

**Cross Creek Stream Restoration
Year One Monitoring Report
Cumberland County, North Carolina**



NCEEP Project Number 105
SCO Number 01-05460-01
EEP Project Manager: Melonie Allen

December 2006

**CROSS CREEK STREAM RESTORATION
YEAR ONE MONITORING REPORT**

CONDUCTED FOR THE NORTH CAROLINA DEPARTMENT
OF
ENVIRONMENT AND NATURAL RESOURCES

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I. EXECUTIVE SUMMARY/PROJECT ABSTRACT

The Cross Creek project consists of 2,090 linear feet of restored stream channel located within the City of Fayetteville, North Carolina. The site was constructed between March 2004 and January 2005. The following report provides the monitoring information for year one of the stream restoration project.

The project consists of portions of two tributaries to the Cape Fear River, Little Cross Creek and Cross Creek. Both are located within the city limits of Fayetteville on public lands south west of Fayetteville State University's Campus in Cumberland County, North Carolina. The watershed area for this project is 25.5 square miles.

The property is located off of the Martin Luther King Freeway (formerly the C.B.D. Loop), between Murchison Road and Bragg Boulevard. Washington Drive and Blue Street, both off of Murchison Road, surround the project site. The site can be accessed from either Washington Drive or Blue Street.

The North Carolina Wetlands Restoration Program (NCWRP), in conjunction with the City of Fayetteville, North Carolina, identified portions of Cross Creek and Little Cross Creek as suitable for stream restoration. Both portions of the identified streams are on property owned by the City of Fayetteville. Both creeks had been impacted from development and had lost ecological functions related to water quality and biological habitat. The main factors in the degradation and impairment of the streams were straightening of the channels and the filling-in of the floodplains.

The Priority 2 restoration involved re-establishing the floodplain at a lower elevation, so that it can be accessed during storm events above bankfull. The new stream has essentially the same profile as the existing stream, but with a bank height ratio of one. The natural meander patterns were restored and rock grade control vanes and rootwads were incorporated for aquatic habitat enhancement and bed and bank stability.

Table I. Project Mitigation Structure and Objectives Table Cross Creek Stream Mitigation Site/Project No. 105					
Project Segment/Reach ID	Mitigation Type	Approach	Linear Footage	Stationing	Comment
Cross Creek	Restoration	Priority 2	1376	11+4.00 to 25+16.58	Instream structures and vegetated buffers
Little Cross Creek	Restoration	Priority 2	714	10+00 to 17+13.687	Instream structures and vegetated buffers

Monitoring of the restored site consists of annually evaluating both the morphology and the vegetation of the restored site for five years post-construction. Morphological stability is determined by evaluating monumented cross-sections, longitudinal profiles, and pebble counts. Surveys follow the methodology contained in the USDA Forest Service manual Stream Channel Reference Sites. Vegetation plots were established to monitor the vegetation on-site. This report contains information from the year one monitoring event conducted by Earth Tech in December 2006 and will address general problem areas found on-site and the stability of the restored stream.

II. PROJECT BACKGROUND

The project consists of portions of two tributaries to the Cape Fear River, Little Cross Creek and Cross Creek. Both are located within the city limits of Fayetteville on public lands south west of Fayetteville State University's Campus in Cumberland County, North Carolina (**Figure 1**).

A. General Description of the Watershed

Cross Creek and its tributary, Little Cross Creek, are located within the Coastal Plain Physiographic Province of the Cape Fear River Basin. Portions of the northwestern areas of the watershed are located within the Sandhills Physiographic Province. The headwaters of Cross Creek originate about 7.5 miles north-northwest of the project area. The headwaters of Little Cross Creek originate 6.0 miles north-northeast of the project area. Both streams enter the site as third-order streams before joining to form a fourth-order stream. Cross Creek (NCDWQ Stream Index Number 18-27-(3)) and Little Cross Creek (18-27-4-(2)) both have a WS-IV classification, which is assigned to water supplies in moderately to highly developed watersheds in North Carolina. Cross Creek and Little Cross Creek account for forty percent of Fayetteville's water supply.

The watershed is approximately 16,300 acres or 25.5 square miles (Figure 2). Approximately 15.5 square miles (9,920 acres) drain into Cross Creek and the remaining 10.0 square miles (6,380 acres) drain into Little Cross Creek. Murchison Road is located along the ridgeline separating the two watersheds.

B. Pre-existing Conditions

The restoration site is located entirely within a highly developed area of Fayetteville. Land immediately adjacent to the restoration site is undeveloped grass covered land slated to be included in the future Martin Luther King Jr. Park expansion. There are both water and sewer utilities within the project limits.

Both Cross Creek and Little Cross Creek have been impacted from development and have lost ecological functions related to water quality and biological habitat. The main factors in the degradation and impairment of the streams are past straightening of the channels and the

filling of their floodplains. The both reaches with the project limits were classified as G5-type channels, with a sinuosity of 1, and entrenchment ratios ranging from 1.25 to 1.9.

C. Goals and Objectives

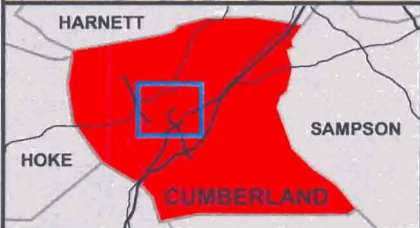
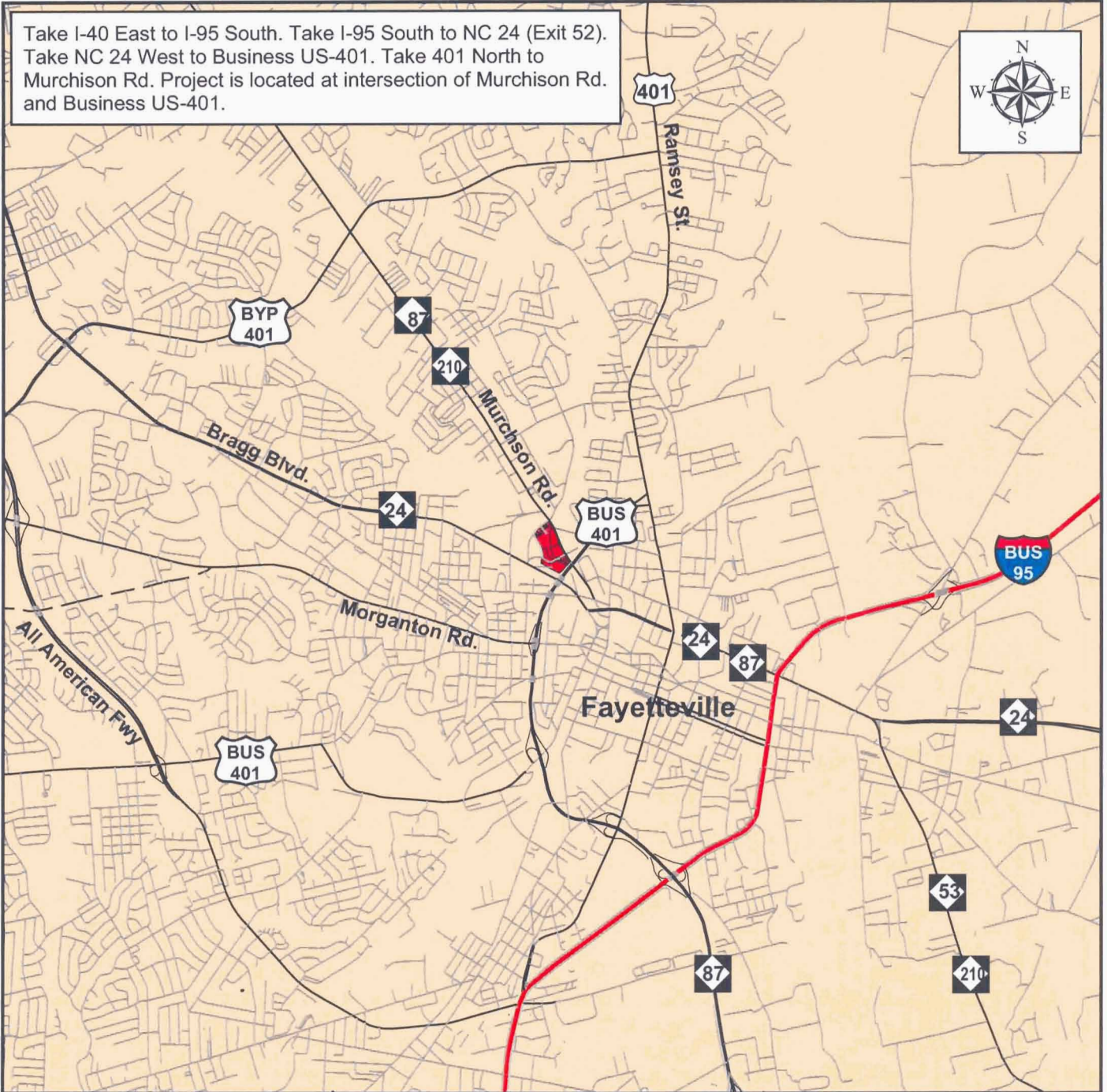
The Priority 2 restoration involved converting the 2,000 ft impaired channel into a sinuous channel that meanders for a total of 2,090 linear feet of stream as measured along the centerline. Rock cross-vanes and rootwads were incorporated for aquatic habitat enhancement and bed and bank stability. A riparian buffer that varies in width from 10 feet to 280 feet was planted with native vegetation and protected by a Conservation Easement.

The project had the following goals and objectives:

1. Provide a stable stream channel that neither aggrades nor degrades while maintaining its dimension, pattern, and profile with the capacity to transport its watershed's water and sediment load.
2. Provide the stream with a floodplain at the stream's current elevation.
3. Improve aquatic habitat with the use of natural material stabilization structures such as root wads, rock vanes, woody debris, and a riparian buffer.
4. Provide wildlife habitat and bank stability through the creation of a riparian zone.

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion Date
Restoration Plan	2002	2002	October 2002
Final Design - 90%	2004	NA	2004
Construction	2004	2004	January 2005
Temporary S&E mix applied to entire project area	2004	2004	2004
Permanent seed mix applied to entire project area	2004	2004	2004
Containerized, B&B, and livestock plantings	January 2005	January 2005	January 2005
Mitigation Plan / As-built (Year 0 Monitoring - baseline)	April 2006	April 2006	July 2006
Year 1 Monitoring	Fall 2006	November 2006	December 2006
Year 2 Monitoring	Fall 2007	NA	NA
Year 3 Monitoring	Fall 2008	NA	NA
Year 4 Monitoring	Fall 2009	NA	NA
Year 5 Monitoring	Fall 2010	NA	NA

Take I-40 East to I-95 South. Take I-95 South to NC 24 (Exit 52). Take NC 24 West to Business US-401. Take 401 North to Murchison Rd. Project is located at intersection of Murchison Rd. and Business US-401.

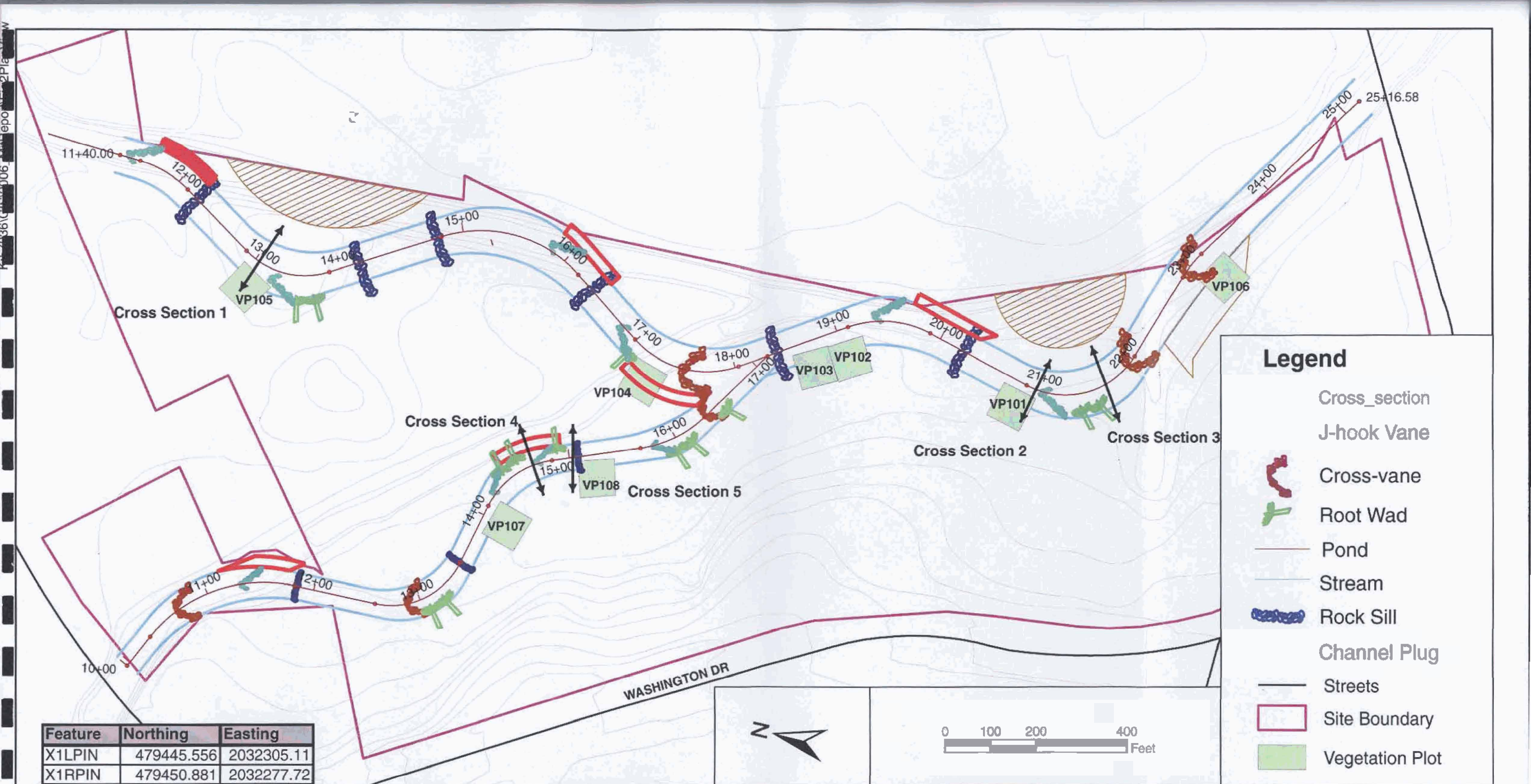


N.C. Ecosystem Enhancement Program

FIGURE 1
Project Location Map

Cross Creek
Cumberland County, North Carolina

December 2006



Legend

- Cross_section
- J-hook Vane
- Cross-vane
- Root Wad
- Pond
- Stream
- Rock Sill
- Channel Plug
- Streets
- Site Boundary
- Vegetation Plot

