ELLERBE CREEK STREAM RESTORATION – Project #127
Fifth Annual Monitoring Report - 2009 - FINAL

Submitted on January 11, 2010 to:

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

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Appendix A. Vegetation Raw Data

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I. Executive Summary

The Ellerbe Creek stream restoration a project is located on the Hillandale Golf Course in Durham, North Carolina just east of the intersection of U.S. 15/501 and Interstate 85 (I-85). The project has restored 6,279 linear feet of the perennial stream in the Neuse River Basin (USGS HUC 03020201050010). The drainage area for the site covers approximately 5,635 acres (Stantec 2005a).

The fifth year of monitoring was completed in July2009. RJG&A's initial 2009 qualitative evaluation was conducted on 06 March. Quantitative vegetation and geomorphologic data were collected between 11 June and 16 July. Stream visual assessment was conducted on 16 July 2009.

The restoration project appears to have met its design goals. No significant geomorphologic changes have occurred during the fifth monitoring year. The average planted woody stem density (732 per acre) has exceeded the vegetation restoration goal of 320 stems per acre.

Overall, current vegetation and stream problems found on the site are minor. Some vegetation problems areas continue to exist throughout the restoration in the form of bare soil and areas associated with rill and gully erosion. Stream problem areas continue to center around the presence of beaver (*Castor canadensis)* and beaverdams. Problem areas involving bank scour/slump and aggradation are far fewer and less severe than the previous years.

II. Project Background

A. Project Objectives

The objectives of the Ellerbe Creek Stream restoration project are to:

1. Establish a new floodplain at a lower elevation and connecting the stream to the new floodplain;
2. Reduce erosion and sedimentation;
3. Provide wildlife habitat through the creation of a more natural riparian buffer;
4. Improve aquatic habitat with the use of natural material stabilization structures and a riparian buffer; and
5. Improve water quality within Ellerbe Creek (Stantec 2005a).

B. Project Structure, Restoration Type, and Approach

A Priority 2 stream restoration was used for the most of project's length to establish a new floodplain, improve sediment transport capability, restore wildlife habitat, and improve water quality. Some stream enhancement was done in the Croasdaile, Hillandale, and Albany reaches, where utility rights-of-way were present. The Albany

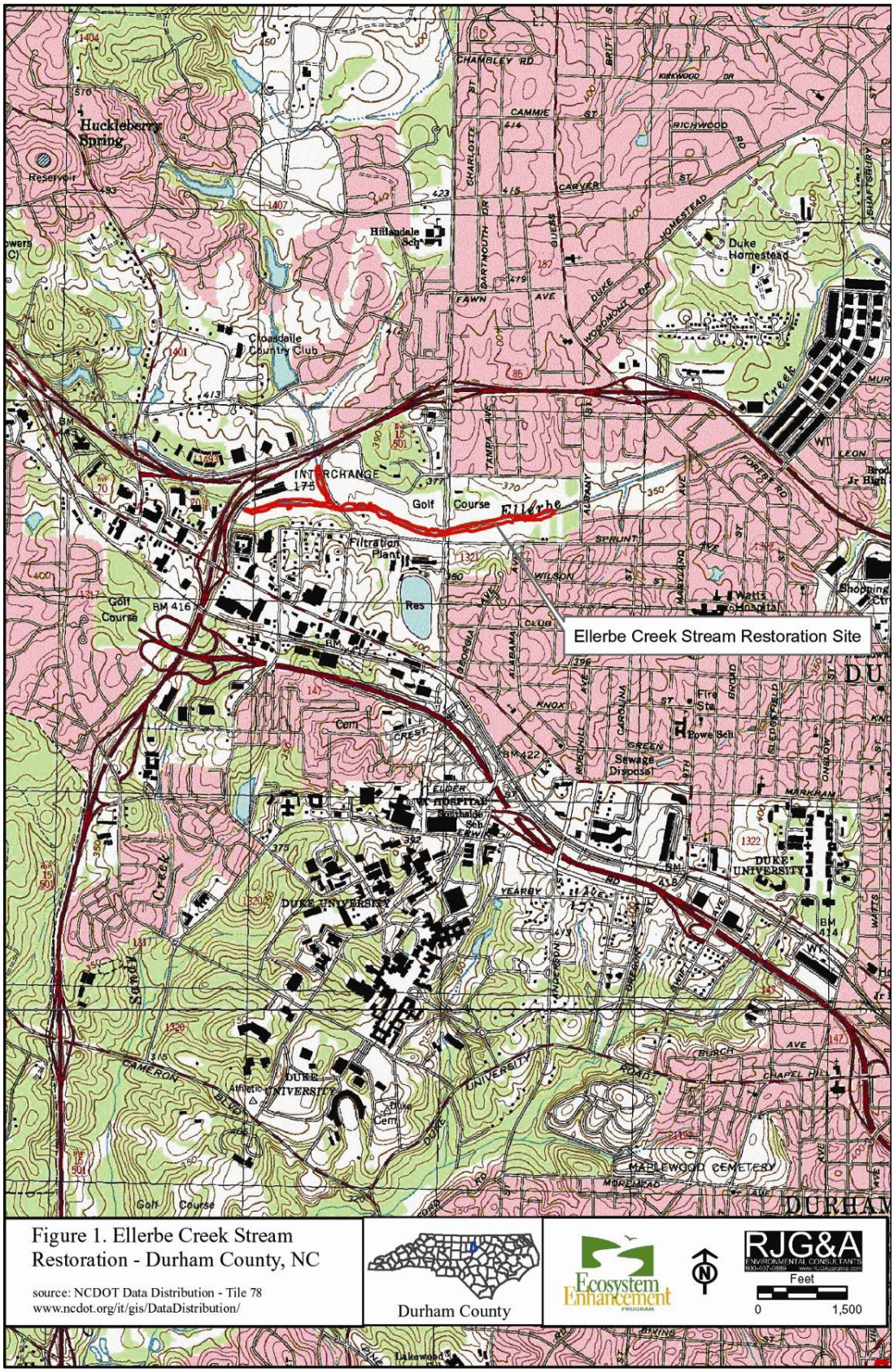
reach also included preservation. The project involved channel dimension adjustments, pattern alterations, in-stream structure installation, and riparian buffer restoration.

Exhibit Table I. Project Restoration Components Ellerbe Creek Stream Restoration - Project #127						
Reach ID	**Existing Feet**	**Mitigation Type**	**Approach**	**Linear Feet or Acreage**	**Stationing**	**Comment**
Hillsborough	1577	R	P2	1663 LF	1010-2673	Changed dimension, pattern, and profile
Croasdaile	788	R	P2	199 LF	CR 1000-1703	Changed dimension, pattern, and profile
Croasdaile		EI	P2	504 LF		Changed dimension and profile
Hillandale	1865	R	P2	1321 LF	2673-4612	Changed dimension, pattern, and profile
Hillandale		EI	P2	618 LF		Changed dimension and profile
Albany	1885	R	P2	1207 LF	4612-6586	Changed dimension, pattern, and profile
Albany		EI	P2	391 LF		Changed dimension and profile
Albany		P	-	376 LF		Protected existing stream
Buffer	NA	R	-	17.41 AC		Restored buffer area
Stormwater Wetland	0	Creation	-	0.15 AC		Created wetlands
Pocket Wetlands	0	Creation	-	0.23 AC		Created wetlands

C. Location and Setting

The Ellerbe Creek restoration is located in the City of Durham on the Hillandale Golf Course. The golf course and restoration area are located approximately 1,500 feet east of the I-85/U.S. 15/501 intersection, on the east and west sides of Hillandale Road. To access the site from I-85, take exit 17a and travel south down Hillandale Road. Ellerbe Creek is at the bottom of the first hill. The restoration site begins where Ellerbe Creek emerges from a double box culvert under I-85, continues east under Belleview Avenue and Hillandale Road, and terminates approximately 300 feet west of Albany Street. Sprunt Avenue parallels most of the site to the south. Indian Trail parallels the Albany reach to the north (Figure 1). The Croasdaile reach is along an unnamed tributary to Ellerbe Creek that emerges from a double box culvert under I-85. It is paralleled by Belleview Avenue to the east.

Maintenance of the immediately surrounding golf course, channel straightening, and the large amount of impervious surface in the surrounding urban watershed were primarily responsible for the stream's instability. The golf course had intensively managed the vegetation adjacent to the stream and only a grass buffer existed along the banks. The


Ellerbe Creek Stream Restoration Site
Figure 1. Ellerbe Creek Stream Restoration - Durham County, NC
source: NCDOT Data Distribution - Tile 78
www.ncdot.org/it/gis/DataDistribution/
Durham County
Ecosystem Enhancement Program
RJG&A
Feet
0
1,500

result was an entrenched stream with low sinuosity. The channel was incised four to six feet and erosion and slumping affected large portions of the banks (Stantec 2005b).

D. History and Background

Exhibit Table II. Activity and Reporting History Ellerbe Creek Stream Restoration – Project #127		
Activity or Report	**Calendar Year of Completion or Planned Completion**	**Actual Completion Date**
Restoration Plan	2003	March 2003
Construction	2005	March 2005
Temporary S&E mix applied	2004	December 2004
Permanent seed mix applied	2004	December 2004
Bare Root Planting	2004	January 2004
Mitigation Plan	2005	May 2005
As-built	2004	May 2005
Year 1 Monitoring	2005	October 2005
Year 2 Monitoring	2006	December 2006
Year 3 Monitoring	2007	October 2007
Year 4 Monitoring	2008	
Vegetation	2008	July 2008
Geomorphological	2008	September 2008
Report	2008	October 2008
Year 5 Monitoring	2009	
Vegetation	2009	July 2009
Geomorphological	2009	June-July 2009
Report (Final)	2010	January 2010

Exhibit Table III. Project Contacts - Ellerbe Creek Stream Restoration – Project #127– Durham, NC	
Design:	Stantec Consulting, Inc. 801 Jones Franklin Road, Suite 300 Raleigh, North Carolina 27606 Mr. Brad Fairley (919) 851-6866
Construction Contractor:	SEI Environmental, Inc. 130 Penmarc Drive Raleigh, NC 27603-2470 Ms. Jackie Utley (919) 832-2535
Planting Contractor:	Harp, Inc. PO Box 655 Newell, NC 28126 Mr. Jim Matthews
Seed Contractor:	SEI Environmental, Inc. 130 Penmarc Drive Raleigh, NC 27603-2470 Ms. Jackie Utley (919) 832-2535
Seed Mix and Nursery Stock Suppliers:	Mellow Marsh Farms 1312 Woody Store Road Siler City, NC 27344 Ms. Sharon Day (919) 742-1200
Monitoring Performers (2005):	Stantec Consulting, Inc. 801 Jones Franklin Road, Suite 300 Raleigh, North Carolina 27606 Mr. Brad Fairley (919) 851-6866
Monitoring Performers (2006 - 2009):	Robert J. Goldstein & Associates 1221 Corporation Parkway, Suite 100 Raleigh, NC 27616 Ms. Jessi O'Neal (919) 872-1174

Exhibit Table IV. Project Background - Ellerbe Creek Stream Restoration – Project #127	
County	Durham
Drainage Area	Hillsborough Reach – 1,140 Acres (1.78 sq. miles)
	Hillandale Reach – 1,810 Acres (2.83 sq. miles)
	Albany Reach – 2,150 Acres (3.36 sq. miles)
	Croasdaile Reach – 535 Acres (0.84 sq. miles)
Drainage Impervious Cover Estimate (%)	80% impervious; 20% forest and residential
Stream Order	Third Order
Physiographic Region	Piedmont
Ecoregion	Triassic Basins
Rosgen Classification of As-built	C4
Dominant Soil Types	Cartecay, Chewacla, and Congaree
Reference Site ID	SCO#010551001A
USGS HUC for Project and Reference	Ellerbe: 03020201; Cabin Branch: 03020201; Tributary to Marks Creek: 03020201
NCDWQ Sub-basin for Project and Reference	Ellerbe: 03-04-01; Cabin Branch: 03-04-01; Tributary to Marks Creek: 03-04-02
NCDWQ Classification for Project and Reference	Ellerbe: Impaired; Cabin Branch: Not Rated; Tributary to Marks Creek: Excellent
Any portion of the project segment 303d listed?	Yes
Any portion of the project segment upstream of a 303d listed segment?	Yes
Reasons for 303d Listing or Stressor	Urban runoff/storm sewers
% of Project Easement Fenced 0%	None

Vegetation Plot Coordinates: Hillsborough Reach			
Plot Side	HB-V1	HB-V2	HB-V3
Pin Coordinate	E 20115741.5610 N 827358.3480	E 20116120.1110 N 827428.6750	E 2016551.0870 N 827505.1970
A	19.5'	31.1'	31.9'
B	52.1'	35.4'	32.6'
C	23.2'	33.1'	31.3'
D	53'	36.2'	39.4'

Vegetation Plot Coordinates: Croasdaile Reach		
Plot Side	CR-V1	CR-V2
Pin Coordinate	E 2016811.8250 N 827741.1850	E 2016933.510 N 827520.8490
A	32.4'	18.3'
B	33.2'	65.5'
C	29.9'	21.7'
D	31.9'	64.1'

	Easting	Northing
Cross-sections		
HB1L	2015742.0022	827332.7693
HB1R	2015772.552	827290.9634
HB2L	2015799.2852	827350.0513
HB2R	2015803.356	827295.5714
HB3L	2016595.6390	827499.8180
HB3R	2016610.0550	827433.3600
HB4L	2015654.5640	827499.8920
HB4R	20116634.3500	827432.4490
CR1L	2016939.2680	827570.7490
CR1R	2016915.6680	827552.4340
CR2L	2016957.7640	827541.2870
CR2R	2016933.5100	827520.8490
Photopoints		
HB-P1	2015577.0052	827347.3258
HB-P2	2015623.7143	827314.4264
HB-P3	2015802.5285	827349.0571
HB-P4	2015961.3634	827401.3361
HB-P5	2016127.5574	827481.3197
HB-P6&P7	2016301.8430	827496.7037
HB-P8	2016523.1130	827464.0709
HB-P9	2016749.2114	827430.4392
HB-P10	2016966.4524	827439.7628
CR-P1	2016781.3114	828053.9579
CR-P2	2016818.9390	827855.0313
CR-P3	2016919.4678	827582.3480

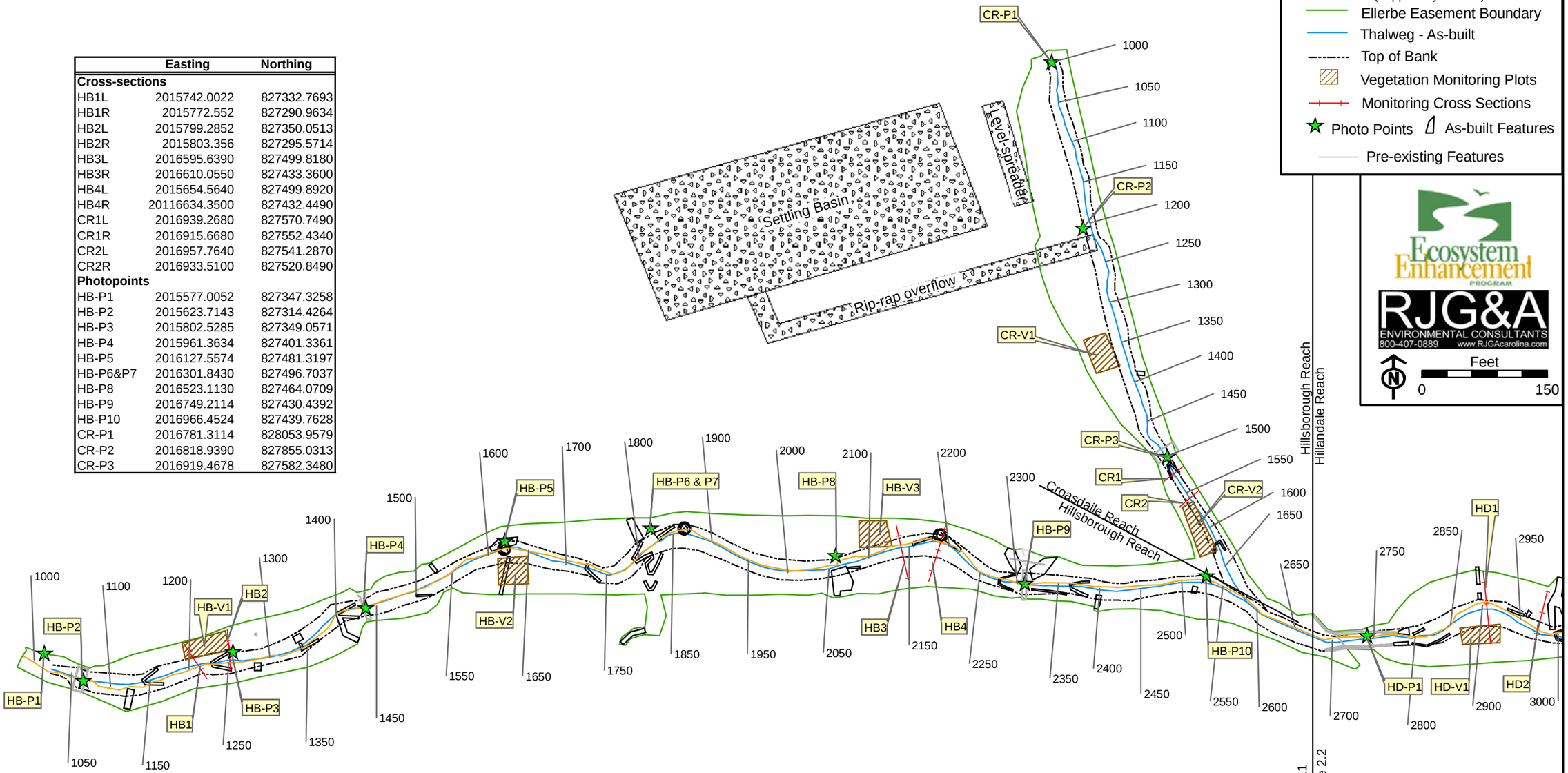


Figure 2.1 - Plan View -
Ellerbe Creek Stream Restoration -
Durham, NC - NCEEP Project #127

LEGEND

- Thalweg-06/30/09 - 07/02/09
- NCDOT Stormwater Structures

As-built Drawings
(Supplied by Stantec)

- Ellerbe Easement Boundary
- Thalweg - As-built
- Top of Bank
- Vegetation Monitoring Plots
- Monitoring Cross Sections
- Photo Points
- As-built Features
- Pre-existing Features

Ecosystem Enhancement Program

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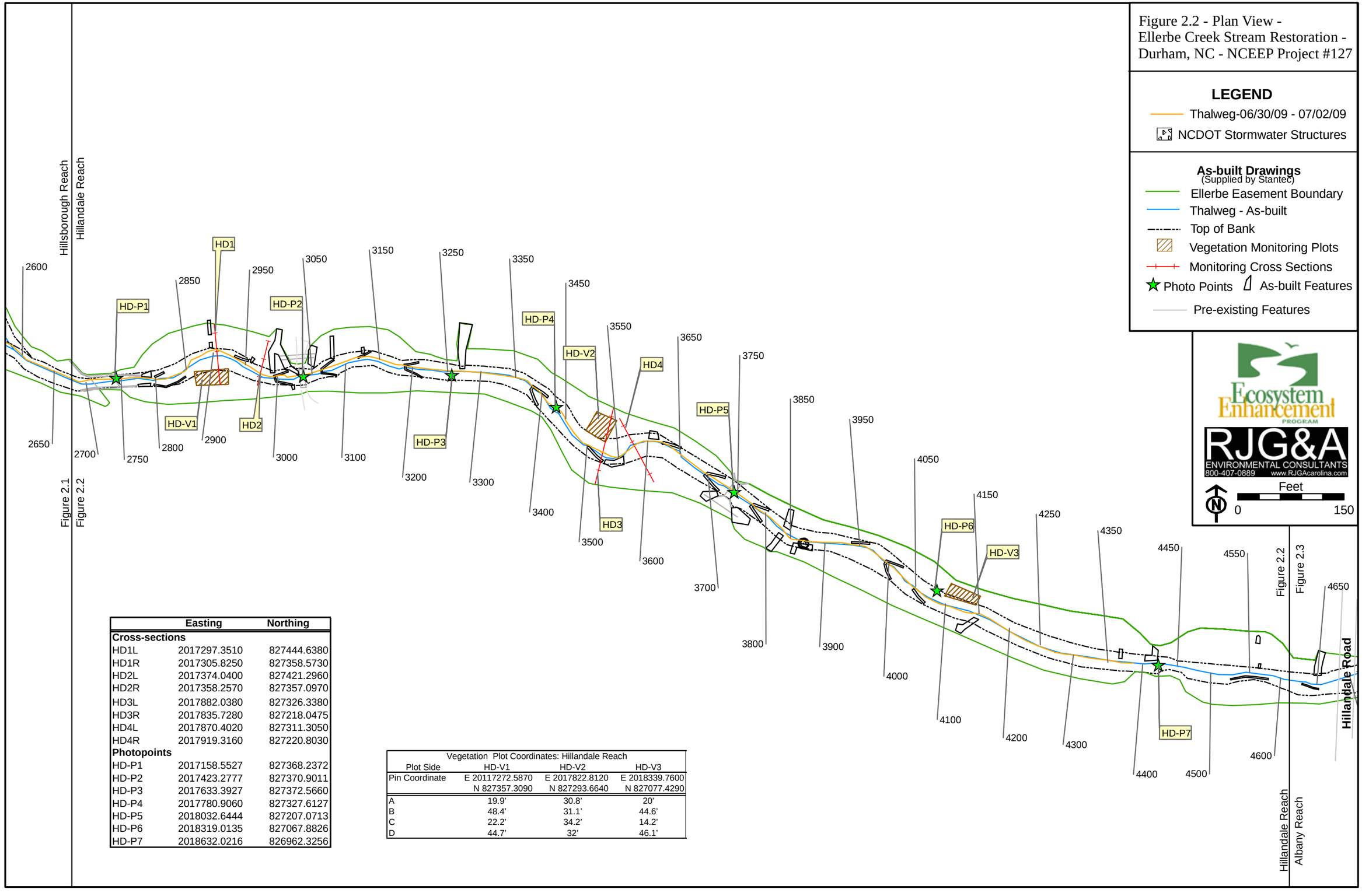
800-407-0889 www.RJGAcarolina.com

N

Feet
0 150

Figure 2.2 - Plan View - Ellerbe Creek Stream Restoration - Durham, NC - NCEEP Project #127



LEGEND

- Thalweg-06/30/09 - 07/02/09
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Feet
0 150

	Easting	Northing
Cross-sections		
HD1L	2017297.3510	827444.6380
HD1R	2017305.8250	827358.5730
HD2L	2017374.0400	827421.2960
HD2R	2017358.2570	827357.0970
HD3L	2017882.0380	827326.3380
HD3R	2017835.7280	827218.0475
HD4L	2017870.4020	827311.3050
HD4R	2017919.3160	827220.8030
Photopoints		
HD-P1	2017158.5527	827368.2372
HD-P2	2017423.2777	827370.9011
HD-P3	2017633.3927	827372.5660
HD-P4	2017780.9060	827327.6127
HD-P5	2018032.6444	827207.0713
HD-P6	2018319.0135	827067.8826
HD-P7	2018632.0216	826962.3256

Vegetation Plot Coordinates: Hillandale Reach

Plot Side	HD-V1	HD-V2	HD-V3
Pin Coordinate	E 20117272.5870 N 827357.3090	E 2017822.8120 N 827293.6640	E 2018339.7600 N 827077.4290
A	19.9’	30.8’	20’
B	48.4’	31.1’	44.6’
C	22.2’	34.2’	14.2’
D	44.7’	32’	46.1’

Figure 2.3 - Plan View -
Ellerbe Creek Stream Restoration -
Durham, NC - NCEEP Project #127

LEGEND

- Thalweg-06/30/09 - 07/02/09
- NCDOT Stormwater Structures

As-built Drawings
(Supplied by Stantec)

- Ellerbe Easement Boundary
- Thalweg - As-built
- Top of Bank
- Vegetation Monitoring Plots
- Monitoring Cross Sections
- Photo Points
- As-built Features
- Pre-existing Features

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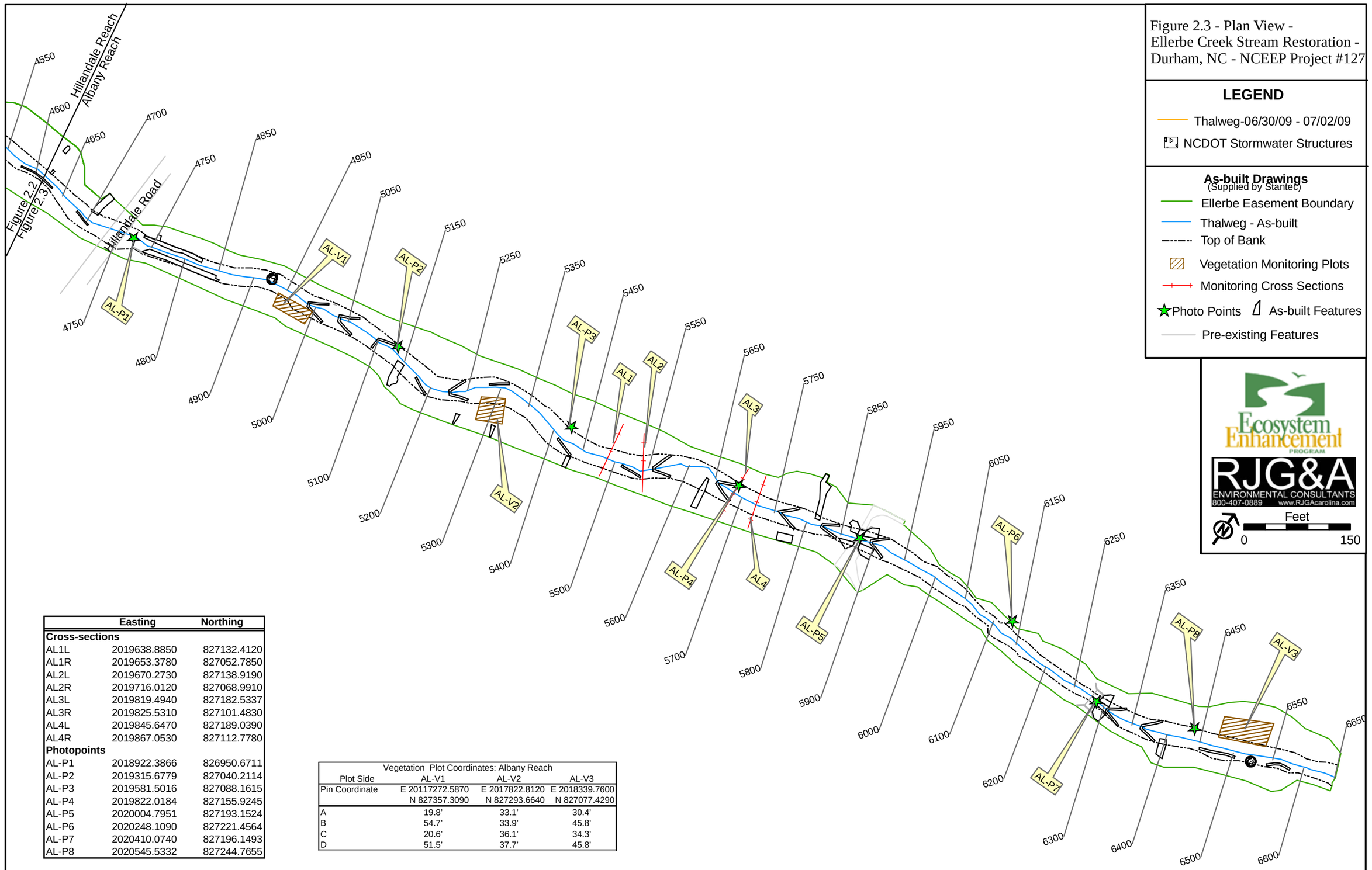
Feet
0 150



	Easting	Northing
Cross-sections		
AL1L	2019638.8850	827132.4120
AL1R	2019653.3780	827052.7850
AL2L	2019670.2730	827138.9190
AL2R	2019716.0120	827068.9910
AL3L	2019819.4940	827182.5337
AL3R	2019825.5310	827101.4830
AL4L	2019845.6470	827189.0390
AL4R	2019867.0530	827112.7780
Photopoints		
AL-P1	2018922.3866	826950.6711
AL-P2	2019315.6779	827040.2114
AL-P3	2019581.5016	827088.1615
AL-P4	2019822.0184	827155.9245
AL-P5	2020004.7951	827193.1524
AL-P6	2020248.1090	827221.4564
AL-P7	2020410.0740	827196.1493
AL-P8	2020545.5332	827244.7655

Vegetation Plot Coordinates: Albany Reach

Plot Side	AL-V1	AL-V2	AL-V3
Pin Coordinate	E 20117272.5870 N 827357.3090	E 2017822.8120 N 827293.6640	E 2018339.7600 N 827077.4290
A	19.8’	33.1’	30.4’
B	54.7’	33.9’	45.8’
C	20.6’	36.1’	34.3’
D	51.5’	37.7’	45.8’

III. Project Conditions and Monitoring Results

RJG&A's 2009 initial assessment was conducted on 06 March and the project appeared to be functioning as designed. Subsequent evaluations in June and July 2009 also revealed relatively complete design compliance.

