

**UNNAMED TRIBUTARY TO BEAR SWAMP CREEK  
STREAM RESTORATION SITE**

**2007 Annual Monitoring Report (Year 5)**

**Franklin County  
EEP Project No. 27  
Design Firm: Arcadis G&M of North Carolina, Inc.**



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## **1.0 EXECUTIVE SUMMARY**

The Unnamed Tributary (UT) to Bear Swamp Creek Stream Mitigation Site (hereafter referred to as the “Site”) was constructed for the North Carolina Ecosystem Enhancement Program (EEP) to provide compensatory stream mitigation in the Tar/Pamlico River Basin. This stream restoration project is located on an unnamed tributary to Bear Swamp Creek at the Murphy Hay Farm just north of the Town of Louisburg. This project involves the permanent exclusion of cattle from the stream, stabilization of eroding stream banks, installation of cross-vane structures for habitat, and the planting of a forested riparian buffer.

The following report summarizes the monitoring activities that have occurred in the past year (the fifth year of project monitoring) at the Site. Site construction began and was completed in July 2002. As-built surveys for the Site were performed in August 2002. First year monitoring was conducted in September 2003, and has continued through the current fifth year of monitoring. The Site must demonstrate vegetative criteria success and a stable restored stream channel for a minimum of five years or until the Site is deemed successful. The following paragraphs summarize the results of the 2007 year monitoring.

### **Vegetation Monitoring**

Vegetation monitoring for Year 5 was performed based on the Carolina Vegetation Survey (CVS) Levels 1 and 2 (Lee et al. 2006). CVS methodology determines density and survival of planted species, and individuals resulting from natural regeneration. Plot locations are consistent with previous years and plot size consists of 5m x 20m. Based on recommendations by EEP, Plot 4 was not surveyed in the current monitoring Year 5. The taxonomic standard for vegetation follows *Flora of the Carolinas, Virginia, Georgia, and surrounding areas* (Weakley, 2007).

Vegetation success criteria for the forested riparian restoration areas are based on a minimum survival of 260 stems per acre of planted species at the end of Year 5. Volunteer woody vegetation will also be included in the survivability calculations. Based on the fifth year surveys, the average count of the surviving planted species is 293 stems per acre. If volunteer species are included, the total number of stems increases to 8690 stems per acre. The Site meets and exceeds the established success criteria for vegetation based on the survival of the planted species.

The apparent cause of mortality for some planted species is competition from fast-growing woody species, principally *Pinus taeda*, and from large herbs such as *Sorghum halapense*, *Solidago* sp., and *Eupatorium capillifolium*. Other early successional species in abundance on the site include red maple (*Acer rubrum*) and sweet gum (*Liquidambar styraciflua*). The heavy loblolly pine colonization is a continuing nuisance as pines compete with the more desirable species for light and nutrients. Drought conditions ranging from moderate to extreme have afflicted Franklin County for the duration of the growing season and may be responsible for some species mortality.

### **Stream Enhancement Monitoring**

Success criteria for the restored stream reach has been established to confirm that no significant changes have occurred to the dimension, pattern, profile, and bed material over the 5-year monitoring period. Location surveys of the constructed features were conducted to verify the performance of the stream. A total station survey was performed to describe the stream longitudinal profile and five permanent stream

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cross-sections (3 riffles and 2 pools). A modified Wolman pebble count and assessment of the constructed features was also undertaken.

Overall, the stream channel bed form is stable. However, many of the grade control structures (rock vanes) in the stream have failed which has led to low to moderate bed degradation immediately behind these structures. Of the twenty-four rock vanes that were installed, sixteen are not performing their intended function. Three vanes have water piping through or behind the structure, six have filled in with sediment and have become obsolete, and the remaining seven are flooded from beaver dams throughout the lower portion of the Site. A total of eight beaver dams were observed within the UT to Bear Swamp Creek and significant impoundments have formed behind them. One beaver dam, constructed at the upstream culvert invert, posed a potential flood hazard to the Murphy Hay Farm driveway. In late 2007, beaver trapping and removal was carried out at the Site to prevent offsite flooding, continued negative impacts to the stream, and potential nuisance impacts to the adjacent landowners.

Based on the cross-sections and visual observations, the channel dimensions have not changed significantly. The stream was designed as a B5c (step-pool) stream (Rosgen 1996), which provides a sand bed channel with moderate entrenchment and a moderate width-depth ratio. During the current survey, bankfull indicators continue to be found at a significantly lower elevation than those described by the designer. The current classification measurements also exhibit a very low width-depth ratio and entrenchment consistent with an E-channel. Pebble counts show no significant change to the channel substrate which is composed primarily of sand and fine gravel.

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## **2.0 PROJECT BACKGROUND**

### **2.1 LOCATION AND SETTING**

The Site is located north of Louisburg in Franklin County, NC, immediately south of West Dyking Road (SR 1235) at the Murphy Hay Farm (Figure 1, Appendix A). From Raleigh follow Highway 401 north to Louisburg. Approximately one mile past the Highway 561 split in Louisburg take a left onto West Dyking Road. The Murphy Hay Farm will be approximately one mile on your left. The entrance to the stream restoration area is accessed by several cattle gates located along an electrified fence. The stream restoration reach begins approximately 460 feet upstream of the driveway crossing and ends approximately 775 feet downstream.

### **2.2 RESTORATION STRUCTURE AND OBJECTIVES**

Approximately 1400 linear feet of an Unnamed Tributary (UT) to Bear Swamp Creek were identified on the 32-acre Murphy Hay Farm. The stream had severely degraded and eroded significantly due to past vegetation removal and the unrestricted access of cattle. The torrential rain events associated with Hurricanes Fran and Floyd provided the final impetus for restoration work. The stream originates at a pond approximately 500 feet east of West Dyking Road and 1000 feet east of the project. Land use in the watershed consists of agriculture, pasture, forest, and single-family residential.

The design of the new stream included both Priority II and III stream restoration. The degraded F5 and G5c stream types were restored to a B5c (Rosgen 1996). Approximately 664 linear feet of new channel was constructed; and 771 linear feet of stream was stabilized in-place. Approximately 800 tons of rock was used to construct 24 rock vanes throughout the reach (Figure 2-1, 2-2, 2-3, Appendix A). The vanes were designed to improve hydraulic flow and reduce shear stress. The vanes were to provide bed stabilization and improved stream habitat by creating pools. The steep, eroded banks were graded back and expanded to increase the entrenchment ratio. Root wads were also installed to provide bank protecting and additional habitat diversity. Approximately 2.4 acres of riparian vegetation was also established along the restored channel in Zone 1 (inner 30 feet) of the Tar/Pamlico Riparian Buffer. This riparian buffer zone has been fenced to exclude cattle. Site construction began and was completed in July 2002. Project monitoring began the next year in September 2003.

The objective of this project is to restore habitat and water quality to the restored reach and the Tar-Pamlico River Basin as a whole. By stabilizing the streambed and banks, the restoration will improve water quality by reducing the amount of sediment contributed to the watershed. Exclusion of cattle and establishment of a permanent riparian buffer should further help reduce sediment and nutrient input. The newly established riparian buffer will provide shade, thereby reducing water temperatures, and increase habitat and food for wildlife.

<b>Exhibit Table I. Project Mitigation Structure and Objectives</b>					
<b>UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27</b>					
<b>Project Segment or Reach ID</b>	<b>Restoration Type</b>	<b>Approach</b>	<b>Linear Footage or Acreage*</b>	<b>Stationing</b>	<b>Comments</b>
Reach 1	R	P2/P3	780 linear feet	Exact locations unknown	--
	EII	SSS	600 linear feet	Exact locations unknown	--
Riparian Vegetation Re-establishment	R	--	2.4 acres	N/A	--

\*Linear footage values in the table are from the current year's survey. Linear footage values provided in the project's Mitigation Plan are 780 linear feet of restoration and 680 linear feet of stabilization – reaches are not distinguished on figures or in text narrative

R = Restoration

P2 = Priority II

P3 = Priority III

SSS = Stream Bank Stabilization

EII = Enhancement II

## 2.3 PROJECT HISTORY AND BACKGROUND

<b>Exhibit Table II. Project Activity and Reporting History</b>			
<b>UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27</b>			
<b>Activity Report</b>	<b>Scheduled Completion</b>	<b>Data Collection Complete</b>	<b>Actual Completion or Delivery</b>
Restoration Plan	NA*	NA*	NA*
Final Design (90%)	NA*	NA*	NA*
Construction	NA*	NA*	July 2002
Temporary S&E mix applied to entire project area	NA*	NA*	NA*
Permanent seed mix applied to reach/segments	NA*	NA*	NA*
Bare Root Seedling Installation	NA*	NA*	NA*
Mitigation Plan	NA*	NA*	April 2003
Minor repairs made filling small washed out areas			May 2003
Final Report	NA*	NA	July 2003
Year 1 Vegetation Monitoring	NA*	Fall 2003	Jan 2004
Year 1 Stream Monitoring	NA*	Sept 2003	
Year 2 Vegetation Monitoring	NA*	NA*	NA*
Year 2 Stream Monitoring	NA*	NA*	
Year 3 Vegetation Monitoring	Dec 2005	Oct 2005	Dec 2005
Year 3 Stream Monitoring	Dec 2005	Nov 2005	Dec 2005
Year 4 Vegetation Monitoring	Dec 2006	Nov 2006	Dec 2006
Year 4 Stream Monitoring	Dec 2006	Nov 2006	Dec 2006
Year 5 Vegetation Monitoring	Dec 2007	Sep 2007	Dec 2007
Year 5 Stream Monitoring	Dec 2007	Sep 2007	Dec 2007

\*NA – Historical project documents necessary to provide this data were unavailable at the time of this report submission.

<b>Exhibit Table III. Project Contacts</b> <b>UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27</b>	
<b>Designer</b> Arcadis G&M of North Carolina, Inc. (ARCADIS)	Mr. Robert Lepsic 801 Corporate Center Drive, Suite 300 Raleigh, NC 27607 (919) 854-1282
<b>Construction Contractor</b> SEI Environmental, Inc.	130 Penmarc Drive, Suite 108 Raleigh, NC 27603-2434
<b>Planting Contractor</b> North State Environmental, Inc.	2889 Lowery Street Winston Salem, NC 27101 (336) 725-2010
<b>Seeding Contactor</b> NA*	NA*
Seed Mix Sources	NA*
Nursery Stock Suppliers	NA*
<b>Monitoring Performers</b>	EcoScience Corporation 1101 Haynes Street, Suite 101 Raleigh, NC 27604 (919) 828-3433
Stream Monitoring POC	Jens Geratz
Vegetation Monitoring POC	Elizabeth Scherrer

\*NA – Historical project documents necessary to provide this data were unavailable at the time of this report submission.



<b>Exhibit Table IV. Project Background</b> <b>UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27</b>	
Project County	Franklin
Drainage Area	0.26 square miles
Impervious cover estimate (%)	<1 percent
Stream Order	1st order
Physiographic Region	Piedmont
Ecoregion (Griffith and Omernik)	Northern Outer Piedmont
Rosgen Classification of As-built	B5c
Cowardin Classification	Stream (R3UB2)
Dominant soil types	Wake-Saw-Wedowee Complex (WaB)
	Wedowee (WeB, WeC)
	Wake-Wateree-Wedowee Complex (WbD)
Reference Site ID	000543201A
USGS HUC for Project and Reference	03020101040010
NCDWQ Sub-basin for Project and Reference	03-03-01
NCDWQ classification for Project and Reference	WS-IV, NSW
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	N/A
Percent of project easement fenced	30-foot buffer fenced around entire reach

### **3.0 PROJECT MONITORING AND RESULTS**

#### **3.1 VEGETATION ASSESSMENT**

##### **3.1.1 Soil Data**

<b>Exhibit Table V. Preliminary Soil Data</b> <b>UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27</b>					
<b>Series</b>	<b>Max Depth (in.)</b>	<b>% Clay on Surface</b>	<b>K</b>	<b>T</b>	<b>OM %</b>
Wake-Saw-Wedowee Complex (WaB)	32	3-20	0.15-0.28	1-4	0.5-3
Wedowee (WeB, WeC)	32	5-20	0.24-0.28	4	0.5-3
Wake-Wateree-Wedowee Complex (WbD)	54	2-20	0.15-0.28	1-4	0.5-3

##### **3.1.2 Vegetation Problem Areas**

<b>Exhibit Table VI. Vegetative Problem Areas</b> <b>UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27</b>			
<b>Feature / Issue</b>	<b>Station # / Range</b>	<b>Probable Cause</b>	<b>Photo #</b>
Invasive Populations	Throughout, but especially at Vegetation Plot 1	loblolly pine ( <i>Pinus taeda</i> ): seeding from adjacent stands	1 and 2 (Appendix B)

### 3.1.3 Stem Counts

Vegetation monitoring for Year 5 was performed based on the Carolina Vegetation Survey (CVS) Levels 1 and 2 (Lee et al. 2006). Plot locations are consistent with previous years and plot size remained 5m x 20m. Based on recommendations by EEP, Plot 4 was not surveyed in the current monitoring year. Stem counts were conducted for all woody species, including volunteer species. The taxonomic standard for vegetation follows *Flora of the Carolinas, Virginia, Georgia, and surrounding areas* (Weakley, 2007). An inventory of planted species is given in Table VIIa, while volunteer species are listed in Table VIIIb. Photos of vegetation problem areas and vegetation plots can be found in Appendix B.

Species	Plots				Year 2 Totals <sup>1</sup>	Year 3 Totals	Year 4 Totals	Year 5 Totals	Survival %
	1	2	3	5					
<b>Shrubs</b>									
Tag alder ( <i>Alnus serrulata</i> )					0	0	0	0	--
Silky dogwood ( <i>Cornus amomum</i> )	1				13	12	1	1	8
Winterberry ( <i>Ilex verticillata</i> )					0	0	0	0	--
Black willow <sup>2</sup> ( <i>Salix nigra</i> )	7	1			19	29	7	8	42
Elderberry ( <i>Sambucus Canadensis</i> )					0	0	0	0	--
<b>Trees</b>									
River birch ( <i>Betula nigra</i> )	9				0	6	13	9	N/A
Ironwood ( <i>Carpinus caroliniana</i> )					1	0	0	0	0
Green ash ( <i>Fraxinus pennsylvanica</i> )		6			8	8	7	6	75
Black walnut ( <i>Juglans nigra</i> )		2			3	3	2	2	66
Red mulberry ( <i>Morus rubra</i> )					1	0	0	0	0
Hophornbeam ( <i>Ostrya virginiana</i> )			1		5	0	2	1	20
Swamp chestnut oak ( <i>Quercus michauxii</i> )	1			1	3	5	3	2	66
Cherrybark oak ( <i>Quercus pagoda</i> )					1	0	2	0	0

<sup>1</sup>Initial Totals for planted species within vegetation plots are not available.

<sup>2</sup>Species not found on initial survey. Current individuals are volunteers.

A total of 29 stems of planted species were counted in the four plots. Stem density per acre for Plots 1, 2, 3, and 5 are 728, 364, 40, and 40 stems per acre. The average density for planted species in all plots is 293 stems per acre, which exceeds the established success criteria of 260 stems per acre for vegetation at year 5.

Silky dogwood and elderberry have survived and grown on moister and more exposed sites on the stream banks, but have largely been out-competed in the drier upland sites where the vegetation plots are located. Survival of tag alder, winterberry, ironwood, red mulberry, and cherrybark oak appears to have been very poor. The apparent cause of mortality for these species is competition from fast-growing woody species, principally loblolly pine, and from large herbs such as Johnson grass (*Sorghum halapense*), goldenrod (*Solidago* sp.), and dog fennel (*Eupatorium capillifolium*). Drought conditions may have also contributed to poor survival throughout the Site.

Species	Plots				Year 2 Totals	Year 3 Totals	Year 4 Totals	Year 5 Totals
	1	2	3	5				
Boxelder ( <i>Acer negundo</i> )	1	2		1	0	3	3	4
Red maple ( <i>Acer rubrum</i> )	44			3	51	73	23	47
Eastern baccharis ( <i>Baccharis halimifolia</i> )		4			0	2	8	4
Sugarberry ( <i>Celtis laevigata</i> )					0	2	0	0
Persimmon ( <i>Diospyros virginiana</i> )					0	1	1	0
Easter red cedar ( <i>Juniperus virginiana</i> )				1	0	0	1	1
Sweetgum ( <i>Liquidambar styraciflua</i> )	15			50	20	26	39	65
Tulip poplar ( <i>Liriodendron tulipifera</i> )	1			1	7	2	3	2
Loblolly pine ( <i>Pinus taeda</i> )	395	107	54	57	250	547	654	613
Sycamore ( <i>Platanus occidentalis</i> )					0	1	0	0
Black cherry ( <i>Prunus serotina</i> )		1		8	0	5	12	9
Winged sumac ( <i>Rhus copallina</i> )					1	0	0	0
Smooth sumac ( <i>Rhus glabra</i> )	44				2	43	0	44
Winged elm ( <i>Ulmus alata</i> )	23				0	41	11	23
Possumhaw ( <i>Viburnum nudum</i> )					0	3	1	0
Chinese privet ( <i>Ligustrum sinense</i> )		1			0	0	1	1

A total of 813 stems of volunteer species were counted in the four plots. Density per acre for Plots 1 through 5 is 21,165, 4,654, 2,185, and 4,897 respectively, with an average of 8,225 volunteer woody stems per acre. Density for Plots 1 through 5, including planted and volunteer species, is 21,894, 5,018, 2,226, and 4,937 respectively, with an average of 8519 stems per acre.

