FINAL
ANNUAL MONITORING REPORT
GOOSE CREEK

STREAM RESTORATION
DURHAM COUNTY, NORTH CAROLINA
(EEP Project Number 147)

Monitoring Year 2 of 5 (2010)

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

January 2011

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Submitted to:
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Axiom Environmental, Inc.

Ecosystem Enhancement PROGRAM

January 2011

1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

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 EEP's Ellerbe Creek Local Watershed Plan 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 on the channel and banks upstream and by rock walls downstream. The goals of the project were to eradicate artificial hardening structures, 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. This report (compiled based on EEP's *Revised Table of Contents for 2009 Monitoring Report Submissions* Version 1.2.1 dated 6/1/09) summarizes data for year 2 (2010) monitoring.

The goals of the Goose Creek stream restoration project were:

- To improve aquatic habitat by removing the fabriform channel liner on the Eastway Elementary School reach and the stone retaining walls on the Longmeadow Park reach and reintroducing a more defined and natural riffle/pool channel geometry sequence.
- 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 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 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.

Success criteria dictate that an average density of 320 stems per acre must be surviving after five monitoring years in accordance with North Carolina Division of Water Quality Administrative Code 15A NCAC 02B.0242 (Neuse River Basin, Mitigation Program for Protection and Maintenance of Existing Riparian Buffers) (NCDWQ 2007). Based on the number of stems counted, average densities were measured at 415 planted stems per acre surviving in year 2 (2010). The dominant species identified at the Site were planted stems of green ash (*Fraxinus pennsylvanica*), tulip tree (*Liriodendron tulipifera*), sycamore (*Platanus occidentalis*), and willow oak (*Quercus phellos*). Two of the individual plots met success criteria when counting planted stems alone. Plots 1 and 2 were one and two stems shy when counting planted stems alone; however, when including appropriate naturally recruited species stems such as elm (*Ulmus* sp.), green ash (*Fraxinus pennsylvanica*), river birch (*Betula nigra*), and eastern redbud (*Cercis Canadensis*) these plots were also well-above success criteria.

Success criteria for stream restoration reaches dictate that little to no change from the as-built channel occurs over the monitoring period. Year 2 (2010) monitoring measurements indicate that there have been minimal changes in cross-sections and profile downstream of Liberty Street as compared to as-built data. Profile upstream of Liberty Street was designed to adjust itself to changes in watershed flows. A total of six bankfull events are documented to have occurred at the Site with three events in year 1 (2009) and three events occurring so far during the year 2 (2010) monitoring period. Noted problem areas within the

Site include an area of bank erosion on the right bank just downstream of Cross-section 7 and at Cross-section 5 (Figure 2, Appendix A). In addition, vandalism of containerized plants and livestakes within the vicinity of Vegetation Plot 2 occurred shortly after planting in late spring/early summer of 2009. This Site is located in a public park and it is suspected that neighborhood kids pulled the plants out of the ground resulting in reduced numbers of planted stems. Naturally recruited stems of appropriate hardwood species are establishing within these areas; it is recommended to watch these areas closely.

In summary, the Site achieved success criteria for vegetation and stream attributes in the Second Monitoring Year (2010). 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 is available from EEP upon request.

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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. Plots were surveyed in June-July 2010 for the year 2 (2010) monitoring season. Sampling was conducted as outlined in the *CVS-EEP Protocol for Recording Vegetation, Version 4.0* (Lee et al. 2006) (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 Figure 2 in Appendix A.

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 assessment of in-stream structures was conducted to determine if failure has 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.

3.0 REFERENCES

Lee, Michael T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0. (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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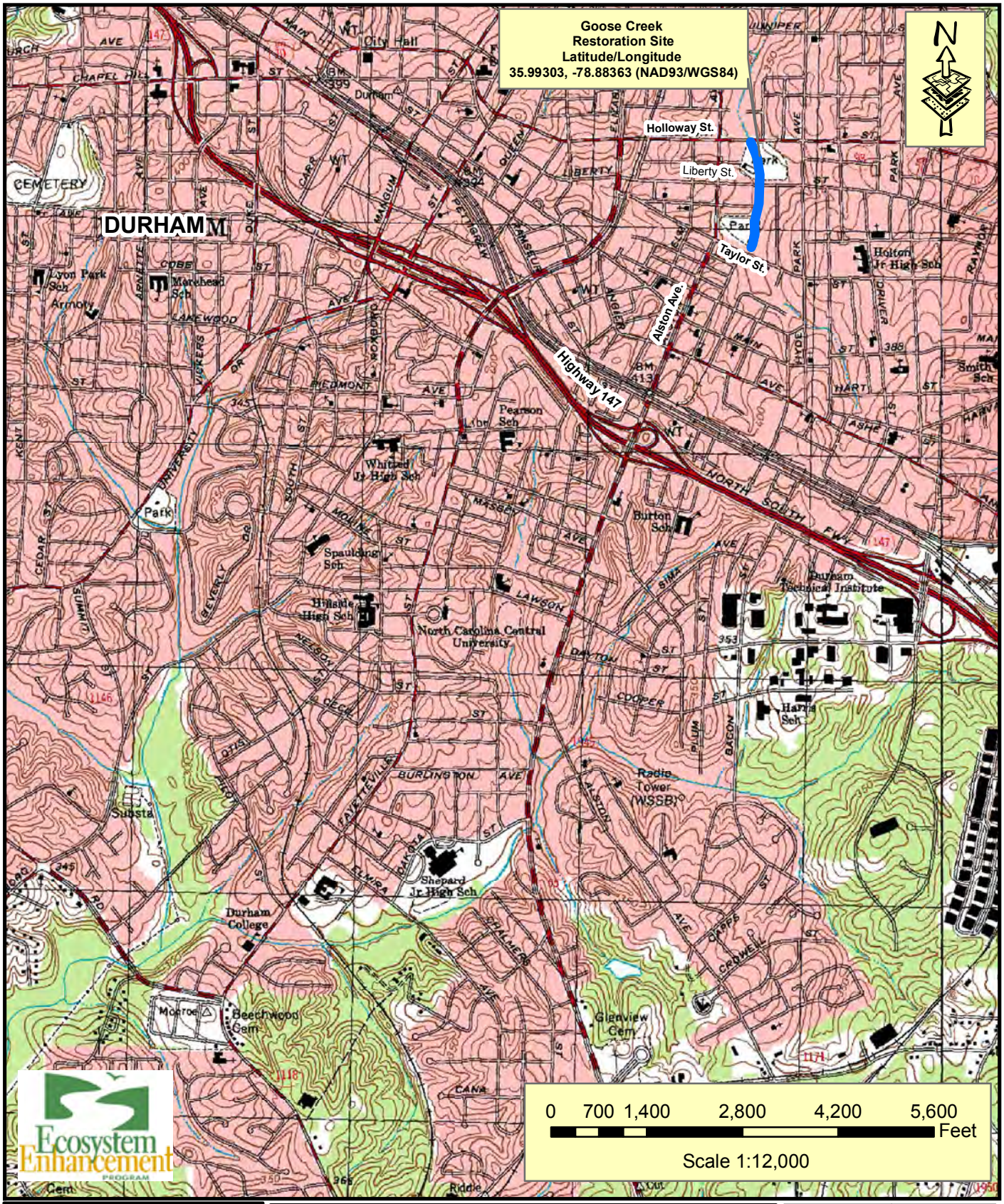
APPENDIX A

