STILLHOUSE CREEK STREAM RESTORATION – Project # 363
First Annual Monitoring Report –Final
February 2008

Submitted to:

North Carolina Department of
Environment and Natural Resources
Ecosystem Enhancement Program
1652 Mail Service Center
Raleigh, NC 27699-1652

Designed by:
United States Department of Agriculture
Natural Resources Conservation Services (NRCS)

CONDUCTED FOR THE NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

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I. Executive Summary/Project Abstract

The Stillhouse Creek stream restoration project is located in Orange County Park, in the historic district of Hillsborough, North Carolina. The project was designed and built through a combination of efforts by the North Carolina Ecosystem Enhancement Program (NCEEP, formerly North Carolina Wetlands Restoration Program), the Orange County Soil and Water Conservation District (SWCD), Natural Resources Conservation Service (NRCS), and Orange County. It includes restoration of 1,210 feet of Stillhouse Creek from south of Margaret Lane to its confluance with the Eno River. The area placed under conservation easement occupies 2.09 acres in USGS HUC 03020201030020 (NCDWQ Neuse River Subbasin 03-04-01). Construction was completed during March 2006.

Qualitative evaluation was conducted by RJG&A on 14 June 2007. The last 2007 visit to the Stillhouse Creek site was on 27 November.

The 2007 evaluation and monitoring of the Stillhouse Creek stream restoration site indicates that the project has met all its design goals after the second post-construction growing season.

As stated below, qualitative evidence of bankfull flow was observed during the June 2007 evaluation. The crest gauge, which was installed during the June evaluation, indicated that at least one more bankfull event had occurred. The project, therefore, has met its hydrologic goals for 2007.

Four vegetation monitoring plots were installed inside the conservation easement and monitored during October 2007, pursuant to the most-recent NCEEP/CVS guidelines. The first annual vegetation monitoring results indicate that the Stillhouse Creek Stream Restoration Project has exceeded its vegetation restoration goal of 320 stems per acre by 48 percent (planted woody stem average = 475 per acre) and 545 percent (all woody stem average = 2,064).

II. Project Background

2.1. Project Objectives

RJG&A did not receive a full copy of the restoration plan, but according to the brief description in the 2005 Erosion and Sediment Control Plan, the Stillhouse Creek Restoration Project was designed to achieve the following objectives:

- Reduce stream bank erosion and prevent downcutting
- Eliminate threat to existing building foundation from lateral channel instability
- Increase nutrient and sediment uptake and retention
- Increase environmental education opportunities
- Improve terrestrial and aquatic, and semi-aquatic habitats
- Provide temporary stormwater storage
- Improve stream corridor aesthetics

2.2. Structure, Restoration Type, and Approach

According to the Erosion and Sediment Control Plan for the Stillhouse Creek Stream Restoration Project, the following changes were made to the creek (NRCS 2003). The upper 235 feet of Stillhouse Creek involved restoration of a degraded, incised stream to a stable stream with a floodplain in a confined valley. The next 400 foot reach involved construction of a new channel reach to restore the pattern, profile, and dimension to that of a stable stream with a floodplain. The restoration of the next 220 feet involved enhancement of the existing stream features, including the stabilization of eroding stream banks. The final 345 feet involved construction of a bankfull bench in a confined valley.

Coir fiber matting, live staking, and brush mattresses were installed to help stabilize the graded stream banks and the outside of meanders. A 20 foot wide buffer was planted with native woody and herbaceous species on both sides the upstream-most reach. The buffer width along the balance of the restoration project is between 20 and 80 feet.

2.3. Location and Setting

To get to the Stillhouse Creek restoration site from I-85, take exit 164 and head north on South Churton Street for 1.3 miles. Turn east on East Margaret Lane. The upstream boundary of the conservation easement is 0.1 mile east of the intersection, on the south side of the road. Its downstream boundary is at Stillhouse Creek's confluence with the Eno River. Figure 1 shows the general location of the project.

Stillhouse Creek's watershed is approximately 152 acres at its confluence with the Eno River. North of East Margaret Lane its watershed is approximately 75 acres. The entire watershed is within downtown Hillsborough and is almost entirely occupied by residential and commercial development.

Prior to its restoration, Stillhouse Creek traversed open lawn for most of its length across the Orange County Park. It had unstable and eroding banks throughout and an actively downcutting streambed that threatened the stability of an adjacent municipal building. A covered picnic shelter with a stone retaining wall was built immediately adjacent to the conservation easement boundary during June 2007.

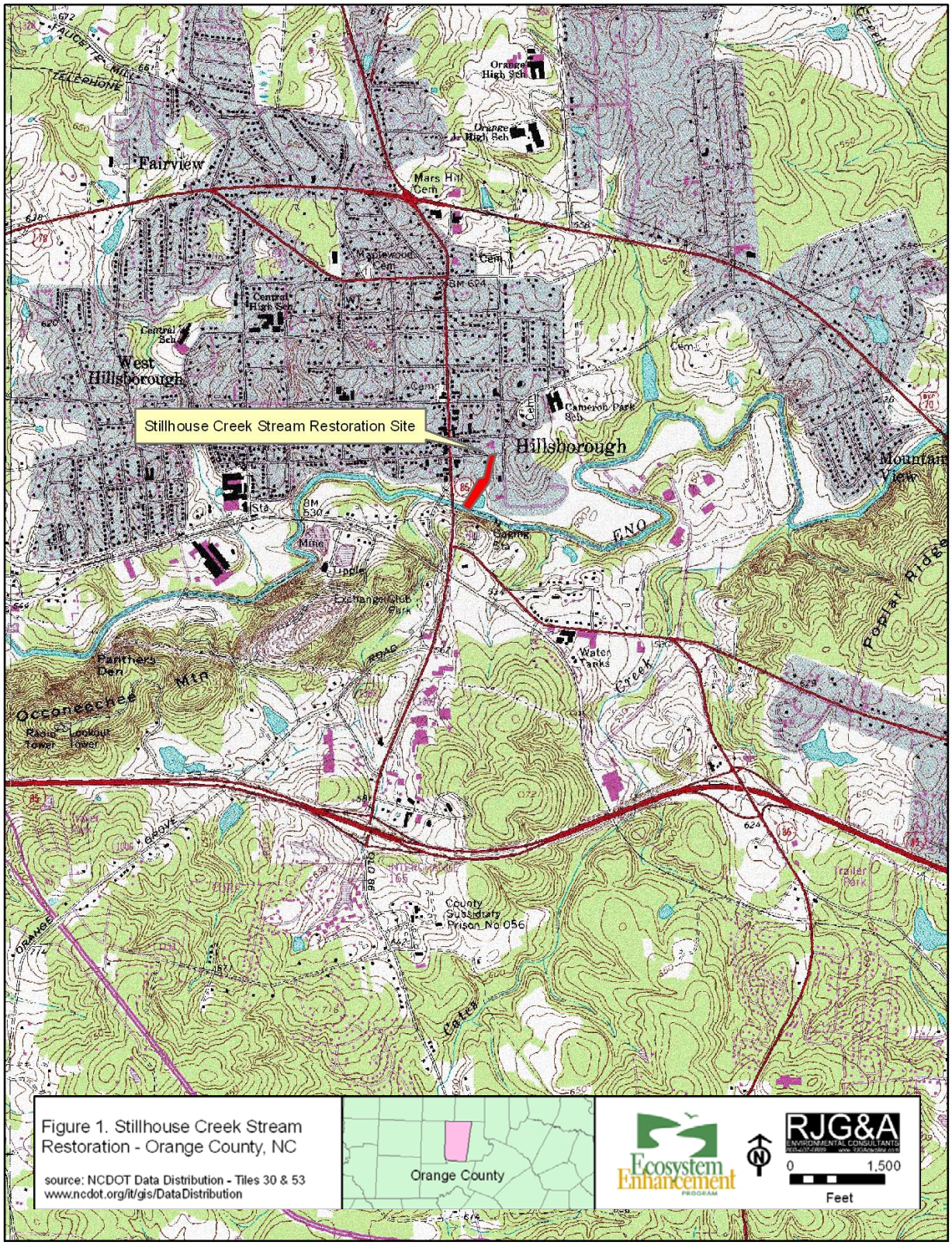


Figure 1. Stillhouse Creek Stream Restoration - Orange County, NC

source: NCDOT Data Distribution - Tiles 30 & 53
www.ncdot.org/it/gis/DataDistribution

2.4. History and Background

A complete copy of the Stillhouse Creek restoration plan was not provided to RJG&A. Data in Exhibit Tables I – III are based on the Sediment and Erosion Control Plan and as-built materials that were provided by EEP (CDM 2005). Mitigation type and approach and type rely on the narrative description of the project and Rosgen (Rosgen 2007).

Exhibit Table I. Mitigation Structure and Objectives Stillhouse Creek Stream Restoration – EEP Project #363

Reach ID	Existing Feet	Type	Approach	Footage	Mitigation Ratio	Mitigation Units	Stationing	Comment
Reach 1	235	R	P2	235	-	-	00+00-02+35	Shallow pools, small meanders, and steep riffles
Reach 2	400	R	P1	400	-	-	02+35-6+35	Realigned, reconnected to floodplain
Reach 3	220	E1	P4	220	-	-	6+35-8+55	Banks stabilized
Reach 4	345	R	P3	345	-	-	8+55-12+10	Connected to floodprone area

Exhibit Table II. Activity and Reporting History Stillhouse Creek Stream Restoration - EEP Project #363

Activity or Report	Data Collection	Completion
Restoration Plan	-	November 2005
Final Design – 90%	-	November 2005
Construction	-	March 2006
Temporary S&E mix applied	-	NA
Permanent seed mix applied	-	NA
Bare Root Planting	-	March 2006
Mitigation Plan/As-built	August 2006	December 2007
Year 1 Monitoring		December 2007
Qualitative Evaluation	June and November 2007	
Vegetation	October 2007	
Geomorphologic	November 2007	

Exhibit Table III. Project Contacts Stillhouse Creek Stream Restoration - EEP Project #363	
Designer Primary project design POC	NRCS -
Construction Contractor Construction Contractor POC	- -
Planting Contractor Planting contractor POC	Fluvial Solutions Peter Jelenevsky
Planting Source	Mellow Marsh
Monitoring Performers Monitoring POC	RJG&A 1221 Corporation Parkway, Suite 100 Raleigh, NC 27616 Ms. Jessi O'Neal (919) 872-1174

Exhibit Table IV. Project Background - Stillhouse Creek Stream Restoration EEP Project #363	
Project County	Orange
Drainage Area	152 acres (0.24 square mile)
Drainage Impervious Cover Estimate (%)	30
Stream Order	First Order
Physiographic Region	Piedmont
Ecoregion	Carolina Slate Belt
Rosgen Classification of As-built[1]	
Reach 1	B-6
Reach 2	E-4
Reach 3	C-4
Dominant Soil Types	
Reach 1	Georgeville-Urban land complex
Reach 2	Georgeville-Urban land complex
Reach 3	Georgeville-Urban land complex and Congaree fine sandy loam
Reference Site ID[2]	Upper Reach: UT to Caraway Creek (Randolph County) and UT to N. Fork New River (Ashe County); Lower Reach: Silas Creek (Forsyth County)
USGS HUC for Project and Reference	03020201030020, NA
NCDWQ Sub-basin for Project and Reference	03-04-01, NA
NCDWQ Classification for Project and Reference	C - NSW
Any portion of the project segment 303d listed?	No

[1] No as-built cross-section data collected. Rosgen classification based on Year 1 monitoring cross-section data.