Feature	Northing	Easting
X1LPIN	479445.556	2032305.11
X1RPIN	479450.881	2032277.72
X2LPIN	478690.785	2032408.94
X2RPIN	478710.651	2032316.17
X3LPIN	478655.91	2032410.55
X3RPIN	478614.423	2032319.94
X4LPIN	479170.613	2032223.45
X4RPIN	479097.331	2032155.53
X5LPIN	479095.855	2032264.59
X5RPIN	479059.877	2032171.31

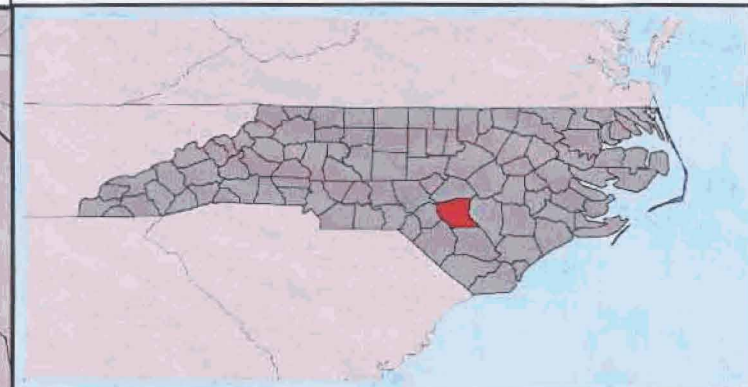
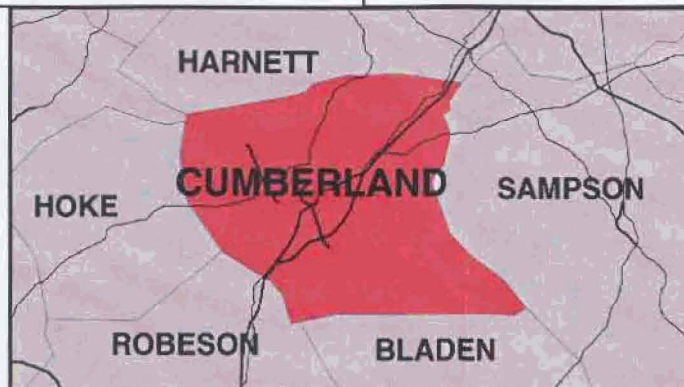
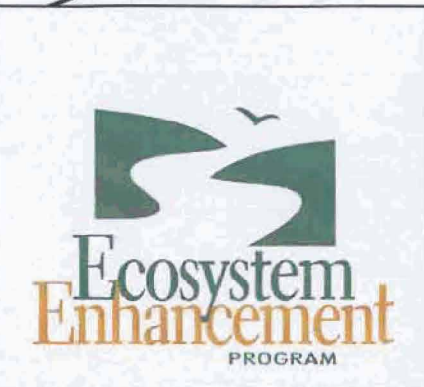


FIGURE 2
Monitoring Plan View
 Cross Creek Stream Restoration Site
 Cumberland County, NC
 December 2006

Table III. Project Contact Table Cross Creek Stream Restoration Site/Project No. 105	
Designer POC	<i>Earth Tech</i> 701 Corporate Center Drive Suite 475 Raleigh, NC 27607 Bill Jenkins PE (919) 854-6200
Construction Contractor POC	<i>Backwater Environmental</i> 2312 New Bern Ave. Raleigh, NC 27610 Wes Newell (919) 231-9227
Planting Contractor POC	<i>Carolina Silvics, Inc.</i> 908 Indian Trail Road Edenton, North Carolina 27932 Mary-Margaret McKinney (252) 482-8491
Seeding Contractor POC	<i>Backwater Environmental</i> 2312 New Bern Ave. Raleigh, NC 27610 Wes Newell (919) 231-9227
Seed Mix Sources	<i>Ernst Conservation Seeds</i> 9006 Mercer Pike Meadville, PA 16335 Stacy Charles (814) 336-2404
Nursery Stock Suppliers	<i>Coastal Plain Conservation Nursery (container plants)</i> 3067 Connors Drive Edenton, NC 27932 Ellen Colodney (252) 482-5707 <i>Cure Nursery (container plants)</i> 880 Buteo Road Pittsboro NC 27312 Jennifer Cure (919)-542-6186 <i>Taylor's Nursery</i> 3705 New Bern Avenue Raleigh, NC 27610 Richard Taylor (919) 231-6161 <i>International Paper</i> 55594 Hwy 38 S Blenheim, SC 29516 Gary Nelson (1-800-222-1290)
Monitoring Performers	<i>Earth Tech</i> 701 Corporation Center Drive, Suite 475 Raleigh, NC 27607 Ron Johnson (919) 854-6210
Stream Monitoring	Ron Johnson
Vegetation Monitoring	Ron Johnson
Wetland Monitoring	NA

Table IV. Project Background Table	
Cross Creek/Little Cross Creek Stream Mitigation Site/Project No. 105	
Project County	Cumberland
Drainage Area	
Cross Creek	10.5/25.5 sq mi
Drainage impervious cover estimate (%)	71%
Stream Order	
Cross Creek/Little Cross Creek	2nd/1st
Physiographic Region	Sandhills/Coastal Plain
Ecoregion	Atlantic Southern Loam Plains
Rosgen Classification of As-Built	C
Cowardin Classification	Riverine
Dominant Soil Types	Chewacla loam Rion fine sandy loam
Reference site ID	Country Club Branch and Little Rockfish Creek
USGS HUC for Project	03030004
USGS HUC for Reference	03030004
NCDWQ Sub-basin for Project	030615
NCDWQ Sub-basin for Reference	030701
NCDWQ Classification for Project	Cross Creek (C), Little Cross Creek (C)
NCDWQ Classification for Reference	UT Cross Creek (Country Club Branch, C), Little Rockfish Creek C
Any portion of any project segment 303D listed?	Yes
Any portion of any project segment upstream of a 303D listed segment?	Yes
Reasons for 303D listing or stressor	Impaired Biological Activity, fecal coliform
% of project easement fenced	0%

III. PROJECT CONDITION AND MONITORING RESULTS

A. Vegetation Assessment

1. Vegetation Success Criteria

The final vegetative success criteria will be the survival of 260 5-year old planted trees per acre at the end of year 5 of the monitoring period. An interim measure of vegetation planting success will be the survival of at least 320 3-year old planted trees per acre at the end of year 3 of the monitoring period.

2. Soil Data

Series	Max Depth (in.)	% Clay in Surface Horizon	K	T	OM % (Surface)
<i>Blaney-Urban land complex- 2-8 % slopes</i>	80	2-10	0.15 to 0.38	5	1 - 4
<i>Faceville Urban Land</i>	72	N/A	0.17 to 0.37	5	0.5 - 1
<i>Ru-Roanoke-Urban land complex -</i>	80	10-18	0.24 to 0.37	4	0.5 - 3

3. Stem Counts

Baseline vegetation plots were established during Year 0 on June 22, 2005 after vegetative planting was completed in January 2005. Eight (8) 10m X 10m vegetation survival plots were staked out in the floodplain of Cross Creek and Little Cross Creek. Survival of rooted vegetation will be evaluated using the eight plots and will continue for at least 5 years to determine survival. Stems were flagged and counted in each plot. The plots were visited on October 26, 2006 to determine survival of woody stems as part of the Year 1 monitoring period.

The original tree species planted include ironwood (*Carpinus caroliniana*), redbud (*Cercis canadensis*), persimmon (*Diospyros virginiana*), green ash (*Fraxinus pennsylvanicum*), black gum (*Nyssa sylvatica*), swamp cottonwood (*Populus heterophylla*), laurel oak (*Quercus laurifolia*), overcup oak (*Quercus lyrata*), willow oak (*Quercus phellos*), shumard oak (*Quercus shumardii*), bald cypress (*Taxodium distichum*), American elm (*Ulmus americana*). Shrubs and livestock were also planted in the floodplain and concentrated along the tops of the bank. Live stake species include silky dogwood (*Cornus amomum*), arrowwood (*Viburnum dentatum*), elderberry (*Sambucus canadensis*), and Carolina willow (*Salix caroliniana*). Shrubs include red chokeberry (*Aronia arbutifolia*), American beautyberry (*Callicarpa americana*), sweet pepperbush (*Clethra alnifolia*), ti-ti (*Cyrilla racemiflora*),

elderberry (*Sambucus canadensis*), witch-alder (*Fothergilla gardenii*), gallberry (*Ilex coriacea*), inkberry (*Ilex glabra*), wax myrtle (*Myrica cerifera*), winged sumac (*Rhus copallinum*), wither-rod (*Viburnum nudum*), and tag-alder (*Alnus serrulata*).

The initial baseline had an average of 470 trees per acre across the restoration easement area. If shrubs are included in the estimate then the average stem density was 835 stems per acre at Year 0. Stem densities have dropped since initial planting. The average tree density is now 309 stems per acre and the overall woody vegetation density is 567 stems per acre. The planted tree density is now below the interim measure of 320 3-year old planted trees per acre at the end of year 3. This number includes the increase in stem density for some species due to the difficulty in determining which planted stems from volunteer stems in some cases. The final vegetative success criteria will be the survival of 260 5-year old planted trees per acre at the end of year 5 of the monitoring period.

4. Vegetation Plot Photos

Photos of the vegetation plots are located in Appendix A.

Exhibit Table VI. Stem Counts for each species arranged by plot												
Scientific Name	Species Common Name	Plots								Initial Totals	Year 2 Totals	Survival %
		Main Channel				Trib						
		101	102	103	104	105	106	107	108			
Shrubs												
<i>Aronia arbutifolia</i>	Red chokeberry	1				2	1			5	4	80.0
<i>Callicarpa americana</i>	American beautyberry	2	3	3						10	8	80.0
<i>Clethra alnifolia</i>	Sweet pepperbush					2		1		5	3	60.0
<i>Sambucus canadensis</i>	Elderberry							1		1	1	100.0
<i>Fothergilla gardenii</i>	Witch-alder				1	1		1	1	9	4	44.4
<i>Ilex decidua</i>	Possumhaw	2	2	4	2	1				18	11	61.1
<i>Ilex glabra</i>	Inkberry	2				2				5	4	80.0
<i>Myrica cerifera</i>	Wax myrtle	1	2			2		2	2	6	9	150.0
<i>Rhus copallinum</i>	Winged sumac							1	1	6	2	33.3
<i>Viburnum nudum</i>	Wither-rod	1	1			3				7	5	71.4
<i>Alnus serrulata</i>	Tag alder							1		0	1	NA
	Total Shrubs	9	8	7	3	13	1	7	4	72	52	72.2
Trees												
<i>Carpinus caroliniana</i>	Ironwood				2				1	4	3	75.0
<i>Cercis canadensis</i>	Redbud							1		2	1	50.0
<i>Diospyros virginiana</i>	Persimmon					1			1	12	2	16.7
<i>Fraxinus pennsylvanicum</i>	Green ash	1			1					7	2	28.6
<i>Nyssa sylvatica</i>	Black gum	1		1		2		2	2	4	8	200.0
<i>Populus heterophylla</i>	Swamp cottonwood		2			1	2			12	5	41.7
<i>Quercus laurifolia</i>	Laurel oak									2	0	0.0
<i>Quercus lyrata</i>	Overcup oak				5	1		2	1	16	9	56.3
<i>Quercus phellos</i>	Willow oak		1	1				1	1	16	5	31.3
<i>Quercus shumardii</i>	Shumard oak		1	1		1			2	2	5	250.0
<i>Taxodium distichum</i>	Bald cypress	4	6	1			5	3		14	19	135.7
<i>Ulmus americana</i>	American elm					1		1		2	2	100.0
	Total Trees	6	10	4	8	7	8	10	8	93	61	65.6
Exotic Species												
	Kudzu	X	X	X				X	X			
	Mimosa	X	X	X								
	Johnson Grass								X			
	Chinese Privet				X							
TABLE SUMMARY	Total Stems of planted Woody vegetation.	15	18	11	11	20	9	17	12	112		
	Total Stems of Planted Trees	6	10	4	8	7	8	10	8	93		
	Current Density											
	Trees per hectare	600	1000	400	800	700	800	1000	800	763		
	Trees per acre	243	405	162	324	283	324	405	324	309		
	Stems per hectare	1500	1800	1100	1100	2000	900	1700	1200	1413		
	Stems per acre	607	729	445	445	810	364	688	486	572		

B. Stream Assessment

Earth Tech personnel performed site visits to the site in October and December of 2006 to perform vegetation and morphology surveys. During the field visits notes were made regarding the condition of the stream restoration project. Cross section and longitudinal surveys were performed in December of 2006. Five cross sections and approximately 1,455 linear feet of Cross Creek and 698 feet of Little Cross Creek were surveyed. Photographs were taken at all permanent photo points and a bed material analysis was performed in October, 2006. Vegetation is well established on the majority of the site.

