

FINAL
ANNUAL MONITORING REPORT
GOOSE CREEK

STREAM RESTORATION
DURHAM COUNTY, NORTH CAROLINA
(EEP Project Number 147, Contract Number 004681)
Construction Completed September 2008

Monitoring Year 5 of 5 (2013)



Submitted to:
North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
Raleigh, North Carolina



January 2014

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Submitted to:
North Carolina Department of Environment and Natural Resources
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Raleigh, North Carolina

Prepared by:
Axiom Environmental, Inc.
218 Snow Avenue
Raleigh, North Carolina 27603

Design Firm:
Biohabitats
8218 Creedmoor Road
Raleigh, North Carolina 27613



January 2014

1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

The Goose Creek stream restoration project originated by the North Carolina Ecosystem Enhancement Program (EEP) was constructed between May 12, 2008 and September 5, 2008. Grading and stream structure installation began on May 14, 2008 and was completed on August 20, 2008. Planting of the buffer was completed on February 18, 2009.

The Goose Creek Stream Restoration Site (Site) is located in the City of Durham, North Carolina in a highly developed watershed (Figure 1, Appendix A). Goose Creek is part of the Neuse River Basin (Upper Neuse, Subbasin 03-04-01) and is located in USGS Cataloging Unit 03020201. This project is located in the EEP's *Ellerbe Creek Local Watershed Plan* (http://www.nceep.net/services/lwps/Upper_Neuse/Ellerbe_Creek_Local_Watershed_Plan.pdf) area, which is targeted for mitigation to protect watershed functions, increase aquatic life, decrease destructive flooding, provide recreational opportunities, and protect the Falls Lake drinking water supply.

The preproject stream was highly modified and artificially confined by concrete along the southern/upstream channel and banks, and by rock walls in the northern/downstream reach. The project aimed to eradicate artificial hardening structures, and restore a more natural channel geometry and riparian buffer. Project restoration efforts provided 1465 linear feet of stream restoration, 1.38 acres of riparian buffer restoration, and 0.06 acre of riparian buffer enhancement. Tables summarizing project objectives and activities can be found in Appendix A. This report (compiled based on the EEP's *Procedural Guidance and Content Requirements for EEP Monitoring Reports* Version 1.4 dated 11/7/11) summarizes data for year 5 (2013) monitoring.

The goals of the Goose Creek stream restoration project included the following.

- To improve aquatic habitat by removing the fabriform channel liner on the Eastway Elementary School reach (upstream/southern reach) and the stone retaining walls on the Longmeadow Park reach (downstream/northern reach) and reintroduce a more defined and natural riffle/pool channel geometry.
- To improve water quality by reducing nutrient loading from adjacent developed properties through restoration of a riparian buffer.
- To improve terrestrial habitat by restoring a riparian buffer.
- To decrease the sediment and nutrient content of stormwater flow originating in the Barnes Street Redevelopment project site, which flows through the Site and into Goose Creek, through the means of a re-configured stormwater channel which slows stormwater flow, allowing sediment to settle and nutrients to be absorbed by planted vegetation.

Goals were accomplished by removing artificial hardening structures; constructing a natural, stable profile and dimension for the stream channel; and reestablishing a continuous riparian buffer along the stream banks. Project implementation has greatly increased the prominence of riffles and pools in the reach and improved aquatic habitat within the Site.

Based on the Goose Creek baseline document (2009), success criteria dictate that after five monitoring years an average density of 260 stems per acre must be surviving in stream restoration areas (Vegetation Plot 4) and 320 stems per acre must be surviving in Neuse River Riparian Buffer restoration credit areas (Vegetation Plots 1, 2, and 3). Based on the number of stems counted, average densities were measured at 485 planted stems per acre (excluding livestakes) surviving in year 5 (2013). The dominant species identified at the Site were planted stems of green ash (*Fraxinus pennsylvanica*), tulip tree (*Liriodendron*

tulipifera), and sycamore (*Platanus occidentalis*). All individual plots met success criteria based on planted stems alone.

Three large willow oaks (*Quercus phellos*) (located on the downstream/northern reach) that had succumbed to the stress of old age and drought were removed by the City of Durham in the winter of 2011 with the approval of EEP. Planting within these areas as well four additional areas on the upstream/southern reach) were planted with 70 five-gallon sized containerized trees of red oak (*Quercus rubra*), sycamore, red chokeberry (*Aronia arbutifolia*), red maple (*Acer rubrum*), cherrybark oak (*Quercus pagoda*), and Shumard oak (*Quercus shumardii*), in addition to 25 livestakes of silky dogwood (*Cornus amomum*). Trees within these areas are doing well; 2012 planting information is provided in Appendix F.

Noted vegetation areas of concern within the Site, depicted on the attached Figures 2A-2B (Appendix B), include the development of invasive species such as Johnson grass (*Sorghum halepense*) scattered along the northern/downstream reach between Liberty Street and Holloway Street. Other invasive species include small patches of Japanese hops (*Humulus japonicas*) just north of the Liberty Street bridge on the right bank and adjacent to the left bank of the western tributary to the southern/upstream reach. Mimosa (*Albizia julibrissin*), chinaberry (*Melia azedarach*), and white mulberry (*Morus alba*), are located in several locations along the northern (downstream reach). Chinese privet (*Ligustrum sinense*) and Japanese privet (*Ligustrum japonicum*) are located just north of the stormwater wetland and adjacent to the fence just south of the tributary to the southern/upstream reach coming from the west. Scotch broom (*Cytisus scoparius*) is located at the very southeastern corner of the Site; some treatment/control of this species occurred in the 2011 monitoring year by cutting plants to remove the seed source. In addition, scattered stems of Bradford pear (*Pyrus calleryana*), white mulberry, wintercreeper (*Euonymus fortunei*), air yam (*Discorea bulbifera*), and multiflora rose (*Rosa multiflora*) are located adjacent to the southern/upstream reach. Herbaceous species including Nepalese browntop (*Microstegium vimineum*) and Asiatic dayflower (*Commelina communis*) are also located in several areas along the southern/upstream reach near the stream channel. Invasive species within the Site are not affecting planted stem survival or growth, and are therefore expected to be shaded out as planted trees mature.

Wisteria (*Wisteria frutescens*) is located just north of Liberty Street on the right bank adjacent to the bridge and giant ragweed (*Ambrosia trifida*) is scattered throughout the Site and occasionally forms thick stands. Wisteria and giant ragweed are not invasive species but can be problematic due to their growth habits and potential to shade or, in the case of wisteria, girdle planted trees. These species have been monitored closely throughout the monitoring period and are not affecting growth of planted stems.

Success criteria for stream restoration reaches dictate that little to no change from the as-built channel occurred over the five-year monitoring period. Year 5 (2013) monitoring measurements indicate that there have been minimal changes in cross-sections and profile downstream of Liberty Street as compared to as-built data. The stream profile upstream of Liberty Street was designed to adjust itself to changes in watershed flows. A total of 16 bankfull events are documented to have occurred at the Site with three events in year 1 (2009), three events in year 2 (2010), three events in year 3 (2011), and four events in the year 4 (2012), and three events to date in year 5 (2013) monitoring period.

Two structures (upstream of Cross-section 5 and downstream of Cross-section 6) that were watched throughout the five-year monitoring period due to boulders that had fallen in the channel are doing well and are not exhibiting additional erosion despite extensive flooding during the 2013 monitoring year. The upper reach of Goose Creek was an unconventional design, which allowed for the evolution of a low flow channel within the larger bankfull channel. Single wing deflectors were installed to increase channel

sinuosity (restricted due to a narrow beltwidth) within the larger bankfull channel, allowing the thalweg to migrate within the bankfull channel. Dense, rooted vegetation has established throughout the reach and adjacent to the structures inhibiting lateral erosion and bed scour. The structures and the entire reach are stable and functioning as designed, and have remained intact despite flashy flows from the upstream watershed, which is primarily comprised of impervious surfaces associated with the City of Durham, and several large rainfall events (Tropical Storm Ida and numerous rain events of greater than 4 inches) that have occurred throughout the five-year monitoring period.

In summary, the Site achieved success criteria for vegetation and stream attributes in the Fifth Monitoring Year (2013). Summary information and 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 tables and figures within this report's appendices. Narrative background and supporting information formerly found in these reports can be found in the mitigation and restoration plan documents available on EEPs website. All raw data supporting the tables and figures in the appendices are available from EEP upon request.

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- Table 2. Project Activity and Reporting History
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Asbuilt Site Photographs

2.0 METHODOLOGY

2.1 Vegetation Assessment

Following Site construction, four plots (10-meters square) were established and monumented with metal rebar at all plot corners. Sampling was conducted for year 5 (2013) on September 10, 2013 as outlined in the *CVS-EEP Protocol for Recording Vegetation, Version 4.2* (Lee et al. 2008) (<http://cvs.bio.unc.edu/methods.htm>); results are included in Appendix C. The taxonomic standard for vegetation used for this document was *Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas* (Weakley 2007). The locations of vegetation monitoring plots are depicted on Figures 2A-2B in Appendix B. Visual assessments were completed on September 10, 2013 for year 5 (2013).

2.2 Stream Assessment

Eight permanent cross-sections were established after construction was completed. Measurements of each cross-section include points at all breaks in slope including top of bank, bankfull, and thalweg. Riffle cross-sections are classified using the Applied Fluvial Morphology (Rosgen 1996) stream classification system. Longitudinal profile measurements of the entire Site restoration reaches include thalweg and water surface; with each measurement taken at the head of facets (i.e. riffle, run, pool, and glide) in addition to the maximum pool depth. Visual assessments of in-stream structures were conducted to determine if failure occurred. Failure of a structure may be indicated by collapse of the structure, undermining of the structure, abandonment of the channel around the structure, and/or stream flow beneath the structure. Stream measurements were completed the week of April 8, 2013 (Appendix D).