Aggressive recruitment of *Pinus taeda* continues at the Site, especially at the northeastern end (Appendix B). A mixed pine-hardwood woodlot near this area provides a nearby source of pine propagules. The northeastern end of the Site, near Plot 1, also features abundant *Rhus* shrubs, principally *Rhus glabra*. While these are abundant, they do not generate the dense shade found under pine saplings. The unbranched stems and weak vegetative growth result in an open understory where grasses and herbs flourish.

An informal inventory of herbaceous species on the site was also taken. Dominant herbaceous species over the Site as a whole are listed below:

long-stalked aster ( <i>Symphyotrichum dumosum</i> )	pokeweed ( <i>Phytolacca americana</i> )
beggar ticks ( <i>Bidens frondosa</i> )	smartweed ( <i>Persicaria</i> sp.)
Indian strawberry ( <i>Potentilla indica</i> )	curly dock ( <i>Rumex crispus</i> )
purple coneflower ( <i>Echinacea purpurea</i> )	horse nettle ( <i>Solanum carolinense</i> )
bottlebrush grass ( <i>Elymus hystrix</i> )	goldenrod ( <i>Solidago</i> sp.)
dog fennel ( <i>Eupatorium capillifolium</i> )	Johnson grass ( <i>Sorghum halapense</i> )
Joe Pye weed ( <i>Eupatorium fistulosum</i> )	poison ivy ( <i>Toxicodendron radicans</i> )
narrowleaf sunflower ( <i>Helianthus angustifolius</i> )	ironweed ( <i>Vernonia</i> sp.)
Japanese honeysuckle ( <i>Lonicera japonica</i> )	

### 3.2 STREAM ASSESSMENT

#### 3.2.1 Bankfull Events

Exhibit Table VIII. Verification of Bankfull Events UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27			
Date of Data Collection	Date of Occurrence	Method	Photo Number
08/28/2007	July 2007	Crest Gauge (Water level was 6-8 inches above bankfull)	7 (Appendix C)

#### 3.2.2 Bank Stability Assessment

Exhibit Table IX. BEHI and Sediment Export Estimates UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27															
Time Point	Segment/Reach	Linear Feet	Extreme		Very High		High		Moderate		Low		Very Low		Sediment Export Tons/year
			ft	%	ft	%	ft	%	ft	%	ft	%	Ft	%	
Year 5	Reach 1 Above Road	463.3	--	--	--	--	--	--	20	4	--	--	443.3	96	3.4
Year 5	Reach 2 Below Road	916.7	--	--	--	--	--	--	20	2	--	--	896.7	98	6.2

### 3.2.3 Stream Problem Areas

<b>Exhibit Table X. Stream Problem Areas</b>			
<b>UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27</b>			
<b>Feature Issue</b>	<b>Station Numbers</b>	<b>Suspected Cause</b>	<b>Photo Number</b>
Vane 2, filled in		Low slope, excess sediment	8**
Vane 3, structure failure		Piping, steep vane arms	
Vane 4, filled in		Low slope, excess sediment	
Vane 5, filled in		Low slope, excess sediment	
Vane 6, structure failure		Piping, steep vane arms	
Vane 8, structure failure		Piping, steep vane arms	
Vane 11, flooded		Beaver dam downstream of structure*	9**
Vane 14, filled in		Low slope, excess sediment	
Vane 15, flooded		Beaver dam downstream of structure*	
Vane 16, flooded		Beaver dam downstream of structure*	
Vane 17, flooded		Beaver dam downstream of structure*	
Vane 18, flooded		Beaver dam downstream of structure*	
Vane 19, flooded		Beaver dam downstream of structure*	
Vane 20, flooded		Beaver dam downstream of structure*	
Vane 22, filled in		Low slope, excess sediment	
Vane 24, filled in		Low slope, excess sediment	

\* Beaver trapping and removal was carried out at the Site in late 2007.

\*\*Photos are representative of similar stream problem areas at other vanes

A stream problem area plan view and photos of problem areas are provided in Appendix C

<b>Exhibit Table XI. Categorical Stream Feature Visual Stability Assessment</b>						
<b>UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27</b>						
<b>Segment/Reach: 1,380 feet</b>						
<b>Feature</b>	<b>Initial</b>	<b>MY-01*</b>	<b>MY-02*</b>	<b>MY-03</b>	<b>MY-04</b>	<b>MY-05</b>
A. Riffles	100%	NA	NA	80%	80%	84%
B. Pools	100%	NA	NA	91%	91%	100%
C. Thalweg	100%	NA	NA	88%	88%	100%
D. Meanders	100%	NA	NA	77%	77%	100%
E. Bed General	100%	NA	NA	95%	95%	99%
F. Rock Vanes	100%	NA	NA	82%	71%	77%
G. Root Wads	100%	NA	NA	86%	86%	88%

\*NA – Historical project documents necessary to provide this data were unavailable at the time of this report submission.

**Exhibit Table XII. Baseline Morphology and Hydraulic Summary  
UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27  
1,380 linear feet**

Parameter	USGS Gage 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
<b>Dimension</b>																		
BF Width (ft)	N/A	N/A	N/A	N/A	N/A	6.7	N/A	N/A	N/A	N/A	N/A	11.0	11.8	11.4	10.0	10.0	10.0	10.0
Floodprone Width (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25.5	80.0	40.6	14.0	22.0	18.0	11.4
BF Cross Sectional Area (ft <sup>2</sup> )	N/A	N/A	N/A	N/A	N/A	8.5	N/A	N/A	N/A	N/A	N/A	10.3	14.0	12.1	8.6	8.6	8.6	8.1
BF Mean Depth (ft)	N/A	N/A	N/A	N/A	N/A	1.0	N/A	N/A	N/A	N/A	N/A	0.9	1.2	1.1	0.8	0.8	0.8	0.9
BF Max Depth (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.9	2.4	2.1	1.4	1.8	1.6	1.5
Width/Depth Ratio	N/A	N/A	N/A	N/A	N/A	6.7	N/A	N/A	N/A	N/A	N/A	11.0	11.8	10.7	12	12	12	8.2
Entrenchment Ratio	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.2	2.4	2.3	1.4	2.2	1.8	1.7
Wetted Perimeter(ft)	N/A	N/A	N/A	N/A	N/A	8.7	N/A	N/A	N/A	N/A	N/A	13.2	14.0	13.6	11.6	11.6	11.6	10.1
Hydraulic radius (ft)	N/A	N/A	N/A	N/A	N/A	1.0	N/A	N/A	N/A	N/A	N/A	0.8	1.0	0.9	0.7	0.7	0.7	0.8
<b>Pattern</b>																		
Channel Beltwidth (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6.0	8.0	7.0	20.0	80.0	37.0	5.5
Radius of Curvature (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	63.0	390.0	240.0	55.0	342.0	199.0	11.0
Meander Wavelength (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	21.0	88.0	46.0	18.0	77.0	40.0	42.4
Meander Width ratio	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5	0.7	0.6	2.0	8.0	3.7	0.6
<b>Profile</b>																		
Riffle length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	NA	NA	NA	NA
Riffle slope (ft/ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.001	0.14	0.04	0.0015	0.132	0.067	0.0026
Pool length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7.0	13.0	9.3	6.0	11.0	8.0	3.9
Pool spacing (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	22.0	69.0	42.0	19.0	61.0	37.0	31.7
<b>Substrate</b>																		
d50 (mm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3	3	3	0.2	0.2	0.2	0.4
d84 (mm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	49.7	49.7	49.7	2.9	2.9	2.9	16
<b>Additional Reach Parameters</b>																		
Valley Length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	1,300	1,300	1,300	1,300
Channel Length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	NA	NA	NA	1,435	1,435	1,435	1,435
Sinuosity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Water Surface Slope (ft/ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.016	0.016	0.016	0.0157	0.0157	0.0154	0.0154
BF slope (ft/ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.016	0.016	0.016	0.0157	0.0157	0.0154	0.0154
Rosgen Classification	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	B5c	B5c	B5c	B5c	B5c	B5c	B5c

\*NA-Historical project documents were unavailable at the time of report submission. \*\* N/A-Not applicable.

**Exhibit Table XIII. Morphology and Hydraulic Monitoring Summary  
UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27**

Parameter	Cross-Section 1* Riffle										Cross-Section 2* Riffle					Cross-Section 3* Pool					Cross-Section 4* Pool				
	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY	MY1	MY2	MY3	MY4	MY5	MY	
	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	Min	Max	Med	
<b>Dimension</b>																									
BF Width (ft)	NA	NA	5.0	6.5	5.3		NA	NA	3.4	3.1	3.1		NA	NA	5.0	6.9	4.6		NA	NA	4.1	7.7	8.9		
Floodprone Width (ft)	NA	NA	9.5	11.1	11.3		NA	NA	7.3	5.6	4.2		NA	NA	9.8	13.1	9.14		NA	NA	32.4	17.7	16.8		
BF Cross Sectional Area (ft <sup>2</sup> )	NA	NA	2.6	3.4	3.5		NA	NA	1.9	2.6	1.1		NA	NA	1.9	2.0	1.1		NA	NA	9.3	11.9	14.3		
BF Mean Depth (ft)	NA	NA	0.5	0.5	0.7		NA	NA	0.6	0.8	0.3		NA	NA	0.4	0.3	0.2		NA	NA	2.2	1.5	1.6		
BF Max Depth (ft)	NA	NA	0.7	0.8	0.9		NA	NA	0.8	0.9	0.6		NA	NA	0.6	0.6	0.4		NA	NA	3.2	2.1	2.0		
Width/Depth Ratio	NA	NA	9.6	12.2	8.1		NA	NA	6.1	3.7	8.8		NA	NA	13.3	24.5	19.4		NA	NA	1.9	5.0	5.6		
Entrenchment Ratio	NA	NA	1.9	1.7	1.2		NA	NA	2.1	1.8	1.6		NA	NA	2.0	1.9	1.4		NA	NA	7.8	2.3	2.1		
Wetted Perimeter(ft)	NA	NA	6.0	6.0	5.1		NA	NA	4.6	4.4	2.8		NA	NA	5.8	5.8	5.6		NA	NA	12.9	12.9	10.1		
Hydraulic radius (ft)	NA	NA	0.8	0.6	0.7		NA	NA	0.4	0.6	0.4		NA	NA	0.3	0.3	0.2		NA	NA	0.7	0.9	1.4		
<b>Substrate</b>																									
d50 (mm)	0.4	NA	0.33	1.8	1.4		NA	NA	0.73	1.4	1.1		1.9	NA	0.65	1.0	0.55		6.9	NA	0.87	0.43	1.5		
d84 (mm)	3.0	NA	0.65	3.9	5.5		NA	NA	4.5	5.2	5.5		2937	NA	1.5	5.4	0.98		3129	NA	1.6	0.97	2.3		
<b>Parameter</b>																									
<b>Pattern</b>																									
Channel Beltwidth (ft)	13.3	62.7	33.2	33.2	NA	NA	13.3	62.7	33.2	33.2	33.2		13.3	62.7	33.2	33.2	13.3		62.7	33.2	33.2	62.7	33.2		
Radius of Curvature (ft)	40.0	500.0	158.5	NA	NA	NA	40.0	500.0	158.5	500.0	158.5		40.0	500.0	158.5	158.5	40.0		500.0	158.5	158.5	500.0	158.5		
Meander Wavelength (ft)	19.2	112.4	57.0	NA	NA	NA	19.2	112.4	57.0	57.0	57.0		19.2	112.4	57.0	57.0	19.2		112.4	57.0	57.0	112.4	57.0		
Meander Width ratio	1.3	6.3	3.4	3.4	NA	NA	2.8	23.9	12.1	12.1	12.1		2.8	23.9	12.1	12.1	4.3		7.5	5.9					
<b>Profile**</b>																									
Riffle length (ft)	NA	NA	NA	NA	NA	NA	NA	NA	3.8	62.7	28.0		3.8	62.7	28.0	28.0	3.6		46.1	17.2					
Riffle slope (ft/ft)	0.002	0.049	0.020	0.020	NA	NA	0.001	0.061	0.014	0.014	0.014		0.001	0.061	0.014	0.014	0.005		0.128	0.025					
Pool length (ft)	3.7	23.9	12.6	NA	NA	NA	1.8	22.7	5.2	5.2	5.2		1.8	22.7	5.2	5.2	1.7		39.0	19.8					
Pool spacing (ft)	17.7	69.3	41.6	NA	NA	NA	14.0	183.0	64.6	64.6	64.6		14.0	183.0	64.6	64.6	4.0		54.9	22.1					
<b>Additional Reach Parameters</b>																									
Valley Length (ft)		1,300				NA		1,300						1,300						1,300					
Channel Length (ft)		1,435				NA		1,439						1,439						1,380					
Sinuosity		1.1				NA		1.1						1.1						1.1					
Water Surface Slope (ft/ft)		0.0161				NA		0.0153						0.0153						0.0154					
BF slope (ft/ft)		0.0161				NA		0.0165						0.0165						0.0158					
Rosgen Classification		B5c				NA		E5/B5c						E5/B5c						E5					

\*NA-Historical project documents were unavailable at the time of report submission \*\*Due to beaver impoundments below the road crossing, profile data were derived from the upstream reach only

**Exhibit Table XIII. cont. Morphology and Hydraulic Monitoring Summary  
UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27**

Parameter	Cross Section 5* Riffle																		
	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	MY1	MY2	MY3	MY4	MY5	MY+	
<b>Dimension</b>																			
BF Width (ft)	NA	NA	5.7	6.7	8.4														
Floodprone Width (ft)	NA	NA	10.1	13.4	13.5														
BF Cross Sectional Area (ft <sup>2</sup> )	NA	NA	6.1	9.8	10.3														
BF Mean Depth (ft)	NA	NA	1.1	1.5	1.2														
BF Max Depth (ft)	NA	NA	1.3	1.9	2.3														
Width/Depth Ratio	NA	NA	5.3	4.6	6.8														
Entrenchment Ratio	NA	NA	1.8	2.0	1.7														
Wetted Perimeter(ft)	NA	NA	7.9	7.9	8.1														
Hydraulic radius (ft)	NA	NA	0.8	1.2	1.3														
<b>Substrate</b>																			
d50 (mm)	0.4	NA	1.5	4.0	6.9														
d84 (mm)	3.0	NA	14.0	9.7	20														

\*NA-Historical project documents were unavailable at the time of report submission.



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#### **4.0 REFERENCES**

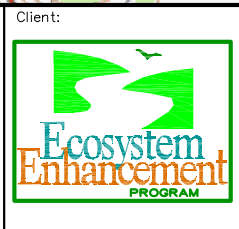
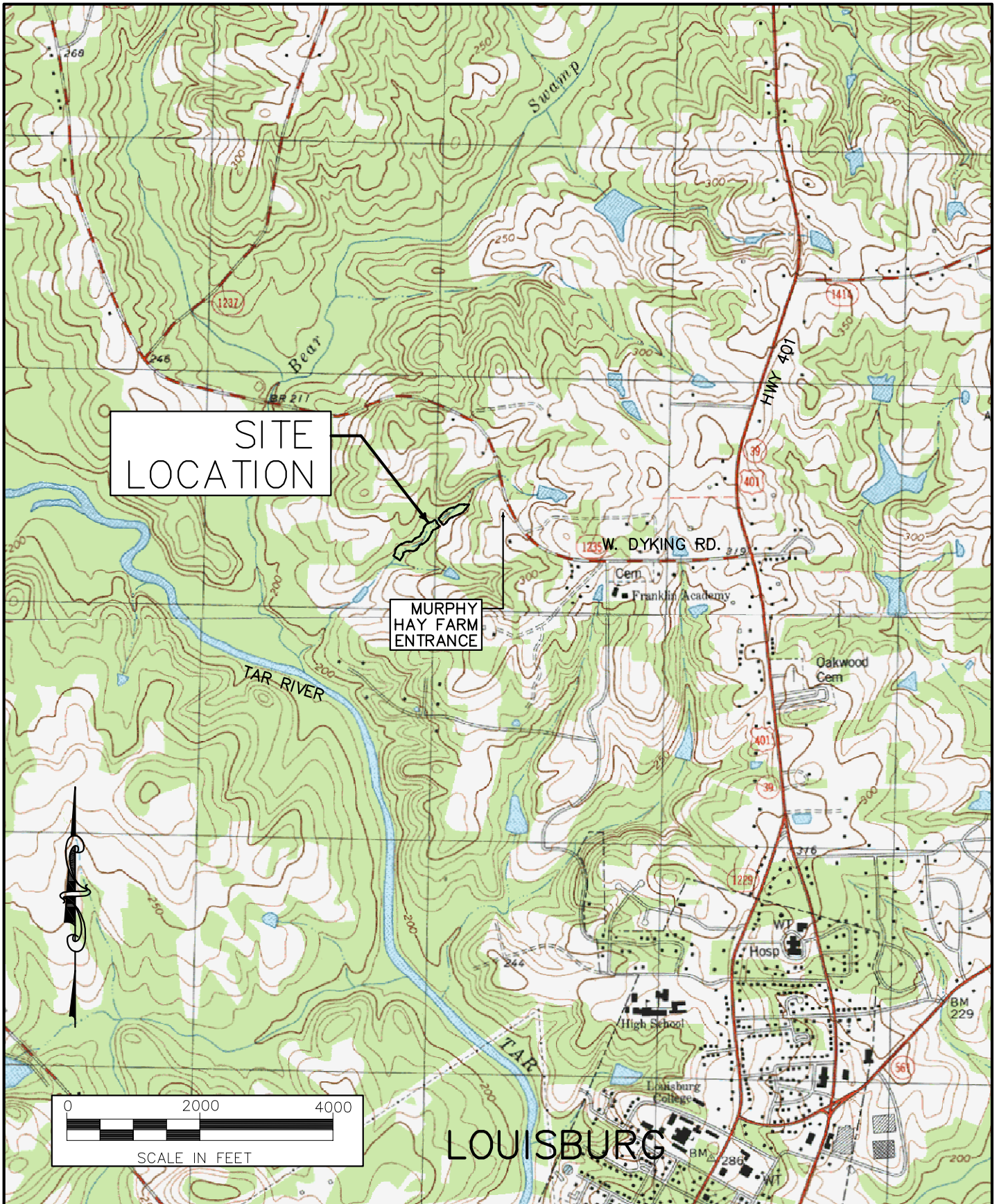
Lee, Michael T., R. K. Peet, S. D. Roberts, and T. R. Wentworth. 2006 CVS-EEP Protocol for Recording Vegetation, Version 4.0 (<http://cvs.bio.unc.edu/methods.htm>)

Weakley, A.S. 2007. Flora of the Carolinas, Virginia, Georgia, and surrounding areas. Working draft of January 2007. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina. 1015pp.

