

**FINAL  
ANNUAL MONITORING REPORT  
BOLD RUN**

**STREAM AND BUFFER RESTORATION  
WAKE COUNTY, NORTH CAROLINA  
(EEP Project Number 439)**

Monitoring Year 5 of 5 (2011)



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



August 2011

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Submitted to:  
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Raleigh, North Carolina 27603

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4601 Six Forks Road  
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August 2011

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## 1.0 EXECUTIVE SUMMARY/PROJECT ABSTRACT

The Bold Run Stream and Buffer Restoration Site (Site) is located five miles northwest of the Town of Wake Forest on Bold Hill Road, approximately 1.5 miles east of the intersection with Mangum Dairy Road in Wake County. The Site is located within United States Geological Survey Hydrologic Unit 03020201065010 (North Carolina Division of Water Quality Subbasin 03-04-08) of the Neuse River Basin. The Site was identified to assist the North Carolina Ecosystem Enhancement Program in meeting stream and buffer restoration goals. Primary activities at the Site included stream restoration and riparian buffer restoration by stabilizing stream banks, installing in-stream structures, adjusting stream plan form, and replanting riparian areas with native vegetation. Project restoration efforts provided 640 Stream Mitigation Units, 14.9 Buffer Mitigation Units, and 14.7 Nutrient Offset Credit. This project was instituted prior to October 11, 2007 and therefore is eligible for riparian buffer restoration credit up to 200 feet from the top of bank of all perennial and intermittent waterways within the Site. This report summarizes data for year 5 (2011) monitoring.

The primary components of the restoration project included the following.

- Construct a stable, riffle-pool stream channel capable of moving sediments supplied by the watershed so the channel neither aggrades nor degrades.
- Stabilize stream banks, install in-stream structures, adjust stream planform, and replant riparian areas with native vegetation.
- Improve water quality and reduce lateral erosion and bed degradation of stream channels by establishment of riparian vegetation.
- Enhance aquatic and terrestrial wildlife habitat through improvements to stream water quality including improved oxygen levels, reduced sediments and nutrients, and varied stream bed features.

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 648 planted stems per acre surviving in year 5 (2011). The dominant species identified at the Site were planted stems of green ash (*Fraxinus pennsylvanica*), oak species (*Quercus* spp.), and elm species (*Ulmus* spp.). In addition, each individual plot met success criteria based on planted stems alone with the exception of Plot 14, which had 283 planted stems per acre. However, when counting appropriate natural recruit species stems such as box elder (*Acer negundo*) and green ashe this plot was well-above success criteria with 850 total stems per acre.

Success criteria for stream restoration reaches should show little to no change from the as-built channel over the five-year monitoring period. Year 5 (2011) monitoring measurements indicate that there have been minimal changes in both the longitudinal profile and cross-sections as compared to as-built data. In addition, a total of seven bankfull event were documented to occur over the five year monitoring period with at least one event occurring in each monitoring year.

In summary, overall the Site has met mitigation success criteria for stream, buffer, and nutrient offset for the entire five-year monitoring period, and is anticipated to be closed out in the Spring of 2012. 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 table 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.

## 2.0 METHODOLOGY

### 2.1 Vegetation Assessment

Following Site construction, fifteen plots (10-meters square) were established and monumented with metal fence posts at all plot corners and PVC at each plot origin. Five plots are located in the streamside riparian buffer planting zone and ten plots are located within the remaining buffer area. Plots were surveyed in June 2010 for the year 4 (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

Five 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.

APPENDIX A  
FIGURES AND PLAN VIEWS

Figure 1. Site Location

Figure 2. Monitoring Plan View

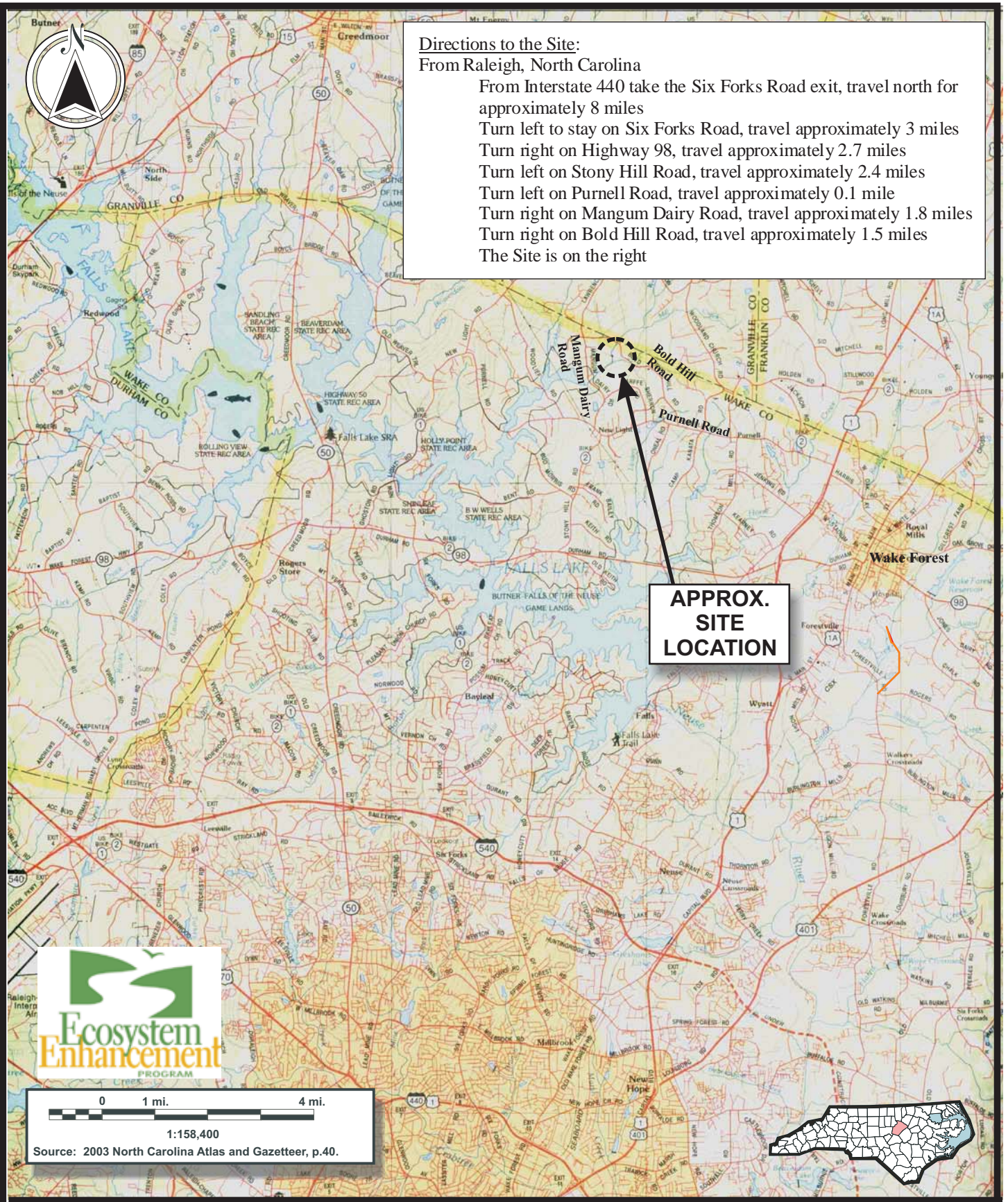
Figure 3. Current Conditions Plan View



Directions to the Site:

From Raleigh, North Carolina

- From Interstate 440 take the Six Forks Road exit, travel north for approximately 8 miles
- Turn left to stay on Six Forks Road, travel approximately 3 miles
- Turn right on Highway 98, travel approximately 2.7 miles
- Turn left on Stony Hill Road, travel approximately 2.4 miles
- Turn left on Purnell Road, travel approximately 0.1 mile
- Turn right on Mangum Dairy Road, travel approximately 1.8 miles
- Turn right on Bold Hill Road, travel approximately 1.5 miles
- The Site is on the right



**APPROX.  
SITE  
LOCATION**



0 1 mi. 4 mi.  
1:158,400  
Source: 2003 North Carolina Atlas and Gazetteer, p.40.