3.0 REFERENCES

- Lee, Michael T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2008. CVS-EEP Protocol for Recording Vegetation, Version 4.2. (online). Available: <http://cvs.bio.unc.edu/methods.htm>
- North Carolina Division of Water Quality (NCDWQ). 2007. Redbook, Surface Waters and Wetlands Standards. North Carolina Department of Environment and Natural Resources, Division of Water Quality. Raleigh, North Carolina.
- Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology (Publisher). Pagosa Springs, Colorado.
- Weakley, Alan S. 2007. Flora of the Carolinas, Virginia, Georgia, and Surrounding Areas (online). Available: <http://www.herbarium.unc.edu/WeakleysFlora.pdf> [February 1, 2008]. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina, Chapel Hill, North Carolina.
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APPENDIX A

PROJECT VICINITY MAP AND BACKGROUND TABLES

Figure 1. Site Location

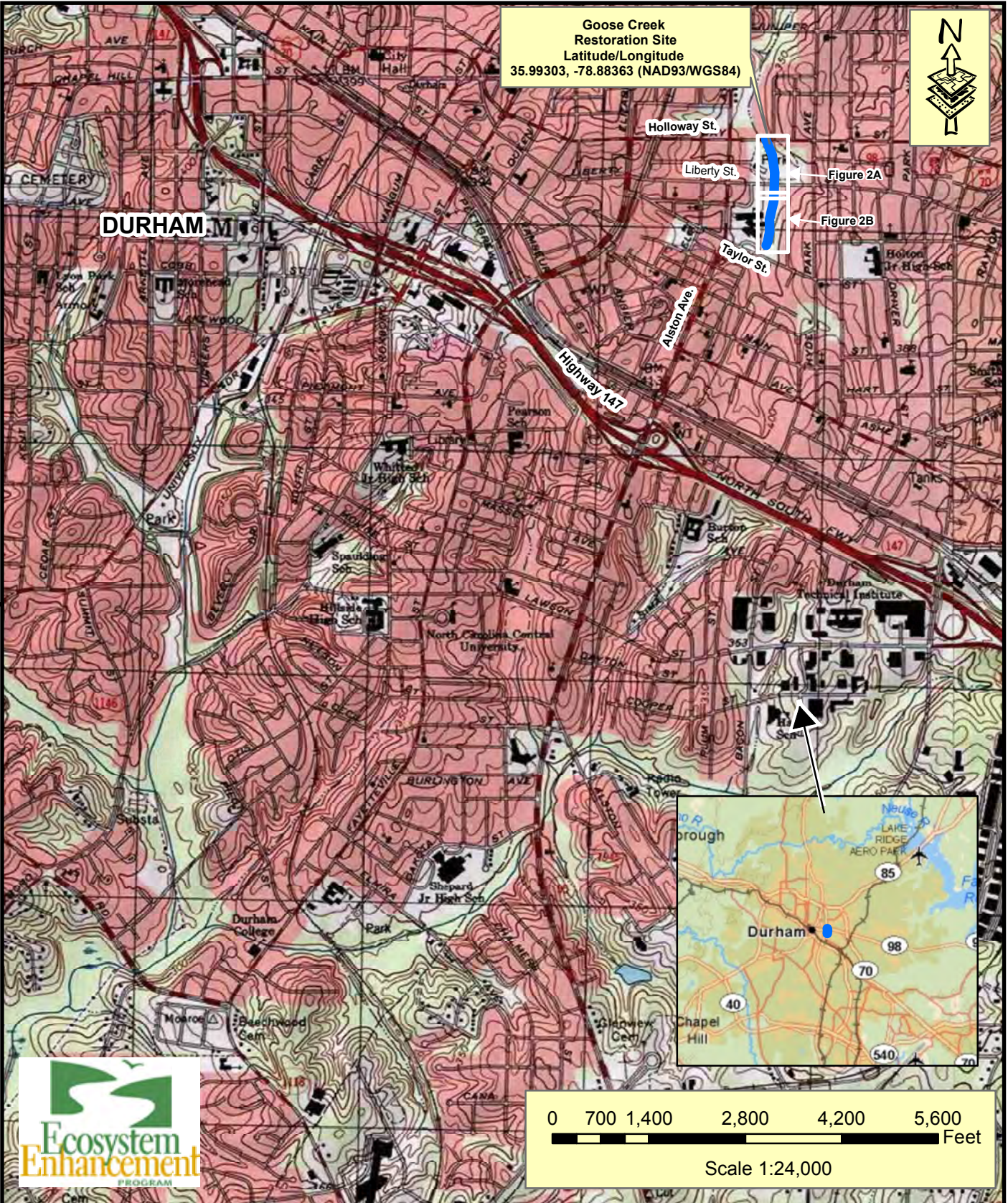
Table 1. Site Restoration Structures and Objectives

Table 2. Project Activity and Reporting History

Table 3. Project Contacts Table

Table 4. Project Attributes Table

Goose Creek
Restoration Site
Latitude/Longitude
35.99303, -78.88363 (NAD93/WGS84)



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Axiom Environmental, Inc.

**SITE LOCATION MAP
GOOSE CREEK SITE
EEP PROJECT NUMBER 147
Durham County, North Carolina**

Dwn. by:
CLF
Date:
June 2011
Project:
10-009

FIGURE
1

**Table 1. Site Restoration Structures and Objectives
Goose Creek Restoration Site (EEP Project Number 147)**

Reach	Pre-Project Length (ft)	Stationing	Restoration Level	Approach	Planted Easement Acreage	Buffer Restoration (acres)*	Buffer Enhancement (acres)*	Restoration Length (ft)**
Eastway Upstream	514	3+48-8+61	Restoration	P2	0.86	--	-	514
Eastway Downstream	347	0+00-3+47	Restoration	P2	1.4	0.58	0.06	347
Longmeadow Park Section	659	0+55-6+59	Restoration	P2	1.69	0.8	--	604
TOTALS	1500				3.95	1.38	0.06	1465
Component Summations								
Restoration Level	Stream (linear feet)				Restoration Buffer (acres)*			
Restoration	1465				1.38			
Enhancement	--				0.06			
TOTALS	1465 linear feet				1.44 acres			
	1465 SMUs				1.41 BMUs			

*Buffer restoration and enhancement is to be used to mitigate for buffer impacts per the Neuse River Buffer Rules

**Restored length of Longmeadow reach does not include 55 feet of stream between the end of the project and the Holloway Street culvert that was not restored.

**Table 2. Project Activity and Reporting History
Goose Creek Restoration Site (EEP Project Number 147)**

Activity or Report	Data Collection Completion	Actual Completion or Delivery
Restoration Plan	July 2005	October 2005
Final Design-Construction Plans	November 2006	April 2008
Construction	--	September 2008
Permanent Seeding Completed	--	September 2008
As-Built	October 2008	December 2008
Planting	--	February 2009
Mitigation Plan	March 2009	March 2009
Year 1 (2009) Monitoring	October 2009	November 2009
Year 2 (2010) Monitoring	August 2010	January 2011
Supplemental Planting		March 2011
Year 3 (2011) Monitoring	June 2011	July 2011
Supplemental Planting		March 2012
Year 4 (2012) Monitoring	August 2012	August 2012
Year 5 (2013) Monitoring	September 2013	October 2013

Table 3. Project Contacts Table
Goose Creek Restoration Site (EEP Project Number 147)

Designer Biohabitats, Inc	8918 Creedmoor Road, Suite 200 Raleigh, NC 27613 Kevin Nunnery 919-518-0311
Construction Contractor Shamrock Environmental, Inc	6106 Corporate Park Dr. Browns Summit, NC 27214 Dan Albert 336-375-1989
Survey Contractor Level Cross Surveying, PLLC	668 Marsh Country Lane Randleman, NC 23717 Sheri Willard 336-495-1713
Planting Contractor Southern Garden, Inc	1932 Holt Rd Cary, NC 27519 Todd Laakso 919-362-1050
Seed Mix Suppliers Green-Resource	1218 Management Way, Garner, NC 27529 Rodney Montgomery 919-779-4727
Planting Stock Suppliers Container Stock-Cure Nursery	880 Buteo Ridge Road Pittsboro, NC 27312 Bill Cure 919-542-6186
Balled in Burlap Taylor's Nursery	3705 New Bern Ave Raleigh, NC 27610 Richard Taylor 919 231-6161
Year 1-5 (2009-13) Monitoring Performer Axiom Environmental, Inc.	218 Snow Avenue Raleigh, NC 27603 Grant Lewis (919) 215-1693

**Table 4. Project Attribute Table
Goose Creek Restoration Site (EEP Project Number 147)**

Project County	Durham		
Physiographic Region	Piedmont		
Ecoregion	Triassic Basin		
Project River Basin	Neuse		
USGS HUC for Project (14 digit)	3020201050010		
NCDWQ Sub-basin for Project	03-04-01		
Within extent of EEP Watershed Plan?	Ellerbe Creek Local Watershed Plan		
WRC Hab Class (Warm, Cool, Cold)	Warm		
% of project easement demarcated	100%		
Beaver activity observed?	No		
	Eastway upstream	Eastway downstream	Longmeadow
Drainage area	350	396	481
Stream order	2	2	2
Restored length (feet)	514	347	604
Perennial or Intermittent	perennial	perennial	perennial
Watershed type (Rural, Urban, etc.)	urban	urban	urban
Watershed LULC Distribution (%)			
Urban-Low Intensity Developed	44	44	43
Urban-High Intensity Developed	22	22	22
Residential Urban	18	18	19
Forest, Herbaceous, Open Water	16	16	16
Watershed impervious cover (%)	~55	~55	~54
NCDWQ AU/Index number	27-5-1	27-5-1	27-5-1
NCDWQ classification	WS-IV, NSW	WS-IV, NSW	WS-IV, NSW
303d listed?	no	no	no
Upstream of a 303d listed segment?	yes	yes	yes
Reasons for 303d listing or stressor	urban stormwater	urban stormwater	urban stormwater
Total acreage of easement	0.9	1.4	1.7
Rosgen classification of pre-existing	N/A	N/A	N/A
Rosgen classification of As-built	Bc5	Bc5	Bc5
Valley type/slope	N/A	N/A	N/A
Valley side slope range (e.g. 2-3.%)	10-15%	10-15%	10-15%
Valley toe slope range (e.g. 2-3.%)	3-5%	3-5%	3-5%
Dominant soil series/characteristics			
Series	Whitestore-Urban	Whitestore-Urban	Whitestore-Urban
Depth	60"	60"	60"
Clay%	5-70	5-70	5-70

Used N/A for items that may not apply. Use "--" for items that are unavailable and "U" for items that are unknown

APPENDIX B
VISUAL ASSESSMENT DATA

Figures 2a-2b. Monitoring Plan View
Table 5a. North Reach Goose Creek Qualitative Stability Assessment
Table 5b. South Reach Goose Creek Qualitative Stability Assessment
Table 6. Vegetation Condition Assessment
Vegetation Monitoring Plot Photos



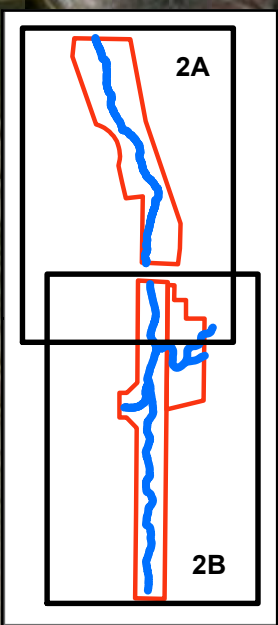
Note: Johnson grass is scattered along the northern/downstream reach between Liberty Street and Holloway Street; however, it does not appear to be affecting planted tree stems. Additional species scattered throughout this area include Bradford pear, mimosa, Japanese privet, china-berry, and white mulberry.