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**APPENDIX A**

**FIGURES**



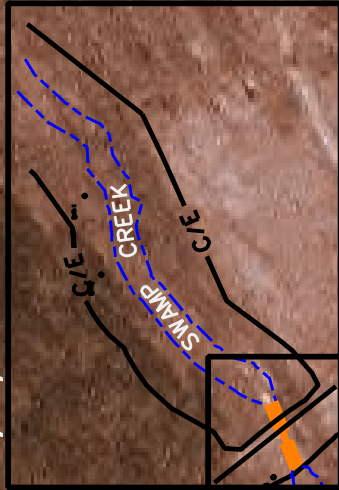
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**EEP Project No. 27**  
 FRANKLIN COUNTY, NORTH CAROLINA

Dwn By: GWN Ckd By: JWG  
 Date: SEP 2006  
 Scale: 1"=2000'  
 ESC Project No.: 06-282.04

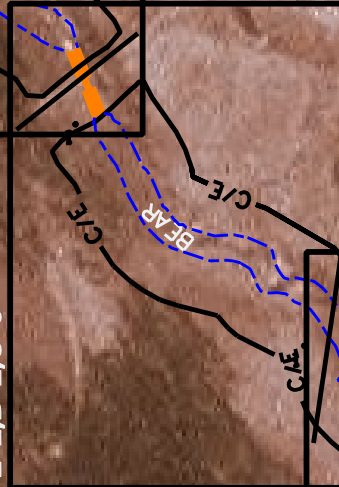
FIGURE **1**



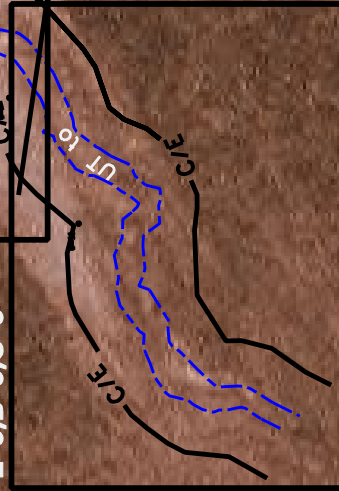
2-1,B-1,C-1



2-2,B-2,C-3



2-3,B-3,C-3



—C/E— CONSERVATION EASEMENT



Client:

Project:

Drawn By: GWN  
Date: DEC 2006

Checked By: JWG  
Scale: 1" = 200'

ESC Project No.: 06-282.03

FIGURE

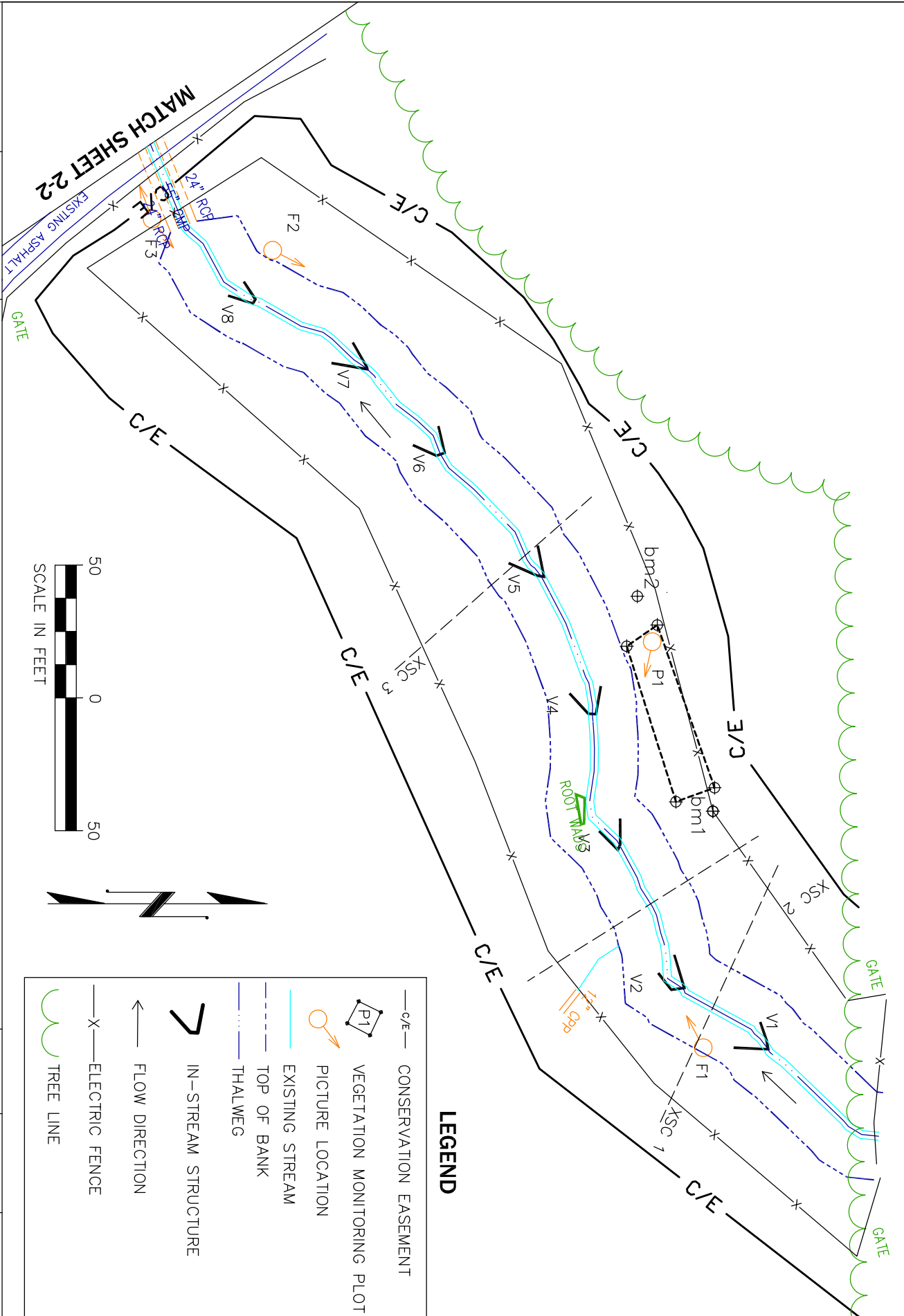
2

### MONITORING PLAN VIEW/SHEET INDEX

## Unnamed Tributary to Bear Swamp Creek Stream Restoration Site

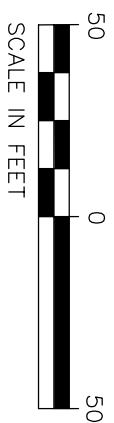
FRANKLIN COUNTY, NORTH CAROLINA





**LEGEND**

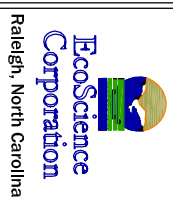
- CONSERVATION EASEMENT
- VEGETATION MONITORING PLOT
- PICTURE LOCATION
- EXISTING STREAM
- TOP OF BANK
- THALWEG
- IN-STREAM STRUCTURE
- FLOW DIRECTION
- ELECTRIC FENCE
- TREE LINE



Client: 

Title:

**MONITORING PLAN VIEW**



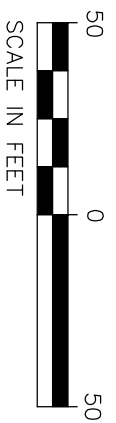
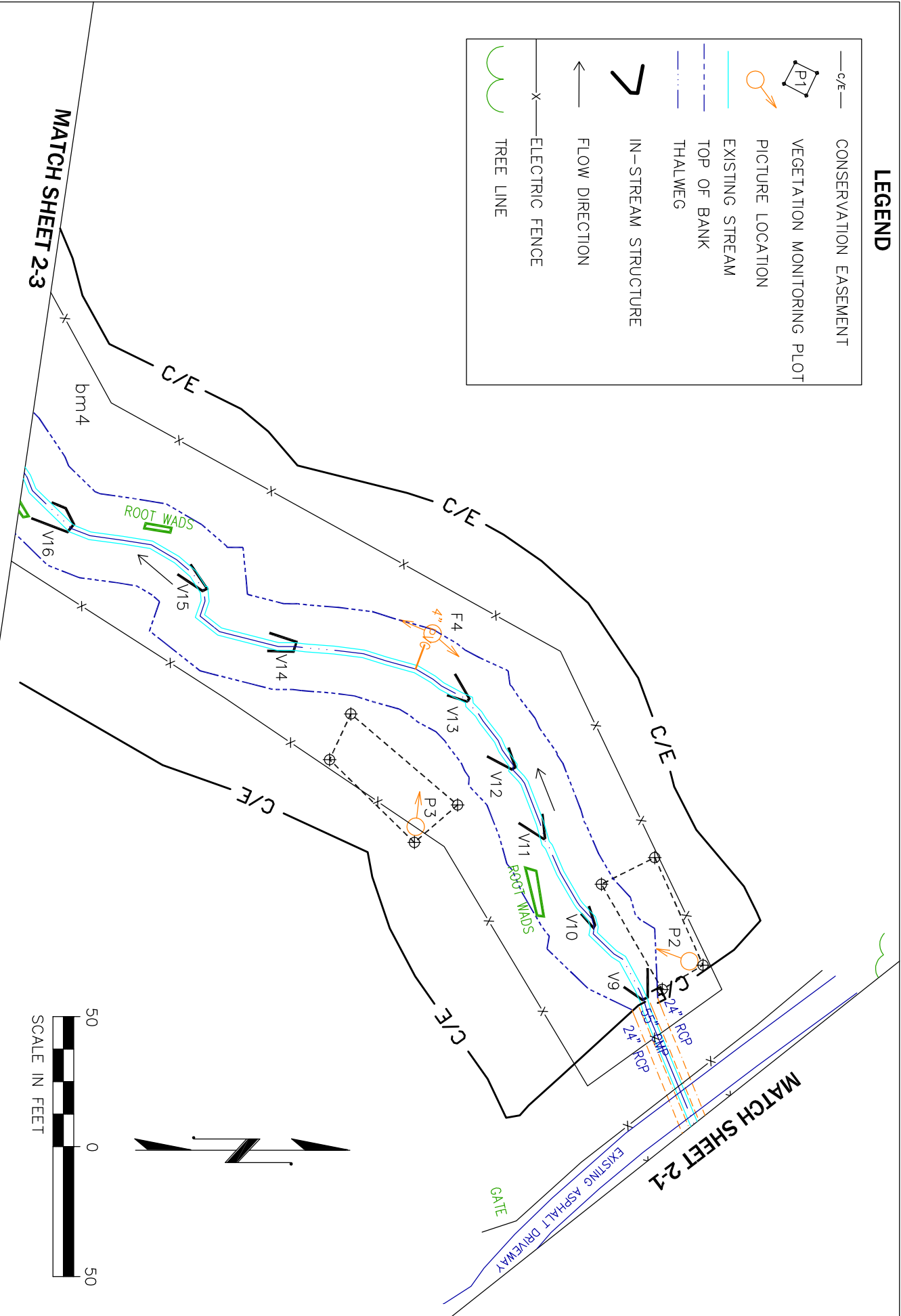
Project: **Unnamed Tributary to Bear Swamp Creek Stream Restoration Site**  
 EEP Project No. 27  
 FRANKLIN COUNTY, NORTH CAROLINA

Dwn By:	GWN	Date:	FEB 2008
Chk By:	JWG	Scale:	1" = 50'
EPC Project No.:		06-282.04	

FIGURE  
**2-1**

# LEGEND

- c/e — CONSERVATION EASEMENT
- P1 VEGETATION MONITORING PLOT
- 📍 PICTURE LOCATION
- EXISTING STREAM
- TOP OF BANK
- THALWEG
- IN-STREAM STRUCTURE
- ➔ FLOW DIRECTION
- X — ELECTRIC FENCE
- ~ TREE LINE



## MONITORING PLAN VIEW

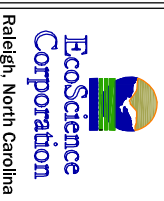


Client: \_\_\_\_\_ Title: \_\_\_\_\_

Project: **Unnamed Tributary to Bear Swamp Creek Stream Restoration Site**  
**EEP Project No. 27**  
 FRANKLIN COUNTY, NORTH CAROLINA

Dwn By:	GWN	Date:	FEB 2008
Ktd By:	JWG	Scale:	1" = 50'
ESC Project No.:		06-282.04	

FIGURE  
**2-2**



Client: **ECOSYSTEM ENHANCEMENT PROGRAM**

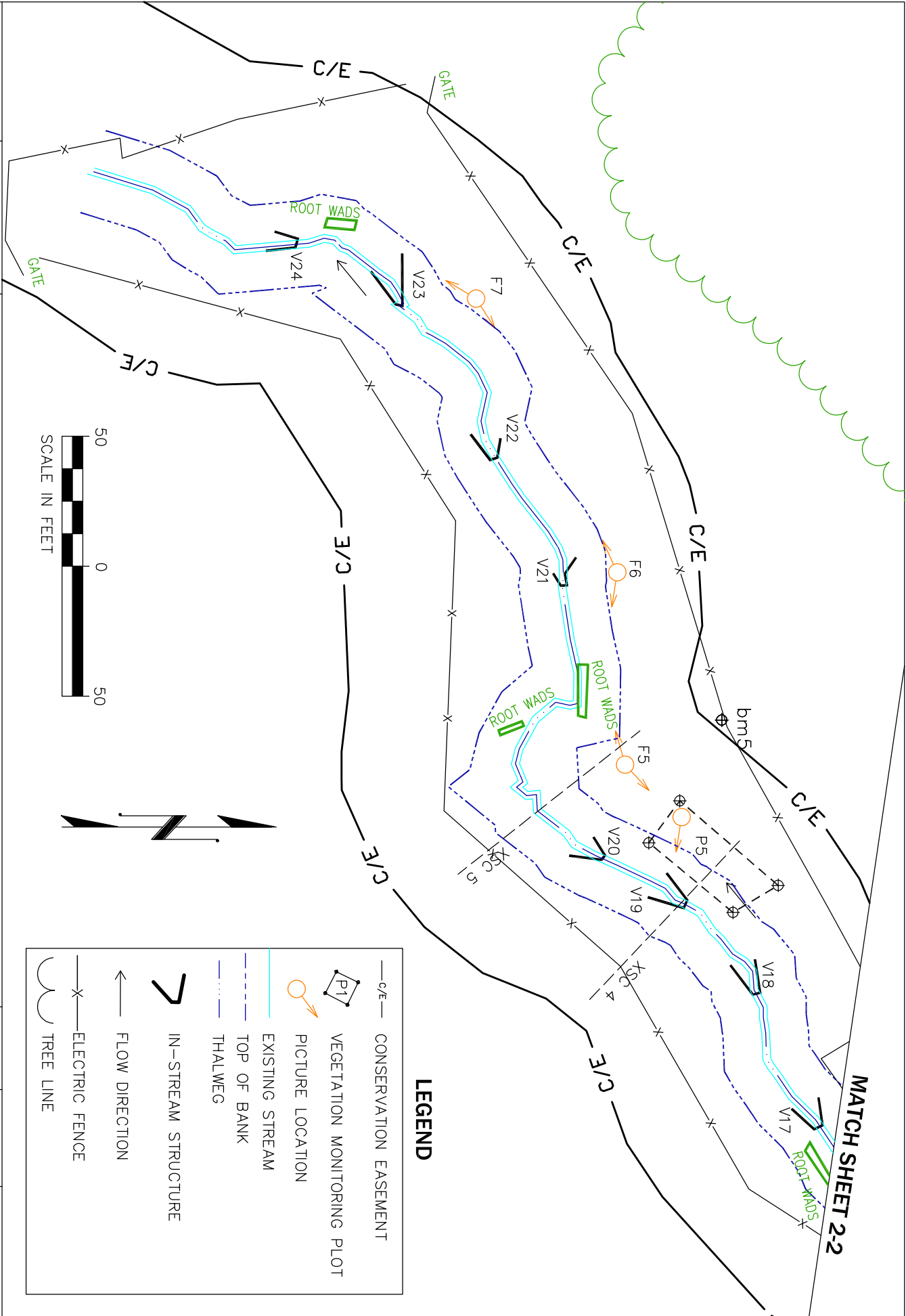
Title: **MONITORING PLAN VIEW**

Project: **Unnamed Tributary to Bear Swamp Creek Stream Restoration Site**  
**EEP Project No. 27**