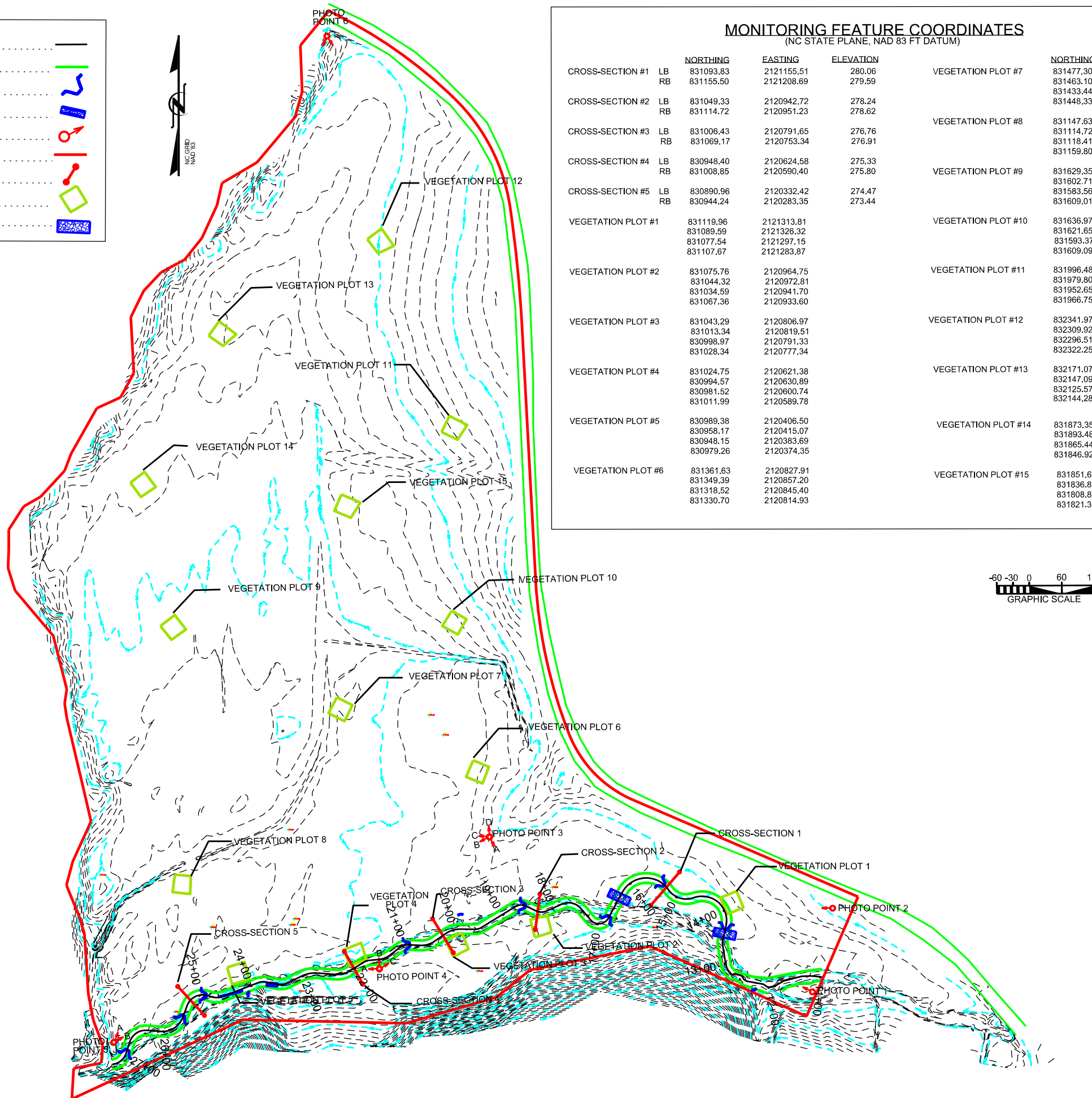

2126 Rowland Pond Dr  
Willow Spring, NC 27592  
(919) 215-1693  
(919) 341-3839 fax

**SITE LOCATION**  
**BOLD RUN RESTORATION SITE**  
**Project Number 439**  
Wake County, North Carolina

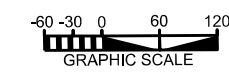
Dwn. by:	CLF
Ckd by:	WGL
Date:	Oct 2008
Project:	08-001

**FIGURE**  
**1**

LEGEND	
STREAM THALWEG	
AS-BUILT TOP OF BANK	
AS-BUILT STRUCTURE	
RIFFLE ENHANCEMENT	
PHOTO REFERENCE POINT	
PROPERTY BOUNDARY	
CROSS-SECTION	
VEGETATION PLOT	
FORD CROSSING	



MONITORING FEATURE COORDINATES (NC STATE PLANE, NAD 83 FT DATUM)							
		NORTHING	EASTING	ELEVATION		NORTHING	EASTING
CROSS-SECTION #1	LB	831093.83	2121155.51	280.06	VEGETATION PLOT #7	831477.30	2120576.84
	RB	831155.50	2121208.69	279.59		831463.10	2120605.34
CROSS-SECTION #2	LB	831049.33	2120942.72	278.24	VEGETATION PLOT #8	831433.44	2120590.84
	RB	831114.72	2120951.23	278.62		831448.33	2120561.39
CROSS-SECTION #3	LB	831006.43	2120791.65	276.76	VEGETATION PLOT #9	831147.63	2120307.85
	RB	831069.17	2120753.34	276.91		831114.72	2120306.17
CROSS-SECTION #4	LB	830948.40	2120624.58	275.33	VEGETATION PLOT #10	831118.41	2120273.86
	RB	831008.85	2120590.40	275.80		831159.80	2120277.98
CROSS-SECTION #5	LB	830890.96	2120332.42	274.47	VEGETATION PLOT #11	831629.35	2120277.54
	RB	830944.24	2120283.35	273.44		831602.71	2120298.24
VEGETATION PLOT #1		831119.96	2121313.81		VEGETATION PLOT #12	831583.56	2120271.75
		831089.59	2121328.32			831609.01	2120251.28
		831077.54	2121297.15			831629.35	2120277.54
		831107.67	2121283.87			831602.71	2120298.24
VEGETATION PLOT #2		831075.76	2120964.75		VEGETATION PLOT #13	831583.56	2120271.75
		831044.32	2120972.81			831609.01	2120251.28
		831034.59	2120941.70			831629.35	2120277.54
		831067.36	2120933.60			831602.71	2120298.24
VEGETATION PLOT #3		831043.29	2120806.97		VEGETATION PLOT #14	831583.56	2120271.75
		831013.34	2120819.51			831609.01	2120251.28
		830998.97	2120791.33			831629.35	2120277.54
		831028.34	2120777.34			831602.71	2120298.24
VEGETATION PLOT #4		831024.75	2120621.38		VEGETATION PLOT #15	831583.56	2120271.75
		830994.57	2120630.89			831609.01	2120251.28
		830981.52	2120600.74			831629.35	2120277.54
		831011.99	2120589.78			831602.71	2120298.24
VEGETATION PLOT #5		830989.38	2120406.50				
		830958.17	2120415.07				
		830948.15	2120383.69				
		830979.26	2120374.35				
VEGETATION PLOT #6		831361.63	2120827.91				
		831349.39	2120857.20				
		831318.52	2120845.40				
		831330.70	2120814.93				