A. Vegetation Assessment

The average live, planted, woody stem density for all plots was 732 stems per acre or approximately 18 individuals per plot (Appendix A-1, Table 5). This exceeds the required 320 stems per acre in the third monitoring year by 129 percent. The eleven vegetation plots contain a total of 154 volunteer woody stems; resulting in a density of 1,299 stems per acre, when combine with the planted stems.

Vegetation problem areas were greatly reduced in 2009. Only one bare soil area persists near station 1890 in the Hillsborough Reach. Any other vegetation problems are small in scale and associated with rill and gully stream problems on the slopes immediately adjacent to the golf course. Some invasive species are scattered throughout the restoration including two stands of mimosa located near stations 1400 and 4200.

B. Stream Assessment

1. Morphometric Criteria

RJG&A staff conducted the initial assessment at the Ellerbe Creek Stream Restoration during March 2009. Vegetation and geomorphology data were collected during June and July 2009 along with qualitative evaluation.

As the quantitative data and qualitative evaluations indicate, during the fifth growing season the structure and function of the entire restoration project very closely match the as built conditions and nearly all structures appear to be functioning as designed.

Since 2006, a structural failure has been monitored at a cross vane on Ellerbe Creek's right bank at station 6330 in the Albany Reach (Appendix B1.3). The vane's downstream-most header rock has become entirely dislodged from the underlying footer and is in the channel below. From the header's former location, the downstream bank is eroding and slumping into the creek for approximately 20 more feet. As indicated in Exhibit Table VII , Stream Feature Visual Stability Assessment, this bank erosion problem has a minimal affect on the overall success and stability of the stream banks in this reach. Areas of scour, aggradation, and structure undermining were also observed at other locations, but again with minimal affect on the stability of the overall stream channel. Stability scores by feature can be found in Exhibit VII and Table B5 in Appendix B. Locations for specific problem areas are identified in Table B1 in Appendix B.

As of 16 July, a total of eight active beaverdams were observed throughout the restoration project, seven of which are located in the Hillsborough and Hillandale reaches. Those eight, along with two additional abandoned dams and one incomplete dam, are impounding water and sediment in these reaches. At station 1719, the dam extends across the entire floodplain and is impounding water above bankfull elevation. All dams are identified in the longitudinal profile (Appendix B).

Several slopes with rill and gully erosion are still present throughout the site (Table B1). Although construction overflow spillway that serves the I-85 stormwater settling basin has altered a portion of the Croasdaile Reach's right bank and the dimensions of the adjacent constructed wetland, it appears to be stable and functioning.

2. Hydrologic Criteria

On 13 June 2007, a crest gauge was installed at station 5818 to document bankfull events. The crest gauge was checked and reset in March and July 2009. The crest gauge data gathered on 06 March did not conclusively confirm that a bankfull event had occurred but data gathered on 16 July 2009 showed that one had occurred between March and July (Table V). Further evidence that a bankfull event has occurred include rack and drift lines, sand deposits, and downed vegetation/stems well above the bankfull elevation that were observed on both occasions throughout the restoration.

NC CRONOS precipitation data indicate that at the National Weather Service COOP station 312515 in Durham County significant rainfall events occurred on March 2 (1.36"), June 4 (2.1"), June 5 (1.4"), and June 10 (1.38") (NC CRONOS 2009).

Exhibit Table V. Verification of Bankfull Events – Ellerbe Creek Stream Restoration – Project #127			
Date of Data Collection	**Date of Occurrence**	**Method**	**Photo #**
4/30/06	Late-April 2006	On-site high water indicators observed	NA
6/28/06	Mid-June 2006	On-site high water indicators	NA
9/19/06	Early-September 2006	On-site high water indicators	NA
02/01/07	November 22, 2006	Proximal USGS gauge	NA
4/11/07	Between 7 December 2006 and 11 April 2007	On-site high water indicators	NA
10/02/07	Between 13 June 2007 and 02 October 2007	Crest Gauge	NA
4/16/08	4 March 2008	On-site high water indicators AND Crest Gauge	NA
9/18/08	28 August, 6 September 2008	On-site high water indicators AND Crest Gauge	NA
3/6/2009	Possible Dates: 3/2/2009 (1.36”)	All cork at bottom of crest gauge; occurrence of bankfull event deemed inconclusive	NA
7/16/2009	Possible Dates: 6/4/2009 (2.1”), 6/5/2009 (1.4”), 6/10/2009 (1.38”)	On-site high water indicators AND Crest Gauge	NA

Table VI BEHI and Sediment Export Estimates. Based on a conversation with EEP Project Manager, BEHI was not assessed in Monitoring Year 5 due to a lack of pre-construction and as-built BEHI data.

Exhibit Table VII. Categorical Stream Feature Visual Stability Assessment - Ellerbe Creek Stream Restoration – Project #127						
Hillsborough Reach (1,663 ft)						
Feature	Initial	MY-01	MY-02	MY-03	MY-04	MY-05
A. Riffles	100%	95%	87%	90%	80%	86%
B. Pools	100%	80%	69%	94%	96%	88%
C. Thalweg	100%	95%	78%	87%	86%	95%
D. Meanders	100%	98%	94%	100%	100%	100%
E. Bed General	100%	85%	100%	100%	99%	100%
G. Bank				98%	95%	98%
F. Vanes/J Hooks, etc.	100%	95%	89%	100%	100%	100%
H. Wads and Boulders	100%	95%	75%	66.5%	67%	100%
Croasdaile Reach (703 ft)						
A. Riffles	100%	95%	100%	100%	95%	95%
B. Pools	100%	95%	100%	100%	93%	93%
C. Thalweg	100%	95%	100%	100%	100%	100%
D. Meanders	100%	95%	100%	100%	100%	100%
E. Bed General	100%	95%	100%	100%	99%	97%
G. Bank				100%	100%	100%
F. Vanes/J Hooks, etc.	100%	95%	100%	100%	100%	100%
H. Wads and Boulders	100%	95%	100%	100%	NA	100%
Hillandale Reach (1,939 ft)						
A. Riffles	100%	90%	93%	95%	84%	81%
B. Pools	100%	85%	89%	96%	90%	98%
C. Thalweg	100%	95%	80%	75%	96%	96%
D. Meanders	100%	95%	83%	92%	97%	97%
E. Bed General	100%	75%	100%	100%	99%	99%
G. Bank				94%	97%	100%
F. Vanes/J Hooks, etc.	100%	95%	92%	89%	86%	86%
H. Wads and Boulders	100%	95%	50%	100%	100%	100%
Albany Reach (1,974 ft)						
A. Riffles	100%	60%	75%	60%	75%	95%
B. Pools	100%	60%	62%	79%	87%	87%
C. Thalweg	100%	80%	75%	45%	74%	80%
D. Meanders	100%	95%	77%	77%	88%	83%
E. Bed General	100%	50%	100%	100%	98%	99%
G. Bank				89%	90%	94%
F. Vanes/J Hooks, etc.	100%	95%	79%	85%	90%	96%
H. Wads and Boulders	100%	95%	75%	75%	75%	75%

Exhibit Table VIII. Baseline Morphology and Hydraulic Summary - Ellerbe Creek Stream Restoration – Project #127 Reaches: Hillsborough, Hillandale, Albany																	
Parameters	**USGS Gage Data**			**Regional Curve Interval**			**Project Reference Stream**		**Pre-Existing Condition**			**Design**			**As-built**		
Dimension	Min	Max	Med	Min	Max	Med	**Min**	**Max**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Bankfull Width (ft)	NA	NA	NA	NA	NA	NA	10.1	14.3	19.9	20.7	NA	22	26	NA	16.3	24.8	NA
Floodprone Width (ft)	NA	NA	NA	NA	NA	NA	47	59	25	40	NA	48	57	NA	50	100	NA
BF Cross Sectional Area (sq ft)	NA	NA	NA	NA	NA	NA	7.2	21.4	37.9	48.3	NA	28.9	42.3	NA	25.8	82.4	NA
BF Mean Depth (ft)	NA	NA	NA	NA	NA	NA	0.7	1.5	1.5	2.4	NA	1.8	2.2	NA	1.3	3.3	NA
Maximum Depth (ft)	NA	NA	NA	NA	NA	NA	1.3	2.2	3.7	4.0	NA	2.7	3.2	NA	2.2	4.8	NA
Width/Depth Ratio	NA	NA	NA	NA	NA	NA	10	14	8	13	NA	NA	NA	NA	13	19	NA
Entrenchment Ratio	NA	NA	NA	NA	NA	NA	3.3	5.8	1.2	2.0	NA	2.2	2.2	NA	2.4	3.9	NA
Bank Height Ratio	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.02	1.31	1.07
Wetted Perimeter (ft)	NA	NA	NA	NA	NA	NA	11.6	17.3	28.3	24.8	NA	21.9	24.6	NA	19.9	38.4	NA
Hydraulic Radius (ft)	NA	NA	NA	NA	NA	NA	0.6	1.2	1.3	2.0	NA	1.3	1.7	NA	1.3	2.6	NA
Pattern																	
Channel Beltwidth (ft)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8	NA	5	NA	NA	4	NA
Radius of Curvature (ft)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	49	NA
Meander Wavelength	NA	NA	NA	NA	NA	NA	38	80	25	33	NA	90	105	NA	12	55	37
Meander Width ratio	NA	NA	NA	NA	NA	NA	38	160	NA	19	15	45	95	NA	35	114	67
Profile																	
Riffle length (ft)	NA	NA	NA	NA	NA	NA	32	105	NA	129	65	85	295	NA	103	304	185
Riffle slope (ft/ft)	NA	NA	NA	NA	NA	NA	3.7	7.9	1.3	1.6	NA	4.0	4.1	NA	0.5	2.4	1.5
Pool length (ft)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	103	NA	NA	NA	NA
Pool spacing (ft)	NA	NA	NA	NA	NA	NA	NA	NA	0.906	1.091	0.011	0.001	0.002	NA	NA	NA	NA
Substrate																	
d50 (mm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	27	NA	NA	NA	NA
d84 (mm)	NA	NA	NA	NA	NA	NA	5	49	19	29	24	24	160	NA	NA	NA	NA
Additional Reach Parameters																	
Valley Length (ft)	NA			NA			NA		5200			NA			NA		
Channel Length (ft)	NA			NA			NA		NA			NA			5576		
Sinuosity	NA			NA			1.2		1.0			1.1			1.1		
Water Surface Slope (ft/ft)	NA			NA			NA		0.994			NA			0.97		
BF slope (ft/ft)	NA			NA			NA		NA			NA			NA		
Rosgen Classification	NA			NA			C4b, C5		G4			C4			C4		
Habitat Index	NA			NA			NA		NA			NA			NA		
Macrobenthos	NA			NA			NA		NA			NA			NA		

Exhibit Table VIII. Baseline Morphology and Hydraulic Summary - Ellerbe Creek Stream Restoration – Project #127 - Reach: Croasdaile																	
Parameters	**USGS Gage Data**			**Regional Curve Interval**			**Project Reference Stream**		**Pre-Existing Condition**			**Design**			**As-built**		
Dimension	Min	Max	Med	Min	Max	Med	**Min**	**Max**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**	**Min**	**Max**	**Med**
Bankfull Width (ft)	NA	NA	NA	NA	NA	NA	10.1	14.3	19.9	20.7	NA	NA	NA	17.5	9.1	11.5	NA
Floodprone Width (ft)	NA	NA	NA	NA	NA	NA	47	59	25	40	NA	NA	NA	50	NA	NA	21
BF Cross Sectional Area (sq ft)	NA	NA	NA	NA	NA	NA	7.2	21.4	37.9	48.3	NA	NA	NA	16.9	14.5	19.7	NA
BF Mean Depth (ft)	NA	NA	NA	NA	NA	NA	0.7	1.5	1.5	2.4	NA	NA	NA	1.5	1.3	2.2	NA
Maximum Depth (ft)	NA	NA	NA	NA	NA	NA	1.3	2.2	3.7	4.0	NA	NA	NA	2.1	1.9	2.8	NA
Width/Depth Ratio	NA	NA	NA	NA	NA	NA	10	14	8	13	NA	NA	NA	12	NA	NA	9
Entrenchment Ratio	NA	NA	NA	NA	NA	NA	3.3	5.8	1.2	2.0	NA	NA	NA	2.9	NA	NA	1.9
Bank Height Ratio	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.34	2.75	NA
Wetted Perimeter (ft)	NA	NA	NA	NA	NA	NA	11.6	17.3	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hydraulic Radius (ft)	NA	NA	NA	NA	NA	NA	0.6	1.2	1.3	2.0	NA	NA	NA	1.0	1.1	1.6	NA
Pattern																	
Channel Beltwidth (ft)	NA	NA	NA	NA	NA	NA	38	80	25	33	NA	NA	NA	83	NA	NA	NA
Radius of Curvature (ft)	NA	NA	NA	NA	NA	NA	38	160	NA	19	15	36	44	NA	NA	NA	NA
Meander Wavelength	NA	NA	NA	NA	NA	NA	32	105	NA	129	65	156	233	NA	NA	NA	NA
Meander Width ratio	NA	NA	NA	NA	NA	NA	4	8	1	2	NA	NA	NA	5	NA	NA	NA
Profile																	
Riffle length (ft)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Riffle slope (ft/ft)	NA	NA	NA	NA	NA	NA	NA	NA	0.9	1.1	0.0	NA	NA	0.0	NA	NA	NA
Pool length (ft)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pool spacing (ft)	NA	NA	NA	NA	NA	NA	NA	NA	19	29	24	29	78	NA	NA	NA	NA
Substrate																	
d50 (mm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8	NA	NA	NA	NA	NA	NA
d84 (mm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Additional Reach Parameters																	
Valley Length (ft)	NA			NA			NA		NA			NA			687		
Channel Length (ft)	NA			NA			NA		NA			NA			703		
Sinuosity	NA			NA			1.20-1.23		1.03			1.05			1.02		
Water Surface Slope (ft/ft)	NA			NA			NA		0.994			NA			NA		
BF slope (ft/ft)	NA			NA			NA		NA			NA			NA		
Rosgen Classification	NA			NA			C4b, C5		G4			C4			B4		
Habitat Index	NA			NA			NA		NA			NA			NA		
Macrobenthos	NA			NA			NA		NA			NA			NA		

Exhibit Table IX. Morphology and Hydraulic Monitoring Summary - Ellerbe Creek Stream Restoration – Project #127 - Hillsborough Reach

	HB-XS1 (Riffle)						HB-XS2 (Pool)						HB-XS3 (Riffle)						HB-XS4 (Pool)					
Dimension	As-built	MY1	MY2	MY3	MY4	MY5	As-built	MY1	MY2	MY3	MY4	MY5	As-built	MY1	MY2	MY3	MY4	MY5	As-built	MY1	MY2	MY3	MY4	MY5
Bankfull Width (ft)	19.3	21.8	21.5	23.2	22.0	25.1	16.3	16.1	19.3	18.0	16.8	21.0	21.9	38.0	22.1	22.4	21.8	23.7	24.8	24.4	26.2	28.1	26.4	28.7
Floodprone Width (ft)	50	100	100	100	62	62.0	NA	100	100	100	100	100	85	100	100	100	85	85	NA	100	100	100	100	100
BF Cross Sectional Area (s	25.8	33.1	31.3	31.4	31.2	38.3	54.2	54.0	58.9	60.3	55.9	66.8	37.7	38.2	35.7	35.3	34.5	35.8	59.1	56.3	58.9	68.5	57.2	52.2
BF Mean Depth (ft)	1.3	1.5	1.5	1.4	1.4	1.5	3.3	3.4	3.1	3.4	3.3	3.2	1.7	1.0	1.6	1.6	1.6	1.5	2.4	2.3	2.2	2.4	2.2	1.8
BFMaximum Depth (ft)	2.2	2.6	2.6	2.7	2.9	3.4	4.5	4.6	5.0	5.0	4.8	5.3	3.1	2.8	3.1	3.2	3.1	3.5	4.5	4.4	4.3	4.4	3.9	3.9
Width/Depth Ratio	14.50	14.30	14.75	17.22	15.57	16.4	NA	4.80	6.32	5.38	5.06	6.60	12.70	37.70	13.69	14.19	13.76	15.74	NA	10.60	11.69	11.50	12.19	15.83
Entrenchment Ratio	2.60	4.60	4.66	4.30	2.80	2.5	NA	6.20	5.18	3.03	5.95	4.76	3.90	2.60	4.52	4.47	4.59	3.58	NA	4.10	3.81	2.48	3.79	3.48
Bank Height Ratio	1.16	NA	NA	1.01	1	1.0	1.07	NA	NA	1.04	1.05	1.06	1.08	NA	NA	1.08	1.09	1.05	1.03	NA	NA	1.05	1.03	1
Wetted Perimeter (ft)	19.9	22.8	22.5	24.3	23.1	26.4	21.1	21.5	24.6	23.6	21.6	26.4	23.2	38.7	23.3	23.7	23.2	25.4	28.0	27.3	29.2	31.5	29.5	32.1
Hydraulic Radius (ft)	1.30	1.50	1.39	1.29	1.35	1.5	2.60	2.50	2.40	2.56	2.59	2.53	1.60	1.00	1.53	1.49	1.49	1.41	2.10	2.10	2.01	2.18	1.94	1.63
Substrate																								
d50 (mm)	12	12	4	6	14	0.3	11	10	0	0	0	1	NA	0	0	7	0	0.05	4	1	2	1	1	0.53
d84 (mm)	49	30	40	19	37	20.4	23	41	16	4	2	2048	NA	1200	3	21	1	0.94	11	13	14	21	15	17.32

Entire Longitudinal Profile (all HB and part of HD)

	MY-1			MY-2			MY-3			MY-4			MY-5		
Pattern	min	max	average	min	max	average	min	max	average	min	max	med	min	max	med
Channel Beltwidth (ft)	NA	NA	NA	9.57	57.91	35.66	12.2	60.9	39.3	14	67.3	44.5	14.2	64.7	44.9
Radius of Curvature (ft)	NA	NA	NA	39.1	126.49	69.6	31	126.2	60.5	26.7	109.8	57.9	26	111.1	62.28
Meander Wavelength	NA	NA	NA	155.44	384.31	384.31	153.5	388.5	248.4	183.8	392.5	229.4	172.3	442.8	221.5
Meander Width ratio			NA			1.21			1.17			1.08			1.34
Profile	min	max	average	min	max	average	min	max	average	min	max	med	min	max	med
Riffle length (ft)	NA	NA	NA	3.54	70.53	22.91	19.1	158.5	56.6	10	123	40.5	13	153	43
Riffle slope (ft/ft)	NA	NA	NA	0.001	0.175	0.042	0	0.03	0.011	0	0.069	0.010	0	0.095	0.010
Pool length (ft)	NA	NA	NA	18.18	425.86	118.6	17.3	93.9	44.2	20	97	40.5	18	67	44.0
Pool spacing (ft)	NA	NA	NA	0.77	51.72	18.78	14.5	344	104.1	0	337	53	0	333	68

Additional Reach Parameters (Stations 1010-4420)

	MY1	MY2	MY3	MY4	MY5
Valley Length (ft)	1586	3,072	3,072	3,072	3,072
Channel Length (ft)	1663	3,398	3,389	3,373	3,365
Sinuosity	1.05	1.11	1.10	1.10	1.10
Water Surface Slope (ft/ft)	0.97	0.0035	0.0047	0.0032	0.0034
BF slope (ft/ft)	NA	0.0018	0.0035	0.0026	0.0024
Rosgen Classification	C4	C5	C5	C5	C5
Habitat Index	NA	NA	NA	NA	NA
Macrobenthos	NA	NA	NA	NA	NA

Exhibit Table IX. Morphology and Hydraulic Monitoring Summary - Ellerbe Creek Stream Restoration – Project #127 - Hillandale Reach

	HD-XS1 (Pool)						HD-XS2 (Riffle)						HD-XS3 (Pool)						HD-XS4 (Riffle)					
Dimension	As-built	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	As-built	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	As-built	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	As-built	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
Bankfull Width (ft)	37.1	30.0	31.1	37.5	45.0	51.7	23.9	21.4	20.6	20.2	19.4	24.4	40.4	45.2	45.1	45.3	45.5	49.1	34.7	35.6	33.8	34.8	35.7	36.10
Floodprone Width (ft)	NA	100	100	100	110	110	75	100	100	100	90	90	NA	100	100	102	102	102	100	105	105	105	105	105
BF Cross Sectional Area (sq f	49.1	37.3	36.5	45.0	52.8	58.2	33.2	36.2	32.0	29.4	33.0	41.7	89.1	101.2	100.5	98.8	96.5	103.7	62.7	69.2	64.1	64.3	62.1	64.7
BF Mean Depth (ft)	1.3	1.2	1.2	1.2	1.2	1.1	1.4	1.7	1.6	1.5	1.7	1.7	2.2	2.2	2.2	2.2	2.1	2.1	1.8	1.9	1.9	1.9	1.7	1.8
BF Maximum Depth (ft)	3.2	3.0	3.0	3.0	3.2	3.4	3.0	2.9	2.8	2.8	3.0	3.3	4.2	4.5	4.6	4.8	4.7	4.9	3.2	4.0	3.7	4.1	4.0	3.8
Width/Depth Ratio	NA	24.20	26.52	31.29	38.27	45.94	17.20	12.67	13.25	13.82	11.42	14.3	NA	20.10	20.22	20.74	21.47	23.24	19.20	18.33	17.88	18.88	20.51	20.09
Entrenchment Ratio	NA	3.30	3.22	2.22	2.45	2.13	3.10	3.14	4.85	3.28	4.64	3.69	NA	2.20	2.22	0.23	2.23	2.07	2.90	2.96	3.10	0.22	2.94	2.91
Bank Height Ratio	1.13	NA	NA	1.14	1.00	1.00	1.02	NA	NA	1.08	1.11	1.02	1.07	NA	NA	1.02	1.00	1.01	1.09	NA	NA	1.12	1.20	1.20
Wetted Perimeter (ft)	38.4	31.2	32.7	39.1	46.5	53.5	25.1	22.9	22.0	21.4	20.5	26.7	41.7	46.6	46.7	47.0	47.4	51.2	35.6	36.7	35.4	36.6	36.9	37.2
Hydraulic Radius (ft)	1.30	1.20	1.11	1.15	1.14	1.09	1.30	1.58	1.46	1.38	1.61	1.6	2.10	2.20	2.15	2.10	2.03	2.02	1.80	1.88	1.81	1.76	1.68	1.74
Substrate																								
d50 (mm)	0.4	0.6	0.1	3.0	5.7	0.9	NA	0.1	0.1	0.1	0.7	0.2	1.7	7.0	9.6	0.8	1.5	1.2	1.8	0.1	0.1	6.9	1.9	0.3
d84 (mm)	5.0	8.0	6.4	13.0	14.0	17.5	10.0	0.1	0.8	0.4	3.6	11.3	10.0	18.0	15.5	14.4	16.8	12.3	6.0	0.1	7.5	15.6	11.3	11.3

