FINAL

AS-BUILT BASELINE MONITORING REPORT
BEAR CREEK (PHILLIPS SITE) RESTORATION PROJECT

Chatham County, North Carolina
EEP Project No. 26 (Contract No. 5715)
DWR Project No. 0713-94
SCO No. 09-07726-01A

Data Collection – March-April 2014

Cape Fear River Basin
Cataloging Unit 03030003

SUBMITTED TO/PREPARED FOR:

North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program
217 West Jones Street, Suite 3000A
Raleigh, North Carolina 27603

SUBMITTED BY:

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

MAY 2014

TABLE OF CONTENTS

1.0 PROJECT SUMMARY 1
2.0 METHODOLOGY 3
2.1 Streams 3
2.2 Vegetation 4
3.0 REFERENCES 5

APPENDICES

Appendix A. Background Tables
Table 1. Project Components and Mitigation Units
Table 2. Project Activity and Reporting History
Table 3. Project Contacts Table
Table 4. Project Attributes Table
Appendix B. Visual Assessment Data
Figure 1. Vicinity Map
Figures 2 & 2A-2B. Current Conditions Plan View
Vegetation Plot Photographs
Appendix C. Vegetation Plot Data
Table 5. Planted Stems
Table 6. Planted and Total Stem Counts
Appendix D. Stream Geomorphology Data
Tables 7a-7f. Baseline Stream Data Summary
Tables 8a-8f. Monitoring Data-Dimensional Data Summary
Cross-section Plots
Longitudinal Profile Plots
Appendix E. As-built Plan Sheets

1.0 PROJECT SUMMARY

The North Carolina Ecosystem Enhancement Program (EEP) has established the Bear Creek (Phillips Site) Restoration Project (Site) located off of Siler City-Glendon Road (SR 1006) in the southwest portion of Chatham County. The Site is encompassed within 14-digit Cataloging Unit 03030003070050 of the Cape Fear River Basin (Figure 1, Appendix B and Table 4, Appendix A). Land use at the Site, prior to mitigation activities, was composed of agricultural uses including livestock grazing and was primarily comprised of open pasture with a few small areas of mixed hardwood forest. Site streams had been impaired by historical and current land management practices, which include timber harvesting, pasture conversion, channelization, and livestock grazing. Completed project activities, reporting history, completion dates, project contacts, and project attributes are summarized in Tables 1-4 (Appendix A).

The Site is located in the *Upper and Middle Rocky River Local Watershed Plan* (LWP) area (http://www.nceep.net/services/lwps/Rocky_Cape_Fear/Summary_of_Findings_and_RecommendationsUpperRocky_CapeFear_.pdf). The LWP identified the following major stressors in the watershed: excess nutrient loading from farming and urban runoff, a lack of riparian vegetation, channel modifications, bacterial contamination, and sediment loading from overland runoff and stream bank erosion. Specifically, cattle access to streams and insufficient bank vegetation were identified as prime causes of streambank erosion in the watershed. The LWP identified the Bear Creek Project as a stream restoration opportunity with the potential to improve water quality and habitat within the Upper Rocky River watershed.

The Site's watershed includes Hydrologic Unit Code (HUC) 03030003070050 which was identified as a Targeted Local Watershed in NCEEP's *Cape Fear River Basin Restoration Priorities (RBRP) 2009* (http://www.nceep.net/services/lwps/cape_fear/RBRP%20Cape%20Fear%202008.pdf) and is identified in the *Upper Rocky River Local Watershed Plan Detailed Assessment and Targeting of Management Report* (http://www.nceep.net/services/lwps/Rocky_Cape_Fear/Rocky_River_ DATMR_Final_6-27-05.pdf).

Site construction resulted in a stable riparian system that will reduce sediment and nutrient loading to Bear Creek while contributing to water quality conditions that support terrestrial and aquatic species identified in the basin. The goals of the Bear Creek Restoration Project address stressors identified in the LWP and include the following.

- Remove harmful nutrients from creek flow,
- Reduce pollution of creeks by excess sediment,
- Improve stream bank stability,
- Increase dissolved oxygen concentrations,
- Improve in-stream habitat,
- Restore terrestrial habitat, and
- Improve aesthetics.

The project goals will be addressed through the following project objectives.

- Cattle will be removed from streams and runoff will be filtered through buffer zones. Flood flows will be filtered through restored floodplain areas, where flood flow will spread through native vegetation, which will uptake excess nutrients.

- Stream bank erosion, which contributes sediment loads to the creek, will be greatly reduced, if not eliminated in the Site. Eroding stream banks will be stabilized by increasing woody root mass on banks and reducing channel incision. Storm flow containing grit and fine sediments will be filtered through restored floodplain areas where flow will spread through native vegetation. The spreading flood flows will reduce velocity, allowing sediment to settle out.
- Eroding stream banks will be stabilized using bioengineering, natural channel design techniques, and grading to reduce bank angles and bank height.
- In-stream structures will promote aeration of water.
- In-stream structures will be constructed to improve habitat diversity and trap detritus. Wood structures were incorporated into the stream as part of the restoration design including log drops and rock structures that incorporate woody debris.
- Adjacent buffer and riparian habitats will be restored with native vegetation as part of the project. Native vegetation will provide cover and food for terrestrial creatures.
- Native plant species will be planted, invasive species will be treated, and eroding and unstable areas will be stabilized as part of this project.

The Site mitigation plan was completed in June 2011 with the final design and construction plans completed in June 2012 (Table 2, Appendix A). Project construction was completed between April and October 2013. The implemented mitigation is as follows (Figure 2, Appendix B and Table 1, Appendix A).

- 4061 Stream Mitigation Units by:
    - Restoring approximately 4061 linear feet of stream channel through construction of stable channel at the historic floodplain elevation.
- Planting a native woody riparian buffer (at least 50 feet in width) adjacent to restored channels within the Site.
- Protecting the Site in perpetuity with a conservation easement.

Stream Success Criteria

Stream restoration success criteria for the Site are based on the *Stream Mitigation Guidelines* issued in April 2003 by the USACE and NCDWQ. Success criteria for stream restoration will include 1) documentation of two bankfull events, 2) little change in the channel cross-section from as-built conditions, 3) stable longitudinal profile, 4) substrate consistency, and 5) photographic evidence of stability.

Bankfull Events

Two bankfull flow events in separate years must be documented within the 5-year monitoring period. Otherwise, the stream monitoring will continue until two bankfull events have been documented in separate years.

Cross-sections

Riffle cross-sections located on the restoration and enhancement reaches should be stable and should show little change in bankfull area, maximum depth ratio, and width-to-depth ratio. Riffle cross-sections should generally fall within the parameters defined for channels of the appropriate Rosgen stream type. If any changes do occur, these changes will be evaluated to assess whether the stream channel is showing signs of instability. Indicators of instability include a vertically incising thalweg or eroding channel banks. Changes in the channel that indicate a movement toward stability or enhanced habitat include a decrease in the width-to-depth ratio in meandering channels or an increase in pool depth.

Longitudinal Profile

Longitudinal profile data for the stream reach should show that bedform features are remaining stable. The riffles should be steeper and shallower than the pools, while the pools should be deep with flat water surface slopes. The relative percentage of riffles and pools should not change significantly from the design parameters.

Bed Material Analysis

Substrate materials in restoration reaches should indicate a progression towards or the maintenance of coarser materials in the riffle features and smaller particles in the pool features.

Photo Reference Sites

Photographs will be used to evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation, and effectiveness of erosion control measures subjectively. Lateral photos should not indicate excessive erosion or continuing degradation of the banks. A series of photos over time should indicate successive maturation of riparian vegetation.

Vegetation Success Criteria

Success criteria have been established to verify that the vegetation component supports community elements necessary for forest development. Success criteria for this project includes an average density of 320 planted stems per acre must be surviving in the first three monitoring years. Subsequently, 290 planted stems per acre must be surviving in year 4, and 260 planted stems per acre in year 5.

2.0 METHODOLOGY

2.1 Streams

Post-restoration monitoring will be conducted for five years following the completion of construction to evaluate the effectiveness of Site restoration activities. Monitored stream parameters include stream dimension (cross-sections), pattern (longitudinal survey), profile (profile survey), and photographic documentation. Baseline stream data can be found in Appendix D.

