

**Northgate Park (Ellerbe Creek)
Stream Restoration Monitoring Report
EEP Project # 272
Monitoring Year 02**



Submitted to:



NCDENR-EEP, 1652 Mail Service Center, Raleigh, NC 27699-1652

**Data Collection: 2010
Construction Completed: December 2008
Submitted: December 2010**

Monitoring Firm



**Landmark Center II, Suite 220
4601 Six Forks Road
Raleigh, NC 27609
Phone: (919) 278-2514
Fax: (919) 783-9266**

**Project Contact: Adam Spiller
Email: adam.spiller@kci.com
KCI Project No: 12071067B_EC10**

Design Firm



URS Corporation – North Carolina
1600 Perimeter Park Drive
Suite 400
Morrisville, North Carolina 27560
(919) 461-1100
Fax (919) 461-1415

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1.0 EXECUTIVE SUMMARY / PROJECT ABSTRACT

In 2008, the North Carolina Ecosystem Enhancement Program (EEP) restored and enhanced a reach of Ellerbe Creek, an Unnamed Tributary to Ellerbe Creek (UT 3), and stream buffer within Northgate Park in Durham County, NC. The project also included the creation of two stormwater wetlands with outfalls to the project streams. The 5.9-mi² project watershed is located in US Geological Survey Hydrologic Unit 03020201-05-0010 (NC Division of Water Quality Sub-basin 03-04-01) of the Neuse River Basin. This Hydrologic Unit is within EEP's *Ellerbe Creek Local Watershed Plan* (2003) area and is also listed as a Targeted Local Watershed (TLW) in EEP's *Neuse River Basin Priorities Plan* (2010). This project is within the Falls Lake watershed, a drinking supply reservoir for the City of Raleigh. The drainage area for the site is urban residential land. The State has a permanent conservation easement of 7.5 acres and the project is located entirely within Northgate Park, which is a City of Durham public park. The project stream begins at the pedestrian bridge near the baseball diamond and flows 2,284 linear feet to the culvert under Acadia Street. The project goals and objectives are listed below.

Project Goals

- Improving water quality.
- Enhancing flood attenuation.
- Restoring aquatic and riparian habitat.

Project Objectives

- Restoring the Project Reach to a stable urban stream channel that will retain its dimension, pattern, and profile over time, and that is capable of transporting watershed flows and sediment load efficiently.
- Using Priority II restoration to change Ellerbe Creek from a G5c type stream channel to a E type channel.
- Enhancing the capacity of the site to mitigate flood flows by improving the connection of the stream to its floodplain.
- Improving aquatic habitat by establishing a heterogeneous bed morphology with riffle-pool sequences supported by in-stream structures.
- Restoring the riparian buffer from park grasses and herbaceous vegetation to Piedmont Bottomland Forest to provide filtration of nutrients and organic matter inputs into the stream, to improve wildlife habitat, and to provide shade for the stream channel.
- Reducing sediment inputs from localized streambank erosion by re-establishing stream geometry and by stabilizing and revegetating the stream banks.
- Installing three stormwater wetland best management practices (BMPs) to reduce stormwater pollutants (namely nitrogen and phosphorus) and improve water quality prior to discharging into the stream.

Construction was completed at the site in December 2008. In March 2009, live stakes were planted along the stream and the stormwater wetlands were planted. The planting of the riparian buffer was delayed until November 2009 when the rest of the site was planted with tublings and containerized plants. After planting, six vegetation plots were installed following the CVS-EEP vegetation monitoring procedure, five in buffer restoration areas and one in the planted stream riparian zone. This report documents the first year of vegetation monitoring. The vegetation monitoring success criterion for the planted stream riparian zone is a density of 320 stems/acre after the third year of monitoring and an allowance for 10% mortality in the fourth and fifth years with a final density of 260 stems/acre. The vegetation monitoring success criterion for the buffer restoration zone is a density of 320 stems/acre after the fifth year of monitoring. The first-year vegetation monitoring was based on the Level 2 CVS-EEP vegetation monitoring protocol. The site's average density for this monitoring period was 384 planted stems/acre. Five of the six plots had greater than 320 planted stems/acre, with plot 4 having only 81 planted stems/acre. Including volunteers, the site averaged 2,434 total stems/acre, with 445 total stems/acre being the lowest stem density of all the

plots. The easement includes a few isolated areas of managed herbaceous zones (as shown in Figure 2) for public safety sight line considerations and pedestrian trail access. Invasive vegetation was present onsite prior to restoration and is present in areas adjacent to the project. Scattered invasive species are present throughout the site, with Japanese hops (*Humulus japonicas*) being the most problematic. The 2010 monitoring found some areas with low densities of planted trees and areas where the conservation easement had been mowed. Low live stake survival rates across the site are attributed to bank erosion washing the stakes away along with deposition burying the stakes. The streamside vegetation, especially the willows (*Salix spp.*) on the lower half of the site, has also been impacted by beaver, and they have destroyed many of the previously large and healthy trees along the bankfull bench. There is no beaver dam or lodge on-site; the beaver are most likely accessing the site from downstream of the project reaches.

The project as-built survey was conducted in January 2009 and KCI conducted the first-year monitoring survey in January 2010. The longitudinal profile in Appendix D includes the longitudinal profile data from both of these surveys. The as-built profile data are limited in that the survey measurements taken were not annotated in the field and water surface measurements were not taken. As a result, the survey is not detailed enough to generate baseline profile morphology data. The five detailed cross-sections were installed after the as-built survey, so there are no baseline dimensional data, but there are first-year dimensional data. This year's cross-sectional survey reveals bank erosion in cross-sections 3, 4, and 5. The longitudinal profile illustrates areas of bed degradation and the lack of well defined riffle features, which can be typical in urban sand bed streams such as this one. The second year of monitoring found most of Reach 1 to be stable and functioning as designed. Upstream of the Lavender St. culvert there is one area of aggradation contributing to adjacent toe erosion, but otherwise there are no other significant problem areas. Downstream of the Lavender St. culvert the stream has more areas of bank erosion and bed degradation. All but three of the project's in-stream structures are functioning without any problems. These areas have been called out in the Current Condition Plan View (CCPV). As a part of the stream success criterion, the stream must experience at least two bankfull events, each in separate monitoring years. The site has experienced multiple bankfull events since construction.

Summary information/data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report appendices. Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report (formerly Mitigation Plan) and in the Mitigation Plan (formerly the Restoration Plan) documents available on the EEP's website. All raw data supporting the tables and figures in the appendices are available from EEP upon request.

2.0 METHODOLOGY

The survey data were collected with a total station instrument, using control coordinates supplied by URS and the as-built surveyor, Level Cross.

The stationing for the longitudinal profile is based on the thalweg stationing and has been adjusted to match grade control structures from previous longitudinal profiles.

The CVS-EEP protocol, Level 2 (<http://cvs.bio.unc.edu/methods.htm>) was used to collect vegetation data from the site.

3.0 REFERENCES

- DWQ, 2000. Neuse Riparian Buffer Mitigation Rules. **15A NCAC 2B .0242**
(<http://ncrules.state.nc.us/ncac/title%2015a%20-%20environment%20and%20natural%20resources/chapter%2002%20-%20environmental%20management/subchapter%20b/15a%20ncac%2002b%20.0242.html>)
- EEP. 2003. Ellerbe Creek Local Watershed Plan.
(http://www.nceep.net/services/lwps/Upper_Neuse/Ellerbe_Creek_Local_Watershed_Plan.pdf)
- EEP. 2010. Neuse River Basin Restoration Priorities.
(draft available:
http://www.nceep.net/services/restplans/DRAFT_RBRP_Neuse_201007.pdf)
- Lee, M. T., R. K. Peet, S. D. Roberts, and T. R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0 (<http://cvs.bio.unc.edu/methods.htm>).
- USACE. 2003. Stream Mitigation Guidelines.
(<http://www.saw.usace.army.mil/wetlands/Mitigation/Documents/Stream/>).
- Weakley, A. S. 2006. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas.
(http://www.herbarium.unc.edu/FloraArchives/WeakleyFlora_2006-Jan.pdf).

Appendix A

Project Vicinity Map and Background Tables

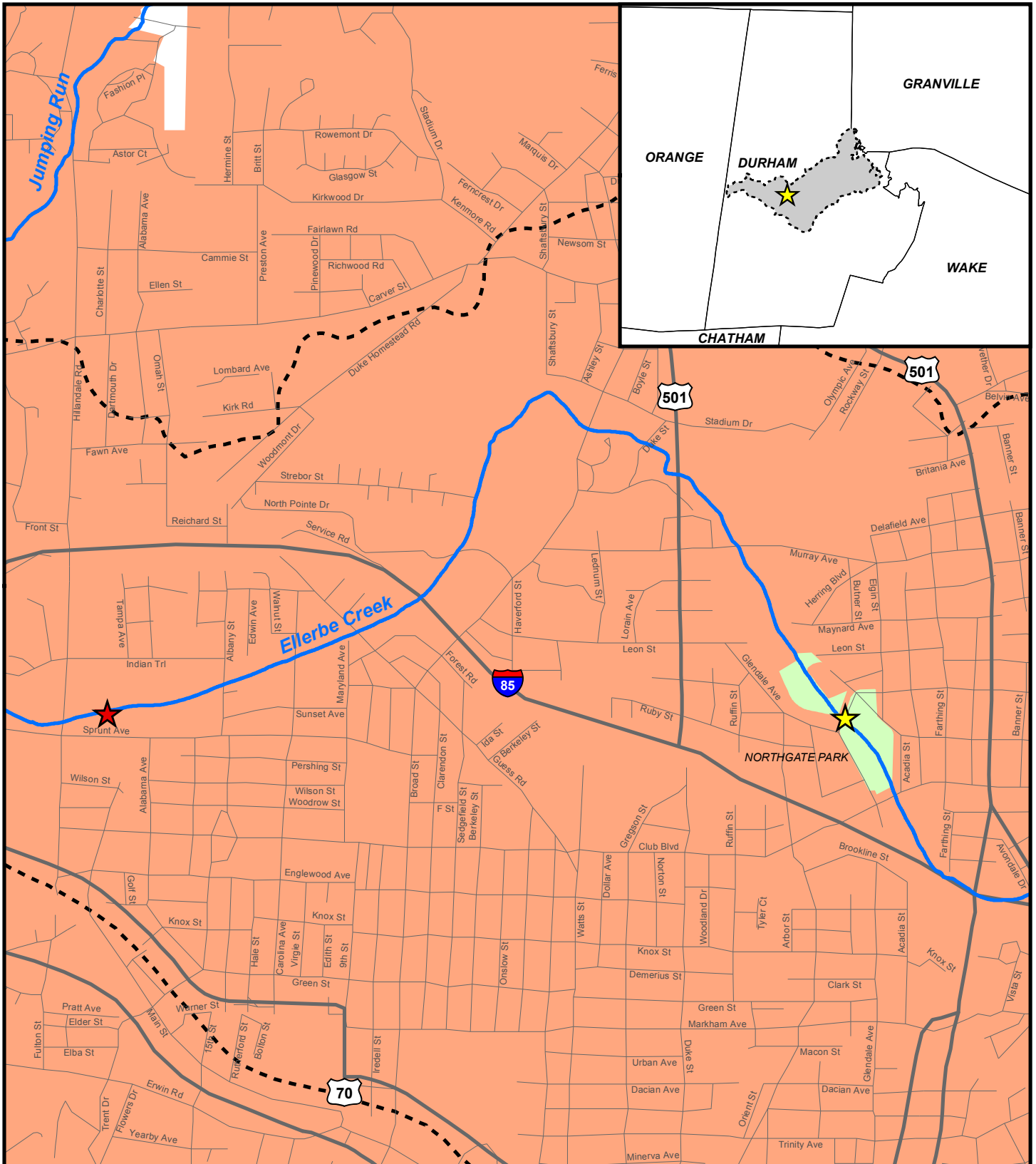
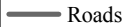

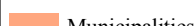

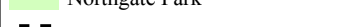
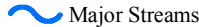




Figure 1. Vicinity Map



-  Roads
-  Counties
-  Municipalities
-  Northgate Park
-  Local Watershed Plan Boundary

-  Major Streams
-  Project Location
-  Hillandale Golf Course Project #127




 1:24,000
 1 inch = 2,000 feet




Table 1a. Project Restoration Components
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)

Segment/ Reach ID	Existing Linear Feet	Restoration Level	Approach	Linear Feet / Square Feet	Stationing	Mitigation Ratio	Mitigation Units	BMP Elements	Comment
Reach 1	1,520	EI	P2	1,242*	10+00 - 25+20	1.5:1	828		Reach was regraded to create a bankfull channel with a new profile and a bankfull bench, and instream structures were installed along the existing planform. Two tributaries enter Reach 1.
Reach 2	646	R	P2	750	25+20 - 32+70	1:1	750	SW	Reach was regraded to create a bankfull channel with a new profile and a bankfull bench, and instream structures were installed along a new planform. One stormwater wetland captures runoff prior to discharge in Reach 2.
UT 3	104	R	P2	117	100+00 - 101+17	1:1	117	SW	Reach was regraded to create a bankfull channel with a new profile and a bankfull bench, and instream structures were installed along a new planform. UT 3 is a perennial stream with a stormwater wetland immediately upstream.
Buffer		R		158,172		1:1	158,172		The existing buffer had fewer than 100 stems/acre and was planted with native vegetation.
Buffer		E		10,000		3:1	3,333		The existing buffer had greater than 100, but fewer than 200 stems/acre and was planted with native vegetation.