FIGURES AND PLAN VIEWS

Figure 1. Site Location

Figures 2a-2b. Monitoring Plan View



Ecosystem Enhancement Program

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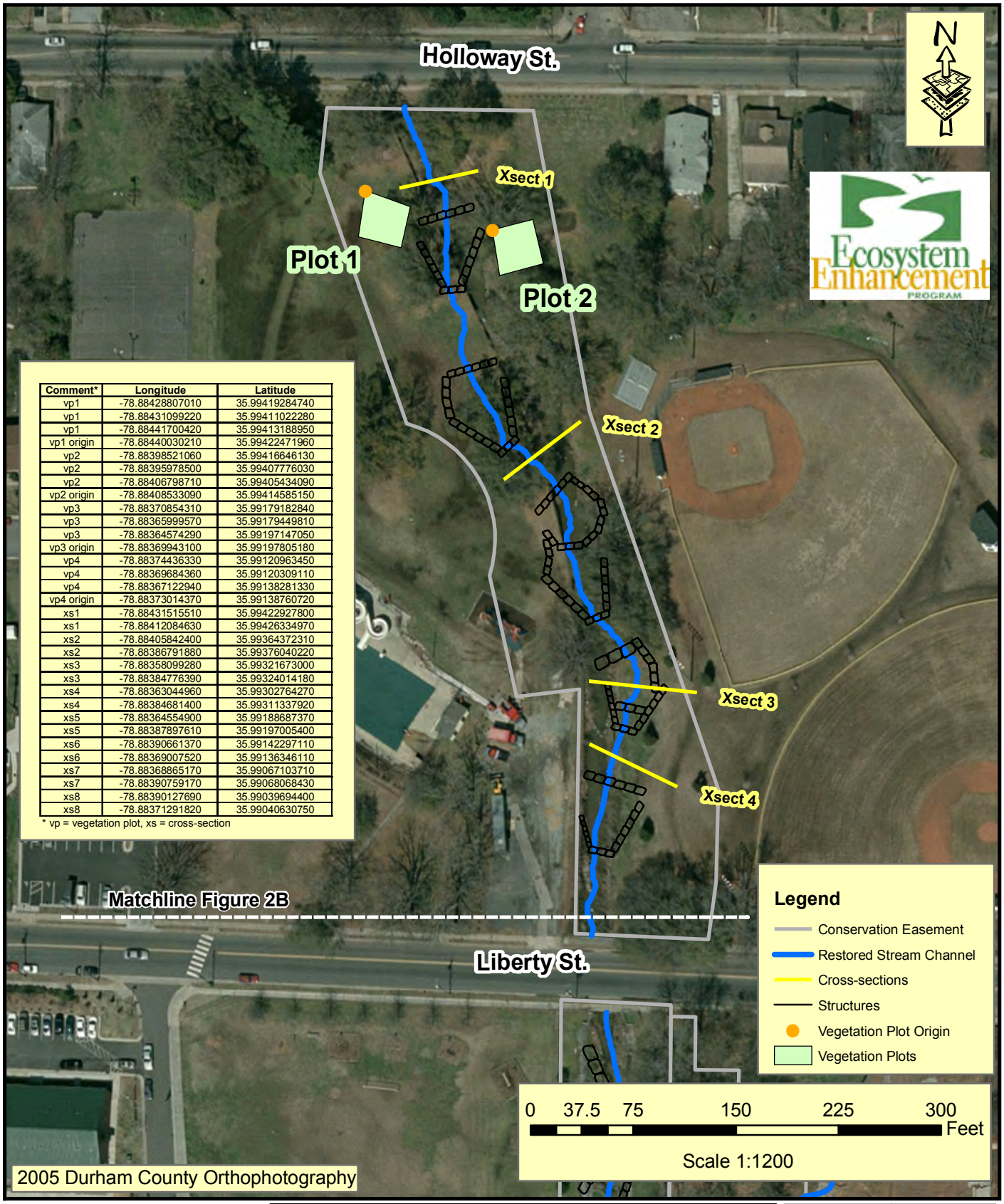
SITE LOCATION MAP
GOOSE CREEK SITE
EEP PROJECT NUMBER 147
Durham County, North Carolina

Dwn. by.	CLF
Date:	NOV 2009
Project:	08-001

FIGURE
1



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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

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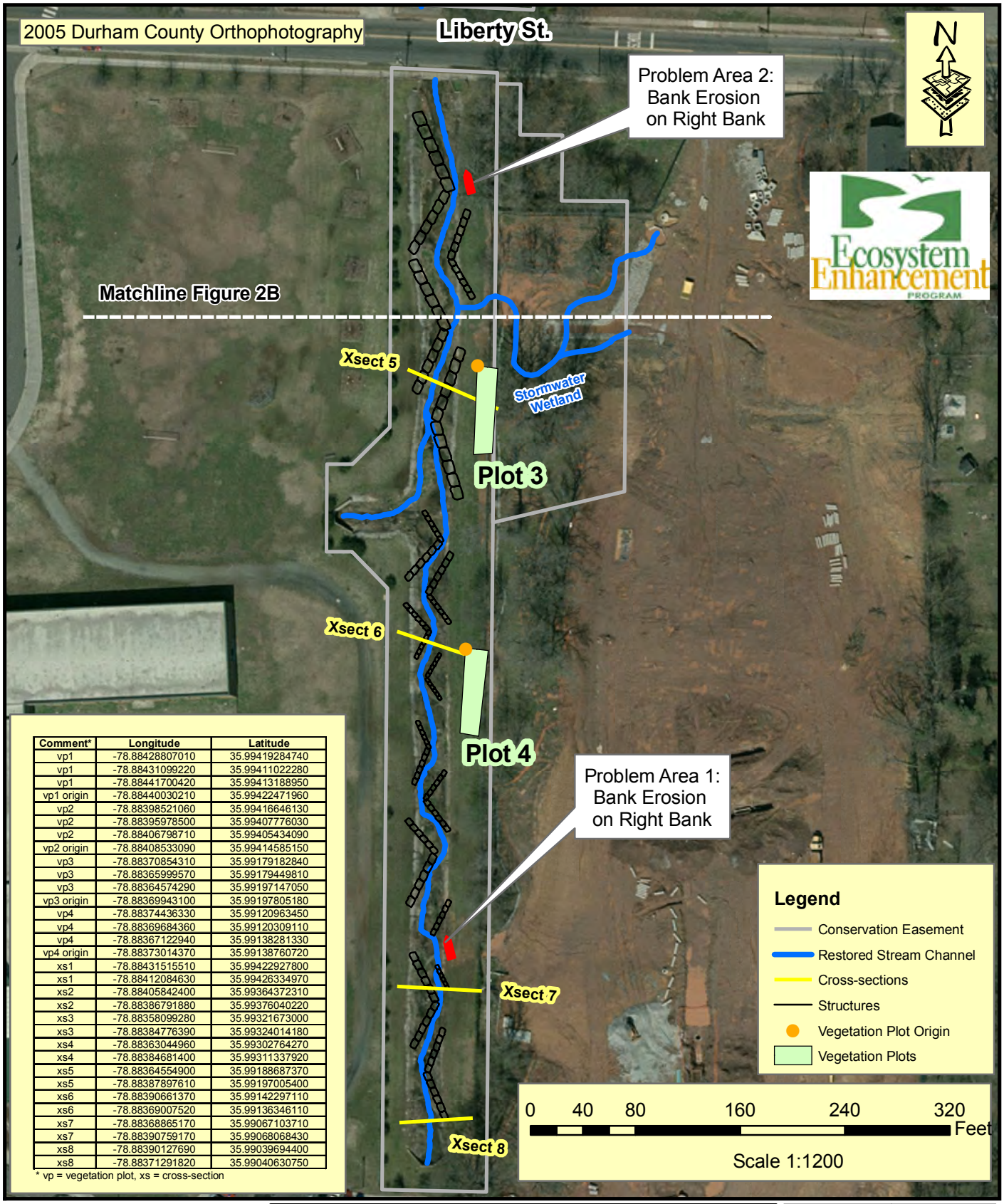
MONITORING PLAN VIEW
GOOSE CREEK SITE
EEP PROJECT NUMBER 147
Durham County, North Carolina

Dwn. by: CLF
Date: FEB 2010
Project: 10-009

FIGURE
2A



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vp1	-78.88431099220	35.99411022280
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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
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vp4	-78.88374436330	35.99120963450
vp4	-78.88369684360	35.99120309110
vp4	-78.88367122940	35.99138281330
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xs1	-78.88431515510	35.99422927800
xs1	-78.88412084630	35.99426334970
xs2	-78.88405842400	35.99364372310
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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

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

Dwn. by: CLF
Date: FEB 2010
Project: 10-009

FIGURE
2B

APPENDIX B

GENERAL PROJECT TABLES

Table 1. Site Restoration Structures and Objectives

Table 2. Project Activity and Reporting History

Table 3. Project Contacts Table

Table 4. Project Attributes Table

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-Builts	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