Bankfull Events

The occurrence of bankfull events within the monitoring period will be documented using a crest gauge and visual observations. The crest gauge was installed along the streambank to record the highest watermark between site visits, and the gauge will be checked each time the Site is visited to determine if a bankfull event has occurred (Figures 2A-2B, Appendix B). Photographs will be used to document the occurrence of debris lines and sediment deposition on the floodplain during monitoring Site visits.

Cross-sections

Ten permanent cross-sections, six riffle and four pool, were established and will be used to evaluate stream dimension; locations are depicted on Figures 2, 2A, and 2B (Appendix B) Because riffle cross-sections are critical in determining bankfull design parameters, the number of riffle cross-sections established outnumber pool cross-sections. Each cross-section is marked on both banks with permanent pins to establish the exact transect location. A common benchmark will be used for cross-section comparisons from year-to-year data. The annual cross-section survey will include points measured at all breaks in slope, including top of bank, bankfull, inner berm, edge of water, and thalweg, if the features are present. Riffle cross-sections will be classified using the Rosgen Stream Classification System.

Longitudinal Profile

After Site construction, approximately 4100 linear feet of longitudinal profile was completed to document baseline conditions. Longitudinal profile will be resurveyed annually for the duration of the five-year monitoring period. Measurements include thalweg, water surface, bankfull, and top of low bank. Each of these measurements will be taken at the head of each channel unit (e.g., riffle, pool) and at the maximum pool depth. The survey will be tied to a permanent benchmark.

Bed Material Analysis

Pebble counts will be conducted for six permanent riffle cross-sections (100-counts per cross section) across the Site. Pebble counts will be completed annually during the five year monitoring period to reveal any changes in sediment gradation over time as the stream adjusts to upstream sediment loads.

Photo Reference Sites

Photographs will be used to visually document restoration success for at least five years following construction. Lateral reference photos should show a stable cross-section with no excessive erosion or degradation of the banks. Reference photographs will show both banks at each permanent cross-section. A survey tape pulled across the cross-section will be centered in the bank photographs. The photographer will make every effort to maintain the same area in each photo over time.

2.2 Vegetation

After planting was completed, an initial evaluation was performed to verify planting methods were successful and to determine initial species composition and density. Twelve sample vegetation plots (10-meter by 10-meter) were installed and measured within the Site as per guidelines established in *CVS-EEP Protocol for Recording Vegetation, Version 4.2* (Lee et al. 2008). Vegetation plots are permanently monumented with 6-foot metal t-posts at each corner. In each sample plot, vegetation parameters to be monitored include species composition and species density. Visual observations of the percent cover of shrub and herbaceous species will also be documented by photograph. Baseline vegetation plot information can be found in Appendix C. Initial stem count measurements indicate an average of 476 planted stems per acre (excluding livestakes) across the Site.

3.0 REFERENCES

Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2008. CVS-EEP Protocol for Recording Vegetation. Version 4.2. North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program. Raleigh, North Carolina.

North Carolina Ecosystem Enhancement Program (NCEEP). 2005. Upper Rocky River Local Watershed Plan Detailed Assessment and Targeting of Management Report (online) Available: http://www.nceep.net/services/lwps/Rocky_Cape_Fear/Rocky_River_ DATMR_Final_6-27-05.pdf. North Carolina Department of Environment and Natural Resources, Raleigh, North Carolina.

North Carolina Ecosystem Enhancement Program (NCEEP). 2009. Cape Fear River Basin Restoration Priorities 2009 (online). Available: http://www.nceep.net/services/lwps/cape_fear/RBRP%20Cape%20Fear%202008.pdf. North Carolina Department of Environment and Natural Resources, Raleigh, North Carolina.

Rosgen, D.L. 1996. Applied River Morphology. Wildland Hydrology Books, Pagosa Springs, CO.

Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, North Carolina Department of Environment, Health, and Natural Resources. Raleigh, North Carolina.

United States Army Corps of Engineers, United States Environmental Protection Agency, North Carolina Wildlife Resources Commission, North Carolina Division of Water Quality (USACE et al.). 2003. Stream Mitigation Guidelines.

United States Geological Survey (USGS). 1974. Hydrologic Unit Map - 1974. State of North Carolina.

Appendix A.
Background Tables

Table 1. Project Components and Mitigation Units
Table 2. Project Activity and Reporting History
Table 3. Project Contacts Table
Table 4. Project Attributes Table

Table 1. Project Components and Mitigation Credits
Bear Creek (Phillips Site) Restoration Project

Mitigation Credits		
Stream	**Riparian Wetland**	**Nonriparian Wetland**
Restoration	**Restoration**	**Restoration**
4061	**--**	**--**

Projects Components							
Station Range	**Existing Linear Footage/ Acreage**	**Priority Approach**	**Restoration/ Restoration Equivalent**	**Restoration Linear Footage/ Acreage**	**Mitigation Ratio**	**Mitigation Credits**	**Comment**
Bear Creek Reach 1 Station 200+60 to 210+63	859	PII	Restoration	1003-25=978	1:1	978	Stream crossing (25 linear feet) removed from credit.
Bear Creek Reach 2 Station 210+63 to 222+52	1050	PII	Restoration	1189-35=1154	1:1	1154	Stream crossing (35 linear feet) removed from credit.
UT to Bear Creek Station 100+00 to 120+11	1857	PI	Restoration	2011-62-20 =1929	1:1	1929	Stream Crossing and forded crossing (62 linear feet and 20 linear feet) removed from credit.

Component Summation			
Restoration Level	**Stream (linear footage)**	**Riparian Wetland (acreage)**	**Nonriparian Wetland (acreage)**
Restoration	4061	--	--
Enhancement (Level 1)	--	--	--
Enhancement (Level II)	--	--	
Totals	**4061**	--	--
Mitigation Units	**4061 SMUs**	**0.00 Riparian WMUs**	**0.00 Nonriparian WMUs**

Table 2. Project Activity and Reporting History
Bear Creek (Phillips Site) Restoration Project

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Mitigation Plan	--	June 2011
Final Design – Construction Plans	--	June 2012
Construction	--	April 2013-October 2013
Temporary S&E Mix applied to Entire Project Site	--	April 2013-October 2013
Permanent Seed Mix applied to the Entire Project Site	--	April 2013-October 2013
Bare Root; Containerized; and B&B Plantings for the Entire Project Site	--	March 2014
Mitigation Plan/ As-Built (Year 0 Monitoring Baseline)	March-April 2014	May 2014
Year 1 Monitoring		
Year 2 Monitoring		
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		