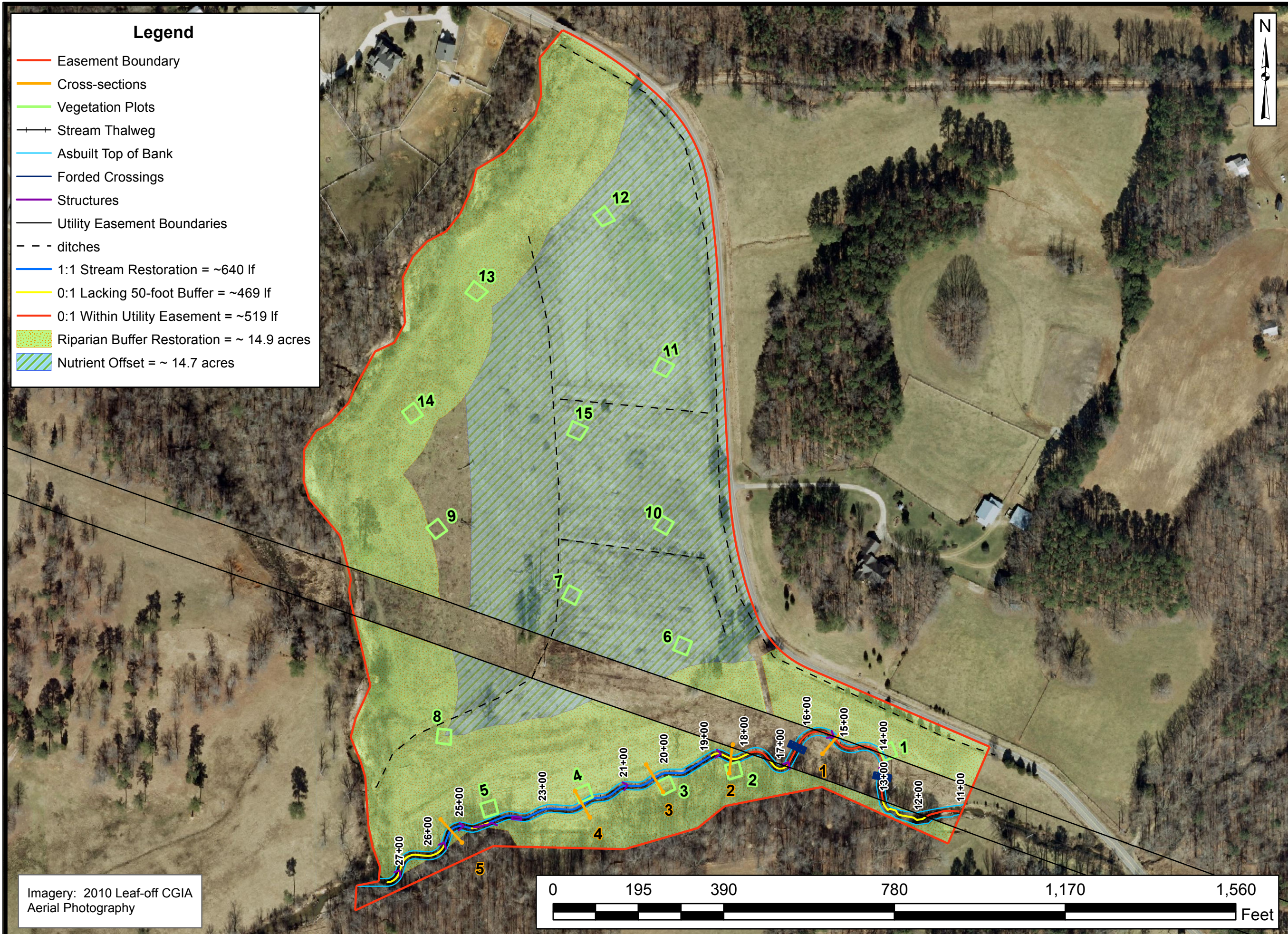
NOTES/REVISIONS

Project:  
**Bold Run  
 Restoration Site**  
 Project No. 439  
 Year 4 (2010) Monitoring Report  
 Wake County  
 North Carolina

Title:  
**Monitoring  
 Plan View**

Scale: As Shown	FIGURE NO. <b>2</b>
Date: Mar 2010	
Project No.: 08-001	





**Legend**

- Easement Boundary
- Cross-sections
- Vegetation Plots
- Stream Thalweg
- Asbuilt Top of Bank
- Forded Crossings
- Structures
- Utility Easement Boundaries
- - - ditches
- 1:1 Stream Restoration = ~640 lf
- 0:1 Lacking 50-foot Buffer = ~469 lf
- 0:1 Within Utility Easement = ~519 lf
- Riparian Buffer Restoration = ~ 14.9 acres
- Nutrient Offset = ~ 14.7 acres



Prepared for:



Project:

**BOLD RUN  
RESTORATION  
SITE**

Wake County, NC

Title:

**CURRENT  
CONDITIONS  
PLAN  
VIEW**

Drawn by:

CLF

Date:

AUG 2011

Scale:

1:2500

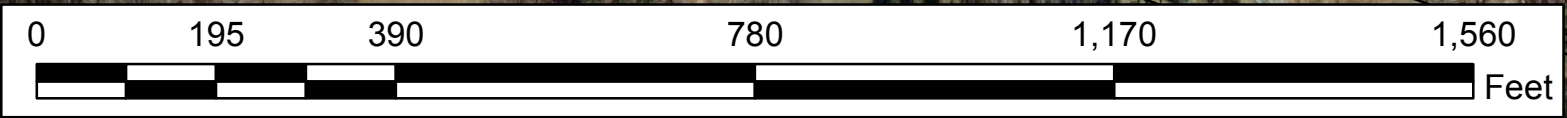
Project No.:

10-009

FIGURE

**3**

Imagery: 2010 Leaf-off CGIA  
Aerial Photography



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  
Bold Run Restoration Site (EEP Project Number 439)**

Restoration Segment/ Reach ID	Existing Linear Footage/Acres	Restoration Type/Approach*	Designed Linear Footage/Acreage	Mitigation Ratio	Mitigation Units	Stationing	Comment
1:1 Stream Restoration	--	Restoration/ P4 & P2	640	1:1	640	--	--
0:1 Stream Restoration Lacking 50-foot Buffers **	--		469	0:1**	0	--	--
0:1 Stream Restoration within Utility Easement **	--		519	0:1**	0	--	--
Riparian Buffer Restoration	0	Restoration	14.9	1:1	14.9	--	--
Nutrient Offset Buffer	0	Restoration	14.7	1:1	14.7	--	--
<b>Mitigation Unit Summations</b>							
<b>Stream</b>	<b>Riparian Wetland</b>	<b>Nonriparian Wetland</b>	<b>Total Wetland</b>	<b>Riparian Buffer</b>		<b>Nutrient Offset</b>	
640	0	0	0	649,039		640,327	

\*P2=Priority 2, P4=Priority 4

\*\*Awaiting guidance for asset reduction.

**Table 2. Project Activity and Reporting History  
Bold Run Restoration Site (EEP Project Number 439)**

Activity or Report	Data Collection Completion	Actual Completion or Delivery
Restoration Plan	November 2005	February 2006
Final Design – Construction Plans	NA	July 2006
Construction	NA	February 2007
Temporary Seed Mix Applied to Entire Project Area	NA	February 2007
Permanent Seed Mix Applied to Entire Project Area	NA	February 2007
Tree Planting	NA	February 2007
Mitigation Plan/As-builts (Year 0 Monitoring-Baseline)	March 2007	March 2007
Year 1 Monitoring (2007)	October 2007	January 2008
Year 2 Monitoring (2008)	September 2008	October 2008
Year 3 Monitoring (2009)	June 2009	July 2009
Year 4 Monitoring (2010)	July 2010	September 2010
Year 5 Monitoring (2011)	June 2011	August 2011

**Table 3. Project Contacts Table  
Bold Run Restoration Site (EEP Project Number 439)**

<b>Designer, Monitoring Year 0 Performer, Monitoring Year 1 (2007) Performer</b>	KCI Associates of NC Landmark Center II, Suite 220 4601 Six Forks Road Raleigh, North Carolina 27609 April Davis and Adam Spiller (919) 783-9214
<b>Construction and Seeding Contractor</b>	Vaughn Contracting, Inc. PO Box 796 Wadesboro, North Carolina 28170 Don Vaughn (704) 694-6450
<b>Planting Contractor and Nursery Stock Supplier</b>	Bruton Nurseries and Landscapes PO Box 1197 Freemont, North Carolina 27830 Kelly Bruton (919) 524-5304
<b>Seed Mix Source</b>	Evergreen Seed Company (919)567-1333
<b>Year 2-5 (2008-2011) Monitoring Performer</b>	Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis (919) 215-1693

**Table 4. Project Attribute Table  
Bold Run Restoration Site (EEP Project Number 439)**

Project County	Wake County, North Carolina
Drainage Area	1.6 square miles
Drainage impervious cover estimate (%)	< 1 percent
Stream Order	Second
Physiographic Region	Piedmont
Ecoregion	Northern Outer Piedmont
Rosgen Classification of As-built	C4-type
Dominant Soil Types	Chewacla, Chewacla variant, Chewacla-Riverview
Reference Site ID	Richland Creek
USGS HUC	Site-03020201065010 Reference-03020201070060
NCDWQ Subbasin	Site-03-04-08 Reference-03-04-02
NCDWQ Classification for Project	WS-IV, NSW, CA (Stream Index # 27-13-(0.1))
Any portion of any project segment 303d listed?	No
Any portion of any project segment upstream of a 303d listed segment?	No
Reasons for 303d listing or stressor	Not Applicable
% of project easement fenced	100 percent

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  
Bold Run Restoration Site (EEP Project Number 439)**

Vegetation Plot ID	Vegetation Survival Threshold Met?	Tract Mean
1	Yes	93%
2	Yes	
3	Yes	
4	Yes	
5	Yes	
6	Yes	
7	Yes	
8	Yes	
9	Yes	
10	Yes	
11	Yes	
12	Yes	
13	Yes	
14	No*	
15	Yes	

\*This plot was one stem shy of meeting success criteria when counting planted stems alone; however, when including naturally recruited stems of box elder (*Acer negundo*) and green ash (*Fraxinus pennsylvanica*) this plot was well-above success criteria.