R = Restoration P2 = Priority 2
 EI = Enhancement I SW = Stormwater Wetland
 E = Enhancement

* The stream length for Reach 1 does not include the following easement exceptions: stream with one-sided easement, Lavender Street road right-of-way, and the pedestrian bridge crossing.

Table 1b. Project Component Summations							
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)							
Restoration Level	Stream (lf)	Riparian Wetland (Ac)		Non-Ripar (Ac)	Upland (Ac)	Buffer (Ac)	BMP
		Riverine	Non-Riverine				
Restoration	867						
Enhancement							
Enhancement I	1,247						
Enhancement II							
Creation							
Preservation							
HQ Preservation							
		0	0				
Totals (Feet/Acres)	2,114	0	0	0	0	3.71	2
MU Totals	1,578	0	0	0	0	3.66	
	Non-Applicable						

Table 2. Project Activity and Reporting History		
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)		
Elapsed Time Since Grading Complete: 2 yr 0 months		
Elapsed Time Since Planting Complete: 1 yr 1 month		
Number of Reporting Years: 2		
Activity or Report	Data Collection Complete	Actual Completion or Delivery
Concept Plan		Jan 06
Restoration Plan		Jun 06
Final Design - 90%		May 07
Construction		Dec 08
As-Built Survey		Jan 09
Live Stake Planting		Mar 09
Riparian Buffer Planting		Nov 09
Year 1 Stream Monitoring and Baseline Vegetation Monitoring	Nov 09 - Jan 10	May 10
Year 2 Stream Monitoring and Year 1 Vegetation Monitoring	Sept 10 - Dec 10	Dec 10

Table 3. Project Contacts Table	
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)	
Design Firm	URS 1600 Perimeter Park Drive, Suite 400 Morrisville, North Carolina 27560 Contact: Ms. Kathleen McKeithan Phone: (919) 461-1597
Construction Contractor	Environmental Quality Resources, LLC 1405 Benson Court, Suite C Arbutus, MD 21227 Contact: Mr. John Talley Phone: (443) 304-3310 ext.110 Fax: (443) 304-3315
Planting Contractor	HARP 301 McCullough Drive, 4th Floor Charlotte, North Carolina 28262 Contact: Mr. Alan Peoples Phone: (704) 841-2841
Monitoring Performers	
MY-00, 01, 02	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 278-2514 Fax: (919) 783-9266

Table 4. Project Attribute Table			
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)			
Project County	Durham County		
Physiographic Region	Piedmont		
Ecoregion	Triassic Basin		
Project River Basin	Neuse		
USGS HUC for Project (14 digit)	03020201050010		
NCDWQ Sub-basin for Project	03-04-01		
Within extent of EEP Watershed Plan?	Yes - Ellerbe Creek LWP		
WRC Class (Warm, Cool, Cold)	Warm		
% of project easement demarcated	100%		
Beaver activity observed during design phase?	No		
Restoration Component Attribute Table			
	Reach 1	Reach 2	UT 3
Drainage Area	5.9 sq.mi.	5.9 sq.mi.	-
Stream Order	Third	Third	First
Restored length (feet)	1,466	690	117
Perennial or Intermittent	Perennial	Perennial	Perennial
Watershed Type (Rural, Urban, Developing, etc.)	Urban		
Watershed LULC Distribution			
Urban	38%		
Ag-Row Crop	0%		
Ag-Livestock	0%		
Forested	62%		
Water/Wetlands	<1%		
Watershed impervious cover (%)	-		
NCDWQ AU/Index Number	27-5-(0.7)		
NCDWQ Classification	WS-IV; NSW		
303d listed?	Yes		
Upstream of a 303d listed segment?	Yes		
Reasons for 303d Listing or Stressor	impaired biological integrity		
Total acreage of easement	7.5 Acres		
Total vegetated acreage within the easement	1.0 Acre		
Total planted acreage as part of the restoration	6.4 Acres		
Rosgen Classification of pre-existing	G5c	G5c	-
Rosgen Classification of As-built	C5	C5	-
Valley Type	U	U	U
Valley Slope	0.0006	0.0005	U
Valley side slope range (e.g. 2-3%)	U	U	U
Valley toe slope range (e.g. 2-3%)	U	U	U
Trout waters designation	No		
Species of concern, endangered etc.? (Y/N)	No		
Dominant soil series and characteristics			
Series	Chewacla and Wehadkee		
Depth Clay%	-	-	-
K	-	-	-
T	-	-	-

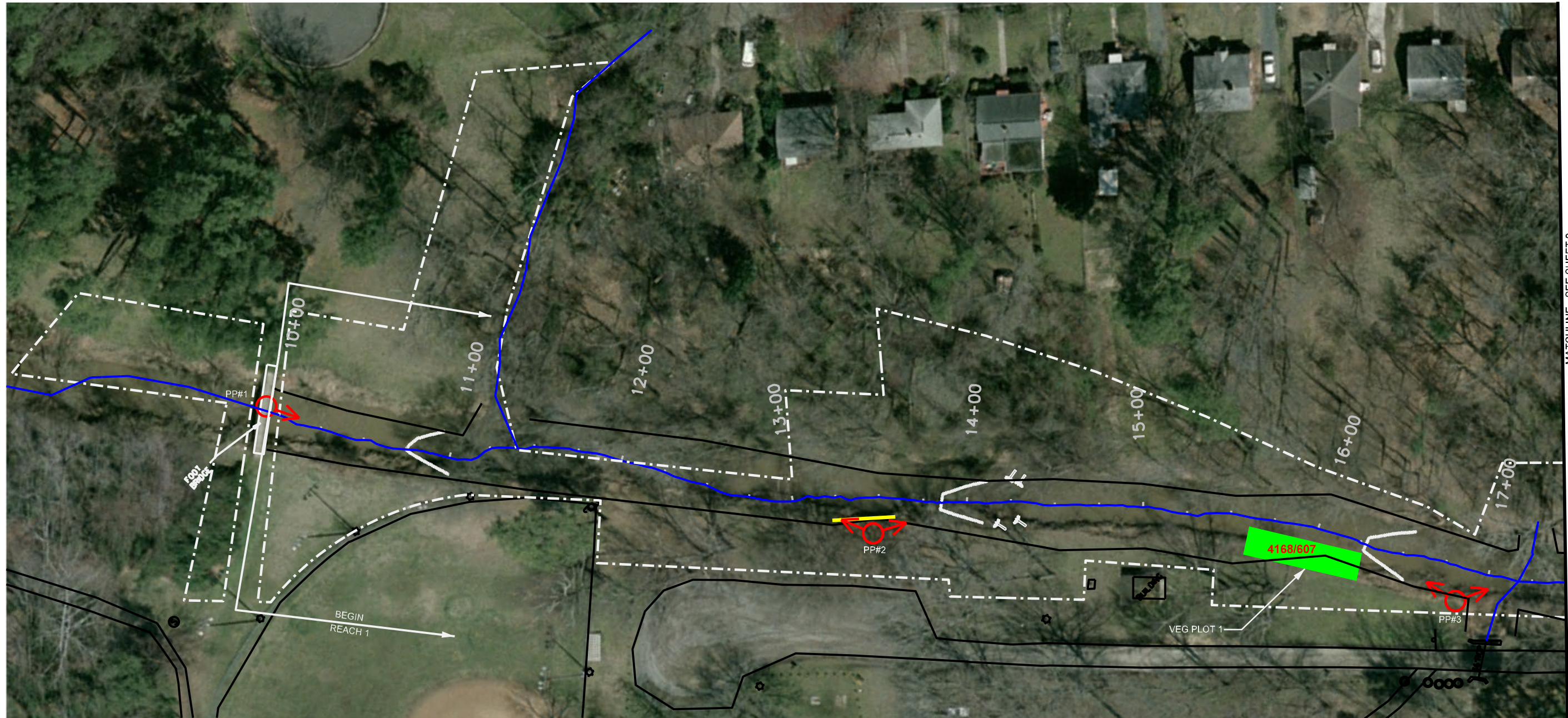
"N/A" is for items that do not apply.

"-" is for items that are unavailable.

"U" is for items that are unknown.

Appendix B

Visual Assessment Data



LEGEND

EASEMENT BOUNDARY.....	
AS-BUILT STATIONED CENTERLINE AND TOP OF BANK.....	
PHOTO POINT.....	
CROSS-SECTION.....	
BMP.....	
OLD STREAM CHANNEL.....	

PROJECT CONDITION

STREAM BED DEGRADATION.....	
BANK EROSION.....	
UNDERCUT BANK.....	
MASS WASTING OF BANK.....	
VEG PLOT ACHIEVING DENSITY CRITERION.....	
VEG PLOT BELOW DENSITY CRITERION.....	
INVASIVE SPECIES.....	
MOWED BUFFER.....	
LOW PLANTED STEM DENSITY.....	

PROJECT CONDITION DETAILS

VEG PLOT TOTAL / PLANTED STEM DENSITY.....	890/423
STRUCTURE PIPING.....	P
STRUCTURE NOT PROTECTING BANKS.....	B
STRUCTURE NOT PROVIDING ADEQUATE GRADE CONTROL.....	G
ALL MAPPED INVASIVE SPECIES AREAS ARE JAPANESE HOPS (HUMULUS JAPONICUS)	



MATCHLINE - SEE SHEET 2

MATCHLINE - SEE SHEET 2

NO.	DATE	REVISIONS



KCI
ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4801 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

**NORTHGATE PARK (ELLERBE CREEK)
PROJECT #272 - MONITORING YEAR 02**
DURHAM, DURHAM COUNTY, NORTH CAROLINA
ELLERBE CREEK: STATION 10+00 TO STATION 17+40

DATE: DEC 2010
SCALE: 1" = 60'
CURRENT CONDITION PLAN VIEW
SHEET 1 OF 3

MATCHLINE - SEE SHEET 1

MATCHLINE - SEE SHEET 1

MATCHLINE - SEE SHEET 3

MATCHLINE - SEE SHEET 3



LEGEND

- EASEMENT BOUNDARY.....
- AS-BUILT STATIONED.....
- CENTERLINE AND TOP OF BANK.....
- PHOTO POINT.....
- CROSS-SECTION.....
- BMP.....
- OLD STREAM CHANNEL.....

PROJECT CONDITION

- STREAM BED DEGRADATION.....
- BANK EROSION.....
- UNDERCUT BANK.....
- MASS WASTING OF BANK.....
- VEG PLOT ACHIEVING DENSITY CRITERION.....
- VEG PLOT BELOW DENSITY CRITERION.....
- INVASIVE SPECIES.....
- MOWED BUFFER.....
- LOW PLANTED.....
- STEM DENSITY.....