Three large willow oaks removed by City of Durham in 2012; area was planted with 165 containerized trees.

Japanese hops are located on the right bank and wisteria on the left bank adjacent to the bridge.

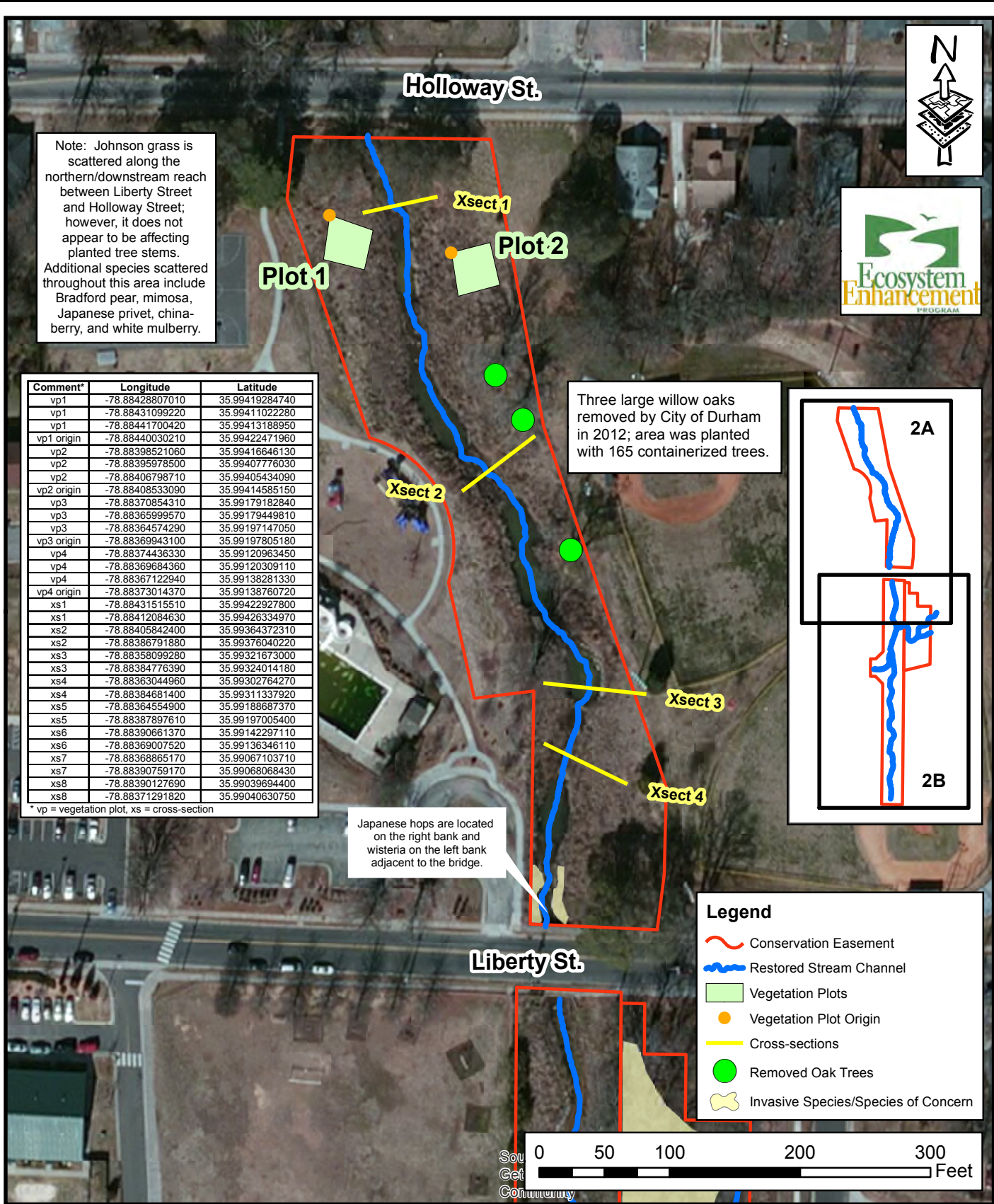
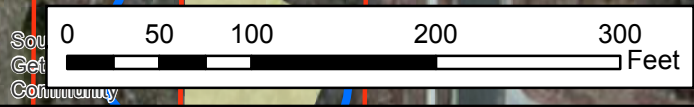
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vp1	-78.88441700420	35.99413188950
vp1 origin	-78.88440030210	35.99422471960
vp2	-78.88398521060	35.99416646130
vp2	-78.88395978500	35.99407776030
vp2	-78.88406798710	35.99405434090
vp2 origin	-78.88408533090	35.99414585150
vp3	-78.88370854310	35.99179182840
vp3	-78.88365999570	35.99179449810
vp3	-78.88364574290	35.99197147050
vp3 origin	-78.88369943100	35.99197805180
vp4	-78.88374436330	35.99120963450
vp4	-78.88369684360	35.99120309110
vp4	-78.88367122940	35.99138281330
vp4 origin	-78.88373014370	35.99138760720
xs1	-78.88431515510	35.99422927800
xs1	-78.88412084630	35.99426334970
xs2	-78.88405842400	35.99364372310
xs2	-78.88386791880	35.99376040220
xs3	-78.88358099280	35.99321673000
xs3	-78.88384776390	35.99324014180
xs4	-78.88363044960	35.99302764270
xs4	-78.88384681400	35.99311337920
xs5	-78.88364554900	35.99188687370
xs5	-78.88387897610	35.99197005400
xs6	-78.88390661370	35.99142297110
xs6	-78.88369007520	35.99136346110
xs7	-78.88368865170	35.99067103710
xs7	-78.88390759170	35.99068068430
xs8	-78.88390127690	35.99039694400
xs8	-78.88371291820	35.99040630750

* vp = vegetation plot, xs = cross-section



Legend

- Conservation Easement
- Restored Stream Channel
- Vegetation Plots
- Vegetation Plot Origin
- Cross-sections
- Removed Oak Trees
- Invasive Species/Species of Concern




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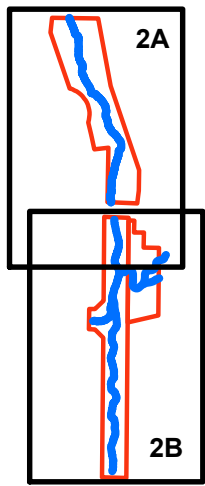
CURRENT CONDITIONS PLAN VIEW
GOOSE CREEK SITE
EEP PROJECT NUMBER 147
Durham County, North Carolina

Dwn. by:	CLF/KRJ	FIGURE 2A
Date:	Oct. 2013	
Project:	12-004.06	



Liberty St.

Scattered Chinese & Japanese privet, Bradford pear, white mulberry, wintercreeper, air yam, and multiflora rose.



Japanese hops

Multiflora rose & Chinese privet

Stormwater Wetland

Plot 3

Plot 4

Xsect 5

Xsect 6

Xsect 7

Scotch broom

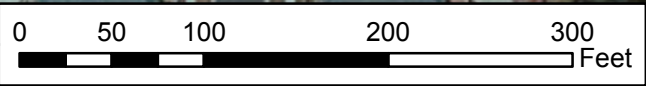
Xsect 8

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vp1	-78.88441700420	35.99413188950
vp1 origin	-78.88440030210	35.99422471960
vp2	-78.88398521060	35.99416646130
vp2	-78.88395978500	35.99407776030
vp2	-78.88406798710	35.99405434090
vp2 origin	-78.88408533090	35.99414585150
vp3	-78.88370854310	35.99179182840
vp3	-78.88365999570	35.99179449810
vp3	-78.88364574290	35.99197147050
vp3 origin	-78.88369943100	35.99197805180
vp4	-78.88374436330	35.99120963450
vp4	-78.88369684360	35.99120309110
vp4	-78.88367122940	35.99138281330
vp4 origin	-78.88373014370	35.99138760720
xs1	-78.88431515510	35.99422927800
xs1	-78.88412084630	35.99426334970
xs2	-78.88405842400	35.99364372310
xs2	-78.88386791880	35.99376040220
xs3	-78.88358099280	35.99321673000
xs3	-78.88384776390	35.99324014180
xs4	-78.88363044960	35.99302764270
xs4	-78.88384681400	35.99311337920
xs5	-78.88364554900	35.99188687370
xs5	-78.88387897610	35.99197005400
xs6	-78.88390661370	35.99142297110
xs6	-78.88369007520	35.99136346110
xs7	-78.88368865170	35.99067103710
xs7	-78.88390759170	35.99068068430
xs8	-78.88390127690	35.99039694400
xs8	-78.88371291820	35.99040630750

* vp = vegetation plot, xs = cross-section

Legend

- Conservation Easement
- Restored Stream Channel
- Structures
- Vegetation Plots
- Vegetation Plot Origin
- Cross-sections
- Invasive Species/Species of Concern




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CURRENT CONDITIONS PLAN VIEW
GOOSE CREEK SITE
EEP PROJECT NUMBER 147
Durham County, North Carolina

Dwn. by.	CLF/KRJ	FIGURE 2B
Date:	Oct. 2013	
Project:	12-004.06	

Table 5a. Eastway (Southern/Upstream) Reach Goose Creek Qualitative Visual Stability Assessment (861 linear feet)

Goose Creek Restoration Site (EEP Project Number 147)

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	% Perform. in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	7	7	N/A	100	100
	2. Armor stable (e.g. no displacement)?	7	7	N/A	100	
	3. Facet grade appears stable?	7	7	N/A	100	
	4. Minimal evidence of embedding/fining?	7	7	N/A	100	
	5. Length appropriate?	7	7	N/A	100	
B. Pools	1. Present? (e.g. no severe aggradation)	6	6	N/A	100	100
	2. Sufficiently deep (Dmax pool:Mean Bkf > 2.2?)	6	6	N/A	100	
	3. Length appropriate?	6	6	N/A	100	
C. Thalweg	1. Upstream of meander bend centering?	NA	NA	N/A		N/A
	2. Downstream of meander centering?	NA	NA	N/A		
D. Meanders	1. Outer bend in state of limited/controlled erosion?	NA	NA	N/A		N/A
	2. Of those eroding, # w/ concomitant point bar formation?	NA	NA	N/A		
	3. Apparent Rc within spec?	NA	NA	N/A		
	4. Sufficient floodplain access and relief?	NA	NA	N/A		
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0	100	100
	2. Channel bed degradation - areas of increasing down cutting or head cutting?	N/A	N/A	0	100	
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A	N/A	0	100	100
G. Vanes	1. Free of back or arm scour?	13	15	N/A	87	100
	2. Height appropriate?	13	15	N/A	87	
	3. Angle and geometry appear appropriate?	15	15	N/A	100	
	4. Free of piping or other structural failures?	13	15	N/A	87	
H. Wads / Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	N/A
	2. Footing stable?	N/A	N/A	N/A	N/A	