**Bold Run Restoration Site  
Year 5 (2011) Annual Monitoring  
Vegetation Plot Photos (taken June 14, 2011)**



**Bold Run Restoration Site  
Year 5 (2011) Annual Monitoring  
Vegetation Plot Photos (taken June 14, 2011), continued**





**Table 6. Vegetation Metadata Table  
Bold Run Restoration Site (EEP Project Number 439)**

<b>Report Prepared By</b>	Corri Faquin
<b>Date Prepared</b>	6/17/2011 14:07
<b>database name</b>	Axiom-EEP-2011-B.mdb
<b>database location</b>	C:\Axiom\Business\CVS
<b>computer name</b>	CORRI-PC
<b>file size</b>	40574976
<b>DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT-----</b>	
<b>Metadata</b>	Description of database file, the report worksheets, and a summary of project(s) and project data.
<b>Proj, planted</b>	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
<b>Proj, total stems</b>	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.
<b>Plots</b>	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
<b>Vigor</b>	Frequency distribution of vigor classes for stems for all plots.
<b>Vigor by Spp</b>	Frequency distribution of vigor classes listed by species.
<b>Damage</b>	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
<b>Damage by Spp</b>	Damage values tallied by type for each species.
<b>Damage by Plot</b>	Damage values tallied by type for each plot.
<b>ALL Stems by Plot and spp</b>	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
<b>PROJECT SUMMARY-----</b>	
<b>Project Code</b>	BR
<b>project Name</b>	Bold Run
<b>Description</b>	Bold Run Stream and Buffer Mitigation Site
<b>River Basin</b>	Neuse
<b>length(ft)</b>	
<b>stream-to-edge width (ft)</b>	
<b>area (sq m)</b>	
<b>Required Plots (calculated)</b>	
<b>Sampled Plots</b>	15



Table 7. Total and Planted Stems by Plot and Species (continued)  
 EEP Project Code 439. Project Name: Bold Run Creek (G)

Scientific Name	Common Name	Species Type	Annual Means																	
			MY5 (2011)			MY4 (2010)			MY3 (2009)			MY2 (2008)			MY1 (2007)			MY0 (2007)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer negundo	boxelder	Tree	2	2	30	1	1	53	1	1	1			3						
Acer rubrum	red maple	Tree			2			5												
Baccharis halimifolia	eastern baccharis	Shrub Tree			30									1						
Betula nigra	river birch	Tree	7	7	7	5	5	6	3	3	3	3	3	7	3	3	3	7	7	7
Celtis laevigata	sugarberry	Shrub Tree	6	6	8	6	6	6	6	6	6	6	6	7	7	7				
Cornus amomum	silky dogwood	Shrub		3	3		3	3		3	3		5	5	2	5	5	2	6	6
Diospyros virginiana	common persimmon	Tree						1												
Fraxinus pennsylvanica	green ash	Tree	49	49	141	46	46	133	45	45	45	45	45	56	33	33	33	34	34	34
Juglans nigra	black walnut	Tree	3	3	3	3	3	3	3	3	3	3	3	2	2	2				
Juniperus virginiana	eastern redcedar	Tree						1												
Liquidambar styraciflua	sweetgum	Tree			11			13						3						
Liriodendron tulipifera	tuliptree	Tree	9	9	13	8	8	11	8	8	8	8	8	10	5	5	5			
Pinus	pine	Tree												9						
Pinus taeda	loblolly pine	Tree			11			12												
Platanus occidentalis	American sycamore	Tree	19	19	41	16	16	46	16	16	16	16	16	30	18	18	18	19	19	19
Prunus serotina	black cherry	Shrub Tree			1			2						1						
Quercus	oak	Shrub Tree													2	2	2	7	7	7
Quercus lyrata	overcup oak	Tree	14	14	14	14	14	14	17	17	17	18	18	18	21	21	21			
Quercus michauxii	swamp chestnut oak	Tree	14	14	14	14	14	14	13	13	13	13	13	13	12	12	12	1	1	1
Quercus pagoda	cherrybark oak	Tree	25	25	25	26	26	26	25	25	25	25	25	25	22	22	22			
Quercus phellos	willow oak	Tree	29	29	29	30	30	30	28	28	28	28	28	28	33	33	33	1	1	1
Rhus copallinum	flameleaf sumac	Shrub Tree						2												
Salix	willow	Shrub Tree																	8	8
Salix nigra	black willow	Tree		11	12		11	11		12	12		9	9		7	7			
Salix sericea	silky willow	Shrub Tree		7	7		8	8		7	7		8	8		7	7			
Sambucus canadensis	Common Elderberry	Shrub Tree	3	3	3	1	1	1	1	1	1	1	1	1		1	1		3	3
Ulmus	elm	Tree	3	3	5	2	2	88				1	1	4						
Ulmus alata	winged elm	Tree	41	41	43			1												
Ulmus americana	American elm	Tree	16	16	26	1	1	1	1	1	1	1	1	1						
Ulmus rubra	slippery elm	Tree							1	1	1	1	1	1						
Unknown	unknown	unknown													4	4	4	105	112	112
	Stem count		240	261	479	173	195	493	168	190	190	169	191	242	164	182	182	176	198	198
	size (ares)		15			15			15			15			15			15		
	size (ACRES)		0.37			0.37			0.37			0.37			0.37			0.37		
	Species count		15	18	23	14	17	26	14	17	17	14	17	22	13	16	16	8	10	10
Totals	Stems per ACRE		647.5	704.15302	1292	466.7	526.1	1330	453.2	512.6	512.6	455.9	515.3	652.9	442.5	491	491	474.8	534.2	534.2
	Stem count		237	255	432	172	191	472	167	186	186	168	185	226	158	172	172	69	77	77
	size (ares)		1			1			1			1			1			1		
	size (ACRES)		0.02			0.02			0.02			0.02			0.02			0.02		
Riparian Buffer Success Criteria	Species count		14	16	19	13	15	20	13	15	15	13	15	18	11	13	13	6	7	7
	Stems per ACRE		639	688	1165	464	515	1273	451	502	502	453	499	610	426	464	464	186	208	208

\*Bolted hardwood tree species are counted toward riparian buffer success criteria.

Color for Density  
 Exceeds requirements by 10%  
 Exceeds requirements, but by less than 10%  
 Fails to meet requirements, by less than 10%  
 Fails to meet requirements by more than 10%

PnoLS = Planted excluding livestakes  
 P-all = All planted stems including livestakes  
 T = All planted and natural recruit stems including livestakes  
 Total includes natural recruit stems

APPENDIX D  
STREAM ASSESSMENT DATA

Fixed-Station Photos

Table 8. Qualitative Visual Stability Assessment

Table 9. Verification of Bankfull Events

Cross-section Plots and Tables

Longitudinal Profile Plots

Pebble Count Plots

**Bold Run Restoration Site  
Fixed-Station Photographs  
taken June 21, 2011**



**Bold Run Restoration Site  
Fixed-Station Photographs  
taken June 2010 (continued)**



**Bold Run Restoration Site  
Fixed-Station Photographs  
taken June 21, 2011 (continued)**



**Table 8. Qualitative Visual Stability Assessment**

**Bold Run Restoration Site (EEP Project Number 439)**

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?	21	21	N/A	100%	<b>100%</b>
	2. Armor stable (e.g. no displacement)?	21	21	N/A	100%	
	3. Facet grade appears stable?	21	21	N/A	100%	
	4. Minimal evidence of embedding/fining?	21	21	N/A	100%	
	5. Length appropriate?	21	21	N/A	100%	
B. Pools	1. Present? (e.g. no severe aggradation)	15	15	N/A	100%	<b>95.6%</b>
	2. Sufficiently deep (Dmax pool:Mean Bkf > 2.2?)	13	15	N/A	86.7%	
	3. Length appropriate?	15	15	N/A	100%	
C. Thalweg	1. Upstream of meander bend centering?	14	14	N/A	100%	<b>100%</b>
	2. Downstream of meander centering?	14	14	N/A	100%	
D. Meanders	1. Outer bend in state of limited/controlled erosion?	14	14	N/A	100%	<b>100%</b>
	2. Of those eroding, # w/ concomitant point bar formation?	0	0	N/A		
	3. Apparent Rc within spec?	14	14	N/A	100%	
	4. Sufficient floodplain access and relief?	14	14	N/A	100%	
E. Bed General	1. General channel bed aggradation areas (bar formation)	N/A	N/A	0	100%	<b>99.5%</b>
	2. Channel bed degradation - areas of increasing down cutting or head cutting?	N/A	N/A	1/20	99%	
F. Bank	1. Actively eroding, wasting, or slumping bank	N/A	N/A	1/30	98%	<b>98%</b>
G. Vanes	1. Free of back or arm scour?	8	8	N/A	100%	<b>100%</b>
	2. Height appropriate?	8	8	N/A	100%	
	3. Angle and geometry appear appropriate?	8	8	N/A	100%	
	4. Free of piping or other structural failures?	8	8	N/A	100%	
H. Wads / Boulders	1. Free of scour?	6	6	N/A	100%	<b>100%</b>
	2. Footing stable?	6	6	N/A	100%	



**Table 9. Verification of Bankfull Events**

**Bold Run Restoration Site (EEP Project Number 439)**

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
November 19, 2007	Between 8/31/2007 and 11/19/2007	Crest Gauge	--
October 8, 2008	August 28, 2008	Total of 3.48 inches* of rain reported to fall over 2 days (August 27 – 28, 2008) as well as crest gauge readings at the Site	--
February 9, 2009	Between 10/8/2008 and 2/9/2009	Crest Gauge	---
June 19, 2009	Between June 15-17, 2009	1.43 inches of rain fall between June 4-5, 2009, followed by 0.5 inches of rain fall between June 9-10, 2009, followed by an additional 2.24 inches of rain fall between June 14-17, 2009* as well as crest gauge readings at the Site	Event Photos 1-2 (see below)
March 16, 2010	November 11, 2009	3.44 inches of rain fall between November 10-12, 2009*	--
February 17, 2010	February 5, 2010	Visual observations of overbank event including wrack lines and sediment deposition resulting from a 1.36 inch* rainfall event on February 5, 2010 that occurred after numerous rainfall events, within the 3 weeks prior, that totaled 3.52 inches.	Event Photo 3 (see below)
June 21, 2011	June 10, 2011	Visual observations of overbank event including wrack lines and sediment deposition resulting from a 1.74 inch* rainfall event on June 10, 2011	--

\* Reported at KNCWAKEF1 Weather Station on Welcome Drive in Wake Forest.