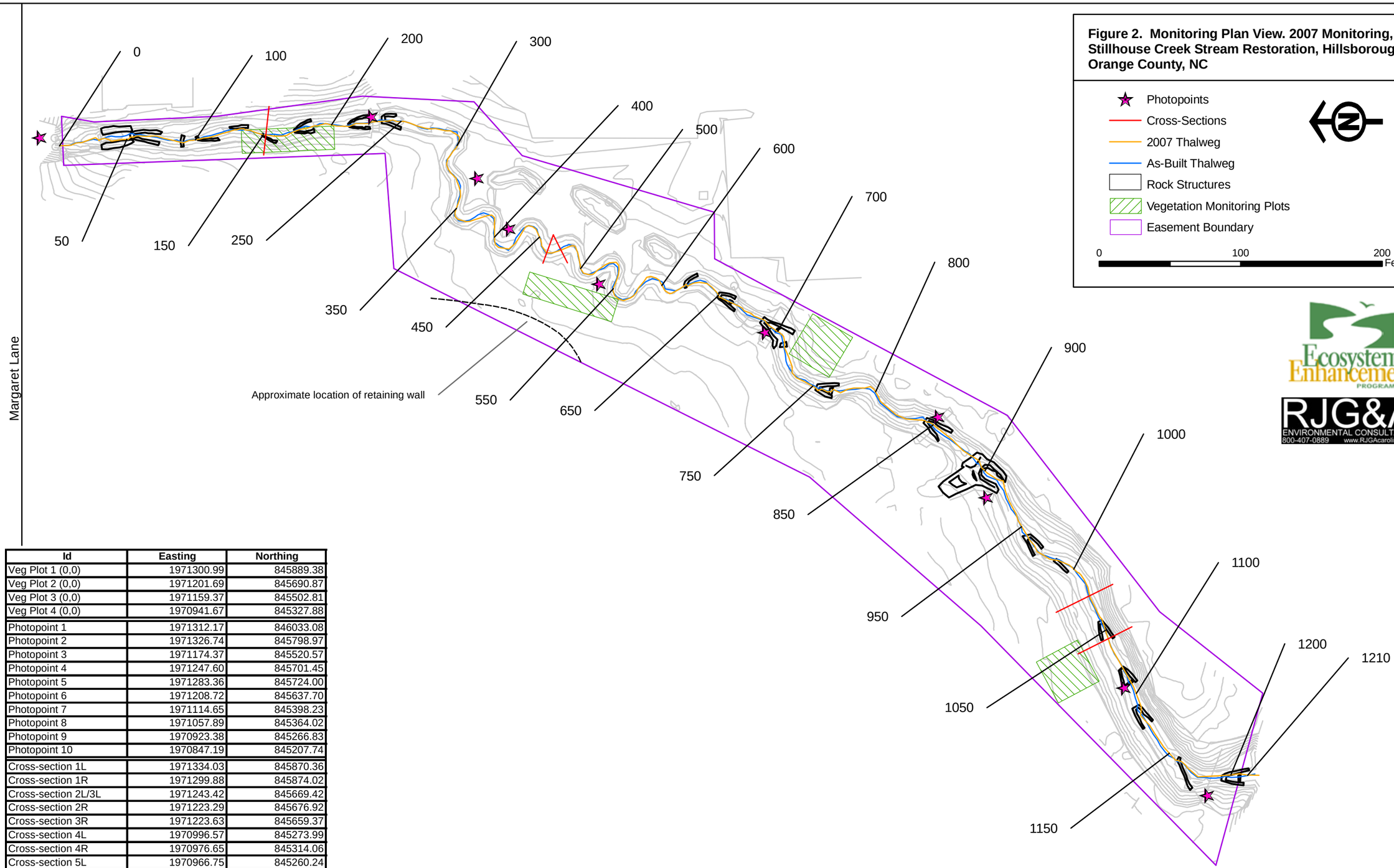
[2] No ID numbers provided by design firm, therefore reference site names included in this table.

Exhibit Table IV. Project Background - Stillhouse Creek Stream Restoration EEP Project #363	
Any portion of the project segment upstream of a 303d listed segment?	No – not in NCDWQ 03-04-01
Reasons for 303d Listing or Stressor	NA
% of Project Easement Fenced	0%

2.5. Monitoring Plan View

See Figure 2 for Monitoring Plan View.

Figure 2. Monitoring Plan View. 2007 Monitoring, Stillhouse Creek Stream Restoration, Hillsborough, Orange County, NC



Id	Easting	Northing
Veg Plot 1 (0,0)	1971300.99	845889.38
Veg Plot 2 (0,0)	1971201.69	845690.87
Veg Plot 3 (0,0)	1971159.37	845502.81
Veg Plot 4 (0,0)	1970941.67	845327.88
Photopoint 1	1971312.17	846033.08
Photopoint 2	1971326.74	845798.97
Photopoint 3	1971174.37	845520.57
Photopoint 4	1971247.60	845701.45
Photopoint 5	1971283.36	845724.00
Photopoint 6	1971208.72	845637.70
Photopoint 7	1971114.65	845398.23
Photopoint 8	1971057.89	845364.02
Photopoint 9	1970923.38	845266.83
Photopoint 10	1970847.19	845207.74
Cross-section 1L	1971334.03	845870.36
Cross-section 1R	1971299.88	845874.02
Cross-section 2L/3L	1971243.42	845669.42
Cross-section 2R	1971223.29	845676.92
Cross-section 3R	1971223.63	845659.37
Cross-section 4L	1970996.57	845273.99
Cross-section 4R	1970976.65	845314.06
Cross-section 5L	1970966.75	845260.24
Cross-section 5R	1970947.34	845298.51

III. Project Conditions and Monitoring Results

The site was initially evaluated on 14 June 2007 and appeared to be functioning as designed. First annual quantitative geomorphologic and vegetation data were collected during October and November 2007. The site was again qualitatively assessed on 14 November 2007.

3.1. Vegetation Assessment

Four representative vegetation survey plots were selected and installed in reaches 1, 2, and 3 during October 2007, pursuant to the EEP/CVS vegetation monitoring protocol. The average live, planted woody stem density for all plots was just under 12 individuals per plot (475.5 stems per acre). This exceeds the required 320 stems per acre by 49 percent. The survival rate for planted woody vegetation in Reach 1 is excellent and consists principally of silky dogwood (*Cornus amomum*), wax myrtle (*Morella cerifera*) and elderberry (*Sambucus canadensis*). The streambanks of Reach 2 are dominated by black willow (*Salix nigra*) and silky dogwood (*Cornus amomum*). On the floodplain the planted vegetation consists primarily of sycamore (*Platanus occidentalis*), green ash (*Fraxinus pennsylvanica*), and tulip poplar (*Liriodendron tulipifera*). The planted vegetation in Reach 3 includes silky dogwood (*Cornus amomum*), black willow (*Salix nigra*), and green ash (*Fraxinus pennsylvanica*) and survival of planted stems is high.

The most abundant volunteer species counted in all plots was sugarberry (*Celtis laevigata*, 40 percent of all volunteers). While not planted, this hardwood species is native to North Carolina and may contribute significantly to the project's stability and overall success.

Tables 1 through 5 in Appendix A contain specifics about vigor and damage by species and plot. Photos of the vegetation monitoring plots can also be found in Appendix A.

3.1.1. Vegetation Problem Areas

See Table 6, Figure A1-Current Conditions Plan View, and Vegetation Problem Area Photos in Appendix A.

Three vegetation problem areas were identified in Reach 2 (Figure A1, Table 1). The area close to the first foot-bridge (Stations 235-300) was probably insufficiently planted at the time of construction. Compacted or nutrient deficient soil could be the cause of the smallest problem area near the pocket wetlands (Stations 400-430) where non-woody vegetation, including sedges and coneflowers, have helped stabilize the soil. The third and largest vegetation problem area in Reach 2 (Stations 320-580) has experienced poor survival of planted woody stems and is currently dominated by fescue. At this point, no remedial action is recommended, but the areas should be observed and replanting may be necessary in the future.

In Reach 3 (Figure A1) the terrace across from vegetation monitoring plot 3 (Stations 715-830) has sufficient planted stem survival, but vigor is low. This may be due to poor soils or soil compaction that occurred prior to or during construction. The right top of bank area near cross-sections 4 and 5 (Stations 1000-1060) has a low survival of planted woody vegetation. Although, sedges and other non-woody vegetation are well-established in this area, it should be monitored in case remedial action is needed in the future. No remediation is recommended at this time.

3.1.2. Current Conditions Plan View (Vegetation)

See Figure A1 in Appendix A for the Current Conditions Plan View for vegetation.

3.2. Stream Assessment

RJG&A staff evaluated the condition and success of the Stillhouse Creek Stream Restoration project during June and November 2007. Overall, the site is maintaining its as-built dimension, pattern, and profile.

3.2.1. Procedural Items

3.2.1.1. Morphometric Criteria

After a detailed preliminary evaluation in June 2007, RJG&A staff selected and installed 5 cross section sites for annual monitoring. The first annual monitoring data were collected during November 2007. For the longitudinal profile, the entire stream restoration (1,210 linear feet) was surveyed. Survey points included thalweg, bankfull, and beginning of each stream feature. Photographs were taken at all cross sections and at the 10 permanent photo locations (established by RJG&A in June 2007).

As the quantitative data and qualitative evaluations indicate for the first monitoring year, the structure and function of the entire restoration project closely match the as-built conditions (i.e. little change has occurred).

3.2.1.2. Hydrologic Criteria

A crest gauge was installed on the Stillhouse Creek site on 14 June 2007. The gauge was checked on 7 October 2007 and no bankfull event had occurred, but when the gauge was checked again on 27 November 2007, a bankfull event had occurred. Based on NC CRONOS data from the weather station (KIGX) at the Chapel Hill Airport, this event most likely occurred between 24 October and 27 October 2007, during which a total of 4.47 inches of rainfall was recorded. On-site qualitative evidence observed in June indicate that at least one bankfull event (rack and drift lines and downed vegetation/stems above the bankfull elevation) had occurred prior to crest gauge installation in 2007 (Table VIII).

Exhibit Table V. Verification of Bankfull Events – Stillhouse Creek Stream Restoration - EEP Project #363			
Date of Data Collection	**Date of Occurrence (mm/dd/yy)**	**Method**	**Photo # (if available)**
07 Oct. 2007 and 23 Nov. 2007	07 Oct. 2007- 23 Nov. 2007	Crest Gauge	NA
June 2007	January - June 2007	On-site highwater indicators	NA

3.2.1.3. Bank Stability Assessments

Table VI BEHI and Sediment Export Estimates only apply to Monitoring year 5 and were not performed during 2007 (monitoring year 1).

3.2.2. Current Conditions Plan View (Stream)

The Current Conditions Plan View for streams can be found in Appendix B.

3.2.3. Problem Areas Table

Minor problem areas were observed in November 2007 including the formation of small bars along riffles, piping, and bank scour. Exhibit Table B.1 in Appendix B identifies these problem areas by station, along with suspected causes and representative photos. In all cases, the problems are considered a low-priority and are probably due primarily to the low flow in the channel resulting from this year's drought. These areas should be monitored, especially if record-low rainfall levels continue into 2008.

3.2.4. Numbered issue photo section

Representative problem area photos listed in Table B.1 can be found in Appendix B immediately following Table B.1.

3.2.5. Fixed station photos

Permanent photopoint images can be found in Appendix B.

3.2.6. Stability Assessment Table

Exhibit Table VI. Categorical Stream Feature Visual Stability Assessment- Stillhouse Creek Stream Restoration - EEP Project #363				
Reach 1 (245 feet)				
Feature	Initial	MY-01	MY-02	MY-03
A. Riffles	100%	100%		
B. Pools	100%	100%		
C. Thalweg	100%	NA		
D. Meanders	100%	NA		
E. Bed General	100%	NA		
F. Vanes/J Hooks, etc.	100%	100%		
G. Wads and Boulders	100%	NA		
Reach 2 (400 feet)				
A. Riffles	100%	99%		
B. Pools	100%	98%		
C. Thalweg	100%	93%		
D. Meanders	100%	75%		
E. Bed General	100%	NA		
F. Vanes/J Hooks, etc.	100%	100%		
G. Wads and Boulders	100%	NA		
Reach 3 (565 feet)				
A. Riffles	100%	100%		
B. Pools	100%	82%		
C. Thalweg	100%	94%		
D. Meanders	100%	75%		
E. Bed General	100%	NA		
F. Vanes/J Hooks, etc.	100%	90%		
G. Wads and Boulders	100%	NA		

Exhibit Table VII. Baseline Morphology and Hydraulic Summary
Stillhouse Creek Stream Restoration – EEP Project #363
Segment/Reach: 1 – 3 (855 feet)

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Reference Reach Stream			Design			As-built		
Dimension	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
BF Width (ft)	-	-	-	-	-	-	6.0	7.0	7.6	7.3	9.7	12.4	7.5	-	9.5	-	-	-
Floodprone Width (ft)	-	-	-	-	-	-	17.1	35.1	47.0	27.0	49.6	74.0	23	-	176	-	-	-
Bankfull Cross Sectional Area (ft^2)	-	-	-	-	-	-	5.6	7.3	8.1	7.3	10.35	13.2	-	9.0	-	-	-	-
Bankfull Mean Depth (ft)	-	-	-	-	-	-	0.8	1.0	1.4	0.9	1.1	1.3	0.95	-	1.2	-	-	-
Bankfull Max Depth (ft)	-	-	-	-	-	-	1.2	1.7	2.0	1.6	1.8	2.0	1.3	-	2.4	-	-	-
Width/Depth Ratio	-	-	-	-	-	-	4.4	7.1	9.3	7.3	9.3	14.0	6.0	-	10.0	-	-	-
Entrenchment Ratio	-	-	-	-	-	-	2.3	5.1	6.3	2.7	5.6	10.1	2.7	-	20.7	-	-	-
Bank Height Ratio	-	-	-	-	-	-	1.0	1.13	1.4	1.0	1.06	1.25	-	1.0	-		-	-
Wetted Perimeter (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pattern																		
Channel Beltwidth (ft)	-	-	-	-	-	-	6	11.6	19	12.4	13.7	16.7	8.5	-	19.6	8.7	16.3	24.7
Radius of Curvature (ft)	-	-	-	-	-	-	8.7	12.2	16.5	6.5	14.6	20.5	12.8	-	23.8	4.6	10.0	32.7
Meander Wavelength (ft)	-	-	-	-	-	-	29	63	116	21.2	34.7	57.0	12.8	-	39.1	23.8	37.8	75.4
Meander Width Ratio	-	-	-	-	-	-	0.9	1.7	2.7	1.0	1.4	2.3	1.0	-	2.3	-	-	-
Profile																		
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.4	6.6	15.3
Riffle Slope (ft/ft)	-	-	-	-	-	-	-	-	-	0.00	0.0204	0.054	0.006	-	0.017	-0.003	0.029	0.140
Pool Length (ft)	-	-	-	-	-	-	11.0	22.5	46.5	7.5	11.8	17.0	8.5	-	19.6	9.4	22.8	76.0
Pool Spacing (ft)	-	-	-	-	-	-	-	37.2	-	-	21.5	-	-	15.3	-	0	5.0	18.2
Substrate																		
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d84 (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																		
Valley Length (ft)		-			-			672			168			672			672	
Channel Length (ft)		-			-			748			267.5			946			855	
Sinuosity (ft)		-			-			1.1			1.6			1.4			1.3	
Water Surface Slope (ft/ft)		-			-			0.0126			0.0094			0.0086			0.011	
BF slope (ft/ft)		-			-			-			-			-			-	
Rosgen Classification		-			-			E4			E4/5			E4				
*Habitat Index		-			-			-			-			-			-	
*Macrobenthos		-			-			-			-			-			-	