Table 5b. Long Meadow (Northern/Downstream) Reach Goose Creek Qualitative Visual Stability Assessment (659 linear feet)

Goose Creek Restoration Site (EEP Project Number 147)

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	% Perform. in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	9	9	N/A	100	100
	2. Armor stable (e.g. no displacement)?	9	9	N/A	100	
	3. Facet grade appears stable?	9	9	N/A	100	
	4. Minimal evidence of embedding/fining?	9	9	N/A	100	
	5. Length appropriate?	9	9	N/A	100	
B. Pools	1. Present? (e.g. no severe aggradation)	7	7	N/A	100	100
	2. Sufficiently deep (Dmax pool:Mean Bkf > 2.2?)	7	7	N/A	100	
	3. Length appropriate?	7	7	N/A	100	
C. Thalweg	1. Upstream of meander bend centering?	NA	NA	N/A		N/A
	2. Downstream of meander centering?	NA	NA	N/A		
D. Meanders	1. Outer bend in state of limited/controlled erosion?	NA	NA	N/A		N/A
	2. Of those eroding, # w/ concomitant point bar formation?	NA	NA	N/A		
	3. Apparent Rc within spec?	NA	NA	N/A		
	4. Sufficient floodplain access and relief?	NA	NA	N/A		
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0	100	100
	2. Channel bed degradation - areas of increasing down cutting or head cutting?	N/A	N/A	0	100	
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A	N/A	0	100	100
G. Vanes	1. Free of back or arm scour?	N/A	N/A	N/A		N/A
	2. Height appropriate?	N/A	N/A	N/A		
	3. Angle and geometry appear appropriate?	N/A	N/A	N/A		
	4. Free of piping or other structural failures?	N/A	N/A	N/A		
H. Wads / Boulders	1. Free of scour?	N/A	N/A	N/A		N/A
	2. Footing stable?	N/A	N/A	N/A		

Table 6 **Vegetation Condition Assessment**
Goose Creek Restoration Site (EEP Project 147)

Planted Acreage¹ **3.8**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	NA	NA	NA	0	0.00	0.0%
2. Low Stem Density Areas	NA	NA	NA	0	0.00	0.0%
				Total	0	0.00
3. Areas of Poor Growth Rates or Vigor	Vegetation growth is slow in the southern portion of the Site.	NA	NA	0	0.00	0.0%
				Cumulative Total	0	0.00

Easement Acreage² **3.8**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern ⁴	Johnson grass is scattered along the northern/downstream reach etween Liberty Street and Holloway Street; however, it does not appear to be affecting planted tree stems. Additional species scattered through this area include Bradford pear, mimosa, Japanese privet, chinaberry, and white mulberry. These areas are difficult to quantify and therefore aren't depicted on mapping (Figure 2A) or accounted for in the following numbers. Additional areas depicted on mapping and accounted for in the following numbers include several small areas containing Chinese & Japanese privet, Bradford pear, white mulberry, wintercreeper, air yam, multiflora rose, Japanese hops, asiatic day flower, and scotch broom.	0.01	Light Yellow	7	0.23	6.1%
5. Easement Encroachment Areas ³	NA	NA	NA	0	0.00	0.0%

¹ = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project effort.

² = The acreage within the easement boundaries.

³ = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e., item 1,2 or 3) as well as a parallel tally in item 5.

⁴ = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern species are those with the potential to directly outcompete native, young, woody stems in the short-term (e.g. monitoring period or shortly thereafter) or affect the community structure for existing, more established tree/shrub stands over timeframes that are slightly longer (e.g. 1-2 decades). The low/moderate concern group are those species that generally do not have this capacity over the timeframes discussed and therefore are not expected to be mapped with regularity, but can be mapped, if in the judgement of the observer their coverage, density or distribution is suppressing the viability, density, or growth of planted woody stems. Decisions as to whether remediation will be needed are based on the integration of risk factors by EEP such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not likely trigger control because of the limited capacities to impact tree/shrub layers within the timeframes discussed and the potential impacts of treating extensive amounts of ground cover. Those species with the "watch list" designator in gray shade are of interest as well, but have yet to be observed across the state with any frequency. Those in *red italics* are of particular interest given their extreme risk/threat level for mapping as points where isolated specimens are found, particularly early in a projects monitoring history. However, areas of discreet, dense patches will of course be mapped as polygons. The symbology scheme below was one that was found to be helpful for symbolizing invasives polygons, particularly for situations where the condition for an area is somewhere between isolated specimens and dense, discreet patches. In any case, the point or polygon/area feature can be symbolized to describe things like high or low concern and species can be listed as a map inset, in legend items if the number of species are limited or in the narrative section of the executive summary.

**Goose Creek Restoration Site
Year 5 (2013) Annual Monitoring
Vegetation Plot Photos (taken June 18, 2012)**

Plot 1



Plot 2



Plot 3



Plot 4



APPENDIX C

VEGETATION ASSESSMENT DATA

Table 7. Vegetation Plot Mitigation Success Summary

CVS Summary Data Tables

Table 8. Vegetation Metadata Table

Table 9. Total and Planted Stems by Plot and Species

**Table 7. Vegetation Plot Mitigation Success Summary Table
Goose Creek Restoration Site (EEP Project Number 147)**

Vegetation Plot ID	Vegetation Survival Threshold Met?	Tract Mean
1	Yes	100%
2	Yes	
3	Yes	
4	Yes	

**Table 8. Vegetation Metadata Table
Goose Creek Restoration Site (EEP Project Number 147)**

Report Prepared By	Corri Faquin
Date Prepared	9/10/2013 15:54
database name	Axiom-EEP-2013-A-v2.3.1.mdb
database location	\\AE-SBS\RedirectedFolders\KJernigan\Desktop
computer name	KEENAN-PC
file size	65798144
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.
ALL 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.
PROJECT SUMMARY-----	
Project Code	147
project Name	Goose Creek
Description	
River Basin	Neuse
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	4

**Table 9. Total and Planted Stems by Plot and Species
Goose Creek Restoration Site (EEP Project Number 147)**

Insert PDF

APPENDIX D
STREAM SURVEY DATA

Cross-section Plots and Tables

Longitudinal Profile Plots

Pebble Count Plots

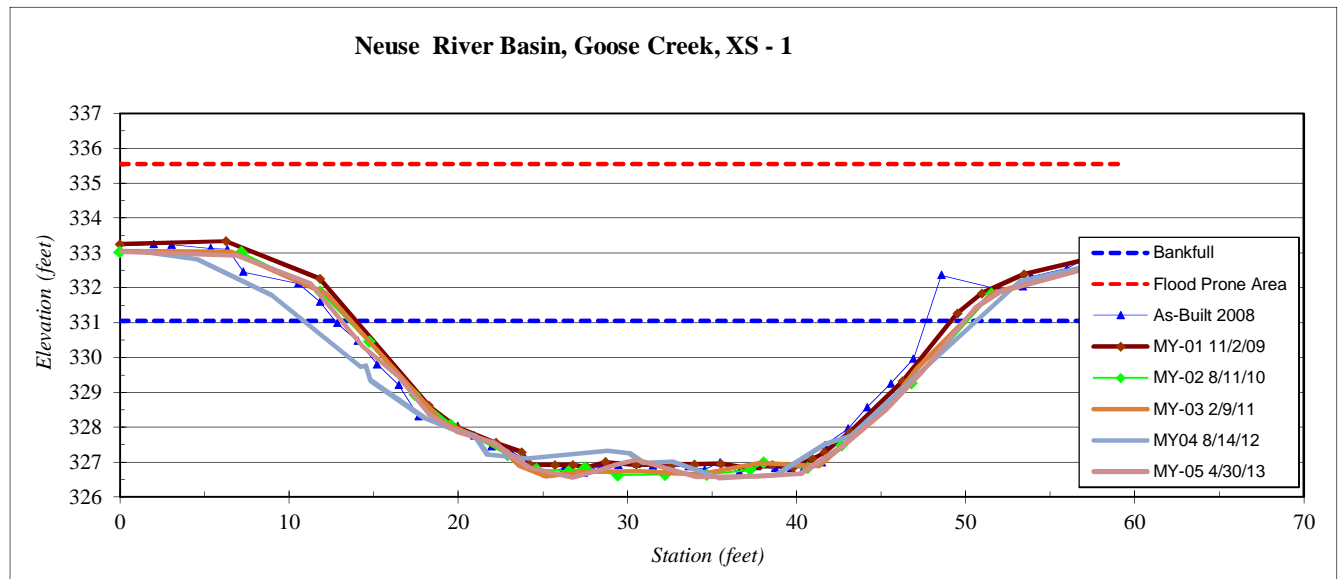
River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 1
Feature	Riffle
Date:	4/30/2013
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.0	333.0
6.9	332.9
11.3	332.1
14.4	330.3
16.5	329.5
18.2	328.4
20.0	327.9
22.1	327.6
24.1	326.8
26.8	326.6
28.4	326.8
29.3	326.9
30.5	327.1
34.1	326.6
37.7	326.6
40.2	326.7
42.6	327.4
45.3	328.5
47.4	329.6
50.6	331.4
52.0	331.9
59.0	332.8

SUMMARY DATA	
Bankfull Elevation:	331.1
Bankfull Cross-Sectional Area:	120.2
Bankfull Width:	36.8
Flood Prone Area Elevation:	335.6
Flood Prone Width:	170.0
Max Depth at Bankfull:	4.5
Mean Depth at Bankfull:	3.3
W / D Ratio:	11.3
Entrenchment Ratio:	4.6
Bank Height Ratio:	1.2