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 1-2 (2009-10) Monitoring Performer Axiom Environmental, Inc.	20 Enterprise Street, Suite 7 Raleigh, NC 27607 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	43
Urban-High Intensity Developed		22	22
Residential Urban		18	19
Forest, Herbaceous, Open Water		16	16
Watershed impervious cover (%)		~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 C

VEGETATION ASSESSMENT DATA

Table 5. Vegetation Plot Mitigation Success Summary

Vegetation Monitoring Plot Photos

CVS Summary Data Tables

Table 6. Vegetation Metadata Table

Table 7. Total and Planted Stems by Plot and Species

Table 5. 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	

Goose Creek Restoration Site
Year 2 (2010) Annual Monitoring
Vegetation Plot Photos (taken June 2010)

Table 6. Vegetation Metadata Table
Goose Creek Restoration Site (EEP Project Number 147)

Report Prepared By	Corri Faquin
Date Prepared	9/29/2010 8:41
database name	Axiom-EEP-2010-A.mdb
database location	C:\Business\Projects\2010\CVS Database
computer name	PHILLIP
file size	40685568
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 7. Total and Planted Stems by Plot and Species
Goose Creek Restoration Site (EEP Project Number 147)

		Current Data (MY2 2010)								Annual Totals					
		plot 1		plot 2		plot 3		plot 4		Current Mean MY2 (2010)		MY1 (2009)		Asbuilt	
Species	CommonName	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total stems	Planted stems	Total stems	Planted stems	Total stems	Planted stems
Acer negundo	boxelder			1		1				2		1			
Acer rubrum	red maple	1	1							1	1	1	1	1	1
Acer saccharinum	sugar maple													2	2
Amelanchier arborea	common serviceberry	2	2			1	1			3	3	3	3	3	3
Baccharis Halimnifolia	eastern baccharis			6		1				7					
Betula nigra	river birch			1		1	1	2	1	4	2	5	2	11	11
Callicarpa americana	american beautyberry	2	2			1	1			3	3	3	3	3	3
Catalpa bignonioides	southern catalpa	5				2		1		8					
Cephalanthus occidentalis	common buttonbush											1	1	10	10
Cercis canadensis	eastern redbud			1		1	1	1	1	3	2	2	2	3	3
Cornus	dogwood			1	1					1	1	1	1		
Fraxinus pennsylvanica	green ash	9		4	1	4	3	5	5	22	9	10	7		
Ilex decidua	possumhaw	1	1					1	1	2	2	4	2	7	7
Juniperus virginiana	eastern red cedar			1						1					
Liquidambar styraciflua	sweetgum			4						4					
Liriodendron tulipifera	tuliptree			5	2	1	1	5	5	11	8	10	10	10	10
Morus	mulberry					90		3		93					
Morus rubra	red mulberry			2						2		20			
Oxydendrum arboreum	sourwood											4	2		4
Platanus occidentalis	American sycamore			10	1	1		4	3	15	4	8	5	6	6
Prunus serotina	black cherry			1	1					1	1	1	1	1	1
Quercus phellos	willow oak					2	2	2	2	4	4	4	4	3	3
Ulmus	Elm	1								1					
unknown	unknown													1	1
Viburnum dentatum	southern arrowwood	1	1							1	1	1	1		
Plot area (acres)		0.0247		0.0247		0.0247		0.0247							
Species Count		**8**	**5**	**12**	**5**	**12**	**7**	**9**	**7**	**21**	**13**	**17**	**15**	**13**	**14**
Stem Count		**22**	**7**	**37**	**6**	**106**	**10**	**24**	**18**	**189**	**41**	**79**	**45**	**61**	**65**
Stems per acre		**891**	**283**	**1498**	**243**	**4291**	**405**	**972**	**729**	**1913**	**415**	**800**	**455**	**617**	**658**

APPENDIX D

STREAM ASSESSMENT DATA

Table 8. Verification of Bankfull Events

Table 9a. North Reach Goose Creek Qualitative Stability Assessment

Table 9b. South Reach Goose Creek Qualitative Stability Assessment

Cross-section Plots and Tables

Longitudinal Profile Plots

Pebble Count Plots

Table 8. 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.	--

* Reported at the Raleigh-Durham Airport (Weather Underground 2010)

Bankfull Event Photos 1-2 showing an overbank event

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

Table 9a. Eastway 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?	5	5	N/A	100	**100**
	2. Height appropriate?	5	5	N/A	100	
	3. Angle and geometry appear appropriate?	5	5	N/A	100	
	4. Free of piping or other structural failures?	5	5	N/A	100	
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 9b. Long Meadow Reach Goose Creek Qualitative Visual Stability Assessment (659 linear feet)

Goose Creek Restoration Site (EEP Project Number 147)

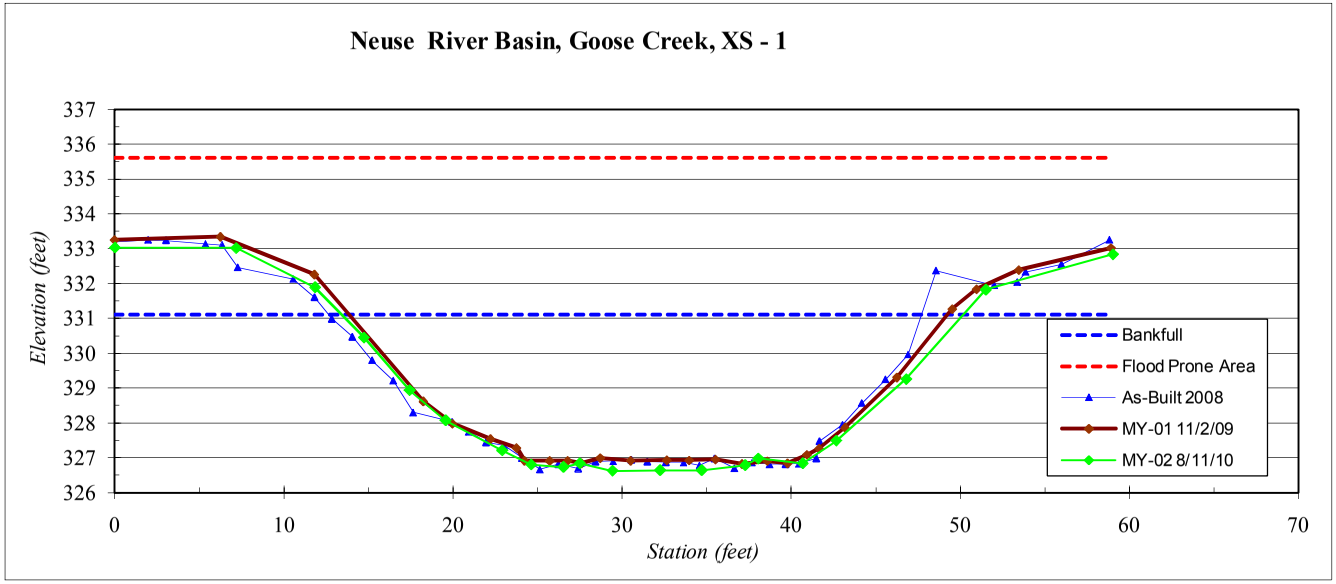
Feature Category	Metric (per As-built and reference baselines)	(# Stable) Number Performing as Intended	Total Number per As-built	Total Number / feet in unstable state	% Perform. in Stable Condition	Feature Perform. Mean or Total
A. Riffles	1. Present?	9	9	N/A	100	**100**
	2. Armor stable (e.g. no displacement)?	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	20	98	**98**
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		

River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 1
Feature	Riffle
Date:	8/11/2010
Field Crew:	Dean, Perkinson

Station	Elevation
0.0	333.03
7.2	333.02
11.8	331.89
14.7	330.45
17.4	328.93
19.6	328.07
22.9	327.21
24.6	326.80
26.5	326.73
27.5	326.83
29.4	326.62
32.2	326.64
34.7	326.64
37.3	326.78
38.1	326.98
40.7	326.83
42.7	327.5
46.8	329.3
51.5	331.8
59.0	332.8

SUMMARY DATA	
Bankfull Elevation:	331.1
Bankfull Cross-Sectional Area:	120.7
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:	11.2
Entrenchment Ratio:	4.6
Bank Height Ratio:	1.0