Table 3. Project Contacts Table
Bear Creek (Phillips Site) Restoration Project

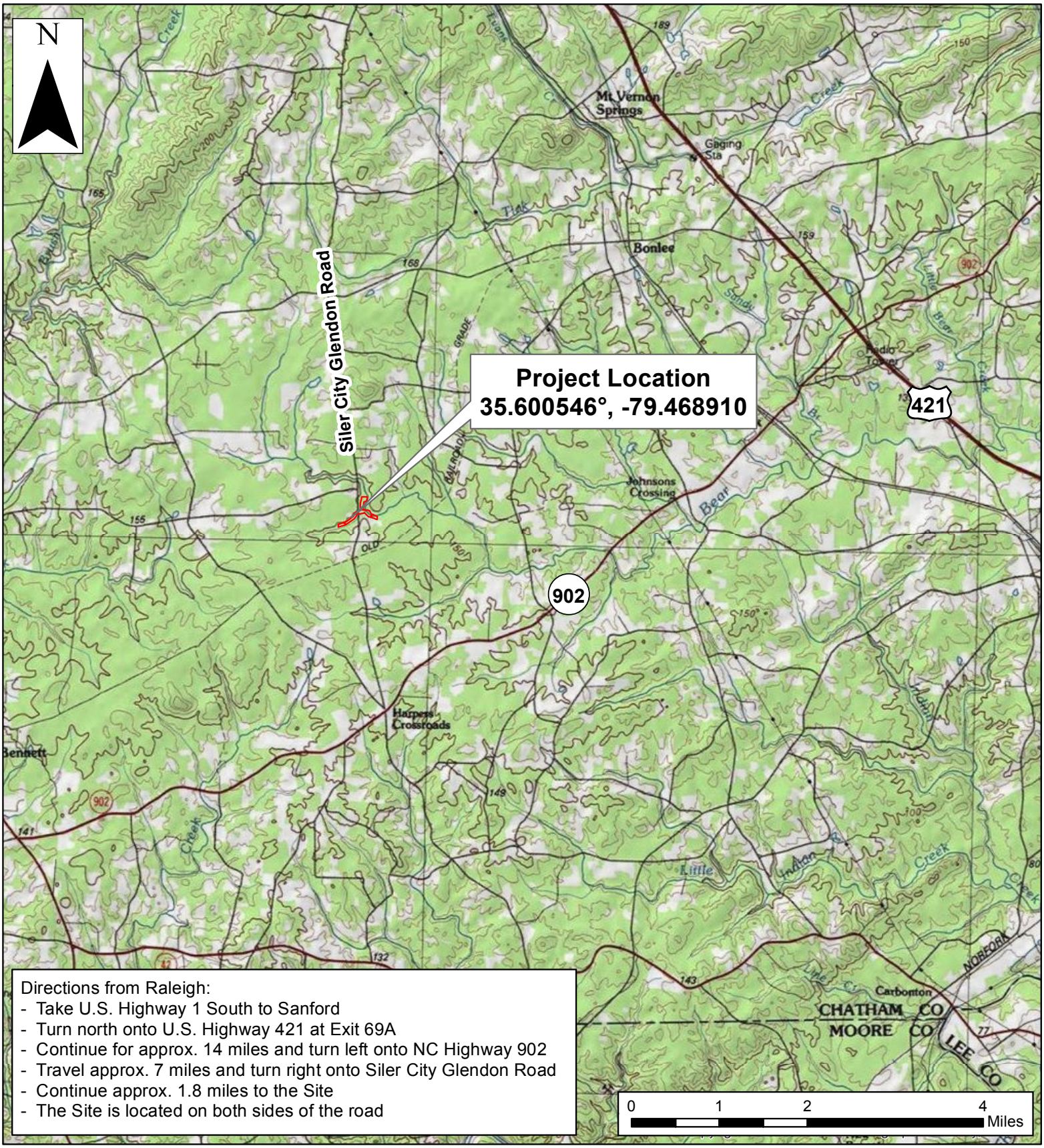
Designer	Wildlands Engineering 1430 South Mint Street, Suite 104 Charlotte, NC 28203 Emily Reinicker 704-332-7754
Construction Plans and Sediment and Erosion Control Plans	Wildlands Engineering 1430 South Mint Street, Suite 104 Charlotte, NC 28203 Emily Reinicker 704-332-7754
Construction Contractor	Land Mechanic Designs, Inc 126 Circle G Lane Willow Spring, NC 27592 Charles Hill 919-639-6132
Planting Contractor	Bruton Natural Systems PO Box 1197 Fremont, NC 27830 Charles Bruton 919-242-6555
As-built Surveyor	Stewart-Proctor Engineering and Surveying Chapanoke Road Raleigh, NC 27603 Herb Proctor 919-779-1855
Baseline Data Collection	Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis 919-215-1693

Table 4. Project Attribute Table
Bear Creek (Phillips Site) Restoration Project

Project County	Chatham County, North Carolina		
Physiographic Region	Carolina Slate Belt		
Ecoregion	Piedmont		
Project River Basin	Cape Fear		
USGS HUC for Project (14 digit)	03030003070050		
NCDWQ Sub-basin for Project	06-06-12		
Planning Area	Upper and Middle Rocky River LWP		
WRC Class (Warm, Cool, Cold)	Warm		
% of project easement fenced or demarcated	100% fenced to exclude livestock		
Beaver activity observed during design phase?	unknown		
	Restoration Component Attribute Table		
	Bear Cr Reach 1	Bear Cr Reach 2	UT to Bear Cr
Drainage Area (acres)	2610	3196	565
Stream Order (USGS topo)	3rd	3rd	2nd
Restored Length (feet)	966	1179	1937
Perennial or Intermittent	P	P	P
Watershed Type	Rural		
Watershed impervious cover	<5%		
NCDWQ AU/Index number	17-43-16		
NCDWQ Classification	C	C	C
303d listed?	No		
Upstream of a 303d listed	No		
Reasons for 303d listed segment	NA		
Total acreage of easement	14.42		
Total existing vegetated acreage of easement	---		
Total planted restoration acreage	~14.42		
Rosgen Classification of preexisting	C4	G4	E/C5
Rosgen Classification of As-built	C4	C4	C5
Valley type	VIII	VIII	VIII
Valley slope	0.0031	0.0018	0.0054
Cowardin classification of proposed	NA	NA	NA
Trout waters designation	No		
Species of concern, endangered etc.	No		
Dominant Soil Series	Callison-Lignum complex 2-6% slopes (CaB)	Riverview silt loam 0-3% slopes (RvA)	Callison - misenheimer complex 6-10% slopes (CbC)

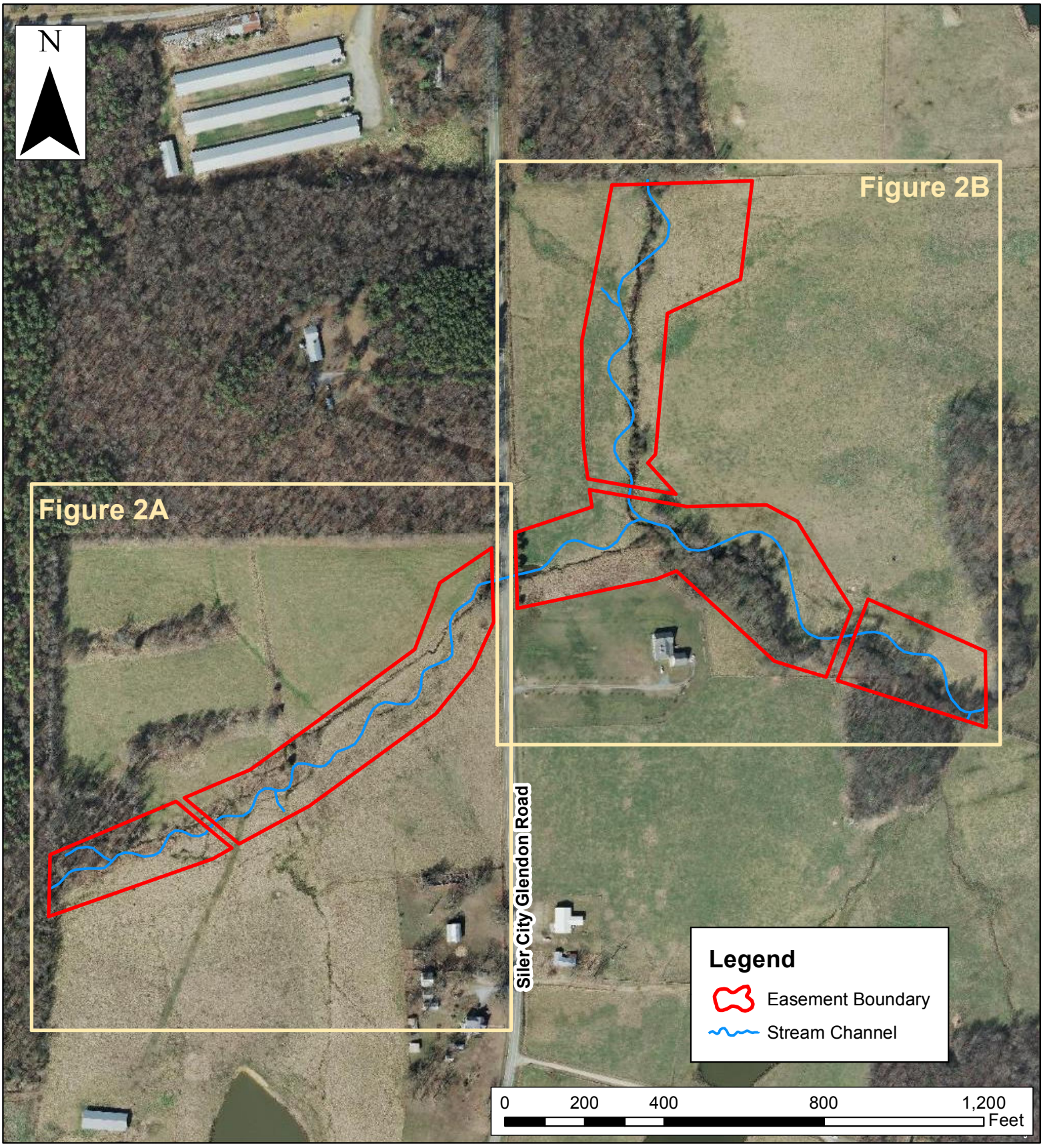
Appendix B
Visual Assessment Data

Figure 1. Vicinity Map
Figures 2 and 2A-2B. Current Conditions Plan View
Vegetation Plot Photographs