Bankfull Event Photos 1-2 showing evidence of overbank through wrack lines on banks and vegetation matted from overland flow within the floodplain.



Bankfull Event Photo 3 showing evidence of overbank through wrack/debris lines on banks.



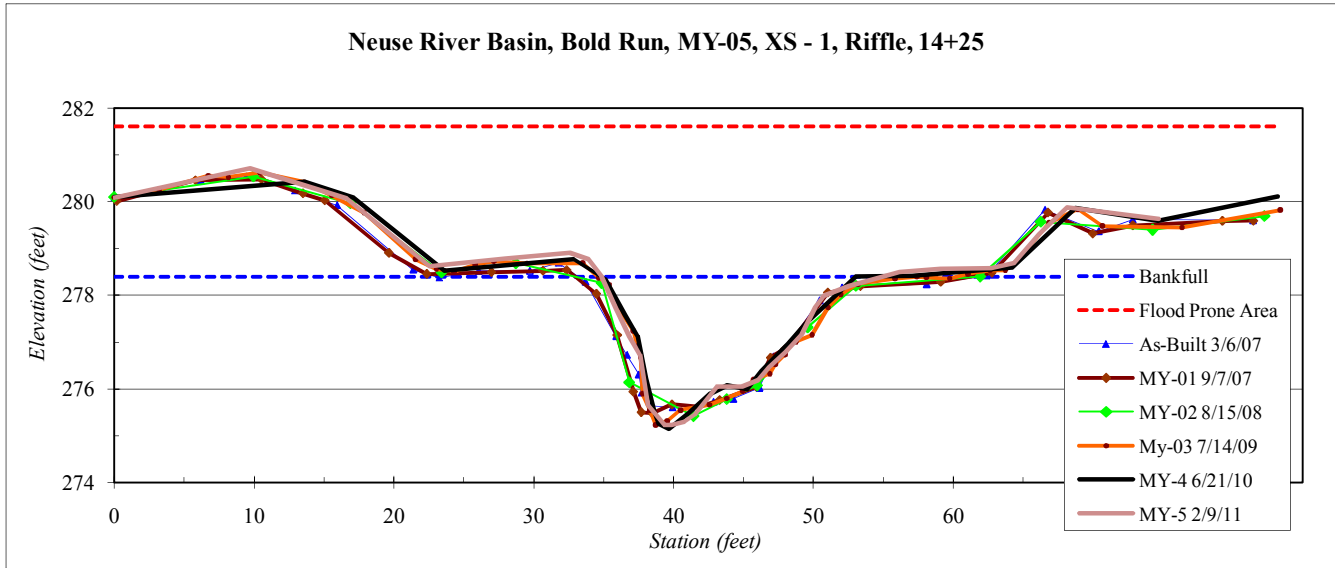
<b>River Basin:</b>	Neuse
<b>Watershed:</b>	Bold Run, MY-05
<b>XS ID</b>	XS - 1, Riffle, 14+25
<b>Drainage Area (sq mi):</b>	1.6
<b>Date:</b>	2/9/2011
<b>Field Crew:</b>	Dean, Perkinson

Station	Elevation
0.00	280.09
13.58	280.42
17.10	280.08
23.59	278.52
32.86	278.77
35.11	278.35
36.52	277.59
37.45	277.13
38.01	276.23
38.61	275.52
38.94	275.26
39.67	275.15
41.03	275.48
42.57	275.89
43.84	276.08
45.28	276.00
46.26	276.38
48.19	276.97
49.47	277.40
53.06	278.40
57.07	278.41
64.19	278.60
68.74	279.87
74.63	279.58
83.23	280.11

<b>Bankfull Elevation:</b>	278.4
<b>Bankfull Cross-Sectional Area:</b>	32.3
<b>Bankfull Width:</b>	20.1
<b>Flood Prone Area Elevation:</b>	281.6
<b>Flood Prone Width:</b>	>80
<b>Max Depth at Bankfull:</b>	3.2
<b>Mean Depth at Bankfull:</b>	1.6
<b>W / D Ratio:</b>	12.5
<b>Entrenchment Ratio:</b>	>4
<b>Bank Height Ratio:</b>	1.0



<b>Stream Type</b>	E4
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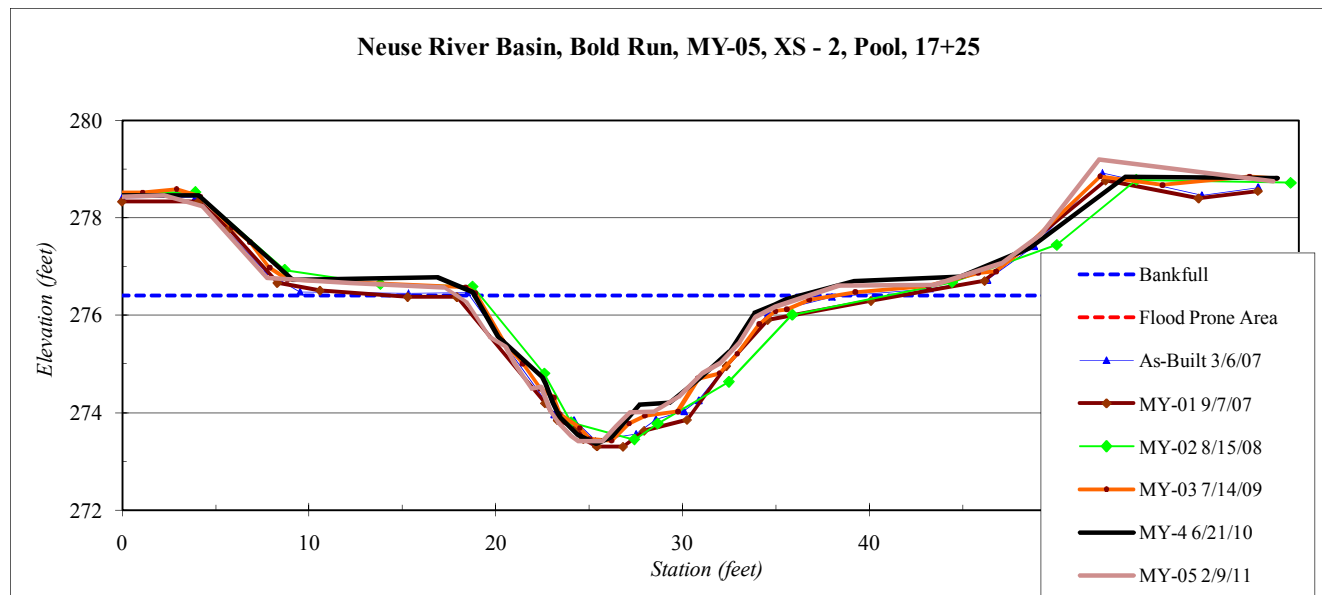
<b>River Basin:</b>	Neuse
<b>Watershed:</b>	Bold Run, MY-05
<b>XS ID</b>	XS - 2, Pool, 17+25
<b>Drainage Area (sq mi):</b>	1.6
<b>Date:</b>	2/9/2011
<b>Field Crew:</b>	Dean, Perkinson



<b>Stream Type</b>	E4
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Station	Elevation
-4.18	274.20
-4.08	278.47
4.08	278.47
9.14	276.73
16.86	276.78
18.77	276.48
20.12	275.55
22.49	274.73
22.65	274.60
23.04	274.22
23.42	273.92
23.76	273.79
24.40	273.55
25.37	273.37
26.24	273.51
27.69	274.16
29.31	274.20
30.95	274.72
32.53	275.27
33.84	276.05
34.95	276.22
35.58	276.34
39.18	276.70
44.91	276.80
48.62	277.38
53.73	278.84
61.88	278.82