FRANKLIN COUNTY, NORTH CAROLINA

Dwn By:	GWN	Date:	FEB 2008
Chd By:	JWG	Scale:	1" = 50'
ESC Project No.:		06-282.04	

FIGURE **2-3**



**LEGEND**

- C/E — CONSERVATION EASEMENT
- P1 VEGETATION MONITORING PLOT
- PICTURE LOCATION
- EXISTING STREAM
- TOP OF BANK
- THALWEG
- IN-STREAM STRUCTURE
- ← FLOW DIRECTION
- X — ELECTRIC FENCE
- TREE LINE

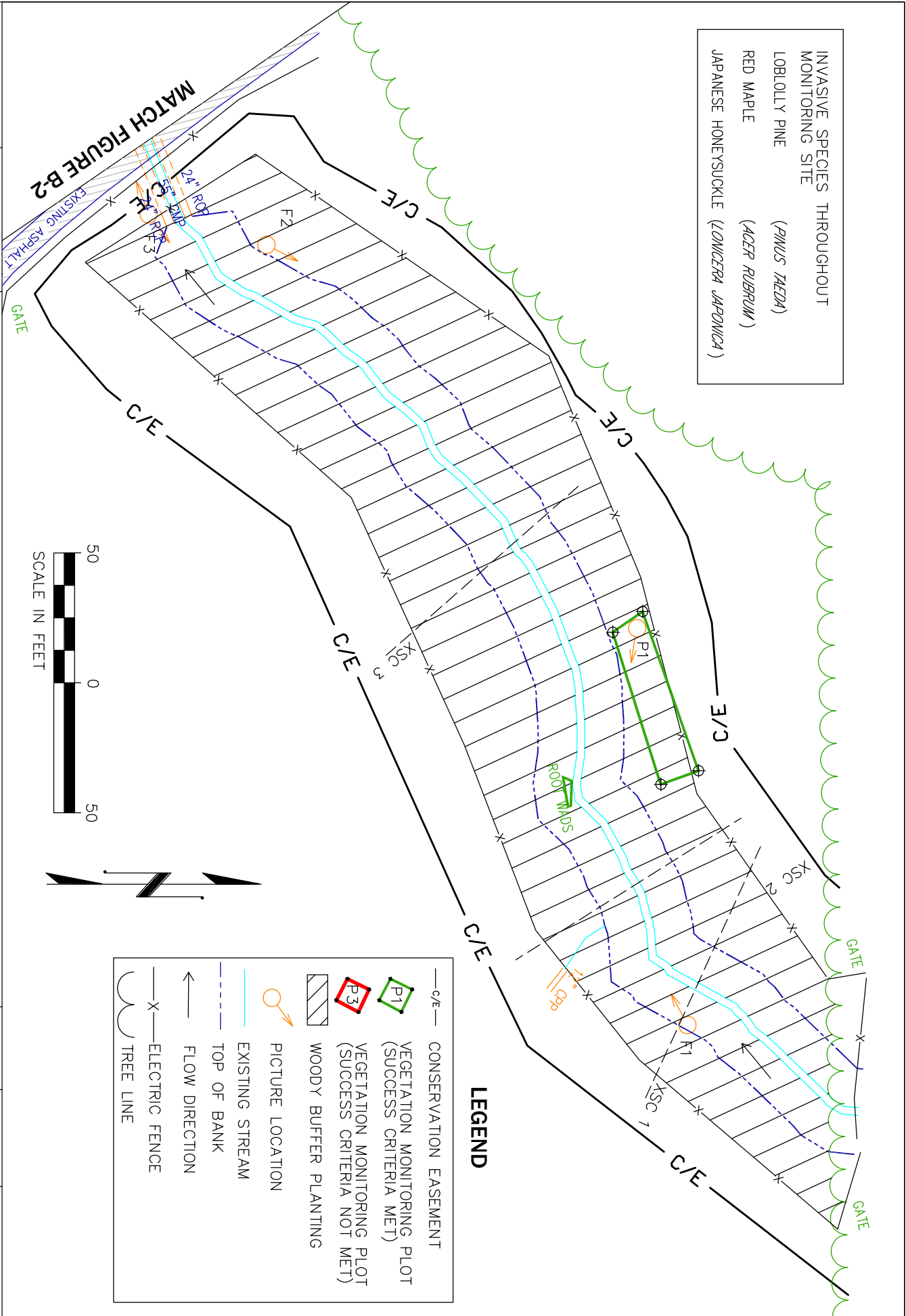
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**APPENDIX B**

**VEGETATION DATA**



- INVASIVE SPECIES THROUGHOUT MONITORING SITE
- LOBLOLLY PINE (*PINUS TAEDA*)
  - RED MAPLE (*ACER RUBRUM*)
  - JAPANESE HONEYSUCKLE (*LONICERA JAPONICA*)



**LEGEND**

- CONSERVATION EASEMENT
- VEGETATION MONITORING PLOT (SUCCESS CRITERIA MET)
- VEGETATION MONITORING PLOT (SUCCESS CRITERIA NOT MET)
- WOODY BUFFER PLANTING
- PICTURE LOCATION
- EXISTING STREAM
- TOP OF BANK
- FLOW DIRECTION
- ELECTRIC FENCE
- TREE LINE



Client: \_\_\_\_\_ Title: \_\_\_\_\_

Project: **Unnamed Tributary to Bear Swamp Creek Stream Restoration Site**  
**EPP Project No. 27**

VEGETATION PROBLEM AREAS

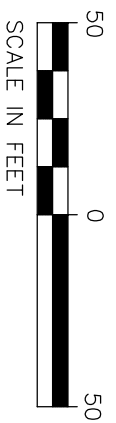
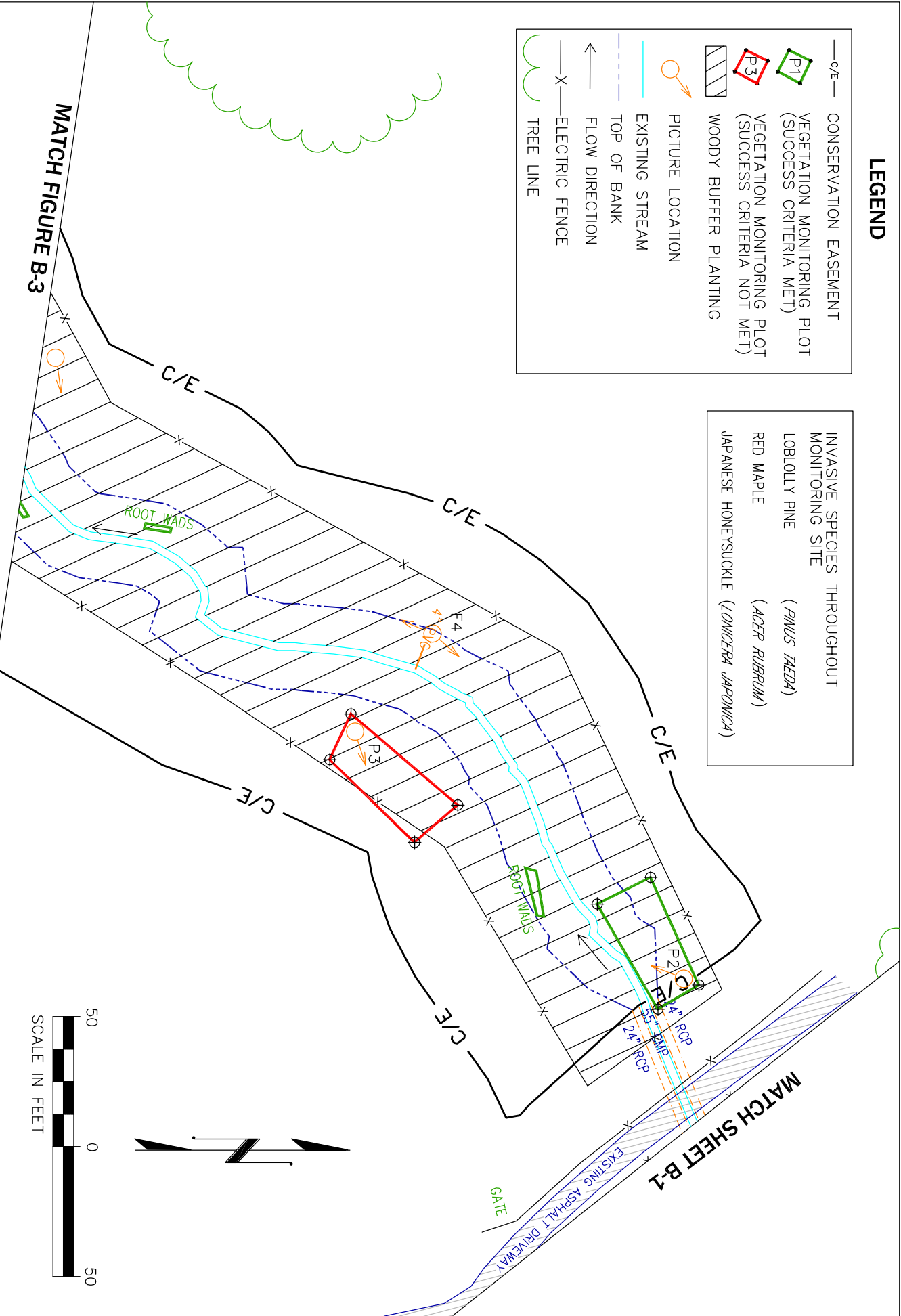
FRANKLIN COUNTY, NORTH CAROLINA

Dwn By:	GWN	Date:	FEB 2008
Chd By:	JWG	Scale:	1" = 50'
EPC Project No.:		06-282.04	
FIGURE			<b>B-1</b>

# LEGEND

- C/E — CONSERVATION EASEMENT
- ▭ P1 VEGETATION MONITORING PLOT (SUCCESS CRITERIA MET)
- ▭ P3 VEGETATION MONITORING PLOT (SUCCESS CRITERIA NOT MET)
- ▨ WOODY BUFFER PLANTING
- PICTURE LOCATION
- EXISTING STREAM
- TOP OF BANK
- ← FLOW DIRECTION
- X— ELECTRIC FENCE
- ~ TREE LINE

- INVASIVE SPECIES THROUGHOUT MONITORING SITE
- LOBLOLLY PINE (*PINUS TAEDA*)
- RED MAPLE (*ACER RUBRUM*)
- JAPANESE HONEYSUCKLE (*LONICERA JAPONICA*)



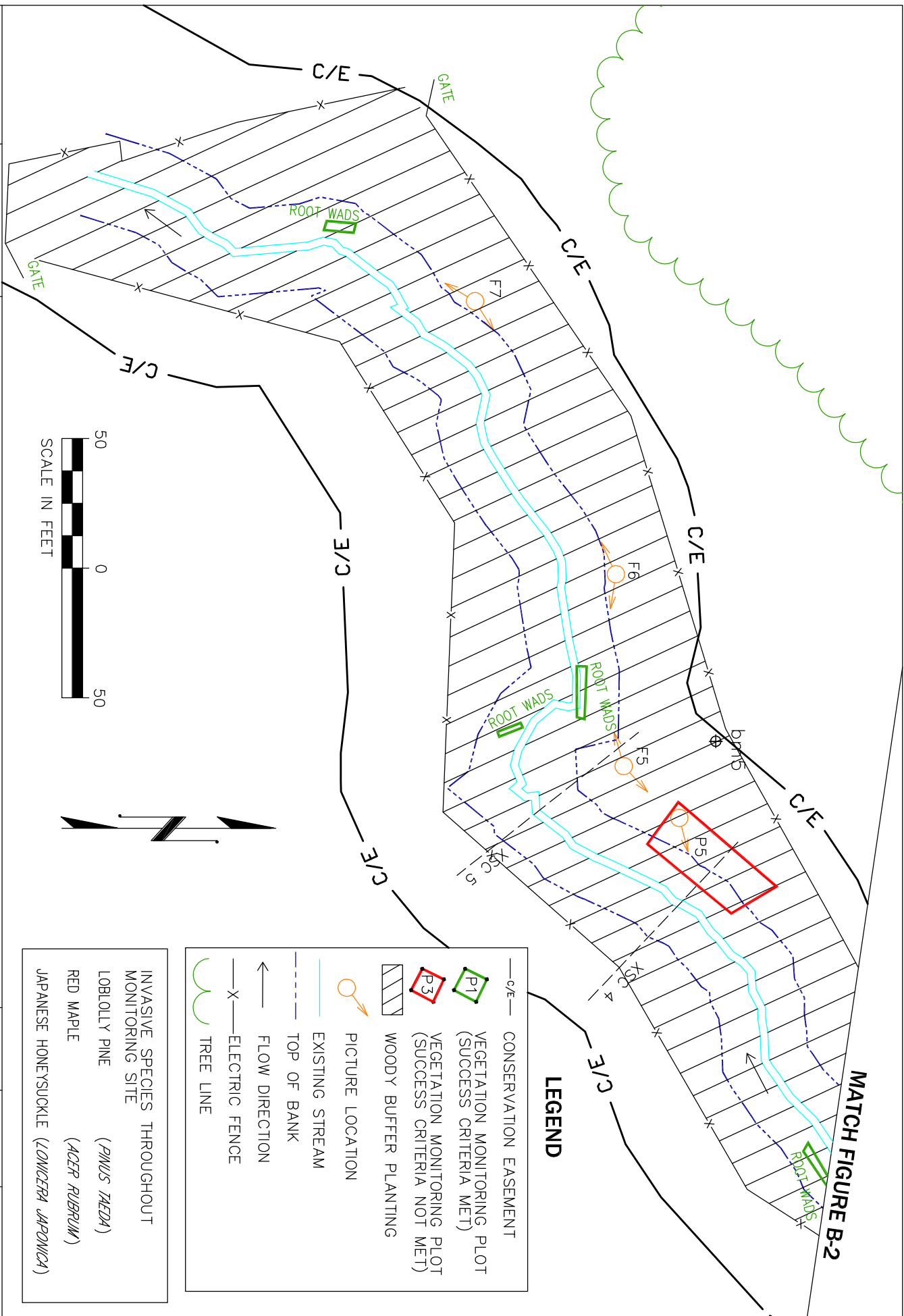
## VEGETATION PROBLEM AREAS



Client: \_\_\_\_\_ Title: \_\_\_\_\_

Project: **Unnamed Tributary to Bear Swamp Creek Stream Restoration Site**  
**EEP Project No. 27**  
 FRANKLIN COUNTY, NORTH CAROLINA

Dwn By: GWN	Date: FEB 2008	FIGURE
Chd By: JWG	Scale: 1" = 50'	
ESC Project No.: 06-282.04		<b>B-2</b>



**LEGEND**

- C/E — CONSERVATION EASEMENT
- E/C — VEGETATION MONITORING PLOT (SUCCESS CRITERIA MET)
- P1 — VEGETATION MONITORING PLOT (SUCCESS CRITERIA NOT MET)
- P3 — WOODY BUFFER PLANTING
- F5, F6, F7 — PICTURE LOCATION
- ROOT WADS — EXISTING STREAM
- TOP OF BANK
- FLOW DIRECTION
- X — ELECTRIC FENCE
- TREE LINE

**INVASIVE SPECIES THROUGHOUT MONITORING SITE**

- LOBLOLLY PINE (*PINUS TAEDA*)
- RED MAPLE (*ACEP RUBRUM*)
- JAPANESE HONEYSUCKLE (*LONICEERA JAPONICA*)



**VEGETATION PROBLEM AREAS**



**Client:** [Blank]

**Title:** [Blank]

**Project:** Unnamed Tributary to Bear Swamp Creek Stream Restoration Site  
EEP Project No. 27

FRANKLIN COUNTY, NORTH CAROLINA

<b>Dwn By:</b> GWN	<b>Date:</b> FEB 2008	<b>FIGURE</b> <b>B-3</b>
<b>Kld By:</b> JWG	<b>Scale:</b> 1" = 50'	
<b>ESC Project No.:</b> 06-282.04		

**UT to Bear Swamp Creek Stream Restoration Site  
Representative Vegetation Problem Areas**



Photo 1. Heavy loblolly pine colonization near Station 1+00.



Photo 2. Heavy loblolly pine colonization near Station 10+00.