Additional Reach Parameters	**MY1**
Valley Length (ft)	1804
Channel Length (ft)	1939
Sinuosity	1.07
Water Surface Slope (ft/ft)	NA
BF slope (ft/ft)	NA
Rosgen Classification	C4
Habitat Index	NA
Macrobenthos	NA

Exhibit Table IX. Morphology and Hydraulic Monitoring Summary - Ellerbe Creek Stream Restoration – Project #127 - Albany Reach

	AL-XS1 (Riffle)						AL-XS2 (Pool)						AL-XS3 (Riffle)						AL-XS4 (Pool)					
Dimension	As-built	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	As-built	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	As-built	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	As-built	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
Bankfull Width (ft)	29.0	31.7	31.9	28.8	34.2	30.9	27.0	28.0	31.9	34.8	27.8	31.0	27.4	21.3	24.0	21.4	21.7	22.0	28.6	28.9	35.9	26.3	26.2	28.30
Floodprone Width (ft)	NA	100	100	100	98	98	100	100	100	100	100	100	NA	100	100	100	87	87	70	72	100	100	71	71.00
BF Cross Sectional Area (sq ft)	60.5	69.1	65.8	63.6	69.0	67.7	68.4	70.1	68.3	72.8	70.5	76.2	82.4	71.4	65.9	61.5	61.9	68.5	55.4	55.7	48.2	45.3	40.2	49.2
BF Mean Depth (ft)	2.1	2.2	2.1	2.2	2.0	2.2	2.5	2.5	2.1	2.1	2.5	2.5	3.0	3.3	2.8	2.9	2.9	3.1	1.9	1.9	1.3	1.7	1.5	1.7
BF Maximum Depth (ft)	3.5	3.9	4.1	4.3	4.4	4.4	4.8	4.6	4.7	4.7	4.7	4.8	5.1	4.4	4.4	4.3	4.3	4.4	3.2	3.3	3.3	3.1	3.3	3.5
Width/Depth Ratio	NA	14.50	15.40	13.08	16.96	14.12	10.70	11.20	14.90	16.66	10.93	12.57	NA	6.40	8.73	7.45	7.59	7.04	14.80	15.00	26.70	15.23	17.12	16.32
Entrenchment Ratio	NA	3.20	3.14	2.79	2.87	3.17	3.70	3.60	3.13	2.41	3.60	3.23	NA	4.70	4.17	0.58	4.01	3.96	2.40	2.50	2.79	0.21	2.69	2.49
Bank Height Ratio	1.07	NA	NA	1.03	1.02	1.05	1.08	NA	NA	1.06	1.07	1.07	1.14	NA	NA	1.14	1.15	1.23	1.31	NA	NA	1.23	1.28	1.20
Wetted Perimeter (ft)	30.2	33.5	33.6	30.8	36.7	33.1	30.7	30.7	35.9	38.4	31.8	34.2	32.3	25.3	28.2	24.9	24.8	26.1	29.6	30.0	37.4	27.4	27.6	30.2
Hydraulic Radius (ft)	2.00	2.10	1.96	2.06	1.88	2.04	2.20	2.30	1.90	1.89	2.22	2.23	2.50	2.80	2.34	2.47	2.50	2.62	1.90	1.90	1.29	1.65	1.45	1.63
Substrate																								
d50 (mm)	0.1	0.1	2.3	0.2	0.6	1.4	0.2	0.9	0.3	0.2	0.3	1.0	0.4	9.2	7.0	0.6	0.2	0.7	0.2	3.5	0.8	2.8	0.1	0.2
d84 (mm)	6.0	3.8	12.2	5.7	11.3	6.3	9.0	10.0	9.1	1.0	18.5	7.5	22.0	22.0	16.8	9.7	13.0	7.1	5.0	12.0	6.5	8.8	3.0	0.5

Additional Reach Parameters	**MY1**
Valley Length (ft)	1888
Channel Length (ft)	1974
Sinuosity	1.04
Water Surface Slope (ft/ft)	NA
BF slope (ft/ft)	NA
Rosgen Classification	C4
Habitat Index	NA
Macrobenthos	NA

Exhibit Table IX. Morphology and Hydraulic Monitoring Summary - Ellerbe Creek Stream Restoration – Project #127 - Croasdaile Reach

	CR-XS1 (Pool)						CR-XS2 (Riffle)					
Dimension	As-built	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	As-built	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**
Bankfull Width (ft)	9.1	9.4	8.6	9.1	8.7	8.59	11.5	13.4	10.3	11.4	10.3	10.9
Floodprone Width (ft)	NA	9.8	9.8	21.9	21.4	21.4	21.2	23.3	23.3	21.8	20.7	20.7
BF Cross Sectional Area (sq ft)	19.7	20.4	18.4	20.5	19.6	19.32	14.5	17.9	11.7	14.0	12.4	14.3
BF Mean Depth (ft)	2.2	2.2	2.1	2.3	2.3	2.25	1.3	1.3	1.1	1.2	1.2	1.3
BF Maximum Depth (ft)	2.8	2.5	2.6	2.8	2.8	2.86	1.9	2.1	1.7	2.0	1.9	2.2
Width/Depth Ratio	NA	4.40	4.02	4.00	3.84	3.82	9.00	10.00	9.06	9.30	8.62	8.31
Entrenchment Ratio	NA	1.00	1.14	2.42	2.47	2.49	1.90	1.70	2.27	1.91	2.00	1.90
Bank Height Ratio	2.34	NA	NA	2.35	2.41	2.37	2.75	NA	NA	2.78	2.94	2.65
Wetted Perimeter (ft)	12.7	11.1	12.1	12.6	12.1	11.95	12.8	14.8	11.4	12.5	11.2	11.9
Hydraulic Radius (ft)	1.60	1.80	1.52	1.62	1.62	1.62	1.10	1.20	1.03	1.12	1.11	1.20
Substrate												
d50 (mm)	9.9	12.0	13.9	5.7	4.7	2.84	14.0	12.0	9.5	8.3	6.7	0.06
d84 (mm)	19.0	24.0	23.9	30.9	27.7	32	27.0	20.0	27.3	20.2	20.7	27.82

Additional Reach Parameters	**MY1**
Valley Length (ft)	687
Channel Length (ft)	703
Sinuosity	1.02
Water Surface Slope (ft/ft)	NA
BF slope (ft/ft)	NA
Rosgen Classification	B4
Habitat Index	NA
Macrobenthos	NA

C. Wetland Assessment

As part of the project design, a stormwater wetland and 11 pocket wetlands were created throughout the Ellerbe Creek floodplain. No monitoring wells were established in relation to any of these wetlands and EEP did not claim any mitigation credit for them. By all appearances, all of the wetlands appear to be functioning as designed. The NCDOT rip-rap stormwater spillway could negatively impact hydrology in the Croasdaile Reach's constructed wetland.

IV. Methodology

Methods employed were a combination those specified in the Mitigation Plan, the First Annual Monitoring Report, and standard regulatory guidance and procedures documents. Photographs were taken digitally. A Trimble Geo XT handheld sub-meter GPS unit was used to collect cross section, vegetation corner, photopoint, and problem area locations. The CVS-EEP Protocol for Recording Vegetation is not used at this site.

A. Stream Methodology

Standard fluvial geomorphic techniques are employed to collect geomorphic data (Rosgen 1997; USACOE 2003). A South Total Station and Nikon automatic level are used for collecting all geomorphic data. RIVERMorph 3.1 is used to analyze data. A *wetted perimeter* bed material analysis is performed at each cross section. Photographs facing downstream are taken at each cross section.

B. Vegetation Methodology

Eleven vegetation survey plots were established during the first year of monitoring. Within each plot, the height and live stem diameter were recorded for each stem location. All planted stems were flagged with survey tape. Volunteer woody vegetation was also identified and categorized by height or diameter class. All vegetation was identified using Radford and Weakley (Radford 1968; Weakley 2007). Photos were taken of each vegetation plot from the 0,0 corner.

Tables 5 and 6 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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Appendix A. Vegetation Data
Ellerbe Creek Stream Restoration – Project #127

1. Vegetation Data Tables
   - Table 5. Stem Count by Plot and Species
   - Table 6. Vegetation Problem Areas

2. Vegetation Problem Area Photos

3. Vegetation Monitoring Plot Photos

Table 5. Stem Counts and Summary Data by Species and Plot - Ellerbe Creek Stream Restoration - Durham County, N.C.

					Hillsborough Reach			Croasdaile Reach		Hillandale Reach			Albany Reach		
Species	**Total Planted**	**Year 5 Total Live (2009)**	**Total Dead**	**% Survival**	**Plot HB - 1**	**Plot HB - 2**	**Plot HB - 3**	**Plot CR - 1**	**Plot CR - 2**	**Plot HD - 1**	**Plot HD - 2**	**Plot HD - 3**	**Plot AL - 1**	**Plot AL - 2**	**Plot AL - 3**
Alnus serrulata	1	1	0	100	0	0	0	1	0	0	0	0	0	0	0
Aronia arbutifolia	33	15	0	45	0	0	1	0	0	0	9	3	0	2	0
Betula nigra	42	22	0	52	3	0	4	0	0	0	3	0	0	1	11
*Cephalanthus occidentalis**	NA	14	0	NA	0	0	0	4	0	6	0	0	3	1	0
Clethra alnifolia	8	23	0	288	0	2	10	1	9	0	1	0	0	0	0
Cornus amomum	93	50	0	54	5	7	10	10	2	1	0	3	2	8	2
Cornus florida	1	4	0	400	0	0	1	0	3	0	0	0	0	0	0
Fraxinus pennsylvanica	35	11	0	31	7	0	0	0	0	0	0	4	0	0	0
Ilex verticillata	3	1	0	33	1	0	0	0	0	0	0	0	0	0	0
Juniperus virginiana	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Morella cerifera	2	1	0	50	0	0	0	1	0	0	0	0	0	0	0
Quercus coccinea	7	5	0	71	1	0	0	1	1	0	0	0	0	0	2
Quercus phellos	24	12	0	50	2	0	1	0	0	0	3	2	0	0	4
Salix sericea	23	12	0	52	0	6	0	0	0	0	0	1	0	5	0
Sambucus canadensis	51	15	0	29	0	2	0	0	3	0	1	0	8	0	1
*Spirea tomentosa***	NA	5	0	NA	0	0	0	0	5	0	0	0	0	0	0
Symphoricarpos orbiculatus	4	7	0	175	0	0	0	0	6	1	0	0	0	0	0
Vaccinium corymbosum	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viburnum nudum	7	1	0	14	0	0	0	0	0	0	0	0	1	0	0
Unknown spp	NA	0	0	NA	0	0	0	0	0	0	0	0	0	0	0
Total per plot					**19**	**17**	**27**	**18**	**29**	**8**	**17**	**13**	**14**	**17**	**20**
Total Planted Stems	**365**	**199**		**54.5**											
Average planted stems per acre	**1,343**	**732**			**Total Volunteer stems**			154		**Average Stems per acre (planted + volunteer)**					**1,299**

* *Cephalanthus occidentalis* may have been identified as *Viburnum nudum* in Monitoring Year-1, due to the opposite leaves, so there is no record of the plant in the total planted vegetation data.

** *Spirea tomentosa* may have been identified as *Clethra alnifolia* in Monitoring Year-1, due to the terminal raceme, so there is no record of the plant in the total planted vegetation data.

Table 6. Vegetation Problem Areas – Ellerbe Creek Stream Restoration – Project #127			
Feature/Issue	**Station/Range**	**Probable Cause**	**Photo #**
Bare soil/eroded slopes	1890-1975	Compacted soil/high runoff from golf course	VP1

Appendix A2. Vegetation Problem Area Photographs - 2009 - Ellerbe Creek Stream Restoration - Project #127

VP1. Bare soil/eroded slopes (7/16/09)

Appendix A3. Vegetation Monitoring Plot Photographs - 2009 - Ellerbe Creek Stream Restoration

HB-V1 (September 29, 2006)

HB-V1 (June 11, 2009)

HB-V2 (September 29, 2006)

HB-V2 (June 11, 2009)

Appendix A3. Vegetation Monitoring Plot Photographs - 2009 - Ellerbe Creek Stream Restoration

HB-V3 (June 26, 2007)

HB-V3 (June 11, 2009)

CR-V1 (June 26, 2007)

CR-V1 (June 10, 2009)

Appendix A3. Vegetation Monitoring Plot Photographs - 2009 - Ellerbe Creek Stream Restoration

CR-V2 (September 29, 2006)

CR-V2 (June 10, 2009)

HD-V1 (June 26, 2007)

HD-V1 (June 11, 2009)

Appendix A3. Vegetation Monitoring Plot Photographs - 2009 - Ellerbe Creek Stream Restoration

HD-V2 (September 29, 2006)

HD-V2 (June 11, 2009)

HD-V3 (September 29, 2006)

HD-V3 (June 11, 2009)

Appendix A3. Vegetation Monitoring Plot Photographs - 2009 - Ellerbe Creek Stream Restoration

AL-V1 (September 29, 2006)

AL-V1 (June 11, 2009)

AL-V2 (September 29, 2006)

AL-V2 (June 11, 2009)

Appendix A3. Vegetation Monitoring Plot Photographs - 2009 - Ellerbe Creek Stream Restoration

AL-V3 (September 29, 2006)

AL-V3 (June 11, 2009)

Appendix B. Stream Data
Ellerbe Creek Stream Restoration – Project #127

1. Figure B1. Stream Current Condition Plan View
2. Table B1. Stream Problem Areas
3. Stream Problem Area Photos
4. Stream Photostation Photos
5. Qualtitative Visual Stability Assessment
6. Cross section Plots
7. Longitudinal Plots
8. Pebble Count Frequency Distribution Plot

Figure B.1.1 - Current Conditions Plan View - 2009 - Monitoring Year 5
Ellerbe Creek Stream Restoration - Durham, NC - NCEEP Project #127

Vegetation Plot Coordinates: Hillsborough Reach			
Plot Side	HB-V1	HB-V2	HB-V3
Pin Coordinate	E 20115741.5610 N 827358.3480	E 20116120.1110 N 827428.6750	E 2016551.0870 N 827505.1970
A	19.5'	31.1'	31.9'
B	52.1'	35.4'	32.6'
C	23.2'	33.1'	31.3'
D	53'	36.2'	39.4'

Vegetation Plot Coordinates: Croasdaile Reach		
Plot Side	CR-V1	CR-V2
Pin Coordinate	E 2016811.8250 N 827741.1850	E 2016933.510 N 827520.8490
A	32.4'	18.3'
B	33.2'	65.5'
C	29.9'	21.7'
D	31.9'	64.1'

	Easting	Northing
Cross-sections		
HB1L	2015742.0022	827332.7693
HB1R	2015772.552	827290.9634
HB2L	2015799.2852	827350.0513
HB2R	2015803.356	827295.5714
HB3L	2016595.6390	827499.8180
HB3R	2016610.0550	827433.3600
HB4L	2015654.5640	827499.8920
HB4R	20116634.3500	827432.4490
CR1L	2016939.2680	827570.7490
CR1R	2016915.6680	827552.4340
CR2L	2016957.7640	827541.2870
CR2R	2016933.5100	827520.8490
Photopoints		
HB-P1	2015577.0052	827347.3258
HB-P2	2015623.7143	827314.4264
HB-P3	2015802.5285	827349.0571
HB-P4	2015961.3634	827401.3361
HB-P5	2016127.5574	827481.3197
HB-P6&P7	2016301.8430	827496.7037
HB-P8	2016523.1130	827464.0709
HB-P9	2016749.2114	827430.4392
HB-P10	2016966.4524	827439.7628
CR-P1	2016781.3114	828053.9579
CR-P2	2016818.9390	827855.0313
CR-P3	2016919.4678	827582.3480

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Feet
0 150

Stream Problem Areas
- Bank undercut/scour
- Aggradation (bar)
- Rill and gully

Vegetation Problem Areas
- Bare Soil
- Thalweg 6/30/09-7/2/09
- NCDOT Stormwater Structures

As-built Drawings
(Supplied by Stantec)
- Ellerbe Easement Boundary
- Thalweg - As-built
- Top of Bank
- Vegetation Monitoring Plots
- Monitoring Cross Sections
- Photo Points
- As-built Features
- Pre-existing Features

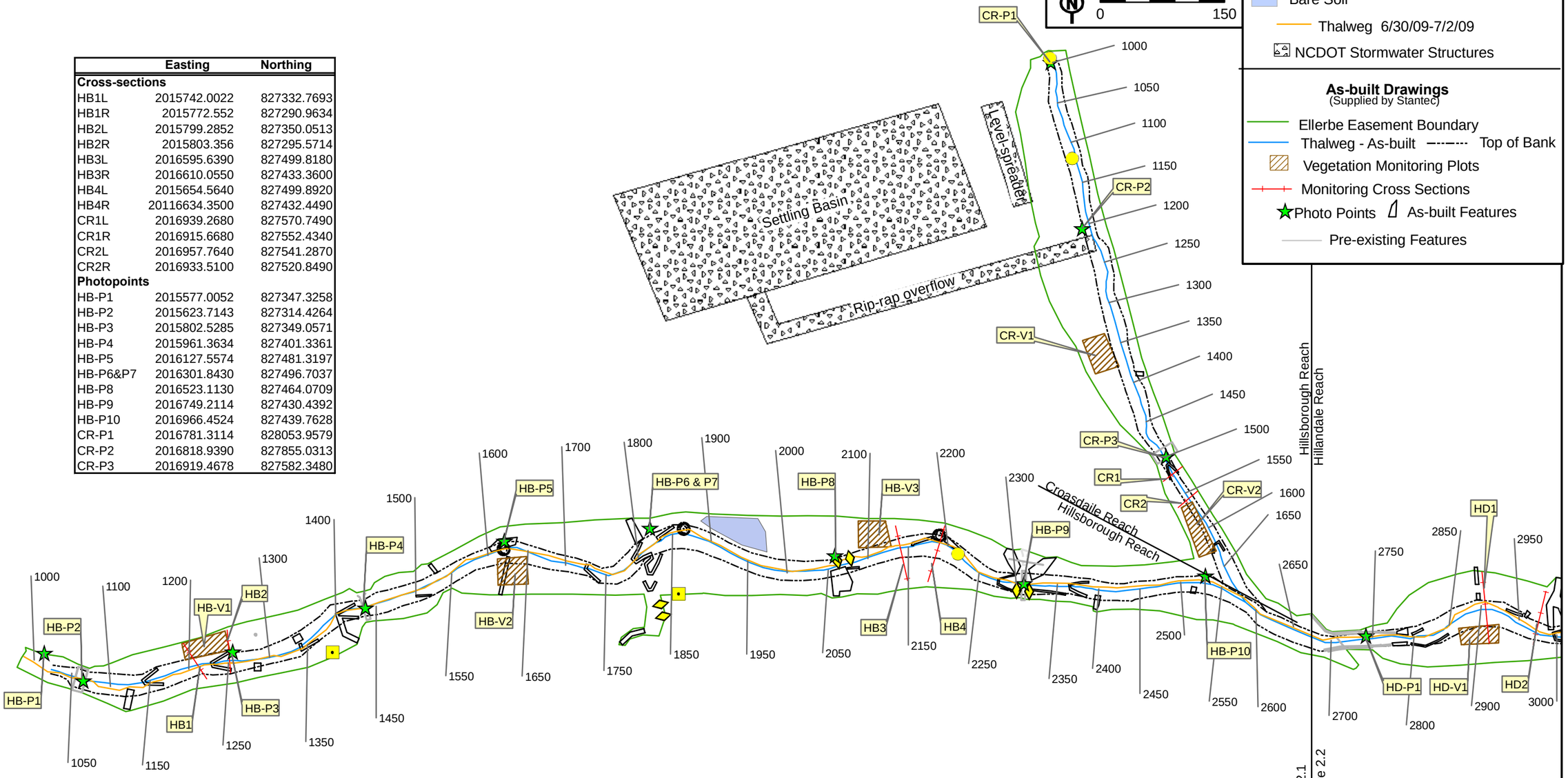

Figure B.1.2 - Current Conditions Plan View - 2009 - Monitoring Year 5
Ellerbe Creek Stream Restoration - Durham, NC - NCEEP Project #127

Ecosystem Enhancement Program

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N

Feet 0 150

Stream Problem Areas

Bank undercut/scour
Aggradation (bar)
Rill and gully

Vegetation Problem Areas

Bare Soil
Thalweg 6/30/09-7/2/09
NCDOT Stormwater Structures

As-built Drawings
(Supplied by Stantec)

Ellerbe Easement Boundary
Thalweg - As-built
Top of Bank
Vegetation Monitoring Plots
Monitoring Cross Sections
Photo Points
As-built Features
Pre-existing Features

Hillsborough Reach
Hillandale Reach
Figure 2.1
Figure 2.2
Figure 2.2
Figure 2.3
Hillandale Reach
Albany Reach
Hillandale Road

HD1 HD2 HD3 HD4
HD-P1 HD-P2 HD-P3 HD-P4 HD-P5 HD-P6 HD-P7
HD-V1 HD-V2 HD-V3

2600 2650 2700 2750 2800 2850 2900 2950 3000 3050 3100 3150 3200 3250 3300 3350 3400 3450 3500 3550 3600 3650 3700 3750 3800 3850 3900 3950 4000 4050 4100 4150 4200 4250 4300 4350 4400 4450 4500 4550 4600 4650

	Easting	Northing
Cross-sections		
HD1L	2017297.3510	827444.6380
HD1R	2017305.8250	827358.5730
HD2L	2017374.0400	827421.2960
HD2R	2017358.2570	827357.0970
HD3L	2017882.0380	827326.3380
HD3R	2017835.7280	827218.0475
HD4L	2017870.4020	827311.3050
HD4R	2017919.3160	827220.8030
Photopoints		
HD-P1	2017158.5527	827368.2372
HD-P2	2017423.2777	827370.9011
HD-P3	2017633.3927	827372.5660
HD-P4	2017780.9060	827327.6127
HD-P5	2018032.6444	827207.0713
HD-P6	2018319.0135	827067.8826
HD-P7	2018632.0216	826962.3256

Vegetation Plot Coordinates: Hillandale Reach

Plot Side	HD-V1	HD-V2	HD-V3
Pin Coordinate	E 20117272.5870 N 827357.3090	E 2017822.8120 N 827293.6640	E 2018339.7600 N 827077.4290
A	19.9’	30.8’	20’
B	48.4’	31.1’	44.6’
C	22.2’	34.2’	14.2’
D	44.7’	32’	46.1’

Figure B.1.3 - Current Conditions Plan View - 2009 - Monitoring Year 5
Ellerbe Creek Stream Restoration - Durham, NC - NCEEP Project #127

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Feet 0 150

Stream Problem Areas

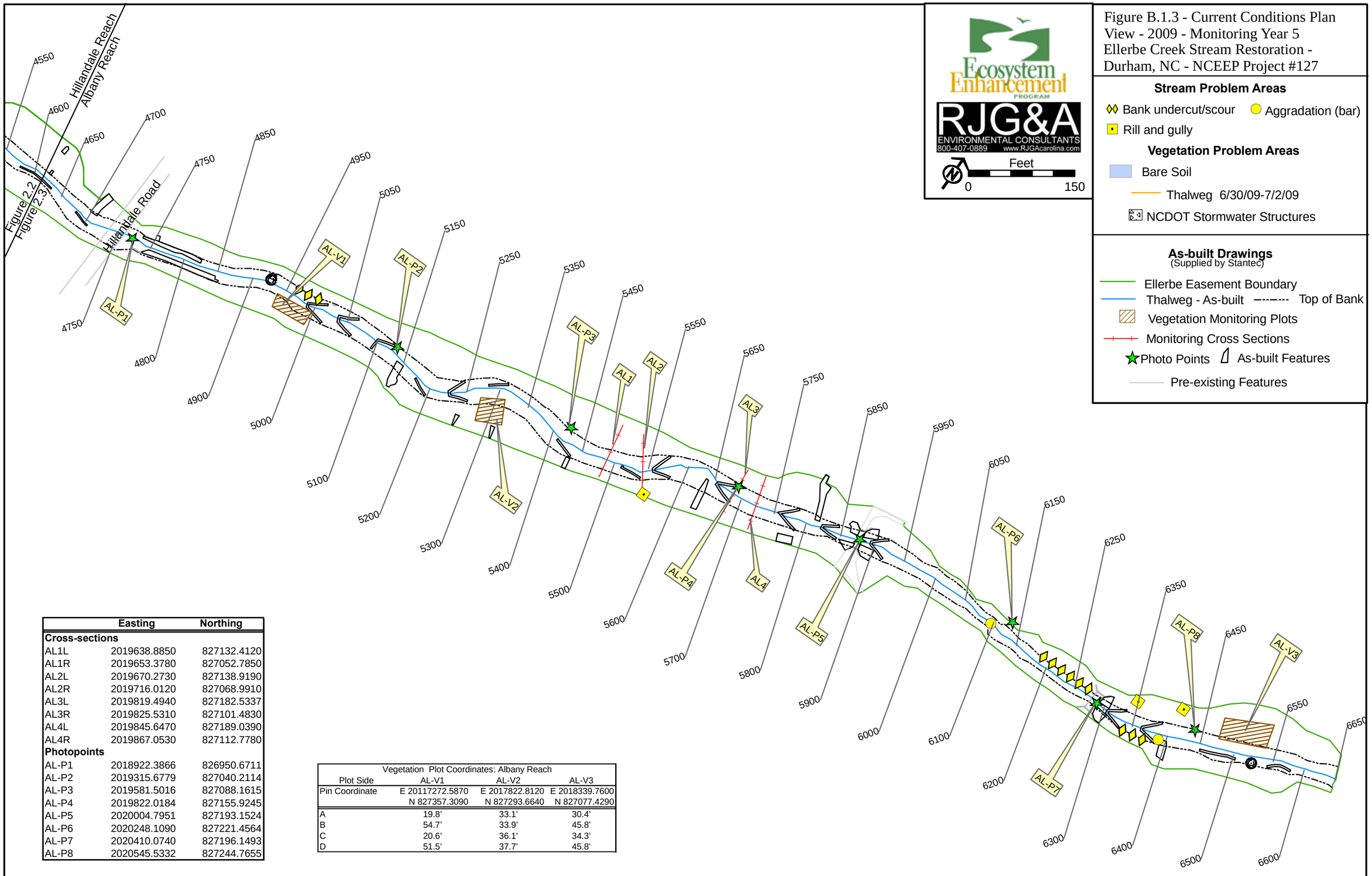
- Bank undercut/scour
- Aggradation (bar)
- Rill and gully