Stream Type	E

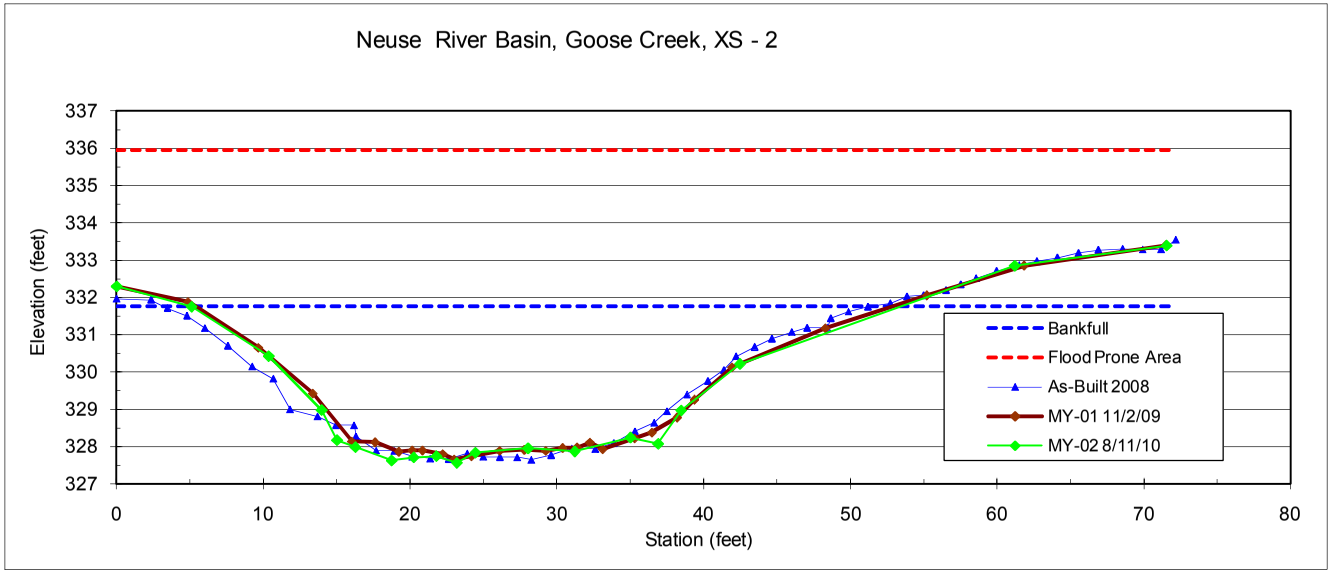


River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 2
Feature	Riffle
Date:	8/11/2010
Field Crew:	Dean, Perkinson

Station	Elevation
0.0	332.3
5.1	331.8
10.4	330.4
14.0	329.0
15.0	328.2
16.3	328.0
18.7	327.6
20.2	327.7
21.8	327.7
23.2	327.6
24.4	327.8
28.0	328.0
31.2	327.9
35.0	328.2
36.9	328.1
38.5	329.0
42.5	330.2
61.2	332.9
71.5	333.4

SUMMARY DATA	
Bankfull Elevation:	331.8
Bankfull Cross-Sectional Area:	120.8
Bankfull Width:	48.3
Flood Prone Area Elevation:	336.0
Flood Prone Width:	300.0
Max Depth at Bankfull:	4.2
Mean Depth at Bankfull:	2.5
W / D Ratio:	19.3
Entrenchment Ratio:	6.2
Bank Height Ratio:	1.0

Stream Type	E/C

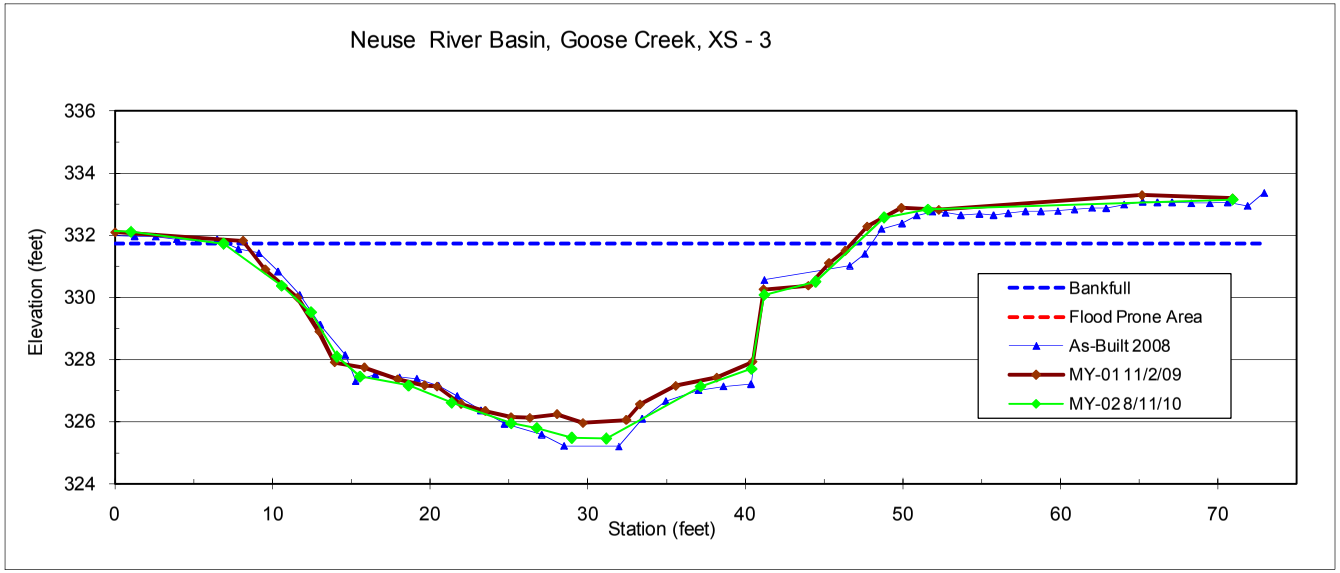


River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 3
Feature	Pool
Date:	8/11/2010
Field Crew:	Dean, Perkinson

Station	Elevation
-8.8	332.34
1.0	332.11
6.9	331.73
10.6	330.38
12.5	329.53
14.1	328.10
15.6	327.46
18.7	327.17
21.4	326.62
25.2	325.95
26.8	325.80
29.0	325.49
31.2	325.47
37.2	327.14
40.4	327.71
41.2	330.08
44.5	330.51
48.8	332.57
51.6	332.83
70.9	333.15

SUMMARY DATA	
Bankfull Elevation:	331.7
Bankfull Cross-Sectional Area:	155.7
Bankfull Width:	40.3
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	6.3
Mean Depth at Bankfull:	3.9
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	1.0

Stream Type	-

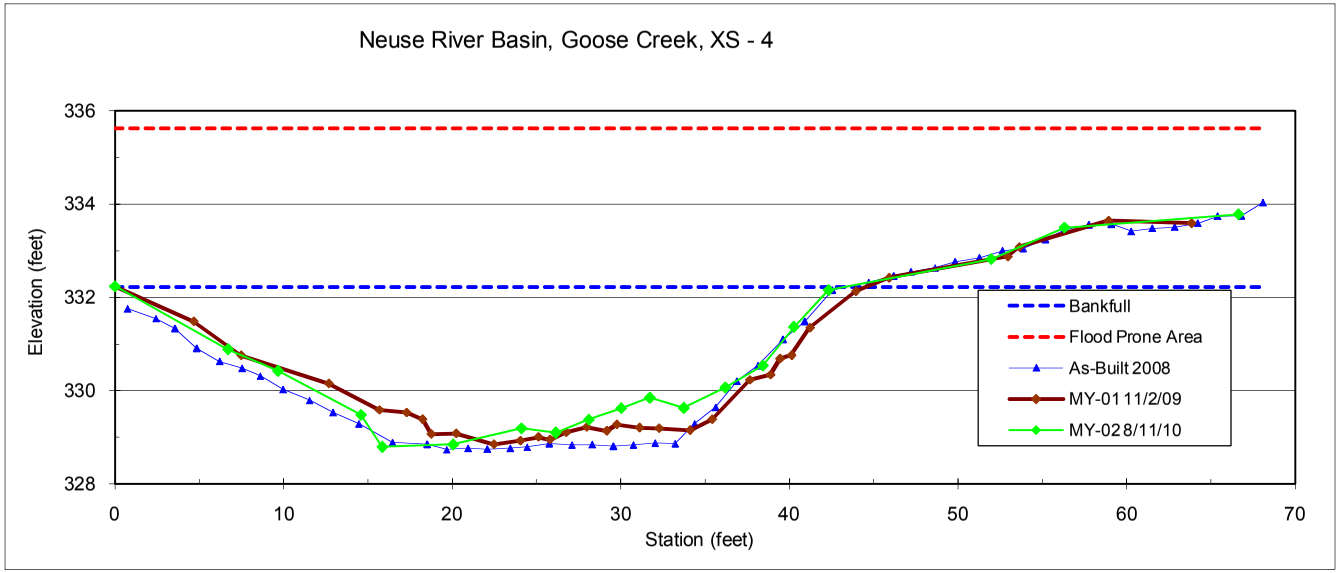


River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 4
Featuer	Riffle
Date:	8/11/2010
Field Crew:	Dean, Perkinson