Overall, the project is doing well with a few minor erosion areas and some areas of minimal vegetation. Repairs are recommended for the only major erosion area of the site, near Station 21+50. The other problem areas need to be watched and if the problems worsen over time, then solutions need to be discussed to assess the reason for the problem and potential options to fix the areas. Vegetative problem areas are described in Table VI and stream problem areas are described in Table IX.

1. Morphometric Criteria

The assessment included the survey of five total cross sections, as well as the longitudinal profile. Cross sections were marked with wooden stakes and rebar. Cross sections are located at the following locations. Station values were calculated using the design alignment as a baseline.

- Cross Section #1. Cross Creek, Station 12+93, midpoint of riffle
- Cross Section #2. Cross Creek, Station 20+91, midpoint of riffle
- Cross Section #3. Cross Creek, Station 21+46, midpoint of pool
- Cross Section #4. Little Cross Creek, Station 14+69, midpoint of pool
- Cross Section #5. Little Cross Creek, Station 15+19, midpoint of riffle

All of the cross sections appeared stable with little or no active bank erosion. Survey data collected during future monitoring periods may vary depending on actual rod placement and alignment; however, from this point forward this information should remain similar in overall appearance. It should be noted that there is an area of sever erosion occurring just downstream of XS-5 and may impact that cross section in the future.

2. Hydrologic Criteria

Monitoring requirements state that at least two bankfull events must be documented through the five-year monitoring period. No surface water gauges exist on Cross Creek or its tributaries. A review of known U.S. Geological Survey (USGS) surface water gauges identified three surface water gauges within 20 miles of the mitigation site: one on Rockfish Creek at Raeford (93.1 square miles), one on the Little River near Manchester (348.0 square miles), and one on the Cape Fear River in Fayetteville (4,395.00 square miles). None of the three streams has a drainage area that is directly comparable to Cross Creek (25.5 square miles). In order to determine future bankfull events for the site it may be necessary to install

a stream gauge onsite since comparison to nearby gauges will not be possible given the large difference in watershed area between existing stream gauges and the project stream.

The December 2006 survey crew noted trash and debris deposits well up on the flood plain that was not in place during the October vegetation survey. A 5” rainfall event occurred in November and it is assumed that this storm created the trash line that is more than 1’ above bankfull. In addition, heavy sand deposits on the bankfull floodplain, to a depth of more than .5’ in places are indicators of several bankfull events. Earth Tech’s field crew found cross section bank pins (rebar) that were up to 2 inches beneath sandy deposits.

Table VII. Verification of Bankfull Events Cross Creek Stream Mitigation Site/Project No. 105			
Date of Data Collection	Date of Occurrence	Method	Photo # (if available)
2006	None	NA	NA

Table VIII. Vegetation Problem Areas Cross Creek Stream Mitigation Site/Project No. 105			
Feature/Issue	Station # /Range	Probable Cause	Photo
Invasive Species	Vegetation Plot 103	Kudzu, Mimosa	VPA.5
	Vegetation Plot 104	Chinese Privet	VPA.6
Establishment Failure	Approximately 18+70	Lack of Vegetation	VPA.1
	Approximately 17+30	Lack of Vegetation	VPA.2
	Approximately 21+60	Lack of Vegetation	VPA.3
Direct Damages	NA	Beaver Damage	VPA.4

3. Bank Stability Assessments

BEHI and NBS assessments are only performed in years 3 and 5 post construction and are not applicable to this report.

4. Problem Areas

During the initial Year 1 Monitoring, some bank scour was noted in a few locations and bar formation was noted on Little Cross Creek at station 11+00. The level spreader was also discovered functioning improperly and channelization erosion occurring immediately down-slope from the spreader. Specific problem areas are detailed in the following table.

Table IX. Stream Problem Areas			
Cross Creek Stream Mitigation Site/Project No. 105			
Feature/Issue	Station # /Range	Probable Cause	Photo #
Bank Scour	14+50	Minimal vegetation, stress on bank.	SPA1
	15+80	Widening and deepening (“bowling”) of stream caused by turbulence from sill.	SPA2
	18+50	Widening and deepening (“bowling”) of stream caused by turbulence from sill.	SPA3
	23+00	Improperly applied level spreader; discharge from 48” pipe is probably much greater than anticipated.	SPA4
	21+50	Combination of shear stress on outside meander and erosion from discharge of 48” pipe.	SPA5
	LCC 10+70	Bank erosion caused by direction of flow towards bank and insufficient resistance of the bank to that flow .	SPA8
Engineered structures - improper function	Level Spreader	Channelization and erosion caused by discharge from 48” pipe.	SPA5
Aggradation/Bar Formation	LCC 10+50	Possible shift in channel location	SPA6
	LCC 12+40	Deposition on bank caused by design of over-widened channel.	
	LCC 14+20	Transverse bar formation causing perpendicular flow into outside bank, and concomitant bank erosion.	SPA9
	LCC 15+20	Transverse bar formation causing perpendicular flow into outside bank, and concomitant bank erosion.	SPA10
	LCC 15+70	Point bar formation caused by aggradation due to design of over-widened channel.	SPA11

**Table X. Categorical Stream Feature Visual Stability Assessment
Cross Creek Stream Mitigation Site/Project No. 105**

Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles	95%	60%				
B. Pools	100%	100%				
C. Thalweg	100%	90%				
D. Meanders	100%					
E. Bed General	95%	95%				
F. Vanes/J Hooks etc.	95%	100%				
G. Wads and Boulders	100%	90%				

C. Wetland Assessment

There is no wetland restoration associated with this site, therefore this table is not applicable to this project.

Table XI.A Baseline Morphology and Hydraulic Summary
Cross Creek Stream Mitigation Site/Project No. 105
(Cross Creek)

Parameter	USGS Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																		
BF Width (ft)				16.0	52.0	29.4	26.0	30.0	27.4	14.5	27.4	34.2			34.2		49.6	38.6
BF Cross Sectional Area (ft ²)				11.6	115.0	88.6	68.8	77.1	73.2	21.1	49.1	73			73		113.6	70.8
BF Mean Depth (ft)				1.3	6.3	2.9	2.5	3.0	2.65	0.8	2.3	2.14			2.14		2.3	2.0
BF Max Depth (ft)							3.3	4.1	3.7	2.1	3.5	3.2			3.2		4.3	3.4
Width/Depth Ratio							8.8	10.3	10.0	8.4	34	16			16		21.7	21.0
Entrenchment Ratio							1.25	1.9	1.6	10.5	14.9	2.7			2.7			
Wetted Perimeter (ft)																		
Hydraulic radius (ft)																		
Pattern																		
Channel Beltwidth (ft)									27.4	20	36				70	170	28	87
Radius of Curvature (ft)									0	7	36				70	120	75	120
Meander Wavelength									0	32	325				240	479	283	377
Meander Width ratio									1.0	0.67	1.8				2.0	5.0	0.82	1.75
Profile																		
Riffle length (ft)															38	177	92	10.99
Riffle slope (ft/ft)															.004	.004	.004	.0019
Pool length (ft)															11.0	42.7	30.5	43.35
Pool spacing (ft)										19	123				152	228	187	12.65
Substrate																		
d50 (mm)																		<.062
d84 (mm)																		.25-.5
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)																		1215.3
Sinuosity																		1442
Water Surface Slope (ft/ft)							1.0	1.0	1.0	1.3	1.5	1.10						1.19
BF slope (ft/ft)							.0022	.0022	0.0022	.0011	.0016	0.0024						0.0030
Rosgen Classification									G5,E5									0.0021
Habitat Index																		C
Macrobenthos																		

Table XLB Baseline Morphology and Hydraulic Summary
Cross Creek Stream Mitigation Site/Project No. 105
(Little Cross Creek)

Parameter	USGS Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Dimension																		
BF Width (ft)				14.0	49.0	25.1	17.3	23.0	20.2	14.5	27.4			24.7	23.3	36.4	29.9	
BF Cross Sectional Area (ft ²)				11.5	200	66.4	33.5	43.6		21.1	49.1			38	35.5	50.1	42.8	
BF Mean Depth (ft)				1.2	5.9	2.6			1.9	0.8	2.3			1.54	1.4	1.5	1.45	
BF Max Depth (ft)							2.5	2.9		2.1	3.5			N/A	2.3	3.0	2.65	
Width/Depth Ratio							8.9	12.1		8.4	34			16	15.3	26.5	20.9	
Entrenchment Ratio									1.6	10.5	14.9			3.3				
Wetted Perimeter (ft)																		
Hydraulic radius (ft)																		
Pattern																		
Channel Beltwidth (ft)									20.2	20	36			50	124	90	61	
Radius of Curvature (ft)									0	7	36			50	86	134	91.5	
Meander Wavelength									0	32	325			173	346	380	295	
Meander Width ratio									1.0	0.67	1.8			2.0	5.0	2.47	2.04	
Profile																		
Rifle length (ft)														58	81	76	12.9	26.4
Rifle slope (ft/ft)														.006	.006	.0016	.0202	.0029
Pool length (ft)														24.3	37.3	27.7	20.3	52.2
Pool spacing (ft)							36	131	83	19	123			90	172	118	8.0	14.2
Substrate																		
d50 (mm)																.5-1.0	1.0-2.0	
d84 (mm)																1.0-2.0	16.0-22.6	
Additional Reach Parameters																		
Valley Length (ft)																		661
Channel Length (ft)																		714
Sinuosity									1.0	1.3	1.5					1.12		1.08
Water Surface Slope (ft/ft)									.0037	.0011	.0016					0.0033		0.0030
BF slope (ft/ft)																		0.0099
Rosgen Classification									G5							C5		C
Habitat Index																		
Macrobenthos																		

Table XII.A Morphology and Hydraulic Monitoring Summary
Cross Creek Stream Mitigation Site/Project No. 105
(Cross Creek)

Parameter	Cross Section 1 1+66.3 Riffle				Cross Section 2 10+04.3 Riffle				Cross Section 3 10+71.0 Pool															
	MY0	MY1	MY2		MY0	MY1	MY2		MY0	MY1	MY2													
Dimension																								
BF Width (ft)	34.2	33.6			38.6	19.37			49.6	37.8														
Floodprone Width (ft) (approx)	>100	91.8			>100	78.37				101.4														
BF Cross Sectional Area (ft ²)	67.8	62.7			70.8	34.6			113.6	78.6														
BF Mean Depth (ft)	2.0	1.87			1.8	1.78			2.3	2.08														
BF Max Depth (ft)	3.2	3.26			3.4	2.25			4.3	4.59														
Width/Depth Ratio	17.3	17.95			21.0	10.9			21.7	18.2														
Entrenchment Ratio	>2.9	2.73			>1.8	4.04				2.68														
Wetted Perimeter (ft)		34.6				20.9				42.4														
Hydraulic radius (ft)		1.81				1.65				1.85														
Substrate																								
d50 (mm)	<.062	.25			1.0-2.0	.37			.5-1.0	.04														
d84 (mm)	.25-.5	.61			16.0-22.6	.83			1.0-2.0	18.84														
Parameter	MY-01 (2006)				MY-02 (2007)				MY-03 (2008)				MY-04 (2009)				MY-05 (2010)				MY+ (2011)			
Pattern	Min	Max	Med		Min	Max	Med		Min	Max	Med		Min	Max	Med		Min	Max	Med		Min	Max	Med	
Channel Beltwidth (ft)	32	90	61																					
Radius of Curvature (ft)	71	134	91.5																					
Meander Wavelength (ft)	210	380	295																					
Meander Width Ratio	1.37	2.47	2.04																					
Profile																								
Riffle Length (ft)	8	78	30																					
Riffle Slope (ft/ft)	.0009	.0067	.0035																					
Pool length (ft)	9	106	46																					
Pool spacing (ft)	27	203	73																					
Additional Reach Parameters																								
Valley Length (ft)		1215.3																						
Channel Length (ft)		1442																						
Sinuosity		1.19																						
Water Surface Slope (ft/ft)		0.00194																						
BF Slope (ft/ft)		0.0021																						
Rosgen Classification		C																						
Habitat Index*																								
Macrobenthos*																								

**Table XII.B Morphology and Hydraulic Monitoring Summary
Cross Creek Stream Mitigation Site/Project No. 105
(Little Cross Creek)**