Vegetation Problem Areas

- Bare Soil
- Thalweg 6/30/09-7/2/09
- NCDOT Stormwater Structures

As-built Drawings
(Supplied by Stantec)

- Ellerbe Easement Boundary
- Thalweg - As-built
- Top of Bank
- Vegetation Monitoring Plots
- Monitoring Cross Sections
- Photo Points
- As-built Features
- Pre-existing Features



	Easting	Northing
Cross-sections		
AL1L	2019638.8850	827132.4120
AL1R	2019653.3780	827052.7850
AL2L	2019670.2730	827138.9190
AL2R	2019716.0120	827068.9910
AL3L	2019819.4940	827182.5337
AL3R	2019825.5310	827101.4830
AL4L	2019845.6470	827189.0390
AL4R	2019867.0530	827112.7780
Photopoints		
AL-P1	2018922.3866	826950.6711
AL-P2	2019315.6779	827040.2114
AL-P3	2019581.5016	827088.1615
AL-P4	2019822.0184	827155.9245
AL-P5	2020004.7951	827193.1524
AL-P6	2020248.1090	827221.4564
AL-P7	2020410.0740	827196.1493
AL-P8	2020545.5332	827244.7655

Vegetation Plot Coordinates: Albany Reach

Plot Side	AL-V1	AL-V2	AL-V3
Pin Coordinate	E 20117272.5870 N 827357.3090	E 2017822.8120 N 827293.6640	E 2018339.7600 N 827077.4290
A	19.8'	33.1'	30.4'
B	54.7'	33.9'	45.8'
C	20.6'	36.1'	34.3'
D	51.5'	37.7'	45.8'

B2. Table B1. Stream Problem Areas – 2009 – Ellerbe Creek Stream Restoration

Feature/Issue	Station	Suspected Cause	Photo #
Rill and gully	1370	Insufficient growth medium	SP1
Beaverdam	1719	Beaver activity	SP8
Bank scour	1790	Scour in stormwater drainageway	SP2
Rill and gully	1860	Insufficient growth medium	SP1
Beaverdam	2060	Beaver activity	
Bank slump/scour	2060-2080	Insufficient rootwad/armoring	SP3
Beaverdam	2130	Beaver activity	SP8
Beaverdam	2219	Beaver activity	SP8
Aggradation (bar)	2220	Sedimentation due to downstream beaver dam	SP7
Bank erosion/scour	2300-2320	Under bridge, poor armoring of constricted flow passage	SP4
Aggradation (bar)	1000*	Sedimentation at culvert from upstream sources	SP7
Aggradation (bar)	1125*	Sedimentation from level spreader	SP7
Beaverdam	2415	Beaver activity	SP8
Beaverdam	2599	Beaver activity	SP8
Beaverdam	2975	Beaver activity	SP8
Beaverdam	3452	Beaver activity	SP8
Beaverdam	3992	Beaver activity	SP8
Beaverdam	4770	Beaver activity	SP8
Bank slump/scour	4955-5005	Insufficient rootwad/armoring	SP6
Rill and gully	5550	Insufficient growth medium	SP1
Mid-channel bar	6110	Sediment from stormwater/scour areas	SP7
Bank slump/scour	6220-6270	Insufficient rootwad/armoring	SP6
Rill and gully	6350	Insufficient growth medium	SP1
Bank undercut/scour	6340-6360	Insufficient rootwad/armoring	SP6
Aggradation (bar)	6390	Sediment from stormwater/scour areas	SP7
Rill and gully	6340	Insufficient growth medium	SP1
Rill and gully	6425	Insufficient growth medium	SP1

B3. Stream Problem Area Photographs - 2009 - Ellerbe Creek Stream Restoration

SP1. Rill and gully (7/16/09)

SP2. Scour in stormwater drainage (7/16/09)

SP3. Bank scour (7/01/09)

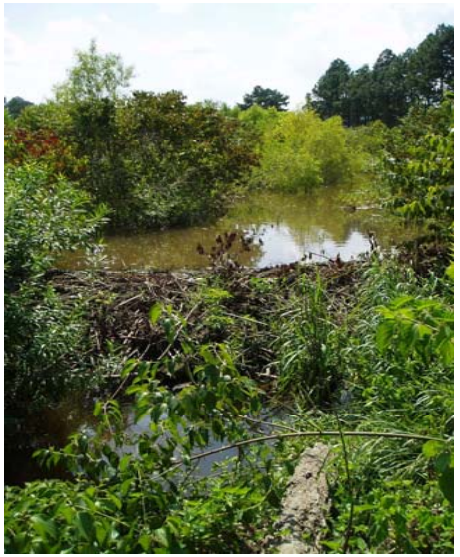
SP4. Scour under bridge footer (7/16/09)

B3. Stream Problem Area Photographs - 2009 - Ellerbe Creek Stream Restoration

SP5. Scour at cross vane arm (7/16/09)

SP6. Bank slump/scour (7/16/09)

SP7. Aggradation (bar) (7/16/09)



SP8. Beaverdams (7/1/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

HB-P01(12/05/06)

HB-P01 facing downstream (03/06/09)

HB-P02 (12/05/06)

HB-P02 facing downstream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

HB-P03 (12/04/06)

HB-P03 facing downstream (03/06/09)

HB-P04 (12/04/06)

HB-P04 facing downstream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

HB-P05 (12/04/06)

HB-P05 facing downstream (03/06/09)

HB-P06 (12/04/06)

HB-P06 looking south across stream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

HB-P07 (12/04/06)

HB-P07 facing downstream (03/06/09)

HB-P08 (12/04/06)

HB-P08 facing downstream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

HB-P09 (12/04/06)

HB-P09 facing downstream (03/06/09)

HB-P10 (12/04/06)

HB-P10 facing downstream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

CR-P01 (12/04/06)

CR-P01 facing downstream (07/25/08)

CR-P02 (12/04/06)

CR-P02 facing downstream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

CR-P03 (12/04/06)

CR-P03 facing downstream (03/06/09)

HD-P01 (12/04/06)

HD-P01 facing downstream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

HD-P02 (12/04/06)

HD-P02 facing downstream (03/06/09)

HD-P03 (12/04/06)

HD-P03 facing downstream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

HD-P04 (12/04/06)

HD-P04 facing downstream (03/06/09)

HD-P05 (12/04/06)

HD-P05 facing downstream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

HD-P06 (12/04/06)

HD-P06 facing downstream (03/06/09)

HD-P07 (12/04/06)

HD-P07 facing downstream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

AL-P01 (12/05/06)

AL-P01 facing downstream (07/02/2009)

AL-P02 (12/05/06)

AL-P02 facing downstream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

AL-P03 (12/05/06)

AL-P03 facing downstream (03/06/09)

AL-P04 (12/05/06)

AL-P04 facing downstream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

AL-P05 (12/05/06)

AL-P05 facing downstream (03/06/09)

AL-P06 (12/05/06)

AL-P06 facing downstream (03/06/09)

Appendix B4. 2009 Permanent Photopoint Photographs - Ellerbe Creek Stream Restoration

AL-P07 (12/05/06)

AL-P07 facing downstream (03/06/09)

AL-P08 (12/05/06)

AL-P08 facing downstream (03/06/09)

B5. Qualitative Visual Stability Assessment - 2009 - Ellerbe Stream Restoration Project - Hillsborough Reach

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	10	14	NA	71	
	2. Armor stable	14	14	NA	100	
	3. Facet grade appears stable	13	14	NA	93	
	4. Minimal evidence of embedding/fining	10	14	NA	71	
	5. Length appropriate	13	14	NA	93	**86**
B. Pools	1. Present	14	16	NA	88	
	2. Sufficiently deep	14	16	NA	88	
	3. Length appropriate	14	16	NA	88	**88**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	10	11	NA	91	
	2. Downstream of meander (glide/inflection) centering	12	12	NA	100	**95**
D. Meanders	1. Outer bend in state of limited/controlled erosion	12	12	NA	100	
	2. Of those eroding, # w/concomitant point bar formation			NA	NA	
	3. Apparent Rc within spec	12	12	NA	100	
	4. Sufficient floodplain access and relief	12	12	NA	100	**100**
E. Bed (General)	1. General channel bed aggradation areas (bar formation)	NA	NA	1/8	100	
	2. Channel bed degradation – areas of increasing downcutting or head cutting	NA	NA	0	100	**100**
F. Bank	1. Actively eroding, wasting or slumping bank	NA	NA	2/28	98	**98**
G. Vanes	1. Free of back or arm scour	7	7	NA	100	
	2. Height appropriate	7	7	NA	100	
	3. Angle and geometry appear appropriate	7	7	NA	100	
	4. Free of piping or other structural failures	7	7	NA	100	**100**
H. Wads/Bould	1. Free of scour	3	3	NA	100	
	2. Footing stable	3	3	NA	100	**100**

B5. Qualitative Visual Stability Assessment - 2009 - Ellerbe Stream Restoration Project - Croasdaile Reach

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	4	4	NA	100	
	2. Armor stable	4	4	NA	100	
	3. Facet grade appears stable	4	4	NA	100	
	4. Minimal evidence of embedding/fining	3	4	NA	75	
	5. Length appropriate	4	4	NA	100	**95**
B. Pools	1. Present	5	5	NA	100	
	2. Sufficiently deep	4	5	NA	80	
	3. Length appropriate	5	5	NA	100	**93**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	4	4	NA	100	
	2. Downstream of meander (glide/inflection) centering	4	4	NA	100	**100**
D. Meanders	1. Outer bend in state of limited/controlled erosion	4	4	NA	100	
	2. Of those eroding, # w/concomitant point bar formation			NA	NA	
	3. Apparent Rc within spec	4	4	NA	100	
	4. Sufficient floodplain access and relief	4	4	NA	100	**100**
E. Bed (General)	1. General channel bed aggradation areas (bar formation)	NA	NA	2/47	93	
	2. Channel bed degradation – areas of increasing downcutting or head cutting	0		0/0	100	**97**
F. Bank	1. Actively eroding, wasting or slumping bank	NA	NA	0/0	100	**100**
G. Vanes	1. Free of back or arm scour	2	2	NA	100	
	2. Height appropriate	2	2	NA	100	
	3. Angle and geometry appear appropriate	2	2	NA	100	
	4. Free of piping or other structural failures	2	2	NA	100	**100**
H. Wads/Bould	1. Free of scour	0	0	NA	100	
	2. Footing stable	0	0	NA	100	**100**

B5. Qualitative Visual Stability Assessment - 2009 - Ellerbe Stream Restoration Project - Hillandale Reach

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	14	NA	86	
	2. Armor stable	12	14	NA	86	
	3. Facet grade appears stable	12	14	NA	86	
	4. Minimal evidence of embedding/fining	10	14	NA	71	
	5. Length appropriate	11	14	NA	79	**81**
B. Pools	1. Present	14	14	NA	100	
	2. Sufficiently deep	13	14	NA	93	
	3. Length appropriate	14	14	NA	100	**98**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	11	12	NA	92	
	2. Downstream of meander (glide/inflection) centering	11	11	NA	100	**96**
D. Meanders	1. Outer bend in state of limited/controlled erosion	11	12	NA	92	
	2. Of those eroding, # w/concomitant point bar formation	0	1	NA		
	3. Apparent Rc within spec	12	12	NA	100	
	4. Sufficient floodplain access and relief	12	12	NA	100	**97**
E. Bed (General)	1. General channel bed aggradation areas (bar formation)	NA	NA	4/50	97	
	2. Channel bed degradation – areas of increasing downcutting or head cutting	NA	NA	0	100	**99**
F. Bank	1. Actively eroding, wasting or slumping bank	NA	NA	0	100	**100**
G. Vanes	1. Free of back or arm scour	7	9	NA	78	
	2. Height appropriate	7	9	NA	78	
	3. Angle and geometry appear appropriate	8	9	NA	89	
	4. Free of piping or other structural failures	9	9	NA	100	**86**
H. Wads/Bould	1. Free of scour	1	1	NA	100	
	2. Footing stable	1	1	NA	100	**100**

B5. Qualitative Visual Stability Assessment - 2009 - Ellerbe Stream Restoration Project - Albany Reach

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	4	4	NA	100	
	2. Armor stable	4	4	NA	100	
	3. Facet grade appears stable	4	4	NA	100	
	4. Minimal evidence of embedding/fining	4	4	NA	100	
	5. Length appropriate	3	4	NA	75	**95**
B. Pools	1. Present	13	13	NA	100	
	2. Sufficiently deep	9	13	NA	69	
	3. Length appropriate	12	13	NA	92	**87**
C. Thalweg	1. Upstream of meander bend (run/inflection) centering	6	8	NA	75	
	2. Downstream of meander (glide/inflection) centering	6	7	NA	86	**80**
D. Meanders	1. Outer bend in state of limited/controlled erosion	5	8	NA	63	
	2. Of those eroding, # w/concomitant point bar formation	1		NA	NA	
	3. Apparent Rc within spec	8	8	NA	100	
	4. Sufficient floodplain access and relief	7	8	NA	88	**83**
E. Bed (General)	1. General channel bed aggradation areas (bar formation)	NA	NA	2/20	99	
	2. Channel bed degradation – areas of increasing downcutting or head cutting	NA	NA	0	100	**99**
F. Bank	1. Actively eroding, wasting or slumping bank	NA	NA	3/120	94	**94**
G. Vanes	1. Free of back or arm scour	11	12	NA	92	
	2. Height appropriate	12	12	NA	100	
	3. Angle and geometry appear appropriate	12	12	NA	100	
	4. Free of piping or other structural failures	11	12	NA	92	**96**
H. Wads/Bould	1. Free of scour	1	2	NA	50	
	2. Footing stable	2	2	NA	100	**75**

River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	HB-1 (riffle)
Reach:	Hillsborough
Date:	6/11/2009
Field Crew:	J.O. and S.D.

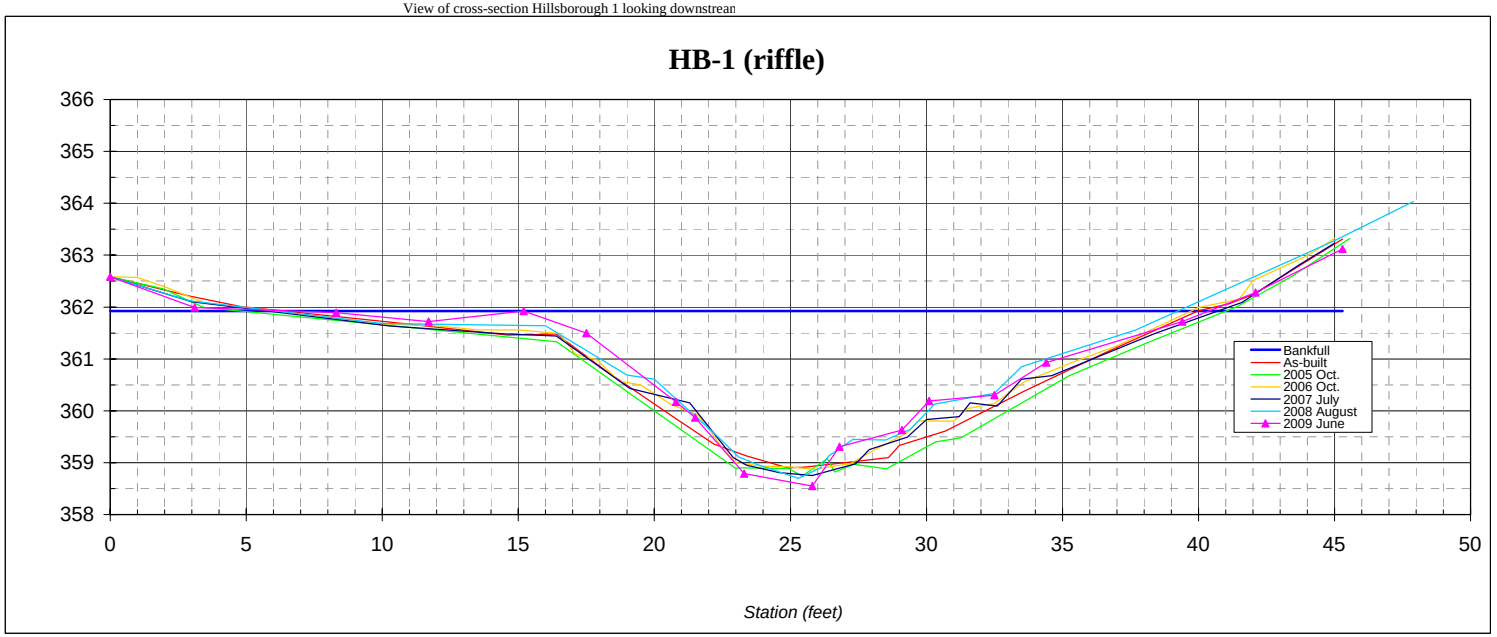
Station	Rod Ht.	Elevation
0	7.45	362.58
3.1	8.04	361.99
8.3	8.14	361.89
11.7	8.31	361.72
15.2	8.11	361.92
17.5	8.53	361.5
20.8	9.86	360.17
21.5	10.16	359.87
23.3	11.24	358.79
25.8	11.48	358.55
26.8	10.72	359.31
29.1	10.4	359.63
30.1	9.84	360.19
32.5	9.73	360.3
34.4	9.1	360.93
39.4	8.31	361.72
42.1	7.75	362.28
45.3	6.91	363.12

SUMMARY DATA

Floodprone Elevation (ft)	365.29
Bankfull Elevation (ft)	361.92
Floodprone Width (ft)	62.00
Bankfull Width (ft)	25.06
Entrenchment Ratio	2.47
Mean Depth (ft)	1.53
Maximum Depth (ft)	3.37
Width/Depth Ratio	16.37
Bankfull Area (sq ft)	38.39
Wetted Perimeter (ft)	26.36
Hydraulic Radius (ft)	1.46

Stream Type: C

View of cross-section Hillsborough 1 looking downstrean



River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	HB-2 (pool)
Reach:	Hillsborough
Date:	6/11/2009
Field Crew:	J.O. and S.D.

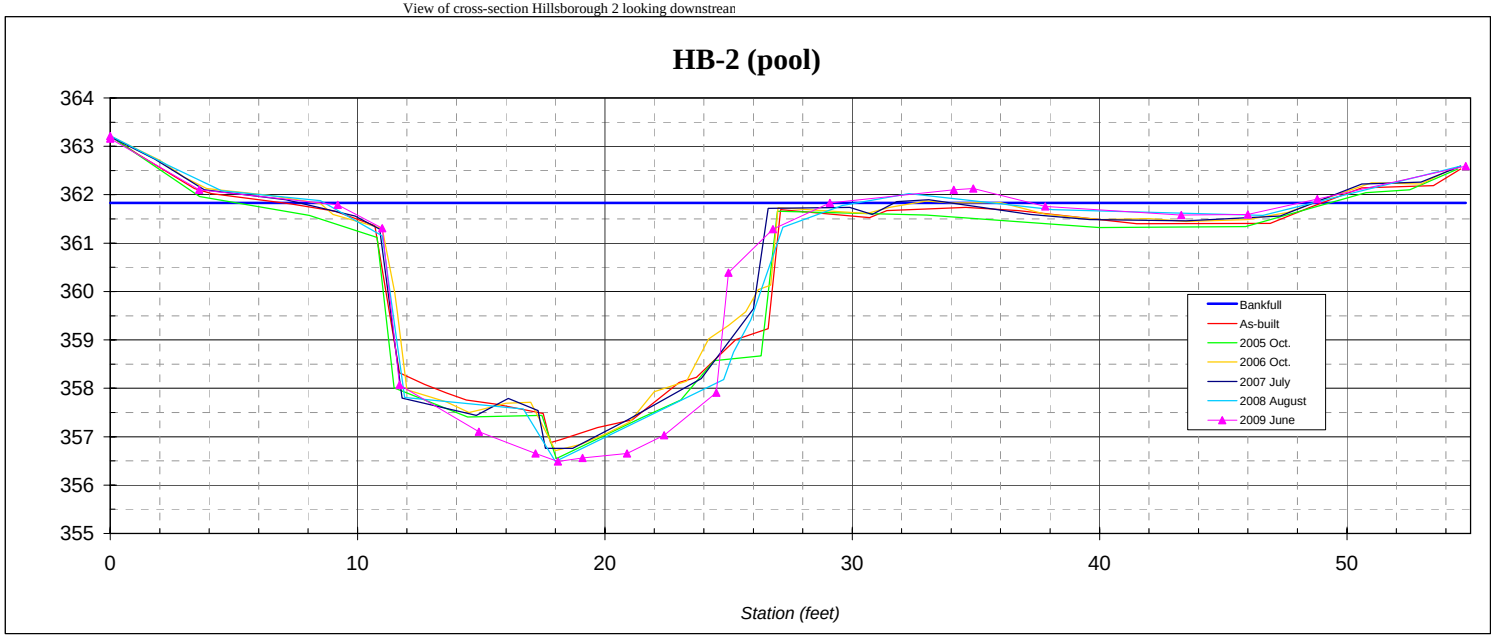
Station	Rod Ht.	Elevation
0	6.74	363.21
0	6.79	363.16
3.6	7.85	362.1
9.2	8.16	361.79
11	8.64	361.31
11.7	11.88	358.07
14.9	12.85	357.1
17.2	13.3	356.65
18.1	13.46	356.49
19.1	13.39	356.56
20.9	13.3	356.65
22.4	12.92	357.03
24.5	12.04	357.91
25	9.56	360.39
26.8	8.66	361.29
29.1	8.12	361.83
34.1	7.82	362.1
34.9	7.85	362.13
37.8	8.19	361.76
43.3	8.37	361.58
46	8.36	361.59
48.8	8.04	361.91
54.8	7.36	362.59

SUMMARY DATA

Floodprone Elevation (ft)	367.17
Bankfull Elevation (ft)	361.83
Floodprone Width (ft)	100.00
Bankfull Width (ft)	21.01
Entrenchment Ratio	4.76
Mean Depth (ft)	3.18
Maximum Depth (ft)	5.34
Width/Depth Ratio	6.60
Bankfull Area (sq ft)	66.83
Wetted Perimeter (ft)	26.42
Hydraulic Radius (ft)	2.53

Stream Type: E

View of cross-section Hillsborough 2 looking downstrean



River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	HB-3 (riffle)
Reach:	Hillsborough
Date:	6/11/2009
Field Crew:	J.O. and S.D.