Stream Type	E
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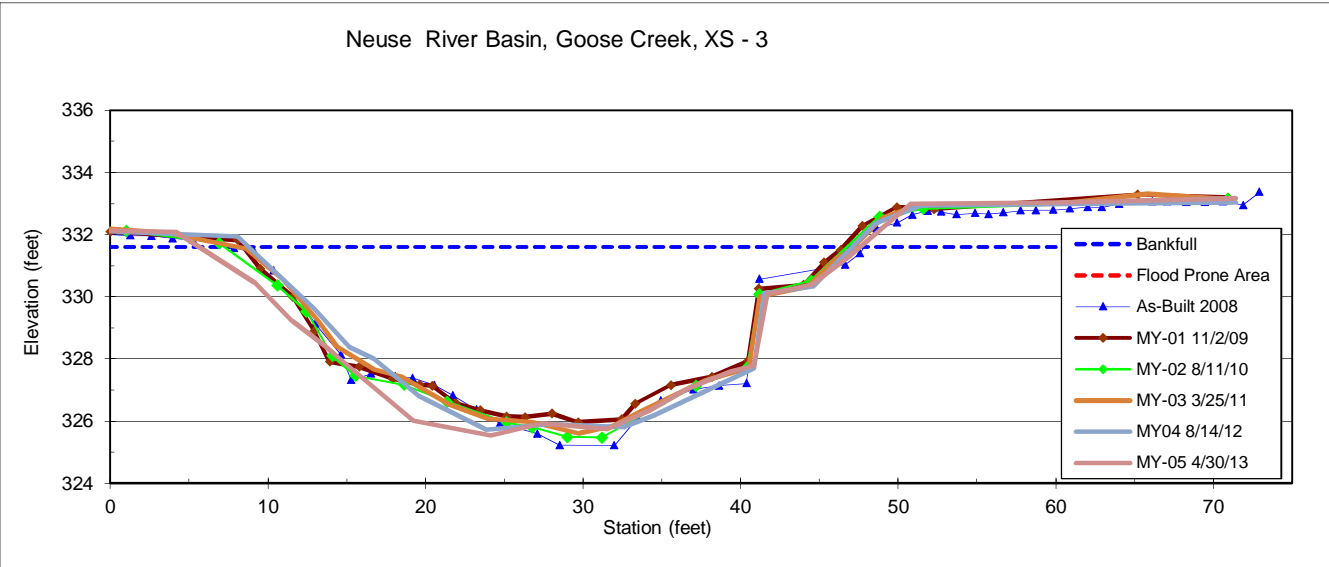
River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 3
Feature	Pool
Date:	4/30/2013
Field Crew:	Perkinson, Jernigan



Station	Elevation
-9.9	332.35
-1.8	332.15
4.2	332.08
9.1	330.45
11.5	329.22
13.6	328.42
14.7	327.95
19.2	326.01
24.1	325.54
27.4	325.92
31.5	325.74
34.2	326.34
36.7	327.07
39.4	327.60
40.9	327.79
41.7	330.08
44.5	330.39
46.8	331.24
50.8	332.98
59.9	333.03
71.4	333.17

SUMMARY DATA	
Bankfull Elevation:	331.6
Bankfull Cross-Sectional Area:	160.5
Bankfull Width:	42.0
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	6.1
Mean Depth at Bankfull:	3.8
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	1.0

Stream Type -



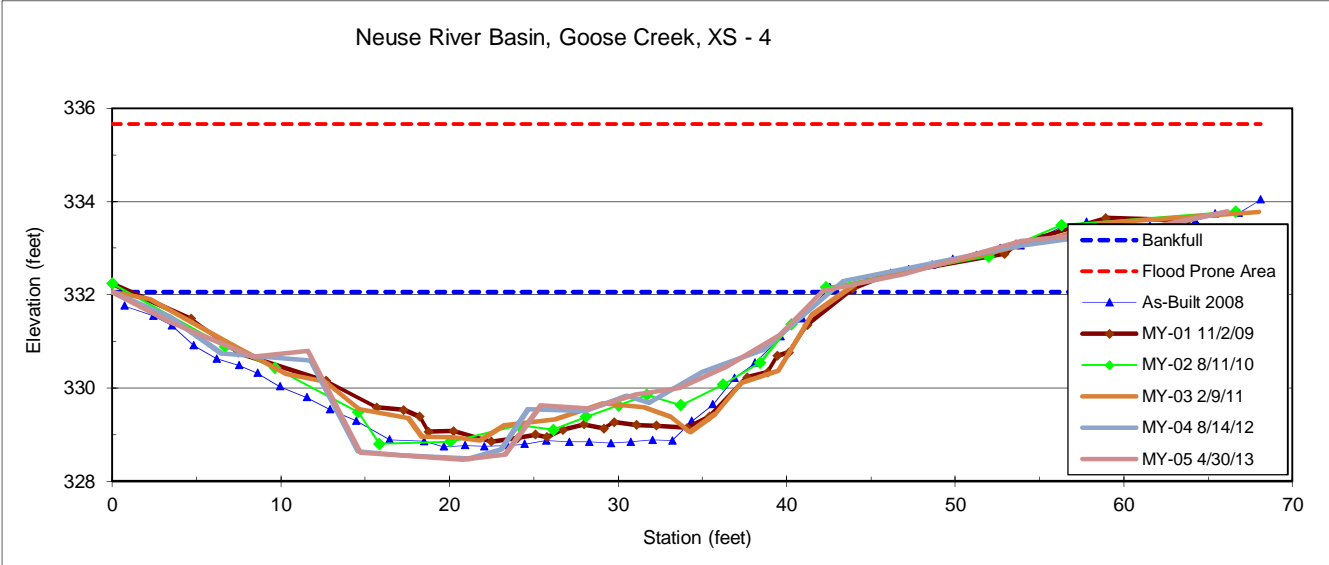
River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 4
Featurer	Riffle
Date:	4/30/2013
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.0	332.1
3.4	331.4
8.3	330.7
11.6	330.8
14.7	328.6
20.8	328.5
23.3	328.6
25.4	329.6
28.3	329.6
31.1	329.9
33.6	330.0
36.5	330.5
39.5	331.1
42.1	332.1
47.0	332.4
54.0	333.2
61.2	333.4
66.2	333.8

SUMMARY DATA	
Bankfull Elevation:	332.1
Bankfull Cross-Sectional Area:	83.5
Bankfull Width:	42.1
Flood Prone Area Elevation:	335.7
Flood Prone Width:	240.0
Max Depth at Bankfull:	3.6
Mean Depth at Bankfull:	2.0
W / D Ratio:	21.2
Entrenchment Ratio:	5.7
Bank Height Ratio:	1.0



Stream Type



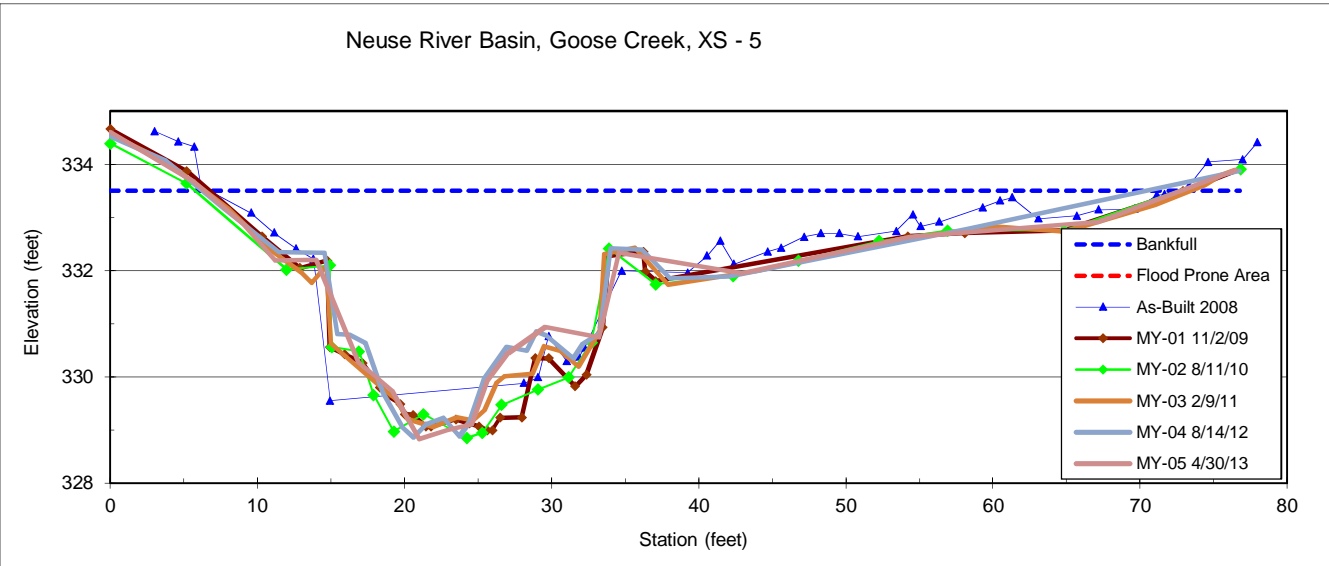
River Basin:	Neuse
Watershed:	Goose Creek
XS ID:	XS - 5
Feature:	Pool
Date:	4/30/2013
Field Crew:	Perkinson, Jernigan



SUMMARY DATA	
Bankfull Elevation:	333.5
Bankfull Cross-Sectional Area:	109.6
Bankfull Width:	66.4
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	4.7
Mean Depth at Bankfull:	1.7
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Station	Elevation
76.5	333.9
67.1	332.9
54.4	332.6
42.9	331.9
34.6	332.3
33.2	330.7
29.6	330.9
27.1	330.4
25.6	329.9
24.6	329.1
22.9	329.0
21.0	328.8
19.2	329.7
16.9	330.3
14.0	332.2
11.2	332.2
9.0	332.9
5.7	333.7
0.0	334.6

Stream Type



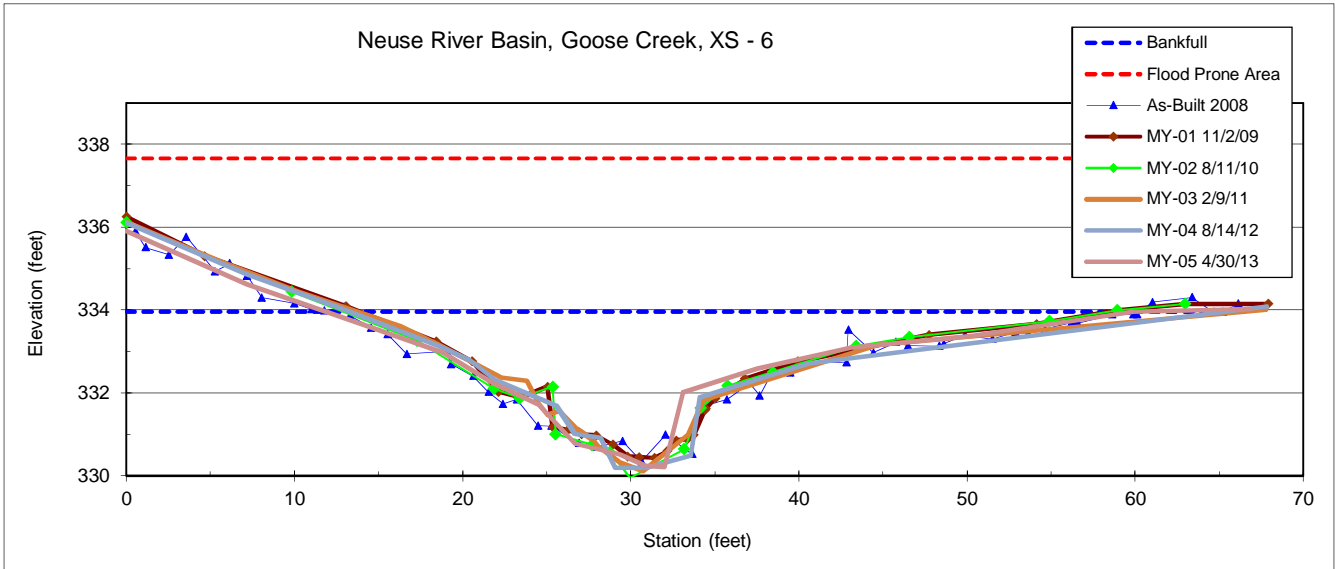
River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 6
Feature	Riffle
Date:	4/30/2013
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.0	335.9
7.2	334.6
14.4	333.6
18.8	333.0
21.8	332.3
24.5	331.7
26.7	330.8
29.4	330.5
30.9	330.2
32.0	330.2
33.1	332.0
37.5	332.6
43.1	333.1
50.3	333.4
59.9	334.0
66.9	334.0