PROJECT CONDITION DETAILS

- VEG PLOT TOTAL / PLANTED STEM DENSITY..... **890/423**
- STRUCTURE PIPING..... **P**
- STRUCTURE NOT PROTECTING BANKS..... **B**
- STRUCTURE NOT PROVIDING ADEQUATE GRADE CONTROL..... **G**
- ALL MAPPED INVASIVE SPECIES AREAS ARE JAPANESE HOPS (HUMULUS JAPONICUS)



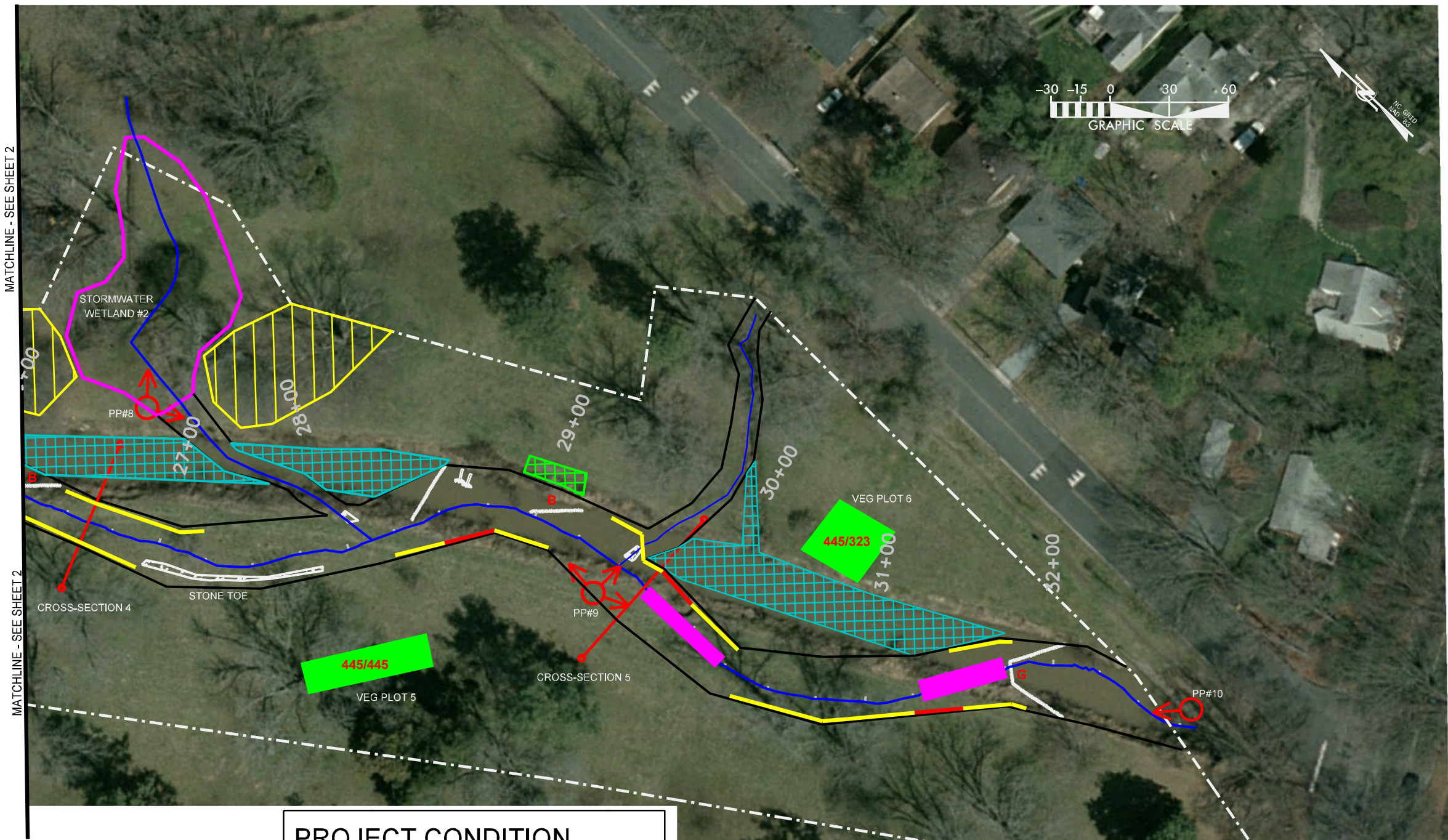
REV.	DATE	DESCRIPTION	APPROVED



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4801 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

**NORTHGATE PARK (ELLERBE CREEK)
PROJECT #272 - MONITORING YEAR 02**
DURHAM, DURHAM COUNTY, NORTH CAROLINA
ELLERBE CREEK: STATION 17+40 TO STATION 28+25

DATE: DEC 2010
SCALE: 1" = 60'
CURRENT CONDITION PLAN VIEW
SHEET 2 OF 3



LEGEND

EASEMENT BOUNDARY.....	
AS-BUILT STATIONED CENTERLINE AND TOP OF BANK.....	
PHOTO POINT.....	
CROSS-SECTION.....	
BMP.....	
OLD STREAM CHANNEL.....	

PROJECT CONDITION

STREAM BED DEGRADATION.....	
BANK EROSION.....	
UNDERCUT BANK.....	
MASS WASTING OF BANK.....	
VEG PLOT ACHIEVING DENSITY CRITERION.....	
VEG PLOT BELOW DENSITY CRITERION.....	
INVASIVE SPECIES.....	
MOWED BUFFER.....	
LOW PLANTED STEM DENSITY.....	

PROJECT CONDITION DETAILS

VEG PLOT TOTAL / PLANTED STEM DENSITY.....	890/423
STRUCTURE PIPING.....	P
STRUCTURE NOT PROVIDING ADEQUATE GRADE CONTROL.....	B
STRUCTURE NOT PROVIDING ADEQUATE GRADE CONTROL.....	G
ALL MAPPED INVASIVE SPECIES AREAS ARE JAPANESE HOPS (HUMULUS JAPONICUS)	

REV.	DATE	DESCRIPTION



KCI
ASSOCIATES OF NC
ENGINEERS • PLANNERS • SCIENTISTS
4801 SIX FORKS ROAD
RALEIGH, NORTH CAROLINA 27609

**NORTHGATE PARK (ELLERBE CREEK)
PROJECT #272 - MONITORING YEAR 02**
DURHAM, DURHAM COUNTY, NORTH CAROLINA
ELLERBE CREEK: STATION 26+25 TO STATION 32+70

DATE: DEC 2010
SCALE: 1" = 60'
CURRENT CONDITION PLAN VIEW
SHEET 3 OF 3

Table 5. Visual Stream Morphology Stability Assessment										
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)										
Reach 1 Assessed Length 1520										
Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run units)	1. <u>Aggradation</u> - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			1	40	97%			
		2. <u>Degradation</u> - Evidence of downcutting			0	0	100%			
	2. Riffle Condition*	1. <u>Texture/Substrate</u> - Riffle maintains coarser substrate	2	8			25%			
		3. Meander Pool Condition ⁺	1. <u>Depth Sufficient</u> (Max Pool Depth : Mean Bankfull Depth \geq 1.6)	6			13			
			2. <u>Length appropriate</u> (>30% of centerline distance between tail of upstream riffle and head of downstream riffle)	6			13			
	4. Thalweg Position ⁺	1. Thalweg centering at upstream of meander bend (Run)	0	0			N/A			
2. Thalweg centering at downstream of meander (Glide)		0	0	N/A						
Totals							9	451	85%	0
2. Bank	1. Scoured/ Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			9	451	85%	0	0	85%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does <u>NOT</u> include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%	0	0	100%
Totals					9	451	85%	0	0	85%
3. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	7	7			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	7	7			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	6	7			86%			
	3. Bank Protection	Bank erosion within the structures extent of influence does <u>not</u> exceed 15%. (See guidance for this table in EEP monitoring guidance document)	6	7			86%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio \geq 1.6 Rootwads/logs providing some cover at base-flow.	7	7			100%			

* Due to the channel's sand bed, all riffles have fine sediment. Additionally, riffles are poorly defined throughout the system because the slope changes only take place at the grade control structures, not at bed features.

⁺This is not a meandering reach, so all pools are associated with structures.

Table 5. Visual Stream Morphology Stability Assessment										
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)										
Reach 2 Assessed Length 750										
Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run units)	1. <u>Aggradation</u> - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. <u>Degradation</u> - Evidence of downcutting			2	115	85%			
	2. Riffle Condition*	1. <u>Texture/Substrate</u> - Riffle maintains coarser substrate	4	5			80%			
		3. Meander Pool Condition+	1. <u>Depth</u> Sufficient (Max Pool Depth : Mean Bankfull Depth \geq 1.6)	6	13			46%		
	2. <u>Length</u> appropriate ($>$ 30% of centerline distance between tail of upstream riffle and head of downstream riffle)		6	13			46%			
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run)	3	5			60%			
		2. Thalweg centering at downstream of meander (Glide)	2	5			40%			
Totals					14	567	62%	0	0	62%
2. Bank	1. Scoured/Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			11	492	67%	0	0	67%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse			3	75	95%	0	0	95%
Totals					14	567	62%	0	0	62%
3. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	3	4			75%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	0	1			0%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	4	4			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	2	4			50%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio \geq 1.6 Rootwads/logs providing some cover at base-flow.	4	4			100%			

* Due to the channel's sand bed, all riffles have fine sediment. Additionally, riffles are poorly defined throughout the system because the slope changes only take place at the grade control structures, not at bed features. This estimate of as-built riffles is from a combination of the as-built and MY01 survey data.

+This also includes pools that are not associated with meander bends.

Table 6. Vegetation Condition Assessment						
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)						
Planted Acreage 6.4			Easement Acreage 7.5			
Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	0.1 acres	Pattern and Color	0	0.00	0.0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 acres	Pattern and Color	1	0.10	1.6%
Total				1	0.10	1.6%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	Pattern and Color	0	0.00	0.0%
Cumulative Total				1	0.10	1.6%
4. Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale).	1000 SF	Pattern and Color	3	0.05	0.7%
5. Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale).	none	Pattern and Color	2	0.15	2.0%

Stream Station Photos



PP#1 – MY01 – 1/19/10



PP#1 – MY02 – 12/9/10



PP#2A – MY01 – 1/19/10



PP#2A – MY02 – 12/9/10



PP#2B – MY01 – 1/19/10



PP#2B – MY02 – 12/9/10



PP#3A – MY01 – 1/19/10



PP#3A – MY02 – 12/9/10



PP#3B – MY01 – 1/19/10



PP#3B – MY02 – 12/9/10



PP#4 – MY01 – 1/19/10



PP#4 – MY02 – 12/9/10



PP#5 – MY01 – 1/19/10



PP#5 – MY02 – 12/7/10



PP#6A – MY01 – 1/19/10



PP#6A – MY02 – 12/7/10



PP#6B – MY01 – 1/19/10



PP#6B – MY02 – 12/7/10



PP#7A – MY01 – 1/19/10



PP#7A – MY02 – 12/7/10



PP#7B – MY01 – 1/19/10



PP#7B – MY02 – 12/7/10



PP#8A – MY01 – 1/19/10



PP#8A – MY02 – 12/7/10



PP#8B – MY01 – 1/19/10



PP#8B – MY02 – 12/7/10



PP#9A – MY01 – 1/19/10



PP#9A – MY02 – 12/7/10



PP#9B – MY01 – 1/19/10



PP#9B – MY02 – 12/7/10



PP#9C – MY01 – 1/19/10



PP#9C – MY02 – 12/7/10



PP#10 – MY01 – 1/19/10



PP#10 – MY02 – 12/7/10

Vegetation Monitoring Plot Photos



Plot 1 Photo – Taken looking southeast from the plot origin. 9/10/10 - MY01



Plot 4 Photo – Taken looking south from the plot origin. 9/10/10 MY01



Plot 2 Photo – Taken looking south from the plot origin. 9/10/10 – MY01



Plot 5 Photo – Taken looking east from the plot origin. 9/10/10 – MY01



Plot 3 Photo – Taken looking east from the plot origin. 10/22/10 – MY01



Plot 6 Photo – Taken looking south from the plot origin. 9/10/10 – MY01

Appendix C

Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment	
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)	
Vegetation Plot ID	Vegetation Survival Threshold Met?
1	Yes
2	Yes
3	Yes
4	No
5	Yes
6	Yes

Table 8. CVS Vegetation Plot Metadata	
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)	
Report Prepared By	Adam Spiller
Date Prepared	12/14/2010 9:50
database name	KCI-2010-EC.mdb
database location	M:\2007\12071067_2007 EEP OPEN END\Veg_database
computer name	12-CSPV0M1
file size	55091200
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT-----	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
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.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY-----	
Project Code	272
project Name	Ellerbe Creek
Description	Stream and Buffer Restoration and Enhancement
River Basin	Neuse
length(ft)	2200
stream-to-edge width (ft)	40
area (sq m)	16349.28
Required Plots (calculated)	6
Sampled Plots	6