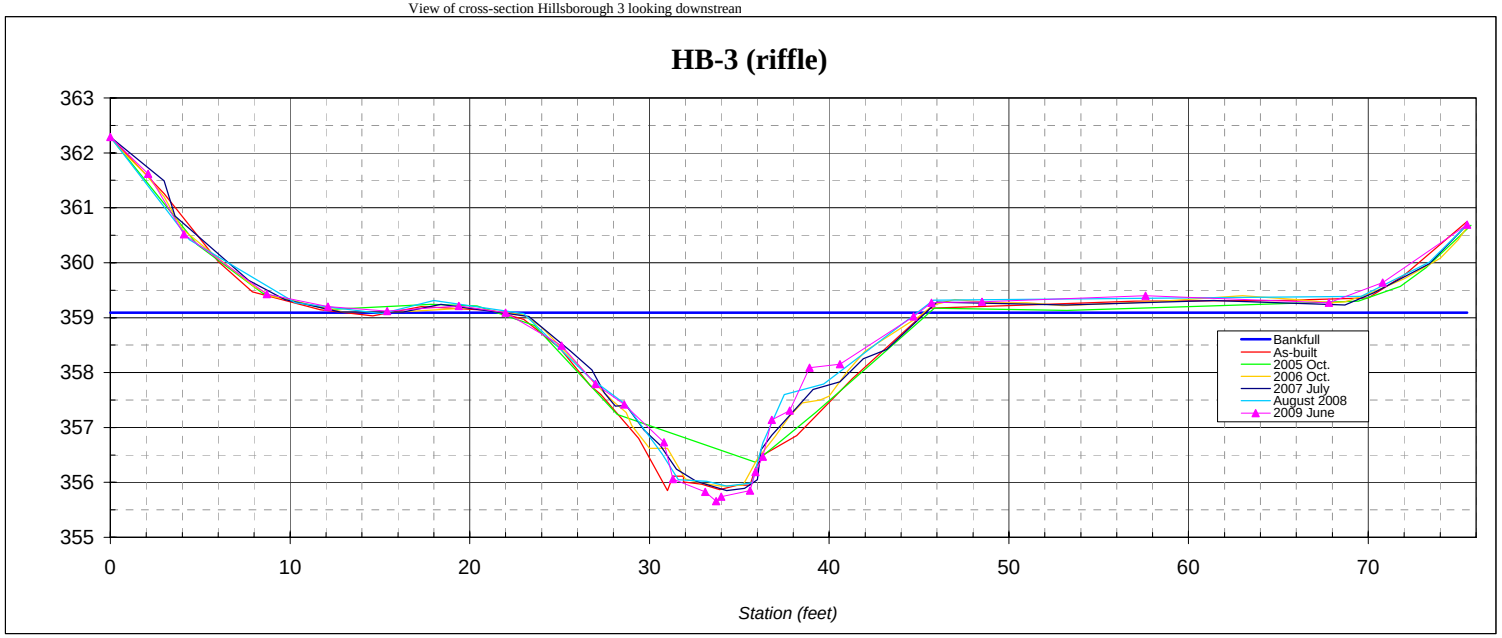
Station	Rod Ht.	Elevation
0	1.76	362.29
2.1	2.43	361.62
4.1	3.53	360.52
8.7	4.62	359.43
12.1	4.85	359.20
15.4	4.93	359.12
19.4	4.84	359.21
22	4.96	359.09
25.1	5.56	358.49
27	6.26	357.79
28.6	6.63	357.42
30.8	7.32	356.73
31.3	7.99	356.06
33.1	8.22	355.83
33.7	8.39	355.66
34	8.31	355.74
35.6	8.2	355.85
35.9	7.86	356.19
36.3	7.58	356.47
36.8	6.91	357.14
37.8	6.74	357.31
38.9	5.96	358.09
40.6	5.9	358.15
44.7	5.03	359.02
45.7	4.78	359.27
48.5	4.76	359.29
57.6	4.65	359.40
67.8	4.78	359.27
70.8	4.41	359.64
75.5	3.36	360.69

SUMMARY DATA

Floodprone Elevation (ft)	362.58
Bankfull Elevation (ft)	359.09
Floodprone Width (ft)	85.00
Bankfull Width (ft)	23.73
Entrenchment Ratio	3.58
Mean Depth (ft)	1.51
Maximum Depth (ft)	3.46
Width/Depth Ratio	15.74
Bankfull Area (sq ft)	35.84
Wetted Perimeter (ft)	25.41
Hydraulic Radius (ft)	1.41

Stream Type: C

View of cross-section Hillsborough 3 looking downstrean



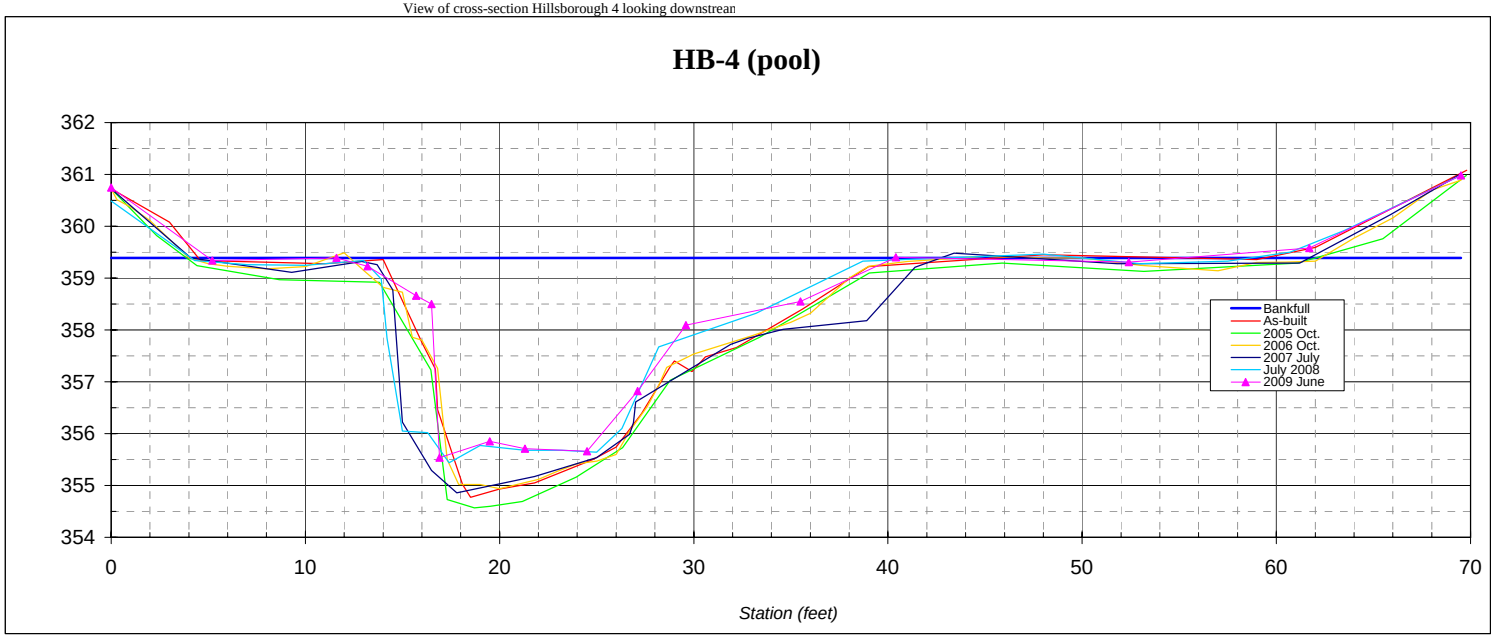
River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	HB-4 (pool)
Reach:	Hillsborough
Date:	6/12/2009
Field Crew:	J.O. and S.D.

Station	Rod Ht.	Elevation
0	6.94	360.75
5.2	8.35	359.34
11.6	8.3	359.39
13.2	8.46	359.23
15.7	9.03	358.66
16.5	9.19	358.5
16.9	12.15	355.54
19.5	11.84	355.85
21.3	11.98	355.71
24.5	12.03	355.66
27.1	10.87	356.82
29.6	9.6	358.09
35.5	9.14	358.55
40.4	8.29	359.4
52.4	8.38	359.31
61.7	8.11	359.58
69.5	6.71	360.98

SUMMARY DATA	
Floodprone Elevation (ft)	363.24
Bankfull Elevation (ft)	359.39
Floodprone Width (ft)	100.00
Bankfull Width (ft)	28.74
Entrenchment Ratio	3.48
Mean Depth (ft)	1.82
Maximum Depth (ft)	3.85
Width/Depth Ratio	15.83
Bankfull Area (sq ft)	52.17
Wetted Perimeter (ft)	32.08
Hydraulic Radius (ft)	1.63

Stream Type: C

View of cross-section Hillsborough 4 looking downstrean



River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	HD-1 (pool)
Reach:	Hillandale
Date:	6/17/2009
Field Crew:	S.D. and A.P.

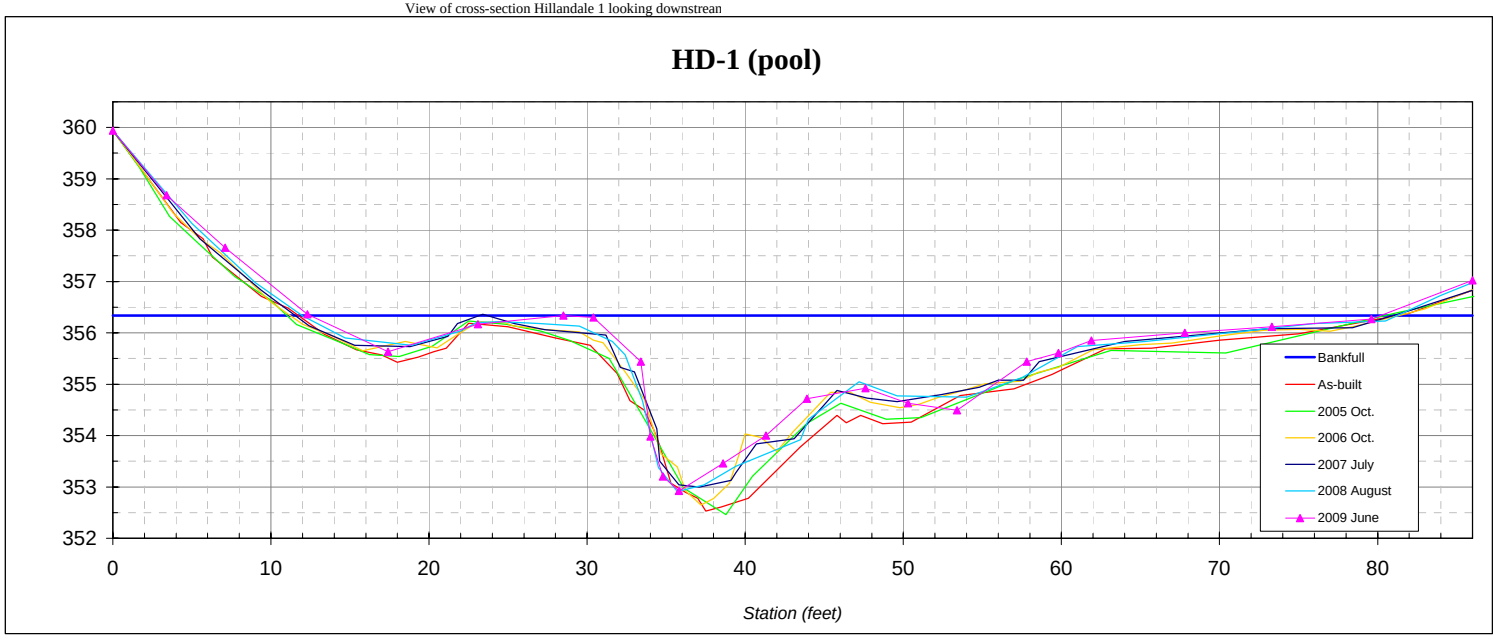
Station	Rod Ht.	Elevation
0	2.52	359.94
3.4	3.78	358.68
7.1	4.8	357.66
12.3	6.1	356.36
17.4	6.83	355.63
23.1	6.29	356.17
28.5	6.12	356.34
30.4	6.16	356.30
33.4	7.02	355.44
34	8.48	353.98
34.8	9.26	353.20
35.8	9.54	352.92
38.6	9	353.46
41.3	8.46	354.00
43.9	7.74	354.72
47.6	7.54	354.92
50.3	7.83	354.63
53.4	7.97	354.49
57.8	7.02	355.44
59.8	6.85	355.61
61.9	6.61	355.85
67.8	6.46	356.00
73.3	6.34	356.12
79.6	6.19	356.27
86	5.44	357.02

SUMMARY DATA

Floodprone Elevation (ft)	359.76
Bankfull Elevation (ft)	356.34
Floodprone Width (ft)	110.00
Bankfull Width (ft)	51.70
Entrenchment Ratio	2.13
Mean Depth (ft)	1.13
Maximum Depth (ft)	3.42
Width/Depth Ratio	45.94
Bankfull Area (sq ft)	58.17
Wetted Perimeter (ft)	53.51
Hydraulic Radius (ft)	1.09

Stream Type: B

View of cross-section Hillandale 1 looking downstrean



River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	HD-2 (riffle)
Reach:	Hillandale
Date:	6/12/2009
Field Crew:	J.O. and S.D.

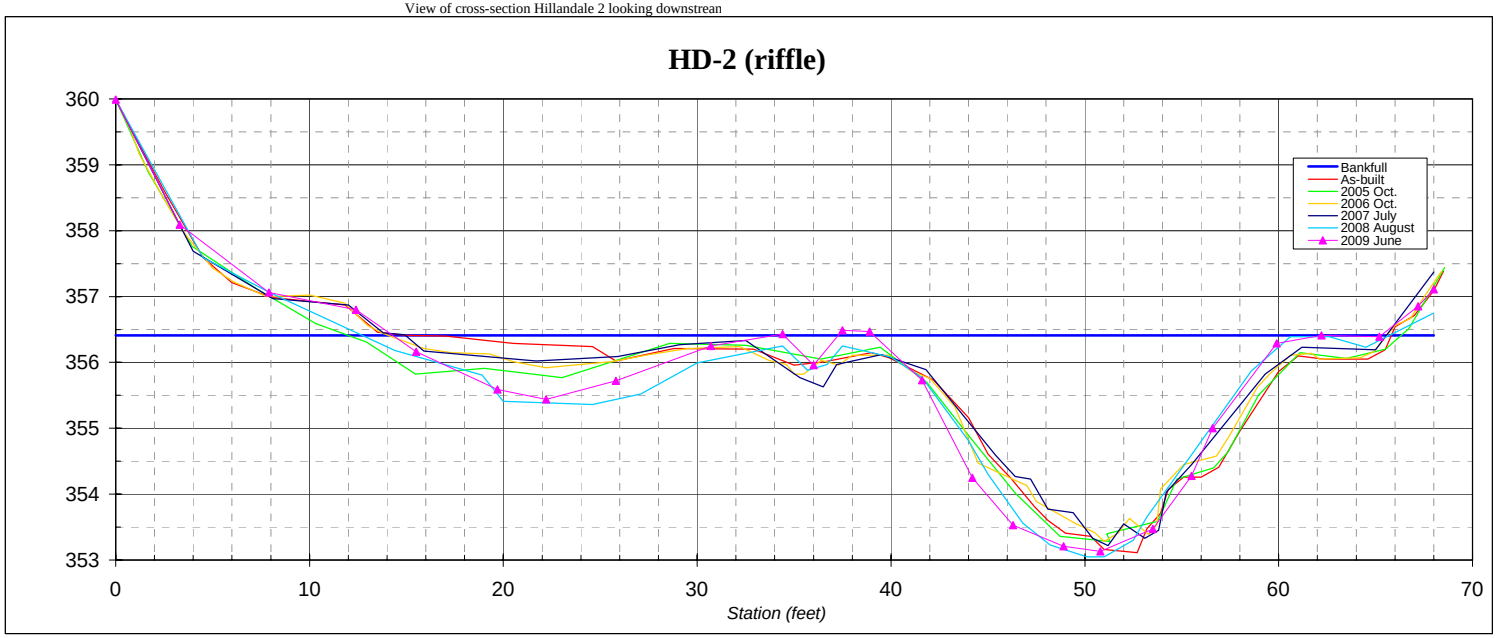
Station	Rod Ht.	Elevation
0	4.36	359.99
3.3	6.26	358.09
7.9	7.29	357.06
12.4	7.55	356.80
15.5	8.19	356.16
19.7	8.76	355.59
22.2	8.91	355.44
25.8	8.63	355.72
30.7	8.1	356.25
34.4	7.92	356.43
36	8.39	355.96
37.5	7.86	356.49
38.9	7.88	356.47
41.6	8.62	355.73
44.2	10.1	354.25
46.3	10.82	353.53
48.9	11.14	353.21
50.8	11.22	353.13
53.5	10.88	353.47
55.5	10.07	354.28
56.6	9.35	355.00
59.9	8.06	356.29
62.2	7.94	356.41
65.2	7.96	356.39
67.2	7.5	356.85
68	7.24	357.11

SUMMARY DATA

Floodprone Elevation (ft)	359.67
Bankfull Elevation (ft)	356.41
Floodprone Width (ft)	90.00
Bankfull Width (ft)	24.40
Entrenchment Ratio	3.69
Mean Depth (ft)	1.71
Maximum Depth (ft)	3.27
Width/Depth Ratio	14.26
Bankfull Area (sq ft)	41.74
Wetted Perimeter (ft)	25.66
Hydraulic Radius (ft)	1.63

Stream Type: C

View of cross-section Hillandale 2 looking downstrean



River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	HD-3 (pool)
Reach:	Hillandale
Date:	6/17/2009
Field Crew:	J.O. and S.D.

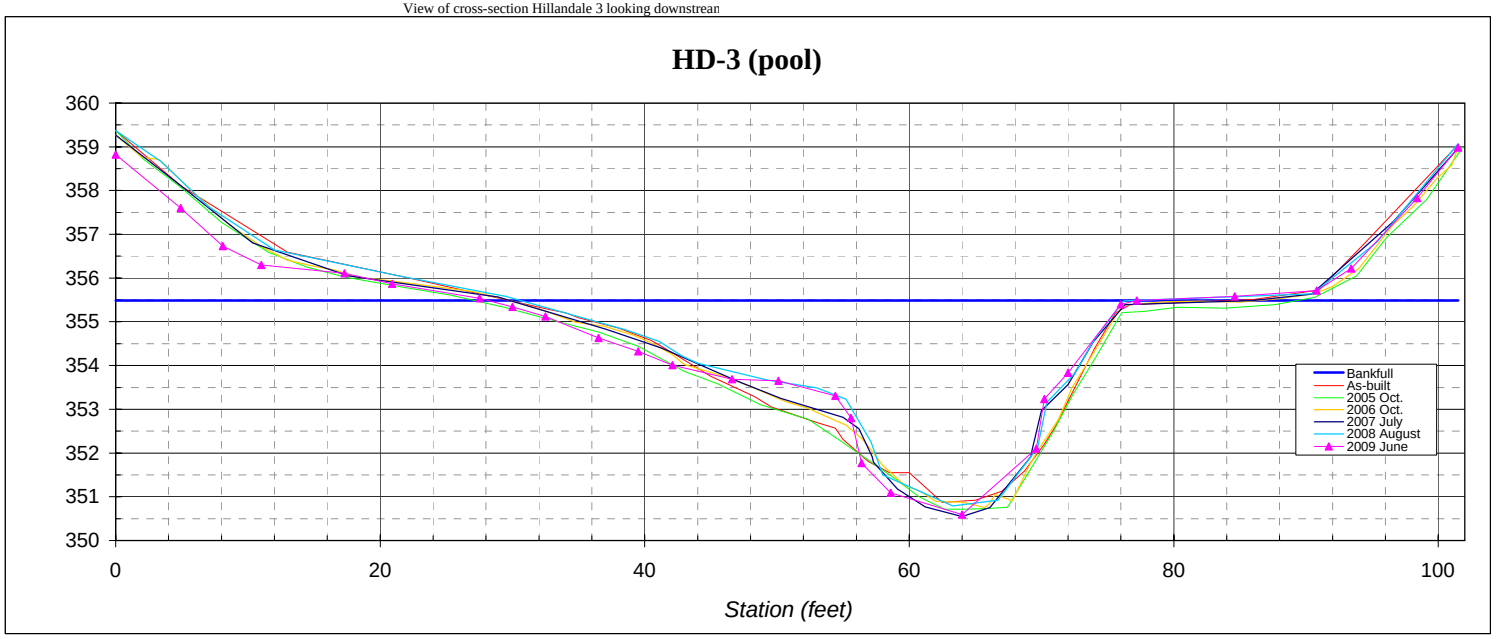
Station	Rod Ht.	Elevation
0	6.7	358.82
4.9	7.92	357.60
8.1	8.79	356.73
11	9.22	356.30
17.3	9.41	356.11
20.9	9.65	355.87
27.5	9.98	355.54
30	10.18	355.34
32.5	10.4	355.12
36.5	10.89	354.63
39.5	11.2	354.32
42.1	11.51	354.01
46.6	11.83	353.69
50.1	11.87	353.65
54.4	12.21	353.31
55.6	12.72	352.80
56.4	13.75	351.77
58.6	14.43	351.09
64	14.93	350.59
69.6	13.42	352.10
70.2	12.29	353.23
72	11.69	353.83
76	10.12	355.40
77.2	10.03	355.49
84.6	9.94	355.58
90.8	9.81	355.71
93.4	9.3	356.22
98.4	7.69	357.83
101.5	6.54	358.98

SUMMARY DATA

Floodprone Elevation (ft)	360.39
Bankfull Elevation (ft)	355.49
Floodprone Width (ft)	101.50
Bankfull Width (ft)	49.08
Entrenchment Ratio	2.07
Mean Depth (ft)	2.11
Maximum Depth (ft)	4.90
Width/Depth Ratio	23.24
Bankfull Area (sq ft)	103.65
Wetted Perimeter (ft)	51.19
Hydraulic Radius (ft)	2.02

Stream Type: B

View of cross-section Hillandale 3 looking downstrean



River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	HD-4 (riffle)
Reach:	Hillandale
Date:	6/17/2009
Field Crew:	S.D. and J.O.

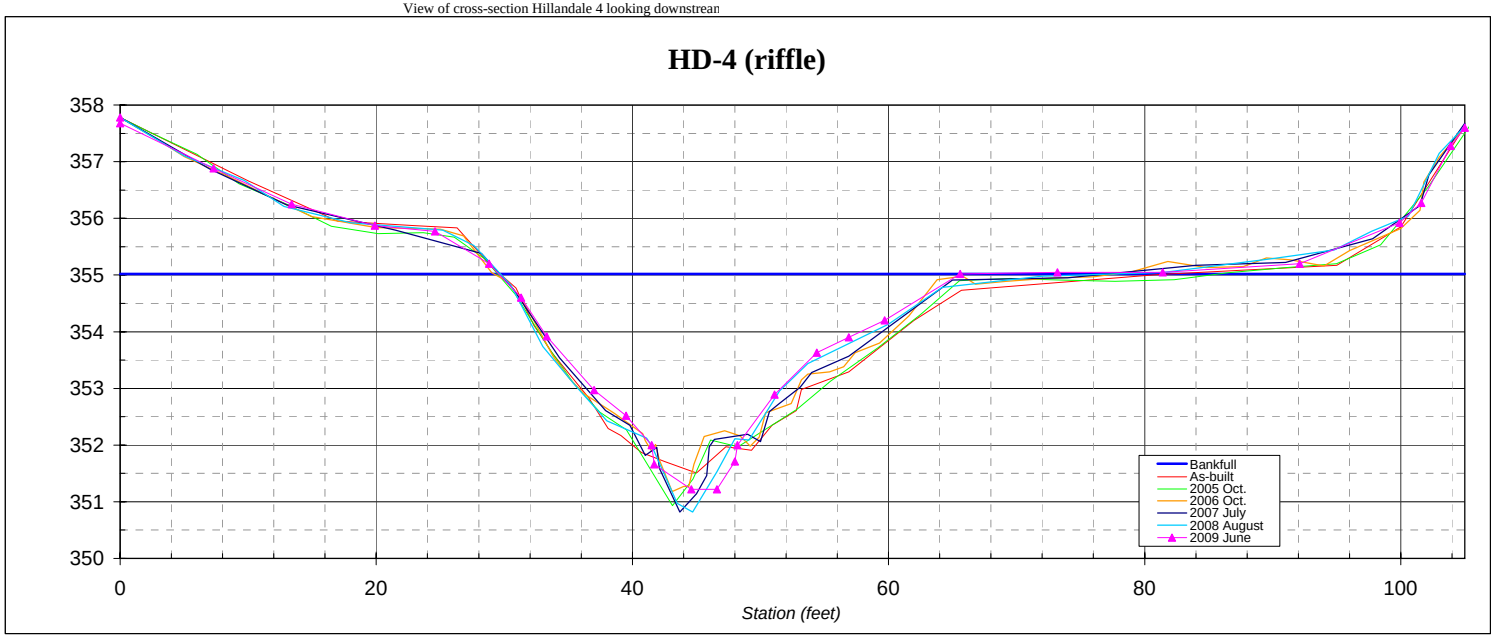
Station	Rod Ht.	Elevation
0	7.75	357.78
0	7.85	357.68
7.3	8.65	356.88
13.4	9.28	356.25
19.9	9.66	355.87
24.6	9.76	355.77
28.8	10.33	355.2
31.3	10.93	354.6
33.3	11.61	353.92
37	12.56	352.97
39.5	13.01	352.52
41.5	13.53	352
41.7	13.87	351.66
44.6	14.31	351.22
46.6	14.31	351.22
48	13.82	351.71
48.2	13.53	352
51.1	12.64	352.89
54.4	11.9	353.63
56.9	11.63	353.9
59.7	11.33	354.2
65.6	10.51	355.02
73.2	10.48	355.05
81.4	10.48	355.05
92.1	10.33	355.2
99.9	9.61	355.92
101.6	9.26	356.27
103.9	8.25	357.28
105	7.93	357.6

SUMMARY DATA

Floodprone Elevation (ft)	358.82
Bankfull Elevation (ft)	355.02
Floodprone Width (ft)	105.00
Bankfull Width (ft)	36.05
Entrenchment Ratio	2.91
Mean Depth (ft)	1.79
Maximum Depth (ft)	3.80
Width/Depth Ratio	20.09
Bankfull Area (sq ft)	64.70
Wetted Perimeter (ft)	37.20
Hydraulic Radius (ft)	1.74

Stream Type: C

View of cross-section Hillandale 4 looking downstrean



River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	AL-1 (riffle)
Reach:	Albany
Date:	6/17/2009
Field Crew:	S.D. and J.O.