**Unnamed Tributary to Bear Swamp Creek Restoration Site  
Year-5 Vegetation Survey Data Tables**

<b>Stem Counts for Each Species Arranged by Plot</b>									
<b>Species</b>	<b>Plots</b>				<b>Year 2 Totals</b>	<b>Year 3 Totals</b>	<b>Year 4 Totals</b>	<b>Year 5 Totals</b>	<b>Survival %</b>
	<b>1</b>	<b>2</b>	<b>3</b>	<b>5</b>					
<b>Shrubs</b>									
Tag alder ( <i>Alnus serrulata</i> )					0	0	0	0	--
Silky dogwood ( <i>Cornum amomum</i> )	1				13	12	1	1	8
Winterberry ( <i>Ilex verticillata</i> )					0	0	0	0	--
Black willow ( <i>Salix nigra</i> )	7	1			19	29	7	8	42
Elderberry ( <i>Sambucus canadensis</i> )					0	0	0	0	--
<b>Trees</b>									
River birch ( <i>Betula nigra</i> )	9				0	6	13	9	N/A
Ironwood ( <i>Carpinus caroliniana</i> )					1	0	0	0	0
Green ash ( <i>Fraxinus pennsylvanica</i> )		6			8	8	7	6	75
Black walnut ( <i>Juglans nigra</i> )		2			3	3	2	2	66
Red mulberry ( <i>Morus rubra</i> )					1	0	0	0	0
Hophornbeam ( <i>Ostrya virginiana</i> )			1		5	0	2	1	20
Swamp chestnut oak ( <i>Quercus michauxii</i> )	1			1	3	5	3	2	66
Cherrybark oak ( <i>Quercus pagoda</i> )					1	0	2	0	0

<b>Total</b>	18	9	1	1
<b>Density (trees/acre)</b>	728	364	40	40
<b>Average Density</b>	293			

**Unnamed Tributary to Bear Swamp Creek Restoration Site  
Year-5 Vegetation Survey Data Tables**

<b>Stem Counts for Volunteer Species Arranged by Plot</b>								
<b>Species</b>	<b>Plots</b>				<b>Year 2 Totals</b>	<b>Year 3 Totals</b>	<b>Year 4 Totals</b>	<b>Year 5 Totals</b>
	<b>1</b>	<b>2</b>	<b>3</b>	<b>5</b>				
Boxelder ( <i>Acer negundo</i> )	1	2		1	0	3	3	4
Red maple ( <i>Acer rubrum</i> )	44			3	51	73	23	47
Eastern baccharis ( <i>Baccharis halimifolia</i> )		4			0	2	8	4
Sugarberry ( <i>Celtis laevigata</i> )					0	2	0	0
Persimmon ( <i>Diospyros virginiana</i> )					0	1	1	0
Easter red cedar ( <i>Juniperus virginiana</i> )				1	0	0	1	1
Sweetgum ( <i>Liquidambar styraciflua</i> )	15			50	20	26	39	65
Tulip poplar ( <i>Liriodendron tulipifera</i> )	1			1	7	2	3	2
Loblolly pine ( <i>Pinus taeda</i> )	395	107	54	57	250	547	654	613
Sycamore ( <i>Platanus occidentalis</i> )					0	1	0	0
Black cherry ( <i>Prunus serotina</i> )		1		8	0	5	12	9
Winged sumac ( <i>Rhus copallina</i> )					1	0	0	0
Smooth sumac ( <i>Rhus glabra</i> )	44				2	43	0	44
Winged elm ( <i>Ulmus alata</i> )	23				0	41	11	23
Possumhaw ( <i>Viburnum nudum</i> )					0	3	1	0
Chinese privet ( <i>Ligustrum sinense</i> )		1			0	0	1	1

**Total**    523    115    54    121  
**Density (trees/acre)**    21165    4654    2185    4897  
**Average Density**    8225

<b>Combined Stem Counts for Planted and Volunteer Species Arranged by Plot</b>				
	<b>Plot 1</b>	<b>Plot 2</b>	<b>Plot 3</b>	<b>Plot 5</b>
<b>Total</b>	541	124	55	122
<b>Density (trees/acre)</b>	21894	5018	2226	4937
<b>Average Density</b>	8519			

**UT to Bear Swamp Creek Stream Restoration Site (Year 5)  
Vegetation Plot Photos**



Photo 3. Plot 1 taken July 31, 2007 from the northwest corner looking southeast.



Photo 4. Plot 2 taken July 31, 2007 from the northwest corner looking southeast.

**UT to Bear Swamp Creek Stream Restoration Site (Year 5)  
Vegetation Plot Photos**



Photo 5. Plot 3 taken July 31, 2007 from the northeast corner looking southwest.



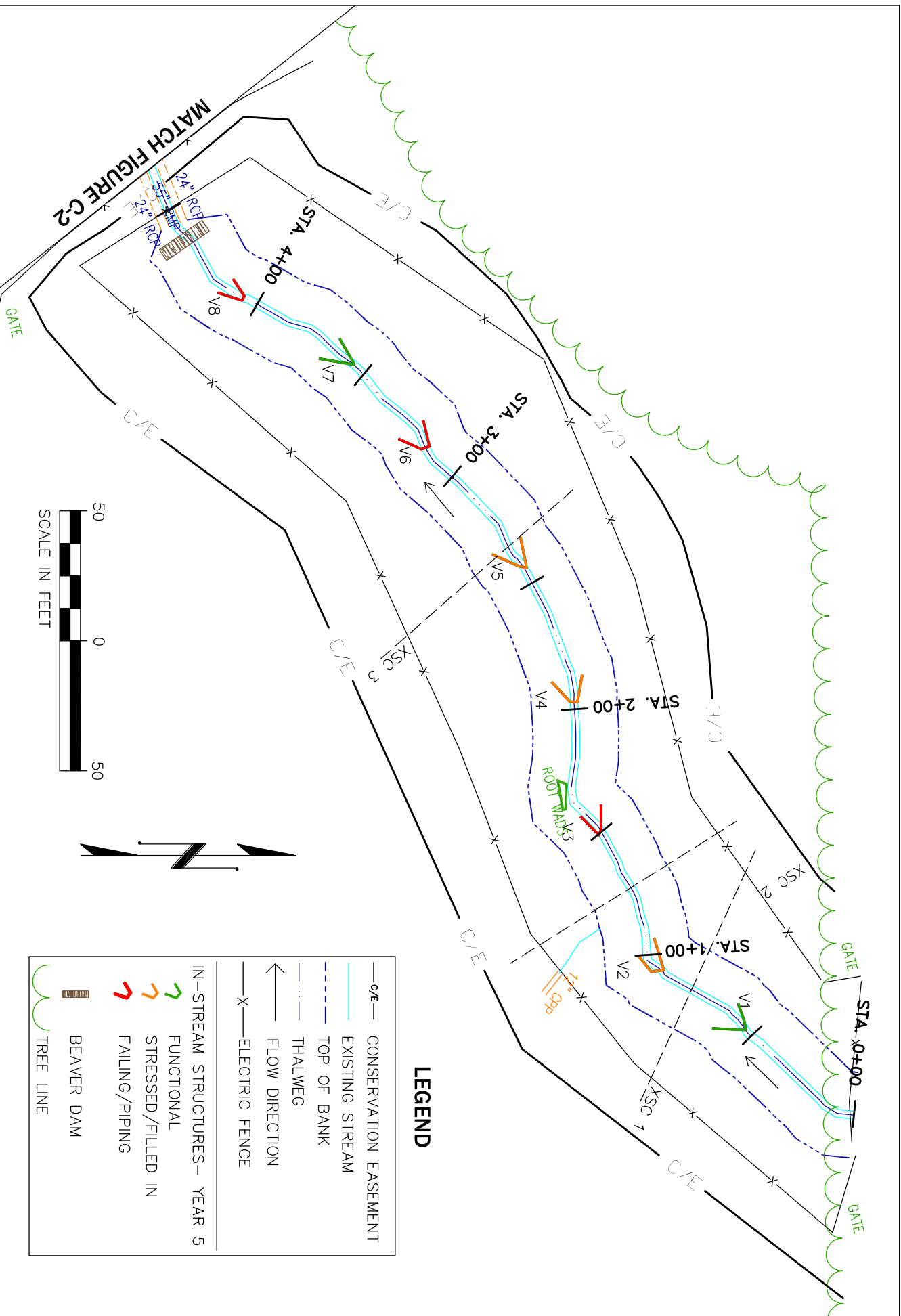
Photo 6. Plot 5 taken July 31, 2007 from the southwest corner looking northeast.



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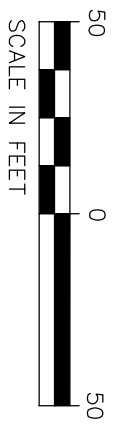
**APPENDIX C**

**STREAM GEOMORPHOLOGY DATA**

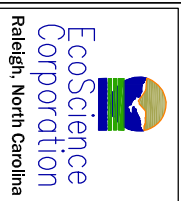


**LEGEND**

— c/e —	CONSERVATION EASEMENT
— (solid blue) —	EXISTING STREAM
- - - (dashed blue) - - -	TOP OF BANK
· · · (dotted blue) · · ·	THALWEG
←	FLOW DIRECTION
— X —	ELECTRIC FENCE
— (dashed blue) —	IN-STREAM STRUCTURES— YEAR 5
↗ (green arrow)	FUNCTIONAL
↘ (orange arrow)	STRESSED/FILLED IN
↖ (red arrow)	FALLING/PIPING
▬▬▬ (hatched)	BEAVER DAM
~ (green wavy)	TREE LINE



**STREAM CURRENT CONDITION PLAN VIEW**



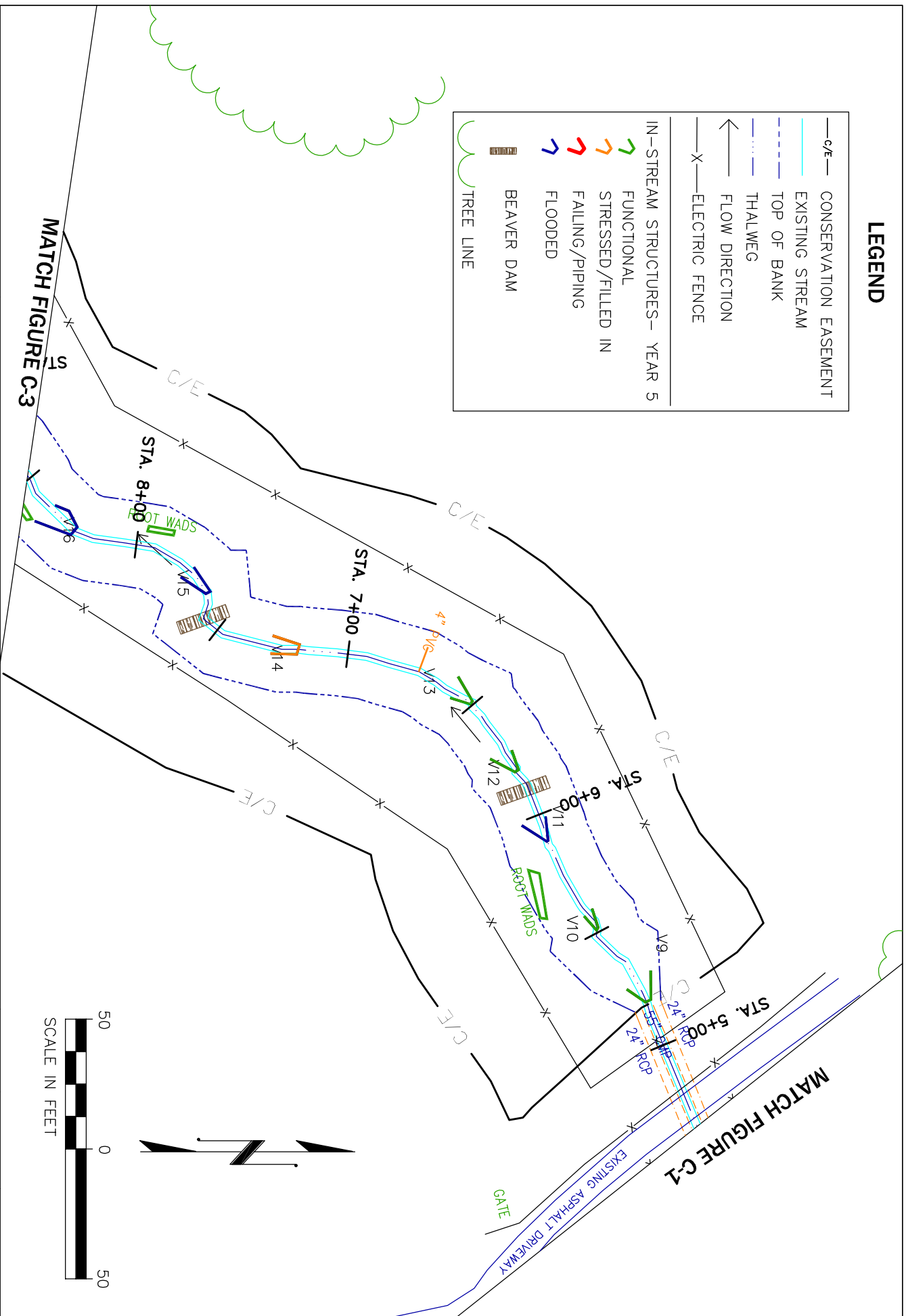
Client: \_\_\_\_\_  
 Title: \_\_\_\_\_  
 Project: **Unnamed Tributary to Bear Swamp Creek Stream Restoration Site**  
**EEP Project No. 27**  
 FRANKLIN COUNTY, NORTH CAROLINA

Dwn By:	GWN	Date:	FEB 2008
Chk By:	JWG	Scale:	1" = 50'
ESC Project No.:		06-282.04	

FIGURE  
**C-1**

# LEGEND

- C/E — CONSERVATION EASEMENT
  - EXISTING STREAM
  - - - TOP OF BANK
  - THALWEG
  - ← FLOW DIRECTION
  - X — ELECTRIC FENCE
- 
- IN-STREAM STRUCTURES— YEAR 5
  - ✓ FUNCTIONAL
  - ✗ STRESSED/FILLED IN
  - ✗ FAILING/PIPING
  - ✗ FLOODED
  - BEAVER DAM
  - TREE LINE



## STREAM CURRENT CONDITION PLAN VIEW



Client: \_\_\_\_\_

Title: \_\_\_\_\_

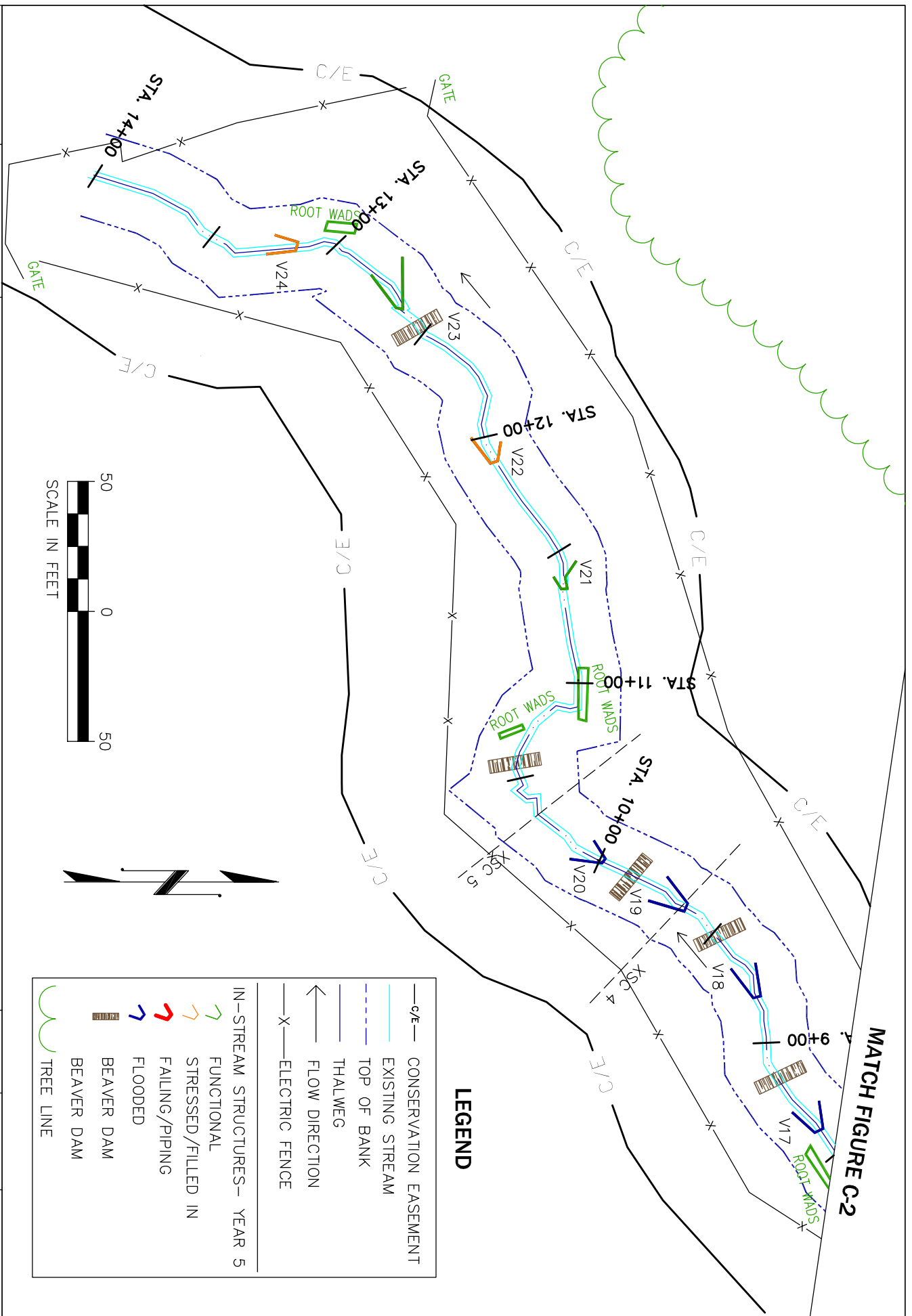
Project: **Unnamed Tributary to Bear Swamp Creek Stream Restoration Site**  
EEP Project No. 27

FRANKLIN COUNTY, NORTH CAROLINA

Dwn By:	GWN	Date:	FEB 2008
Chk By:	JWG	Scale:	1" = 50'
ESC Project No.:		06-282.04	

FIGURE

# C-2



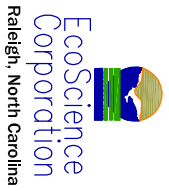
IN-STREAM STRUCTURES- YEAR 5	
	FUNCTIONAL
	STRESSED/FILLED IN
	FALLING/PIPING
	FLOODED
	BEAVER DAM
	BEAVER DAM
	TREE LINE

	CONSERVATION EASEMENT
	EXISTING STREAM
	TOP OF BANK
	THALWEG
	FLOW DIRECTION
	ELECTRIC FENCE

**LEGEND**

**STREAM CURRENT CONDITION PLAN VIEW**



**Client:** EcoScience Corporation  
**Title:** Unnamed Tributary to Bear Swamp Creek Stream Restoration Site  
**Project:** EEP Project No. 27  
 FRANKLIN COUNTY, NORTH CAROLINA

<b>Dwn By:</b> GWN	<b>Date:</b> FEB 2008
<b>Ktd By:</b> JWG	<b>Scale:</b> 1" = 50'
<b>ESC Project No.:</b> 06-282.04	

**FIGURE C-3**

**UT to Bear Swamp Creek Stream Restoration Site (Year 5)  
Verification of Bankfull Event**



Photo 7. Crest gauge showing particulate deposited 6-8 inches above bankfull during a storm event in July 2007.