Table 9. CVS Stem Count Total and Planted by Plot and Species
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)

			Current Plot Data (MY1 2010)																		Annual Means						
Scientific Name	Common Name	Species Type	272-A-0001			272-A-0002			272-A-0003			272-A-0004			272-A-0005			272-A-0006			MY1 (2010)			MY0 (2009)			
			P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	P-LS	P-all	T	
Acer	maple																									5	5
Acer rubrum	red maple	Tree			1																						
Acer saccharum	sugar maple	Shrub Tree					4	4																			
Alnus serrulata	hazel alder	Shrub Tree			4																						
Aronia arbutifolia	Red Chokeberry	Shrub																									
Betula nigra	river birch	Tree			3																						
Celtis laevigata	sugarberry	Shrub Tree			8																						
Cornus	dogwood	Shrub Tree																									
Cornus amomum	silky dogwood	Shrub																									
Diospyros virginiana	common persimmon	Tree																									
Fraxinus pennsylvanica	green ash	Tree			24																						
Juniperus virginiana	eastern redcedar	Tree			2																						
Liquidambar styraciflua	sweetgum	Tree			37																						
Liriodendron tulipifera	tuliptree	Tree			4																						
Oxydendrum arboreum	sourwood	Shrub Tree																									
Physocarpus	ninebark																										
Pinus taeda	loblolly pine	Tree																									
Platanus occidentalis	American sycamore	Tree			5																						
Quercus	oak	Shrub Tree																									
Quercus coccinea	scarlet oak	Tree																									
Quercus lyrata	overcup oak	Tree																									
Quercus michauxii	swamp chestnut oak	Tree			5																						
Quercus pagoda	cherrybark oak	Tree																									
Quercus phellos	willow oak	Tree																									
Salix nigra	black willow	Tree																									
Sambucus canadensis	Common Elderberry	Shrub Tree			10																						
Spiraea	spirea																										
Symphoricarpos orbiculatus	coralberry	Shrub																									
Ulmus	elm	Tree																									
Unknown		unknown																									
Stem count			0	15	103	0	12	32	0	9	44	0	2	160	0	11	11	0	8	11	0	57	361	4	89	89	
size (ares)			1			1			1			1			1			1			6			6			
size (ACRES)			0.02			0.02			0.02			0.02			0.02			0.02			0.15			0.15			
Species count			0	3	11	0	4	10	0	5	8	0	2	10	0	5	5	0	4	6	0	17	26	3	22	22	
Stems per ACRE			0	607	4168	0	486	1295	0	364	1781	0	80.9	6475	0	445	445	0	324	445	0	384	2435	27	600	600	

Appendix D

Stream Survey Data

Cross-Section Plots

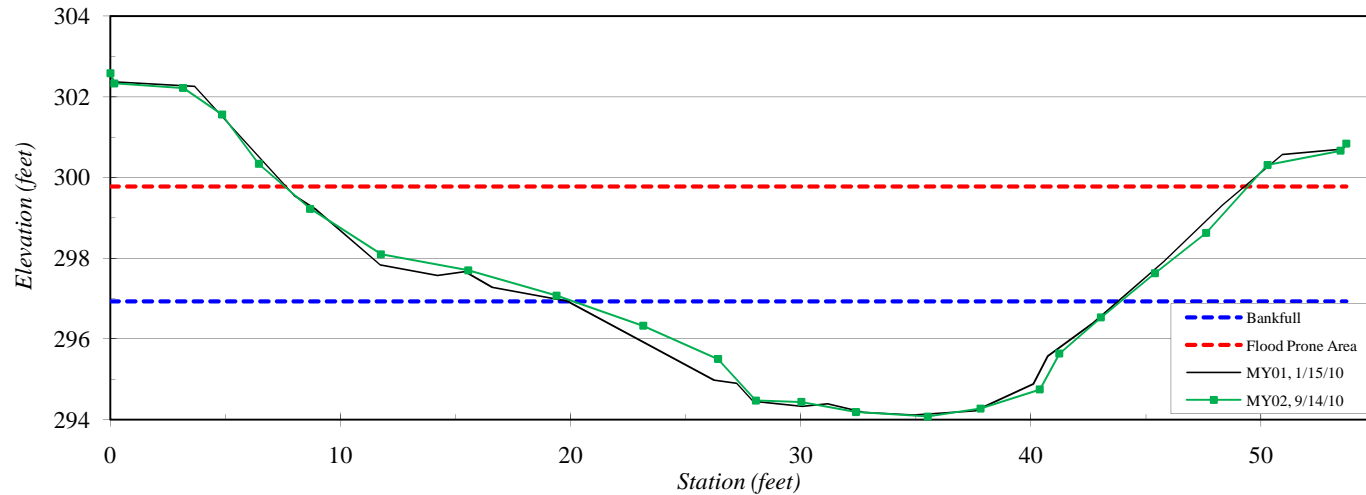
River Basin:	Neuse
Watershed:	Ellerbe Creek, MY02
XS ID	XS - 1, Reach 1, Riffle
Drainage Area (sq mi):	5.9
Date:	9/14/2010
Field Crew:	A. French, A. Helms



Station	Elevation
0.0	302.59
0.2	302.33
3.2	302.22
4.9	301.56
6.5	300.34
8.7	299.22
11.8	298.10
15.5	297.70
19.4	297.08
23.2	296.33
26.4	295.50
28.1	294.47
30.0	294.44
32.4	294.19
35.5	294.08
37.8	294.28
40.4	294.75
41.2	295.64
43.0	296.53
45.4	297.63
47.6	298.63
50.3	300.31
53.5	300.66
53.7	300.84

SUMMARY DATA	
Bankfull Elevation:	296.9
Bankfull Cross-Sectional Area:	43.1
Bankfull Width:	23.8
Flood Prone Area Elevation:	299.8
Flood Prone Width:	42
Max Depth at Bankfull:	2.8
Mean Depth at Bankfull:	1.8
W / D Ratio:	13.1
Entrenchment Ratio:	1.8
Bank Height Ratio:	1.0

Neuse River Basin, Ellerbe Creek, MY02, XS - 1, Reach 1, Riffle



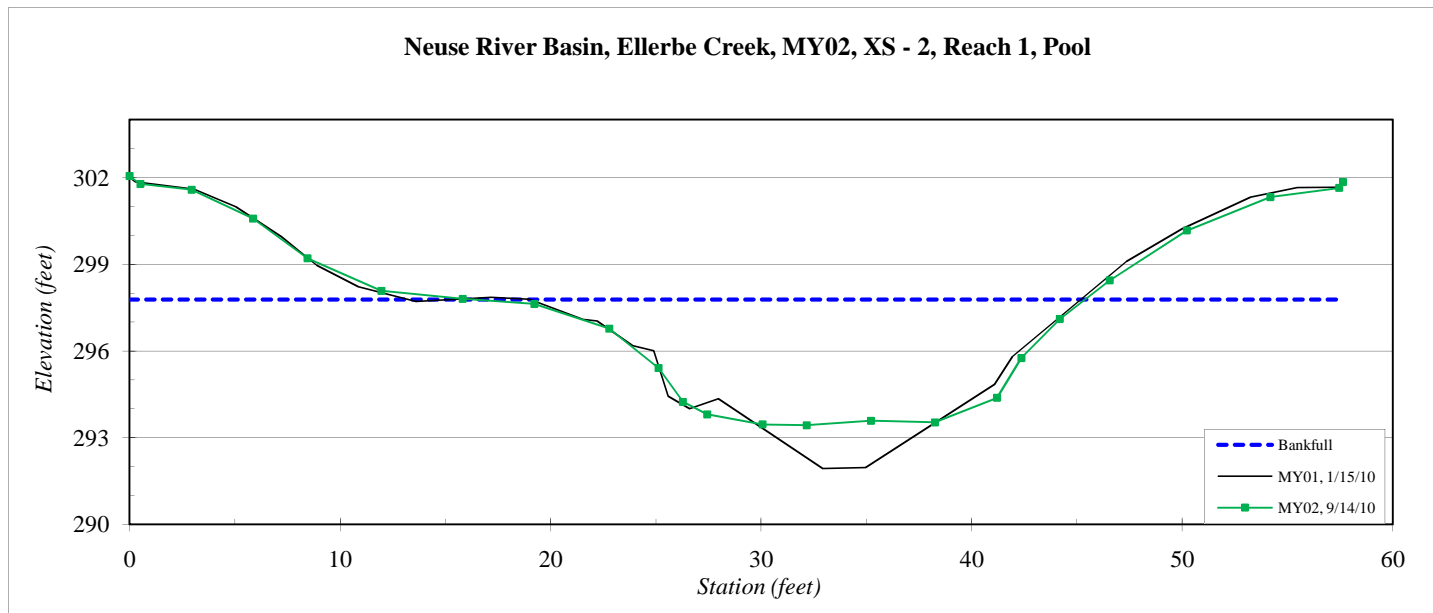
River Basin:	Neuse
Watershed:	Ellerbe Creek, MY02
XS ID	XS - 2, Reach 1, Pool
Drainage Area (sq mi):	5.9
Date:	9/14/2010
Field Crew:	A. French, A. Helms



Station	Elevation
0.0	302.05
0.5	301.78
2.9	301.58
5.9	300.58
8.5	299.20
12.0	298.08
15.8	297.81
19.2	297.63
22.8	296.77
25.1	295.41
26.3	294.24
27.4	293.81
30.1	293.46
32.2	293.43
35.2	293.59
38.3	293.53
41.2	294.38
42.4	295.75
44.2	297.11
46.6	298.44
50.2	300.17
54.2	301.32
57.5	301.64
57.6	301.84

SUMMARY DATA	
Bankfull Elevation:	297.8
Bankfull Cross-Sectional Area:	77.3
Bankfull Width:	29.2
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	4.3
Mean Depth at Bankfull:	2.6
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Neuse River Basin, Ellerbe Creek, MY02, XS - 2, Reach 1, Pool



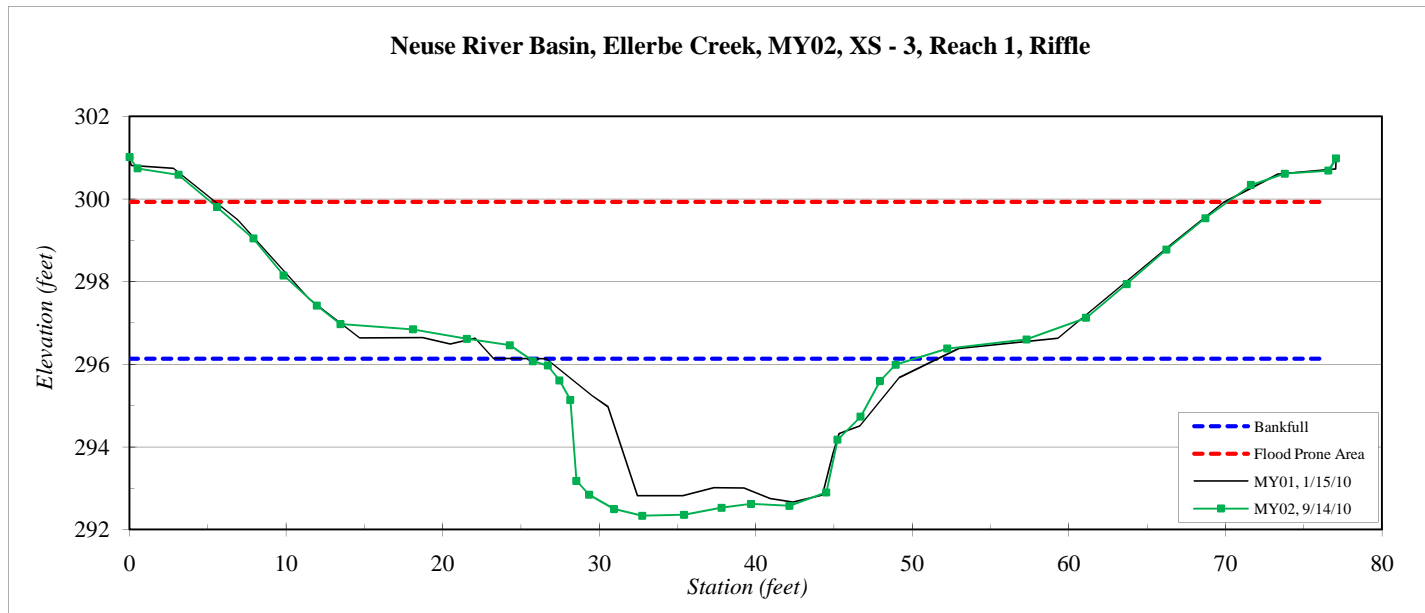
River Basin:	Neuse
Watershed:	Ellerbe Creek, MY02
XS ID	XS - 3, Reach 1, Riffle
Drainage Area (sq mi):	5.9
Date:	9/14/2010
Field Crew:	A. French, A. Helms



