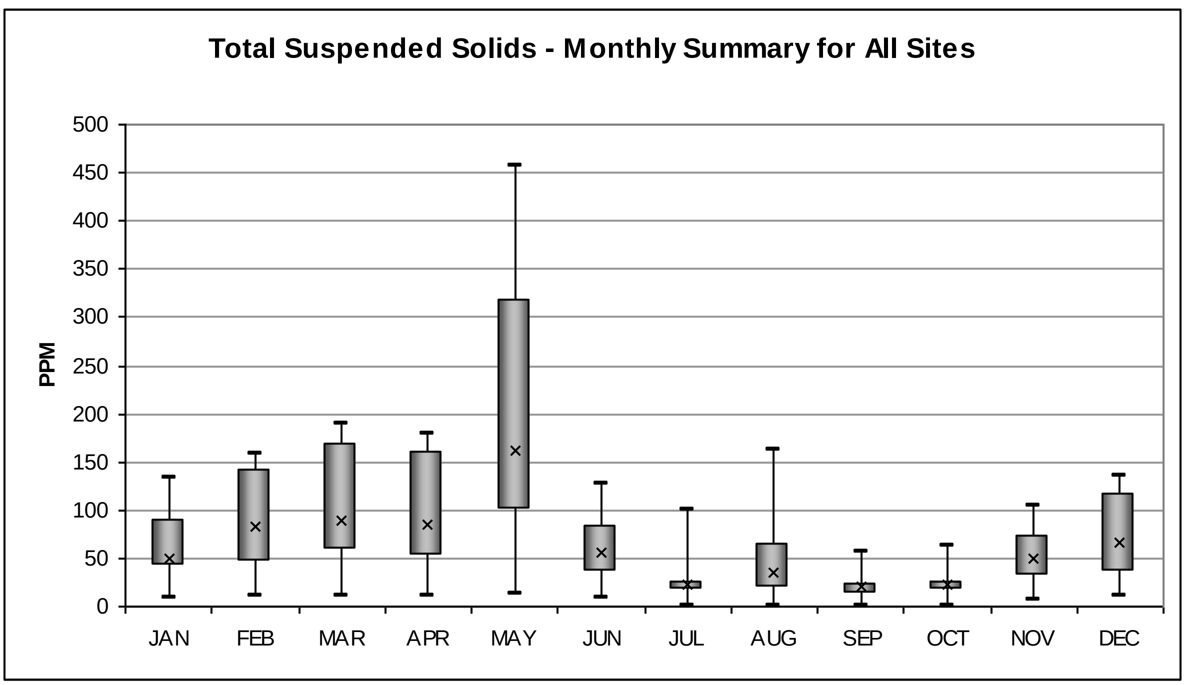
LAND USE	SITE	Average	Min	25th	Median	75th	Max	Range	IQ Range
Ag	CC 1	59.7	23.1	32.7	44.0	59.4	161.6	138.5	26.8
Urban	CC 2	75.0	11.2	17.1	82.5	110.1	177.4	166.2	93.0
Urban	CC 3	145.4	50.2	90.8	129.7	163.2	456.3	406.1	72.4
Ag	EB 1	42.1	21.9	27.2	36.7	51.1	84.6	62.7	23.9
Ag	SB 1	109.4	19.8	25.6	80.7	158.0	365.2	345.4	132.5
Forest	WB 1	6.4	0.0	0.0	8.6	9.9	13.3	13.3	9.9

Total Suspended Solids (ppm) – Monthly Summary for All Sites

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average	63.6	88.2	103.1	97.0	207.3	60.8	31.2	53.4	22.1	24.9	52.2	72.4
Min	9.3	9.9	10.4	10.0	13.3	7.8	0.0	0.0	0.0	0.0	6.7	9.6
25th	41.0	46.4	58.2	51.5	100.1	34.5	15.8	18.6	13.4	17.0	30.2	34.7
Median	48.8	82.6	88.3	84.8	162.1	56.1	23.6	35.5	21.1	23.4	49.4	66.0
75th	89.0	141.7	167.8	159.2	318.3	83.1	25.5	65.2	22.9	25.0	72.8	116.6
Max	133.8	158.2	189.3	178.3	456.3	125.6	100.3	161.6	56.3	62.3	103.2	135.2