Station	Elevation
0.0	332.2
6.7	330.9
9.7	330.4
14.6	329.5
15.9	328.8
20.1	328.9
24.1	329.2
26.1	329.1
28.1	329.4
30.0	329.6
31.7	329.9
33.7	329.6
36.2	330.1
38.4	330.5
40.3	331.4
42.3	332.2
52.0	332.8
56.3	333.5
66.6	333.8

SUMMARY DATA	
Bankfull Elevation:	332.2
Bankfull Cross-Sectional Area:	91.6
Bankfull Width:	43.3
Flood Prone Area Elevation:	335.6
Flood Prone Width:	240.0
Max Depth at Bankfull:	3.4
Mean Depth at Bankfull:	2.1
W / D Ratio:	20.5
Entrenchment Ratio:	5.5
Bank Height Ratio:	1.0

Stream Type	C

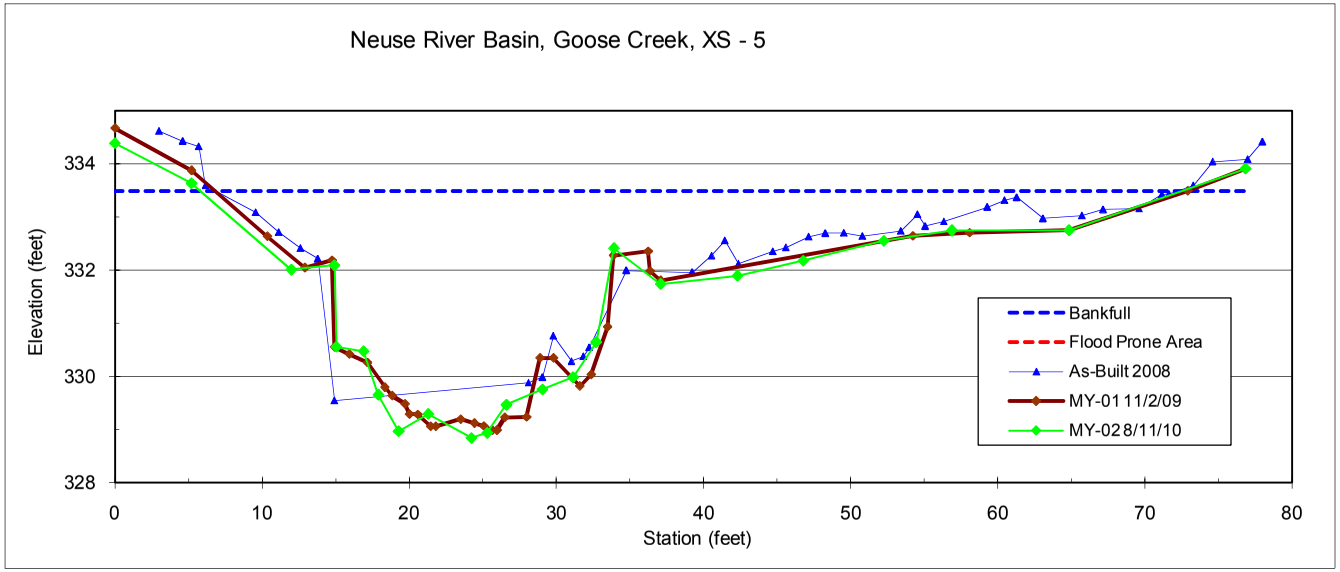


River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 5
Feature	Pool
Date:	8/11/2010
Field Crew:	Dean, Perkinson

Station	Elevation
0.0	334.4
5.2	333.6
12.0	332.0
14.9	332.1
15.1	330.6
16.9	330.5
17.9	329.7
19.3	329.0
21.3	329.3
24.2	328.8
25.3	328.9
26.6	329.5
29.1	329.8
31.1	330.0
32.7	330.6
33.9	332.4
37.1	331.7
42.3	331.9
46.8	332.2
52.3	332.6
56.9	332.8
64.8	332.8
76.8	333.9

SUMMARY DATA	
Bankfull Elevation:	333.4
Bankfull Cross-Sectional Area:	115.4
Bankfull Width:	65.9
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	4.6
Mean Depth at Bankfull:	1.8
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	-

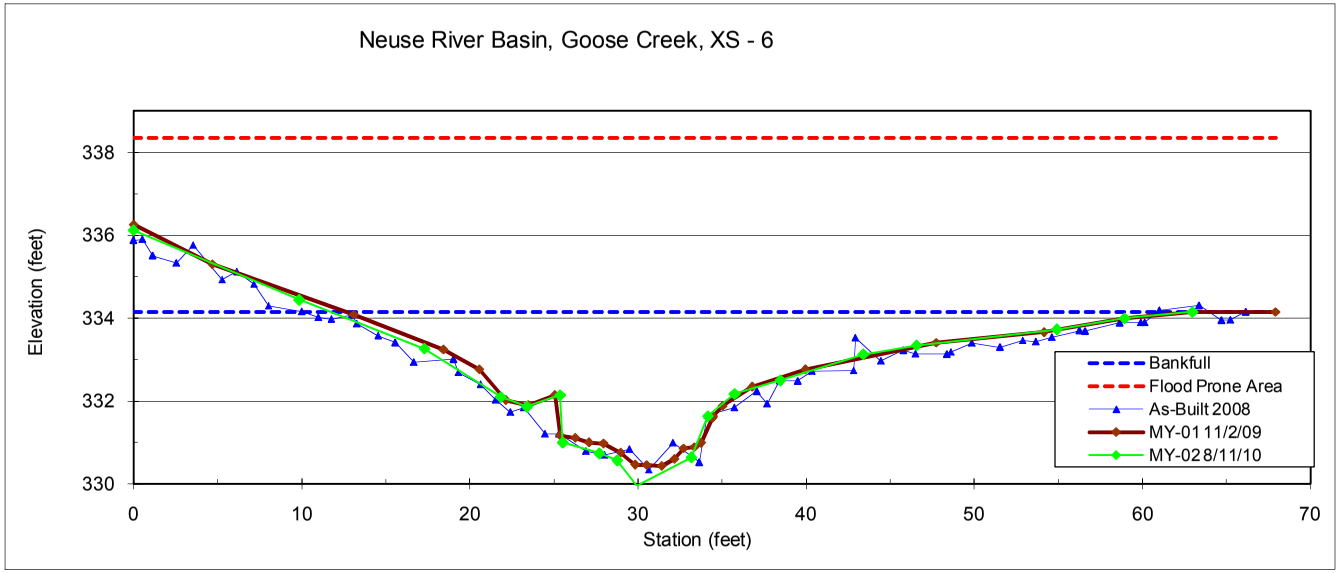


River Basin:	Neuse
Watershed:	Goose Creek
XS ID	XS - 6
Feature	Riffle
Date:	8/11/2010
Field Crew:	Dean, Perkinson

Station	Elevation
0.0	336.1
9.8	334.4
17.3	333.3
21.9	332.1
23.4	331.9
25.4	332.1
25.5	331.0
27.7	330.7
28.8	330.6
29.9	330.0
33.2	330.6
34.2	331.6
35.7	332.2
38.5	332.5
43.4	333.1
46.6	333.3
54.9	333.7
58.9	334.0
63.0	334.2
67.9	334.1