Station	Elevation
0.0	301.01
0.5	300.74
3.1	300.58
5.6	299.80
7.9	299.04
9.8	298.15
12.0	297.42
13.5	296.97
18.1	296.84
21.5	296.62
24.3	296.46
25.8	296.07
26.7	295.97
27.5	295.61
28.2	295.14
28.5	293.18
29.4	292.84
31.0	292.50
32.7	292.33
35.4	292.36
37.8	292.53
39.7	292.62
42.2	292.58
44.5	292.90
45.2	294.17
45.9	294.73
47.2	295.59
48.1	295.99
51.4	296.38
56.5	296.60
60.3	297.12
62.9	297.94
65.4	298.78
67.9	299.54
70.8	300.33
73.0	300.61
75.8	300.68
76.3	300.98

SUMMARY DATA	
Bankfull Elevation:	296.1
Bankfull Cross-Sectional Area:	63.4
Bankfull Width:	23.8
Flood Prone Area Elevation:	299.9
Flood Prone Width:	62
Max Depth at Bankfull:	3.8
Mean Depth at Bankfull:	2.7
W / D Ratio:	8.9
Entrenchment Ratio:	2.6
Bank Height Ratio:	1.0

Neuse River Basin, Ellerbe Creek, MY02, XS - 3, Reach 1, Riffle



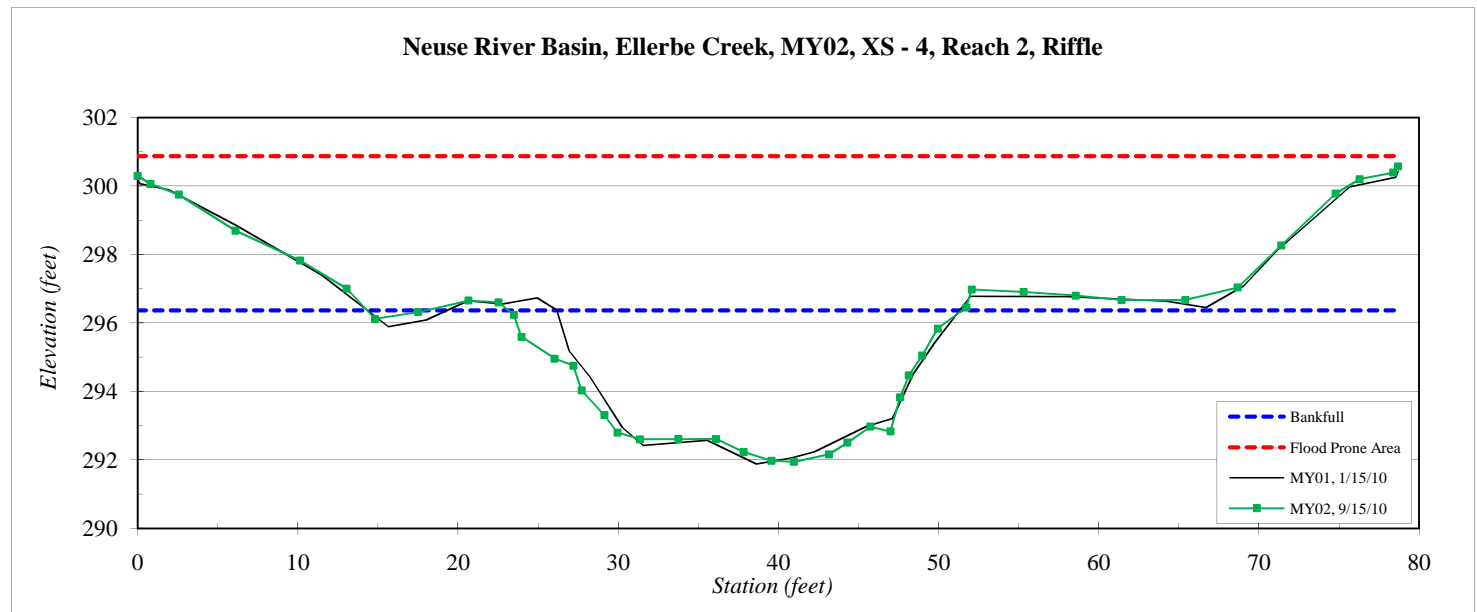
River Basin:	Neuse
Watershed:	Ellerbe Creek, MY02
XS ID	XS - 4, Reach 2, Riffle
Drainage Area (sq mi):	5.9
Date:	9/15/2010
Field Crew:	A. French, A. Helms



Station	Elevation
0.0	300.29
0.8	300.06
2.6	299.74
6.1	298.69
10.1	297.82
13.1	297.00
14.8	296.12
17.5	296.31
20.7	296.65
22.5	296.60
23.5	296.24
24.0	295.59
26.0	294.96
27.2	294.75
27.7	294.03
29.1	293.31
30.0	292.80
31.4	292.60
33.7	292.60
36.1	292.61
37.8	292.23
39.6	291.97
41.0	291.94
43.2	292.16
44.3	292.50
45.7	292.97
47.0	292.83
47.6	293.82
48.1	294.47
49.0	295.04
50.0	295.83
51.7	296.45
52.1	296.97
55.3	296.90
58.6	296.80

SUMMARY DATA	
Bankfull Elevation:	296.4
Bankfull Cross-Sectional Area:	84.9
Bankfull Width:	28.4
Flood Prone Area Elevation:	300.9
Flood Prone Width:	>75
Max Depth at Bankfull:	4.4
Mean Depth at Bankfull:	3.0
W / D Ratio:	9.5
Entrenchment Ratio:	>3.0
Bank Height Ratio:	1.0

Neuse River Basin, Ellerbe Creek, MY02, XS - 4, Reach 2, Riffle



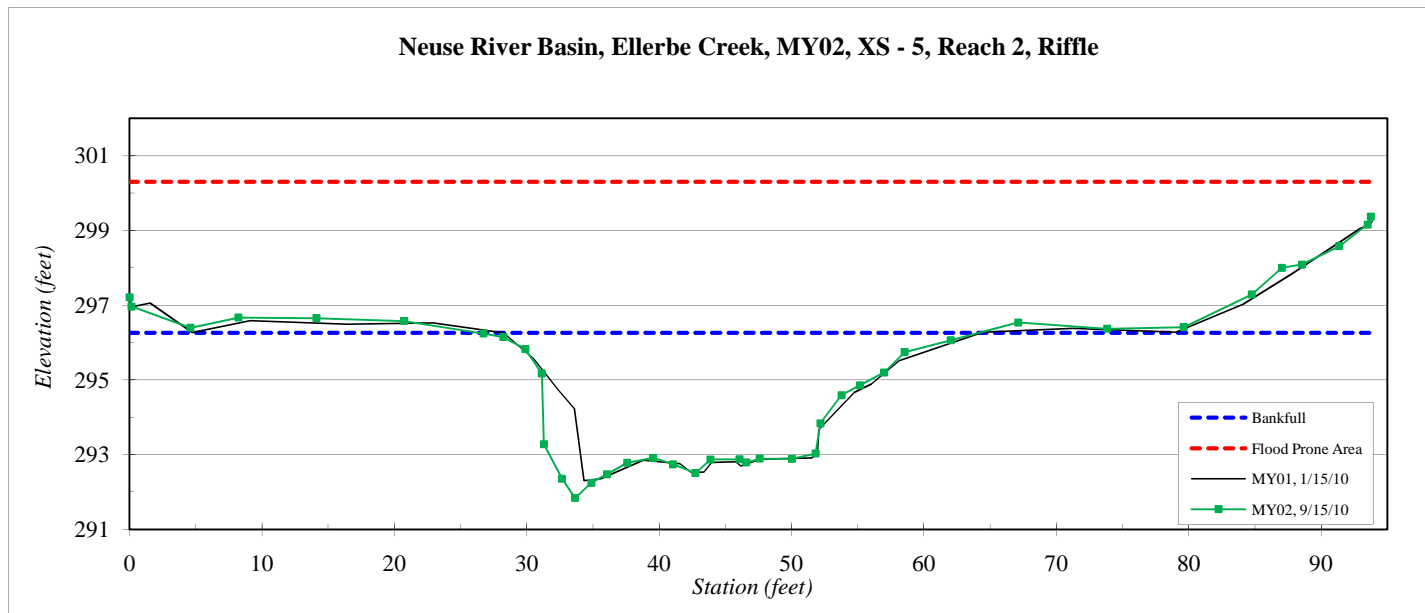
River Basin:	Neuse
Watershed:	Ellerbe Creek, MY02
XS ID	XS - 5, Reach 2, Riffle
Drainage Area (sq mi):	5.9
Date:	9/15/2010
Field Crew:	A. French, A. Helms

Station	Elevation
0.0	297.21
0.2	296.96
4.6	296.40
8.2	296.67
14.1	296.65
20.7	296.57
26.7	296.24
28.2	296.15
29.9	295.82
31.1	295.17
31.3	293.28
32.7	292.36
33.7	291.84
34.9	292.25
36.1	292.47
37.6	292.78
39.6	292.91
41.1	292.74
42.7	292.51
43.9	292.87
46.1	292.87
46.6	292.79
47.6	292.89
50.0	292.89
51.8	293.03
52.2	293.84
53.8	294.59
55.2	294.86
57.0	295.20
58.5	295.74
62.0	296.06
67.1	296.54
73.8	296.37
79.6	296.41
84.8	297.29
87.0	298.00
88.6	298.09
91.4	298.58
93.5	299.16
93.8	299.37

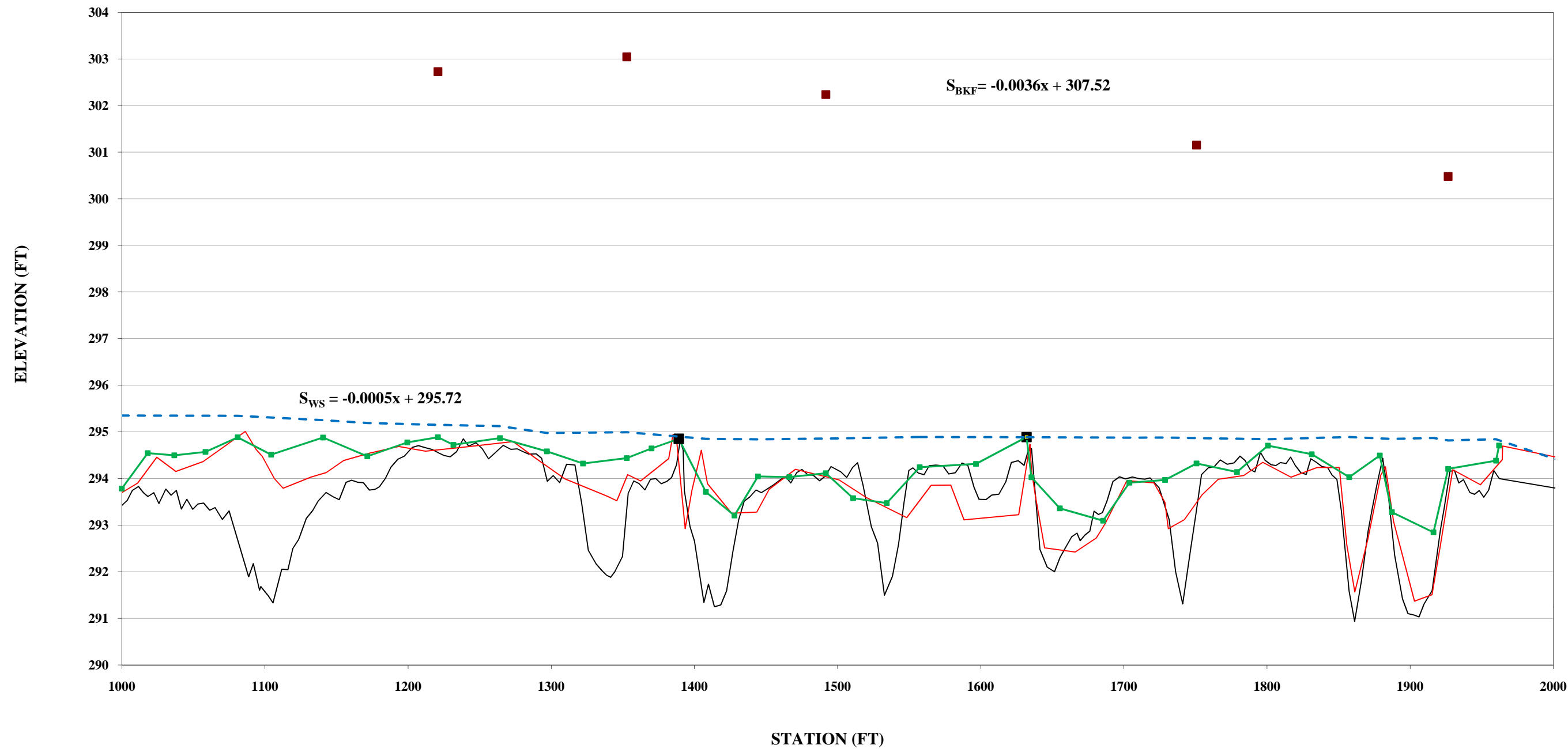
SUMMARY DATA	
Bankfull Elevation:	296.3
Bankfull Cross-Sectional Area:	81.2
Bankfull Width:	26.9
Flood Prone Area Elevation:	300.3
Flood Prone Width:	>90
Max Depth at Bankfull:	4.4
Mean Depth at Bankfull:	3.0
W / D Ratio:	8.9
Entrenchment Ratio:	>2.5
Bank Height Ratio:	1.0