SUMMARY DATA	
<b>Bankfull Elevation:</b>	276.4
<b>Bankfull Cross-Sectional Area:</b>	29.7
<b>Bankfull Width:</b>	18.9
<b>Flood Prone Area Elevation:</b>	-
<b>Flood Prone Width:</b>	-
<b>Max Depth at Bankfull:</b>	3.0
<b>Mean Depth at Bankfull:</b>	1.6
<b>W / D Ratio:</b>	-
<b>Entrenchment Ratio:</b>	-
<b>Bank Height Ratio:</b>	-



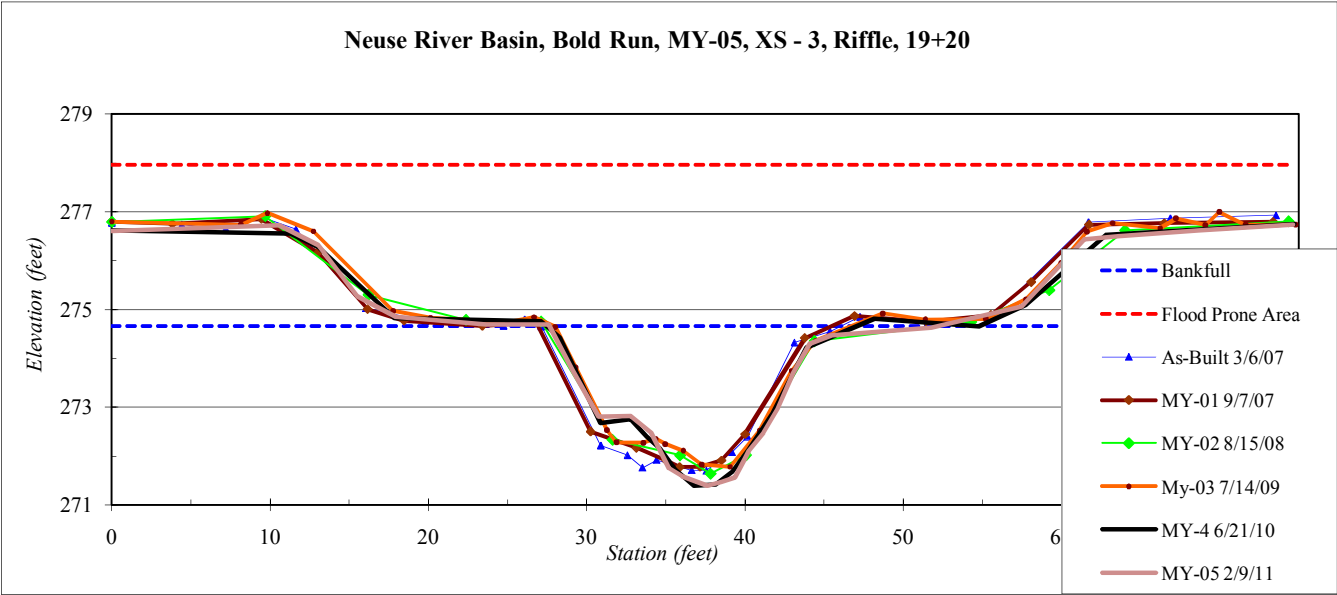
<b>River Basin:</b>	Neuse
<b>Watershed:</b>	Bold Run, MY-05
<b>XS ID</b>	XS - 3, Riffle, 19+20
<b>Drainage Area (sq mi):</b>	1.6
<b>Date:</b>	2/9/2011
<b>Field Crew:</b>	Dean, Perkinson



Station	Elevation
0.00	276.61
10.60	276.72
13.05	276.32
15.49	275.26
17.93	274.86
23.63	274.69
27.59	274.69
29.10	273.77
30.74	272.81
32.78	272.82
34.08	272.47
35.19	271.74
36.00	271.59
37.61	271.39
38.54	271.47
39.38	271.56
40.00	271.95
40.27	272.11
41.18	272.48
42.08	272.96
43.07	273.69
44.12	274.30
45.48	274.47
51.78	274.63
57.49	275.06
61.44	276.44
63.62	276.51
68.68	276.62
74.63	276.74

SUMMARY DATA	
<b>Bankfull Elevation:</b>	274.7
<b>Bankfull Cross-Sectional Area:</b>	28.5
<b>Bankfull Width:</b>	19.3
<b>Flood Prone Area Elevation:</b>	278.0
<b>Flood Prone Width:</b>	>74
<b>Max Depth at Bankfull:</b>	3.3
<b>Mean Depth at Bankfull:</b>	1.5
<b>W / D Ratio:</b>	13.1
<b>Entrenchment Ratio:</b>	>3
<b>Bank Height Ratio:</b>	1.0

Stream Type E4



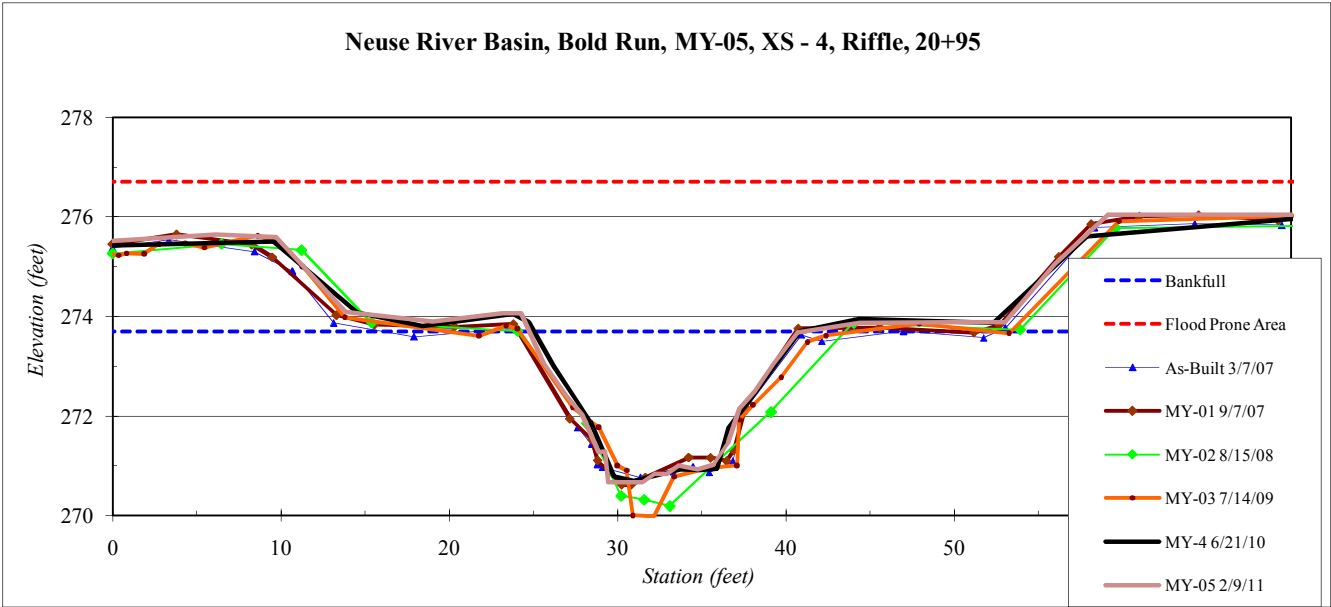
<b>River Basin:</b>	Neuse
<b>Watershed:</b>	Bold Run, MY-05
<b>XS ID</b>	XS - 4, Riffle, 20+95
<b>Drainage Area (sq mi):</b>	1.6
<b>Date:</b>	2/9/2011
<b>Field Crew:</b>	Dean, Perkinson

Station	Elevation
-1.3	275.4
9.6	275.5
14.6	274.1
18.4	273.8
23.8	274.1
24.7	273.9
26.2	273.0
28.4	271.9
29.8	270.8
30.9	270.7
33.7	270.9
35.0	270.9
35.9	270.9
36.6	271.8
38.4	272.6
40.9	273.7
44.4	273.9
52.3	273.9
57.9	275.6
73.0	276.0

SUMMARY DATA	
<b>Bankfull Elevation:</b>	273.7
<b>Bankfull Cross-Sectional Area:</b>	30.6
<b>Bankfull Width:</b>	16.3
<b>Flood Prone Area Elevation:</b>	276.7
<b>Flood Prone Width:</b>	>70
<b>Max Depth at Bankfull:</b>	3.0
<b>Mean Depth at Bankfull:</b>	1.9
<b>W / D Ratio:</b>	8.7
<b>Entrenchment Ratio:</b>	>4
<b>Bank Height Ratio:</b>	1.0