Exhibit Table VII. Baseline Morphology and Hydraulic Summary
Stillhouse Creek Stream Restoration – EEP Project #363
Segment/Reach: 4 (355 feet)

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Reference Reach Stream			Design			As-built		
Dimension	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
BF Width (ft)	-	-	-	-	-	-	9.8	11.8	14.8	23.1	25.6	28.0	14.9	-	19.5	-	-	-
Floodprone Width (ft)	-	-	-	-	-	-	15.5	19.3	26.8	33.0	33.7	35.0	17.9	-	35.1	-	-	-
Bankfull Cross Sectional Area (ft^2)	-	-	-	-	-	-	19.2	21.7	24.7	68.5	43.5	48.9	18	-	22	-	-	-
Bankfull Mean Depth (ft)	-	-	-	-	-	-	1.7	1.9	2.0	1.5	1.7	1.9	1.1	-	1.2	-	-	-
Bankfull Max Depth (ft)	-	-	-	-	-	-	2.6	2.7	2.8	2.4	2.7	2.9	1.7	-	1.9	-	-	-
Width/Depth Ratio	-	-	-	-	-	-	4.9	6.2	8.6	12.4	15.2	17.2	12.4	-	17.2	-	-	-
Entrenchment Ratio	-	-	-	-	-	-	1.4	1.6	1.8	1.2	1.3	1.4	1.2	-	1.8	-	-	-
Bank Height Ratio	-	-	-	-	-	-	2.5	2.6	2.9	1.0	1.0	1.0		1.0		-	-	-
Wetted Perimeter (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydraulic Radius (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pattern																		
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-	-	40	43.7	51	23.8	-	39	12.0	19.6	27.9
Radius of Curvature (ft)	-	-	-	-	-	-	-	-	-	19.5	41.25	54.0	29.8	-	39.0	25.4	40.3	55.4
Meander Wavelength (ft)	-	-	-	-	-	-	-	-	-	130	168	245	39	-	94	96.2	132.6	187.8
Meander Width Ratio	-	-	-	-	-	-	-	-	-	1.6	1.7	2.0	1.6	-	2.0	-	-	-
Profile																		
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	9.5	18.4	29.0	6.0	-	19.5	2.5	17.3	40.1
Riffle Slope (ft/ft)	-	-	-	-	-	-	-	-	-	0.008	0.012	0.016	0.017	-	0.034	0.043	0.129	0.164
Pool Length (ft)	-	-	-	-	-	-	-	-		8.2	31.2	68.0	5	-	53	15.0	70.1	42.6
Pool Spacing (ft)	-	-	-	-	-	-	-	-	-	27.2	62.4	129.0	39	-	94	0	11.1	40.1
Substrate																		
d50 (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d84 (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																		
Valley Length (ft)		-			-			282			325			282			282	
Channel Length (ft)		-			-			314			348			314			355	
Sinuosity (ft)		-			-			1.1			1.07			1.1			1.3	
Water Surface Slope (ft/ft)		-			-			0.017			0.008			0.017			0.020	
BF slope (ft/ft)		-			-			-			-			-			-	
Rosgen Classification		-			-			G4c/1			B4c/1			B4/1			-	
*Habitat Index		-			-			-			-			-			-	
*Macrobenthos		-			-			-			-			-			-	

Exhibit Table VIII. Morphology and Hydraulic Monitoring Summary – Stillhouse Creek Steam Restoration – EEP Project #363

Reach 1 (235 feet)

Parameter	Cross Section 1 (Riffle)				
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
BF Width (ft)	18.4				
Floodprone Width (ft)	34.44				
BF Cross-Sectional Area (sq ft)	24.28				
BF Mean Depth (ft)	1.32				
BF Max Depth (ft)	2.71				
Width/Depth Ratio	13.95				
Entrenchment Ratio	1.87				
Bank Height Ratio	1.19				
Wetted Perimeter (ft)	19.5				
Hydraulic Radius (ft)	1.24				
Substrate					
d50 (mm)	0.04				
d84 (mm)	0.57				

	MY-01 (2007)			**MY-03 (2009)**			**MY-03 (2010)**			**MY-04 (2011)**			**MY-05 (2012)**		
Pattern	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean
Channel Beltwidth (ft)	7.6	12.1	10.6												
Radius of Curvature (ft)	NA	NA	NA												
Meander Wavelength (ft)	NA	NA	NA												
Meander Width ratio			0.6												
Profile															
Riffle length (ft)	2	14	8.3												
Riffle slope (ft/ft)	-0.04	0.06	0.01												
Pool length (ft)	10	30	19												
Pool spacing (ft)	0	14	7.3												

Additional Reach Parameters	MY-01	MY-02	MY-03	MY-04	MY-05
Valley Length (ft)	230				
Channel Length (ft)	245				
Sinuosity	1.07				
Water Surface Slope (ft/ft)	0.009				
BF slope (ft/ft)	0.01				
Rosgen Classification	B6				
Habitat Index	NA				
Macrobenthos	NA				

Exhibit Table VIII. Morphology and Hydraulic Monitoring Summary – Stillhouse Creek Steam Restoration – EEP Project #363
Reach 2 (400 feet)

Parameter	Cross Section 2 (Pool)					Cross Section 3 (Riffle)				
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
BF Width (ft)	15.82					12.41				
Floodprone Width (ft)	94.5					107				
BF Cross-Sectional Area (sq ft)	22.62					8.61				
BF Mean Depth (ft)	1.46					0.69				
BF Max Depth (ft)	2.62					1.14				
Width/Depth Ratio	11.07					17.87				
Entrenchment Ratio	6					8.7				
Bank Height Ratio	1.17					1.13				
Wetted Perimeter (ft)	17.21					13.12				
Hydraulic Radius (ft)	1.31					0.66				
Substrate										
d50 (mm)	6.85					6.85				
d84 (mm)	14.59					36.88				

	MY-01 (2007)			**MY-03 (2009)**			**MY-03 (2010)**			**MY-04 (2011)**			**MY-05 (2012)**		
Pattern	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean
Channel Beltwidth (ft)	9.1	23.6	18.5												
Radius of Curvature (ft)	2.6	11.6	4.9												
Meander Wavelength (ft)	27.2	40	33												
Meander Width ratio			1.3												
Profile															
Riffle length (ft)	7	20	10.9												
Riffle slope (ft/ft)	-0.07	0.06	0.003												
Pool length (ft)	9	28	17												
Pool spacing (ft)	0	26	10.9												

Additional Reach Parameters	MY-01	MY-02	MY-03	MY-04	MY-05
Valley Length (ft)	286				
Channel Length (ft)	400				
Sinuosity	1.4				
Water Surface Slope (ft/ft)	0.008				
BF slope (ft/ft)	0.007				
Rosgen Classification	C4				
Habitat Index	NA				
Macrobenthos	NA				

Exhibit Table VIII. Morphology and Hydraulic Monitoring Summary – Stillhouse Creek Steam Restoration – EEP Project #363

Reach 3 (565 feet)

Parameter	Cross Section 4 (Riffle)					Cross Section 5 (Pool)				
Dimension	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
BF Width (ft)	12.44					8.36				
Floodprone Width (ft)	29.3					26.48				
BF Cross-Sectional Area (sq ft)	13.16					11.4				
BF Mean Depth (ft)	1.06					1.36				
BF Max Depth (ft)	2.06					1.93				
Width/Depth Ratio	11.75					6.13				
Entrenchment Ratio	2.36					3.17				
Bank Height Ratio	1.10					1.24				
Wetted Perimeter (ft)	13.23					9.96				
Hydraulic Radius (ft)	0.99					1.14				
Substrate										
d50 (mm)	2.67					16				
d84 (mm)	58.57					50.7				

	MY-01 (2007)			**MY-03 (2009)**			**MY-03 (2010)**			**MY-04 (2011)**			**MY-05 (2012)**		
Pattern	min	max	mean	min	max	mean	min	max	mean	min	max	mean	min	max	mean
Channel Beltwidth (ft)	12	27.6	20.9												
Radius of Curvature (ft)	10.4	53.7	27.1												
Meander Wavelength (ft)	70.7	187	111.7												
Meander Width ratio			2												
Profile															
Riffle length (ft)	4	41	16.4												
Riffle slope (ft/ft)	-0.004	0.12	0.04												
Pool length (ft)	18	48	27.9												
Pool spacing (ft)	0	44	15.4												

Additional Reach Parameters	MY-01	MY-02	MY-03	MY-04	MY-05
Valley Length (ft)	507				
Channel Length (ft)	565				
Sinuosity	1.11				
Water Surface Slope (ft/ft)	0.018				
BF slope (ft/ft)	0.016				
Rosgen Classification	C4				
Habitat Index	NA				
Macrobenthos	NA				

IV. Methodology

Monitoring methodologies follow the current EEP-provided templates and guidelines (Lee *et al* 2006). Photographs were taken digitally. A Trimble Geo XT handheld mapping-grade unit was used to collect cross section, vegetation corner, photopoint, and problem area locations. Additional notations were written on the as-built plan sheets.

4.1. Stream Methodology

Methods employed were a combination those specified in the Mitigation Plan, the First Annual Monitoring Report, and standard regulatory guidance and procedures documents. Stream monitoring data was collected using the techniques described in US ACE Stream Mitigation Guidelines, US Forest Service's Stream Channel Reference Sites, and Applied River morphology (USACE, 2003; Harrelson et al., 1994; Rosgen, 1996). A South Total Station and Nikon automatic level were used for collecting all geomorphic data. Photographs facing downstream were taken at each cross section.

4.2. Vegetation Methodology

Four representative vegetation survey plots were selected and installed in reaches 1, 2, and 3 during October 2007, pursuant to the EEP/CVS vegetation monitoring protocol (Lee *et al* 2006). All plots measure 100 square meters and are either 10 meters by 10 meters, or five meters by 20 meters. The four corners of each plot (either 10x100 or 5x20 feet) were marked with 18-inch long, one-half-inch diameter galvanized steel conduit.

Level 1 (planted woody stems) and Level 2 (volunteer woody stems) data collection was performed during October 2007. Within each plot, each planted woody stem location (x and y) was recorded, and height and live stem diameter were recorded for each stem location. All planted stems were identified with pink flagging. Vegetation was identified using Weakley (Weakley 2007). Photos were taken of each vegetation plot from the 0,0 corner.

Tables 1 through 5 in Appendix A contain the data from the vegetation monitoring. Monitoring plot photos can also be found in Appendix A.

References

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Harrelson, Cheryl, C. L. Rawlins, and John Potpondy. (1994). *Stream Channel Reference Sites: An Illustrated Guide to Field Technique.* USDA, Forest Service. General Technical Report RM-245.

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Weakley, Alan (2007). *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas*. Retrieved March 27, 2007 from: http://www.herbarium.unc.edu/flora.htm.

Appendix A Vegetation Data

Table 1. Vegetation Metadata

Report Prepared By	Sean Doig
Date Prepared	2/11/2008 13:21
database name	Stillhouse.mdb
database location	C:\SeanD\EEP\07 Monitoring\Stillhouse

DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------

Metadata	This worksheet, which is a summary of the project and the project data.
Plots	List of plots surveyed.
Vigor	Frequency distribution of vigor classes.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Stem Count by Plot and Spp	Count of living stems of each species for each plot; dead and missing stems are excluded.