Neuse River Basin, Ellerbe Creek, MY02, XS - 5, Reach 2, Riffle

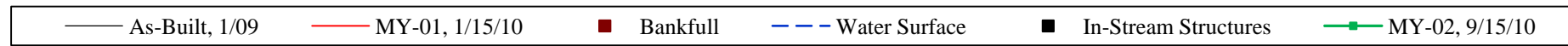
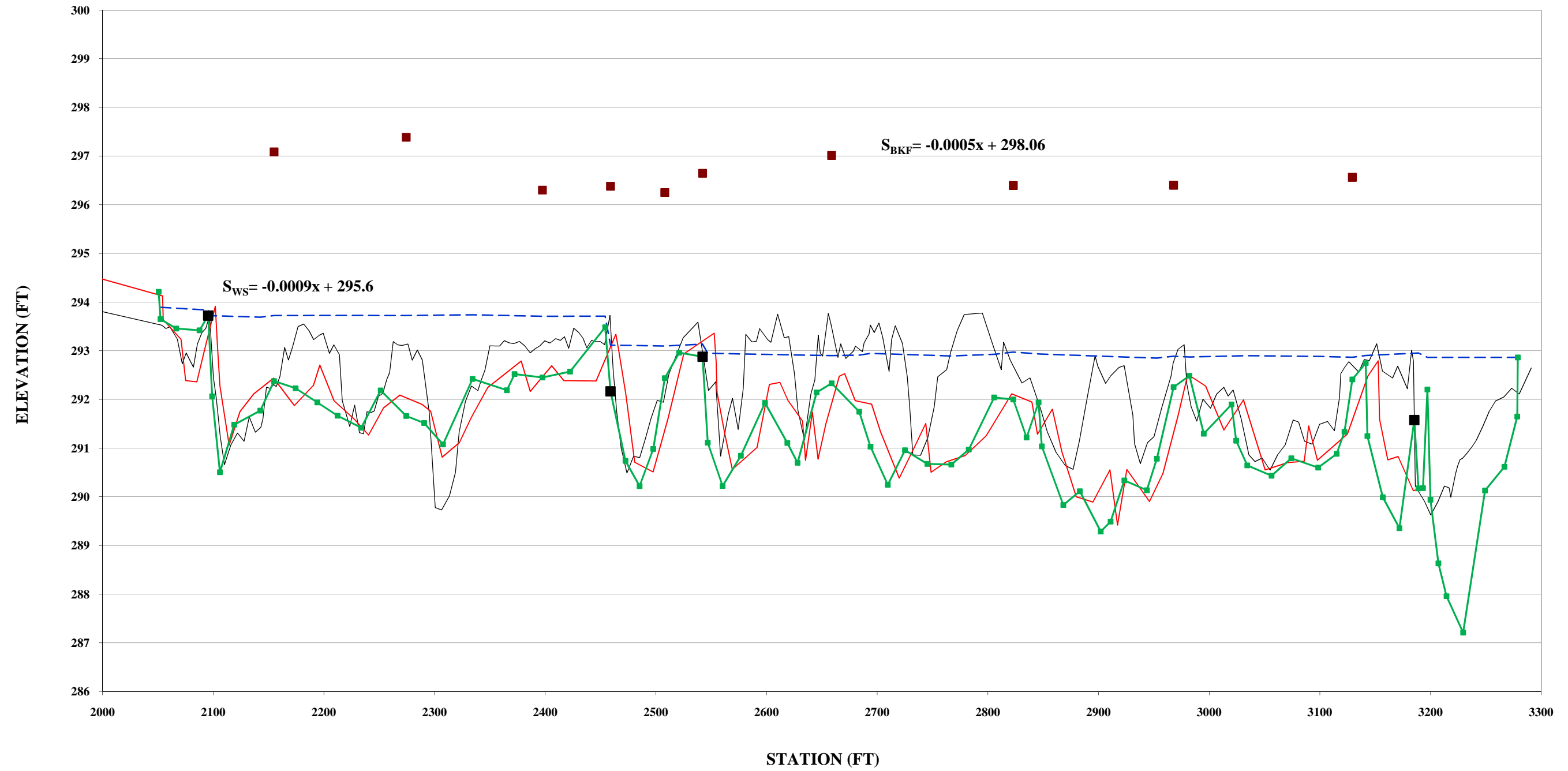


**Longitudinal Profile
 Ellerbe Creek
 EEP Project Number 272- MY02
 Stations 10+00 - 20+00**



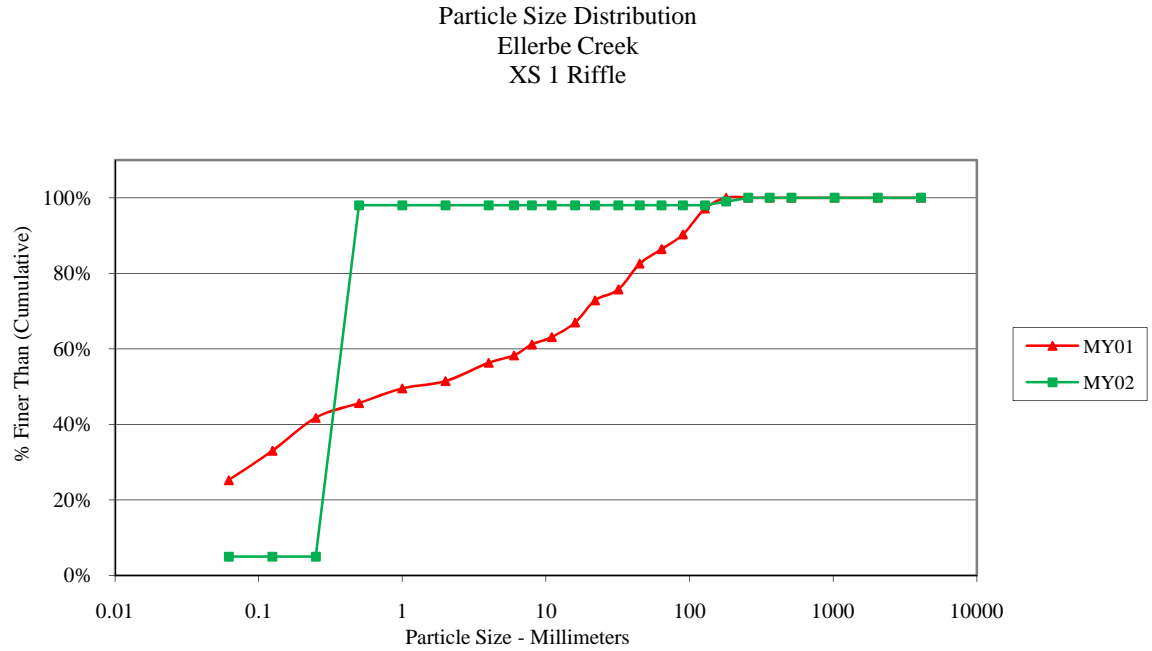
As-Built, 1/09
 MY-01, 1/15/10
 Bankfull
 In-Stream Structures
 MY-02, 9/14/10
 Water Surface

**Longitudinal Profile
 Ellerbe Creek
 EEP Project Number 272- MY02
 Stations 20+00 - 33+00**



Pebble Count Plots

Cross-Section 1 Riffle - MY02			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	5
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	93
Coarse	.50 - 1	D	
Very Coarse	1 - 2	S	
Very Fine	2 - 4		
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	
Medium	8 - 11.3	A	
Medium	11.3 - 16	V	
Coarse	16 - 22.6	E	
Coarse	22.6 - 32	L	
Very Coarse	32 - 45	S	
Very Coarse	45 - 64		
Small	64 - 90	C	
Small	90 - 128	O	
Large	128 - 180	B	1
Large	180 - 256	L	1
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	100
Note:			

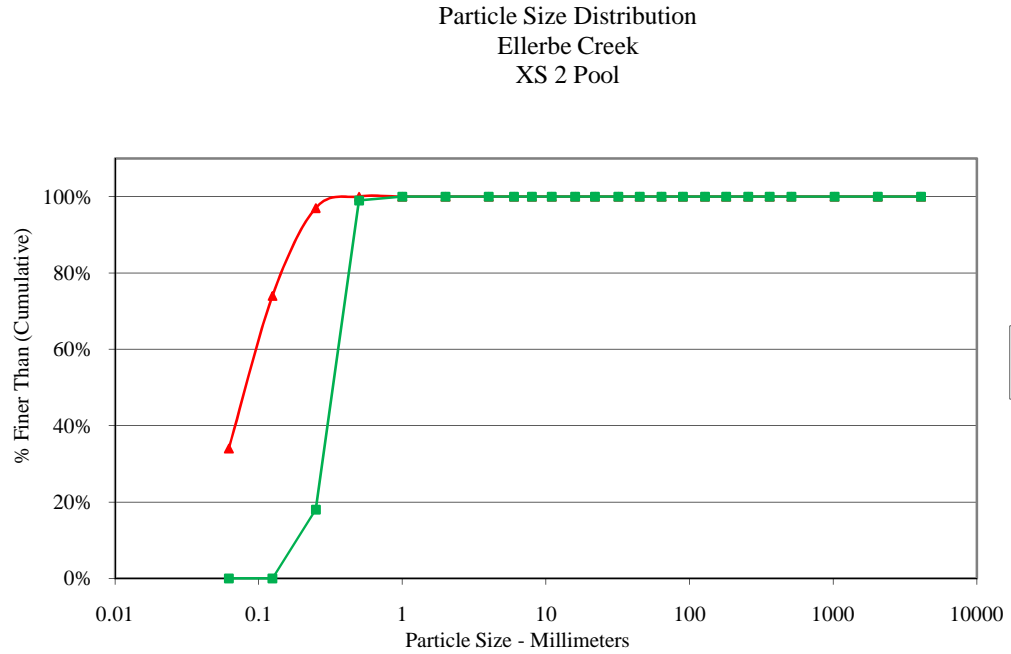


Size (mm)	
D16	0.27
D35	0.31
D50	0.35
D65	0.39
D84	0.45
D95	0.49

Size Distribution	
mean	0.3
dispersion	1.3
skewness	0.00

Type	
silt/clay	5%
sand	93%
gravel	0%
cobble	2%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 2 Pool - MY02			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	18
Medium	.25 - .50	N	81
Coarse	.50 - 1	D	1
Very Coarse	1 - 2	S	
Very Fine	2 - 4		
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	
Medium	8 - 11.3	A	
Medium	11.3 - 16	V	
Coarse	16 - 22.6	E	
Coarse	22.6 - 32	L	
Very Coarse	32 - 45	S	
Very Coarse	45 - 64		
Small	64 - 90	C	
Small	90 - 128	O	
Large	128 - 180	B	
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	100
Note:			