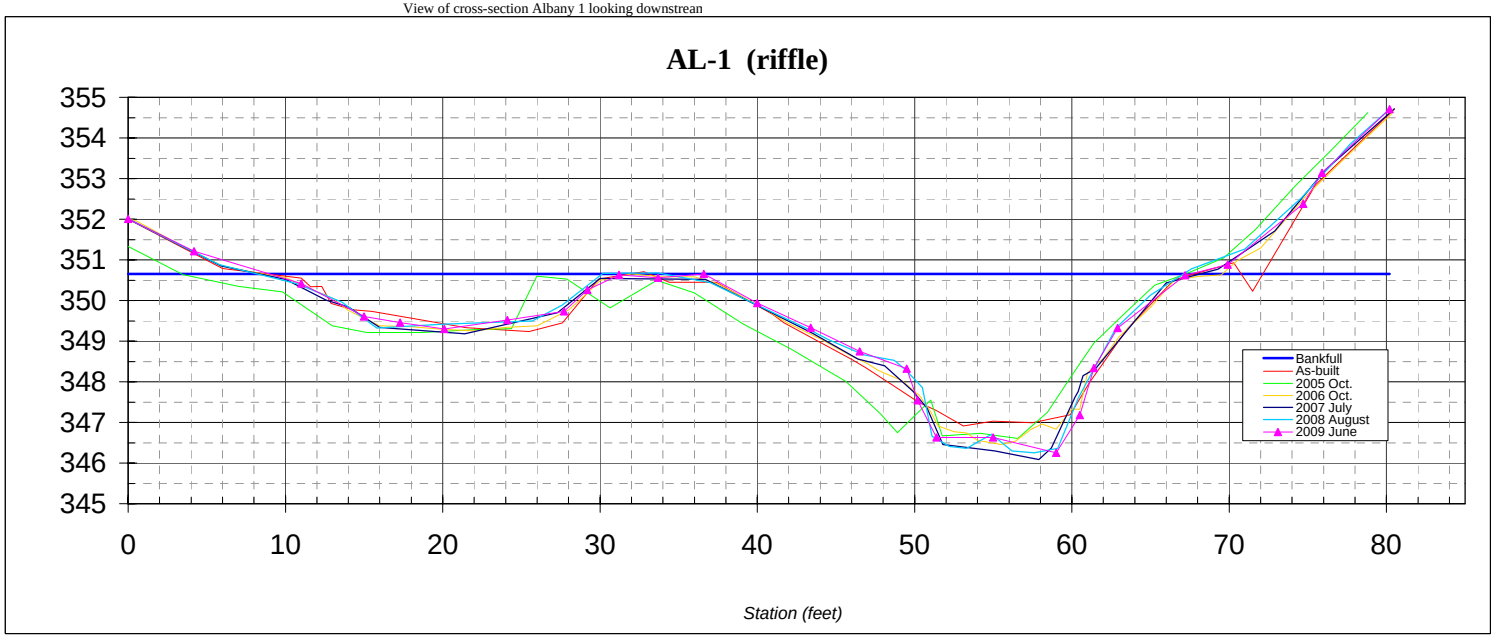
Station	Rod Ht.	Elevation
0	4.68	352.01
4.2	5.48	351.21
11	6.27	350.42
15	7.08	349.61
17.3	7.23	349.46
20.1	7.39	349.30
24.1	7.17	349.52
27.7	6.96	349.73
29.2	6.43	350.26
31.2	6.06	350.63
33.7	6.13	350.56
36.6	6.04	350.65
40	6.75	349.94
43.4	7.36	349.33
46.5	7.94	348.75
49.5	8.37	348.32
50.2	9.15	347.54
51.4	10.06	346.63
55	10.06	346.63
59	10.44	346.25
60.5	9.51	347.18
61.4	8.35	348.34
62.9	7.37	349.32
67.2	6.07	350.62
69.9	5.81	350.88
74.7	4.31	352.38
75.9	3.55	353.14
80.2	1.98	354.71

SUMMARY DATA

Floodprone Elevation (ft)	355.05
Bankfull Elevation (ft)	350.65
Floodprone Width (ft)	98.00
Bankfull Width (ft)	30.91
Entrenchment Ratio	3.17
Mean Depth (ft)	2.19
Maximum Depth (ft)	4.40
Width/Depth Ratio	14.12
Bankfull Area (sq ft)	67.65
Wetted Perimeter (ft)	33.11
Hydraulic Radius (ft)	2.04

Stream Type: C

View of cross-section Albany 1 looking downstrean



River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	AL-2 (pool)
Reach:	Albany
Date:	6/17/2009
Field Crew:	S.D. and J.O.

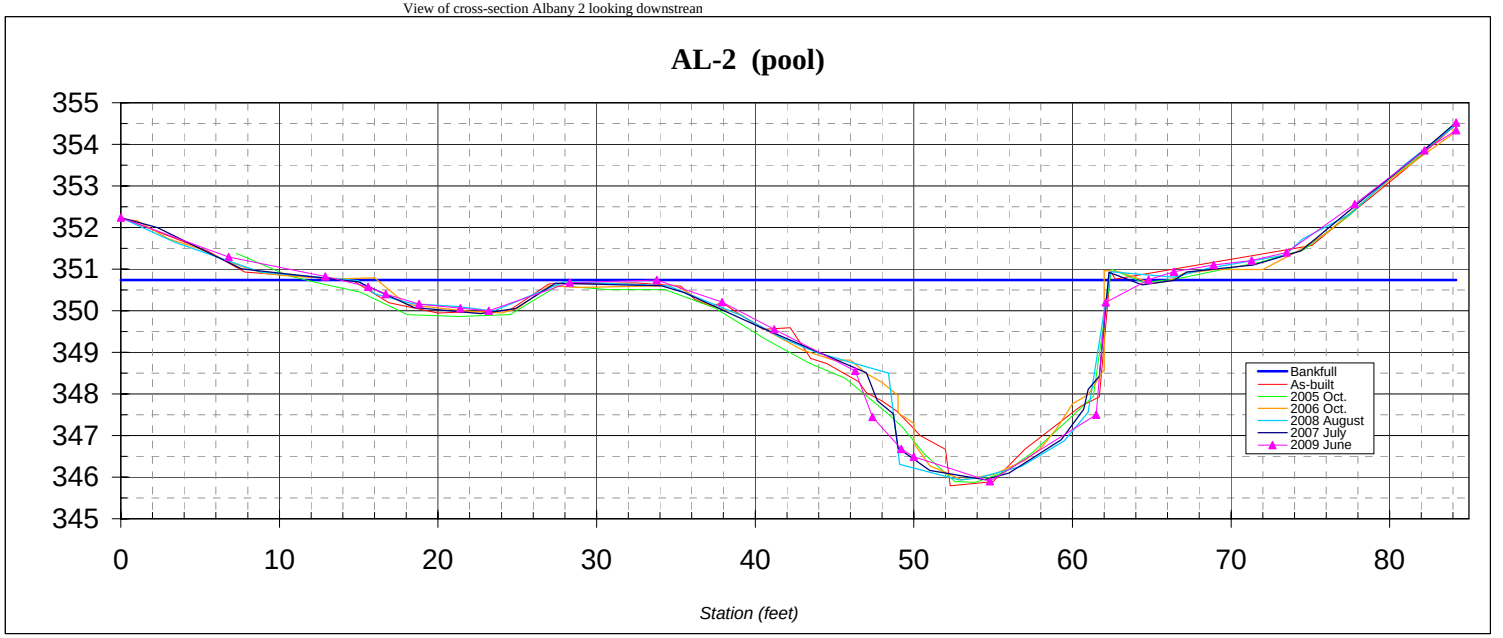
Station	Rod Ht.	Elevation
0	4.56	352.24
6.8	5.51	351.29
12.9	5.98	350.82
15.6	6.22	350.58
16.7	6.4	350.4
18.8	6.64	350.16
21.4	6.74	350.06
23.2	6.8	350
28.3	6.12	350.68
33.8	6.06	350.74
37.9	6.59	350.21
41.2	7.25	349.55
46.3	8.25	348.55
47.4	9.35	347.45
49.2	10.12	346.68
50	10.31	346.49
54.8	10.9	345.9
61.5	9.3	347.5
62.1	6.6	350.2
64.8	6.05	350.75
66.4	5.86	350.94
68.9	5.7	351.1
71.3	5.59	351.21
73.5	5.4	351.4
77.8	4.24	352.56
82.2	2.95	353.85
84.2	2.46	354.34
84.2	2.28	354.52

SUMMARY DATA

Floodprone Elevation (ft)	355.58
Bankfull Elevation (ft)	350.74
Floodprone Width (ft)	100.00
Bankfull Width (ft)	30.95
Entrenchment Ratio	3.23
Mean Depth (ft)	2.46
Maximum Depth (ft)	4.84
Width/Depth Ratio	12.57
Bankfull Area (sq ft)	76.23
Wetted Perimeter (ft)	34.23
Hydraulic Radius (ft)	2.23

Stream Type: C

View of cross-section Albany 2 looking downstrean



River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	AL-3 (pool)
Reach:	Albany
Date:	6/17/2009
Field Crew:	S.D. and J.O.

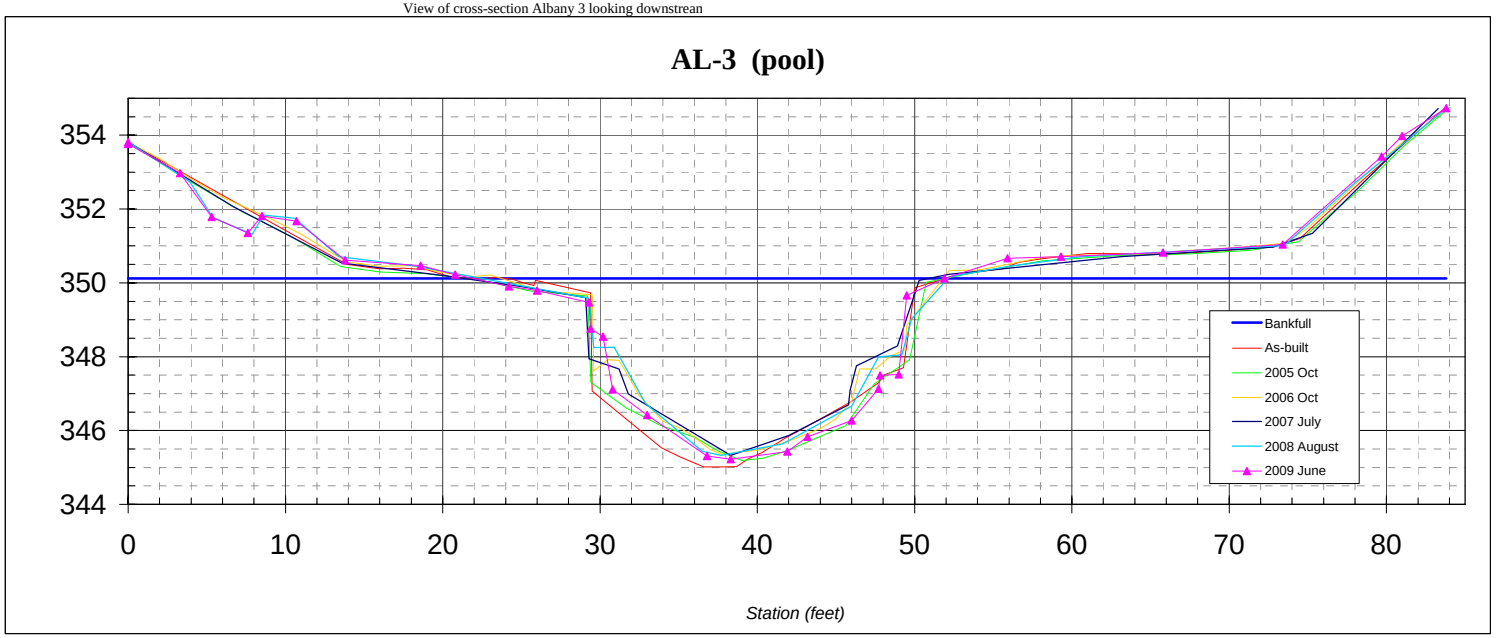
Station	Rod Ht.	Elevation
0	2.26	353.81
0	2.31	353.76
3.3	3.1	352.97
5.3	4.29	351.78
7.6	4.72	351.35
8.5	4.26	351.81
10.7	4.4	351.67
13.8	5.46	350.61
18.6	5.6	350.47
20.8	5.85	350.22
24.2	6.17	349.90
26	6.28	349.79
29.3	6.6	349.47
29.4	7.31	348.76
30.2	7.53	348.54
30.8	8.96	347.11
33	9.65	346.42
36.8	10.76	345.31
38.3	10.85	345.22
41.9	10.64	345.43
43.2	10.24	345.83
46	9.8	346.27
47.7	8.94	347.13
47.8	8.58	347.49
49	8.55	347.52
49.5	6.41	349.66
51.9	5.95	350.12
55.9	5.4	350.67
59.3	5.36	350.71
65.8	5.25	350.82
73.4	5.03	351.04
79.7	2.65	353.42
81	2.09	353.98
83.8	1.34	354.73

SUMMARY DATA

Floodprone Elevation (ft)	354.06
Bankfull Elevation (ft)	349.64
Floodprone Width (ft)	87.00
Bankfull Width (ft)	21.95
Entrenchment Ratio	3.96
Mean Depth (ft)	3.12
Maximum Depth (ft)	4.42
Width/Depth Ratio	7.04
Bankfull Area (sq ft)	68.43
Wetted Perimeter (ft)	26.08
Hydraulic Radius (ft)	2.62

Stream Type: E

View of cross-section Albany 3 looking downstrean



River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	AL-4 (riffle)
Reach:	Albany
Date:	6/17/2009
Field Crew:	S.D. and J.O.

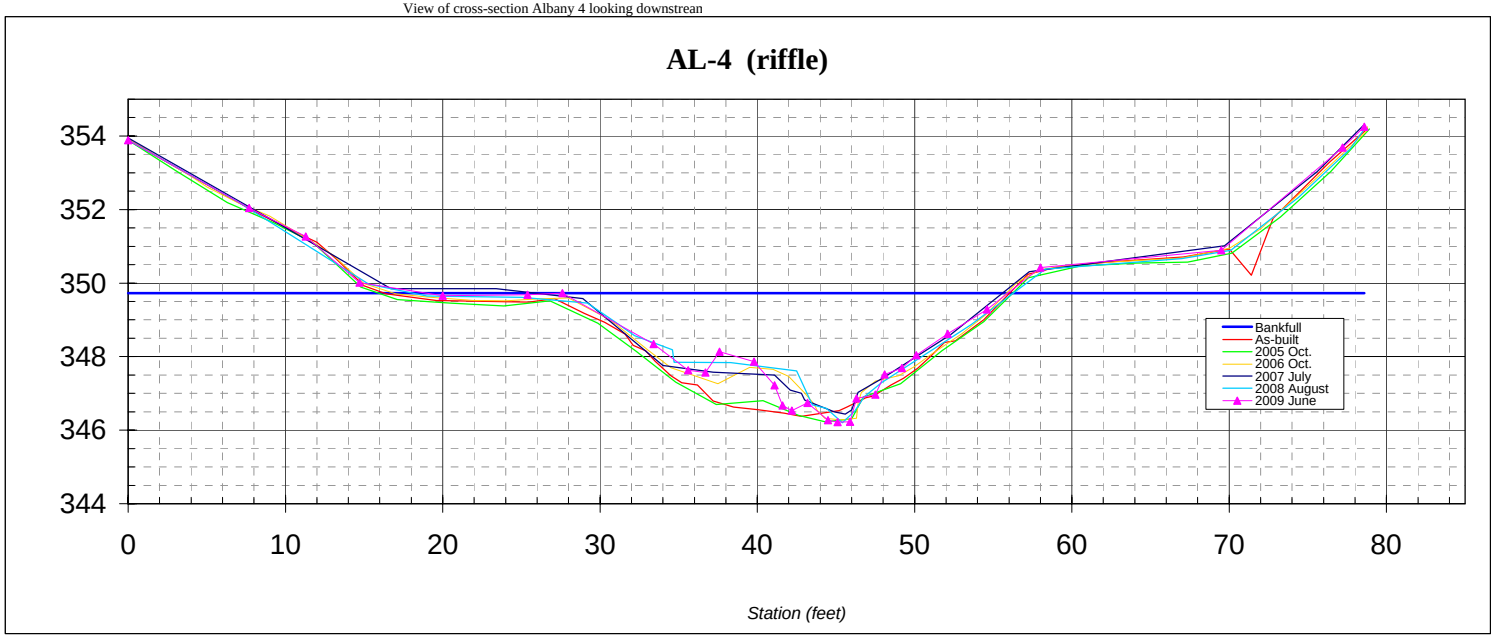
Station	Rod Ht.	Elevation
0	1.58	353.89
7.7	3.43	352.04
11.3	4.2	351.27
14.7	5.46	350.01
20	5.81	349.66
25.4	5.79	349.68
27.6	5.74	349.73
33.4	7.13	348.34
35.6	7.84	347.63
36.7	7.9	347.57
37.6	7.34	348.13
39.8	7.61	347.86
41.1	8.25	347.22
41.6	8.8	346.67
42.2	8.94	346.53
43.2	8.73	346.74
44.5	9.2	346.27
45.1	9.25	346.22
45.9	9.24	346.23
46.3	8.61	346.86
47.5	8.5	346.97
48.1	7.95	347.52
49.2	7.78	347.69
50.1	7.43	348.04
52.1	6.85	348.62
54.6	6.19	349.28
58	5.05	350.42
69.5	4.58	350.89
77.2	1.78	353.69
78.6	1.22	354.25

SUMMARY DATA

Floodprone Elevation (ft)	353.24
Bankfull Elevation (ft)	349.73
Floodprone Width (ft)	70.50
Bankfull Width (ft)	28.34
Entrenchment Ratio	2.49
Mean Depth (ft)	1.74
Maximum Depth (ft)	3.51
Width/Depth Ratio	16.32
Bankfull Area (sq ft)	49.23
Wetted Perimeter (ft)	30.20
Hydraulic Radius (ft)	1.63

Stream Type: C

View of cross-section Albany 4 looking downstrean



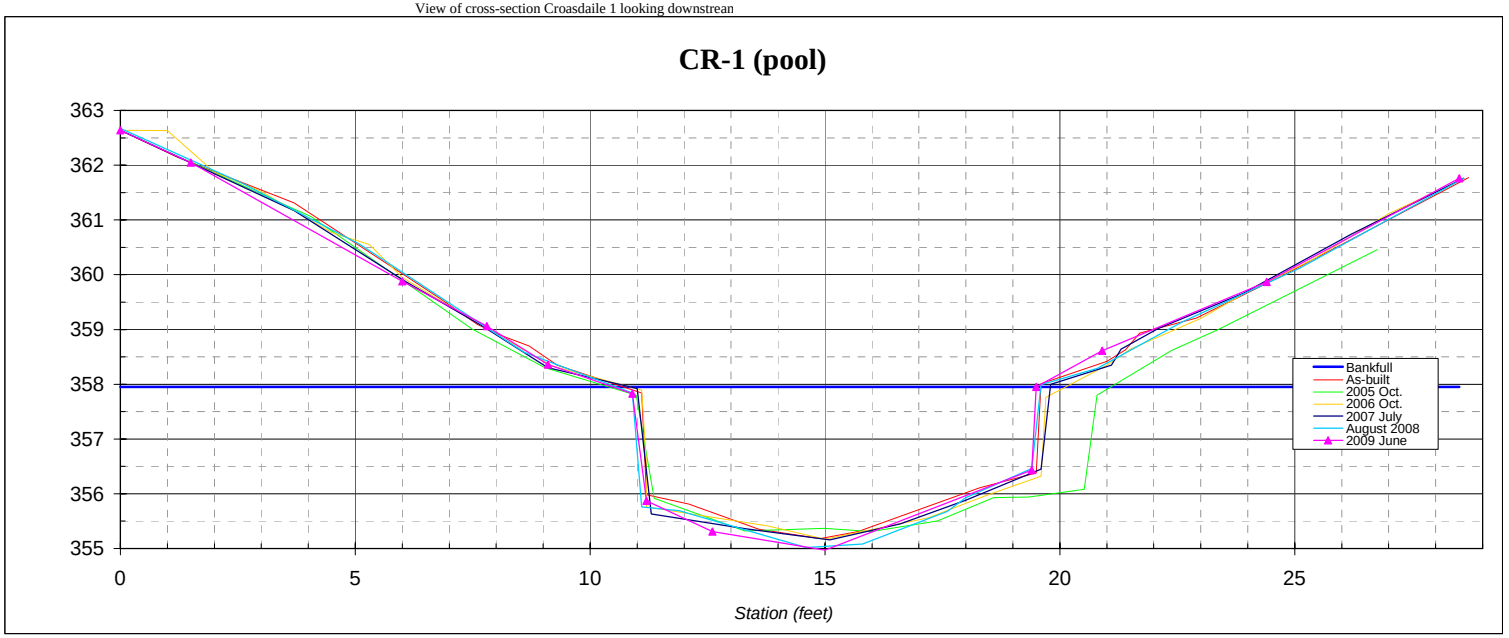
River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	CR-1 (pool)
Reach:	Croasdaile
Date:	6/12/2009
Field Crew:	J.O. and S.D.

Station	Rod Ht.	Elevation
28.5	5.74	361.76
24.4	7.63	359.87
20.9	8.89	358.61
19.5	9.55	357.95
19.4	11.07	356.43
15	12.53	354.97
12.6	12.19	355.31
11.2	11.63	355.87
10.9	9.67	357.83
9.1	9.14	358.36
7.8	8.44	359.06
6	7.62	359.88
1.5	5.45	362.05
0	4.86	362.64

SUMMARY DATA	
Floodprone Elevation (ft)	360.69
Bankfull Elevation (ft)	357.83
Floodprone Width (ft)	21.40
Bankfull Width (ft)	8.59
Entrenchment Ratio	2.49
Mean Depth (ft)	2.25
Maximum Depth (ft)	2.86
Width/Depth Ratio	3.82
Bankfull Area (sq ft)	19.32
Wetted Perimeter (ft)	11.95
Hydraulic Radius (ft)	1.62

Stream Type: E

View of cross-section Croasdaile 1 looking downstrean



River Basin:	Neuse
Watershed:	Ellerbe Creek
XS ID	CR-2 (riffle)
Reach:	Croasdaile
Date:	6/12/2009
Field Crew:	J.O. and S.D.

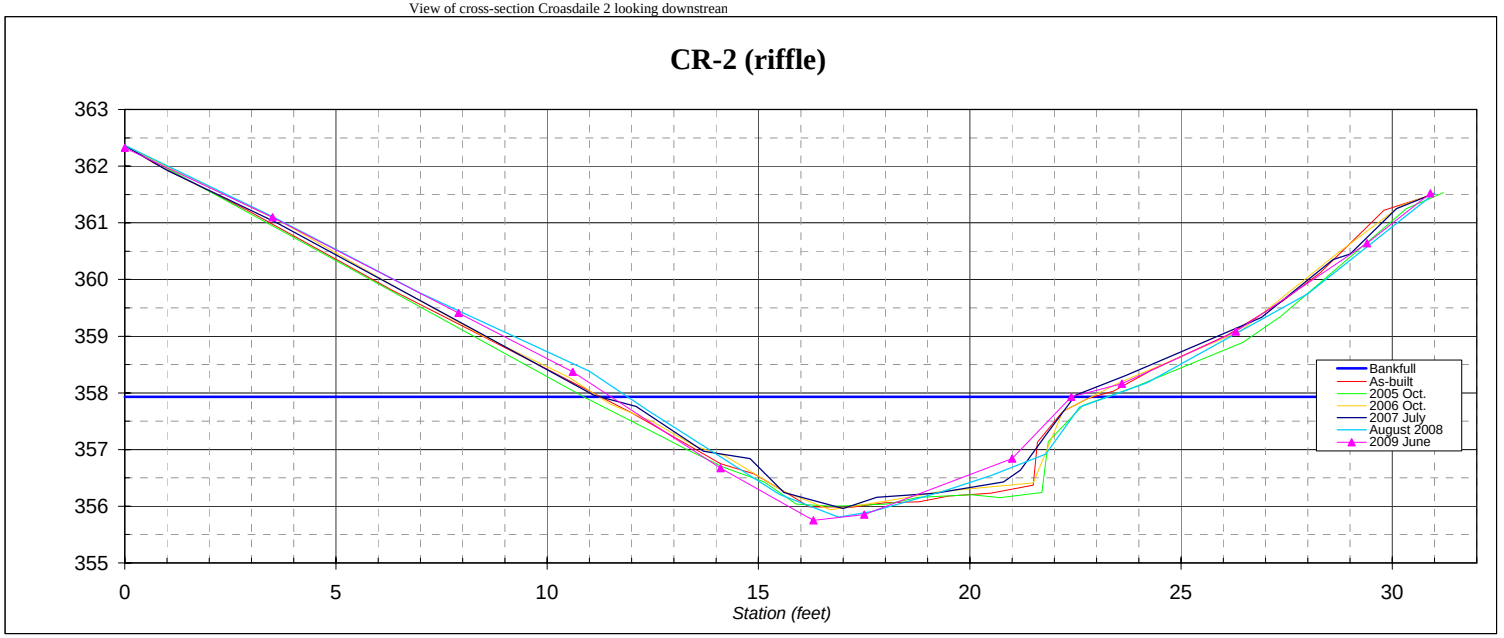
Station	Rod Ht.	Elevation
30.9	6.34	361.52
29.4	7.22	360.64
26.3	8.78	359.08
23.6	9.7	358.16
22.4	9.93	357.93
21	11.02	356.84
17.5	12.01	355.85
16.3	12.11	355.75
14.1	11.19	356.67
10.6	9.49	358.37
7.9	8.45	359.41
3.5	6.76	361.1
0	5.54	362.32