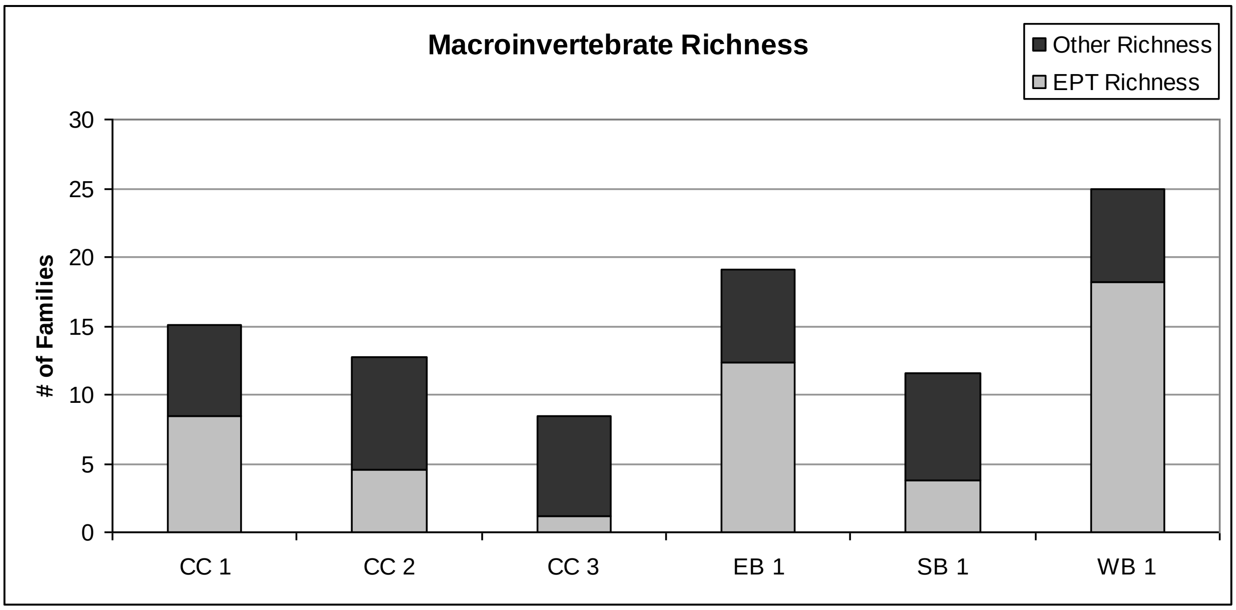
Total Suspended Solids Graphs – College Creek Case Study