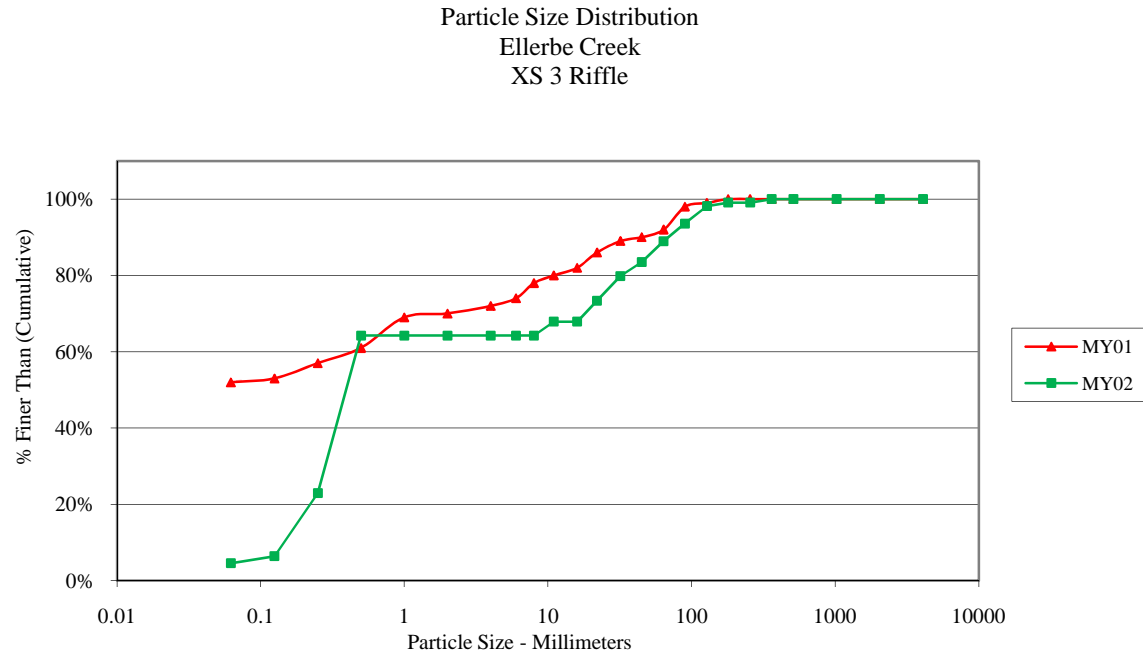


Size (mm)	
D16	0.23
D35	0.29
D50	0.33
D65	0.37
D84	0.44
D95	0.48

Size Distribution	
mean	0.3
dispersion	1.4
skewness	-0.03

Type	
silt/clay	0%
sand	100%
gravel	0%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 3 Riffle - MY02			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	5
Very Fine	.062 - .125	S	2
Fine	.125 - .25	A	18
Medium	.25 - .50	N	45
Coarse	.50 - 1	D	
Very Coarse	1 - 2	S	
Very Fine	2 - 4		
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	
Medium	8 - 11.3	A	4
Medium	11.3 - 16	V	
Coarse	16 - 22.6	E	6
Coarse	22.6 - 32	L	7
Very Coarse	32 - 45	S	4
Very Coarse	45 - 64		6
Small	64 - 90	C	5
Small	90 - 128	O	5
Large	128 - 180	B	1
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	108
Note:			

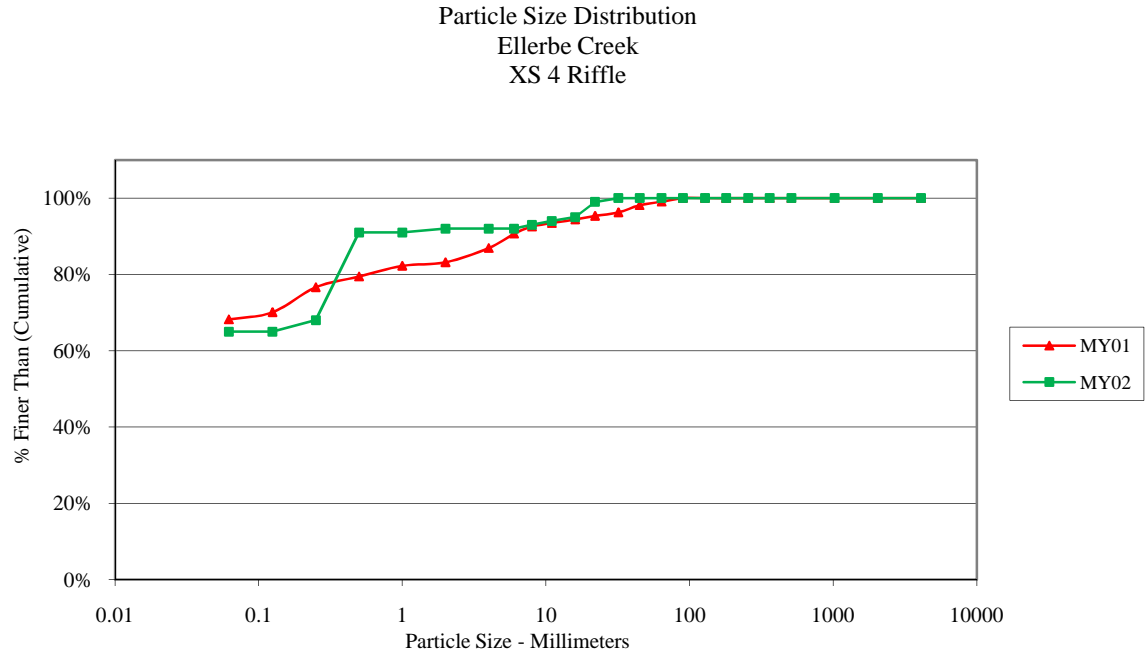


Size (mm)	
D16	0.19
D35	0.3
D50	0.39
D65	8.1
D84	44
D95	94

Size Distribution	
mean	2.9
dispersion	57.4
skewness	0.57

Type	
silt/clay	5%
sand	60%
gravel	25%
cobble	10%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 4 Riffle - MY02			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	65
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	3
Medium	.25 - .50	N	23
Coarse	.50 - 1	D	
Very Coarse	1 - 2	S	1
Very Fine	2 - 4		
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	1
Medium	8 - 11.3	A	1
Medium	11.3 - 16	V	1
Coarse	16 - 22.6	E	4
Coarse	22.6 - 32	L	1
Very Coarse	32 - 45	S	
Very Coarse	45 - 64		
Small	64 - 90	C	
Small	90 - 128	O	
Large	128 - 180	B	
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
	Total		100
Note:			

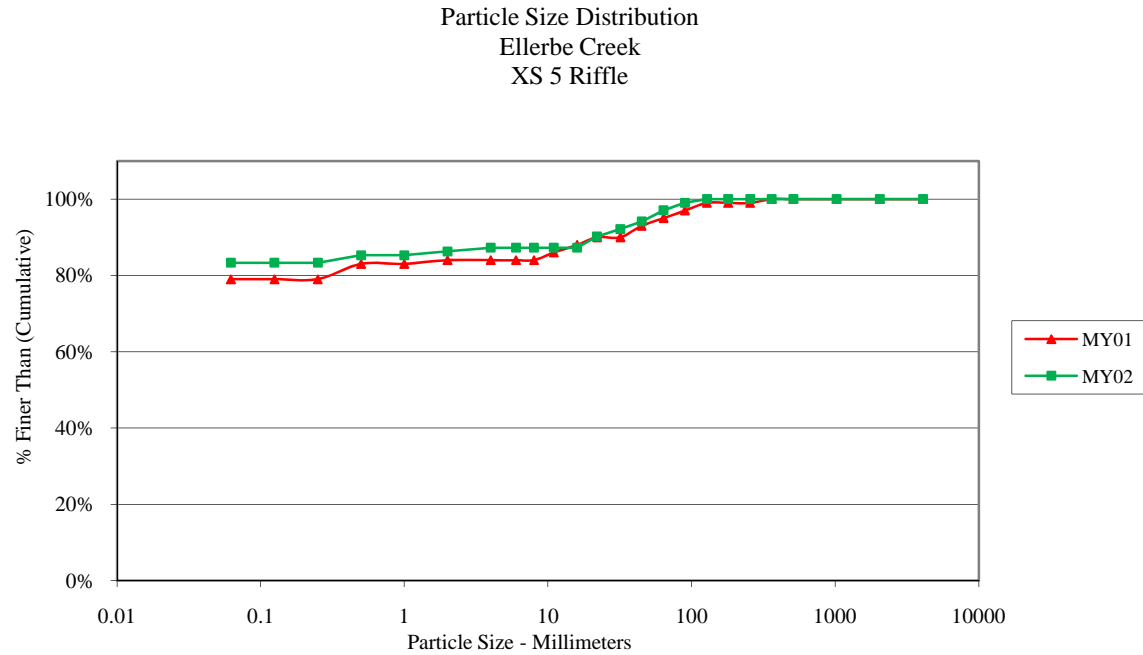


Size (mm)	
D16	0.062
D35	0.062
D50	0.062
D65	0.062
D84	0.4
D95	16

Size Distribution	
mean	0.2
dispersion	3.7
skewness	0.45

Type	
silt/clay	65%
sand	27%
gravel	8%
cobble	0%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Cross-Section 5 Riffle - MY02			
Particle	Millimeter		Count
Silt/Clay	< 0.062	S/C	85
Very Fine	.062 - .125	S	
Fine	.125 - .25	A	
Medium	.25 - .50	N	2
Coarse	.50 - 1	D	
Very Coarse	1 - 2	S	1
Very Fine	2 - 4		1
Fine	4 - 5.7	G	
Fine	5.7 - 8	R	
Medium	8 - 11.3	A	
Medium	11.3 - 16	V	
Coarse	16 - 22.6	E	3
Coarse	22.6 - 32	L	2
Very Coarse	32 - 45	S	2
Very Coarse	45 - 64		3
Small	64 - 90	C	2
Small	90 - 128	O	1
Large	128 - 180	B	
Large	180 - 256	L	
Small	256 - 362	B	
Small	362 - 512	L	
Medium	512 - 1024	D	
Lrg- Very Lrg	1024 - 2048	R	
Bedrock	>2048	BDRK	
		Total	102
Note:			



Size (mm)	
D16	0.062
D35	0.062
D50	0.062
D65	0.062
D84	0.32
D95	50

Size Distribution	
mean	0.1
dispersion	3.1
skewness	0.42

Type	
silt/clay	83%
sand	3%
gravel	11%
cobble	3%
boulder	0%
bedrock	0%
hardpan	0%
wood/det	0%
artificial	0%

Appendix D

Stream Assessment Data

Table 10. Baseline - Stream Data Summary Table

Project Number and Name: 272 – Northgate Park (Ellerbe Creek)

Segment Reach: Reach 1 (1,520 ft.)

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Mean	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Bankfull Width (ft)							30.8			13.5			30.0					
Floodprone Width (ft)							60			300								
Bankfull Cross-Sectional Area (ft ²)							118.6			30.8			54.6					
Bankfull Mean Depth (ft)							3.9			2.3			1.8					
Bankfull Maximum Depth (ft)							4.6			3.8			2.5					
Width/Depth Ratio							8.0			5.9			16.7					
Entrenchment Ratio							1.9			22.2								
Bank Height Ratio							1.7			0.9			1.0					
Pattern																		
Channel Beltwidth (ft)							50	100		50	125		40	60				
Radius of Curvature (ft)							150	180		16	30		165	180				
Meander Wavelength (ft)							700	1000		115	200		700	1000				
Meander Width Ratio							1.6	3.2		3.7	9.3		1.3	2.0				
Profile																		
Riffle Length (ft)																		
Riffle Slope (ft/ft)							0.014			0.005			0.002					
Pool Length (ft)																		
Pool Spacing (ft)							45	521		45	93		83	172				
Substrate																		
d50 (mm)																		
d84 (mm)																		
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)							1,466			1,466			1,466					
Sinuosity							1.02			1.33			1.01					
Water Surface Slope (ft/ft)							0.0009			0.0019			0.0006					
BF Slope (ft/ft)																		
Rosgen Classification							G5c			E5			C5					

Note: The Pre-Existing Condition and Project Reference Stream Data are the same for both reaches and are from the Restoration Plan document. The Design data are also from the Restoration Plan, except for the Dimension Parameter, which is from the Construction Plans. As-Built data were not taken due to project delays.