Parameter	Cross Section 4 1+94 Pool						Cross Section 5 2+91 Riffle											
	MY0	MY1	MY2	MY0	MY1	MY2	MY0	MY1	MY2	MY0	MY1	MY2						
Dimension																		
BF Width (ft)	36.4	67		23.3	17.5													
Floodprone Width (ft) (approx)		100.5		90.0	89.4													
BF Cross Sectional Area (ft ²)	50.1	69		35.5	23.4													
BF Mean Depth (ft)	1.4	1.03		1.5	1.36													
BF Max Depth (ft)	3.0	3.16		2.3	2.61													
Width/Depth Ratio	26.5	65.1		15.3	12.9													
Entrenchment Ratio		1.5		3.9	5.01													
Wetted Perimeter (ft)		69.2			22.5													
Hydraulic radius (ft)		1.0			1.06													
Substrate																		
d50 (mm)	062-125	42		5-10	.35													
d84 (mm)	20-40	10-97		20-40	.97													
Parameter	MY-01 (2006)			MY-02 (2007)			MY-03 (2008)			MY-04 (2009)			MY-05 (2010)			MY+ (2011)		
Pattern	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med
Channel Beltwidth (ft)	32	90	61															
Radius of Curvature (ft)	71	134	91.5															
Meander Wavelength (ft)	210	380	295															
Meander Width Ratio	1.37	2.47	2.04															
Profile																		
Riffle Length (ft)	10	64	23															
Riffle Slope (ft/ft)	.0011	.0145	.0056															
Pool length (ft)	12	67	42.8															
Pool spacing (ft)	10	46	30															
Additional Reach Parameters																		
Valley Length (ft)		661																
Channel Length (ft)		714																
Sinuosity		1.08																
Water Surface Slope (ft/ft)		0.002879																
BF Slope (ft/ft)		0.0099																
Rosgen Classification		C																
Habitat Index*																		
Macrobenthos*																		

Appendix A

- A-1 Vegetation Survey Data Tables**
- A-2 Vegetation Problem Area Photos**
- A-3 Vegetation Monitoring Plot Photos**
- A-4 Vegetation Monitoring Plot Locations**

Exhibit Table VIII. Stem Counts for each species arranged by plot														Initial Totals	Year 2 Totals	Survival %	
Scientific Name	Common Name	Plots											Initial Totals	Year 2 Totals	Survival %		
		101	102	103	104	105	106	107	108								
Shrubs																	
<i>Aronia arbutifolia</i>	Red chokeberry	1				2	1							5	4	80.0	
<i>Callicarpa americana</i>	American beautyberry	2	3	3										10	8	80.0	
<i>Clethra alnifolia</i>	Sweet pepperbush					2					1			5	3	60.0	
<i>Sambucus canadensis</i>	Elderberry										1			1	1	100.0	
<i>Fothergilla gardenii</i>	Witch-alder				1	1	1	1	1	1	1	1	1	9	4	44.4	
<i>Ilex decidua</i>	Possumhaw	2	2	4	2	1								18	11	61.1	
<i>Ilex glabra</i>	Inkberry	2				2								5	4	80.0	
<i>Myrica cerifera</i>	Wax myrtle	1	2			2				2	2	2	2	6	9	150.0	
<i>Rhus copallinum</i>	Winged sumac										1	1	1	6	2	33.3	
<i>Viburnum nudum</i>	Wither-rod	1	1					3						7	5	71.4	
<i>Alnus serrulata</i>	Tag alder										1	1	1	0	1	NA	
	Total Shrubs	9	8	7	3	13	1	7	4	1	7	4	4	72	51		
Trees																	
<i>Carpinus caroliniana</i>	Ironwood				2									1	4	3	75.0
<i>Cercis canadensis</i>	Redbud										1			2	1	50.0	
<i>Diospyros virginiana</i>	Persimmon						1					1		12	2	16.7	
<i>Fraxinus pennsylvanicum</i>	Green ash	1			1									7	2	28.6	
<i>Nyssa sylvatica</i>	Black gum	1		1		2				2	2	2	2	4	8	200.0	
<i>Populus heterophylla</i>	Swamp cottonwood		2			1	2							12	5	41.7	
<i>Quercus laurifolia</i>	Laurel oak													2	0	0.0	
<i>Quercus lyrata</i>	Overcup oak				5	1				2	1	1	1	16	9	56.3	
<i>Quercus phellos</i>	Willow oak		1	1			1			1	1	1	1	16	5	31.3	
<i>Quercus shumardii</i>	Shumard oak		1	1		1						2	2	2	5	250.0	
<i>Taxodium distichum</i>	Bald cypress	4	6	1			5	3						14	19	135.7	
<i>Ulmus americana</i>	American elm					1				1				2	2	100.0	
	Total Trees	6	10	4	8	7	8	10	8	7	8	10	8	93	61		
Exotic Species																	
	Kudzu	X	X	X										X	X		
	Mimosa	X	X	X													
	Johnson Grass														X		
	Total Stems of planted Woody vegetation.	15	18	11	11	20	9	17	12	12	12	12	12	113			
	Total Stems of Planted Trees	6	10	4	8	7	8	10	8	10	8	10	8	93			
	Current Density																
	Trees per hectare	600	1000	400	800	700	800	1000	800	1000	800	1000	800	763			
	Trees per acre	243	405	162	324	283	324	405	324	405	324	405	324	309			
	Stems per hectare	1500	1800	1100	1100	2000	900	1700	1200	1200	1413	1200	1413				
	Stems per acre	607	729	445	445	810	364	688	486	486	572	486	572				

TABLE SUMMARY

**Cross Creek Stream Restoration Site
Mitigation Report
Appendix A-2
Vegetation Problem Area Photos**



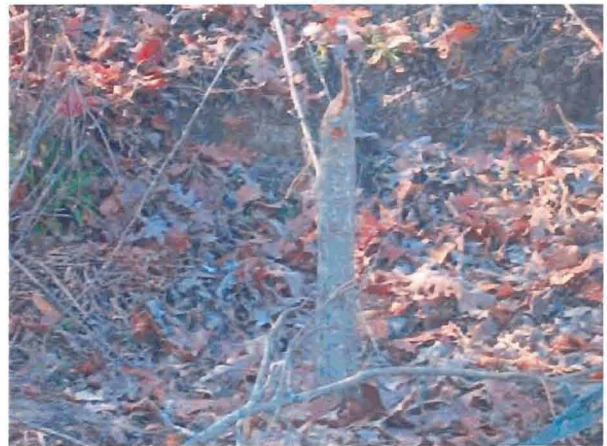
VPA1. Vegetation failure near Station 18+70



VPA2. Vegetation failure near Station 17+30



VPA3. Vegetation failure near Station 21+60



VPA4. Evidence of beaver damage.



VPA5. Invasive Species. Kudzu and Mimosa



VPA6. Invasive Species. Kudzu and Privet

**Cross Creek Stream Restoration Site
Mitigation Report
Appendix A-3
Vegetation Monitoring Plot Photos**



Vegetation Plot 101



Vegetation Plot 102



Vegetation Plot 103



Vegetation Plot 104



Vegetation Plot 105



Vegetation Plot 106

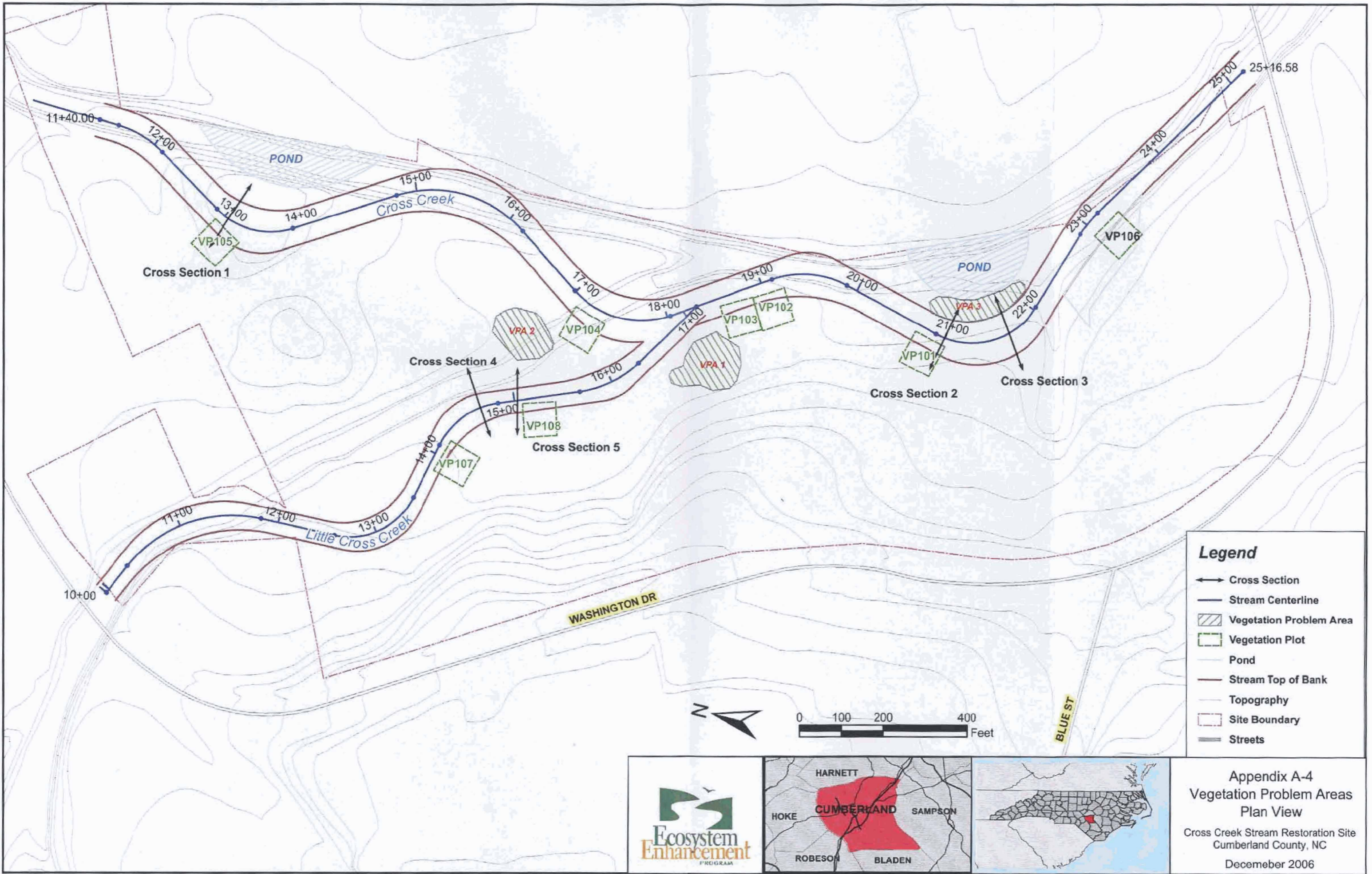
**Cross Creek Stream Restoration Site
Mitigation Report
Appendix A-3
Vegetation Monitoring Plot Photos**



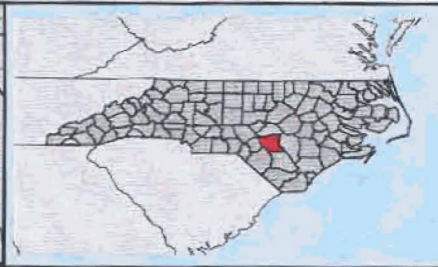
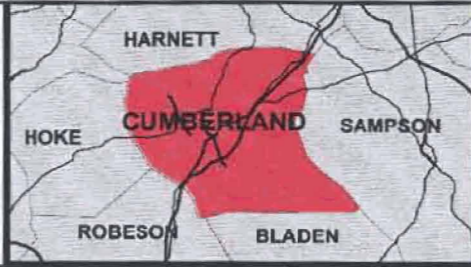
Vegetation Plot 107