PROJECT SUMMARY----------

Project Code	St_house
project Name	Stillhouse
Description	
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	

Table 2. Vegetation Vigor by Species

	Species	4	3	2	1	0	Missing
	Ailanthus altissima						
	Betula nigra						
	Carya illinoinensis						
	Carya ovata						
	Celtis laevigata						
	Cornus amomum	5					
	Fraxinus pennsylvanica	4	1	1			
	Ilex verticillata	4	2				
	Lagerstroemia indica						
	Ligustrum sinense						
	Liquidambar styraciflua						
	Nyssa sylvatica		1				
	Quercus nigra						
	Quercus phellos	2				1	
	Salix nigra						
	Sambucus canadensis	5					
	Ulmus alata						
	Morella cerifera	12					
	Rhus copallinum						
	Carpinus caroliniana						
	Quercus rubra	4		1			
	Carya						
	Lindera benzoin	2					
	Liriodendron tulipifera	1					
	Platanus occidentalis	2					
	Acer negundo						
	Acer rubrum						
TOT:	**27**	**41**	**4**	**2**		**1**	

Table 3. Damage by Species

	Species	All Damage Categories	(no damage)	Insects
	Acer negundo	3	3	
	Acer rubrum	1	1	
	Ailanthus altissima	1	1	
	Betula nigra	1	1	
	Carpinus caroliniana	2	2	
	Carya	1	1	
	Carya illinoinensis	2	2	
	Carya ovata	1	1	
	Celtis laevigata	4	4	
	Cornus amomum	5	5	
	Fraxinus pennsylvanica	8	7	1
	Ilex verticillata	6	6	
	Lagerstroemia indica	1	1	
	Ligustrum sinense	3	3	
	Lindera benzoin	2	2	
	Liquidambar styraciflua	1	1	
	Liriodendron tulipifera	1	1	
	Morella cerifera	12	12	
	Nyssa sylvatica	1	1	
	Platanus occidentalis	2	2	
	Quercus nigra	1	1	
	Quercus phellos	3	3	
	Quercus rubra	5	4	1
	Rhus copallinum	1	1	
	Salix nigra	1	1	
	Sambucus canadensis	5	5	
	Ulmus alata	1	1	
TOT:	**27**	**75**	**73**	**2**

Table 4. Damage by Plot

	plot	All Damage Categories	(no damage)	Insects
	St_house-jo&sd-0001	23	23	
	St_house-jo&sd-0002	8	8	
	St_house-jo&sd-0003	26	24	2
	St_house-jo&sd-0004	18	18	
TOT:	**4**	**75**	**73**	**2**

Table 5. Stem County by Plot and Species

	Species	Total Stems	# plots	avg# stems	plot St_house-jo&sd-0001	plot St_house-jo&sd-0002	plot St_house-jo&sd-0003	plot St_house-jo&sd-0004
	Cornus amomum	5	2	2.5	3		2	
	Fraxinus pennsylvanica	6	3	2		2	2	2
	Ilex verticillata	6	3	2	3		2	1
	Lindera benzoin	2	2	1			1	1
	Liriodendron tulipifera	1	1	1				1
	Morella cerifera	12	4	3	4	1	6	1
	Nyssa sylvatica	1	1	1				1
	Platanus occidentalis	2	1	2		2		
	Quercus phellos	2	2	1			1	1
	Quercus rubra	5	2	2.5			4	1
	Sambucus canadensis	5	1	5	5			
TOT:	**11**	**47**	**11**		**15**	**5**	**18**	**9**

Table 6. Vegetation Problem Areas – Stillhouse Creek Stream Restoration EEP Project #363			
Feature/Issue	**Station/Range**	**Probable Cause**	**Photo #**
Limited woody stem planting	235-300	Planting Oversight	VP1
Low planted woody stem success	400-430	Soil Compaction	VP2
Low planted woody stem success	320-580	Soil Compaction	VP1
Low planted woody stem vigor	715-830	Soil Compaction	VP3
Low planted woody stem success	1000-1060	Soil Compaction	VP4

Appendix A2. Vegetation Problem Area Photographs - Year 1 - 2007 - Stillhouse Creek Riparian Buffer Restoration

VP1. Limited woody stem planting

VP2. Low planted woody stem success

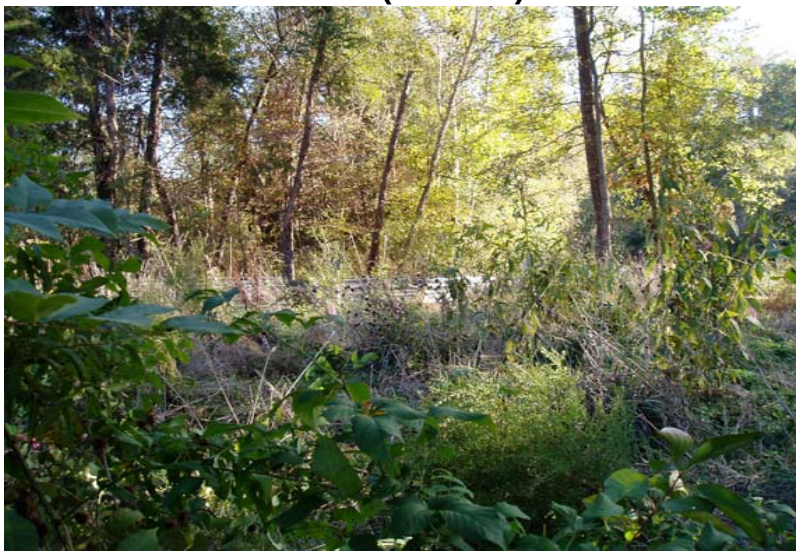
VP3. Low planted woody stem vigor

VP4. Low planted woody stem success

A3. Vegetation Monitoring Plot Photographs Year 1 - 2007 - Stillhouse Creek Riparian Buffer Restoration

Plot 1 (10/31/07)

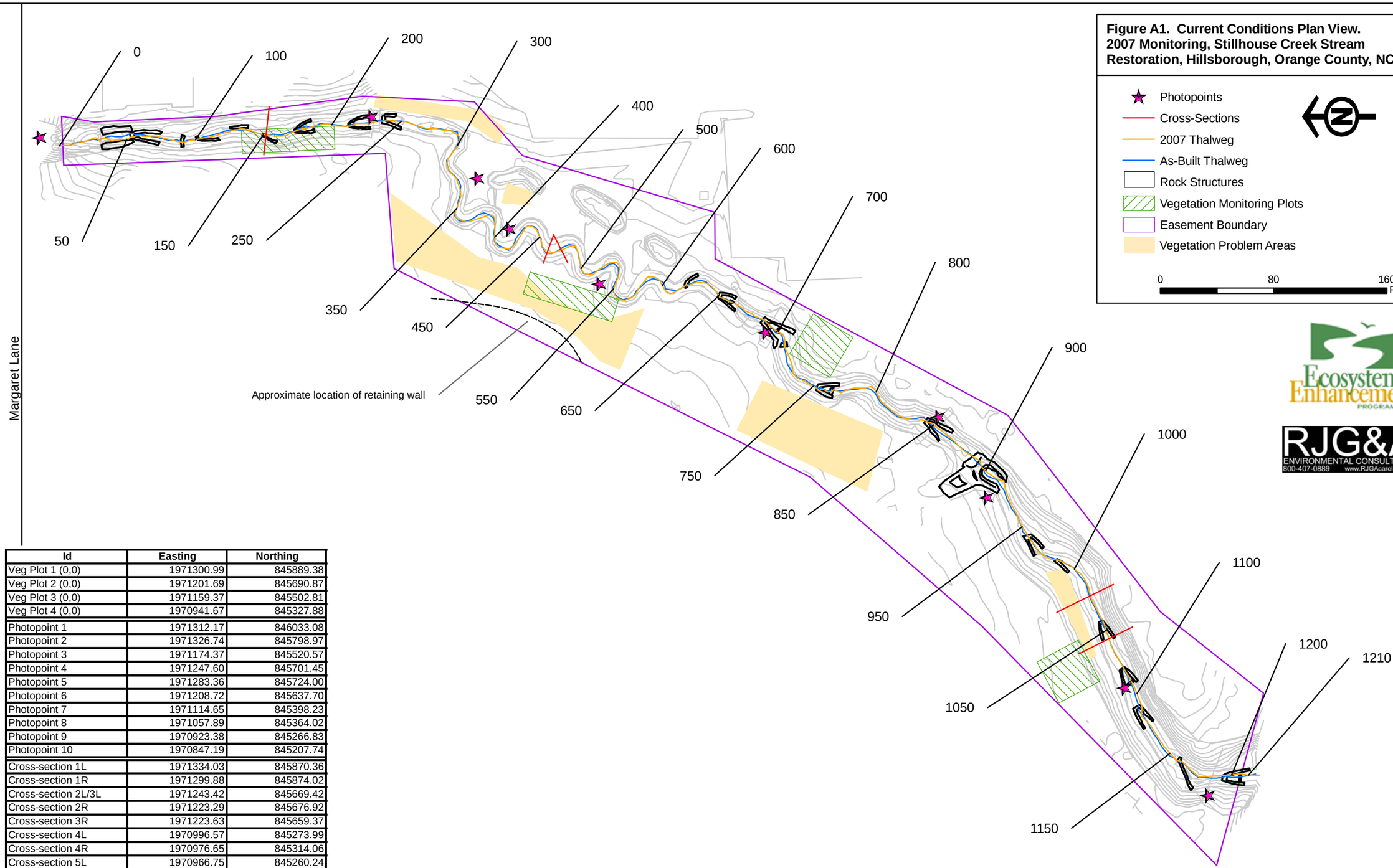
Plot 2 (10/31/07)



Plot 3 (10/31/07)

Plot 4 (10/31/07)

Figure A1. Current Conditions Plan View. 2007 Monitoring, Stillhouse Creek Stream Restoration, Hillsborough, Orange County, NC



Id	Easting	Northing
Veg Plot 1 (0,0)	1971300.99	845889.38
Veg Plot 2 (0,0)	1971201.69	845690.87
Veg Plot 3 (0,0)	1971159.37	845502.81
Veg Plot 4 (0,0)	1970941.67	845327.88
Photopoint 1	1971312.17	846033.08
Photopoint 2	1971326.74	845798.97
Photopoint 3	1971174.37	845520.57
Photopoint 4	1971247.60	845701.45
Photopoint 5	1971283.36	845724.00
Photopoint 6	1971208.72	845637.70
Photopoint 7	1971114.65	845398.23
Photopoint 8	1971057.89	845364.02
Photopoint 9	1970923.38	845266.83
Photopoint 10	1970847.19	845207.74
Cross-section 1L	1971334.03	845870.36
Cross-section 1R	1971299.88	845874.02
Cross-section 2L/3L	1971243.42	845669.42
Cross-section 2R	1971223.29	845676.92
Cross-section 3R	1971223.63	845659.37
Cross-section 4L	1970996.57	845273.99
Cross-section 4R	1970976.65	845314.06
Cross-section 5L	1970966.75	845260.24
Cross-section 5R	1970947.34	845298.51