Table 10. Baseline - Stream Data Summary Table
Project Number and Name: 272 – Northgate Park (Ellerbe Creek)
Segment Reach: Reach 2 (750 ft.)

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Mean	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Bankfull Width (ft)							30.8			13.5			40.0					
Floodprone Width (ft)							60			300								
Bankfull Cross-Sectional Area (ft ²)							118.6			30.8			75.6					
Bankfull Mean Depth (ft)							3.9			2.3			1.9					
Bankfull Maximum Depth (ft)							4.6			3.8			2.8					
Width/Depth Ratio							8.0			5.9			21.1					
Entrenchment Ratio							1.9			22.2								
Bank Height Ratio							1.7			0.9			1.0					
Pattern																		
Channel Beltwidth (ft)							50	100		50	125		80	100				
Radius of Curvature (ft)							150	180		16	30		63	100				
Meander Wavelength (ft)							700	1000		115	200		260	300				
Meander Width Ratio							1.6	3.2		3.7	9.3		3.2	4.0				
Profile																		
Riffle Length (ft)																		
Riffle Slope (ft/ft)							0.014			0.005			0.001					
Pool Length (ft)																		
Pool Spacing (ft)							45	521		45	93		83	172				
Substrate																		
d50 (mm)																		
d84 (mm)																		
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)									1,466						690			
Sinuosity									1.02			1.33			1.02			
Water Surface Slope (ft/ft)									0.0009			0.0019			0.0005			
BF Slope (ft/ft)																		
Rosgen Classification									G5c			E5			C5			

Note: The Pre-Existing Condition and Project Reference Stream Data are the same for both reaches and are from the Restoration Plan document. The Design data are also from the Restoration Plan, except for the Dimension Parameter, which is from the Construction Plans. As-Built data were not taken due to project delays.

Table 10. Baseline - Stream Data Summary Table

Project Number and Name: 272 – Northgate Park (Ellerbe Creek)

Segment Reach: UT 3 (117 ft.)

Parameter	USGS Gage Data			Regional Curve Interval			Pre-Existing Condition			Project Reference Stream			Design			As-built		
	Min	Max	Mean	Min	Max	Med	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Bankfull Width (ft)										13.5			3.2					
Floodprone Width (ft)										300								
Bankfull Cross-Sectional Area (ft ²)										30.8			1.5					
Bankfull Mean Depth (ft)										2.3			0.5					
Bankfull Maximum Depth (ft)										3.8			0.7					
Width/Depth Ratio										5.9			6.4					
Entrenchment Ratio										22.2								
Bank Height Ratio										0.9			1.0					
Pattern																		
Channel Beltwidth (ft)										50	125							
Radius of Curvature (ft)										16	30							
Meander Wavelength (ft)										115	200							
Meander Width Ratio										3.7	9.3							
Profile																		
Riffle Length (ft)																		
Riffle Slope (ft/ft)										0.005								
Pool Length (ft)																		
Pool Spacing (ft)										45	93							
Substrate																		
d50 (mm)																		
d84 (mm)																		
Additional Reach Parameters																		
Valley Length (ft)																		
Channel Length (ft)													117					
Sinuosity												1.33						
Water Surface Slope (ft/ft)												0.0019						
BF Slope (ft/ft)																		
Rosgen Classification												E5			E5			

Note: The Project Reference Stream Data are from the Restoration Plan document. The Design data are from the Construction Plans. There were no Pattern or Profile data for UT3 in the Restoration Plan.

Table 11a. Monitoring - Cross-Section Morphology Data Tables

Project Number and Name: 272 – Northgate Park (Ellerbe Creek)

Segment Reach: Reach 1 (1,520 ft.) and Reach 2 (750 ft.)

Parameter	Cross-Section 1 Riffle - Reach 1						Cross-Section 2 Pool - Reach 1						Cross-Section 3 Riffle - Reach 1					
	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
Record Elevation (datum) used		296.9	296.9					297.8	297.8					296.1	296.1			
Bankfull Width (ft)		24.0	23.8					28.5	29.2					25.0	23.8			
Floodprone Width (ft)		42	42					-	-					62	62			
Bankfull Cross-Sectional Area (ft ²)		45.0	43.1					82.4	77.3					53.4	63.4			
Bankfull Mean Depth (ft)		1.9	1.8					2.9	2.6					2.1	2.7			
Bankfull Maximum Depth (ft)		2.8	2.8					5.8	4.3					3.4	3.8			
Width/Depth Ratio		12.8	13.1					-	-					11.7	8.9			
Entrenchment Ratio		1.8	1.8					-	-					2.5	2.6			
Bank Height Ratio		1.0	1.0					-	-					1.0	1.0			
Cross-Sectional Area Between End Pins (ft ²)		-	188.5					-	250.3					-	327.4			
d50 (mm)		1.2	0.35					0.08	0.33					0.06	0.39			

Parameter	Cross-Section 4 Riffle - Reach 2						Cross-Section 5 Riffle - Reach 2					
	MY0	MY1	MY2	MY3	MY4	MY5	MY0	MY1	MY2	MY3	MY4	MY5
Record Elevation (datum) used		296.4	296.4					296.3	296.3			
Bankfull Width (ft)		25.2	28.4					36.1	26.9			
Floodprone Width (ft)		>75	>75					>90	>90			
Bankfull Cross-Sectional Area (ft ²)		80.2	84.9					82.0	81.2			
Bankfull Mean Depth (ft)		3.2	3.0					2.3	3.0			
Bankfull Maximum Depth (ft)		4.5	4.4					4.0	4.4			
Width/Depth Ratio		7.9	9.5					15.9	8.9			
Entrenchment Ratio		>3.0	>3.0					>2.5	>2.5			
Bank Height Ratio		1.0	1.0					1.0	1.0			
Cross-Sectional Area Between End Pins (ft ²)		-	326.9					-	151.8			
d50 (mm)		0.06	0.06					0.06	0.06			

Table 11b. Monitoring - Stream Reach Morphology Data Table

Project Number and Name: 272 – Northgate Park (Ellerbe Creek)

Segment Reach: Reach 1 (1,520 ft.)

Parameter	MY - 01 (2009)						MY - 02 (2010)						MY - 03 (2011)						MY - 04 (2012)						MY - 05 (2013)					
	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension																														
Bankfull Width (ft)	24.0	24.5		25.0		2	23.8	23.8		23.8		2																		
Floodprone Width (ft)	42	52		62		2	42	52		62		2																		
Bankfull Mean Depth (ft)	1.9	2.0		2.1		2	1.8	2.3		2.7		2																		
Bankfull Max Depth (ft)	2.8	3.1		3.4		2	2.8	3.3		3.8		2																		
Bankfull Cross-Sectional Area (ft ²)	45.0	49.2		53.4		2	43.1	53.3		63.4		2																		
Width/Depth Ratio	11.7	12.3		12.8		2	8.9	11.0		13.1		2																		
Entrenchment Ratio	1.8	2.2		2.5		2	1.8	2.2		2.6		2																		
Bank Height Ratio	1.0	1.0		1.0		2	1.0	1.0		1.0		2																		
Pattern																														
Channel Beltwidth (ft)	*	*	*	*	*	*																								
Radius of Curvature (ft)	*	*	*	*	*	*																								
Rad. of Curv. : Bankfull Width (ft/ft)	*	*	*	*	*	*																								
Meander Wavelength (ft)	*	*	*	*	*	*																								
Meander Width Ratio	*	*	*	*	*	*																								
Profile																														
Riffle Length (ft)	24		35	85			33	34		34		2																		
Riffle Slope (ft/ft)	0.0000		0.0006	0.0010			0.0011	0.0010		0.0008		2																		
Pool Length (ft)	10		37	53			29	36	36	43	25.6	5																		
Pool Max Depth (ft)							1.6	2.4	2.4	3.2	0.65	6																		
Pool Spacing (ft)	29		89	211			93	257	212	479	136	5																		
Additional Reach Parameters																														
Valley Length (ft)			1,518						1,518																					
Channel Thalweg Length (ft)			1,580						1,580																					
Sinuosity			1.04						1.04																					
Water Surface Slope (ft/ft)			0.0014						0.0014																					
Bankfull Slope (ft/ft)									0.0060																					
Rosgen Classification			C5						C5																					
Ri% / Ru% / P% / G% / S%									10 / 35 / 20 / 35 / 0																					
SC% / Sa% / G% / C% / B% / Be%			25 / 26 / 35 / 14 / 0 / 0						5 / 60 / 25 / 10 / 0 / 0																					
d16 / d35 / d50 / d84 / d95			0.062 / 0.15 / 1.2 / 51 / 110						0.019 / 0.3 / 0.39 / 44 / 94																					
% of Reach with Eroding Banks									15%																					

*Reach 1 was enhanced, and is not a meandering channel

Table 11b. Monitoring - Stream Reach Morphology Data Table

Project Number and Name: 272 – Northgate Park (Ellerbe Creek)

Segment Reach: Reach 2 (750 ft.)

Parameter	MY - 01 (2009)						MY - 02 (2010)						MY - 03 (2011)						MY - 04 (2012)						MY - 05 (2013)					
	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
Dimension																														
Bankfull Width (ft)	25.2	30.7		36.1		2	23.8	25.4		28.4		2																		
Floodprone Width (ft)	36.1	55.55		75		2	42.0	68.5		90.0		2																		
Bankfull Mean Depth (ft)	2.3	2.7		3.2		2	1.8	2.8		3.0		2																		
Bankfull Max Depth (ft)	4.0	4.3		4.5		2	2.8	4.1		4.4		2																		
Bankfull Cross-Sectional Area (ft ²)	80.2	81.1		82.0		2	43.1	72.3		84.9		2																		
Width/Depth Ratio	7.9	11.9		15.9		2	8.9	9.2		13.1		2																		
Entrenchment Ratio	2.5	2.8		3.0		2	1.8	2.6		3.0		2																		
Bank Height Ratio	1.0	1.0		1.0		2	1.0	1.0		1.0		2																		
Pattern																														
Channel Beltwidth (ft)	59		74	94																										
Radius of Curvature (ft)	51		68	107																										
Rad. of Curv. : Bankfull Width (ft/ft)																														
Meander Wavelength (ft)	237		276	303																										
Meander Width Ratio	2.1		2.7	3.4																										
Profile																														
Riffle Length (ft)	9		16	29			12		16	25		3																		
Riffle Slope (ft/ft)	0.0010		0.0014	0.0026			0.0010	0.0012	0.0015	0.0031		3																		
Pool Length (ft)	18		67	91			64	80	73	104		3																		
Pool Max Depth (ft)							2.5	2.9	2.7	3.6		3																		
Pool Spacing (ft)	68		157	184			155	170		186		2																		
Additional Reach Parameters																														
Valley Length (ft)			658						658																					
Channel Thalweg Length (ft)			710						710																					
Sinuosity			1.08						1.08																					
Water Surface Slope (ft/ft)			0.00017						0.0009																					
Bankfull Slope (ft/ft)									0.0005																					
Rosgen Classification			C5						C5																					
Ri% / Ru% / P% / G% / S%									10 / 30 / 20 / 40 / 0																					
SC% / Sa% / G% / C% / B% / Be%			68 / 15 / 16 / 1 / 0 / 0						65 / 27 / 8 / 0 / 0 / 0																					
d16 / d35 / d50 / d84 / d95			0.062 / 0.062 / .0062 / 2.3 / 20						0.062 / 0.062 / 0.062 / 0.4 / 16																					
% of Reach with Eroding Banks									41																					

Appendix E

Hydrologic Data

Table 12. Verification of Bankfull Events
Project Number and Name: 272 - Northgate Park (Ellerbe Creek)

Date of Data Collection	Date of Occurrence	Method	Photo Number
6/14/2009	6/11/2009	Site visit to evaluate indicators of stage after storm event	N/A
11/11/2009	11/11/2009	Site visit to evaluate indicators of stage after storm event	N/A
12/25/2009	12/25/2009	Eye-witness account	N/A
1/25/2010	1/25/2010	Site visit to evaluate indicators of stage after storm event	N/A
5/17/2010	5/17/2010	Site visit to evaluate indicators of stage after storm event	N/A
9/30/2010	9/30/2010	Site visit to evaluate indicators of stage after storm event	N/A