Vegetation Plot 108



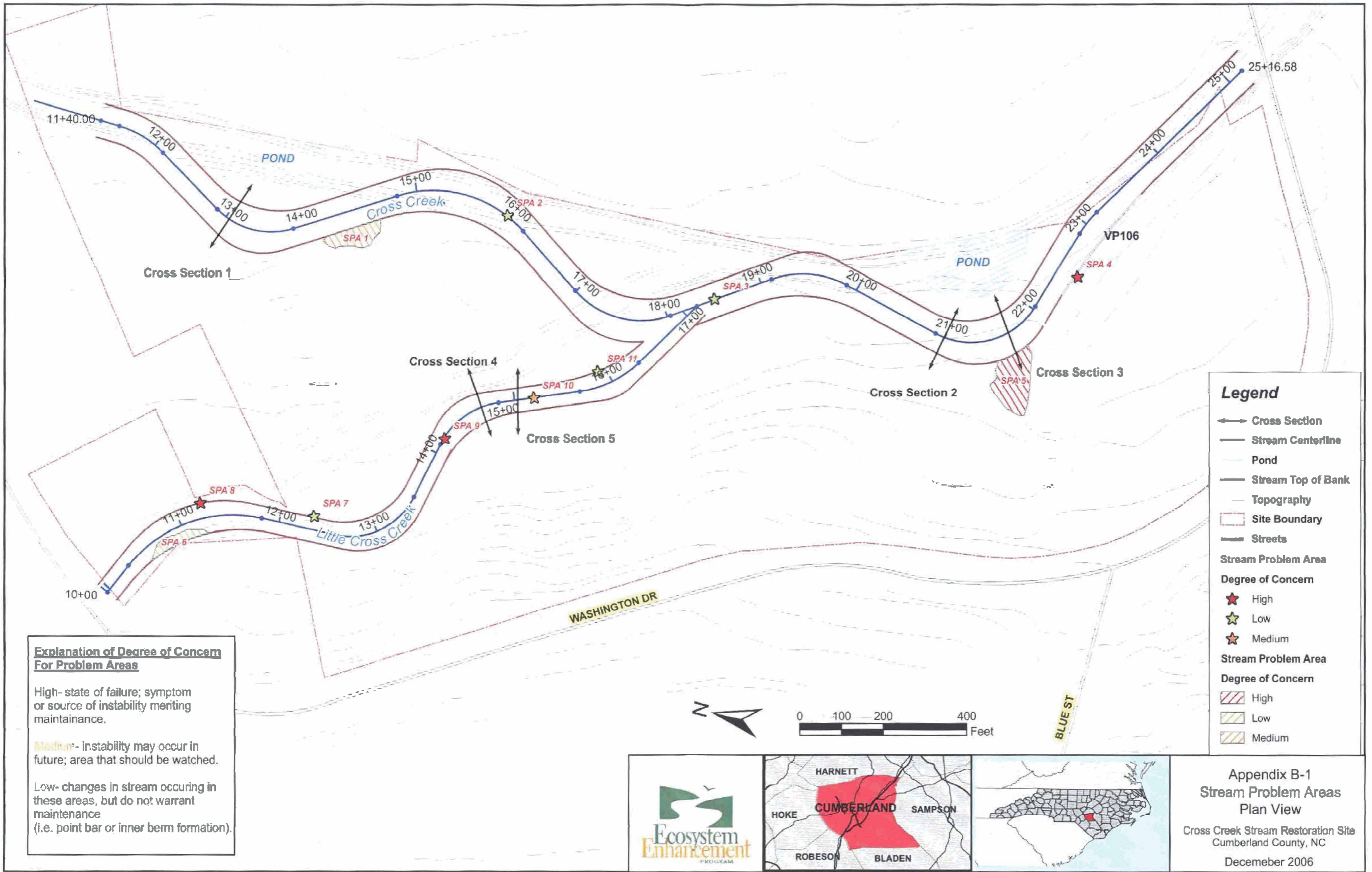
- Legend**
- ↔ Cross Section
 - Stream Centerline
 - ▨ Vegetation Problem Area
 - - - Vegetation Plot
 - Pond
 - Stream Top of Bank
 - Topography
 - - - Site Boundary
 - Streets



Appendix A-4
Vegetation Problem Areas
Plan View
Cross Creek Stream Restoration Site
Cumberland County, NC
December 2006

Appendix B

- B-1 Problem Areas Plan View**
- B-2 Representative Stream Problem Area Photos**
- B-3 Stream Photo Station Points**
- B-4 Exhibit Table B.1. Qualitative Visual Stability Assessment - NOT INCLUDED**
- B-5 Cross Sectional Plots and Raw Data Tables**
- B-6 Longitudinal Plots and Raw Data Tables**
- B-7 Pebble Count Plots and Raw Data Tables**



Explanation of Degree of Concern For Problem Areas

High- state of failure; symptom or source of instability meriting maintenance.

Medium- instability may occur in future; area that should be watched.

Low- changes in stream occurring in these areas, but do not warrant maintenance (i.e. point bar or inner berm formation).

Legend

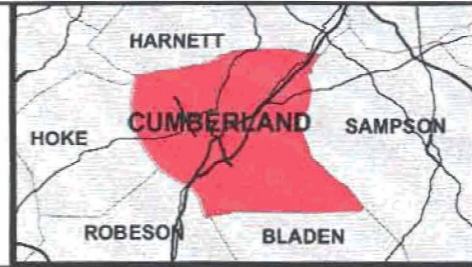
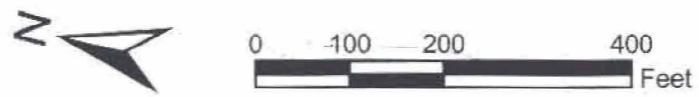
- ↔ Cross Section
- Stream Centerline
- Pond
- Stream Top of Bank
- - - Topography
- Site Boundary
- Streets

Stream Problem Area Degree of Concern

- ★ High
- ☆ Low
- ☆ Medium

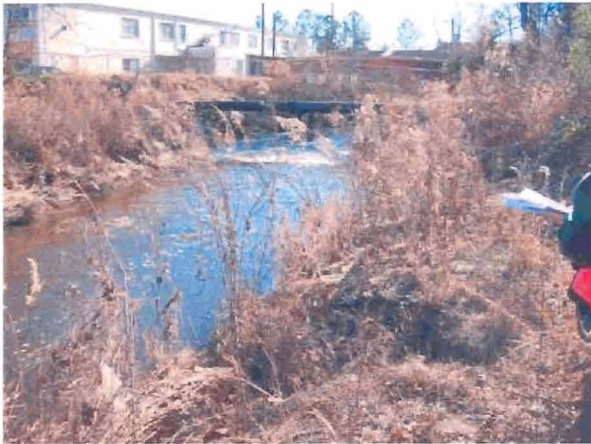
Stream Problem Area Degree of Concern

- ▨ High
- ▨ Low
- ▨ Medium



Appendix B-1
Stream Problem Areas
Plan View
 Cross Creek Stream Restoration Site
 Cumberland County, NC
 December 2006

**Cross Creek Stream Restoration Site
Mitigation Report
Appendix B-2
Stream Problem Area Photos**



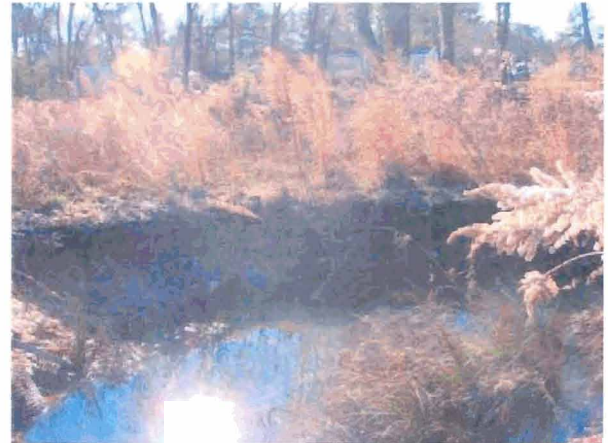
SPA 1. Station 14+50 Erosion on right bank above utility pipe.



SPA 2. Station 15+80 Bowling effect caused by pool formation below utility pipe.



SPA 3. Station 18+50 Bowling effect caused by pool formation below sill.



SPA 4. Station 23+00 Erosion due to failed level spreader.



SPA 5. Station 21+50 As-built outside meander with toe revetment.

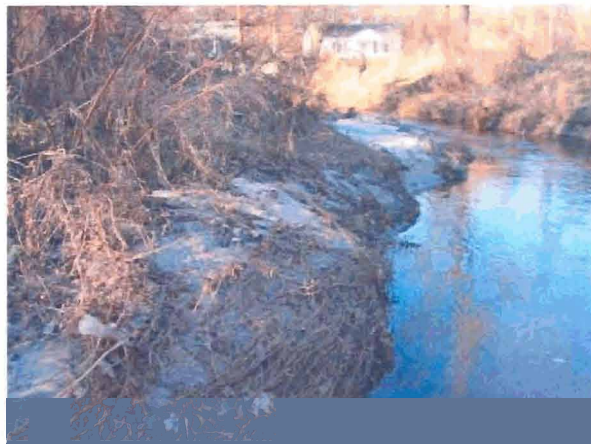


SPA 5. Station 21+50 Current state of outside meander; bank failure occurring.

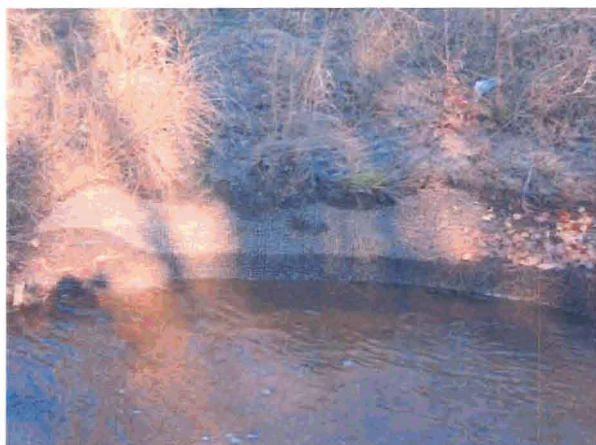
**Cross Creek Stream Restoration Site
Mitigation Report
Appendix B-2
Stream Problem Area Photos**



SPA 6. Station 10+50 on Little Cross Creek (LCC). Deposition causing point bar formation.



SPA 7. Station 10+70 on LCC Deposition on left bank.



SPA 8. Station 12+00 on LCC. Undercut matting on left bank.



SPA 9. Station 14+20 on LCC. Transverse bar formation and concomitant erosion on left bank.



SPA 10a. Station 15+20 on LCC. Looking downstream at bar formation in stream.



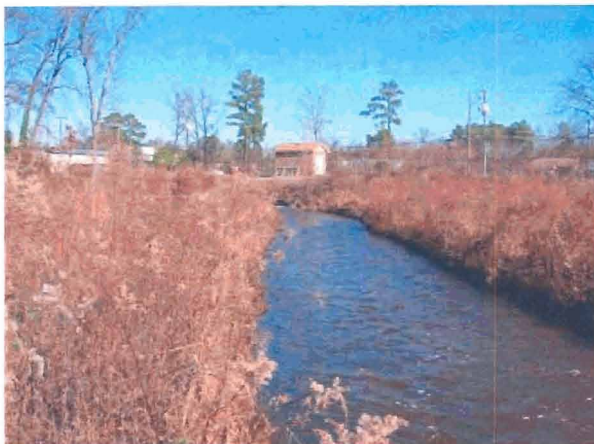
SPA 10b. Station 15+20 on LCC. Looking downstream at bar formation in stream.

**Cross Creek Stream Restoration Site
Mitigation Report
Appendix B-2
Stream Problem Area Photos**



SPA 11. Station 16+00 on LCC. Aggradation causing point bar formation above structure. Looking upstream.

**Cross Creek Stream Restoration Site
Mitigation Report
Appendix B-3
Stream Photo Station Points**



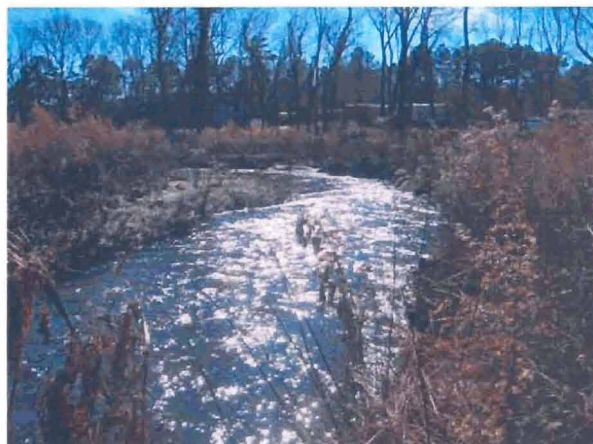
Cross-Section 1 (Station 13+03) Facing US



Cross-Section 1 (Station 13+03) Facing DS



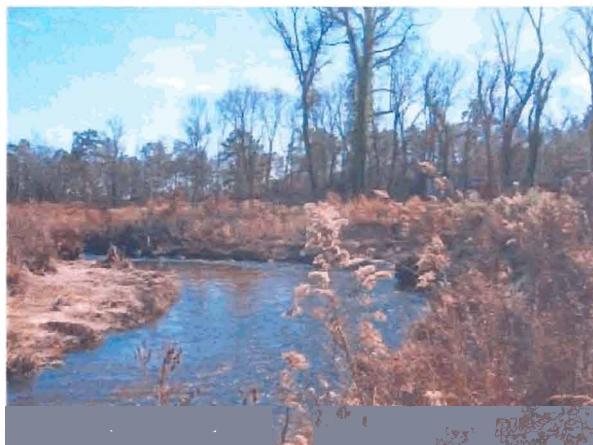
Cross-Section 2 (Station 21+00) Facing US



Cross-Section 2 (Station 21+00) Facing DS



Cross-Section 3 (Station 21+61) Facing US



Cross-Section 3 (Station 21+61) Facing DS

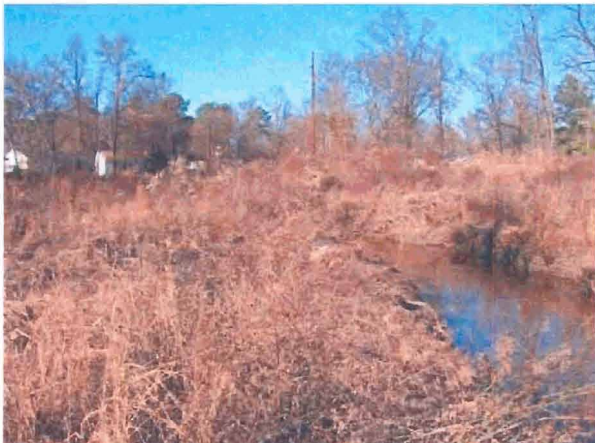
**Cross Creek Stream Restoration Site
Mitigation Report
Appendix B-3
Stream Photo Station Points**