SUMMARY DATA	
Bankfull Elevation:	334.0
Bankfull Cross-Sectional Area:	62.0
Bankfull Width:	48.1
Flood Prone Area Elevation:	337.7
Flood Prone Width:	162.0
Max Depth at Bankfull:	3.7
Mean Depth at Bankfull:	1.3
W / D Ratio:	37.3
Entrenchment Ratio:	3.4
Bank Height Ratio:	1.0



Stream Type C



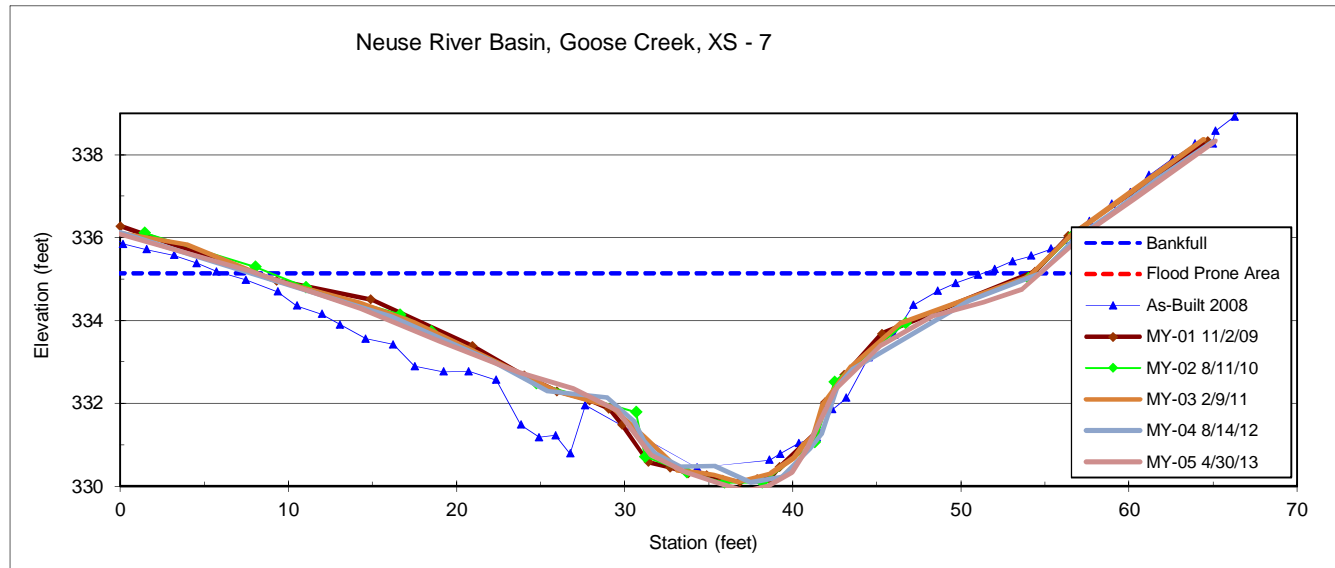
River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 7
Feature	Pool
Date:	4/30/2013
Field Crew:	Perkinson, Jernigan

Station	Elevation
-0.3	336.1
7.7	335.2
14.3	334.3
19.0	333.5
23.8	332.7
27.0	332.4
29.6	331.8
31.6	330.8
33.5	330.3
35.7	330.1
37.2	329.9
38.5	330.0
40.0	330.3
40.9	330.9
42.5	332.3
45.2	333.4
48.3	334.1
51.4	334.4
53.6	334.7
57.4	336.1
60.3	336.9
65.1	338.3

SUMMARY DATA	
Bankfull Elevation:	335.1
Bankfull Cross-Sectional Area:	106.0
Bankfull Width:	46.2
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	5.2
Mean Depth at Bankfull:	2.3
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-



Stream Type	-
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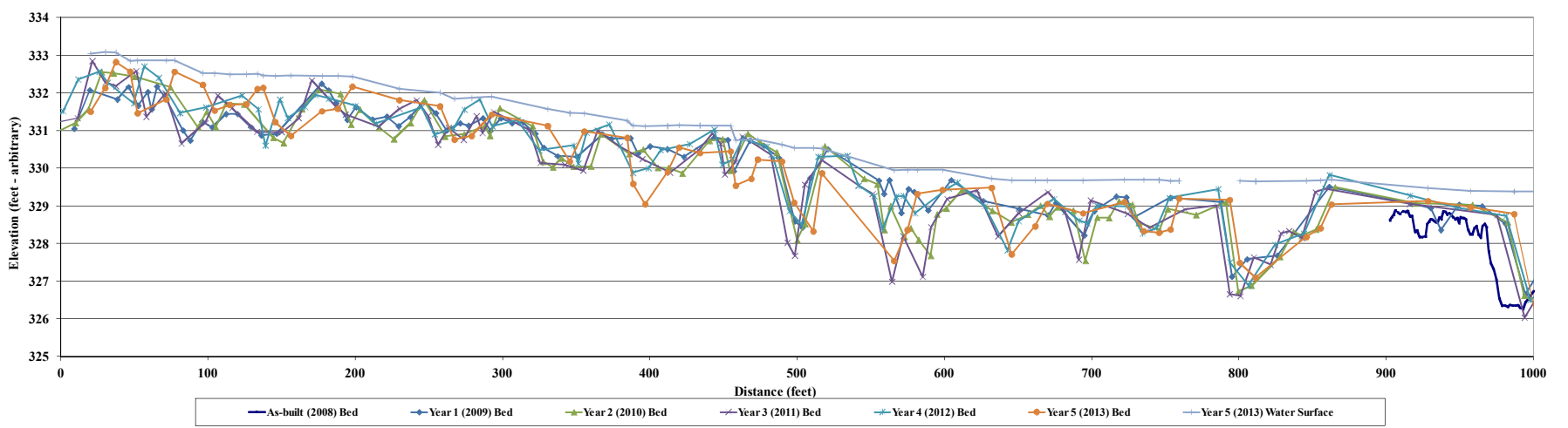


Project Name: Goose Creek - Year 5 (2013) Profile
 Reach: 00+00 to 10+00
 Profile: Profile
 Date: 4/30/13
 Crew: Perkinson, Jernigan

2008 As-built Survey		2009 Year 1 Monitoring /Survey		2010 Year 2 Monitoring /Survey		2011 Year 3 Monitoring /Survey			2012 Year 4 Monitoring /Survey			2013 Year 5 Monitoring /Survey		
Station	Bed Elevation	Station	Bed Elevation	Station	Bed Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation
902.6	328.6	0.0		1001.6	326.4	-6.7	331.2	333.0	-7.0	331.3	333.0	1001.2	326.2	329.4
903.9	328.7	9.1	331.1	993.7	326.6	11.4	331.3	333.0	1.6	331.5	333.0	986.8	328.8	329.4
905.2	328.8	19.6	332.1	982.5	328.6	21.4	332.8	333.0	11.8	332.4	333.0	957.2	329.0	329.4
906.4	328.9	38.4	331.8	958.4	329.0	30.2	332.3	332.9	26.2	332.6	333.0	928.3	329.1	329.5
907.9	328.8	46.1	332.2	920.3	329.1	37.5	332.2	332.9	31.9	332.3	333.0	862.8	329.0	329.7
909.4	328.8	52.6	331.7	865.1	329.5	51.3	332.6	332.8	49.7	331.7	333.0	855.4	328.4	329.7
911.2	328.9	59.1	332.0	852.5	328.4	58.0	331.4	332.6	56.7	332.7	333.0	845.7	328.2	329.7
913.4	328.8	61.7	331.6	842.6	328.2	71.0	332.0	332.6	66.5	332.4	332.7	811.3	327.1	329.7
914.7	328.9	65.3	332.2	837.0	328.3	81.9	330.7	332.6	80.9	331.5	332.5	800.5	327.5	329.7
916.2	328.7	71.2	331.9	827.8	327.7	98.1	331.2	332.6	98.6	331.6	332.5	793.7	329.2	
917.6	328.7	83.0	331.0	808.5	326.9	106.6	331.9	332.7	123.0	331.9	332.5	759.3	329.2	329.7
919.6	328.3	87.9	330.7	799.6	326.7	116.3	331.6	332.6	134.2	331.6	332.5	753.5	328.4	329.7
921.2	328.3	96.0	331.2	791.1	329.1	133.0	331.0	332.6	139.0	330.6	332.5	745.7	328.3	329.7
922.7	328.2	102.8	331.1	771.0	328.8	150.2	331.0	332.6	148.9	331.8	332.5	735.3	328.3	329.7
924.4	328.2	112.2	331.4	751.6	328.9	161.6	331.3	332.6	154.1	331.3	332.5	722.1	329.1	329.7
926.7	328.2	120.0	331.4	746.2	328.4	170.4	332.3	332.6	165.8	331.6	332.5	694.1	328.8	329.7
927.8	328.5	129.1	331.1	732.1	328.5	186.7	331.6	332.2	173.0	331.9	332.4	669.8	329.1	329.7
929.2	328.6	136.3	330.9	727.6	329.0	193.4	331.4	332.2	182.0	331.8	332.3	661.7	328.5	329.7
930.3	328.6	146.6	330.9	718.5	329.1	216.1	331.1	332.2	200.0	331.7	331.9	645.6	327.7	329.7
931.5	328.6	177.2	332.2	711.7	328.7	230.1	331.6	332.2	214.2	331.2	331.9	632.0	329.5	329.7
932.7	328.6	181.8	332.1	705.7	328.7	241.7	331.8	332.1	245.0	331.6	331.9	598.7	329.4	330.0
933.8	328.6	186.9	331.7	695.8	327.5	249.4	331.4	332.0	253.9	330.9	331.9	581.6	329.3	330.0
935.1	328.6	194.6	331.3	687.5	328.9	256.1	330.6	332.0	266.8	331.1	332.0	574.9	328.4	330.0
936.1	328.7	200.5	331.6	676.9	329.0	263.4	331.1	332.0	274.1	331.6	332.0	565.8	327.5	330.0
937.5	328.6	211.7	331.3	671.4	328.7	273.6	330.8	332.0	284.5	331.8	332.0	516.8	329.9	330.5
938.8	328.9	221.4	331.4	665.3	329.0	282.3	331.4	332.0	293.0	331.1	331.7	511.0	328.3	330.5
940.3	328.8	229.3	331.1	656.7	328.8	286.4	330.9	332.0	310.1	331.3	331.6	497.9	329.1	330.5
941.4	328.8	237.5	331.4	645.4	328.6	294.0	331.5	332.0	324.8	330.5	331.4	489.6	330.2	330.6
942.6	328.8	246.7	331.8	632.4	328.9	318.3	331.0	331.5	348.4	330.6	331.4	473.2	330.2	330.8