Appendix B Geomorphologic Raw Data

Figure B1. Current Conditions Plan View

B2. Stream Problem Areas Table

B3. Representative Stream Problem Area Photos

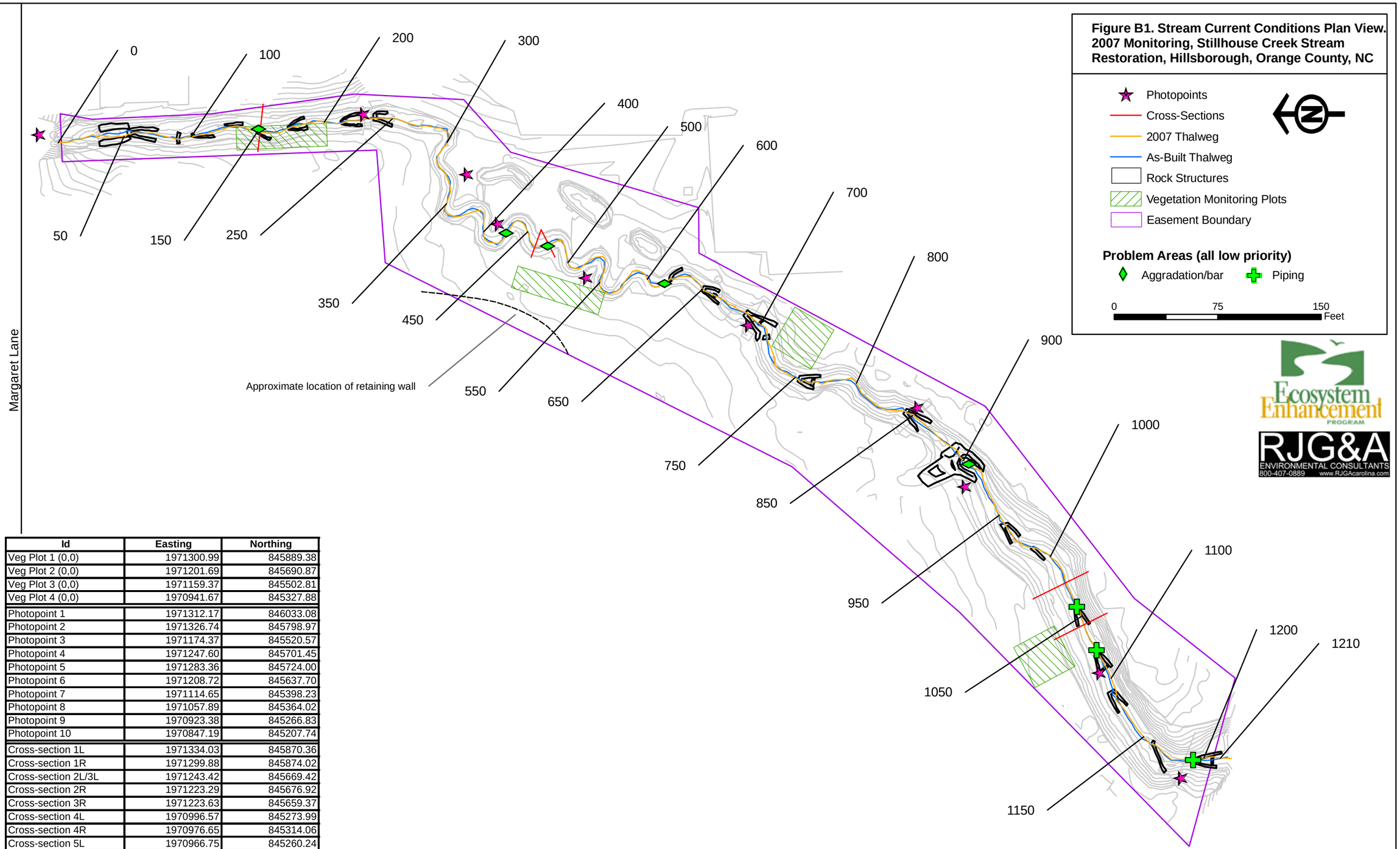
B4. Stream Photo-station Photos

B5. Qualitative Visual Stability Assessment Table

B6. Cross section Plots and Raw Data Tables

B7. Longitudinal Plots and Raw Data Tables

B8. Pebble Counts



Id	Easting	Northing
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Veg Plot 2 (0,0)	1971201.69	845690.87
Veg Plot 3 (0,0)	1971159.37	845502.81
Veg Plot 4 (0,0)	1970941.67	845327.88
Photopoint 1	1971312.17	846033.08
Photopoint 2	1971326.74	845798.97
Photopoint 3	1971174.37	845520.57
Photopoint 4	1971247.60	845701.45
Photopoint 5	1971283.36	845724.00
Photopoint 6	1971208.72	845637.70
Photopoint 7	1971114.65	845398.23
Photopoint 8	1971057.89	845364.02
Photopoint 9	1970923.38	845266.83
Photopoint 10	1970847.19	845207.74
Cross-section 1L	1971334.03	845870.36
Cross-section 1R	1971299.88	845874.02
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Cross-section 3R	1971223.63	845659.37
Cross-section 4L	1970996.57	845273.99
Cross-section 4R	1970976.65	845314.06
Cross-section 5L	1970966.75	845260.24
Cross-section 5R	1970947.34	845298.51

ETableB.. Stream Problem Areas - Stillhouse Creek Stream Restoration - EEP Project #363			
Feature/Issue	**Station**	**Suspected Cause**	**Photo #**
Reach 1			
Aggradation/bar in riffle	152	Low flow due to drought	SP1
Reach 2			
Aggradation/bar in riffle	430	Low flow due to drought	SP1
Aggradation/bar in riffle	474	Low flow due to drought	SP1
Aggradation/bar in riffle	618	Low flow due to drought	SP1
Reach 3			
Aggradation/bar in riffle	905	Low flow due to drought	SP1
Piping under cross-vane	1042	Low flow due to drought	SP2
Piping under cross-vane	1075	Low flow due to drought	SP2
Piping under cross-vane	1190	Low flow due to drought	SP2

Appendix B3. Stream Problem Photographs - Year 1 - 2007 - Stillhouse Creek Riparian Buffer Restoration

SP1. Aggradation/bar in riffle

SP2. Piping under cross-vane

Appendix B4. Permanent Photopoint Photographs - Year 1 - 2007 -Stillhouse Creek Stream Restoration

PP #1 – Looking Downstream (06/14/07)

PP #2 – Looking Downstream (06/14/07)

PP #3 – Looking South (06/14/07)

PP #4 – Looking Downstream (06/14/07)

Appendix. B4. Permanent Photopoint Photographs - Year 1 - 2007 Stillhouse Creek Stream Restoration

PP #5 – Looking Upstream (06/14/07)

PP #6 – Looking Upstream (06/14/07)

PP #7 – Looking Downstream (06/14/07)

PP #8 – Looking Downstream (06/14/07)

Appendix B4. Permanent Photopoint Photographs - Year 1 - 2007 - Stillhouse Creek Stream Restoration

PP #9 – Looking Downstream (06/14/07)

PP #10 – Looking Upstream (06/14/07)

B5. Visual Morphological Assessment Stillhouse Creek Stream Restoration Project - Reach 1 - Project #363

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total Number per As-built	Total Number/ feet in Unstable State	Percent Performing in Stable Condition	Feature Performing Mean (%)
A. Riffles	1. Present	7	7	0/0	100	
	2. Armor stable	7	7	0/0	100	
	3. Facet grade appears stable	7	7	0/0	100	
	4. Minimal evidence of embedding/fining	7	7	0/0	100	
	5. Length appropriate	7	7	0/0	100	**100**
B. Pools	1. Present	8	8	0/0	100	
	2. Sufficiently deep	8	8	0/0	100	
	3. Length appropriate	8	8	0/0	100	**100**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	0	0	0/0	NA	
	2. Downstream of meander (glide/inflection) centering	0	0	0/0	NA	**NA**
D. Meanders	1. Outer bend in state of limited/controlled erosion	0	0	0/0	NA	
	2. Of those eroding, # w/concomitant point bar formation	0	0	0/0	NA	
	3. Apparent Rc within spec	0	0	0/0	NA	
	4. Sufficient floodplain access and relief	0	0	0/0	NA	**NA**
E. Bed (General)	1. General channel bed aggradation areas (bar formation)	0	0	1/6	NA	
	2. Channel bed degradation – areas of increasing downcutting or head cutting	0	0	0/0	NA	**NA**
F. Vanes	1. Free of back or arm scour	7	7	0/0	100	
	2. Height appropriate	7	7	0/0	100	
	3. Angle and geometry appear appropriate	7	7	0/0	100	
	4. Free of piping or other structural failures	7	7	0/0	100	**100**
G. Wads/Bould	1. Free of scour	0	0	0/0	NA	
	2. Footing stable	0	0	0/0	NA	**NA**

B5. Visual Morphological Assessment Stillhouse Creek Stream Restoration Project - Reach 2 - Project #363

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total Number per As-built	Total Number/ feet in Unstable State	Percent Performing in Stable Condition	Feature Performing Mean (%)
A. Riffles	1. Present	13	14	1/10	93	
	2. Armor stable	14	14	0/0	100	
	3. Facet grade appears stable	14	14	0/0	100	
	4. Minimal evidence of embedding/fining	14	14	0/0	100	
	5. Length appropriate	14	14	0/0	100	**99**
B. Pools	1. Present	16	16	0/0	100	
	2. Sufficiently deep	16	16	0/0	100	
	3. Length appropriate	15	16	1/25	94	**98**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	13	15	2/6	87	
	2. Downstream of meander (glide/inflection) centering	15	15	0/0	100	**93**
D. Meanders	1. Outer bend in state of limited/controlled erosion	15	15	0/0	100	
	2. Of those eroding, # w/concomitant point bar formation	0	15	0/0	0	
	3. Apparent Rc within spec	15	15	0/0	100	
	4. Sufficient floodplain access and relief	15	15	0/0	100	**75**
E. Bed (General)	1. General channel bed aggradation areas (bar formation)	0	0	4/41	NA	
	2. Channel bed degradation – areas of increasing downcutting or head cutting	0	0	0/0	NA	**NA**
F. Vanes	1. Free of back or arm scour	1	1	0/0	100	
	2. Height appropriate	1	1	0/0	100	
	3. Angle and geometry appear appropriate	1	1	0/0	100	
	4. Free of piping or other structural failures	1	1	0/0	100	**100**
G. Wads/Bould	1. Free of scour	0	0	0/0	NA	
	2. Footing stable	0	0	0/0	NA	**NA**

B5. Visual Morphological Assessment Stillhouse Creek Stream Restoration Project - Reach 3 - Year 1 - 2007

Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total Number per As-built	Total Number/ feet in Unstable State	Percent Performing in Stable Condition	Feature Performing Mean (%)
A. Riffles	1. Present	12	12	1/10	100	
	2. Armor stable	14	14	0/0	100	
	3. Facet grade appears stable	14	14	0/0	100	
	4. Minimal evidence of embedding/fining	14	14	0/0	100	
	5. Length appropriate	14	14	0/0	100	**100**
B. Pools	1. Present	11	13	0/0	85	
	2. Sufficiently deep	10	13	0/0	77	
	3. Length appropriate	11	13	1/25	85	**82**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	8	8	0/0	100	
	2. Downstream of meander (glide/inflection) centering	7	8	1/2	88	**94**
D. Meanders	1. Outer bend in state of limited/controlled erosion	4	4	NA	100	
	2. Of those eroding, # w/concomitant point bar formation	0	4	NA	0	
	3. Apparent Rc within spec	4	4	NA	100	
	4. Sufficient floodplain access and relief	4	4	NA	100	**75**
E. Bed (General)	1. General channel bed aggradation areas (bar formation)	0	0	1/12	NA	
	2. Channel bed degradation – areas of increasing downcutting or head cutting	0	0	0/0	NA	**NA**
F. Vanes	1. Free of back or arm scour	12	12	0/0	100	
	2. Height appropriate	11	12	1/2	92	
	3. Angle and geometry appear appropriate	12	12	0/0	100	
	4. Free of piping or other structural failures	8	12	4/8	67	**90**
G. Wads/Bould	1. Free of scour	0	0	0/0	NA	
	2. Footing stable	0	0	0/0	NA	**NA**

River Basin:	Neuse
Watershed:	Stillhouse Creek
XS ID	XS 1 (riffle)
Reach:	1
Date:	11/5/2007
Field Crew:	S.D. and J.O.

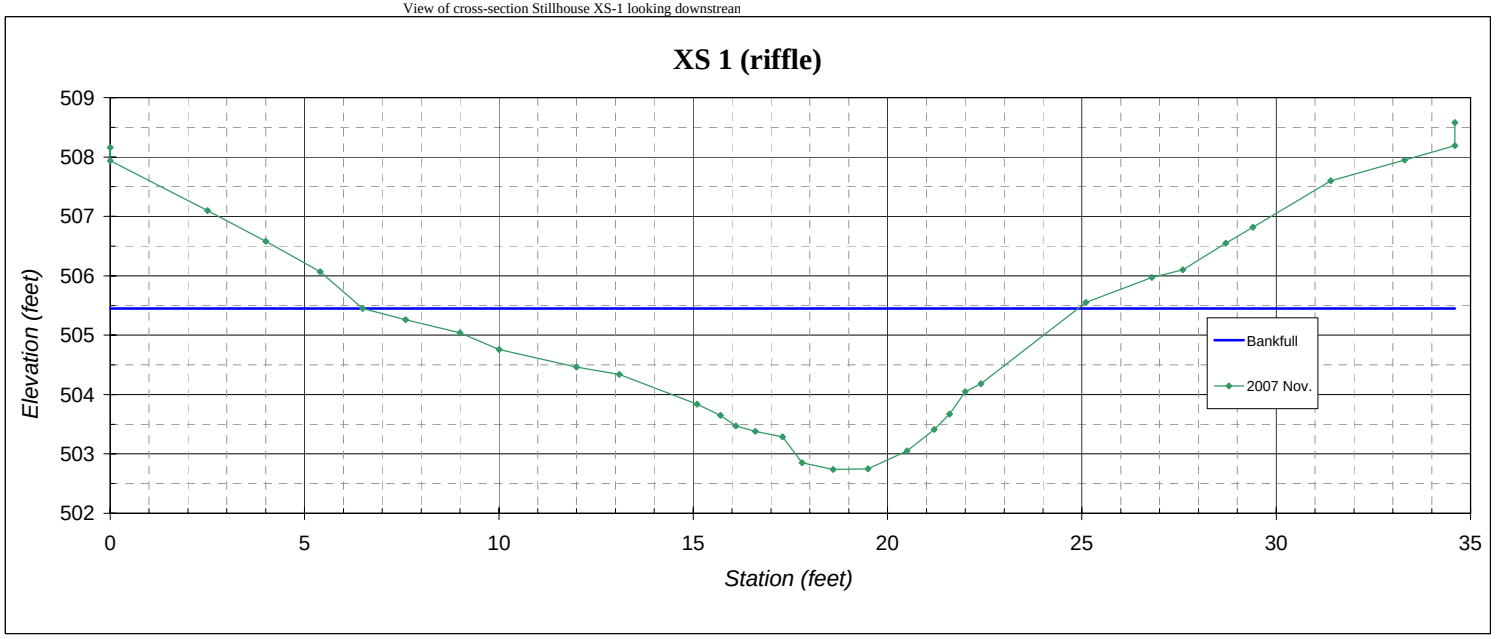
Station	Rod Ht.	Elevation
0	5	508.16
0	5.22	507.94
2.5	6.06	507.10
4	6.58	506.58
5.4	7.09	506.07
6.5	7.71	505.45
7.6	7.9	505.26
9	8.12	505.04
10	8.4	504.76
12	8.7	504.46
13.1	8.82	504.34
15.1	9.32	503.84
15.7	9.51	503.65
16.1	9.69	503.47
16.6	9.78	503.38
17.3	9.87	503.29
17.8	10.31	502.85
18.6	10.42	502.74
19.5	10.41	502.75
20.5	10.11	503.05
21.2	9.75	503.41
21.6	9.49	503.67
22	9.11	504.05
22.4	8.98	504.18
25.1	7.61	505.55
26.8	7.19	505.97
27.6	7.06	506.10
28.7	6.61	506.55
29.4	6.34	506.82
31.4	5.56	507.60
33.3	5.21	507.95
34.6	4.97	508.19
34.6	4.58	508.58

SUMMARY DATA

Floodprone Elevation (ft)	508.16
Bankfull Elevation (ft)	505.45
Floodprone Width (ft)	34.44
Bankfull Width (ft)	18.40
Entrenchment Ratio	1.87
Mean Depth (ft)	1.32
Maximum Depth (ft)	2.71
Width/Depth Ratio	13.95
Bankfull Area (sq ft)	24.28
Wetted Perimeter (ft)	19.51
Hydraulic Radius (ft)	1.24

Stream Type: B-6c

View of cross-section Stillhouse XS-1 looking downstrean



River Basin:	Neuse
Watershed:	Stillhouse Creek
XS ID	XS 2 (pool)
Reach:	2
Date:	11/5/2007
Field Crew:	S.D. and J.O.