Cross-Section 4 (Station 14+61) Facing US



Cross-Section 4 (Station 14+61) Facing DS



Cross-Section 5 (Station 15+30) Facing US



Cross-Section 5 (Station 15+30) Facing DS

B5.1a: RIVERMORPH CROSS SECTION SUMMARY
 Cross Creek - XS-1

Cross Section Name: XS-1 (1725-1050)
 Survey Date: 10/06

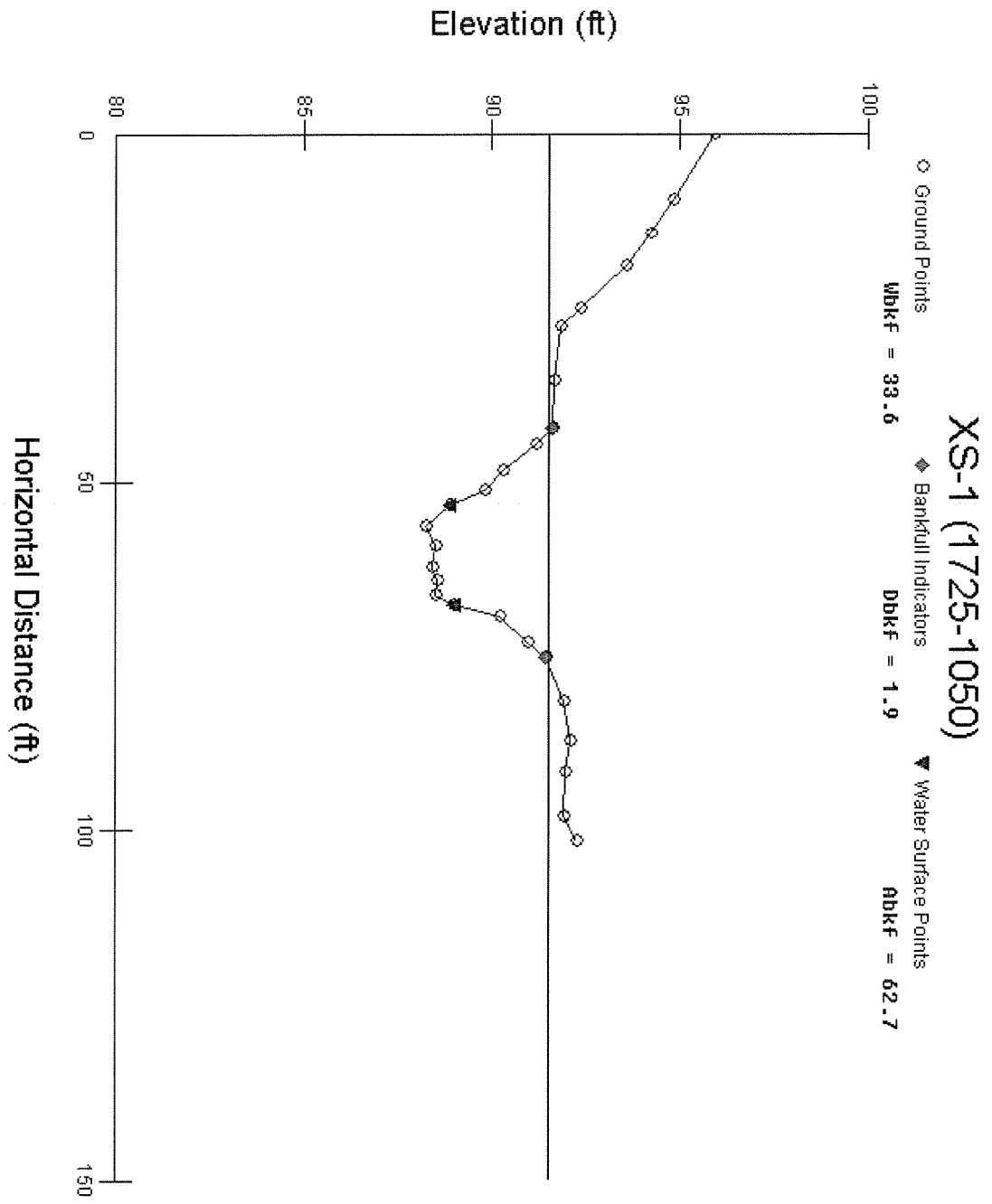
Cross Section Data Entry

BM Elevation: 95.88 ft
 Backsight Rod Reading: 7.05 ft

TAPE	FS	ELEV	NOTE
0	7.05	95.88	1725 RB PIN
9.3	8.11	94.82	
14.2	8.75	94.18	
18.9	9.4	93.53	
24.9	10.61	92.32	
27.6	11.1	91.83	
35.2	11.29	91.64	
42.1	11.34	91.59	BKF
44.6	11.79	91.14	
48.3	12.65	90.28	
51.1	13.11	89.82	
53.3	14.06	88.87	REW
56.2	14.69	88.24	
59.2	14.43	88.5	
62.1	14.53	88.4	
64.1	14.41	88.52	
66.2	14.43	88.5	
67.7	13.95	88.98	LEW
69.3	12.75	90.18	
73.1	12.01	90.92	
75.1	11.51	91.42	BKF
81.5	11.03	91.9	
87.2	10.86	92.07	
91.6	11	91.93	
98.1	11.02	91.91	
101.5	10.71	92.22	

Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	94.76	94.76	----
Bankfull Elevation (ft)	91.5	91.5	----
Floodprone Width (ft)	91.74	----	----
Bankfull Width (ft)	33.57	41.98	----
Entrenchment Ratio	2.73	----	----
Mean Depth (ft)	1.87	1.87	----
Maximum Depth (ft)	3.26	3.26	----
Width/Depth Ratio	17.95	22.45	----
Bankfull Area (sq ft)	62.74	62.74	----
Wetted Perimeter (ft)	34.63	34.63	----
Hydraulic Radius (ft)	1.81	1.81	----
Begin BKF Station	42.6	42.6	----
End BKF Station	76.17	76.17	----



B5.2a: RIVERMORPH CROSS SECTION SUMMARY
 Cross Creek - XS-2

Cross Section Name: XS-2 (1541-1529)
 Survey Date: 11/06

 Cross Section Data Entry

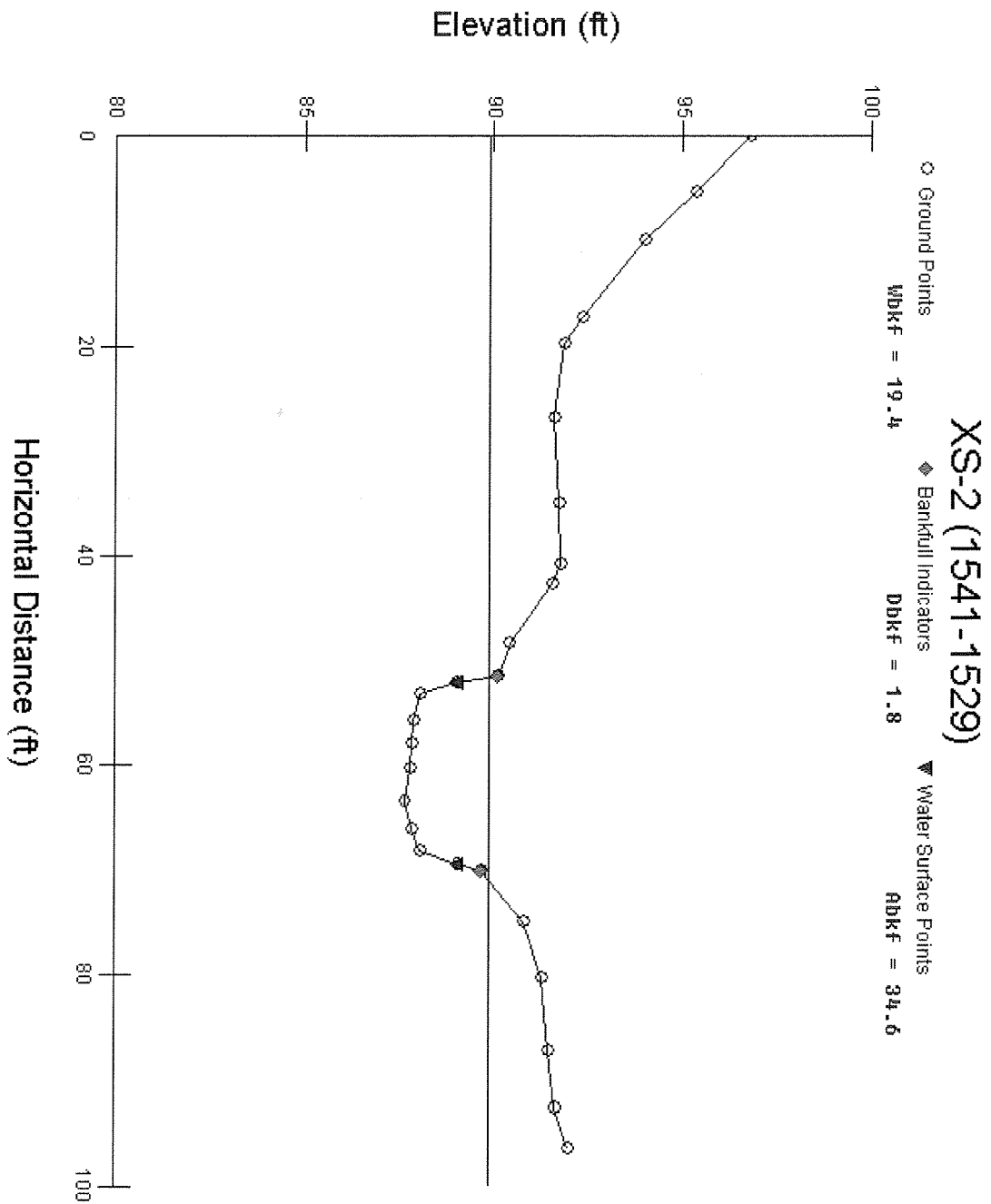
BM Elevation: 96.76 ft
 Backsight Rod Reading: 6.4 ft

TAPE	FS	ELEV	NOTE
0	6.4	96.76	1541 RB PIN
5.3	7.81	95.35	
9.8	9.18	93.98	
17.2	10.81	92.35	
19.8	11.31	91.85	
26.8	11.57	91.59	
35	11.42	91.74	
40.8	11.4	91.76	
42.7	11.59	91.57	
48.3	12.72	90.44	
51.5	13.02	90.14	BKF
52.1	14.13	89.03	REW
53.2	15.08	88.08	
55.8	15.25	87.91	
58	15.3	87.86	
60.3	15.34	87.82	
63.5	15.5	87.66	
66.1	15.3	87.86	
68.2	15.09	88.07	
69.4	14.11	89.05	LEW
70	13.48	89.68	BKF
74.9	12.35	90.81	
80.3	11.88	91.28	
87.2	11.69	91.47	
92.6	11.53	91.63	
96.4	11.17	91.99	

 Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	92.16	92.16	92.16
Bankfull Elevation (ft)	89.91	89.91	89.91
Floodprone Width (ft)	78.21	----	----
Bankfull Width (ft)	19.37	9.69	9.69
Entrenchment Ratio	4.04	----	----
Mean Depth (ft)	1.78	1.86	1.71
Maximum Depth (ft)	2.25	2.14	2.25
Width/Depth Ratio	10.88	5.21	5.67
Bankfull Area (sq ft)	34.57	18.03	16.54
Wetted Perimeter (ft)	20.93	12.71	12.49
Hydraulic Radius (ft)	1.65	1.42	1.32
Begin BKF Station	51.62	51.62	61.31
End BKF Station	71	61.31	71