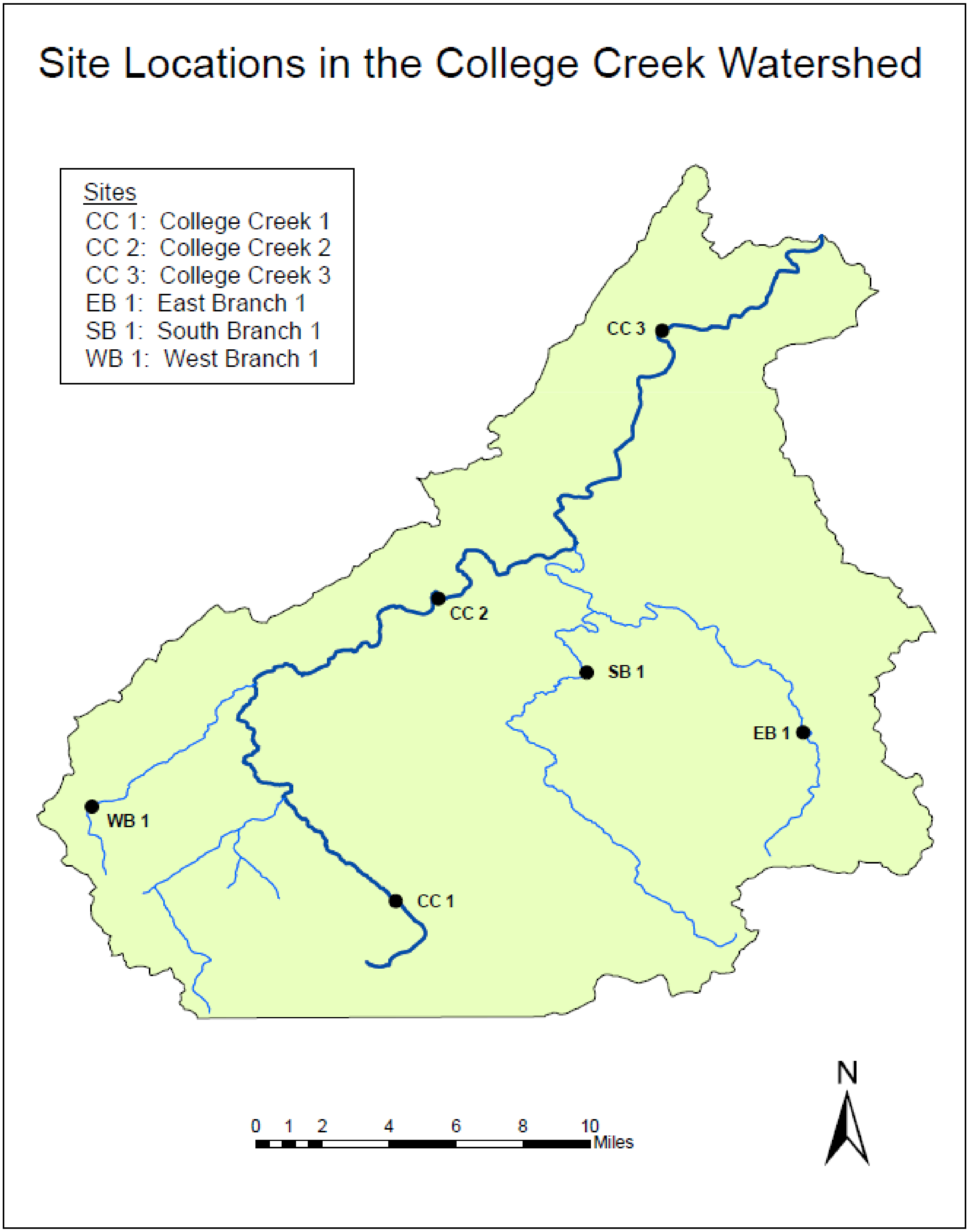


Raw Data and Statistical Summaries – College Creek Case Study

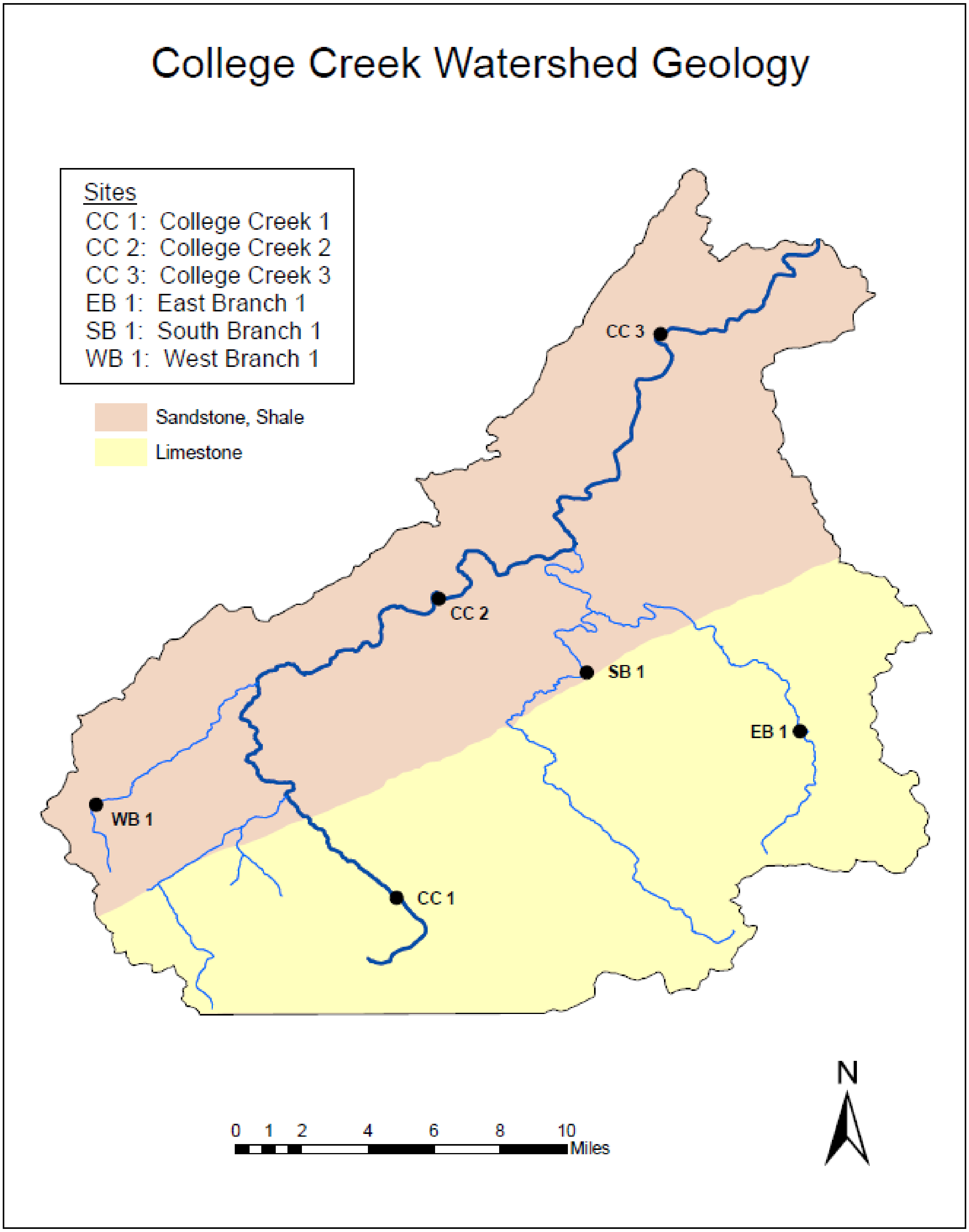
LAND USE	SITE	EPT Richness	Other Richness	Total Richness
Ag	CC 1	8.5	6.6	15.1
Urban	CC 2	4.5	8.2	12.7
Urban	CC 3	1.2	7.3	8.5
Ag	EB 1	12.4	6.7	19.1
Ag	SB 1	3.8	7.8	11.6
Forest	WB 1	18.2	6.8	25.0