Directions from Raleigh:
- Take U.S. Highway 1 South to Sanford
- Turn north onto U.S. Highway 421 at Exit 69A
- Continue for approx. 14 miles and turn left onto NC Highway 902
- Travel approx. 7 miles and turn right onto Siler City Glendon Road
- Continue approx. 1.8 miles to the Site
- The Site is located on both sides of the road

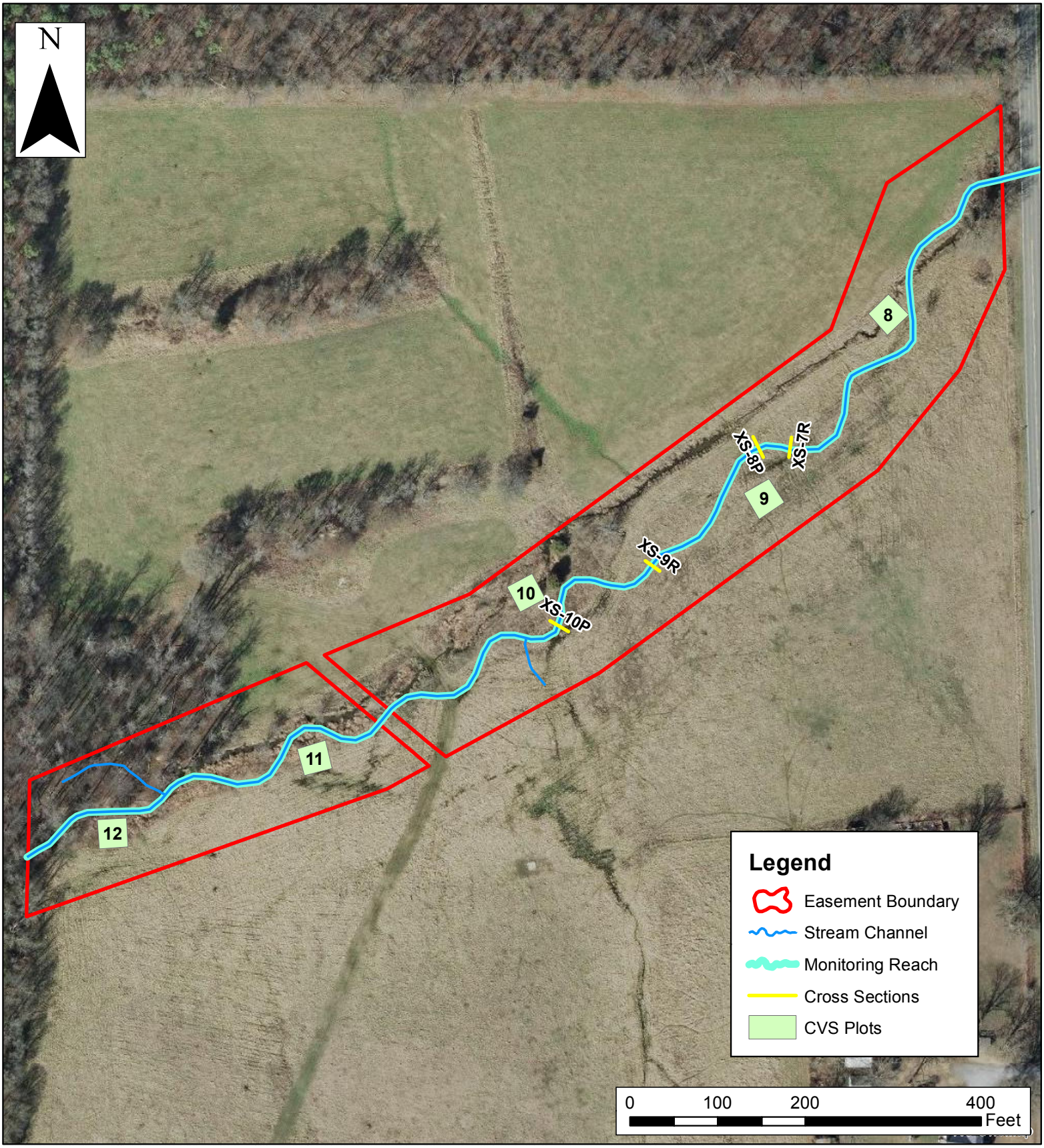
Prepared by:	Prepared for:			
Axiom Environmental, Inc.	Ecosystem Enhancement Program	VICINITY MAP BEAR CREEK (PHILLIPS) EEP PROJECT NUMBER 26 Chatham County, North Carolina	Dwn. by: PHP/KRJ Date: April 2014 Project: 12.004.17	FIGURE 1



Prepared by:	Prepared for:	CURRENT CONDITIONS PLAN VIEW BEAR CREEK (PHILLIPS) EEP PROJECT NUMBER 26 Chatham County, North Carolina	Dwn. by. PHP/KRJ Date: April 2014 Project: 12.004.17	FIGURE 2

Axiom Environmental, Inc.

Ecosystem Enhancement Program



Prepared by:
Axiom Environmental, Inc.

Prepared for:
Ecosystem Enhancement Program

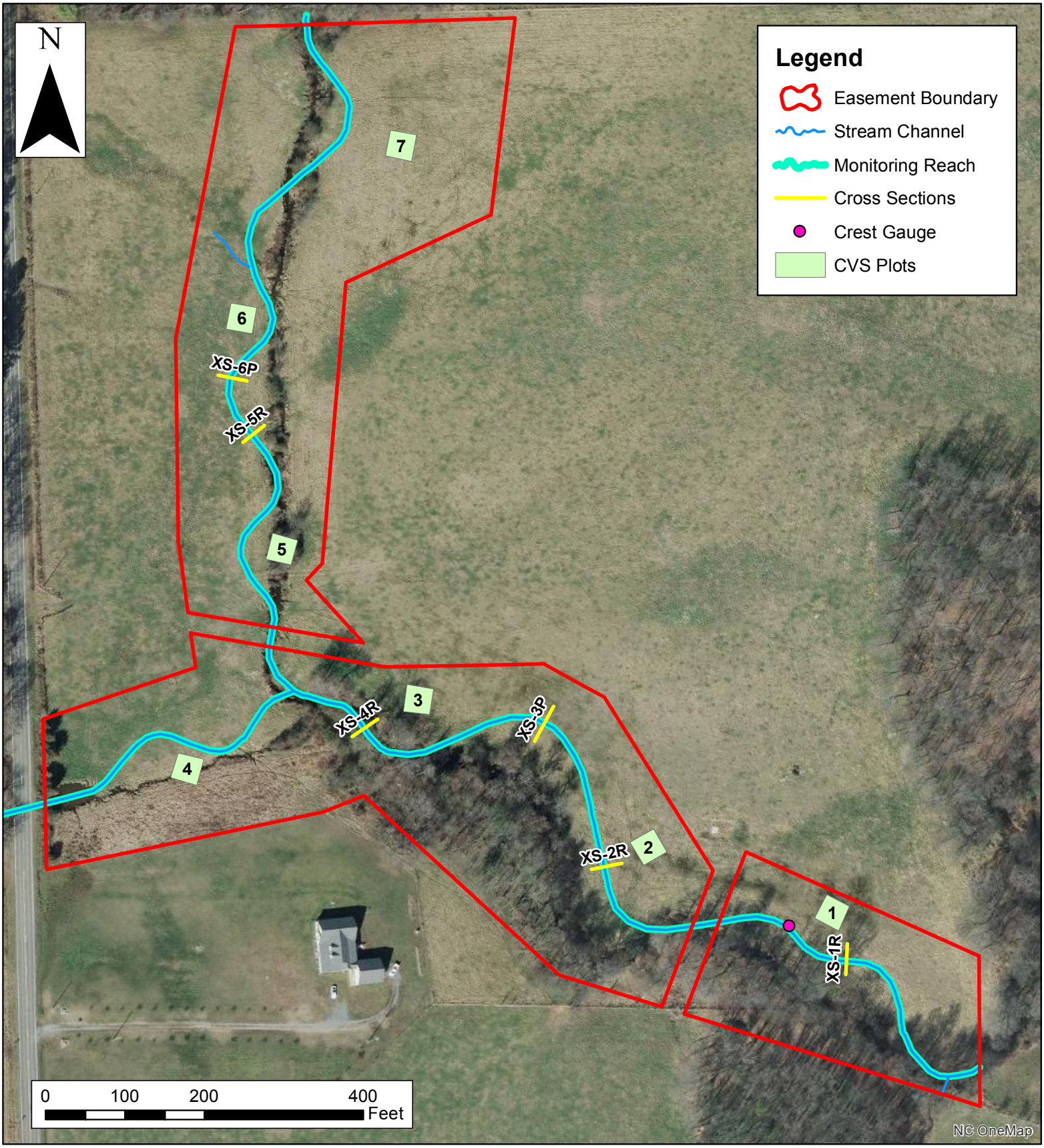
CURRENT CONDITIONS PLAN VIEW
BEAR CREEK (PHILLIPS)
EEP PROJECT NUMBER 26
Chatham County, North Carolina