	2009	2010	2011	2012	2013
Avg. Water Surface Slope	0.0037	0.0037	0.0037	0.0038	0.0039
Riffle Length	35	36	37	35	37
Avg. Riffle Slope	0.2290	0.0075	0.0102	0.0050	0.0075
Pool Length	40	33	30	15	21
Pool Slope	0.0008	0.0007	0.0008	0.0006	0.0005

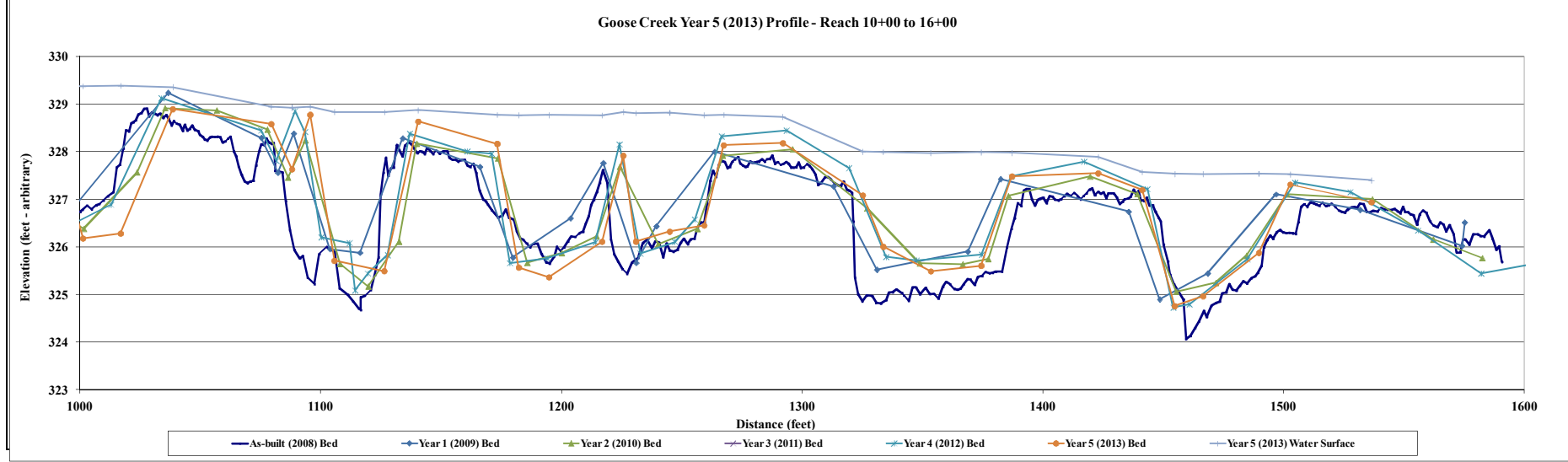
Goose Creek Year 5 (2013) Profile - Reach 00+00 to 10+00



Project Name: Goose Creek - Year 5 (2013) Profile
 Reach: 10+00 to 16+00
 Feature: Profile
 Date: 4/30/13
 Crew: Perkinson, Jernigan

2008 As-built Survey		2009 Year 1 Monitoring /Survey		2010 Year 2 Monitoring /Survey		2011 Year 3 Monitoring /Survey			2012 Year 4 Monitoring /Survey			2013 Year 5 Monitoring /Survey		
Station	Bed Elevation	Station	Bed Elevation	Station	Bed Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation
998.4	326.6	994.5	326.7	1582.5	325.8	993.9	326.0	329.4	997.8	326.5	329.5	1536.4	326.9	327.4
1000.2	326.7	1036.6	329.2	1562.1	326.2	1020.3	327.7	329.4	1012.9	326.9	329.4	1502.7	327.3	327.5
1001.1	326.8	1075.4	328.3	1536.8	327.0	1032.8	329.0	329.4	1033.8	329.1	329.4	1489.6	325.9	327.5
1002.9	326.9	1082.2	327.6	1501.2	327.1	1069.2	328.5	328.9	1075.2	328.4	329.0	1466.5	325.0	327.5
1004.9	326.8	1088.8	328.4	1484.5	325.8	1078.2	327.1	328.8	1081.6	327.8	329.0	1454.7	324.8	327.5
1006.7	326.9	1103.8	326.0	1471.8	325.2	1085.6	328.7	328.8	1089.3	328.9	329.0	1441.2	327.2	327.6
1008.2	326.9	1116.3	325.9	1455.3	325.1	1101.7	325.7	328.8	1093.5	328.4	329.0	1422.9	327.5	327.9
1009.8	327.0	1134.0	328.3	1439.1	327.1	1114.4	325.1	328.8	1100.3	326.2	329.0	1387.1	327.5	328.0
1011.6	327.1	1166.1	327.7	1419.5	327.5	1124.5	325.8	328.8	1112.0	326.1	329.1	1374.3	325.6	328.0
1013.9	327.2	1179.8	325.8	1385.7	327.1	1134.6	328.6	328.8	1114.3	325.1	329.0	1353.4	325.5	328.0
1015.3	327.7	1203.7	326.6	1377.3	325.8	1166.8	328.1	328.7	1119.6	325.4	329.0	1333.6	326.0	328.0
1016.7	327.7	1217.4	327.8	1366.6	325.6	1183.0	325.4	328.7	1127.8	325.8	329.0	1325.1	327.1	328.0
1018.1	328.1	1231.0	325.7	1348.8	325.7	1207.3	326.2	328.7	1137.0	328.4	329.0	1291.9	328.2	328.7
1019.1	328.4	1239.4	326.4	1327.0	326.8	1218.5	327.8	328.7	1160.9	328.0	328.9	1267.4	328.1	328.8
1020.4	328.4	1263.6	328.0	1296.0	328.1	1228.7	325.9	328.7	1171.0	328.0	328.9	1259.3	326.5	328.8
1021.3	328.6	1313.0	327.3	1267.0	327.9	1239.7	326.4	328.7	1178.6	325.7	328.9	1244.9	326.3	328.8
1022.3	328.6	1331.0	325.5	1256.5	326.4	1251.6	326.7	328.7	1194.0	325.8	328.8	1230.9	326.1	328.8
1023.2	328.7	1368.8	325.9	1240.1	326.1	1264.0	328.3	328.7	1214.1	326.1	328.9	1225.7	327.9	328.8
1024.3	328.8	1382.4	327.4	1224.2	327.7	1290.3	328.0	328.3	1224.1	328.2	328.9	1216.8	326.1	328.8
1025.6	328.8	1435.6	326.7	1214.6	326.2	1315.6	327.2	327.9	1232.8	325.9	328.9	1194.8	325.4	328.8
1026.7	328.9	1448.5	324.9	1200.1	325.9	1336.1	325.6	327.9	1247.1	326.1	328.9	1182.3	325.6	328.8
1027.9	328.9	1468.4	325.4	1185.8	325.7	1346.6	325.6	327.9	1255.4	326.6	328.9	1173.3	328.2	328.8
1028.7	328.7	1496.8	327.1	1173.6	327.9	1358.8	325.9	327.9	1266.5	328.3	328.9	1140.5	328.6	328.9
1030.0	328.8	1531.7	326.8	1139.8	328.2	1374.9	325.6	327.9	1293.5	328.4	328.9	1126.4	325.5	328.8
1031.0	328.8	1574.0	326.0	1132.5	326.1	1387.6	327.2	327.9	1319.5	327.7	328.0	1105.7	325.7	328.8
1032.2	328.8	1575.2	326.5	1119.7	325.2	1429.4	327.3	327.7	1334.8	325.8	328.1	1095.6	328.8	328.9
1033.4	328.8			1108.0	325.6	1444.3	327.0	327.5	1347.5	325.7	328.0	1088.1	327.6	328.9

	2009	2010	2011	2012	2013
Avg. Water Surface Slope	0.0037	0.0037	0.0037	0.0038	0.0039
Riffle Length	35	36	37	35	37
Avg. Riffle Slope	0.2290	0.0075	0.0102	0.0050	0.0075
Pool Length	40	33	30	15	21
Pool Slope	0.0008	0.0007	0.0008	0.0006	0.0005



Weighted Pebble Count																																											
Percent Riffle:	50	Percent Run:																																									
Percent Pool:	50	Percent Glide:																																									
Material	Size Range (mm)		Total #	Goose Creek																																							
silt/clay	0	0.062	33.0	---																																							
very fine sand	0.062	0.13	7.0	---																																							
fine sand	0.13	0.25	12.0	Note: Goose Creek Downstream Reach 2013																																							
medium sand	0.25	0.5	7.0																																								
coarse sand	0.5	1	10.0	<table border="1"> <thead> <tr> <th colspan="5">Size percent less than (mm)</th> <th colspan="6">Percent by substrate type</th> </tr> <tr> <th>D16</th> <th>D35</th> <th>D50</th> <th>D84</th> <th>D95</th> <th>silt/clay</th> <th>sand</th> <th>gravel</th> <th>cobble</th> <th>boulder</th> <th>bedrock</th> </tr> </thead> <tbody> <tr> <td>#N/A</td> <td>0.08</td> <td>0.2</td> <td>25</td> <td>45</td> <td>33%</td> <td>40%</td> <td>26%</td> <td>1%</td> <td>0%</td> <td>0%</td> </tr> </tbody> </table>							Size percent less than (mm)					Percent by substrate type						D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock	#N/A	0.08	0.2	25	45	33%	40%	26%	1%	0%	0%
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very fine gravel	2	4	0.0																																								
fine gravel	4	6	2.0																																								
fine gravel	6	8	2.0																																								
medium gravel	8	11	3.0																																								
medium gravel	11	16	1.0																																								
coarse gravel	16	22	2.0																																								
coarse gravel	22	32	3.0																																								
very coarse gravel	32	45	9.0																																								
very coarse gravel	45	64	4.0																																								
small cobble	64	90	1.0																																								
medium cobble	90	128	0.0																																								
large cobble	128	180	0.0																																								
very large cobble	180	256	0.0																																								
small boulder	256	362	0.0																																								
small boulder	362	512	0.0																																								
medium boulder	512	1024	0.0																																								
large boulder	1024	2048	0.0																																								
very large boulder	2048	4096	0.0																																								
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APPENDIX E
HYDROLOGIC DATA