SUMMARY DATA

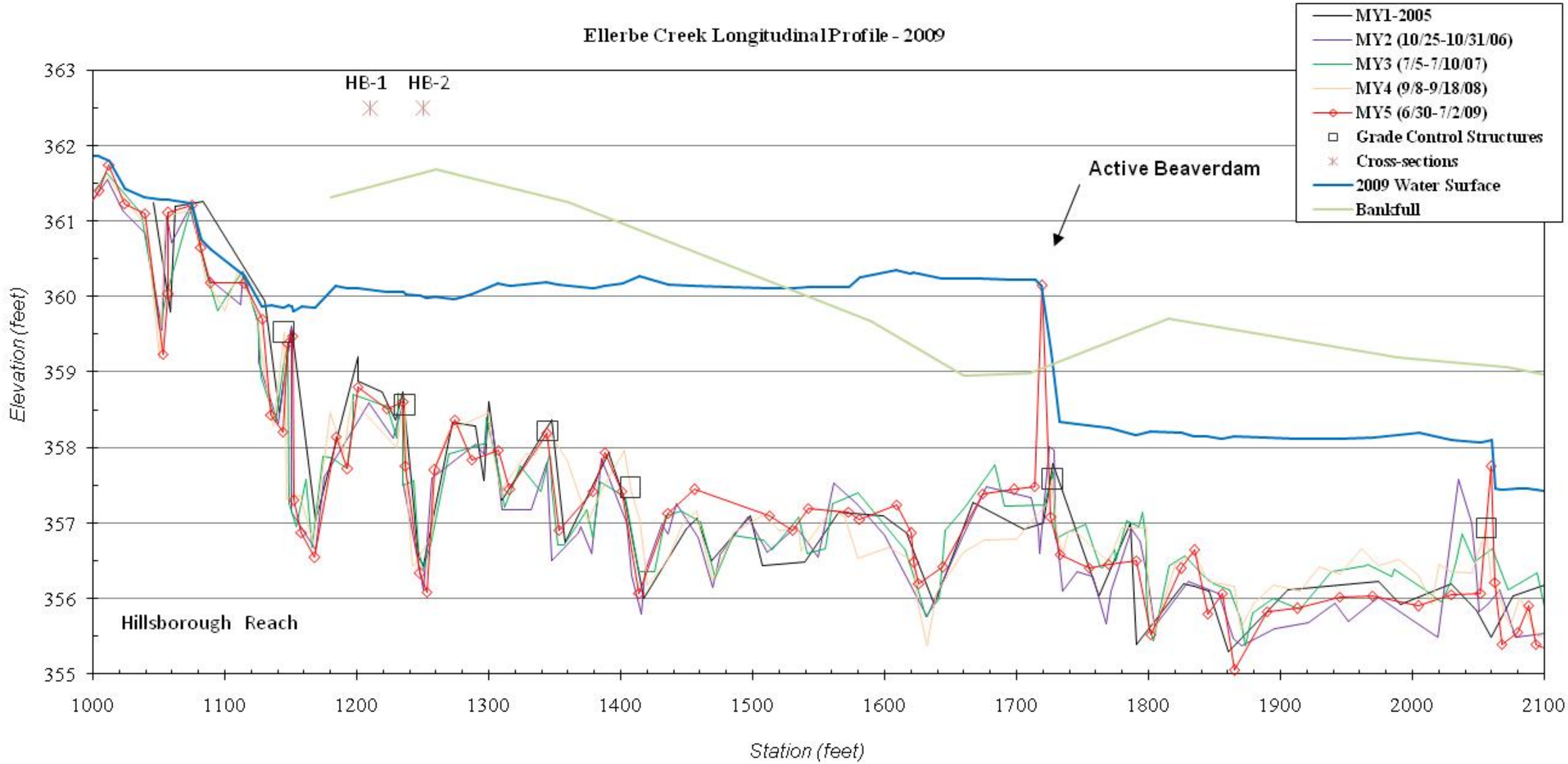
Floodprone Elevation (ft)	360.11
Bankfull Elevation (ft)	357.93
Floodprone Width (ft)	20.65
Bankfull Width (ft)	10.89
Entrenchment Ratio	1.90
Mean Depth (ft)	1.31
Maximum Depth (ft)	2.18
Width/Depth Ratio	8.31
Bankfull Area (sq ft)	14.28
Wetted Perimeter (ft)	11.88
Hydraulic Radius (ft)	1.20

Stream Type: B

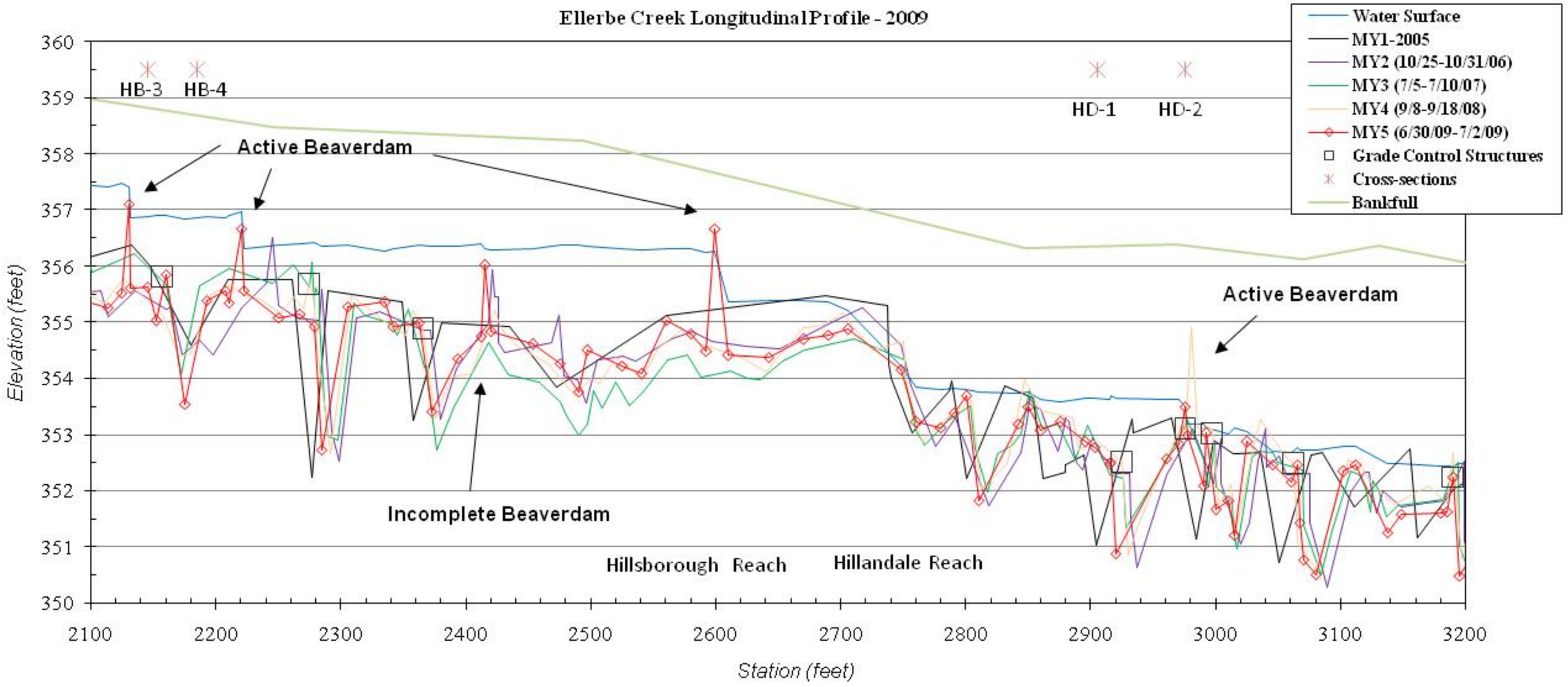
View of cross-section Croasdaile 2 looking downstrean



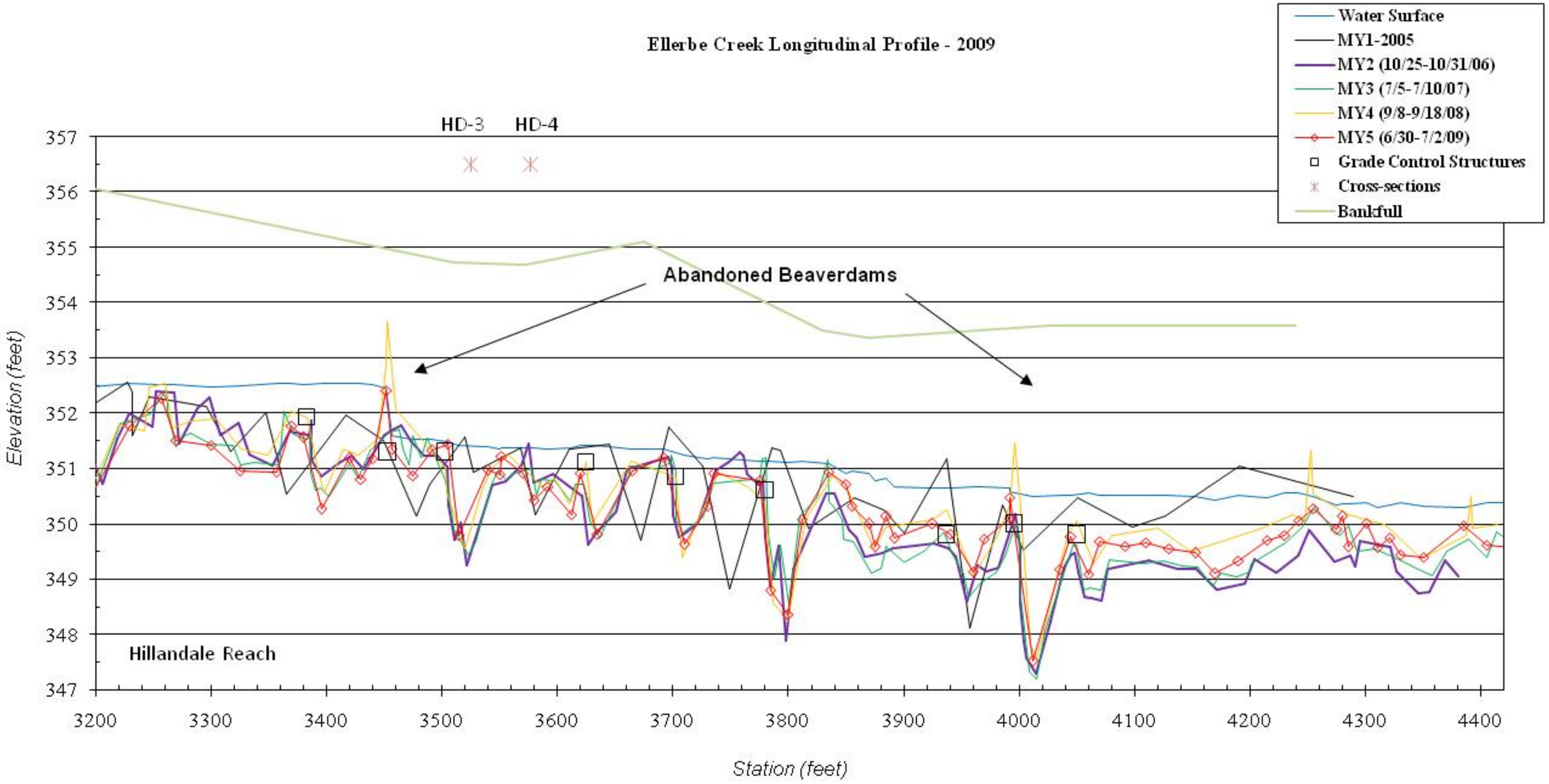
B7. Longitudinal Profile – 2009 – Ellerbe Creek Stream Restoration



B7. Longitudinal Profile – 2009 – Ellerbe Creek Stream Restoration



B7. Longitudinal Profile – 2009 – Ellerbe Creek Stream Restoration



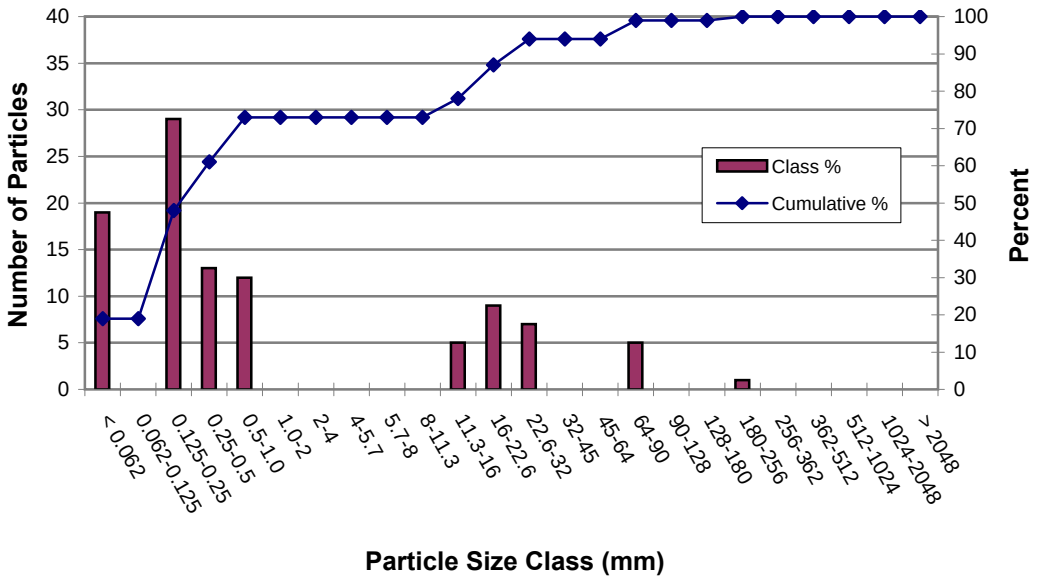
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section HB-XS1

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	19	19	19
Sand	Very Fine Sand	0.062-0.125	0	0	19
	Fine Sand	0.125-0.25	29	29	48
	Medium Sand	0.25-0.5	13	13	61
	Coarse Sand	0.5-1.0	12	12	73
	Very Course Sand	1.0-2	0	0	73
Gravel	Very Fine Gravel	2-4	0	0	73
	Fine Gravel	4-5.7	0	0	73
	Fine Gravel	5.7-8	0	0	73
	Medium Gravel	8-11.3	0	0	73
	Medium Gravel	11.3-16	5	5	78
	Coarse Gravel	16-22.6	9	9	87
	Coarse Gravel	22.6-32	7	7	94
	Very Course Gravel	32-45	0	0	94
	Very Course Gravel	45-64	0	0	94
Cobble	Small Cobble	64-90	5	5	99
	Small Cobble	90-128	0	0	99
	Medium Cobble	128-180	0	0	99
	Large Cobble	180-256	1	1	100
Boulder	Small Boulders	256-362	0	0	100
	Small Boulders	362-512	0	0	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 0.29 mm

d_{84} = 20.4 mm



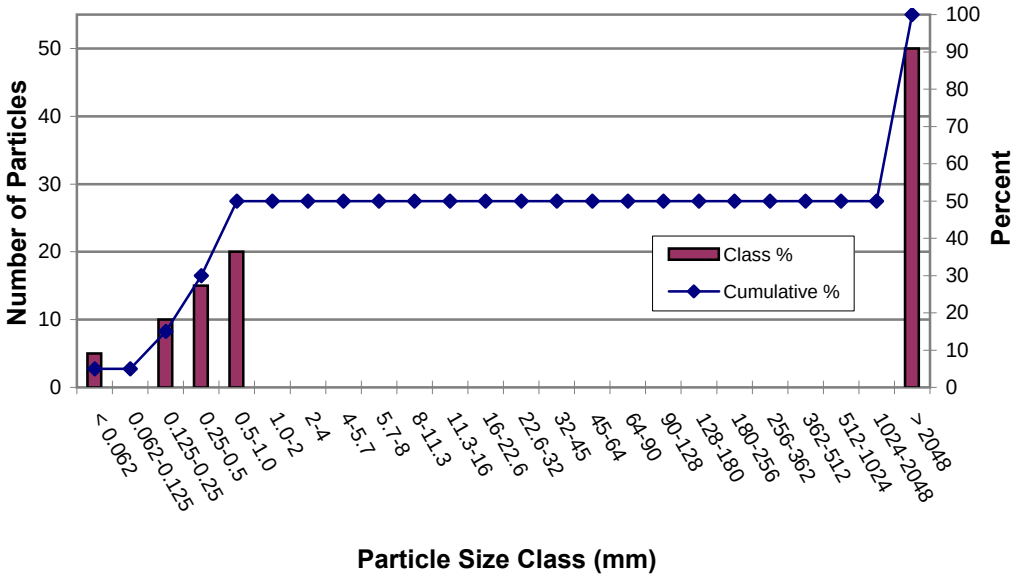
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section HB-XS2

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	5	5	5
Sand	Very Fine Sand	0.062-0.125	0	0	5
	Fine Sand	0.125-0.25	10	10	15
	Medium Sand	0.25-0.5	15	15	30
	Coarse Sand	0.5-1.0	20	20	50
	Very Course Sand	1.0-2	0	0	50
Gravel	Very Fine Gravel	2-4	0	0	50
	Fine Gravel	4-5.7	0	0	50
	Fine Gravel	5.7-8	0	0	50
	Medium Gravel	8-11.3	0	0	50
	Medium Gravel	11.3-16	0	0	50
	Coarse Gravel	16-22.6	0	0	50
	Coarse Gravel	22.6-32	0	0	50
	Very Course Gravel	32-45	0	0	50
	Very Course Gravel	45-64	0	0	50
Cobble	Small Cobble	64-90	0	0	50
	Small Cobble	90-128	0	0	50
	Medium Cobble	128-180	0	0	50
	Large Cobble	180-256	0	0	50
Boulder	Small Boulders	256-362	0	0	50
	Small Boulders	362-512	0	0	50
	Medium Boulders	512-1024	0	0	50
	Large Boulders	1024-2048	0	0	50
	Bedrock	> 2048	50	50	100
	Total		100		

d_{50} = 1.00 mm

d_{84} = 2048 mm



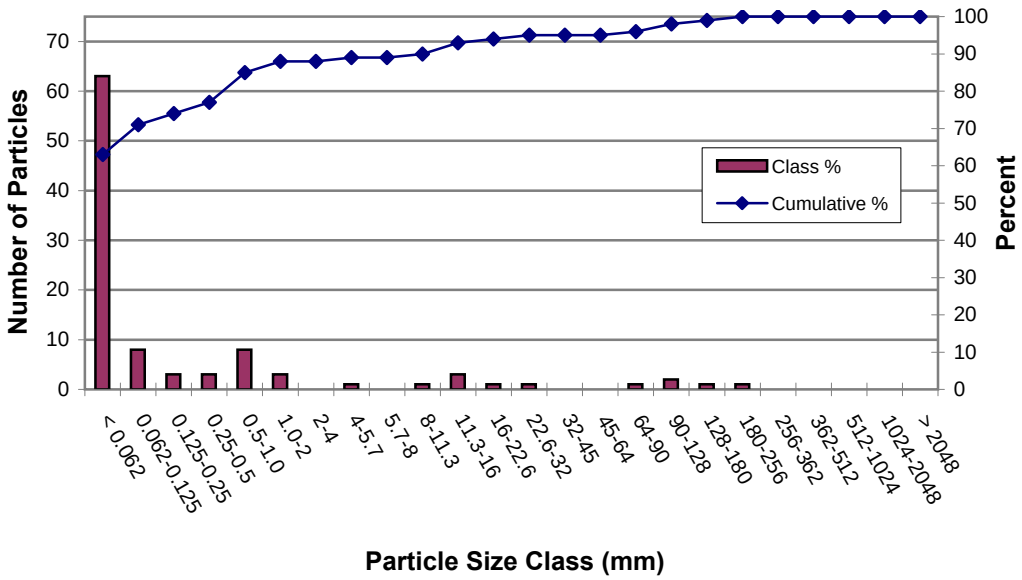
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section HB-XS3

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	63	63	63
Sand	Very Fine Sand	0.062-0.125	8	8	71
	Fine Sand	0.125-0.25	3	3	74
	Medium Sand	0.25-0.5	3	3	77
	Coarse Sand	0.5-1.0	8	8	85
	Very Course Sand	1.0-2	3	3	88
Gravel	Very Fine Gravel	2-4	0	0	88
	Fine Gravel	4-5.7	1	1	89
	Fine Gravel	5.7-8	0	0	89
	Medium Gravel	8-11.3	1	1	90
	Medium Gravel	11.3-16	3	3	93
	Coarse Gravel	16-22.6	1	1	94
	Coarse Gravel	22.6-32	1	1	95
	Very Course Gravel	32-45	0	0	95
	Very Course Gravel	45-64	0	0	95
Cobble	Small Cobble	64-90	1	1	96
	Small Cobble	90-128	2	2	98
	Medium Cobble	128-180	1	1	99
	Large Cobble	180-256	1	1	100
Boulder	Small Boulders	256-362	0	0	100
	Small Boulders	362-512	0	0	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 0.05 mm

d_{84} = 0.94 mm



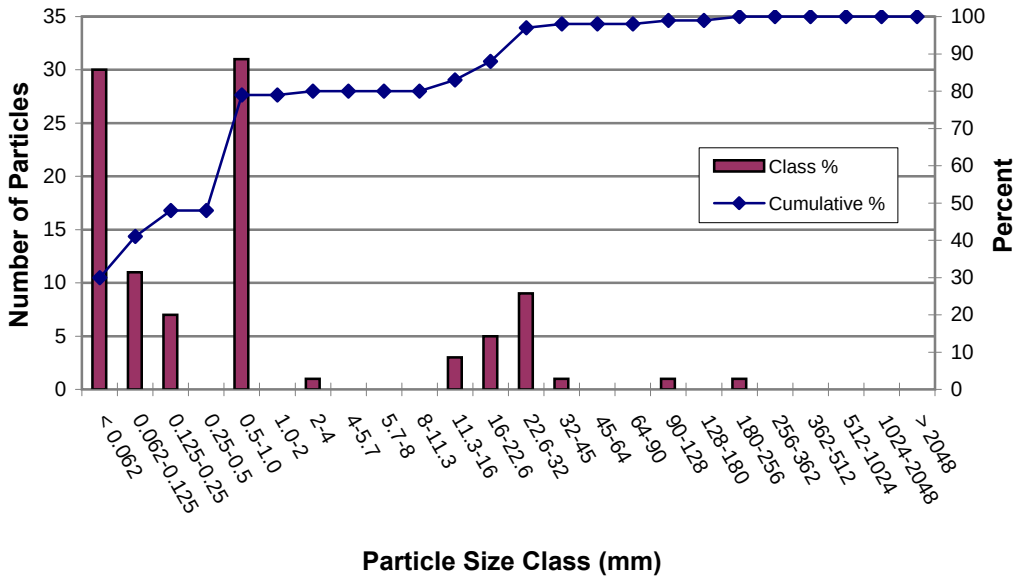
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section HB-XS4

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	30	30	30
Sand	Very Fine Sand	0.062-0.125	11	11	41
	Fine Sand	0.125-0.25	7	7	48
	Medium Sand	0.25-0.5	0	0	48
	Coarse Sand	0.5-1.0	31	31	79
	Very Course Sand	1.0-2	0	0	79
Gravel	Very Fine Gravel	2-4	1	1	80
	Fine Gravel	4-5.7	0	0	80
	Fine Gravel	5.7-8	0	0	80
	Medium Gravel	8-11.3	0	0	80
	Medium Gravel	11.3-16	3	3	83
	Coarse Gravel	16-22.6	5	5	88
	Coarse Gravel	22.6-32	9	9	97
	Very Course Gravel	32-45	1	1	98
	Very Course Gravel	45-64	0	0	98
Cobble	Small Cobble	64-90	0	0	98
	Small Cobble	90-128	1	1	99
	Medium Cobble	128-180	0	0	99
	Large Cobble	180-256	1	1	100
Boulder	Small Boulders	256-362	0	0	100
	Small Boulders	362-512	0	0	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 0.53 mm

d_{84} = 17.32 mm



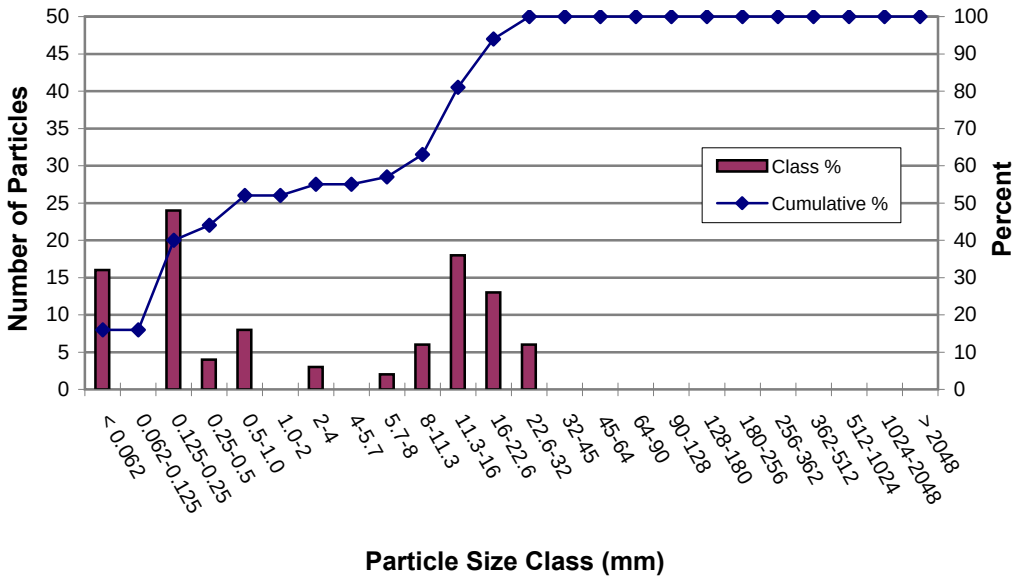
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section HD-XS1