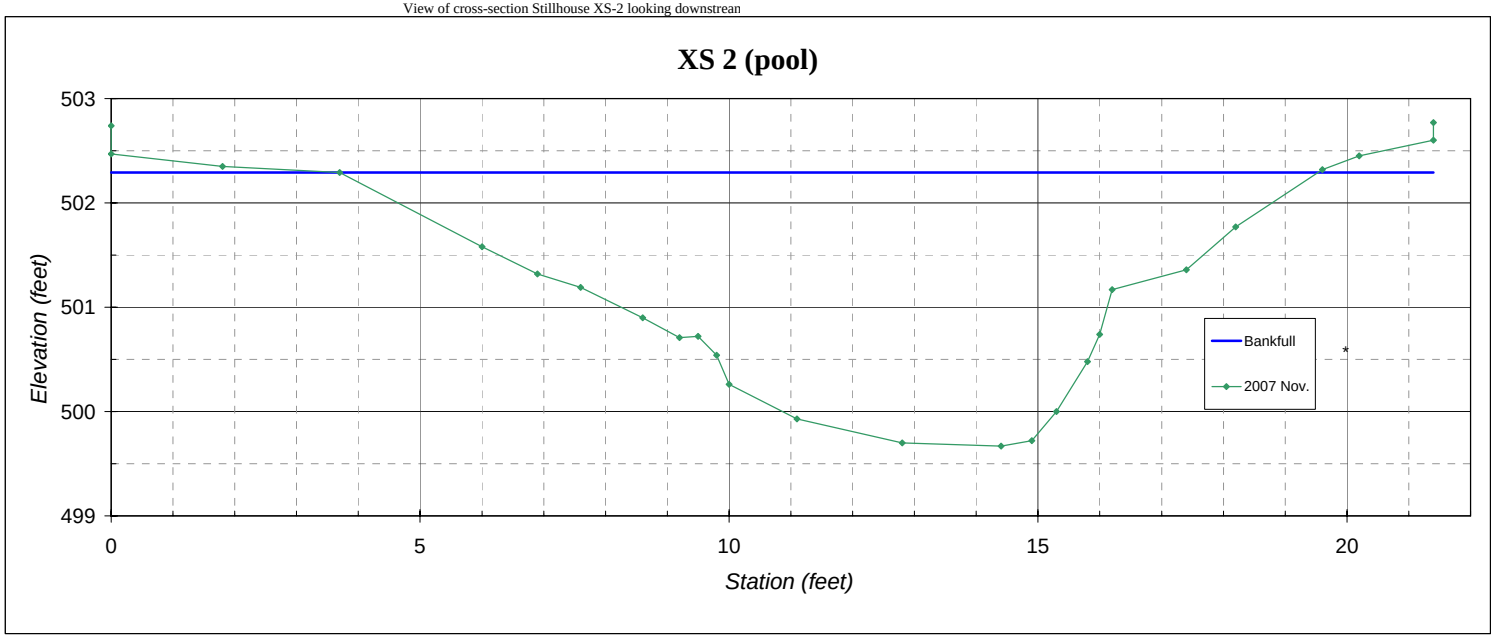
Station	Rod Ht.	Elevation
0	4.66	502.74
0	4.93	502.47
1.8	5.05	502.35
3.7	5.11	502.29
6	5.82	501.58
6.9	6.08	501.32
7.6	6.21	501.19
8.6	6.5	500.90
9.2	6.69	500.71
9.5	6.68	500.72
9.8	6.86	500.54
10	7.14	500.26
11.1	7.47	499.93
12.8	7.7	499.70
14.4	7.73	499.67
14.9	7.68	499.72
15.3	7.4	500.00
15.8	6.92	500.48
16	6.66	500.74
16.2	6.23	501.17
17.4	6.04	501.36
18.2	5.63	501.77
19.6	5.08	502.32
20.2	4.95	502.45
21.4	4.8	502.60
21.4	4.63	502.77

SUMMARY DATA

Floodprone Elevation (ft)	504.91
Bankfull Elevation (ft)	502.29
Floodprone Width (ft)	94.50
Bankfull Width (ft)	15.82
Entrenchment Ratio	6.00
Mean Depth (ft)	1.43
Maximum Depth (ft)	2.62
Width/Depth Ratio	11.07
Bankfull Area (sq ft)	22.62
Wetted Perimeter (ft)	17.21
Hydraulic Radius (ft)	1.31

Stream Type: E4

View of cross-section Stillhouse XS-2 looking downstrean



River Basin:	Neuse
Watershed:	Stillhouse Creek
XS ID	XS 3 (riffle)
Reach:	2
Date:	11/5/2007
Field Crew:	S.D. and J.O.

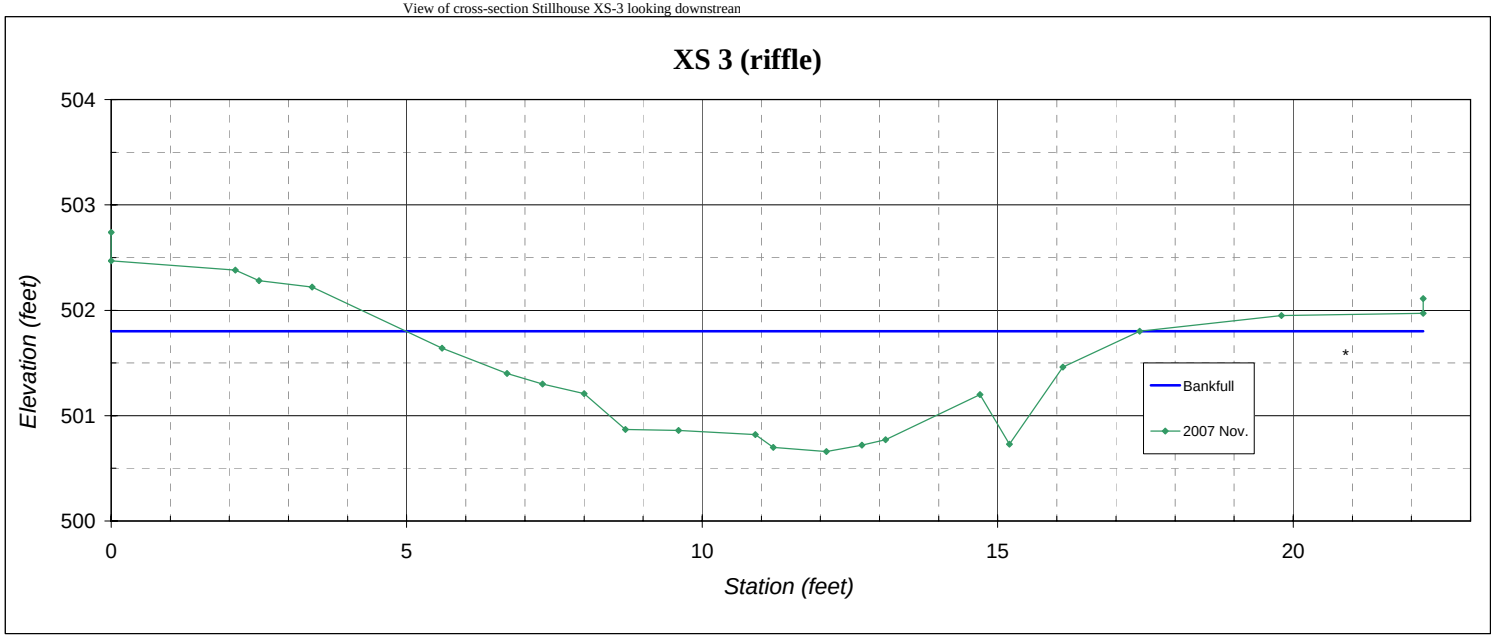
Station	Rod Ht.	Elevation
0	4.66	502.74
0	4.93	502.47
2.1	5.02	502.38
2.5	5.12	502.28
3.4	5.18	502.22
5.6	5.76	501.64
6.7	6	501.40
7.3	6.1	501.30
8	6.19	501.21
8.7	6.53	500.87
9.6	6.54	500.86
10.9	6.58	500.82
11.2	6.7	500.70
12.1	6.74	500.66
12.7	6.68	500.72
13.1	6.63	500.77
14.7	6.2	501.20
15.2	6.67	500.73
16.1	5.94	501.46
17.4	5.6	501.80
19.8	5.45	501.95
22.2	5.43	501.97
22.2	5.29	502.11

SUMMARY DATA

Floodprone Elevation (ft)	502.94
Bankfull Elevation (ft)	501.80
Floodprone Width (ft)	107.00
Bankfull Width (ft)	12.41
Entrenchment Ratio	8.70
Mean Depth (ft)	0.69
Maximum Depth (ft)	1.14
Width/Depth Ratio	17.87
Bankfull Area (sq ft)	8.61
Wetted Perimeter (ft)	13.12
Hydraulic Radius (ft)	0.66

Stream Type: C4

View of cross-section Stillhouse XS-3 looking downstrean



River Basin:	Neuse
Watershed:	Stillhouse Creek
XS ID	XS 4 (riffle)
Reach:	3
Date:	11/6/2007
Field Crew:	S.D. and J.O.

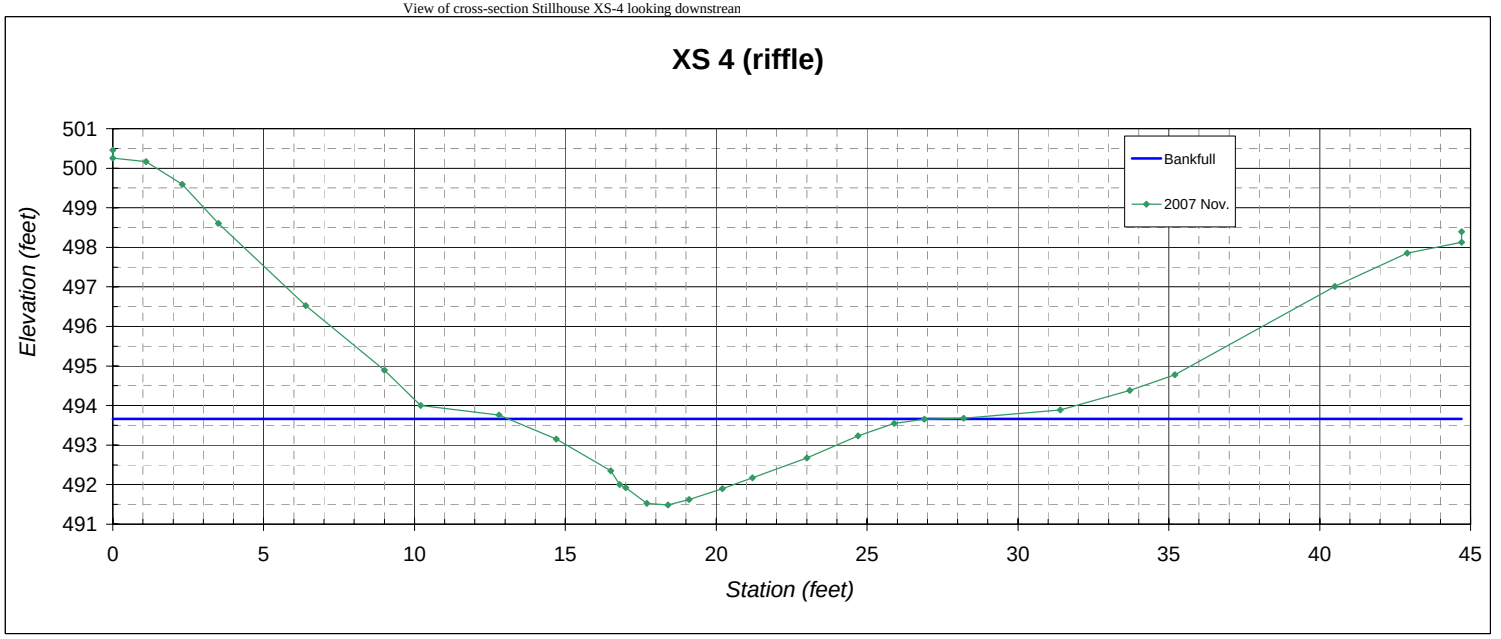
Station	Rod Ht.	Elevation
0	2.02	500.46
0	2.22	500.26
1.1	2.31	500.17
2.3	2.88	499.60
3.5	3.87	498.61
6.4	5.95	496.53
9	7.58	494.90
10.2	8.47	494.01
12.8	8.72	493.76
14.7	9.32	493.16
16.5	10.12	492.36
16.8	10.47	492.01
17	10.55	491.93
17.7	10.95	491.53
18.4	10.99	491.49
19.1	10.85	491.63
20.2	10.58	491.90
21.2	10.3	492.18
23	9.8	492.68
24.7	9.24	493.24
25.9	8.93	493.55
26.9	8.82	493.66
28.2	8.8	493.68
31.4	8.59	493.89
33.7	8.09	494.39
35.2	7.7	494.78
40.5	5.46	497.02
42.9	4.62	497.86
44.7	4.35	498.13
44.7	4.08	498.40