<b>Stream Type</b>	E4
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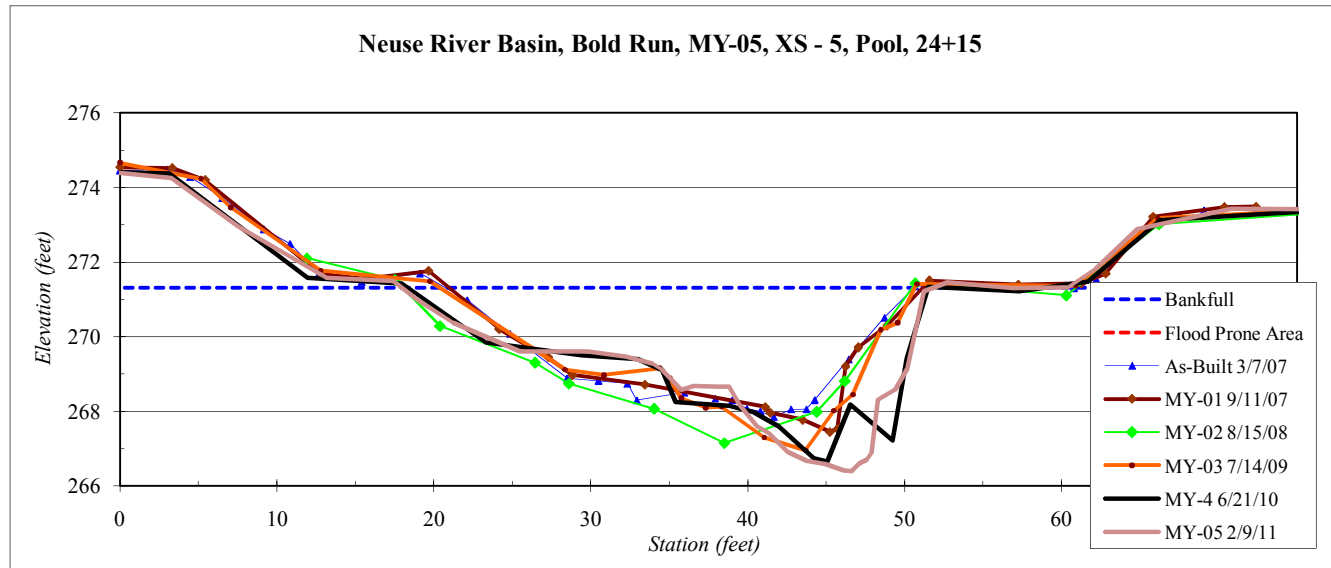
<b>River Basin:</b>	Neuse
<b>Watershed:</b>	Bold Run, MY-05
<b>XS ID</b>	XS - 5, Pool, 24+15
<b>Drainage Area (sq mi):</b>	1.6
<b>Date:</b>	2/9/2011
<b>Field Crew:</b>	Dean, Perkinson



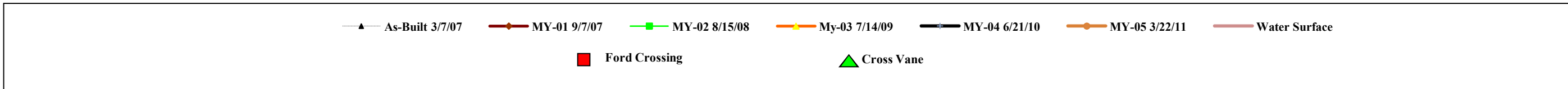
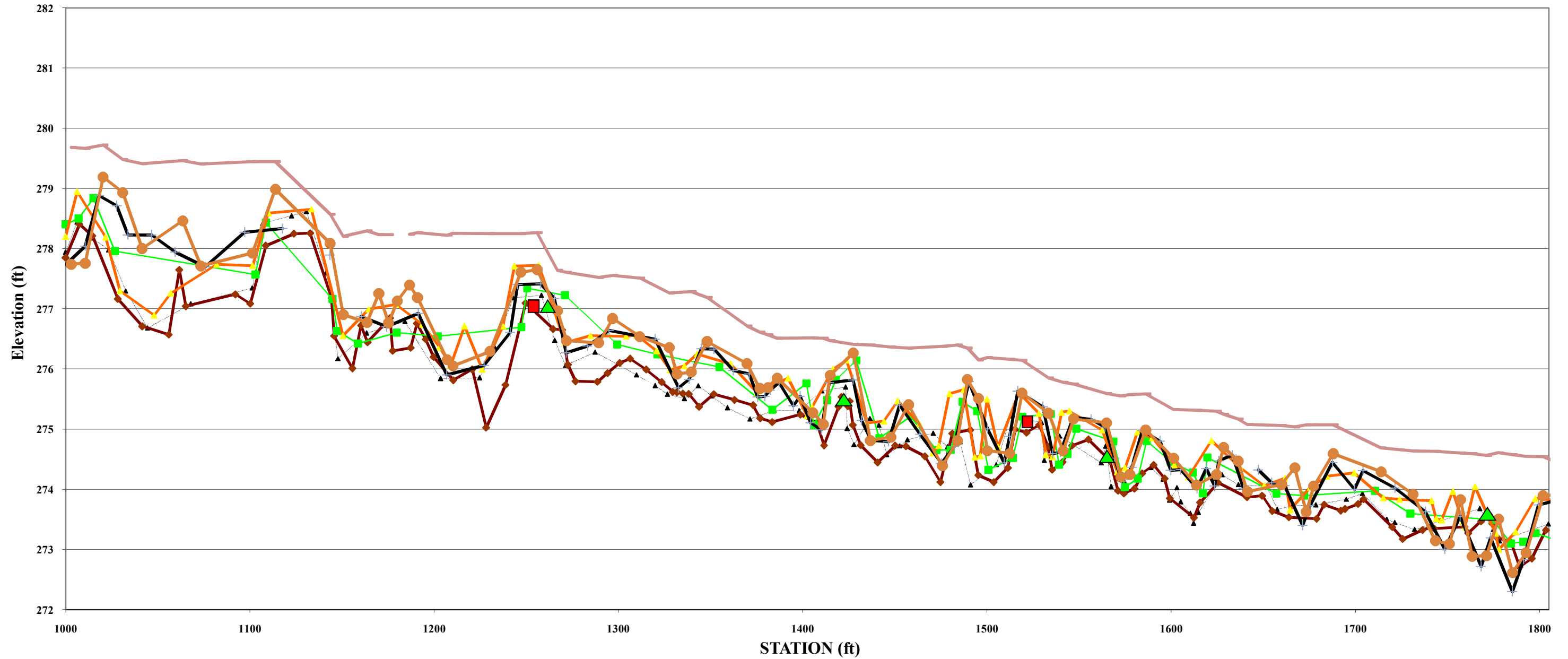
Stream Type E4

Station	Elevation
-1.7	274.4
3.1	274.4
12.0	271.6
18.0	271.4
23.3	269.8
29.4	269.5
33.0	269.4
34.5	269.1
35.4	268.2
38.8	268.2
40.4	268.0
42.0	267.6
44.2	266.7
45.1	266.7
46.5	268.2
49.2	267.2
50.1	269.4
51.5	271.3
57.3	271.2
61.7	271.5
66.3	273.1
77.7	273.4

SUMMARY DATA	
<b>Bankfull Elevation:</b>	271.3
<b>Bankfull Cross-Sectional Area:</b>	80.9
<b>Bankfull Width:</b>	33.8
<b>Flood Prone Area Elevation:</b>	-
<b>Flood Prone Width:</b>	-
<b>Max Depth at Bankfull:</b>	4.9
<b>Mean Depth at Bankfull:</b>	2.4
<b>W / D Ratio:</b>	-
<b>Entrenchment Ratio:</b>	-
<b>Bank Height Ratio:</b>	-