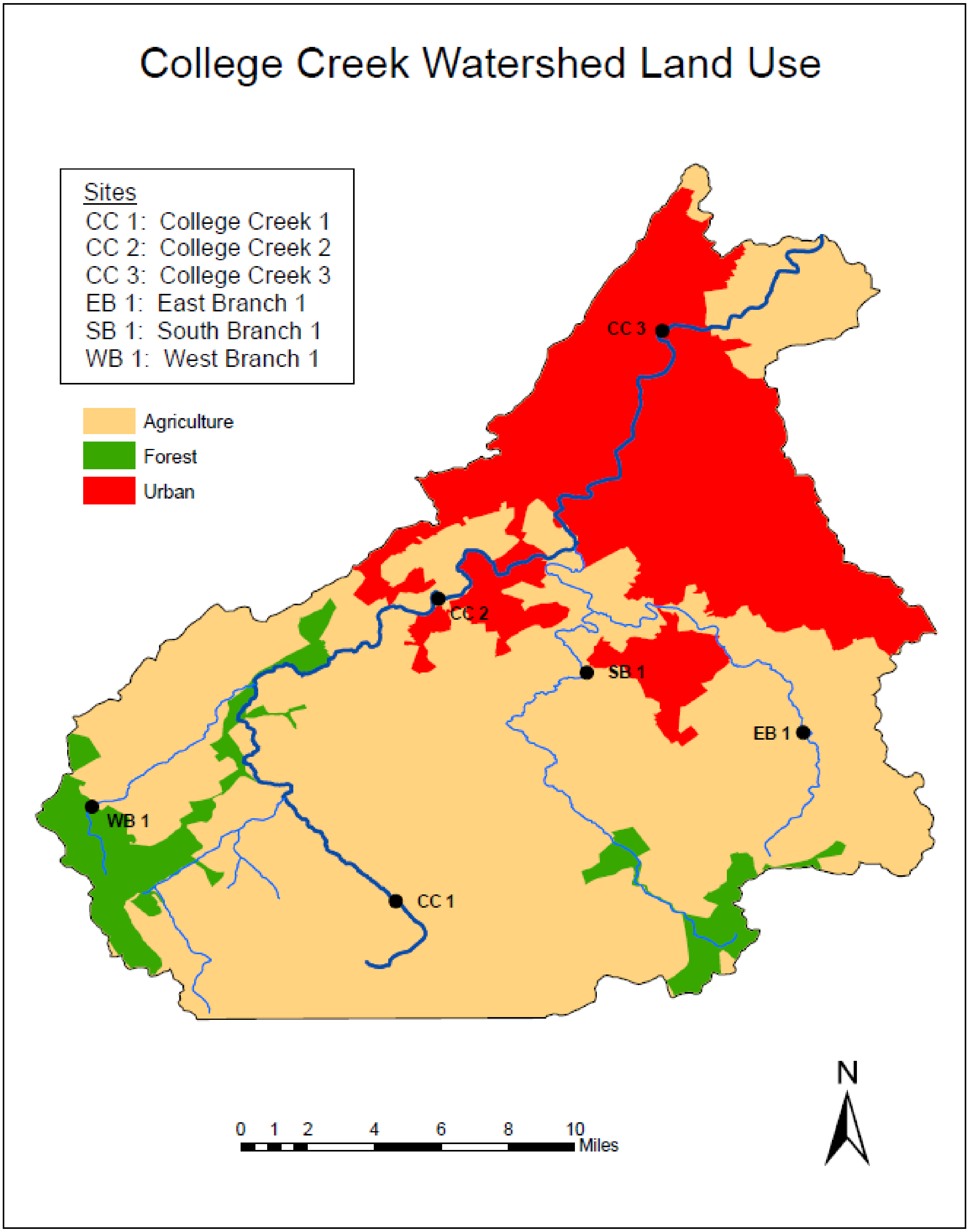
College Creek Watershed Map: Site Locations



College Creek Watershed Map: Geology



College Creek Watershed Map: Land Use



College Creek Watershed Map: Discharge Locations