B5.2b: Cross Creek XS-2 Plot



Cross Section Name: XS-3 (1543-1519)
 Survey Date: 11/06

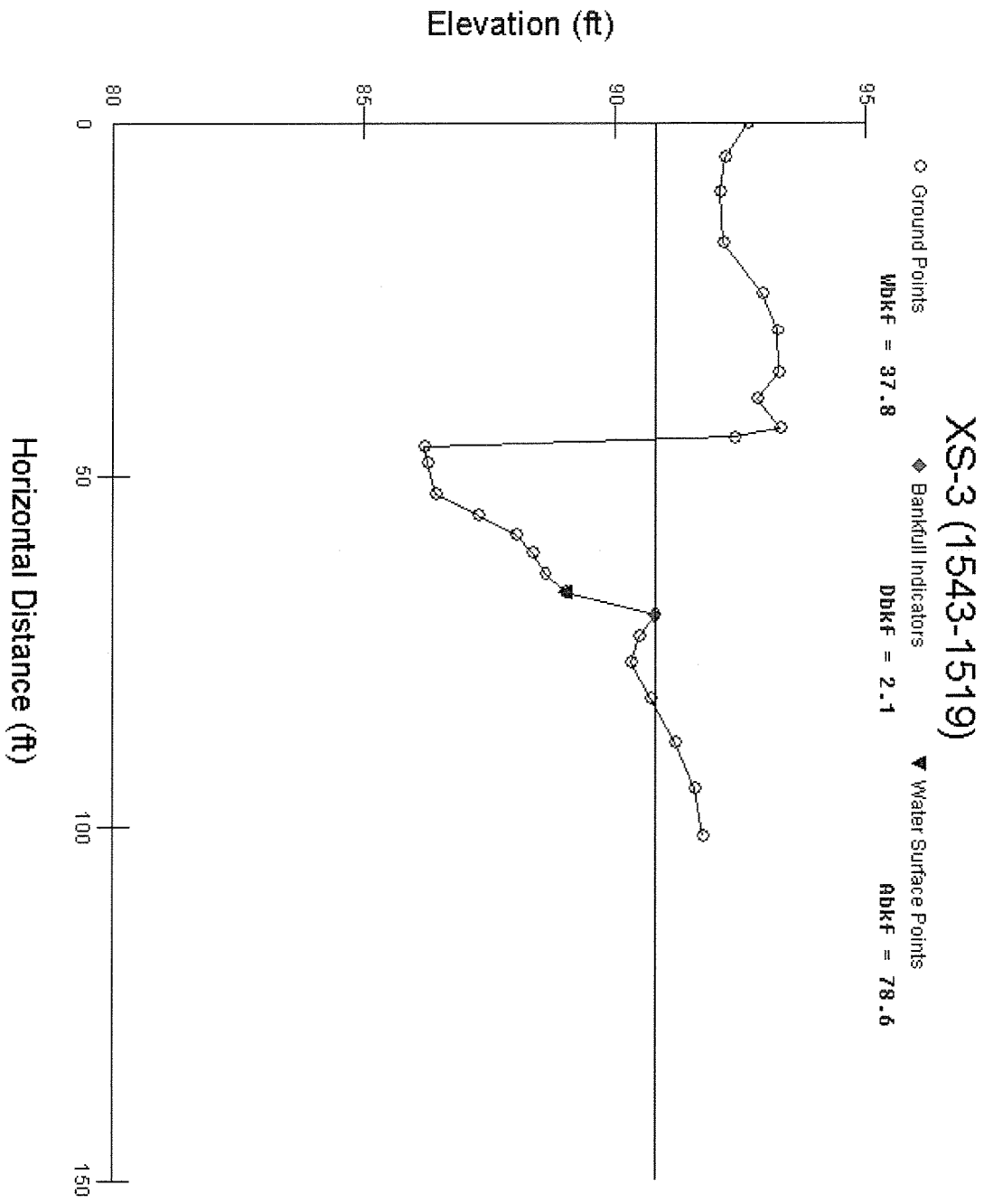
 Cross Section Data Entry

BM Elevation: 92.64 ft
 Backsight Rod Reading: 11.93 ft

TAPE	FS	ELEV	NOTE
0	11.93	92.64	1543 RB Pin
4.9	12.38	92.19	
9.6	12.47	92.1	
17	12.43	92.14	
24.2	11.64	92.93	
29.4	11.34	93.23	
35.3	11.32	93.25	
39	11.74	92.83	
43.2	11.27	93.3	
44.6	12.19	92.38	RB TOB EOW
45.8	18.36	86.21	
48.3	18.29	86.28	
52.7	18.14	86.43	
55.6	17.27	87.3	
58.4	16.54	88.03	
61	16.21	88.36	
64.1	15.96	88.61	
66.7	15.55	89.02	LEW
69.9	13.77	90.8	BKF
73	14.09	90.48	
76.7	14.25	90.32	
81.7	13.85	90.72	
88.1	13.36	91.21	
94.5	12.97	91.6	
101.4	12.8	91.77	

 Cross Sectional Geometry

	Channel	Left	Right
Floodprone Elevation (ft)	95.39	95.39	95.39
Bankfull Elevation (ft)	90.8	90.8	90.8
Floodprone Width (ft)	101.4	----	----
Bankfull Width (ft)	37.84	18.92	18.91
Entrenchment Ratio	2.68	----	----
Mean Depth (ft)	2.08	3.52	0.64
Maximum Depth (ft)	4.59	4.59	2.21
Width/Depth Ratio	18.19	5.38	29.55
Bankfull Area (sq ft)	78.56	66.54	12.02
Wetted Perimeter (ft)	42.41	25.17	21.66
Hydraulic Radius (ft)	1.85	2.64	0.56
Begin BKF Station	44.91	44.91	63.83
End BKF Station	82.74	63.83	82.74



B5.4a: RIVERMORPH CROSS SECTION SUMMARY

Cross Creek - XS-4

Cross Section Name: XS-4 (1691-1616)

Survey Date: 12/28/06

Cross Section Data Entry

BM Elevation: 93.57 ft

Backsight Rod Reading: 1.41 ft

TAPE	FS	ELEV	NOTE
0	1.41	93.57	1691 RB Pin
2.1	2.18	92.8	
5.4	2.77	92.21	
9	3.49	91.49	
12.8	4.29	90.69	
16.9	4.92	90.06	
22.3	4.96	90.02	
27.2	4.99	89.99	
32.2	5.3	89.68	
36	5.63	89.35	
40.5	4.59	90.39	BKF
43	5.64	89.34	
44	7.1	87.88	REW
45.8	7.58	87.4	
47.6	7.38	87.6	
49.7	7.53	87.45	
52.7	7.64	87.34	
55.1	7.75	87.23	
57	7.78	87.2	
58.4	7.05	87.93	LEW
59.2	6.54	88.44	
62.1	4.64	90.34	BKF
64.2	4.5	90.48	
66.7	4.53	90.45	
68.6	4.56	90.42	
71.1	4.8	90.18	
74.3	4.85	90.13	
77.5	5.12	89.86	
82.9	5.34	89.64	
89.9	4.51	90.47	
92.7	3.7	91.28	
95.3	3.14	91.84	
101.6	1.15	93.83	

Cross Sectional Geometry

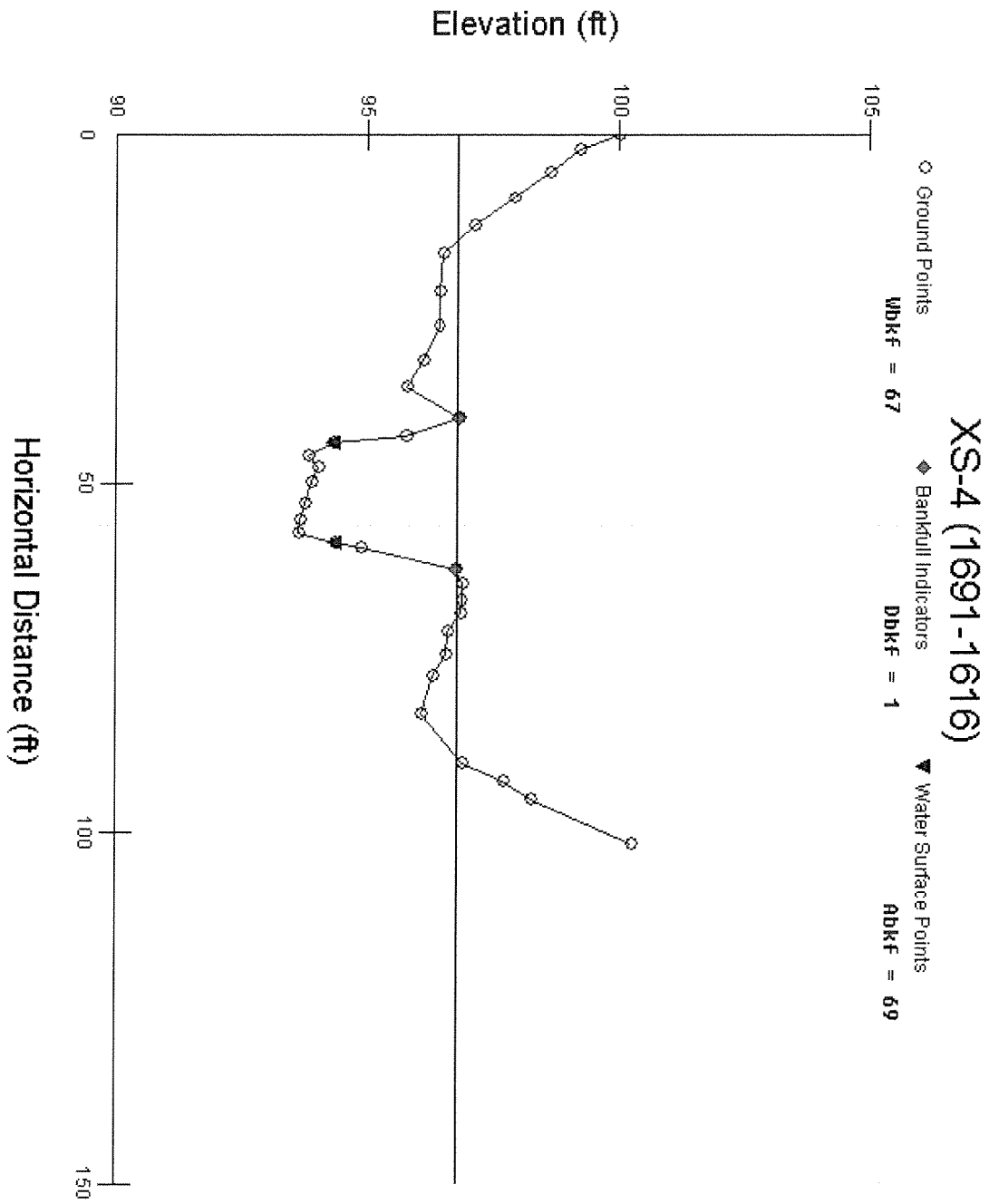
	Channel	Left	Right
Floodprone Elevation (ft)	93.52	93.52	93.52
Bankfull Elevation (ft)	90.36	90.36	90.36
Floodprone Width (ft)	100.48	-----	-----
Bankfull Width (ft)	67	33.5	40.52
Entrenchment Ratio	1.5	-----	-----
Mean Depth (ft)	1.03	0.82	1.24
Maximum Depth (ft)	3.16	2.96	3.16
Width/Depth Ratio	65.05	40.85	32.68
Bankfull Area (sq ft)	68.98	27.21	41.77
Wetted Perimeter (ft)	69.18	37.34	37.49
Hydraulic Radius (ft)	1	0.73	1.11
Begin BKF Station	14.95	14.95	48.45
End BKF Station	88.97	48.45	88.97