Dwn. by.
PHP/KRJ

Date:
April 2014

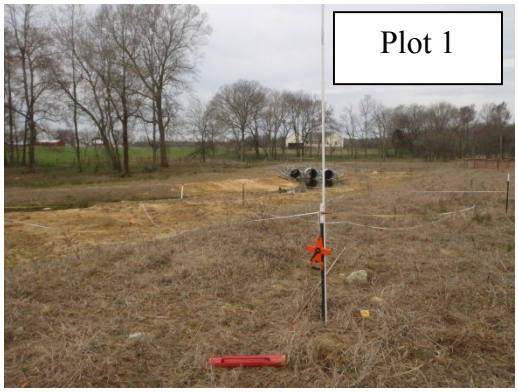
Project:
12.004.17

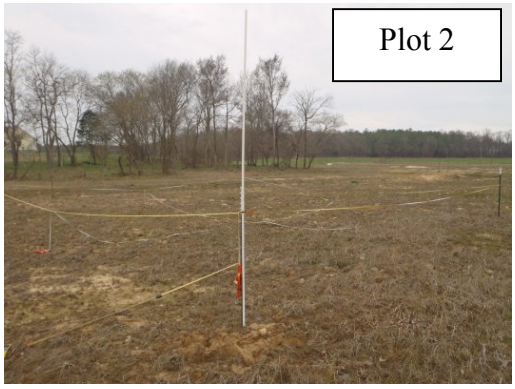
FIGURE
2A

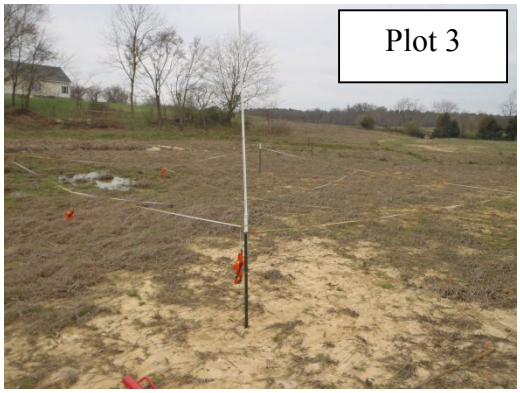


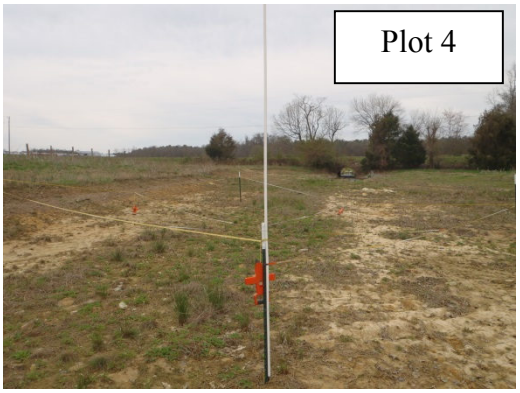
Prepared by:	Prepared for:			
Axiom Environmental, Inc.	Ecosystem Enhancement Program	CURRENT CONDITIONS PLAN VIEW BEAR CREEK (PHILLIPS) EEP PROJECT NUMBER 26 Chatham County, North Carolina	Dwn. by. PHP/KRJ Date: April 2014 Project: 12.004.17	FIGURE 2B

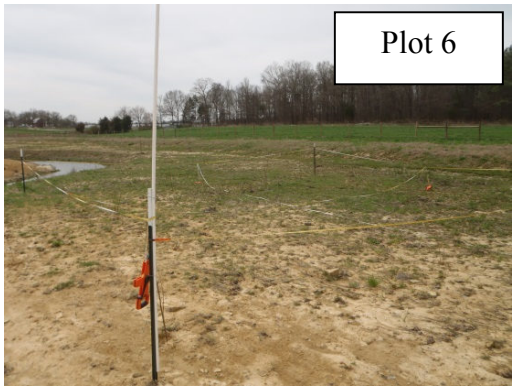
Bear Creek (Phillips Site)
Baseline Vegetation Monitoring Photographs
Taken April 2014



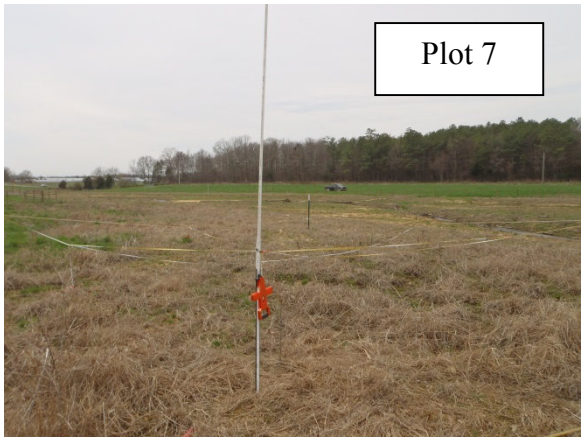


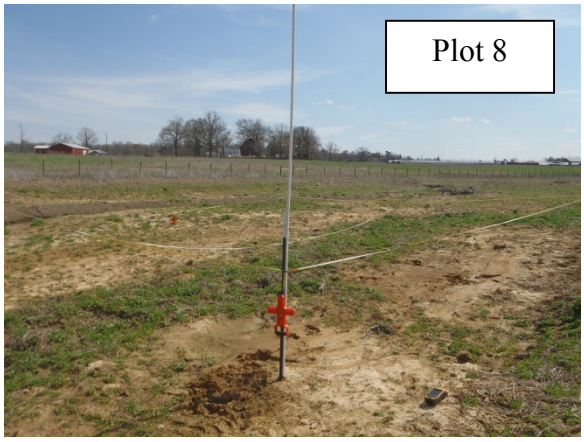


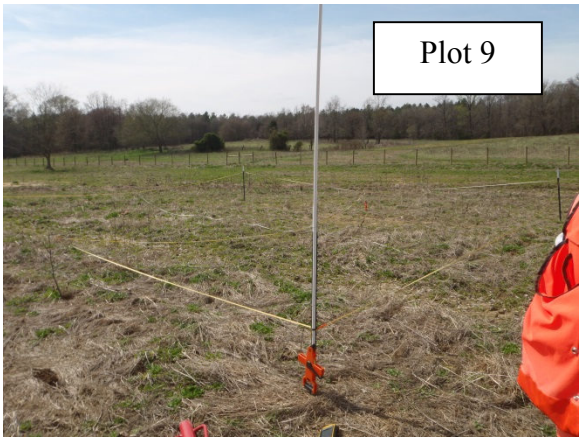


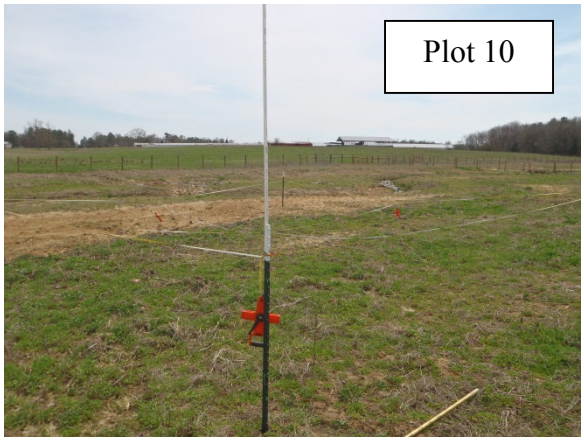


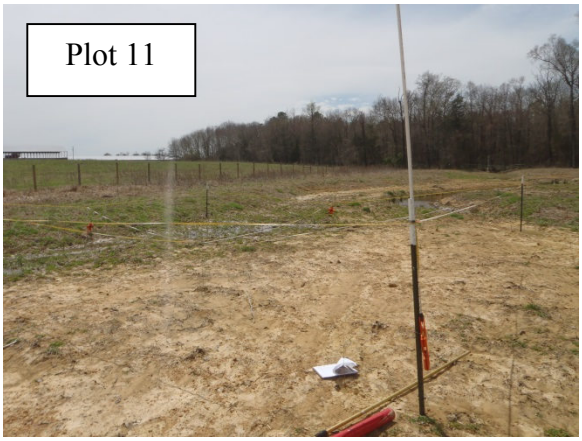
Bear Creek (Phillips Site)
Baseline Vegetation Monitoring Photographs
Taken April 2014
(continued)