**UT to Bear Swamp Creek Stream Restoration Site (Year 5)  
Stream Problem Areas**



Photo 8. Rock vane 14 has filled in with sediment but stream remains stable.



Photo 9. Rock vane 20 flooded from downstream beaver dams.

**UT to Bear Swamp Creek Stream Restoration Site (Year 5)  
Permanent Station Photos**



Photo 10. Photo Station 1 taken August 28, 2007 looking downstream.



Photo 11. Photo Station 2 taken August 28, 2007 looking upstream.

**UT to Bear Swamp Creek Stream Restoration Site (Year 5)  
Permanent Station Photos**



Photo 12. Photo Station 3 taken August 28, 2007 looking upstream.



Photo 13. Photo Station 3 taken August 28, 2007 looking downstream.



**UT to Bear Swamp Creek Stream Restoration Site (Year 5)  
Permanent Station Photos**



Photo 14. Photo Station 4 taken August 28, 2007 looking upstream.



Photo 15. Photo Station 4 taken August 28, 2007 looking downstream.

**UT to Bear Swamp Creek Stream Restoration Site (Year 5)  
Permanent Station Photos**



Photo 16. Photo Station 5 taken August 28, 2007 looking upstream.



Photo 17. Photo Station 5 taken August 28, 2007 looking downstream.

**UT to Bear Swamp Creek Stream Restoration Site (Year 5)  
Permanent Station Photos**



Photo 18. Photo Station 6 taken August 28, 2007 looking upstream.



Photo 19. Photo Station 6 taken August 28, 2007 looking downstream.

**UT to Bear Swamp Creek Stream Restoration Site (Year 5)  
Permanent Station Photos**



Photo 20. Photo Station 7 taken August 28, 2007 looking upstream.

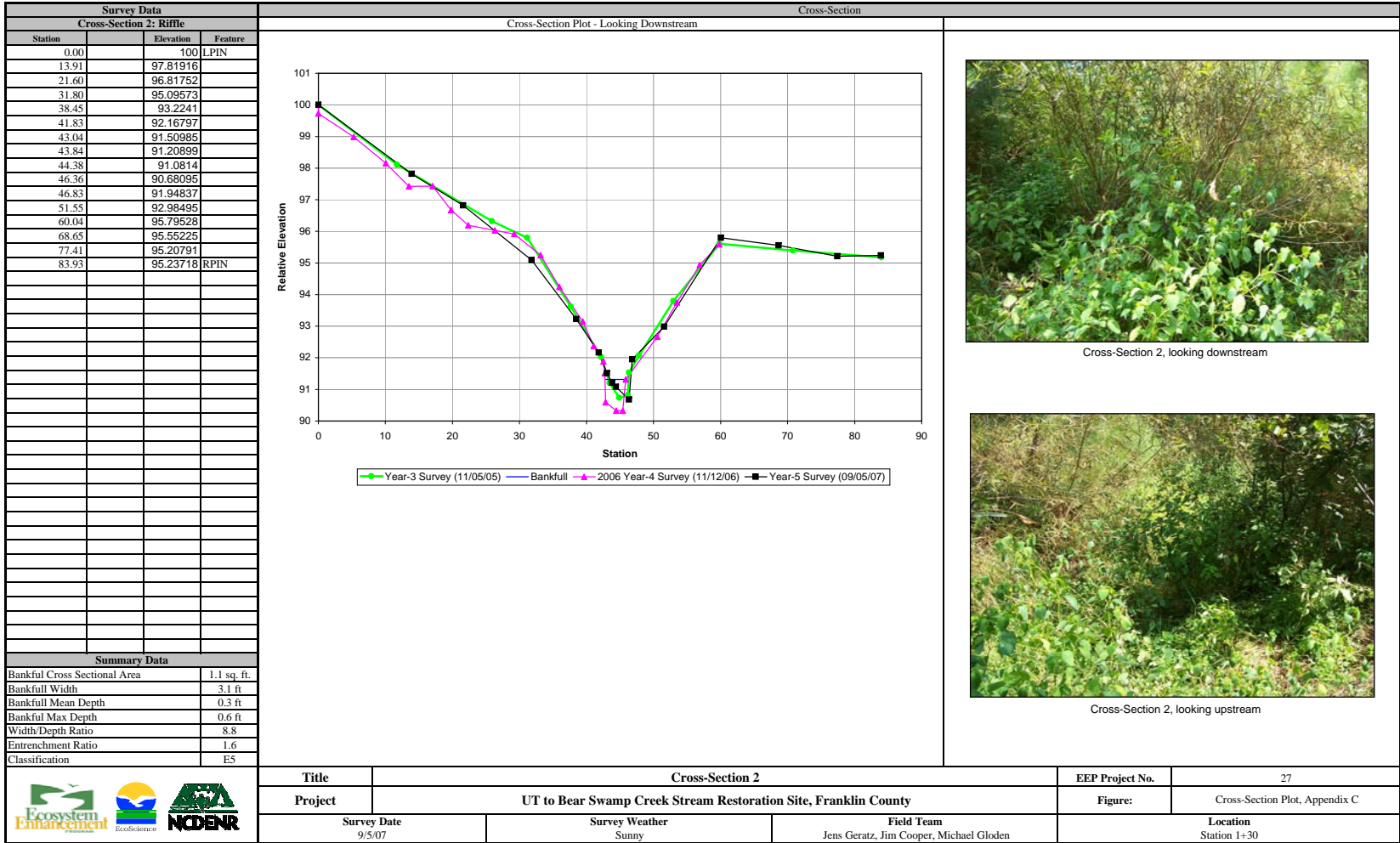


Photo 21. Photo Station 7 taken August 28, 2007 looking downstream.

Table B1. Visual Morphological Stability Assessment						
UT to Bear Swamp Creek Stream Restoration Site / EEP Project No. 27						
1,380 linear feet						
Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended <sup>1</sup>	Total number per As-built <sup>2</sup>	Total Number / feet in unstable state	% Perform in Stable Condition	Feature Perform Mean or Total
A. Riffles	1. Present?	21	25	N/A	84	
	2. Armor stable (e.g. no displacement)?	21	25	N/A	84	
	3. Facet grade appears stable?	21	25	N/A	84	
	4. Minimal evidence of embedding/fining?	21	25	N/A	84	
	5. Length appropriate?	21	25	N/A	84	<b>84%</b>
B. Pools	1. Present? (e.g not subject to severe aggrad. or migrat.?)	34	24	N/A	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	34	24	N/A	100	
	3. Length appropriate?	34	24	N/A	100	<b>100%</b>
C. Thalweg	1. Upstream of meander bend (run/inflection) centering?	N/A	N/A	N/A	100	
	2. Downstream of meander (glide/inflection) centering?	N/A	N/A	N/A	100	<b>100%</b>
D. Meanders	1. Outer bend in state of limited/controlled erosion?	N/A	N/A	N/A	100	
	2. Of those eroding, # w/concomitant point bar formation?	N/A	N/A	N/A	100	
	3. Apparent Rc within spec?	N/A	N/A	N/A	100	
	4. Sufficient floodplain access and relief?	N/A	N/A	N/A	100	<b>100%</b>
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	N/A	100	
	2. Channel bed degradation – areas of increasing down-cutting or head cutting?	N/A	N/A	1/22	98	<b>99%</b>
F. Vanes	1. Free of back or arm scour?	16	24	N/A	67	
	2. Height appropriate?	18	24	N/A	75	
	3. Angle and geometry appear appropriate?	22	24	N/A	92	
	4. Free of piping or other structural failures? <sup>3</sup>	18	24	N/A	75	<b>77%</b>
G. Wads/ Boulders	1. Free of scour?	7	8	N/A	88	
	2. Footing stable?	7	8	N/A	88	<b>88%</b>

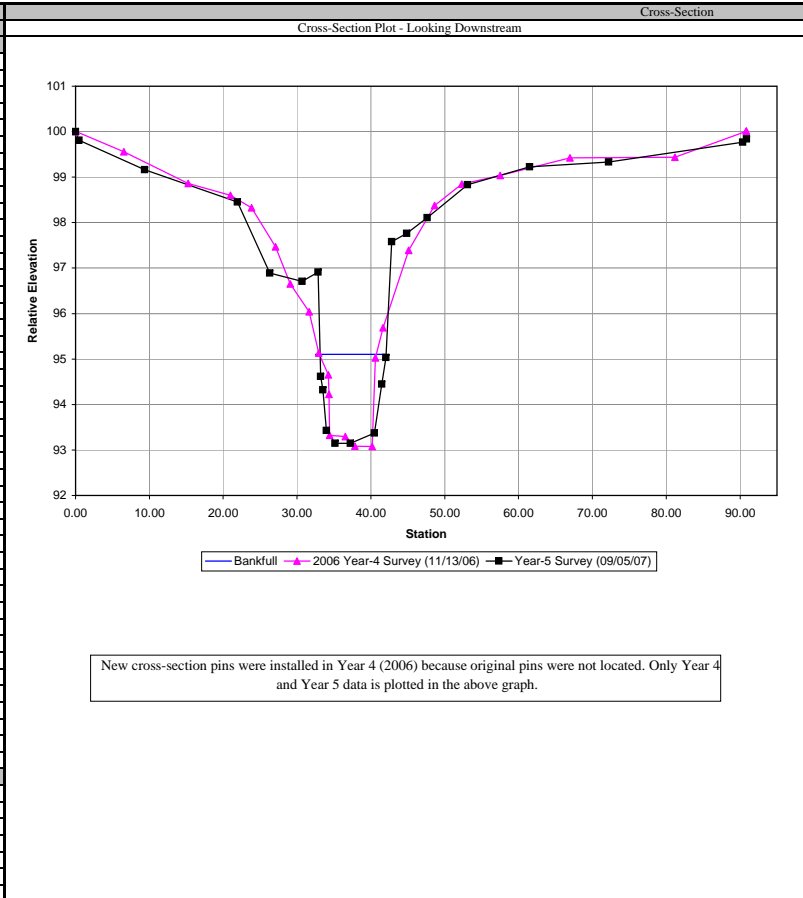
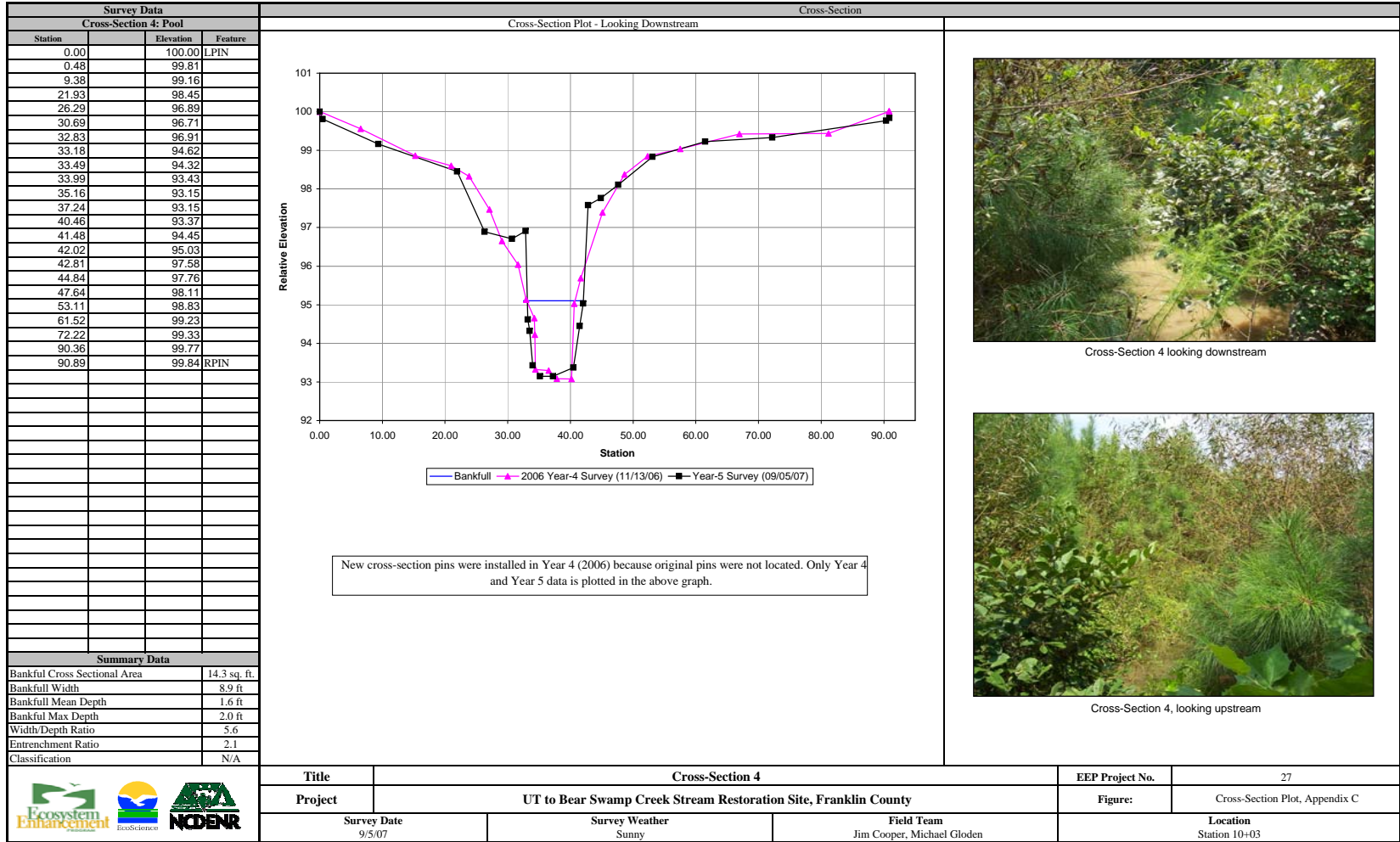
1. Includes constructed riffles and pools that are functioning as intended, as well as any others observed in the field.
2. Based on Rosgen type B stream with every structure having an associated riffle and pool.
3. Flooding from beaver dams within UT to Bear Swamp Creek prohibited an evaluation of some vanes. Any vanes observed to be piping or failing during Year 4 Monitoring, but are currently flooded, are still considered failing in Year 5.