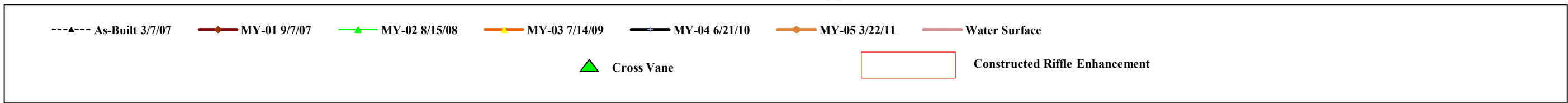


**Longitudinal Profile**  
**Bold Run Creek**  
**EEP Project Number 439 MY-05**  
**Stations 10+00 - 18+00**

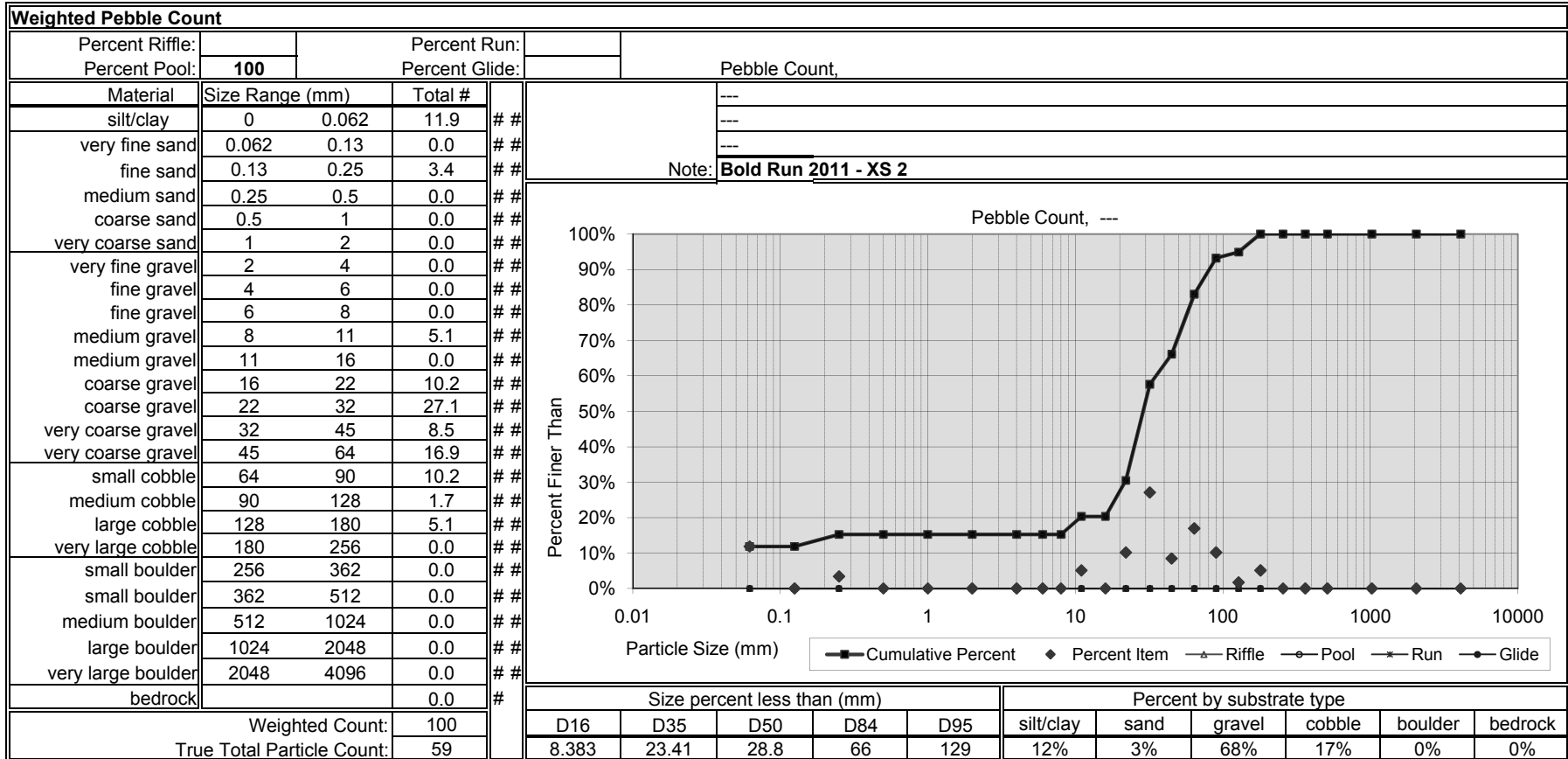




**Longitudinal Profile  
 Bold Run Creek  
 EEP Project Number 439 MY-05  
 Stations 18+00 - 26+30**



Weighted Pebble Count															
Percent Riffle:	100		Percent Run:												
Percent Pool:			Percent Glide:		Pebble Count,										
Material	Size Range (mm)		Total #	#	#										
silt/clay	0	0.062	0.0	#	#										
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	0.0	#	#										
very coarse sand	1	2	0.0	#	#										
very fine gravel	2	4	0.0	#	#										
fine gravel	4	6	0.0	#	#										
fine gravel	6	8	0.0	#	#										
medium gravel	8	11	7.7	#	#										
medium gravel	11	16	0.0	#	#										
coarse gravel	16	22	7.7	#	#										
coarse gravel	22	32	3.8	#	#										
very coarse gravel	32	45	7.7	#	#										
very coarse gravel	45	64	3.8	#	#										
small cobble	64	90	30.8	#	#										
medium cobble	90	128	26.9	#	#										
large cobble	128	180	11.5	#	#										
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	#	#										
bedrock			0.0	#	#										
Weighted Count:			100												
True Total Particle Count:			52												
					Note: <b>Bold Run 2011 - XS 1</b>										
					<p>Pebble Count, ---</p> <p>Percent Finer Than</p> <p>Particle Size (mm)</p> <p>Legend: Cumulative Percent (solid line with squares), Percent Item (diamonds), Riffle (triangles), Pool (circles), Run (crosses), Glide (dots)</p>										
					Size percent less than (mm)			Percent by substrate type							
					D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
					23.359	67.07	79.2	121	155	0%	0%	31%	69%	0%	0%



Weighted Pebble Count										
Percent Riffle:	100		Percent Run:							
Percent Pool:			Percent Glide:		Pebble Count,					
Material	Size Range (mm)		Total #	#	#					
silt/clay	0	0.062	0.0	#	#	---				
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	#	#	Note: <b>Bold Run 2011 - XS 3</b>				
coarse sand	0.5	1	6.0	#	#					
very coarse sand	1	2	0.0	#	#					
very fine gravel	2	4	0.0	#	#					
fine gravel	4	6	0.0	#	#					
fine gravel	6	8	0.0	#	#					
medium gravel	8	11	4.0	#	#					
medium gravel	11	16	0.0	#	#					
coarse gravel	16	22	16.0	#	#					
coarse gravel	22	32	10.0	#	#					
very coarse gravel	32	45	8.0	#	#					
very coarse gravel	45	64	10.0	#	#					
small cobble	64	90	26.0	#	#					
medium cobble	90	128	16.0	#	#					
large cobble	128	180	4.0	#	#					
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	#	#					
bedrock			0.0	#	#					
Weighted Count:			100							
True Total Particle Count:			50							
Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
18.029	30.82	55.6	98	125	0%	6%	48%	46%	0%	0%

Weighted Pebble Count										
Percent Riffle:	100		Percent Run:							
Percent Pool:			Percent Glide:		Pebble Count,					
Material	Size Range (mm)		Total #	#	#					
silt/clay	0	0.062	0.0	#	#					
very fine sand	0.062	0.13	0.0	#	#					
fine sand	0.13	0.25	2.0	#	#	Note: <b>Bold Run 2011 - XS 4</b>				
medium sand	0.25	0.5	0.0	#	#					
coarse sand	0.5	1	4.0	#	#					
very coarse sand	1	2	0.0	#	#					
very fine gravel	2	4	0.0	#	#					
fine gravel	4	6	0.0	#	#					
fine gravel	6	8	0.0	#	#					
medium gravel	8	11	6.0	#	#					
medium gravel	11	16	0.0	#	#					
coarse gravel	16	22	0.0	#	#					
coarse gravel	22	32	20.0	#	#					
very coarse gravel	32	45	8.0	#	#					
very coarse gravel	45	64	22.0	#	#					
small cobble	64	90	20.0	#	#					
medium cobble	90	128	12.0	#	#					
large cobble	128	180	4.0	#	#					
very large cobble	180	256	2.0	#	#					
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	#	#					
bedrock			0.0	#	#					
Weighted Count:			100							
True Total Particle Count:			50							

Pebble Count, ---

Percent Finer Than

Particle Size (mm)

Legend: Cumulative Percent (squares), Percent Item (diamonds), Riffle (triangles), Pool (circles), Run (crosses), Glide (dots)

Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
23.712	36.36	52.8	95	139	0%	6%	56%	38%	0%	0%

Weighted Pebble Count										
Percent Riffle:		Percent Run:			Pebble Count,					
Percent Pool:	<b>100</b>	Percent Glide:								
Material	Size Range (mm)		Total #	#	#					
silt/clay	0	0.062	18.0	#	#					
very fine sand	0.062	0.13	10.0	#	#					
fine sand	0.13	0.25	24.0	#	#	Note: <b>Bold Run 2011 - XS 5</b>				
medium sand	0.25	0.5	4.0	#	#					
coarse sand	0.5	1	12.0	#	#					
very coarse sand	1	2	0.0	#	#					
very fine gravel	2	4	0.0	#	#					
fine gravel	4	6	0.0	#	#					
fine gravel	6	8	0.0	#	#					
medium gravel	8	11	0.0	#	#					
medium gravel	11	16	0.0	#	#					
coarse gravel	16	22	10.0	#	#					
coarse gravel	22	32	10.0	#	#					
very coarse gravel	32	45	6.0	#	#					
very coarse gravel	45	64	6.0	#	#					
small cobble	64	90	0.0	#	#					
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	#	#					
bedrock			0.0	#	#					
Weighted Count:			100							
True Total Particle Count:			50							

Pebble Count, ---

Percent Finer Than

Particle Size (mm)

Cumulative Percent  
 Percent Item  
 Riffle  
 Pool  
 Run  
 Glide

Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
#N/A	0.15	0.2	28	48	18%	50%	32%	0%	0%	0%