SUMMARY DATA

Floodprone Elevation (ft)	495.61
Bankfull Elevation (ft)	493.55
Floodprone Width (ft)	29.30
Bankfull Width (ft)	12.44
Entrenchment Ratio	2.36
Mean Depth (ft)	1.06
Maximum Depth (ft)	2.06
Width/Depth Ratio	11.75
Bankfull Area (sq ft)	13.16
Wetted Perimeter (ft)	13.23
Hydraulic Radius (ft)	0.99

Stream Type: C4

View of cross-section Stillhouse XS-4 looking downstrean



River Basin:	Neuse
Watershed:	Stillhouse Creek
XS ID	XS 5 (pool)
Reach:	3
Date:	11/6/2007
Field Crew:	S.D. and J.O.

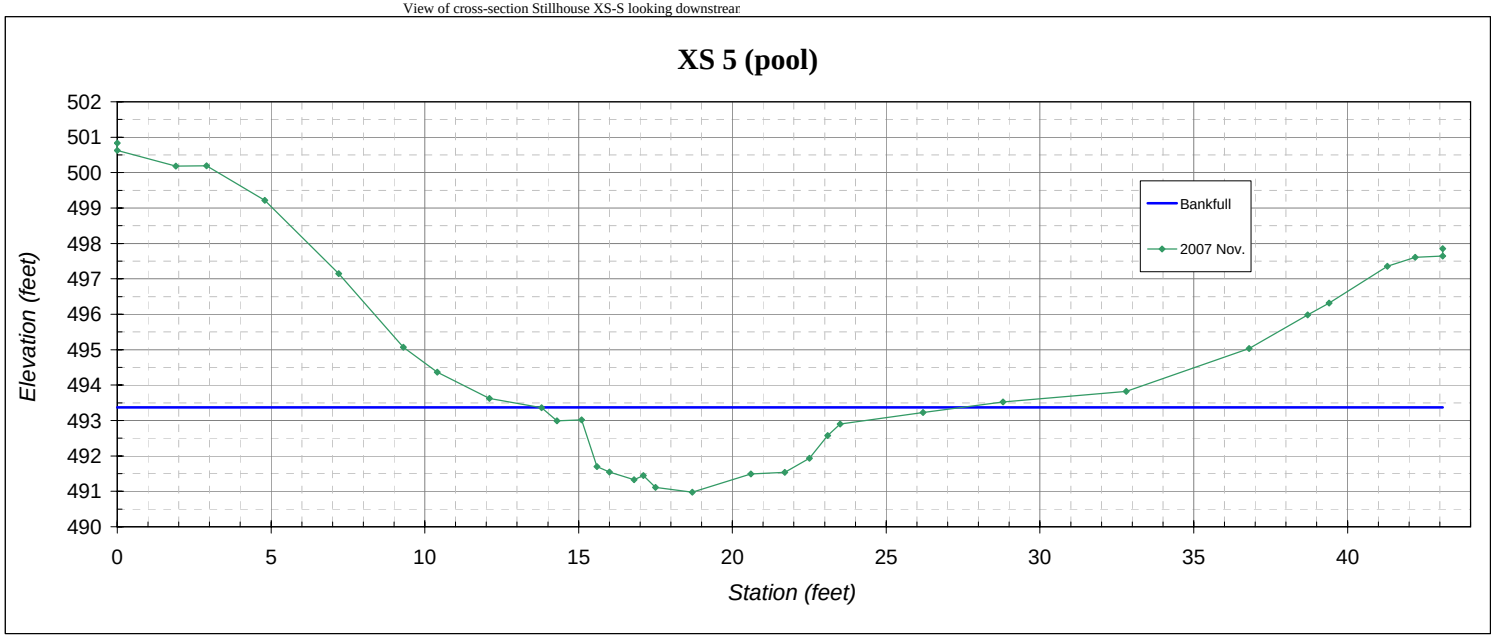
Station	Rod Ht.	Elevation
0	1.64	500.84
0	1.85	500.63
1.9	2.29	500.19
2.9	2.28	500.20
4.8	3.26	499.22
7.2	5.33	497.15
9.3	7.41	495.07
10.4	8.11	494.37
12.1	8.85	493.63
13.8	9.11	493.37
14.3	9.48	493.00
15.1	9.46	493.02
15.6	10.78	491.70
16	10.93	491.55
16.8	11.15	491.33
17.1	11.03	491.45
17.5	11.36	491.12
18.7	11.5	490.98
20.6	10.98	491.50
21.7	10.94	491.54
22.5	10.54	491.94
23.1	9.9	492.58
23.5	9.57	492.91
26.2	9.25	493.23
28.8	8.95	493.53
32.8	8.65	493.83
36.8	7.44	495.04
38.7	6.49	495.99
39.4	6.16	496.32
41.3	5.12	497.36
42.2	4.87	497.61
43.1	4.83	497.65
43.1	4.62	497.86

SUMMARY DATA

Floodprone Elevation (ft)	494.82
Bankfull Elevation (ft)	492.91
Floodprone Width (ft)	26.48
Bankfull Width (ft)	8.36
Entrenchment Ratio	3.17
Mean Depth (ft)	1.36
Maximum Depth (ft)	1.93
Width/Depth Ratio	6.13
Bankfull Area (sq ft)	11.40
Wetted Perimeter (ft)	9.96
Hydraulic Radius (ft)	1.14

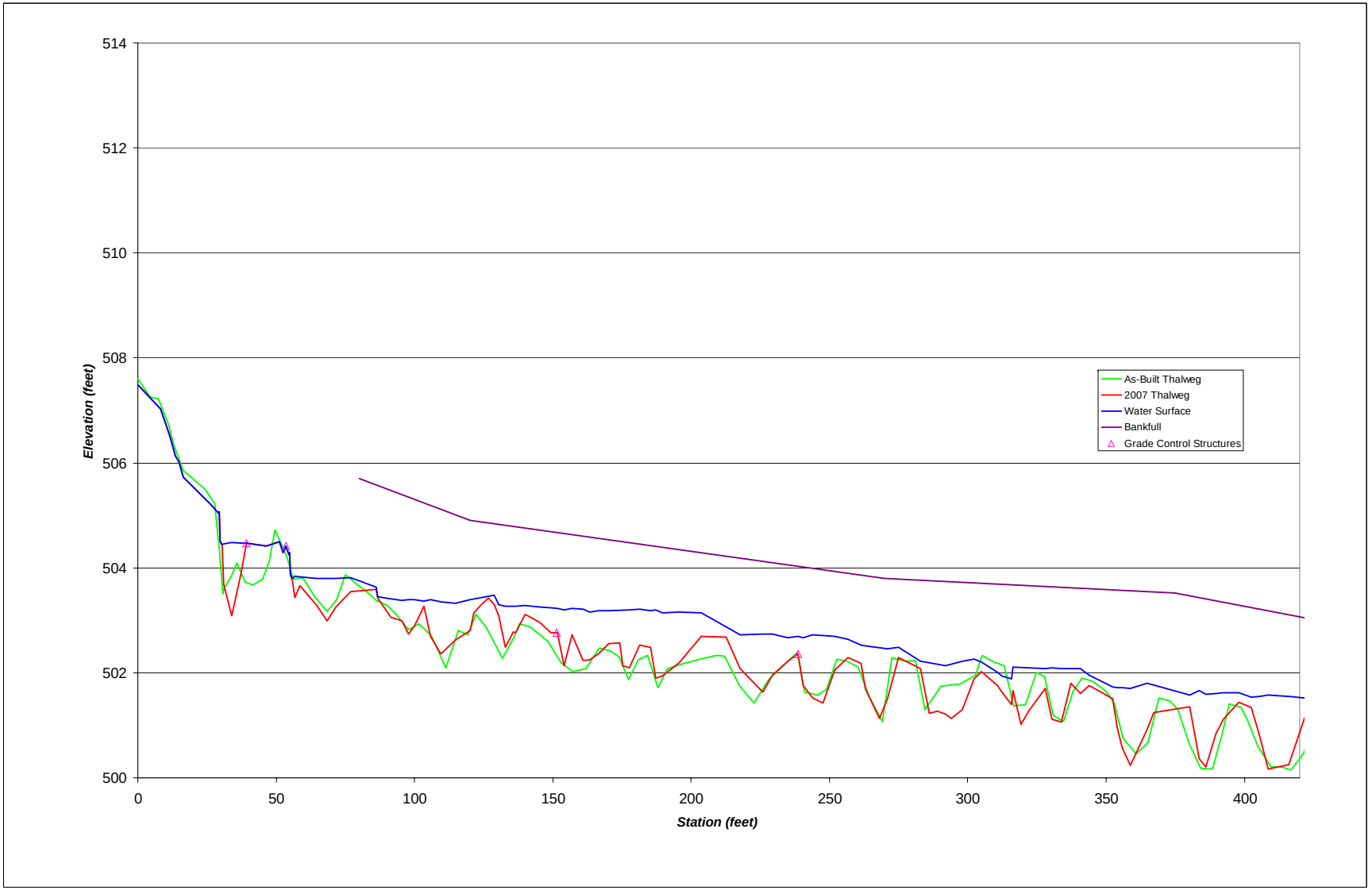
Stream Type: C4

View of cross-section Stillhouse XS-S looking downstrear



B7. Longitudinal Plots and Raw Data Tables – Stillhouse Creek Stream Restoration – EEP Project #363

Stationing 0 – 400



B7. Longitudinal Plots and Raw Data Tables – Stillhouse Creek Stream Restoration – EEP Project #363

Stationing 400 – 800

B7. Longitudinal Plots and Raw Data Tables – Stillhouse Creek Stream Restoration – EEP Project #363

Stationing 800 – 1210

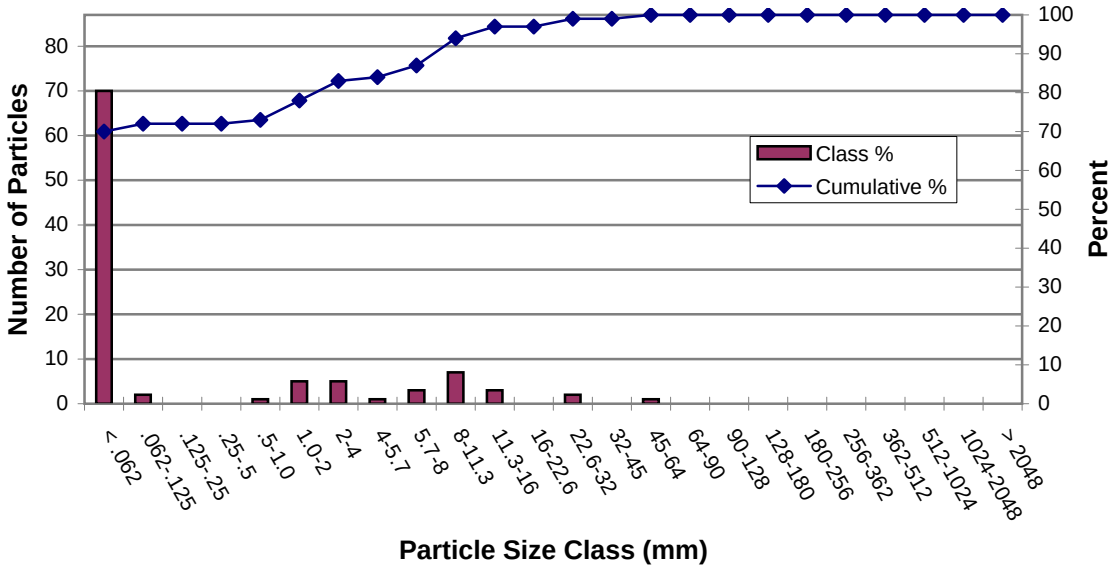
B8. Pebble Count - Stillhouse Creek Stream Restoration First Year Monitoring 11/14/2007