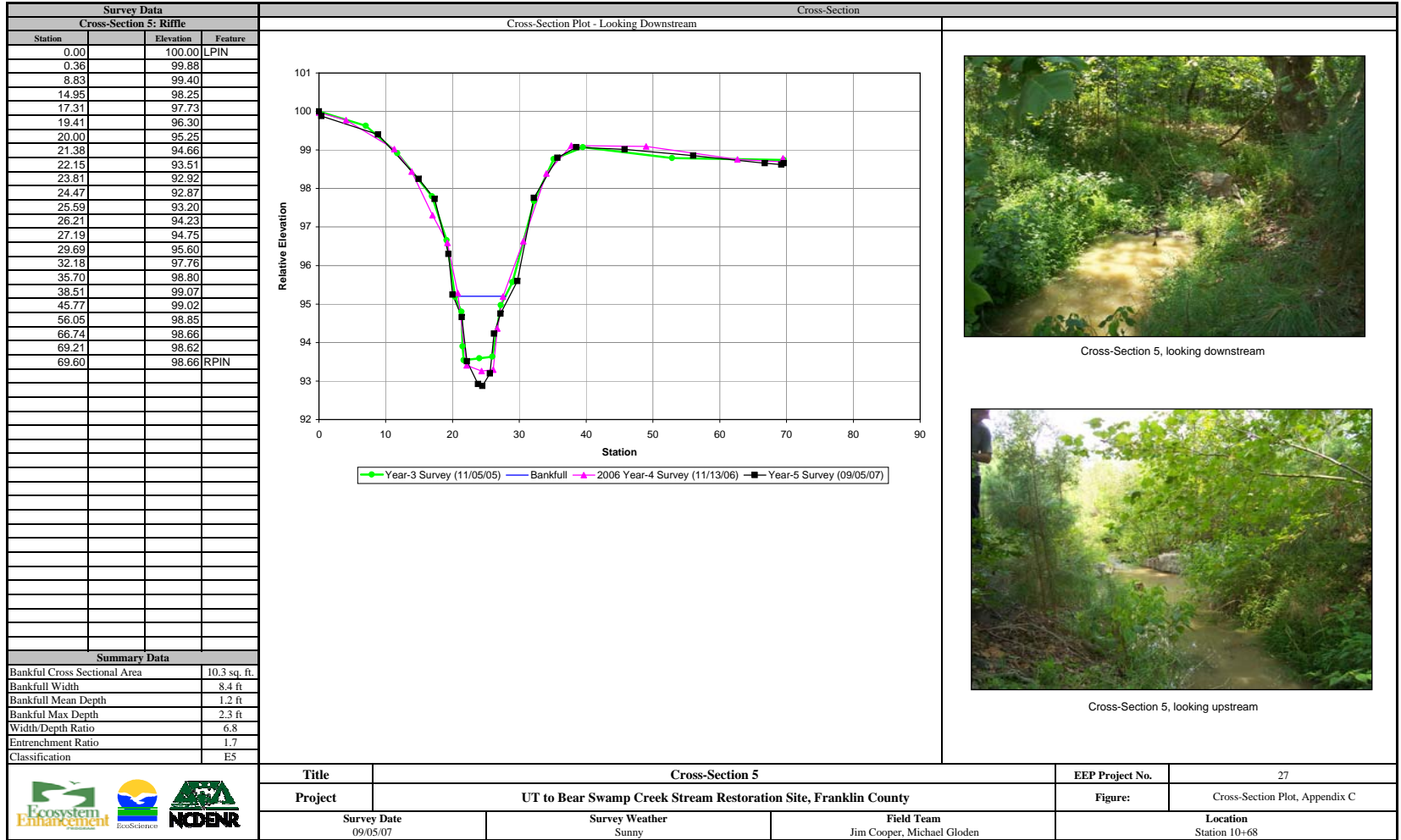




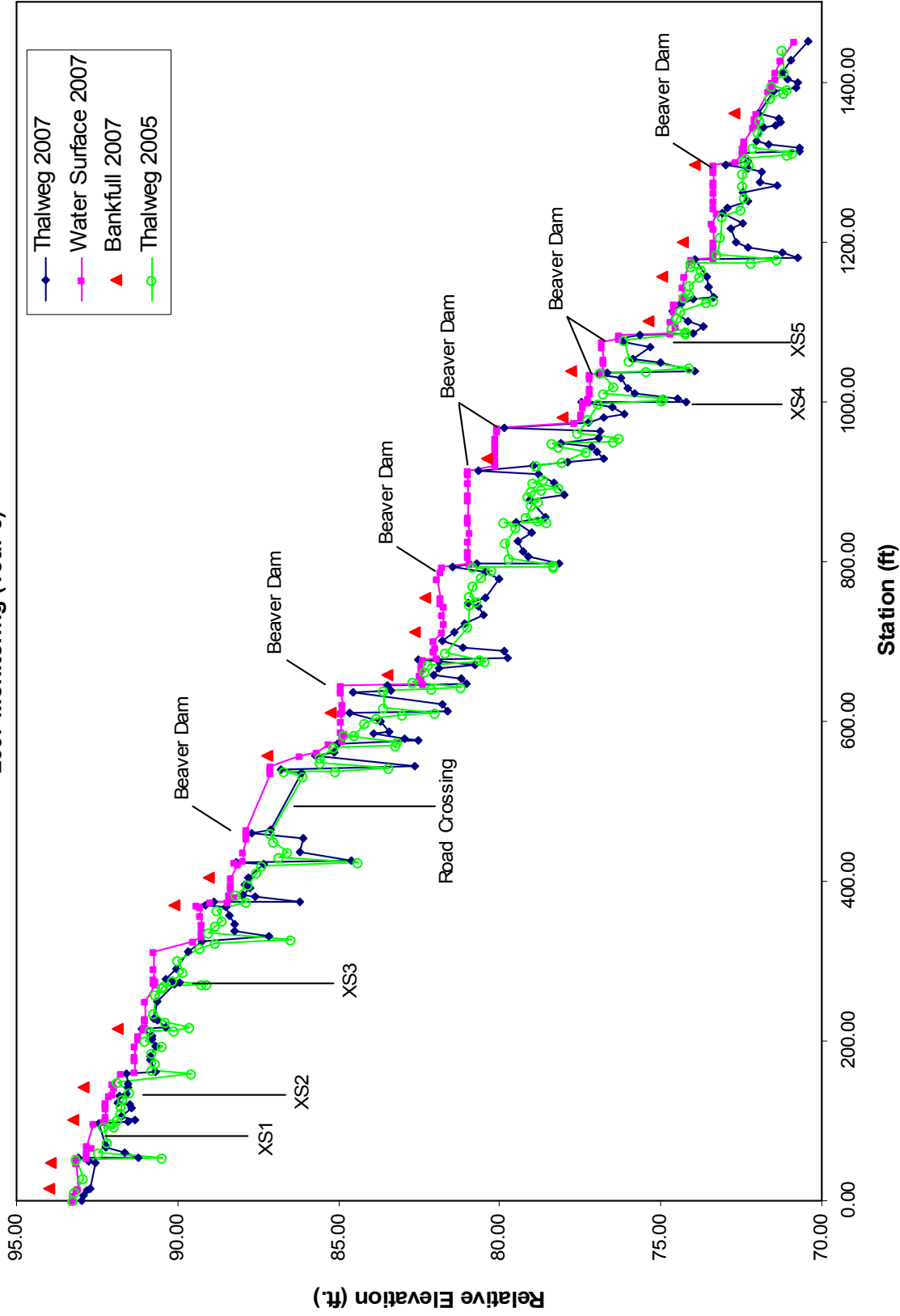
Cross-Section 4 looking downstream



Cross-Section 4, looking upstream



**UT to Bear Swamp Creek  
Longitudinal Profile  
2007 Monitoring (Year 5)**

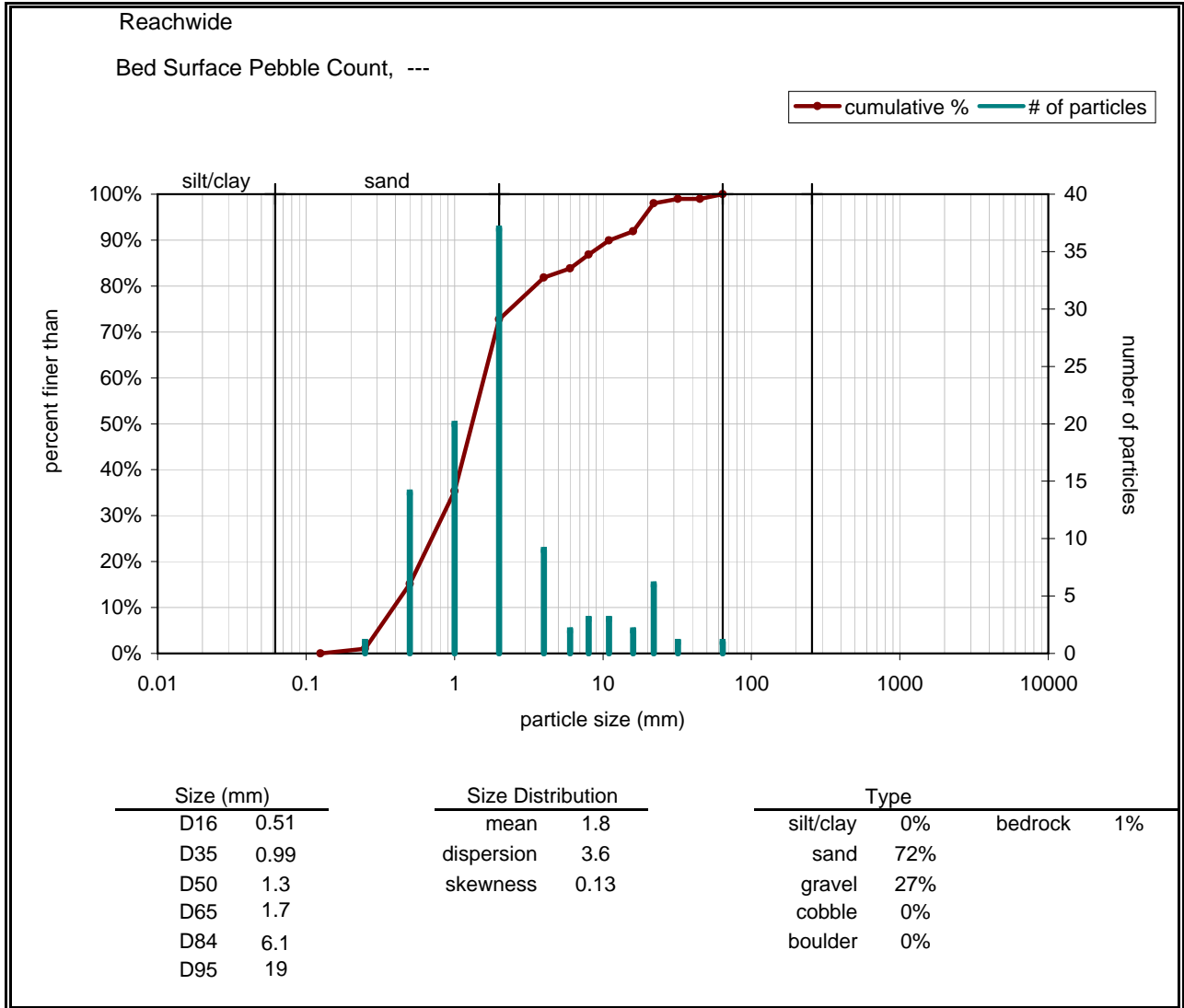


**UT to Bear Swamp Creek  
Longitudinal Profile Data (Year-5)**

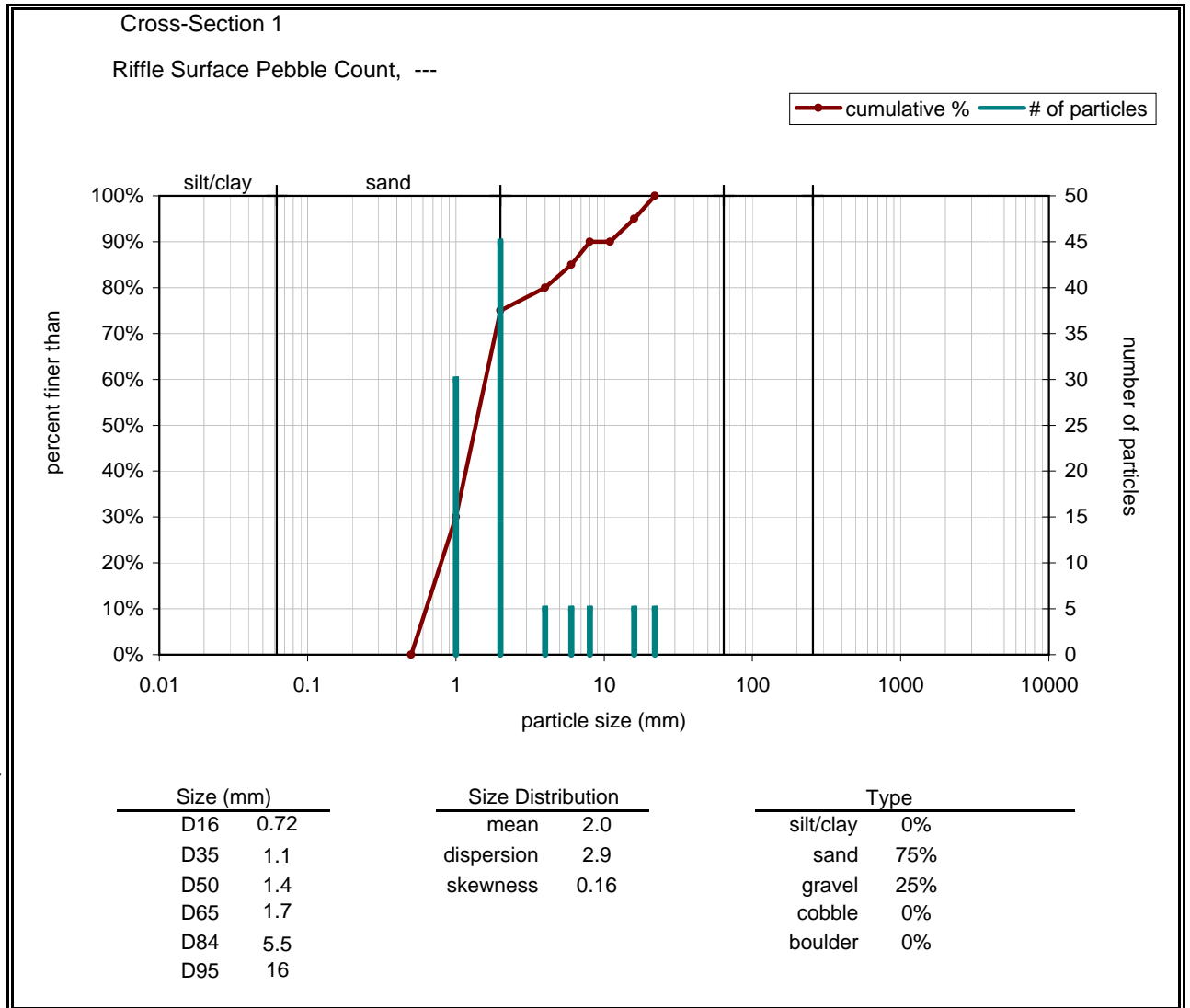
Station	TW Elevation	WS Elevation	BKF Elevation	Station	TW Elevation	WS Elevation	BKF Elevation
0.00	92.99	93.23		367.90	88.51	89.27	
6.47	92.91	93.23		369.68	89.14	89.42	90.12
12.25	92.80	93.16		373.29	88.84	88.96	
14.96	92.71	93.08	94.00	374.30	86.22	88.43	
46.58	92.55	93.16	93.91	379.56	87.60	88.25	
48.67	92.79	93.14		383.52	87.97	88.39	
53.08	93.10	93.11		390.81	87.75	88.34	
54.32	91.23	92.84		395.07	87.91	88.34	
59.18	91.66	92.84		403.72	87.78	88.34	89.01
66.90	92.25	92.65		421.74	87.34	88.14	
68.97	92.24	92.81		423.72	88.16	88.26	
97.36	92.42	92.62		425.78	84.61	87.98	
98.51	91.54	92.30		437.22	86.19	87.98	
100.34	91.33	92.24	93.25	453.69	86.09	87.86	
106.07	91.74	92.24		460.46	87.68	87.86	
115.57	91.41	92.24		463.27	87.09	87.86	
119.61	91.48	92.24		534.34	86.17	87.11	
123.34	91.83	92.24		538.50	86.80	87.11	
130.52	91.81	92.10		543.18	82.65	87.11	
133.95	91.58	92.04		556.36	85.72	86.18	87.20
142.15	91.55	91.98	92.90	560.26	85.12	85.66	
146.40	91.51	92.02		571.38	85.04	85.29	
159.58	91.57	91.73		574.94	82.55	84.87	
162.23	90.68	91.33		578.31	82.93	84.87	
175.28	90.86	91.33		585.16	83.91	84.83	
181.14	90.85	91.33		586.90	83.43	84.91	
192.61	90.70	91.33		599.84	83.71	84.91	
201.25	90.77	91.22		610.79	84.67	84.91	85.24
206.11	90.79	91.23		612.70	81.61	84.86	
214.13	91.10	91.05	91.88	620.59	81.80	84.86	
217.31	90.38	91.00		637.15	84.56	84.91	
225.93	90.65	91.00		639.30	83.37	84.91	
228.55	90.74	90.99		644.04	83.47	84.91	
250.05	90.64	90.99		645.80	81.06	82.39	
269.73	90.08	90.67		653.03	81.20	82.41	
273.91	89.95	90.76		657.06	82.03	82.45	83.50
275.61	90.12	90.68		666.48	81.88	82.39	
278.28	90.38	90.73		669.68	80.74	82.40	
289.58	90.07	90.73	90.75	674.62	81.88	82.37	
311.94	89.68	90.73		676.49	82.51	82.37	
324.37	89.23	89.51		680.03	79.74	81.96	
330.54	87.14	89.24		688.28	79.86	82.03	
337.95	88.24	89.24		692.44	81.14	81.99	
346.19	88.24	89.24		700.07	81.78	82.04	
355.93	88.40	89.30		712.03	81.43	81.79	82.61