SUMMARY DATA	
Bankfull Elevation:	334.2
Bankfull Cross-Sectional Area:	72.5
Bankfull Width:	55.5
Flood Prone Area Elevation:	338.4
Flood Prone Width:	162.0
Max Depth at Bankfull:	4.2
Mean Depth at Bankfull:	1.3
W / D Ratio:	42.5
Entrenchment Ratio:	2.9
Bank Height Ratio:	1.0

Stream Type	C

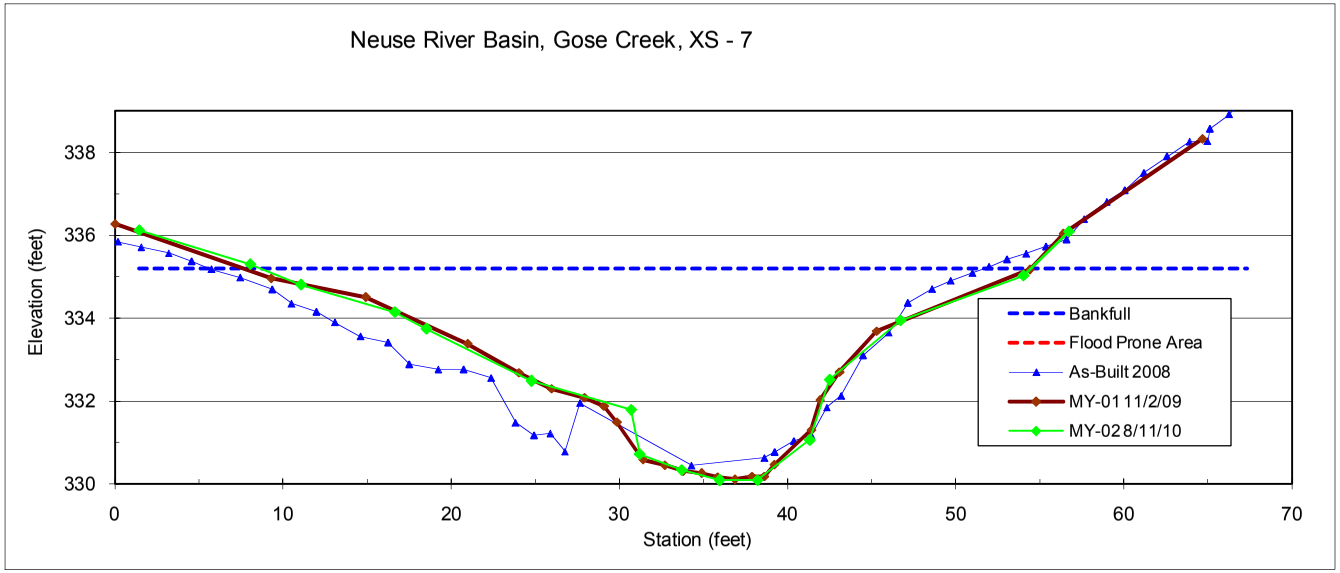


River Basin:	Neuse
Watershed:	Gose Creek
XS ID	XS - 7
Feature	Pool
Date:	8/11/2010
Field Crew:	Dean, Perkinson

Station	Elevation
1.4	336.1
8.0	335.3
11.1	334.8
16.6	334.1
18.5	333.7
24.8	332.5
30.7	331.8
31.2	330.7
33.7	330.3
35.9	330.1
38.2	330.1
41.3	331.1
42.5	332.5
46.7	333.9
54.0	335.0
56.7	336.1
64.7	338.3

SUMMARY DATA	
Bankfull Elevation:	335.2
Bankfull Cross-Sectional Area:	104.6
Bankfull Width:	45.5
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	5.1
Mean Depth at Bankfull:	2.3
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	-

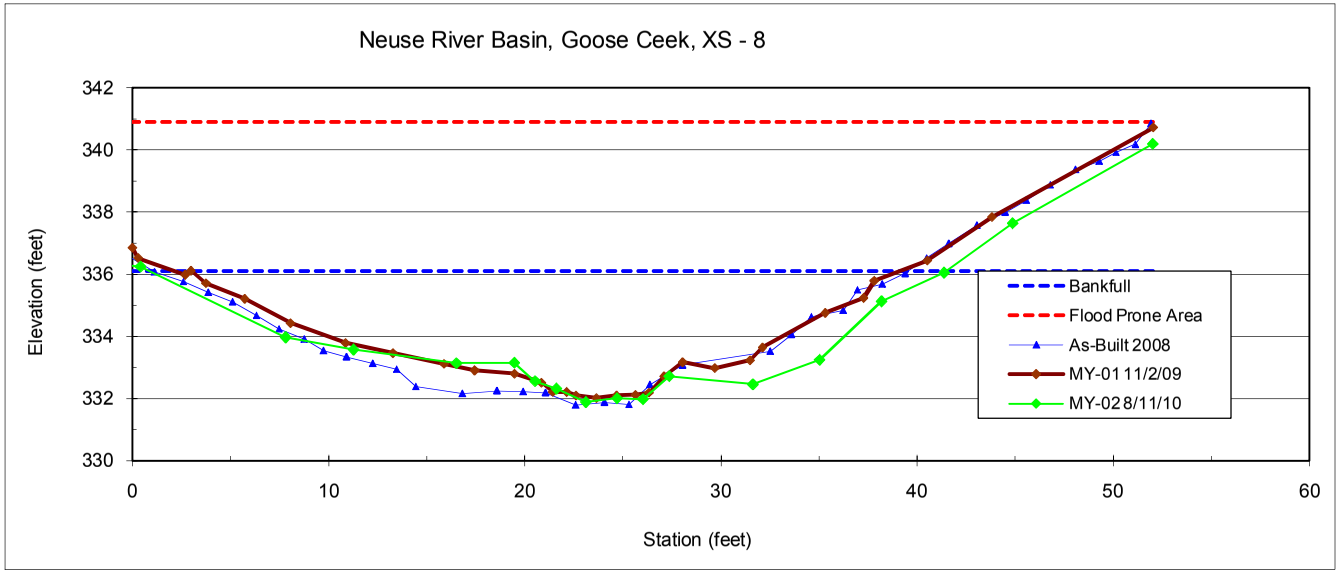


River Basin:	Neuse
Watershed:	Goose Ceek
XS ID	XS - 8
Feature	Riffle
Date:	8/11/2010
Field Crew:	Dean, Perkinson

Station	Elevation
52.0	340.2
44.9	337.6
41.4	336.0
38.2	335.1
35.0	333.2
31.6	332.5
27.4	332.7
26.0	332.0
24.7	332.0
23.1	331.9
21.6	332.3
20.5	332.6
19.5	333.2
16.5	333.14
11.3	333.58
7.8	333.97
0.4	336.24
-6.3	336.80

SUMMARY DATA	
Bankfull Elevation:	337.1
Bankfull Cross-Sectional Area:	87.7
Bankfull Width:	38.1
Flood Prone Area Elevation:	340.9
Flood Prone Width:	170.0
Max Depth at Bankfull:	3.8
Mean Depth at Bankfull:	2.3
W / D Ratio:	16.6
Entrenchment Ratio:	4.5
Bank Height Ratio:	1.0