Appendix C.
Vegetation Plot Data

Table 5. Planted Stems
Table 6. Planted and Total Stem Counts

Table 5. Planted Woody Vegetation
Bear Creek (Phillips Site) Restoration Project

SPECIES	QUANTITY
Bare Root Seedlings	
River birch (*Betula nigra*)	300
Green ash (*Fraxinus pennsylvanica*)	600
Sweetgum (*Liquidambar styraciflua*)	200
Tulip poplar (*Liriodendron tulipifera*)	200
Red chokeberry (*Photinia pyrifolia*)	280
American sycamore (*Platanus occidentalis*)	900
Scarlet oak (*Quercus coccinea*)	300
Swamp chestnutoak (*Quercus michauxii*)	800
Willow oak (*Quercus phellos*)	800
Southern arrowwood (*Viburnum dentatum*)	670
Rusty blackhaw (*Viburnum rifidulum*)	150
TOTAL	**5200**
Livestakes	
Silky dogwood (*Cornus amomum*)	2940
Black willow (*Salix nigra*)	1260
TOTAL	**4200**

Table 6. Total and Planted Stem Counts
EEP Project Code 26. Project Name: Bear Creek (Phillips Site)

			Current Plot Data (MY0 2014)																					
			026-01-0001			026-01-0002			026-01-0003			026-01-0004			026-01-0005			026-01-0006			026-01-0007			026-01-0008		
Scientific Name	**Common Name**	**Species Type**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**	**PnoLS**	**P-all**	**T**
Betula nigra	river birch	Tree	2	2	2				1	1	1				1	1	1	5	5	5	1	1	1			
Fraxinus pennsylvanica	green ash	Tree	3	3	3	2	2	2	3	3	3				1	1	1	2	2	2				6	6	6
Liriodendron tulipifera	tuliptree	Tree																			1	1	1			
Photinia pyrifolia	red chokeberry					3	3	3				1	1	1	1	1	1	1	1	1				2	2	2
Platanus occidentalis	American sycamore	Tree	1	1	1	1	1	1	1	1	1				3	3	3	4	4	4	2	2	2	2	2	2
Quercus	oak	Tree	2	2	2	5	5	5	7	7	7	8	8	8	6	6	6	4	4	4	3	3	3	5	5	5
Quercus michauxii	swamp chestnut oak	Tree							1	1	1				1	1	1									
Quercus phellos	willow oak	Tree	1	1	1																					
Viburnum	viburnum	shrub							1	1	1	1	1	1							1	1	1			
Viburnum dentatum	southern arrowwood	Shrub																								
		Stem count	9	9	9	11	11	11	14	14	14	10	10	10	13	13	13	16	16	16	8	8	8	15	15	15
		size (ares)	1			1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	5	5	5	4	4	4	6	6	6	3	3	3	6	6	6	5	5	5	5	5	5	4	4	4
		Stems per ACRE	364.2	364.2	364.2	445.2	445.2	445.2	566.6	566.6	566.6	404.7	404.7	404.7	526.1	526.1	526.1	647.5	647.5	647.5	323.7	323.7	323.7	607	607	607

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 stems excluding live stakes
P-all = Planted stems including live stakes
T = Planted stems and natural recruits
Total includes stems of natural recruits

Table 6. Total and Planted Stem Counts
EEP Project Code 26. Project Name: Bear Creek (Phillips Site)

			Current Plot Data (MY0 2014)												Annual Means		
			026-01-0009			026-01-0010			026-01-0011			026-01-0012			MY0 (2014)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Betula nigra	river birch	Tree				5	5	5	8	8	8	3	3	3	26	26	26
Fraxinus pennsylvanica	green ash	Tree	1	1	1										18	18	18
Liriodendron tulipifera	tuliptree	Tree													1	1	1
Photinia pyrifolia	red chokeberry														8	8	8
Platanus occidentalis	American sycamore	Tree				2	2	2	3	3	3	3	3	3	22	22	22
Quercus	oak	Tree	4	4	4	3	3	3	5	5	5	4	4	4	56	56	56
Quercus michauxii	swamp chestnut oak	Tree										1	1	1	3	3	3
Quercus phellos	willow oak	Tree										1	1	1	2	2	2
Viburnum	viburnum	shrub				1	1	1							4	4	4
Viburnum dentatum	southern arrowwood	Shrub				1	1	1							1	1	1
		Stem count	5	5	5	12	12	12	16	16	16	12	12	12	141	141	141
		size (ares)	1			1			1			1			12		
		size (ACRES)	0.02			0.02			0.02			0.02			0.30		
		Species count	2	2	2	5	5	5	3	3	3	5	5	5	10	10	10
		Stems per ACRE	202.3	202.3	202.3	485.6	485.6	485.6	647.5	647.5	647.5	485.6	485.6	485.6	475.5	475.5	475.5

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 stems excluding live stakes
P-all = Planted stems including live stakes
T = Planted stems and natural recruits
Total includes stems of natural recruits

Appendix D.
Stream Geomorphology Data

Tables 7a-7f. Baseline Stream Data Summary
Tables 8a-8f. Monitoring Data-Dimensional Data Summary
Cross-section Plots
Longitudinal Profile Plots

Table 7a. Baseline Stream Data Summary (Bear Creek Reach 1)
Bear Creek (Phillips Site) Restoration Project - EEP Project Number 26

Parameter	Gauge	Regional Curve			Pre-Existing Condition (Reach 1)					Reference Reach(es) Data					Design (Reach 1)			Monitoring Baseline				
Dimension and Substrate - Riffle Only		**LL**	**UL**	**Eq.**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Max**	**Med**	**Min**	**Mean**	**Med**	**Max**	**SD**
BF Width (ft)							24.4			10.7			11.2				24.5			23.8		
Floodprone Width (ft)							310.0			60			114+		126	394				250		
BF Mean Depth (ft)							2.1			1.6			1.8				1.9			1.8		
BF Max Depth (ft)							3.2			2.1			2.6				2.8			2.8		
BF Cross Sectional Area (ft^2)							50.8			17.8			19.7				47.1			42.3		
Width/Depth Ratio							11.7			5.8			7.1				12.7			13.3		
Entrenchment Ratio							12.7			5.5			10.2+		5.1	16.1				10.5		
Bank Height Ratio							1.1					1.0					1.0			1.0		
Profile																						
Riffle length (ft)					The existing reach had little, measurable patter or profile features																	
Riffle slope (ft/ft)												0.0130			0.0040	0.0060						
Pool length (ft)																						
Pool Max depth (ft)												3.3			2.5	6.0						
Pool spacing (ft)												71.0			91.0	147.0						
Pattern																						
Channel Beltwidth (ft)					The existing reach had little, measurable patter or profile features					38			41				144			144		
Radius of Curvature (ft)										11			15		44	70		44			70	
Rc:Bankfull width (ft/ft)										1.3			1.4		1.8	2.9		1.8			2.9	
Meander Wavelength (ft)										46			48		154	286		154			286	
Meander Width ratio										4.1			4.4		6.3	11.7		6.3			11.7	
Transport parameters																						
Reach Shear Stress (competency) lbs/ft^2																						
Max part size (mm) mobilized at bankfull																						
Stream Power (transport capacity) W/m^2																						
Additional Reach Parameters																						
Rosgen Classification					C4					E4					C4							
Bankfull Velocity (fps)					4.5										4.9							
Bankfull Discharge (cfs)					230																	
Valley Length (ft)					781					----												
Channel Thalweg Length (ft)					859					----					----							
Sinuosity					1.1					2.3												
Water Surface Slope (ft/ft)					0.0034					0.0047												
BF slope (ft/ft)					----					----					----							
Bankfull Floodplain Area (acres)					----					----					----							
% of Reach with Eroding Banks					----					----												
Channel Stability or Habitat Metric					----					----												
Biological or Other					----					----												