Table 10. Verification of Bankfull Events

Table 10. Verification of Bankfull Events**Goose Creek Restoration Site (EEP Project Number 147)**

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
November 11, 2009	November 11, 2009	Visual observation of overbank as the result of Tropical Storm Ida	1-2
September 29, 2010	June 11, 2009	Visual observation of overbank in addition to a total of 0.82 inches* of rain occurring after numerous rain events, within the 2 weeks prior, that totaled 2.75 inches*.	--
September 29, 2010	September 23, 2009	Visual observations of wrack lines within the floodplain with a total of 1.7 inches* of rain occurring within a 2-day period from September 22-23, 2009.	--
February 10, 2010	February 5, 2010	Visual observations of overbank event including wrack lines and sediment deposition resulting from a 1.37 inch* rainfall event on February 5, 2009 that occurred after numerous rainfall events, within the 3 weeks prior, that totaled 3.94 inches*.	3-4
September 29, 2010	May 23, 2010	A total of 4.57 inches* of rain occurring between May 16-23, 2010.	--
September 29, 2010	September 27, 2010	A total of 2.9 inches* of rain fall between September 26-27, 2010 with more rain expected to follow.	--
June 23, 2011	May 27, 2011	Visual observations of overbank event including wrack lines resulting from a 1.64 inch* rainfall event on May 27, 2011.	5
August 20, 2012	July 31, 2011	A total of 3.26 inches* of rain occurring between July 30-31, 2011.	--
August 20, 2012	August 6, 2011	A total of 4.31 inches* of rain fall between August 6, 2011.	--
August 20, 2012	March 21, 2012	A total of 3.61 inches* of rain occurring between March 16-26, 2012.	--
August 20, 2012	July 28, 2012	A total of 3.7 inches* of rain fall between July 20-28, 2012.	--
September 30, 2013	September 3, 2012	A total of 2.8 inches* of rain fall between September 2-3, 2012.	--
September 30, 2013	September 18, 2012	A total of 3.1 inches* of rain fall between September 16-18, 2012.	--
September 30, 2013	May 20, 2013	A total of 2.4 inches* of rain fall between May 18-20, 2013.	6
September 30, 2013	June 7, 2013	A total of 5.1 inches* of rain fall on June 7, 2013.	--
September 30, 2013	August 3, 2013	A total of 3.1 inches* of rain fall on August 2-3, 2013.	--

* Reported at the Raleigh-Durham Airport (Weather Underground 2013)

Bankfull Event Photos 1-2 showing an overbank event



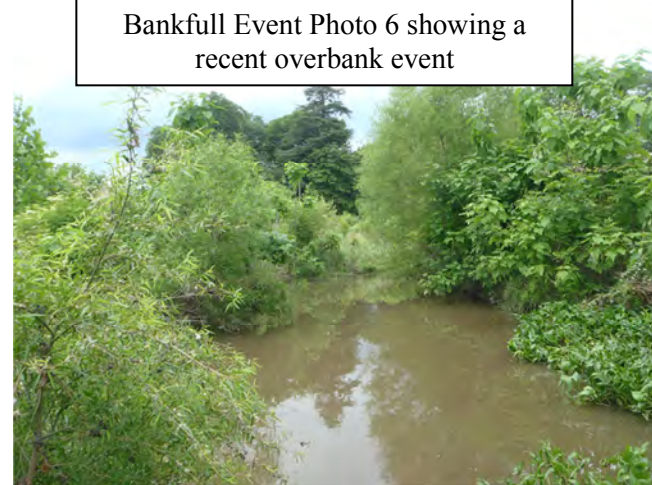
Bankfull Event Photos 3-4 showing evidence of a recent overbank event



Bankfull Event Photo 5 showing wrack due to a recent overbank event



Bankfull Event Photo 6 showing a recent overbank event



APPENDIX F
SUPPLEMENTAL PLANTING

INSPECTION REPORT

Date of Inspection: March 9, 2012

Date of Report: March 9, 2012

Project: Goose Creek – EEP #147

Location: Durham, NC

Inspection of: Supplemental Planting (Direct Pay for Services)

By: Riverworks Inc. (Contractor)

Name & Title of Inspector Perry Sugg – EEP Project Mgr

COMMENTS:

At the direction of EEP, River Works Inc. installed 70 containerized trees and 25 live stakes at the Goose Creek project site in Durham NC on March 9, 2012. The containerized trees were owner-provided plants grown by NCWRC's plant nursery in Yanceyville NC. WRC delivered all plants on the day of planting. River Works supplied the live stakes.

River Works installed 70 five-gal containerized trees within targeted areas identified by EEP (see attached map). Two areas planted on Long Meadow Park were in the vicinity of 2 large dead willow oaks that the City of Durham had removed the previous September 2011. George Morris (River Works) was instructed to plant the planting areas with appropriate representation of species, and spaced at least 10 feet from existing trees. The 25 live stakes (silky dogwood) were installed along the Eastway Reach in two small areas of bare banks.

Species	Quantity Planted
Red Oak (<i>Quercus rubra</i>)	10
Sycamore (<i>Platanus occidentalis</i>)	15
Red Chokeberry (<i>Aronia arbutifolia</i>)	10
Red maple (<i>Acer rubrum</i>)	10
Cherrybark Oak (<i>Quercus pagoda</i>)	15
Shumard Oak (<i>Quercus shumardii</i>)	10

All trees planted met NC EEP size and vigor requirements. A final walk through was conducted by EEP upon completion on 3/9/2012 and approved.

Supplemental Planting
March 13, 2012



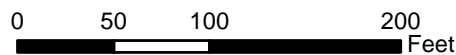
NOTE:
Quantities of container plant material installed for each area shown for each area. Areas are approximate.

LONG MEADOW PARK REACH

EEP Stream Restoration
Goose Creek - EEP #147
Durham NC
March 2012

Legend

- CE_Goose_FINAL
- Supplemental_Planting_2012





Supplemental Planting
March 13, 2012

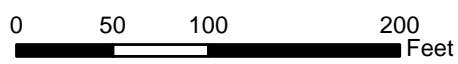
NOTE:
Quantities of container plant material installed
for each area shown for each area. Areas are approximate.

EASTWAY REACH

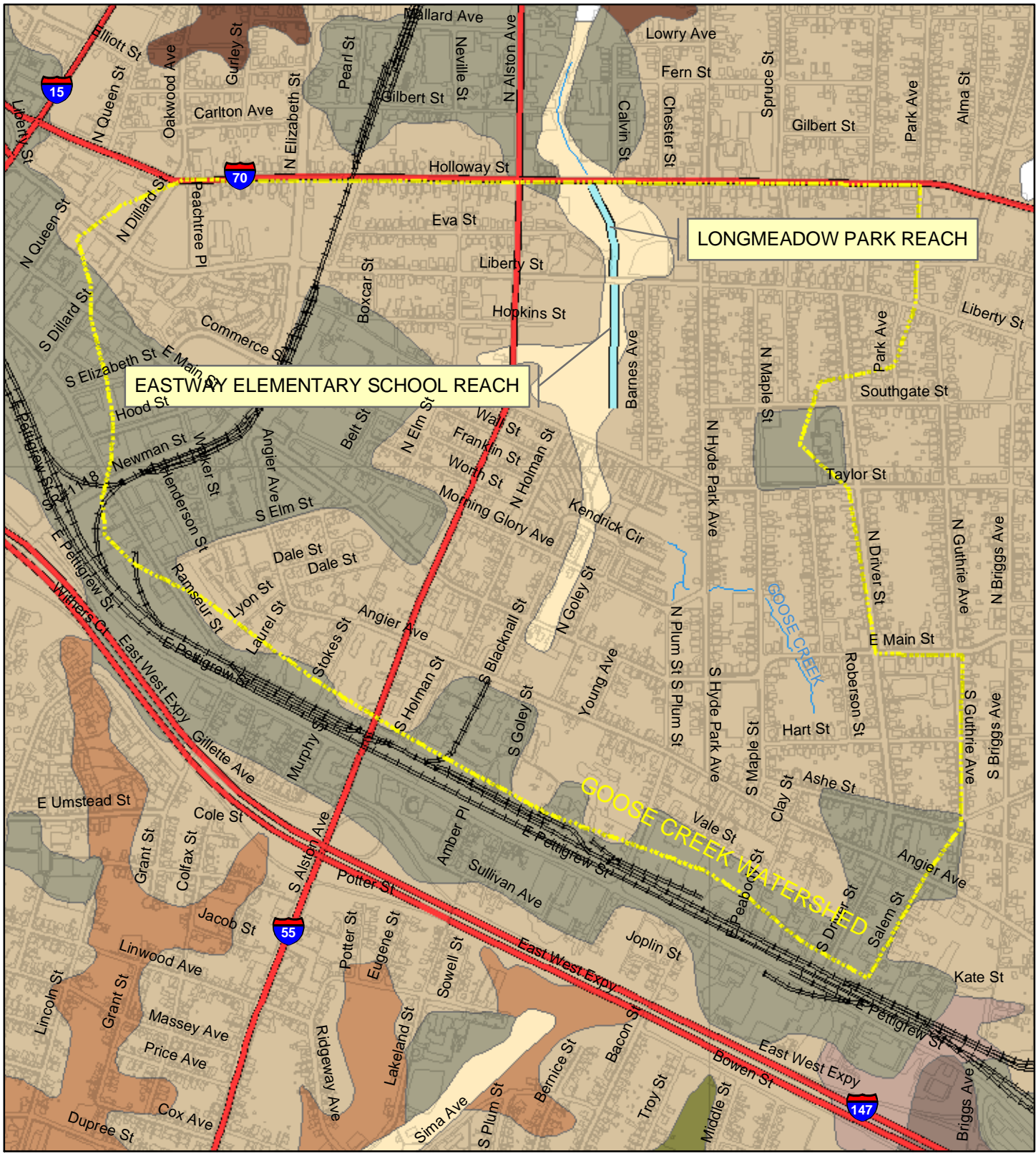
EEP Stream Restoration
Goose Creek - EEP #147
Durham NC
March 2011

Legend

- CE_Goose_FINAL
- Supplemental_Planting_2012











APPENDIX G
ADDITIONAL SITE MAPPING
Restoration Plan Figure 5. Soil Types



25000 Feet



Soil Symbol

	Cc		WsC
	CrB		WSE
	MrC		WwC
	Ur		WwE

Goose Creek Restoration
 Durham County, North Carolina
 Biohabitats Project No. 04802.02

**Figure 5
 Soil Types**



APPENDIX H
ADDITIONAL SITE PHOTOGRAPHS
Preconstruction Site Photographs
Asbuilt Site Photographs

Preconstruction Site Photographs



Preconstruction Site Photographs (continued)



Asbuilt Site Photographs