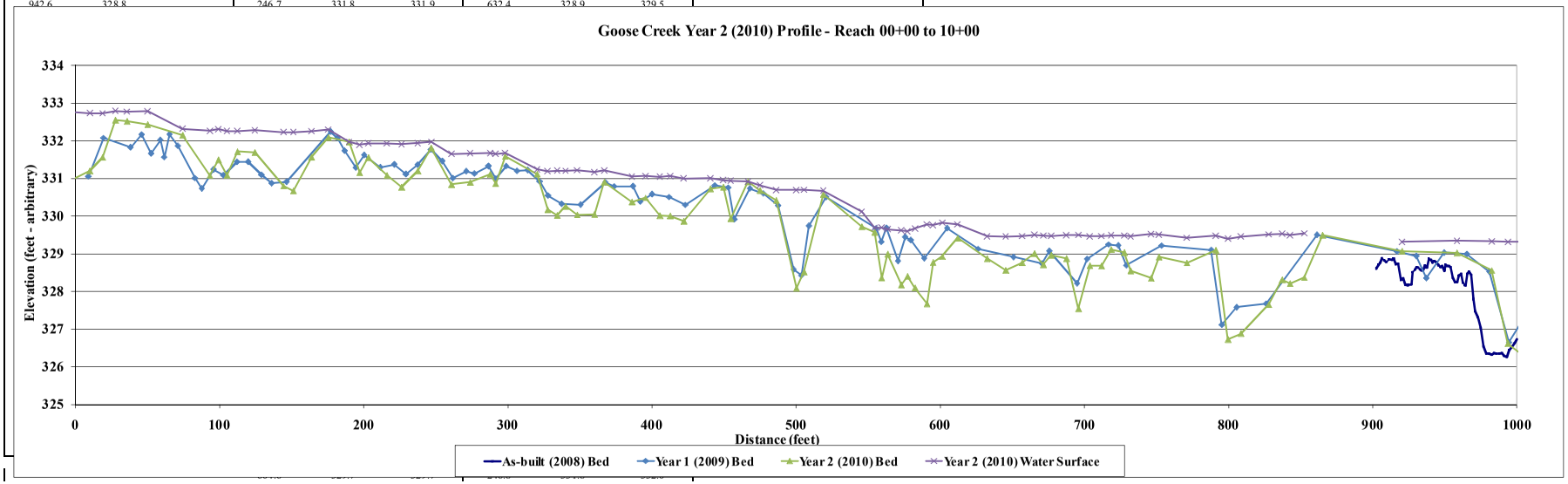
Stream Type	E/C



Project Name	Goose Creek - Year 2 (2010) Profile
Reach	00+00 to 10+00
Feature	Profile
Date	8/11/09
Crew	Dean, Perkinson

2008 As-built Survey			2009 Year 1 Monitoring \Survey			2010 Year 2 Monitoring \Survey			2011 Year 3 Monitoring \Survey		
Station	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**
902.6	328.6		0.0		332.3	1001.6	326.4	329.3			
903.9	328.7		9.1	331.1	332.3	993.7	326.6	329.3			
905.2	328.8		19.6	332.1	332.3	982.5	328.6	329.3			
906.4	328.9		38.4	331.8		958.4	329.0	329.3			
907.9	328.8		46.1	332.2	332.2	920.3	329.1	329.3			
909.4	328.8		52.6	331.7	332.3	865.1	329.5				
911.2	328.9		59.1	332.0	332.3	852.5	328.4	329.5			
913.4	328.8		61.7	331.6	332.3	842.6	328.2	329.5			
914.7	328.9		65.3	332.2	332.4	837.0	328.3	329.5			
916.2	328.7		71.2	331.9	332.4	827.8	327.7	329.5			
917.6	328.7		83.0	331.0	332.3	808.5	326.9	329.5			
919.6	328.3		87.9	330.7	332.3	799.6	326.7	329.4			
921.2	328.3		96.0	331.2	332.3	791.1	329.1	329.5			
922.7	328.2		102.8	331.1	332.3	771.0	328.8	329.4			
924.4	328.2		112.2	331.4	332.3	751.6	328.9	329.5			
926.7	328.2		120.0	331.4	332.3	746.2	328.4	329.5			
927.8	328.5		129.1	331.1	332.3	732.1	328.5	329.5			
929.2	328.6		136.3	330.9	332.3	727.6	329.0	329.5			
930.3	328.6		146.6	330.9	332.3	718.5	329.1	329.5			
931.5	328.6		177.2	332.2	332.3	711.7	328.7	329.5			
932.7	328.6		181.8	332.1	332.1	703.7	328.7	329.5			
933.8	328.6		186.9	331.7	331.9	695.8	327.5	329.5			
935.1	328.6		194.6	331.3	331.9	687.5	328.9	329.5			
936.1	328.7		200.5	331.6	331.9	676.9	329.0	329.5			
937.5	328.6		211.7	331.3	331.9	671.4	328.7	329.5			
938.8	328.9		221.4	331.4	332.0	665.3	329.0	329.5			
940.3	328.8		229.3	331.1	331.9	656.7	328.8	329.5			
941.4	328.8		237.5	331.4	331.9	645.4	328.6	329.5			
942.6	328.8		246.7	331.8	331.9	632.4	328.9	329.5			

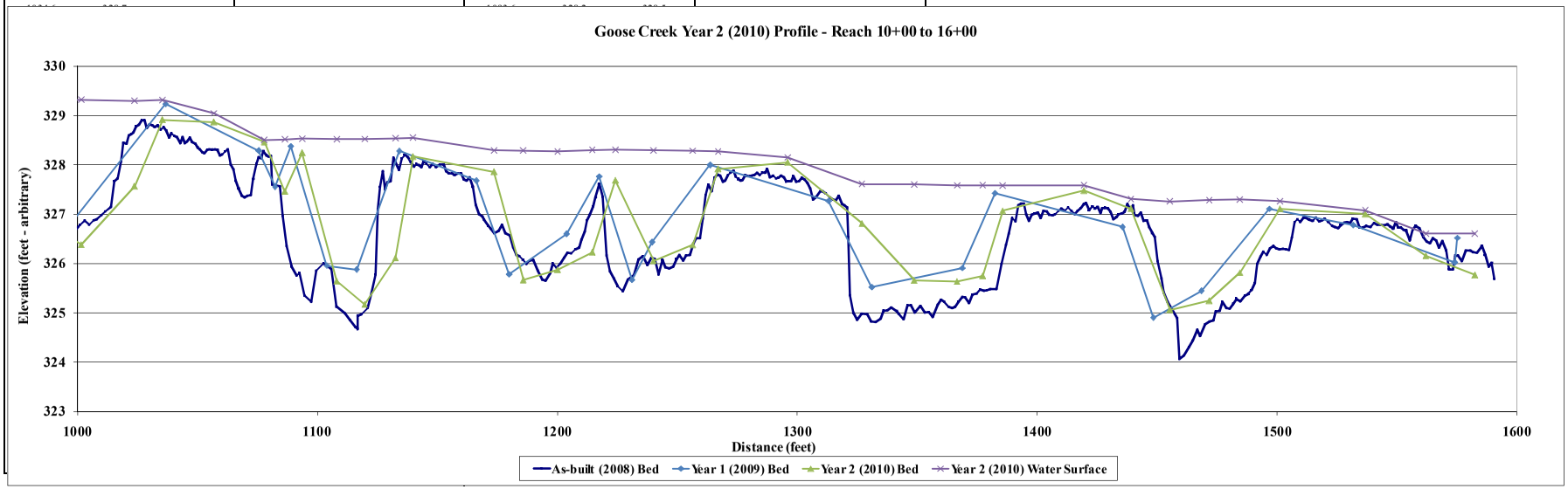
	2009	2010	2011	2012
Avg. Water Surface Slope	0.0037	0.0037		
Riffle Length	35	36		
Avg. Riffle Slope	0.2290	0.0075		
Pool Length	40	33		
Pool Slope	0.0008	0.0007		



Project Name	Goose Creek - Year 2 (2010) Profile
Reach	10+00 to 16+00
Feature	Profile
Date	8/11/10
Crew	Dean, Perkinson