Station	TW Elevation	WS Elevation	BKF Elevation	Station	TW Elevation	WS Elevation	BKF Elevation
721.16	81.06	81.72		1077.77	76.27	76.27	
732.58	80.49	81.79		1082.84	75.67	76.27	
743.62	80.65	81.72		1086.05	74.02	74.70	
747.69	80.99	81.81		1093.62	73.70	74.55	
754.07	80.46	81.83	82.33	1099.62	74.15	74.68	75.40
777.40	80.00	81.93		1112.46	74.62	74.60	
787.04	80.43	81.83		1122.69	74.39	74.60	
793.13	81.48	81.77		1128.24	74.02	74.28	
797.19	80.70	80.95		1131.24	73.35	74.30	
797.40	78.16	80.90		1143.02	73.54	74.31	
804.99	79.13	80.98		1156.27	73.57	74.25	74.95
813.34	79.27	80.96		1177.19	73.93	74.08	
824.66	79.42	80.98		1180.36	70.74	73.36	
835.92	79.03	80.92		1187.18	71.23	73.36	
848.50	79.51	81.00		1192.01	72.28	73.35	
856.20	78.56	81.00		1199.59	72.67	73.36	74.34
877.08	79.05	80.99		1215.76	72.80	73.36	
882.78	77.99	80.99		1222.22	72.47	73.39	
897.31	78.34	80.98		1234.85	73.07	73.27	
910.01	78.81	80.98		1242.11	72.91	73.36	
913.10	80.64	80.98		1249.71	72.31	73.36	
919.32	78.94	80.10		1261.01	72.46	73.34	
924.42	77.90	80.10		1269.17	71.40	73.36	
927.34	76.79	80.10	80.38	1274.60	71.91	73.35	
937.45	76.98	80.13		1286.33	71.88	73.36	
943.46	77.15	80.13		1292.35	72.27	73.36	
947.32	78.11	80.13		1295.62	73.00	73.33	73.96
955.00	76.94	80.14		1301.05	72.28	72.68	
962.13	76.90	80.08		1310.04	72.44	72.46	
967.01	79.85	80.08		1312.12	70.68	72.41	
972.55	77.26	77.69		1317.61	70.70	72.43	
979.80	76.77	77.46	78.07	1321.81	71.63	72.41	
984.54	76.13	77.45		1326.99	72.01	72.42	
992.67	76.51	77.41		1342.26	71.79	72.11	
999.23	77.48	77.41		1345.01	71.44	72.09	
999.55	74.19	77.27		1348.93	71.28	72.04	
1003.59	74.46	77.27		1353.14	71.35	72.09	
1009.47	75.83	77.20		1359.26	71.99	72.01	72.70
1016.12	76.03	77.21		1387.92	71.47	71.66	
1029.60	76.23	77.20		1392.68	70.80	71.52	
1033.56	76.91	77.20		1398.96	70.73	71.52	
1036.61	76.68	76.81		1403.30	71.05	71.44	
1038.74	73.93	76.84	77.76	1412.22	71.24	71.43	
1048.46	75.01	76.80		1427.53	70.95	71.27	
1053.59	75.88	76.75		1451.49	70.41	70.84	
1067.76	75.34	76.84					
1074.01	76.17	76.84					

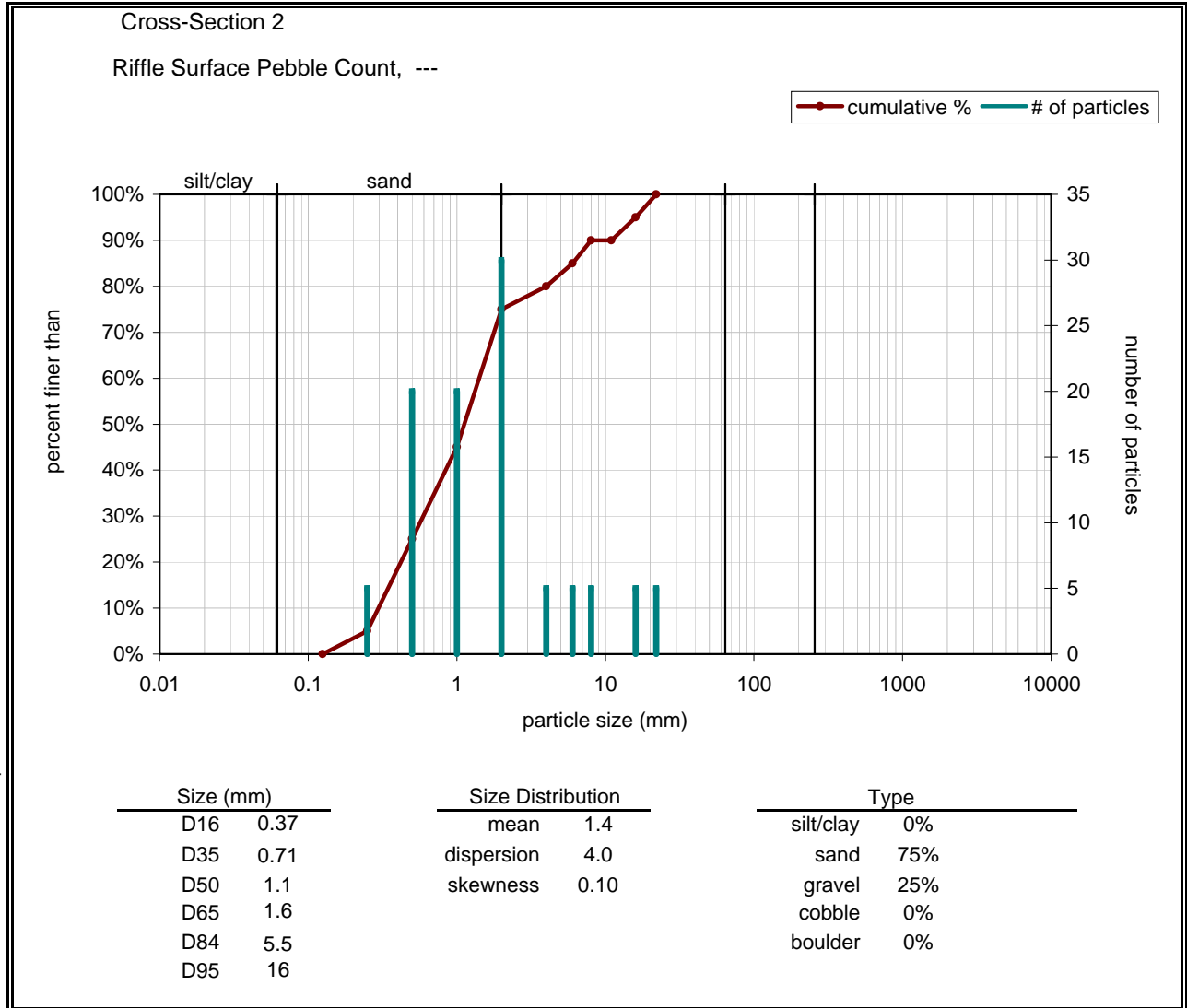
Bed Surface		
Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	1
medium sand	0.25 - 0.5	14
coarse sand	0.5 - 1	20
very coarse sand	1 - 2	37
very fine gravel	2 - 4	9
fine gravel	4 - 6	2
fine gravel	6 - 8	3
medium gravel	8 - 11	3
medium gravel	11 - 16	2
coarse gravel	16 - 22	6
coarse gravel	22 - 32	1
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	1
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		99
bedrock		1
clay hardpan		
detritus/wood		
artificial		
total count:		100
Note: Reach-wide classification count		



Riffle Surface		
Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	30
very coarse sand	1 - 2	45
very fine gravel	2 - 4	5
fine gravel	4 - 6	5
fine gravel	6 - 8	5
medium gravel	8 - 11	
medium gravel	11 - 16	5
coarse gravel	16 - 22	5
coarse gravel	22 - 32	
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	-----	
clay hardpan	-----	
detritus/wood	-----	
artificial	-----	
total count:		100
Note: XS1 (Riffle) Pebble Count		

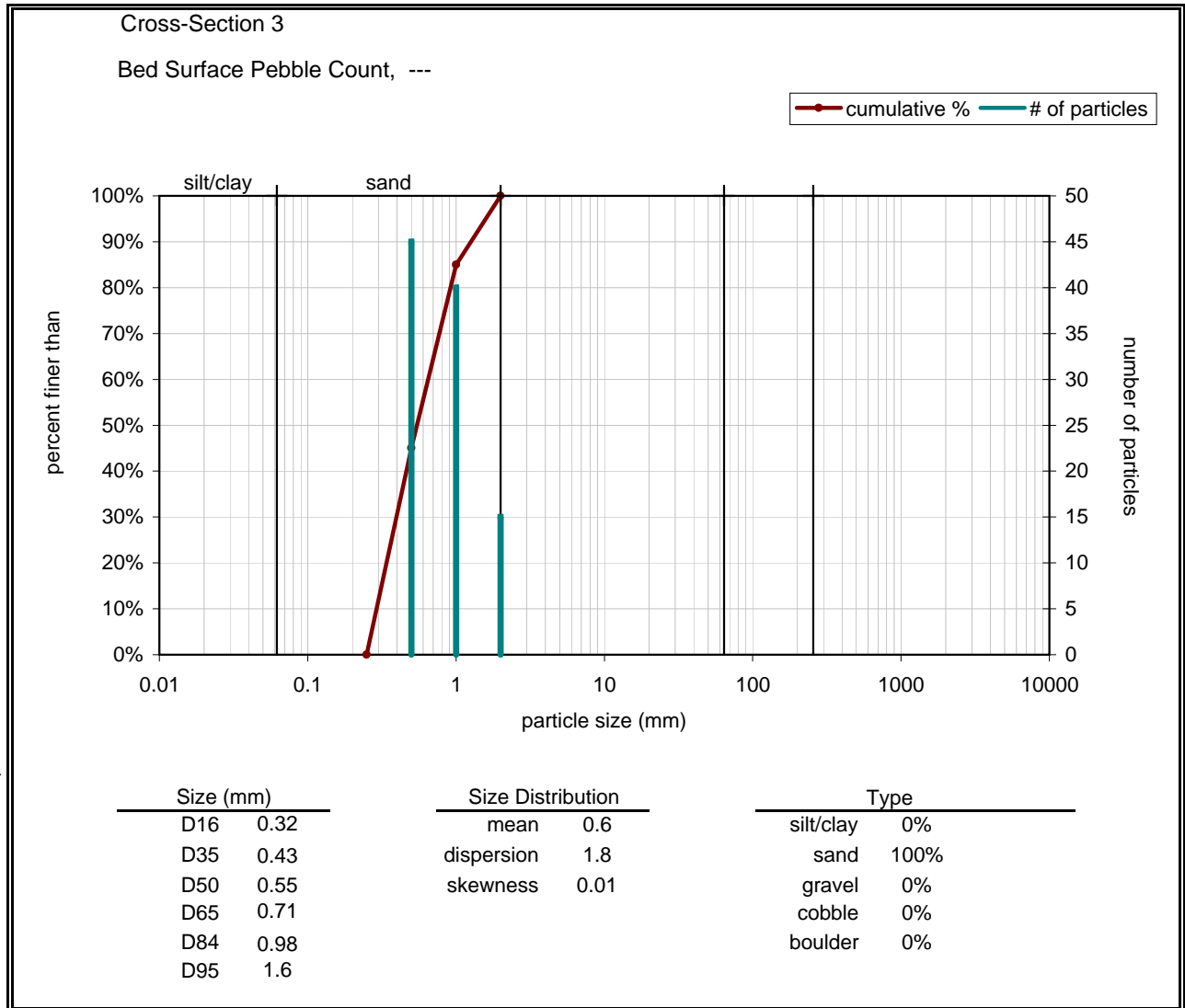


Riffle Surface		
Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	5
medium sand	0.25 - 0.5	20
coarse sand	0.5 - 1	20
very coarse sand	1 - 2	30
very fine gravel	2 - 4	5
fine gravel	4 - 6	5
fine gravel	6 - 8	5
medium gravel	8 - 11	
medium gravel	11 - 16	5
coarse gravel	16 - 22	5
coarse gravel	22 - 32	
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	-----	
clay hardpan	-----	
detritus/wood	-----	
artificial	-----	
total count:		100
Note: XS2 (Riffle) Pebble Count		

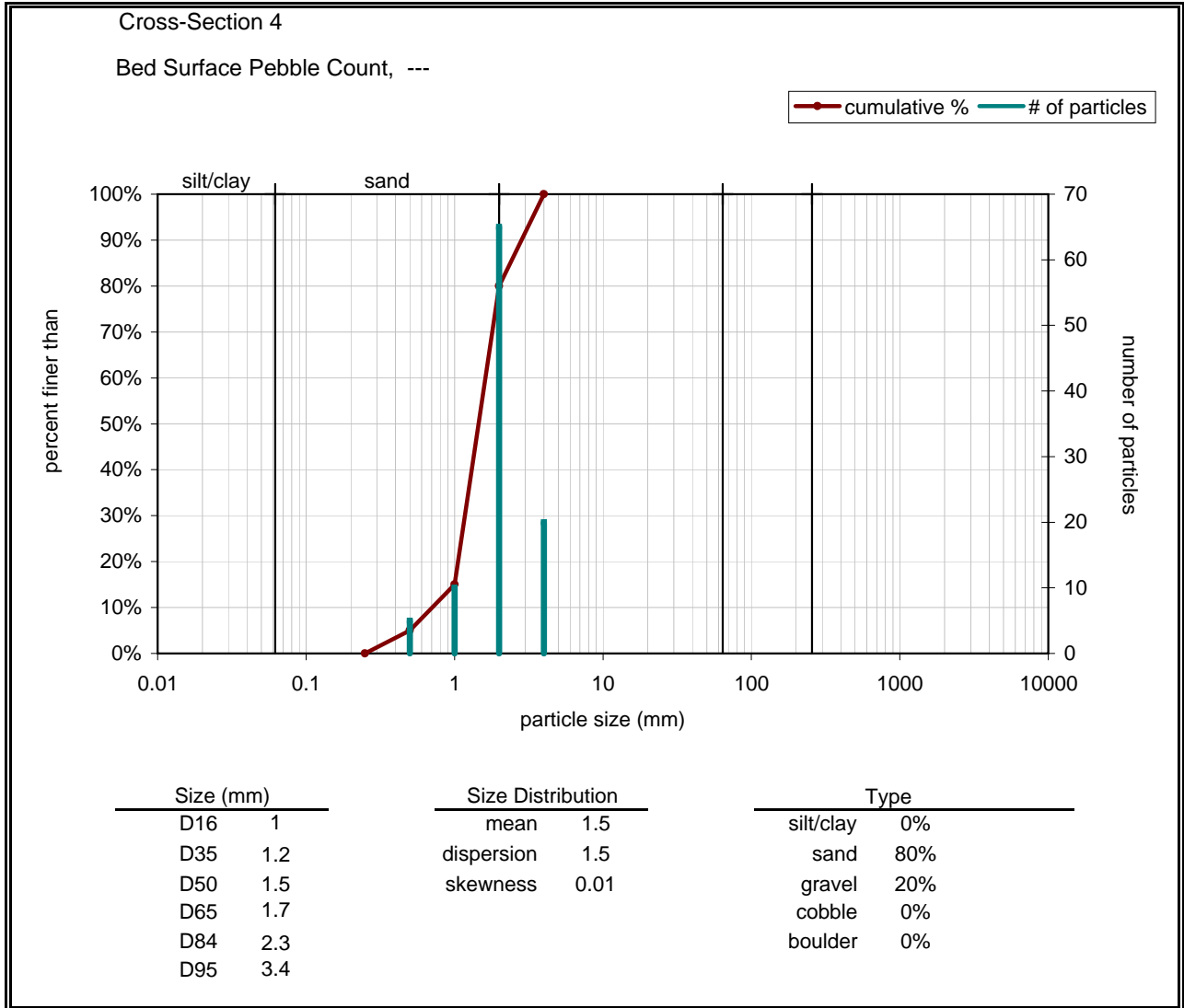




Bed Surface		
Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	45
coarse sand	0.5 - 1	40
very coarse sand	1 - 2	15
very fine gravel	2 - 4	
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	
medium gravel	11 - 16	
coarse gravel	16 - 22	
coarse gravel	22 - 32	
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	-----	
clay hardpan	-----	
detritus/wood	-----	
artificial	-----	
total count:		100
Note: XS3 (Pool) Pebble Count		



Bed Surface		
Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	5
coarse sand	0.5 - 1	10
very coarse sand	1 - 2	65
very fine gravel	2 - 4	20
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	
medium gravel	11 - 16	
coarse gravel	16 - 22	
coarse gravel	22 - 32	
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		100
bedrock	-----	
clay hardpan	-----	
detritus/wood	-----	
artificial	-----	
total count:		100
Note: XS4 (Pool) Pebble Count		



Riffle Surface		
Material	Size Range (mm)	Count
silt/clay	0 - 0.062	
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	
very coarse sand	1 - 2	30
very fine gravel	2 - 4	15
fine gravel	4 - 6	
fine gravel	6 - 8	5
medium gravel	8 - 11	15
medium gravel	11 - 16	
coarse gravel	16 - 22	20
coarse gravel	22 - 32	5
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	5
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	
total particle count:		95
bedrock	-----	5
clay hardpan	-----	
detritus/wood	-----	
artificial	-----	
total count:		100
Note: XS5 (Riffle) Pebble Count		