Cross Creek Stream Restoration Monitoring Report

NCEEP Project Number 105

Earth Tech

Year 1 of 5



B5.5a: RIVERMORPH CROSS SECTION SUMMARY
 Cross Creek - XS-5

Cross Section Name: XS-5 (1690-1618)
 Survey Date: 11/23/06

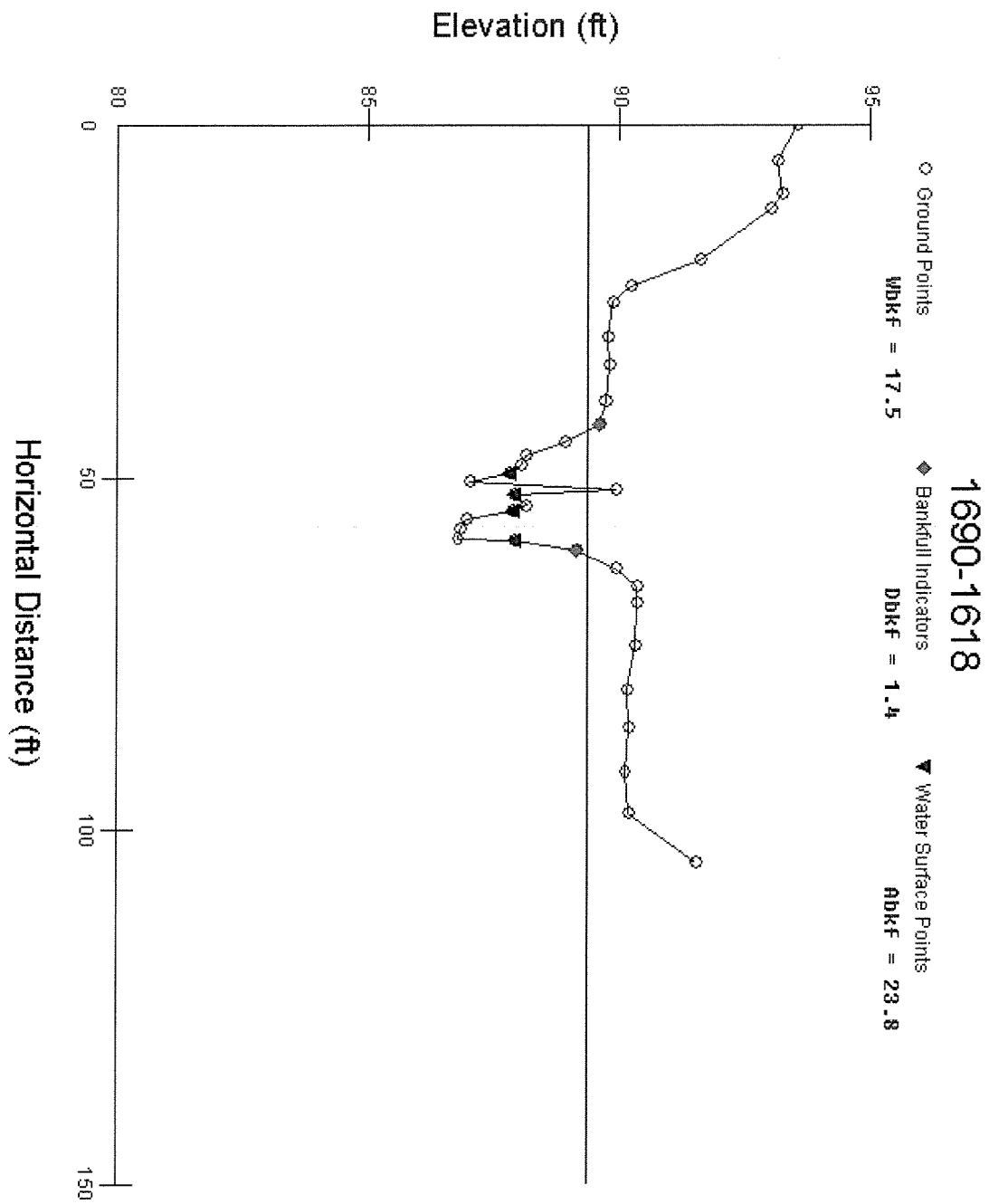
 Cross Section Data Entry

BM Elevation: 93.51 ft
 Backsight Rod Reading: 7.92 ft

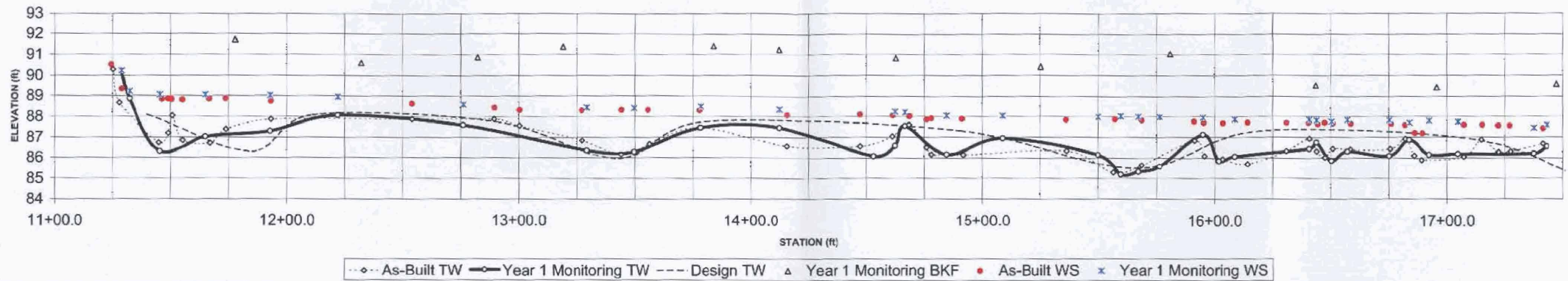
TAPE	FS	ELEV	NOTE
0	7.92	93.51	1690 RB Pin
5	8.29	93.14	
9.7	8.21	93.22	
11.9	8.42	93.01	
19	9.83	91.6	
22.8	11.21	90.22	
25	11.55	89.88	
30	11.66	89.77	
34	11.62	89.81	
39.2	11.71	89.72	
42.4	11.82	89.61	BKF
45	12.51	88.92	
46.8	13.3	88.13	
48.2	13.4	88.03	
49.3	13.62	87.81	REW
50.6	14.4	87.03	
51.6	11.51	89.92	
52.5	13.53	87.9	REW BAR @ SILL
53.9	13.28	88.15	
54.8	13.56	87.87	LEW BAR @ SILL
56	14.47	86.96	
57.3	14.6	86.83	
58.8	14.65	86.78	
59	13.51	87.92	LEW
60.4	12.27	89.16	BKF
62.9	11.5	89.93	
65.4	11.06	90.37	
67.9	11.08	90.35	
73.8	11.12	90.31	
80.1	11.26	90.17	
85.4	11.25	90.18	
91.9	11.32	90.11	
97.6	11.23	90.2	
104.7	9.89	91.54	

 Cross Sectional Geometry

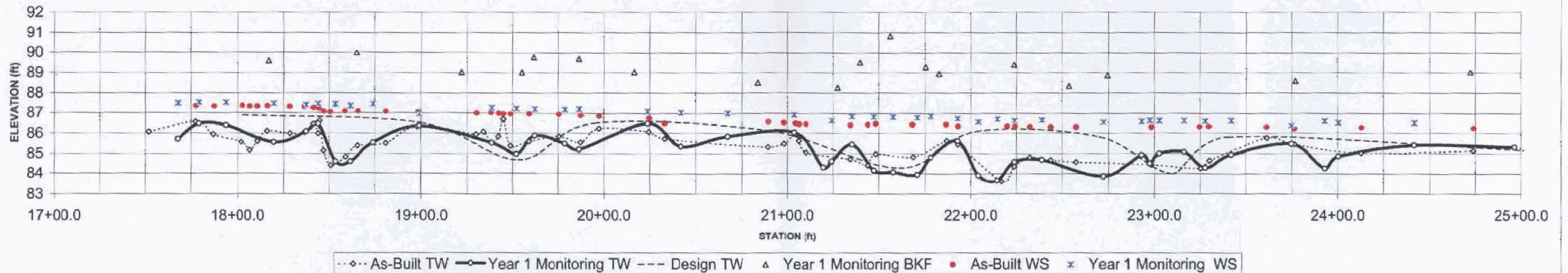
	Channel	Left	Right
Floodprone Elevation (ft)	92	92	92
Bankfull Elevation (ft)	89.39	89.39	89.39
Floodprone Width (ft)	87.71	-----	-----
Bankfull Width (ft)	17.5	8.75	9.17
Entrenchment Ratio	5.01	-----	-----
Mean Depth (ft)	1.36	1.08	1.61
Maximum Depth (ft)	2.61	2.36	2.61
Width/Depth Ratio	12.87	8.1	5.7
Bankfull Area (sq ft)	23.77	8.97	14.8
Wetted Perimeter (ft)	22.45	11.01	12.09
Hydraulic Radius (ft)	1.06	0.81	1.22
Begin BKF Station	43.23	43.23	51.98
End BKF Station	61.15	51.98	61.15



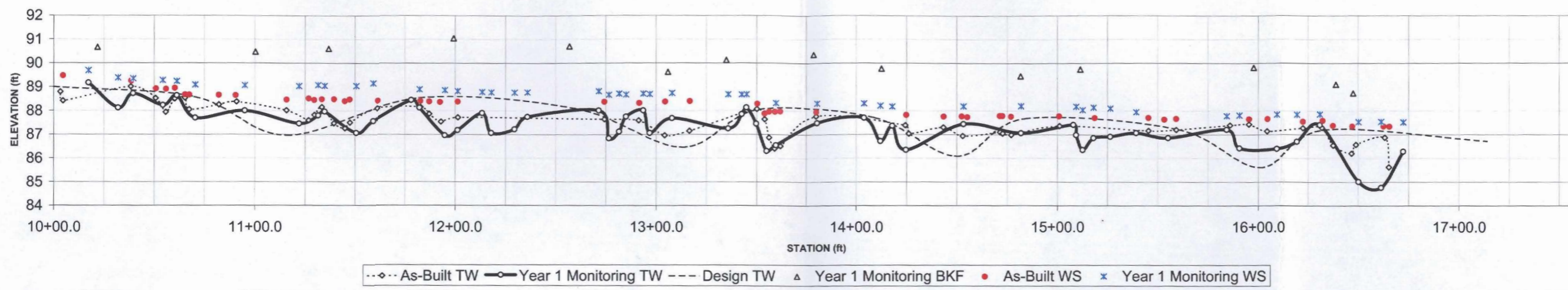
CROSS CREEK LONG PROFILE- YEAR 1 MONITORING



CROSS CREEK LONG PROFILE- YEAR 1 MONITORING



LITTLE CROSS CREEK LONG PROFILE- YEAR 1 MONITORING



B7.1: RIVERMORPH PARTICLE SUMMARY

Cross Creek - XS-1

Sample Name: PC1
 Survey Date: 12/26/06

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	4	4.00	4.00
0.062 - 0.125	0	0.00	4.00
0.125 - 0.25	47	7.00	51.00
0.25 - 0.50	31	1.00	82.00
0.50 - 1.0	9	9.00	91.00
1.0 - 2.0	0	0.00	91.00
2.0 - 4.0	0	0.00	91.00
4.0 - 5.7	3	3.00	94.00
5.7 - 8.0	0	0.00	94.00
8.0 - 11.3	6	6.00	100.00
11.3 - 16.0	0	0.00	100.00
16.0 - 22.6	0	0.00	100.00
22.6 - 32.0	0	0.00	100.00
32 - 45	0	0.00	100.00
45 - 64	0	0.00	100.00
64 - 90	0	0.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	0.16
D35 (mm)	0.21
D50 (mm)	0.25
D84 (mm)	0.61
D95 (mm)	8.55
D100 (mm)	11.3
Silt/Clay (%)	4

B7.2: RIVERMORPH PARTICLE SUMMARY
Cross Creek - XS-2

Sample Name: PC2
Survey Date: 12/26/06

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	3	3.00	3.00
0.062 - 0.125	0	0.00	3.00
0.125 - 0.25	32	32.00	35.00
0.25 - 0.50	32	32.00	67.00
0.50 - 1.0	26	26.00	93.00
1.0 - 2.0	0	0.00	93.00
2.0 - 4.0	6	6.00	99.00
4.0 - 5.7	1	1.00	100.00
5.7 - 8.0	0	0.00	100.00
8.0 - 11.3	0	0.00	100.00
11.3 - 16.0	0	0.00	100.00
16.0 - 22.6	0	0.00	100.00
22.6 - 32.0	0	0.00	100.00
32 - 45	0	0.00	100.00
45 - 64	0	0.00	100.00
64 - 90	0	0.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	0.18
D35 (mm)	0.25
D50 (mm)	0.37
D84 (mm)	0.83
D95 (mm)	2.67
D100 (mm)	5.7
Silt/Clay (%)	3
Sand (%)	90
Gravel (%)	7
Cobble (%)	0
Boulder (%)	0
Bedrock (%)	0

B7.3: RIVERMORPH PARTICLE SUMMARY
Cross Creek - XS-3

Sample Name: PC3
Survey Date: 12/26/06

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	75	69.44	69.44
0.062 - 0.125	0	0.00	69.44
0.125 - 0.25	0	0.00	69.44
0.25 - 0.50	4	3.70	73.15
0.50 - 1.0	2	1.85	75.00
1.0 - 2.0	0	0.00	75.00
2.0 - 4.0	1	0.93	75.93
4.0 - 5.7	2	1.85	77.78
5.7 - 8.0	0	0.00	77.78
8.0 - 11.3	5	4.63	82.41
11.3 - 16.0	0	0.00	82.41
16.0 - 22.6	4	3.70	86.11
22.6 - 32.0	13	12.04	98.15
32 - 45	2	1.85	100.00
45 - 64	0	0.00	100.00
64 - 90	0	0.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	0.02
D35 (mm)	0.03
D50 (mm)	0.04
D84 (mm)	18.84
D95 (mm)	29.54
D100 (mm)	45
Silt/Clay (%)	69.44
Sand (%)	5.56
Gravel (%)	25
Cobble (%)	0
Boulder (%)	0
Bedrock (%)	0

B7.4: RIVERMORPH PARTICLE SUMMARY
Cross Creek - XS-4

Sample Name: PC4
Survey Date: 12/26/06

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	42	42.00	42.00
0.25 - 0.50	12	12.00	54.00
0.50 - 1.0	17	17.00	71.00
1.0 - 2.0	0	0.00	71.00
2.0 - 4.0	0	0.00	71.00
4.0 - 5.7	4	4.00	75.00
5.7 - 8.0	0	0.00	75.00
8.0 - 11.3	10	10.00	85.00
11.3 - 16.0	1	1.00	86.00
16.0 - 22.6	8	8.00	94.00
22.6 - 32.0	6	6.00	100.00
32 - 45	0	0.00	100.00
45 - 64	0	0.00	100.00
64 - 90	0	0.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	0.17
D35 (mm)	0.23
D50 (mm)	0.42
D84 (mm)	10.97
D95 (mm)	24.17
D100 (mm)	32
Silt/Clay (%)	0
Sand (%)	71
Gravel (%)	29
Cobble (%)	0
Boulder (%)	0

B7.5: RIVERMORPH PARTICLE SUMMARY
Cross Creek - XS-5

Sample Name: PC 5
Survey Date: 12/29/06

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	2	2.27	2.27
0.062 - 0.125	0	0.00	2.27
0.125 - 0.25	31	35.23	37.50
0.25 - 0.50	28	31.82	69.32
0.50 - 1.0	14	15.91	85.23
1.0 - 2.0	2	2.27	87.50
2.0 - 4.0	9	10.23	97.73
4.0 - 5.7	1	1.14	98.86
5.7 - 8.0	1	1.14	100.00
8.0 - 11.3	0	0.00	100.00
11.3 - 16.0	0	0.00	100.00
16.0 - 22.6	0	0.00	100.00
22.6 - 32.0	0	0.00	100.00
32 - 45	0	0.00	100.00
45 - 64	0	0.00	100.00
64 - 90	0	0.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	0.17
D35 (mm)	0.24
D50 (mm)	0.35
D84 (mm)	0.96
D95 (mm)	3.47
D100 (mm)	8
Silt/Clay (%)	2.27
Sand (%)	85.23
Gravel (%)	12.5
Cobble (%)	0
Boulder (%)	0
Bedrock (%)	0