Table 7b. Baseline Stream Data Summary (Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)
Bear Creek (Phillips Site) Restoration Project - EEP Project Number 26

Parameter	Pre-Existing Condition							Reference Reach(es) Data							Design							Monitoring Baseline						
Ri%/RU%P%G%/S%																											
SC%/SA%/G%/C%/B%BE%																											
d16/d35/d50/d84/d95	NA	11.5	14.1	27.3	57.7																						
Entrainment Class <1.5/1.5-1.99/2.0-4.9/5.0-																											
Incision Class <1.2/1.2-1.49/1.5-1.99/>2.0																											

Table 7c. Baseline Stream Data Summary (Bear Creek Reach 2)
Bear Creek (Phillips Site) Restoration Project - EEP Project Number 26

Parameter	Gauge	Regional Curve			Pre-Existing Condition (Reach 2)					Reference Reach(es) Data					Design (Reach 2)			Monitoring Baseline				
Dimension and Substrate - Riffle Only		**LL**	**UL**	**Eq.**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Max**	**Med**	**Min**	**Mean**	**Med**	**Max**	**SD**
BF Width (ft)							26.0			10.7			11.2				28.5	27.2	28.5	29.0	29.3	1.1
Floodprone Width (ft)							250.0			60			114+		233	256			250			
BF Mean Depth (ft)							2.4			1.6			1.8				2.0	1.8	1.9	1.8	2.1	0.2
BF Max Depth (ft)							4.1			2.1			2.6				2.8	2.7	2.9	2.7	3.4	0.4
BF Cross Sectional Area (ft^2)							70.8			17.8			19.7				57.6	48.8	54.3	52.9	61.1	6.3
Width/Depth Ratio							9.7			5.8			7.1				14.1	14.0	15.1	15.0	16.1	1.1
Entrenchment Ratio							9.4			5.5			10.2+		8.2	9.0		8.5	8.8	8.6	9.2	0.4
Bank Height Ratio							1.1					1.0					1.0		1.0			
Profile																						
Riffle length (ft)																						
Riffle slope (ft/ft)												0.0130			0.0017	0.0028						
Pool length (ft)																						
Pool Max depth (ft)							4.7					3.3			2.5	6.0						
Pool spacing (ft)					100.0			250.0				71.0			82.0	203.0						
Pattern																						
Channel Beltwidth (ft)					100			180		38			41				176			176		
Radius of Curvature (ft)					80			200		11			15		55	85		55			85	
Rc:Bankfull width (ft/ft)					3.1			7.7		1.3			1.4		1.9	3		1.9			3	
Meander Wavelength (ft)					300			480		46			48		158	374		158			374	
Meander Width ratio					4.2			6.9		4.1			4.4				6.2			62		
Transport parameters																						
Reach Shear Stress (competency) lbs/ft^2																						
Max part size (mm) mobilized at bankfull																						
Stream Power (transport capacity) W/m^2																						
Additional Reach Parameters																						
Rosgen Classification					G4					E4					C4							
Bankfull Velocity (fps)					3.8										4.7							
Bankfull Discharge (cfs)					270																	
Valley Length (ft)					955					----												
Channel Thalweg Length (ft)					1050					----					----							
Sinuosity					1.1					2.3					1.2							
Water Surface Slope (ft/ft)					0.0016					0.0047					0.0041							
BF slope (ft/ft)					----					----					----							
Bankfull Floodplain Area (acres)					----					----					----							
% of Reach with Eroding Banks					----					----												
Channel Stability or Habitat Metric					----					----												
Biological or Other					----					----												

Table 7d. Baseline Stream Data Summary (Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)
Bear Creek (Phillips Site) Restoration Project - EEP Project Number 26

Parameter	Pre-Existing Condition							Reference Reach(es) Data							Design							Monitoring Baseline						
Ri%/RU%P%G%/S%																											
SC%/SA%/G%/C%/B%BE%																											
d16/d35/d50/d84/d95																											
Entrainment Class <1.5/1.5-1.99/2.0-4.9/5.0-																											
Incision Class <1.2/1.2-1.49/1.5-1.99/>2.0																											

Table 7e. Baseline Stream Data Summary (UT to Bear Creek)
Bear Creek (Phillips Site) Restoration Project - EEP Project Number 26

Parameter	Gauge	Regional Curve			Pre-Existing Condition (UT)					Reference Reach(es) Data					Design (UT)			Monitoring Baseline				
Dimension and Substrate - Riffle Only		**LL**	**UL**	**Eq.**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Max**	**Med**	**Min**	**Mean**	**Med**	**Max**	**SD**
BF Width (ft)					11.9			20.3				7.0					13.5	11.4	12.0	12.0	12.5	0.8
Floodprone Width (ft)					79.0			114.0				81+			92	236			80			
BF Mean Depth (ft)					0.8			1.2				1.1					1.1	0.9	1.0	1.0	1.0	0.1
BF Max Depth (ft)					1.8			2.2				2.0					1.5	1.4	1.5	1.5	1.6	0.1
BF Cross Sectional Area (ft^2)					14.0			17.6				7.7					14.6	10.0	10.9	10.9	11.8	1.3
Width/Depth Ratio					9.9			24.7				6.4					12.5	12.5	12.6	12.6	12.7	0.1
Entrenchment Ratio					4.3			9.6				11.6+			6.8	17.5		6.4	6.7	6.7	7.0	0.4
Bank Height Ratio					1.0			1.6				1.0					1.0		1.0			
Profile																						
Riffle length (ft)					The existing reach had little, measurable patter or profile features																	
Riffle slope (ft/ft)												0.0140			0.0070	0.0125						
Pool length (ft)																						
Pool Max depth (ft)												2.5					2.5					
Pool spacing (ft)										19.0			42.0		51.0	106.0						
Pattern																						
Channel Beltwidth (ft)					The existing reach had little, measurable patter or profile features					11			27		68	77		68			77	
Radius of Curvature (ft)										6			16		27	47		27			47	
Rc:Bankfull width (ft/ft)										0.8			2.3		2	3.5		2			3.5	
Meander Wavelength (ft)										38			43		79	165		79			165	
Meander Width ratio										2.8			6		5	5.7		5			5.7	
Transport parameters																						
Reach Shear Stress (competency) lbs/ft^2																						
Max part size (mm) mobilized at bankfull																						
Stream Power (transport capacity) W/m^2																						
Additional Reach Parameters																						
Rosgen Classification					E/C5					E/C4					C5							
Bankfull Velocity (fps)					5.7										5.5							
Bankfull Discharge (cfs)					80																	
Valley Length (ft)					1857					----												
Channel Thalweg Length (ft)					1857					----					1929							
Sinuosity					1					2.5					1.2							
Water Surface Slope (ft/ft)					0.0041					0.0033					0.0045							
BF slope (ft/ft)					----					----					----							
Bankfull Floodplain Area (acres)					----					----					----							
% of Reach with Eroding Banks					----					----												
Channel Stability or Habitat Metric					----					----												
Biological or Other					----					----												

Table 7f. Baseline Stream Data Summary (Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)
Bear Creek (Phillips Site) Restoration Project - EEP Project Number 26

Parameter	Pre-Existing Condition							Reference Reach(es) Data							Design							Monitoring Baseline						
Ri%/RU%P%G%/S%																												
SC%/SA%/G%/C%/B%BE%																												
d16/d35/d50/d84/d95	NA	0.1	0.3	10.6	18.6			<0.062	0.1	1.0	16.0	22.3																
Entrainment Class <1.5/1.5-1.99/2.0-4.9/5.0-																												
Incision Class <1.2/1.2-1.49/1.5-1.99/>2.0																												

Table 8a. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)
Bear Creek (Phillips Site) Restoration Project - EEP Project Number 26

Parameter	Cross Section 1 (Reach 2 - Downstream)							Cross Section 2 (Reach 2 - Downstream)							Cross Section 3 (Reach 2 - Downstream)							Cross Section 4 (Reach 2 - Downstream)						
	Riffle							Riffle							Pool							Riffle						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	29.0							29.3							30.1							27.2						
Floodprone Width (ft) (approx)	250.0							250.0							NA							250.0						
BF Mean Depth (ft)	1.8							2.1							2.3							1.8						
BF Max Depth (ft)	2.7							3.4							4.6							2.7						
BF Cross Sectional Area (ft^2)	52.9							61.1							70.0							48.8						
Width/Depth Ratio	15.9							14.1							NA							15.2						
Entrenchment Ratio	8.6							8.5							NA							9.2						
Bank Height Ratio	1.0							1.0							1.0							1.0						
d50 (mm)	22.7							45.0							----							22.8						