2008 As-built Survey			2009 Year 1 Monitoring \Survey			2010 Year 2 Monitoring \Survey			2011 Year 3 Monitoring \Survey		
Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation	Station	Bed Elevation	Water Elevation
998.4	326.6		994.5	326.7	329.4	1582.5	325.8	326.6			
1000.2	326.7		1036.6	329.2	329.4	1562.1	326.2	326.6			
1001.1	326.8		1075.4	328.3	328.6	1536.8	327.0	327.1			
1002.9	326.9		1082.2	327.6	328.6	1501.2	327.1	327.3			
1004.9	326.8		1088.8	328.4	328.5	1484.5	325.8	327.3			
1006.7	326.9		1103.8	326.0	328.5	1471.8	325.2	327.3			
1008.2	326.9		1116.3	325.9	328.5	1455.3	325.1	327.3			
1009.8	327.0		1134.0	328.3	328.5	1439.1	327.1	327.3			
1011.6	327.1		1166.1	327.7	328.2	1419.5	327.5	327.6			
1013.9	327.2		1179.8	325.8	328.2	1385.7	327.1	327.6			
1015.3	327.7		1203.7	326.6	328.2	1377.3	325.8	327.6			
1016.7	327.7		1217.4	327.8	328.2	1366.6	325.6	327.6			
1018.1	328.1		1231.0	325.7	328.2	1348.8	325.7	327.6			
1019.1	328.4		1239.4	326.4	328.2	1327.0	326.8	327.6			
1020.4	328.4		1263.6	328.0	328.2	1296.0	328.1	328.2			
1021.3	328.6		1313.0	327.3	327.5	1267.0	327.9	328.3			
1022.3	328.6		1331.0	325.5	327.5	1256.5	326.4	328.3			
1023.2	328.7		1368.8	325.9	327.6	1240.1	326.1	328.3			
1024.3	328.8		1382.4	327.4	327.6	1224.2	327.7	328.3			
1025.6	328.8		1435.6	326.7	327.3	1214.6	326.2	328.3			
1026.7	328.9		1448.5	324.9	327.2	1200.1	325.9	328.3			
1027.9	328.9		1468.4	325.4	327.3	1185.8	325.7	328.3			
1028.7	328.7		1496.8	327.1	327.2	1173.6	327.9	328.3			
1030.0	328.8		1531.7	326.8	326.9	1139.8	328.2	328.6			
1031.0	328.8		1574.0	326.0	326.5	1132.5	326.1	328.5			
1032.2	328.8		1575.2	326.5		1119.7	325.2	328.5			
1033.4	328.8					1108.0	325.6	328.5			

	2009	2010	2011	2012
Avg. Water Surface Slope	0.0037	0.0037		
Riffle Length	35	36		
Avg. Riffle Slope	0.2290	0.0075		
Pool Length	40	33		
Pool Slope	0.0008	0.0007		

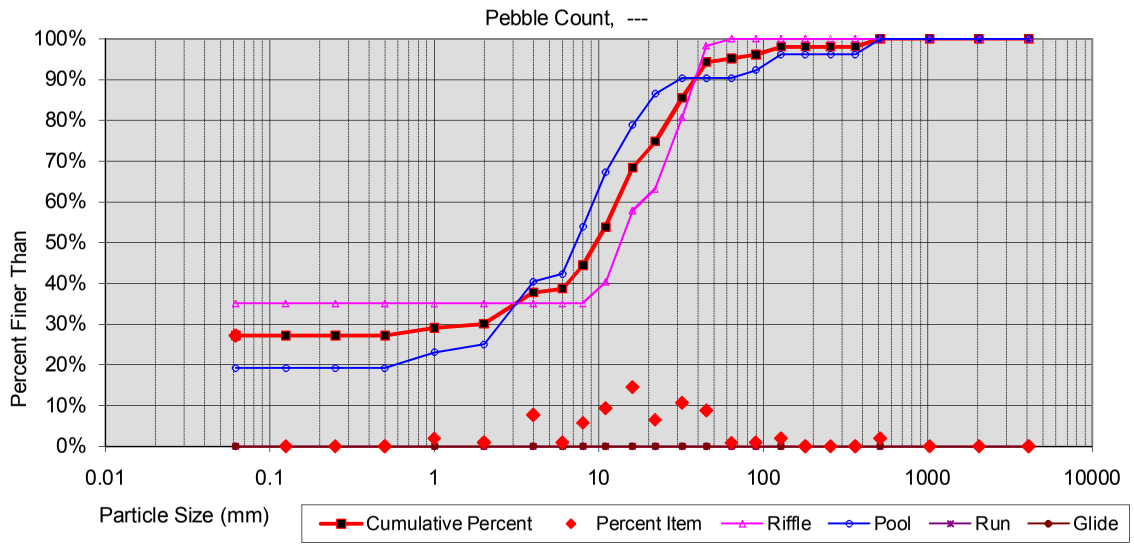


Weighted Pebble Count

Percent Riffle:	50	Percent Run:	
Percent Pool	50	Percent Glide:	

Material	Size Range (mm)		Total #
silt/clay	0	0.062	27.2
very fine sand	0.062	0.13	0.0
fine sand	0.13	0.25	0.0
medium sand	0.25	0.5	0.0
coarse sand	0.5	1	1.9
very coarse sand	1	2	1.0
very fine gravel	2	4	7.7
fine gravel	4	6	1.0
fine gravel	6	8	5.8
medium gravel	8	11	9.4
medium gravel	11	16	14.5
coarse gravel	16	22	6.5
coarse gravel	22	32	10.7
very coarse gravel	32	45	8.8
very coarse gravel	45	64	0.9
small cobble	64	90	1.0
medium cobble	90	128	1.9
large cobble	128	180	0.0
very large cobble	180	256	0.0
small boulder	256	362	0.0
small boulder	362	512	1.9
medium boulder	512	1024	0.0
large boulder	1024	2048	0.0
very large boulder	2048	4096	0.0
bedrock			0.0
		Weighted Count:	100
		True Total Particle Count	109

Note: Goose Creek Upstream Reach 2010



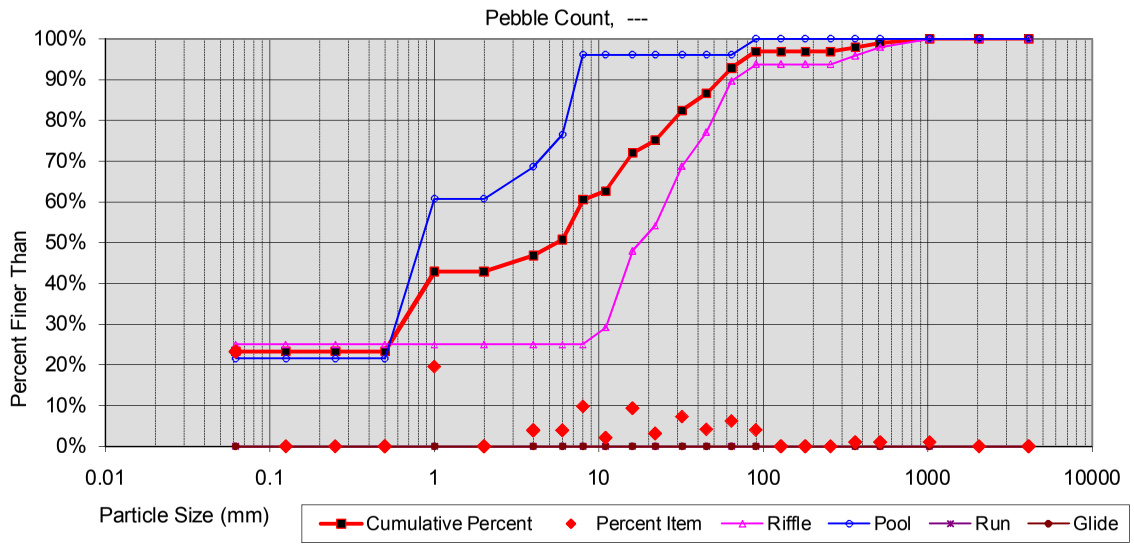
Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	3.13	9.7	30	59	27%	3%	65%	3%	2%	0%

Weighted Pebble Count

Percent Riffle:	50	Percent Run:	
Percent Pool	50	Percent Glide:	

Material	Size Range (mm)		Total #
silt/clay	0	0.062	23.3
very fine sand	0.062	0.13	0.0
fine sand	0.13	0.25	0.0
medium sand	0.25	0.5	0.0
coarse sand	0.5	1	19.6
very coarse sand	1	2	0.0
very fine gravel	2	4	3.9
fine gravel	4	6	3.9
fine gravel	6	8	9.8
medium gravel	8	11	2.1
medium gravel	11	16	9.4
coarse gravel	16	22	3.1
coarse gravel	22	32	7.3
very coarse gravel	32	45	4.2
very coarse gravel	45	64	6.3
small cobble	64	90	4.0
medium cobble	90	128	0.0
large cobble	128	180	0.0
very large cobble	180	256	0.0
small boulder	256	362	1.0
small boulder	362	512	1.0
medium boulder	512	1024	1.0
large boulder	1024	2048	0.0
very large boulder	2048	4096	0.0
bedrock			0.0
	Weighted Count:		100
	True Total Particle Count:		99

Note: Goose Creek Downstream Reach 201(



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.76	5.6	36	77	23%	20%	50%	4%	3%	0%