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	16	16	16
Sand	Very Fine Sand	0.062-0.125	0	0	16
	Fine Sand	0.125-0.25	24	24	40
	Medium Sand	0.25-0.5	4	4	44
	Coarse Sand	0.5-1.0	8	8	52
	Very Course Sand	1.0-2	0	0	52
Gravel	Very Fine Gravel	2-4	3	3	55
	Fine Gravel	4-5.7	0	0	55
	Fine Gravel	5.7-8	2	2	57
	Medium Gravel	8-11.3	6	6	63
	Medium Gravel	11.3-16	18	18	81
	Coarse Gravel	16-22.6	13	13	94
	Coarse Gravel	22.6-32	6	6	100
	Very Course Gravel	32-45	0	0	100
	Very Course Gravel	45-64	0	0	100
Cobble	Small Cobble	64-90	0	0	100
	Small Cobble	90-128	0	0	100
	Medium Cobble	128-180	0	0	100
	Large Cobble	180-256	0	0	100
Boulder	Small Boulders	256-362	0	0	100
	Small Boulders	362-512	0	0	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 0.88 mm

d_{84} = 17.52 mm



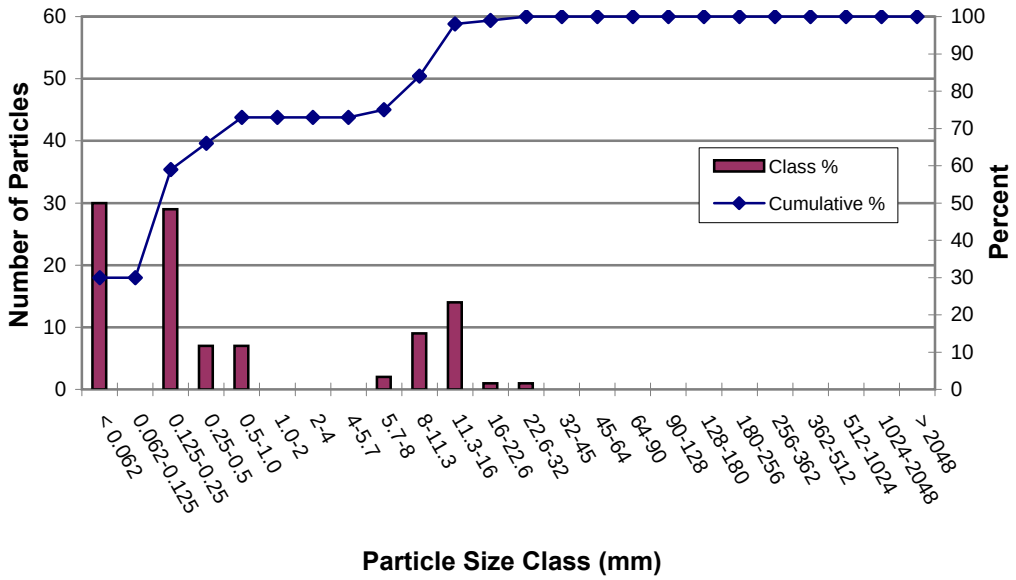
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section HD-XS2

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	30	30	30
Sand	Very Fine Sand	0.062-0.125	0	0	30
	Fine Sand	0.125-0.25	29	29	59
	Medium Sand	0.25-0.5	7	7	66
	Coarse Sand	0.5-1.0	7	7	73
	Very Course Sand	1.0-2	0	0	73
Gravel	Very Fine Gravel	2-4	0	0	73
	Fine Gravel	4-5.7	0	0	73
	Fine Gravel	5.7-8	2	2	75
	Medium Gravel	8-11.3	9	9	84
	Medium Gravel	11.3-16	14	14	98
	Coarse Gravel	16-22.6	1	1	99
	Coarse Gravel	22.6-32	1	1	100
	Very Course Gravel	32-45	0	0	100
	Very Course Gravel	45-64	0	0	100
Cobble	Small Cobble	64-90	0	0	100
	Small Cobble	90-128	0	0	100
	Medium Cobble	128-180	0	0	100
	Large Cobble	180-256	0	0	100
Boulder	Small Boulders	256-362	0	0	100
	Small Boulders	362-512	0	0	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 0.21 mm

d_{84} = 11.30 mm



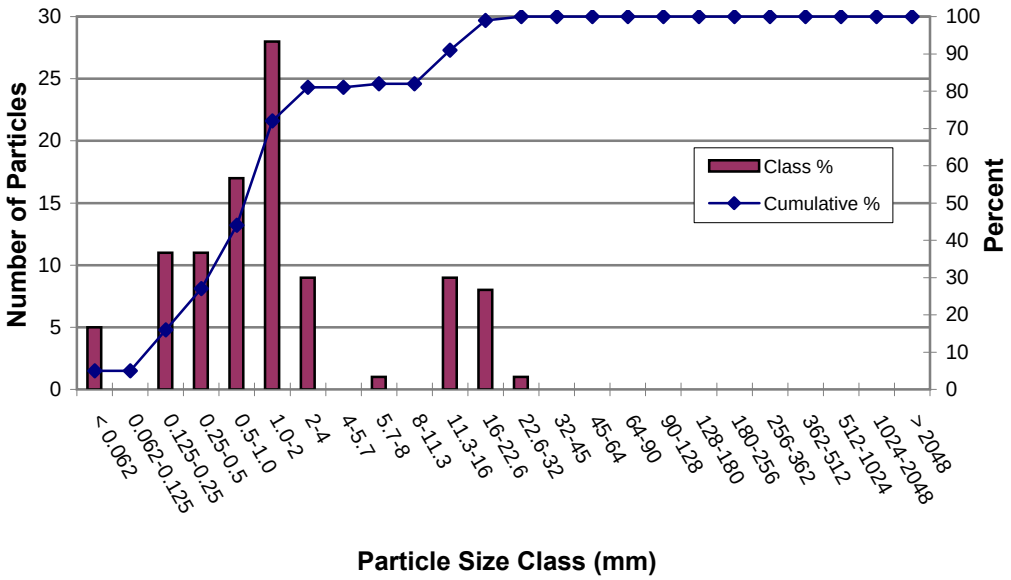
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section HD-XS3

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	5	5	5
Sand	Very Fine Sand	0.062-0.125	0	0	5
	Fine Sand	0.125-0.25	11	11	16
	Medium Sand	0.25-0.5	11	11	27
	Coarse Sand	0.5-1.0	17	17	44
	Very Course Sand	1.0-2	28	28	72
Gravel	Very Fine Gravel	2-4	9	9	81
	Fine Gravel	4-5.7	0	0	81
	Fine Gravel	5.7-8	1	1	82
	Medium Gravel	8-11.3	0	0	82
	Medium Gravel	11.3-16	9	9	91
	Coarse Gravel	16-22.6	8	8	99
	Coarse Gravel	22.6-32	1	1	100
	Very Course Gravel	32-45	0	0	100
	Very Course Gravel	45-64	0	0	100
Cobble	Small Cobble	64-90	0	0	100
	Small Cobble	90-128	0	0	100
	Medium Cobble	128-180	0	0	100
	Large Cobble	180-256	0	0	100
Boulder	Small Boulders	256-362	0	0	100
	Small Boulders	362-512	0	0	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 1.21 mm

d_{84} = 12.34 mm



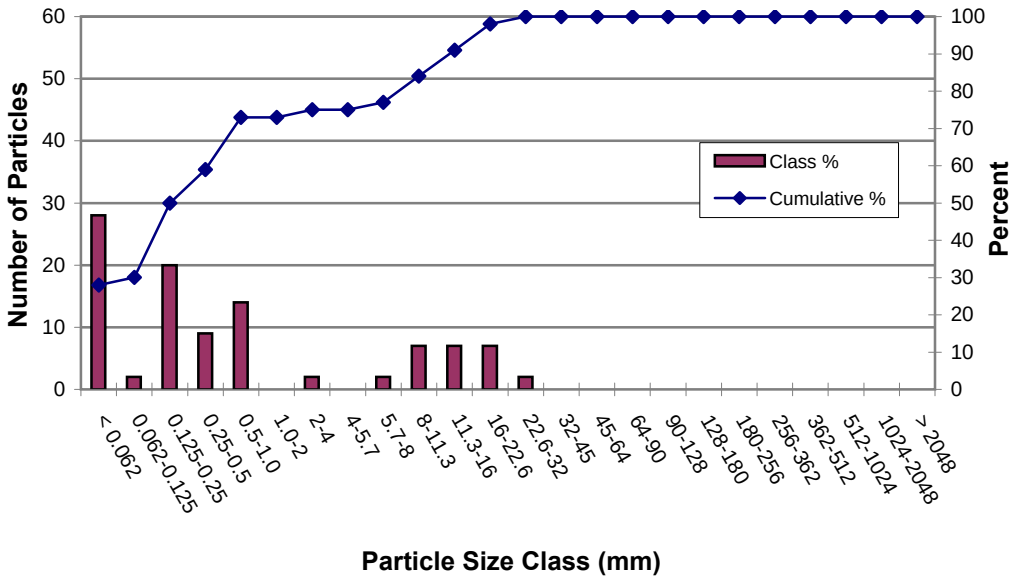
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section HD-XS4

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	28	28	28
Sand	Very Fine Sand	0.062-0.125	2	2	30
	Fine Sand	0.125-0.25	20	20	50
	Medium Sand	0.25-0.5	9	9	59
	Coarse Sand	0.5-1.0	14	14	73
	Very Course Sand	1.0-2	0	0	73
Gravel	Very Fine Gravel	2-4	2	2	75
	Fine Gravel	4-5.7	0	0	75
	Fine Gravel	5.7-8	2	2	77
	Medium Gravel	8-11.3	7	7	84
	Medium Gravel	11.3-16	7	7	91
	Coarse Gravel	16-22.6	7	7	98
	Coarse Gravel	22.6-32	2	2	100
	Very Course Gravel	32-45	0	0	100
	Very Course Gravel	45-64	0	0	100
Cobble	Small Cobble	64-90	0	0	100
	Small Cobble	90-128	0	0	100
	Medium Cobble	128-180	0	0	100
	Large Cobble	180-256	0	0	100
Boulder	Small Boulders	256-362	0	0	100
	Small Boulders	362-512	0	0	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 0.25 mm

d_{84} = 11.30 mm



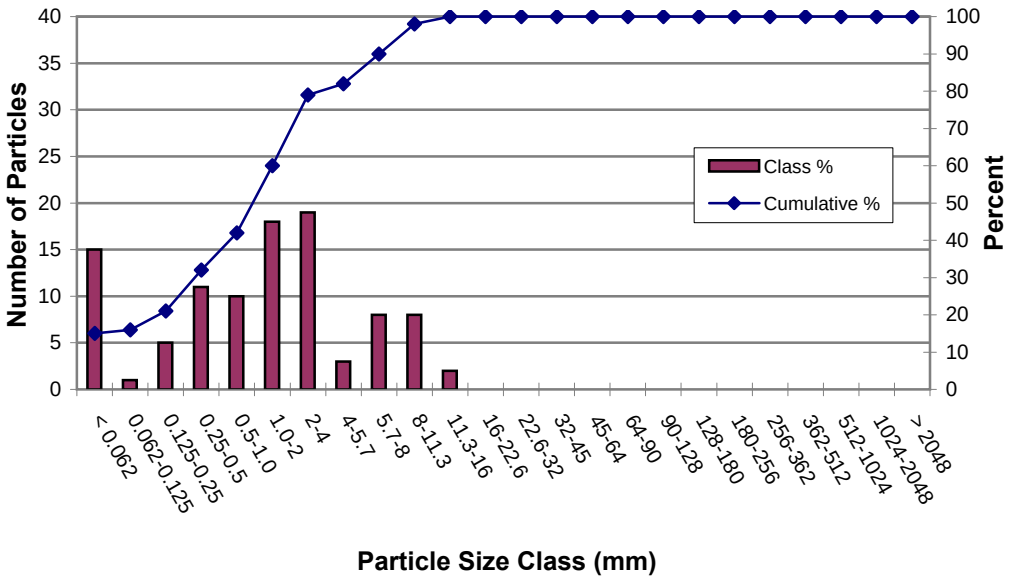
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section AL-XS1

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	15	15	15
Sand	Very Fine Sand	0.062-0.125	1	1	16
	Fine Sand	0.125-0.25	5	5	21
	Medium Sand	0.25-0.5	11	11	32
	Coarse Sand	0.5-1.0	10	10	42
	Very Course Sand	1.0-2	18	18	60
Gravel	Very Fine Gravel	2-4	19	19	79
	Fine Gravel	4-5.7	3	3	82
	Fine Gravel	5.7-8	8	8	90
	Medium Gravel	8-11.3	8	8	98
	Medium Gravel	11.3-16	2	2	100
	Coarse Gravel	16-22.6	0	0	100
	Coarse Gravel	22.6-32	0	0	100
	Very Course Gravel	32-45	0	0	100
	Very Course Gravel	45-64	0	0	100
Cobble	Small Cobble	64-90	0	0	100
	Small Cobble	90-128	0	0	100
	Medium Cobble	128-180	0	0	100
	Large Cobble	180-256	0	0	100
Boulder	Small Boulders	256-362	0	0	100
	Small Boulders	362-512	0	0	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 1.44 mm

d_{84} = 6.27 mm



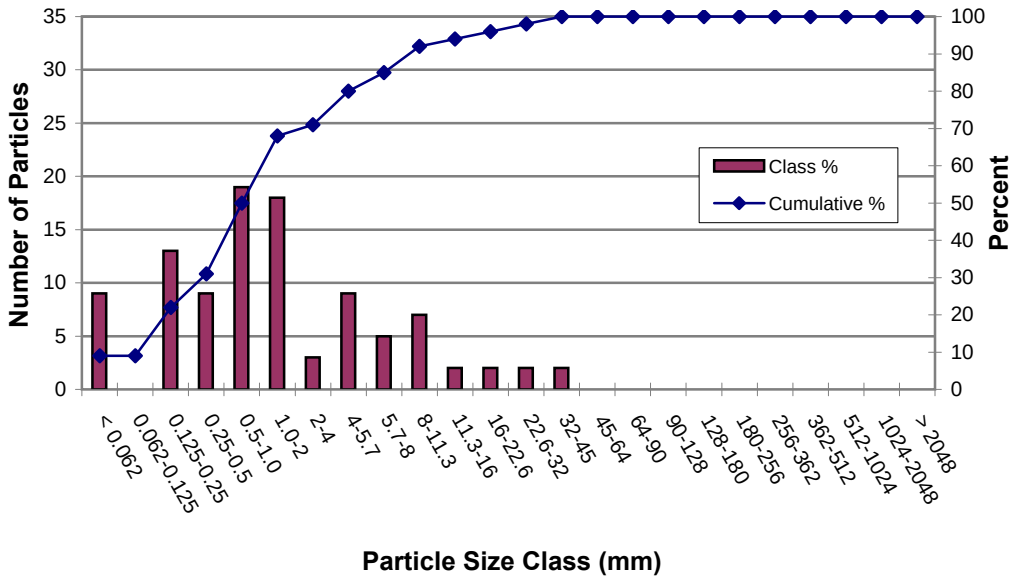
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section AL-XS2

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	9	9	9
Sand	Very Fine Sand	0.062-0.125	0	0	9
	Fine Sand	0.125-0.25	13	13	22
	Medium Sand	0.25-0.5	9	9	31
	Coarse Sand	0.5-1.0	19	19	50
	Very Course Sand	1.0-2	18	18	68
Gravel	Very Fine Gravel	2-4	3	3	71
	Fine Gravel	4-5.7	9	9	80
	Fine Gravel	5.7-8	5	5	85
	Medium Gravel	8-11.3	7	7	92
	Medium Gravel	11.3-16	2	2	94
	Coarse Gravel	16-22.6	2	2	96
	Coarse Gravel	22.6-32	2	2	98
	Very Course Gravel	32-45	2	2	100
	Very Course Gravel	45-64	0	0	100
Cobble	Small Cobble	64-90	0	0	100
	Small Cobble	90-128	0	0	100
	Medium Cobble	128-180	0	0	100
	Large Cobble	180-256	0	0	100
Boulder	Small Boulders	256-362	0	0	100
	Small Boulders	362-512	0	0	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 1.00 mm

d_{84} = 7.54 mm



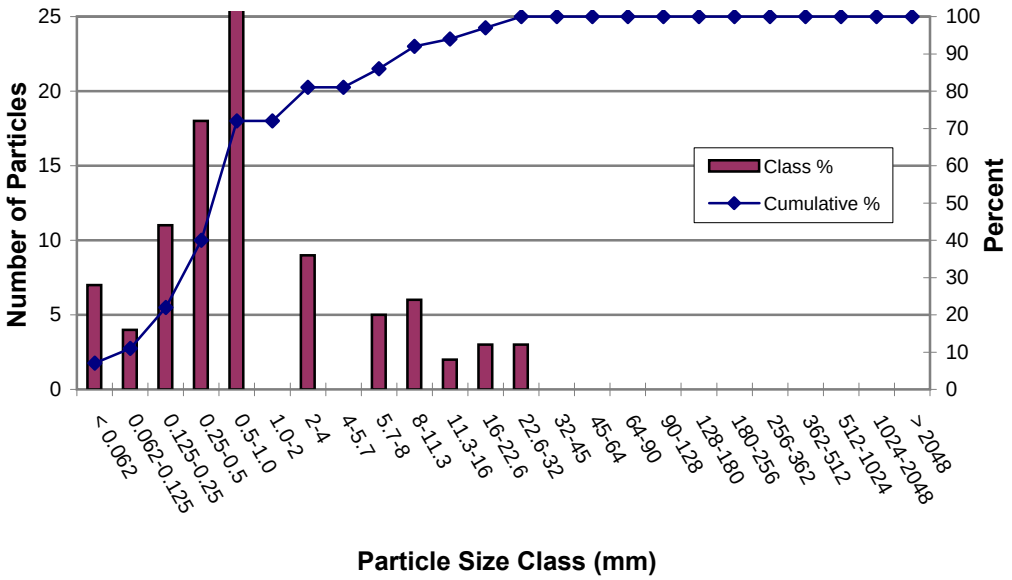
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section AL-XS3

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	7	7	7
Sand	Very Fine Sand	0.062-0.125	4	4	11
	Fine Sand	0.125-0.25	11	11	22
	Medium Sand	0.25-0.5	18	18	40
	Coarse Sand	0.5-1.0	32	32	72
	Very Course Sand	1.0-2	0	0	72
Gravel	Very Fine Gravel	2-4	9	9	81
	Fine Gravel	4-5.7	0	0	81
	Fine Gravel	5.7-8	5	5	86
	Medium Gravel	8-11.3	6	6	92
	Medium Gravel	11.3-16	2	2	94
	Coarse Gravel	16-22.6	3	3	97
	Coarse Gravel	22.6-32	3	3	100
	Very Course Gravel	32-45	0	0	100
	Very Course Gravel	45-64	0	0	100
Cobble	Small Cobble	64-90	0	0	100
	Small Cobble	90-128	0	0	100
	Medium Cobble	128-180	0	0	100
	Large Cobble	180-256	0	0	100
Boulder	Small Boulders	256-362	0	0	100
	Small Boulders	362-512	0	0	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 0.66 mm

d_{84} = 7.08 mm



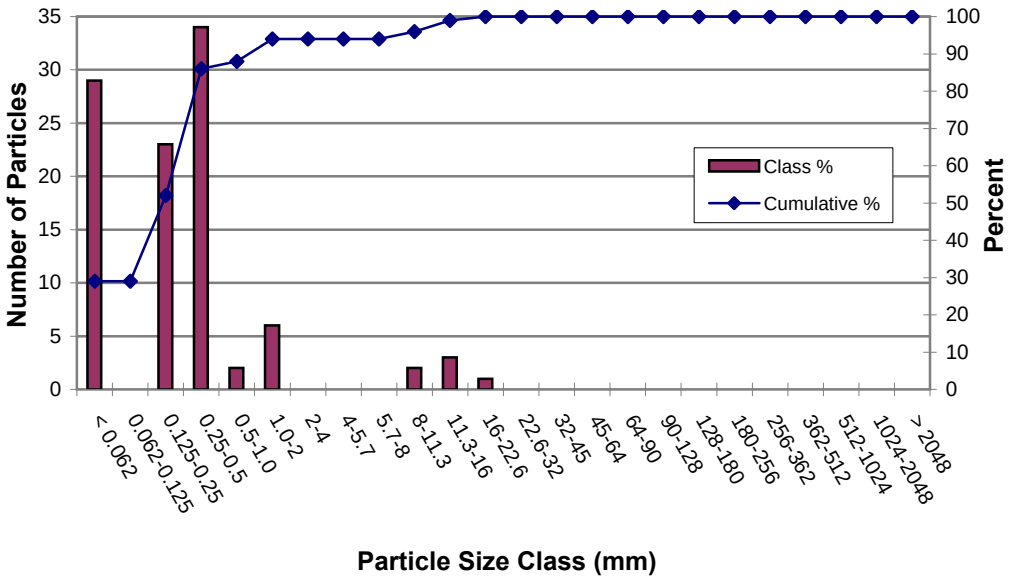
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section AL-XS4

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	29	29	29
Sand	Very Fine Sand	0.062-0.125	0	0	29
	Fine Sand	0.125-0.25	23	23	52
	Medium Sand	0.25-0.5	34	34	86
	Coarse Sand	0.5-1.0	2	2	88
	Very Course Sand	1.0-2	6	6	94
Gravel	Very Fine Gravel	2-4	0	0	94
	Fine Gravel	4-5.7	0	0	94
	Fine Gravel	5.7-8	0	0	94
	Medium Gravel	8-11.3	2	2	96
	Medium Gravel	11.3-16	3	3	99
	Coarse Gravel	16-22.6	1	1	100
	Coarse Gravel	22.6-32	0	0	100
	Very Course Gravel	32-45	0	0	100
	Very Course Gravel	45-64	0	0	100
Cobble	Small Cobble	64-90	0	0	100
	Small Cobble	90-128	0	0	100
	Medium Cobble	128-180	0	0	100
	Large Cobble	180-256	0	0	100
Boulder	Small Boulders	256-362	0	0	100
	Small Boulders	362-512	0	0	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 0.24 mm

d_{84} = 0.49 mm



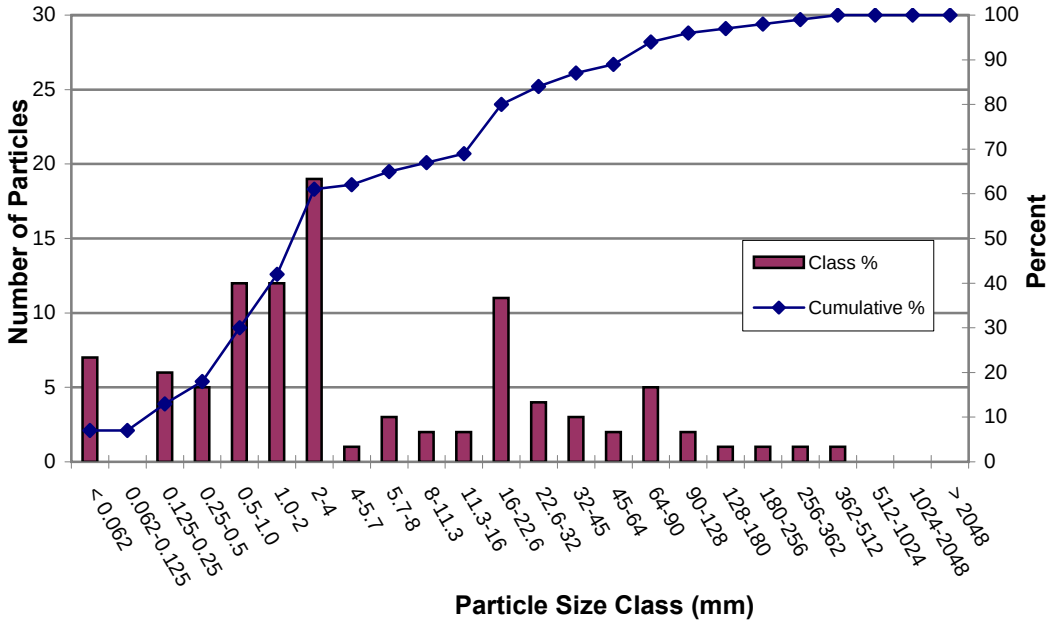
B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section CR-XS1

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	7	7	7
Sand	Very Fine Sand	0.062-0.125	0	0	7
	Fine Sand	0.125-0.25	6	6	13
	Medium Sand	0.25-0.5	5	5	18
	Coarse Sand	0.5-1.0	12	12	30
	Very Course Sand	1.0-2	12	12	42
Gravel	Very Fine Gravel	2-4	19	19	61
	Fine Gravel	4-5.7	1	1	62
	Fine Gravel	5.7-8	3	3	65
	Medium Gravel	8-11.3	2	2	67
	Medium Gravel	11.3-16	2	2	69
	Coarse Gravel	16-22.6	11	11	80
	Coarse Gravel	22.6-32	4	4	84
	Very Course Gravel	32-45	3	3	87
	Very Course Gravel	45-64	2	2	89
Cobble	Small Cobble	64-90	5	5	94
	Small Cobble	90-128	2	2	96
	Medium Cobble	128-180	1	1	97
	Large Cobble	180-256	1	1	98
Boulder	Small Boulders	256-362	1	1	99
	Small Boulders	362-512	1	1	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 2.84 mm

d_{84} = 32.00 mm



B8. Pebble Count - 2009 - Ellerbe Creek Stream Restoration 07/16/2009

Cross Section CR-XS2

	Particle	Size Range (mm)	Total #	Class %	Cumulative %
S/C	Silt/Clay	< 0.062	53	53	53
Sand	Very Fine Sand	0.062-0.125	0	0	53
	Fine Sand	0.125-0.25	5	5	58
	Medium Sand	0.25-0.5	1	1	59
	Coarse Sand	0.5-1.0	6	6	65
	Very Course Sand	1.0-2	0	0	65
Gravel	Very Fine Gravel	2-4	0	0	65
	Fine Gravel	4-5.7	0	0	65
	Fine Gravel	5.7-8	2	2	67
	Medium Gravel	8-11.3	1	1	68
	Medium Gravel	11.3-16	6	6	74
	Coarse Gravel	16-22.6	5	5	79
	Coarse Gravel	22.6-32	9	9	88
	Very Course Gravel	32-45	0	0	88
	Very Course Gravel	45-64	2	2	90
Cobble	Small Cobble	64-90	5	5	95
	Small Cobble	90-128	1	1	96
	Medium Cobble	128-180	1	1	97
	Large Cobble	180-256	3	3	100
Boulder	Small Boulders	256-362	0	0	100
	Small Boulders	362-512	0	0	100
	Medium Boulders	512-1024	0	0	100
	Large Boulders	1024-2048	0	0	100
	Bedrock	> 2048	0	0	100
	Total		100		

d_{50} = 0.06 mm

d_{84} = 27.82 mm