Cross Section One

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< .062	70	70	70
Sand	Very Fine Sand	.062-.125	2	2	72
	Fine Sand	.125-.25		0	72
	Medium Sand	.25-.5		0	72
	Coarse Sand	.5-1.0	1	1	73
	Very Course Sand	1.0-2	5	5	78
Gravel	Very Fine Gravel	2-4	5	5	83
	Fine Gravel	4-5.7	1	1	84
	Fine Gravel	5.7-8	3	3	87
	Medium Gravel	8-11.3	7	7	94
	Medium Gravel	11.3-16	3	3	97
	Coarse Gravel	16-22.6		0	97
	Coarse Gravel	22.6-32	2	2	99
	Very Course Gravel	32-45		0	99
	Very Course Gravel	45-64	1	1	100
Cobble	Small Cobble	64-90		0	100
	Small Cobble	90-128		0	100
	Medium Cobble	128-180		0	100
	Large Cobble	180-256		0	100
Boulder	Small Boulders	256-362		0	100
	Small Boulders	362-512		0	100
	Medium Boulders	512-1024		0	100
	Large Boulders	1024-2048		0	100
	Bedrock	> 2048		0	100
	Total		100		

d_{50} = 0.04 mm

d_{84} = 0.57 mm



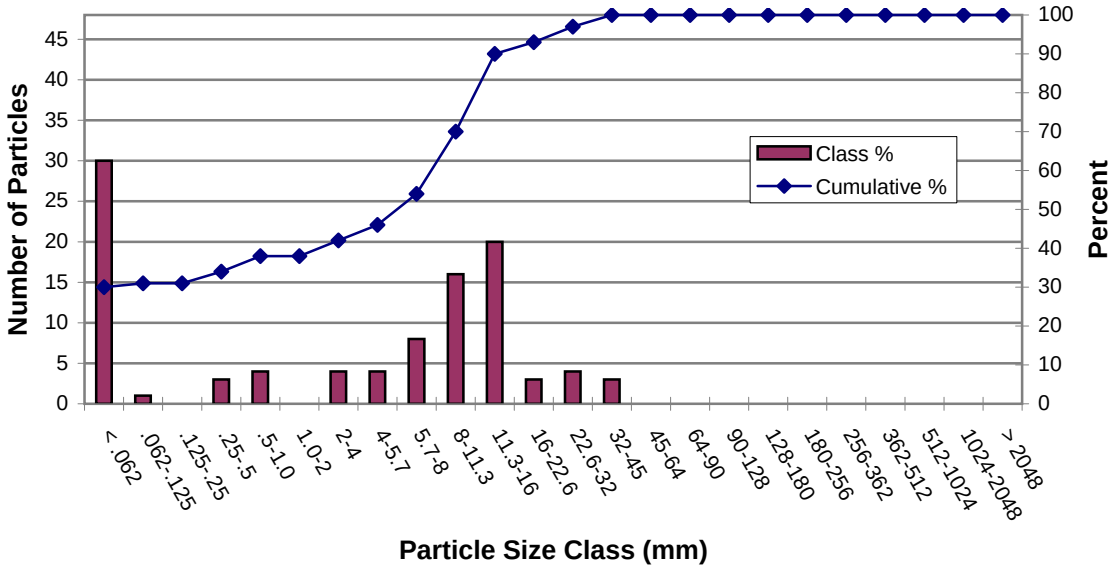
B8. Pebble Count - Stillhouse Creek Stream Restoration First Year Monitoring 11/14/2007

Cross Section Two

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< .062	30	30	30
Sand	Very Fine Sand	.062-.125	1	1	31
	Fine Sand	.125-.25		0	31
	Medium Sand	.25-.5	3	3	34
	Coarse Sand	.5-1.0	4	4	38
	Very Course Sand	1.0-2		0	38
Gravel	Very Fine Gravel	2-4	4	4	42
	Fine Gravel	4-5.7	4	4	46
	Fine Gravel	5.7-8	8	8	54
	Medium Gravel	8-11.3	16	16	70
	Medium Gravel	11.3-16	20	20	90
	Coarse Gravel	16-22.6	3	3	93
	Coarse Gravel	22.6-32	4	4	97
	Very Course Gravel	32-45	3	3	100
	Very Course Gravel	45-64		0	100
Cobble	Small Cobble	64-90		0	100
	Small Cobble	90-128		0	100
	Medium Cobble	128-180		0	100
	Large Cobble	180-256		0	100
Boulder	Small Boulders	256-362		0	100
	Small Boulders	362-512		0	100
	Medium Boulders	512-1024		0	100
	Large Boulders	1024-2048		0	100
	Bedrock	> 2048		0	100
	Total		100		

d_{50} = 6.85 mm

d_{84} = 14.59 mm



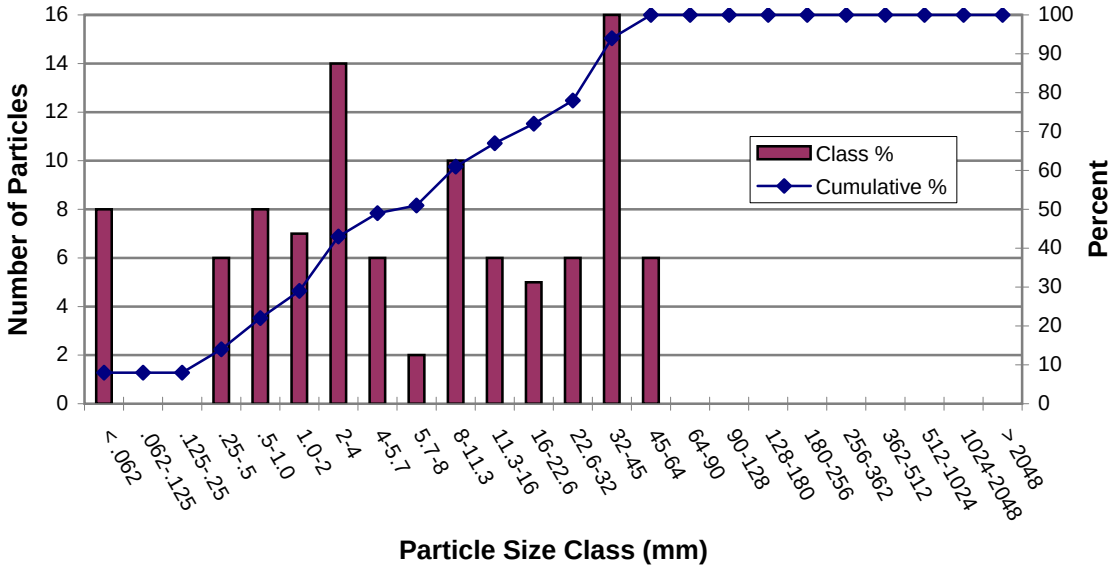
B8. Pebble Count - Stillhouse Creek Stream Restoration First Year Monitoring 11/14/2007

Cross Section Three

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< .062	8	8	8
Sand	Very Fine Sand	.062-.125		0	8
	Fine Sand	.125-.25		0	8
	Medium Sand	.25-.5	6	6	14
	Coarse Sand	.5-1.0	8	8	22
	Very Course Sand	1.0-2	7	7	29
Gravel	Very Fine Gravel	2-4	14	14	43
	Fine Gravel	4-5.7	6	6	49
	Fine Gravel	5.7-8	2	2	51
	Medium Gravel	8-11.3	10	10	61
	Medium Gravel	11.3-16	6	6	67
	Coarse Gravel	16-22.6	5	5	72
	Coarse Gravel	22.6-32	6	6	78
	Very Course Gravel	32-45	16	16	94
	Very Course Gravel	45-64	6	6	100
Cobble	Small Cobble	64-90		0	100
	Small Cobble	90-128		0	100
	Medium Cobble	128-180		0	100
	Large Cobble	180-256		0	100
Boulder	Small Boulders	256-362		0	100
	Small Boulders	362-512		0	100
	Medium Boulders	512-1024		0	100
	Large Boulders	1024-2048		0	100
	Bedrock	> 2048		0	100
	Total		100		

d_{50} = 6.85 mm

d_{84} = 36.88 mm



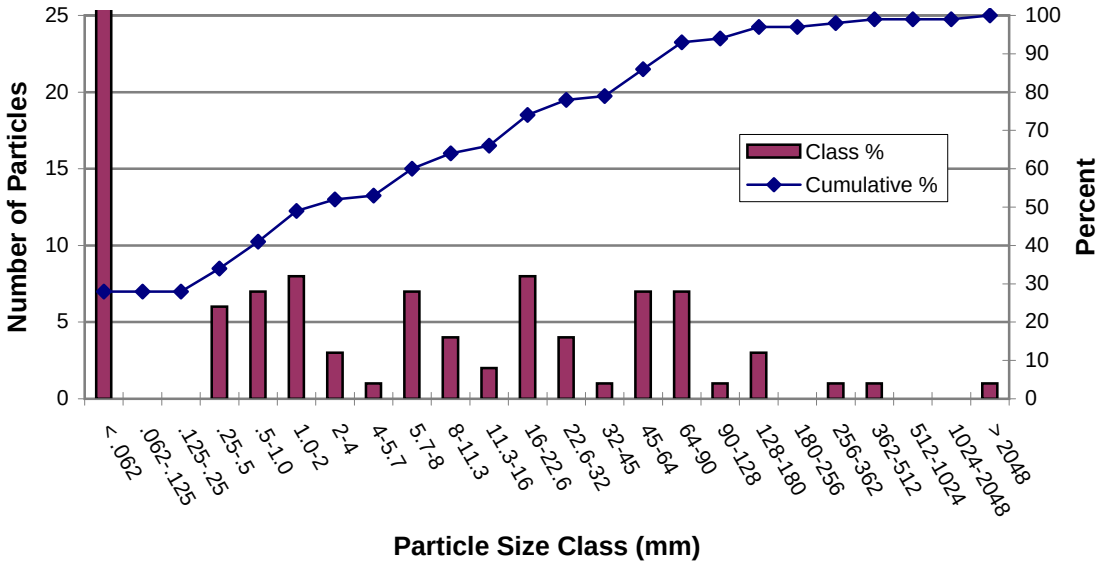
B8. Pebble Count - Stillhouse Creek Stream Restoration First Year Monitoring 11/14/2007

Cross Section Four

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< .062	28	28	28
Sand	Very Fine Sand	.062-.125		0	28
	Fine Sand	.125-.25		0	28
	Medium Sand	.25-.5	6	6	34
	Coarse Sand	.5-1.0	7	7	41
	Very Course Sand	1.0-2	8	8	49
Gravel	Very Fine Gravel	2-4	3	3	52
	Fine Gravel	4-5.7	1	1	53
	Fine Gravel	5.7-8	7	7	60
	Medium Gravel	8-11.3	4	4	64
	Medium Gravel	11.3-16	2	2	66
	Coarse Gravel	16-22.6	8	8	74
	Coarse Gravel	22.6-32	4	4	78
	Very Course Gravel	32-45	1	1	79
	Very Course Gravel	45-64	7	7	86
Cobble	Small Cobble	64-90	7	7	93
	Small Cobble	90-128	1	1	94
	Medium Cobble	128-180	3	3	97
	Large Cobble	180-256		0	97
Boulder	Small Boulders	256-362	1	1	98
	Small Boulders	362-512	1	1	99
	Medium Boulders	512-1024		0	99
	Large Boulders	1024-2048		0	99
	Bedrock	> 2048	1	1	100
	Total		100		

d_{50} = 2.67 mm

d_{84} = 58.57 mm



B8. Pebble Count - Stillhouse Creek Stream Restoration First Year Monitoring 11/14/2007

Cross Section Five

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< .062	12	12	12
Sand	Very Fine Sand	.062-.125		0	12
	Fine Sand	.125-.25		0	12
	Medium Sand	.25-.5	2	2	14
	Coarse Sand	.5-1.0	9	9	23
	Very Course Sand	1.0-2	4	4	27
Gravel	Very Fine Gravel	2-4	6	6	33
	Fine Gravel	4-5.7	2	2	35
	Fine Gravel	5.7-8	4	4	39
	Medium Gravel	8-11.3	6	6	45
	Medium Gravel	11.3-16	5	5	50
	Coarse Gravel	16-22.6	10	10	60
	Coarse Gravel	22.6-32	10	10	70
	Very Course Gravel	32-45	11	11	81
	Very Course Gravel	45-64	10	10	91
Cobble	Small Cobble	64-90	4	4	95
	Small Cobble	90-128		0	95
	Medium Cobble	128-180		0	95
	Large Cobble	180-256		0	95
Boulder	Small Boulders	256-362		0	95
	Small Boulders	362-512	2	2	97
	Medium Boulders	512-1024		0	97
	Large Boulders	1024-2048		0	97
	Bedrock	> 2048	3	3	100
	Total		100		

d_{50} = 16.0 mm

d_{84} = 50.7 mm