Table 8b. Monitoring Data - Stream Reach Data Summary
Bear Creek (Phillips Site) Restoration Project - EEP Project Number 26

Parameter	Baseline (Downstream Reach 2)					MY-1					MY-2					MY-3					MY-4					MY-5				
Dimension and Substrate - Riffle Only	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Mean**	**Med**	**Max**	**SD**	**Min**	**Mean**	**Med**	**Max**	**SD**
BF Width (ft)	27.2	28.5	29.0	29.3	1.1																								
Floodprone Width (ft)		250																											
BF Mean Depth (ft)	1.8	1.9	1.8	2.1	0.2																								
BF Max Depth (ft)	2.7	2.9	2.7	3.4	0.4																								
BF Cross Sectional Area (ft^2)	48.8	54.3	52.9	61.1	6.3																								
Width/Depth Ratio	14.0	15.1	15.0	16.1	1.1																								
Entrenchment Ratio	8.5	8.8	8.6	9.2	0.4																								
Bank Height Ratio		1.0																											
Profile - Downstream Reach 2																													
Riffle length (ft)	19	45	41	78	19																								
Riffle slope (ft/ft)	0.0005	0.0052	0.0037	0.0091	0.0033																								
Pool length (ft)	8.0	33.0	39.0	48.0	14.0																								
Pool Max depth (ft)		4.6																											
Pool spacing (ft)	68.0	107.0	102.0	150.0	30.0																								
Pattern																													
Channel Beltwidth (ft)			176																										
Radius of Curvature (ft)	55			85																									
Rc:Bankfull width (ft/ft)	1.9			3																									
Meander Wavelength (ft)	158			374																									
Meander Width ratio			62																										
Additional Reach Parameters																													
Rosgen Classification	C-Type																												
Channel Thalweg Length (ft)	946																												
Sinuosity	1.2																												
Water Surface Slope (Channel) (ft/ft)	0.0019																												
BF slope (ft/ft)	----																												
Ri%/RU%P%G%/S%	47	16	21	16																									
SC%/SA%/G%/C%/B%BE%																													
d16/d35/d50/d84/d95																													
% of Reach with Eroding Banks																													
Channel Stability or Habitat Metric																													
Biological or Other																													

Table 8c. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)
Bear Creek (Phillips Site) Restoration Project - EEP Project Number 26

Parameter	Cross Section 5 (Reach 1 - Upstream) Riffle							Cross Section 6 (Reach 1 - Upstream) Pool						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	23.8							26.9						
Floodprone Width (ft) (approx)	250.0							NA						
BF Mean Depth (ft)	1.8							2.1						
BF Max Depth (ft)	2.8							3.4						
BF Cross Sectional Area (ft^2)	42.3							55.4						
Width/Depth Ratio	13.4							NA						
Entrenchment Ratio	10.5							NA						
Bank Height Ratio	1.0							1.0						
d50 (mm)	9.4							----						

Table 8d. Monitoring Data - Stream Reach Data Summary
Bear Creek (Phillips Site) Restoration Project - EEP Project Number 26

Parameter	Baseline					MY-1					MY-2					MY-3					MY-4					MY-5				
Dimension and Substrate - Riffle Only	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD
BF Width (ft)			23.8																										
Floodprone Width (ft)			250																										
BF Mean Depth (ft)			1.8																										
BF Max Depth (ft)			2.8																										
BF Cross Sectional Area (ft^2)			42.3																										
Width/Depth Ratio			13.3																										
Entrenchment Ratio			10.5																										
Bank Height Ratio			1.0																										
Profile - Reach 1 - Upstream																													
Riffle length (ft)	18	57	45	118	35																								
Riffle slope (ft/ft)	0.0004	0.0053	0.0047	0.0107	0.0039																								
Pool length (ft)	5.0	26.0	20.0	64.0	18.0																								
Pool Max depth (ft)		3.4																											
Pool spacing (ft)	60.0	115.0	116.0	198.0	42.0																								
Pattern																													
Channel Beltwidth (ft)			144																										
Radius of Curvature (ft)	44			70																									
Rc:Bankfull width (ft/ft)	1.8			2.9																									
Meander Wavelength (ft)	154			286																									
Meander Width ratio	6.3			11.7																									
Additional Reach Parameters																													
Rosgen Classification	C-Type																												
Channel Thalweg Length (ft)	1088																												
Sinuosity	1.2																												
Water Surface Slope (Channel) (ft/ft)	0.0017																												
BF slope (ft/ft)	----																												
Ri%/RU%P%G%/S%	37	15	24	9																									
SC%/SA%/G%/C%/B%BE%																													
d16/d35/d50/d84/d95																													
% of Reach with Eroding Banks																													
Channel Stability or Habitat Metric																													
Biological or Other																													

Table 8e. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)
Bear Creek (Phillips Site) Restoration Project - EEP Project Number 26

Parameter	Cross Section 7 (Unnamed Tributary) Riffle							Cross Section 8 (Unnamed Tributary) Pool							Cross Section 9 (Unnamed Tributary) Riffle							Cross Section 10 (Unnamed Tributary) Pool						
Dimension	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+	MY0	MY1	MY2	MY3	MY4	MY5	MY5+
BF Width (ft)	12.5							16.3							11.4							14.2						
Floodprone Width (ft) (approx)	80.0							NA							80.0							NA						
BF Mean Depth (ft)	0.9							1.4							0.9							1.3						
BF Max Depth (ft)	1.6							2.8							1.4							2.3						
BF Cross Sectional Area (ft^2)	11.8							22.2							10.0							18.4						
Width/Depth Ratio	13.2							NA							13.0							NA						
Entrenchment Ratio	6.4							NA							7.0							NA						
Bank Height Ratio	1.0							1.0							1.0							1.0						
d50 (mm)	4.3							----							25.7							----						

Table 8f. Monitoring Data - Stream Reach Data Summary
Bear Creek (Phillips Site) Restoration Project - EEP Project Number 26

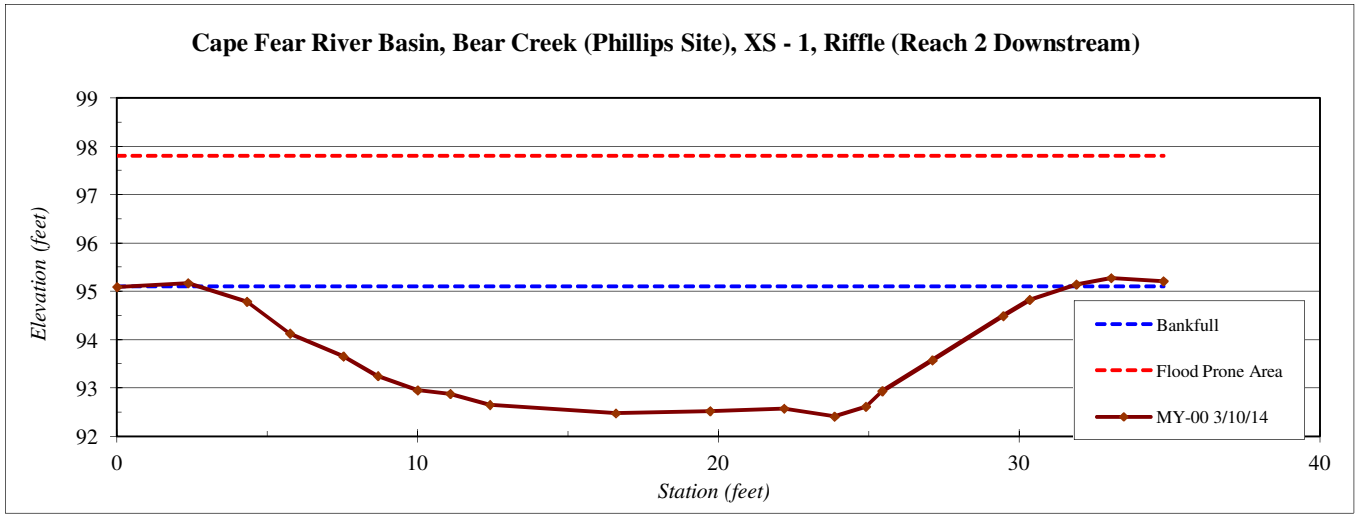
Parameter	Baseline					MY-1					MY-2					MY-3					MY-4					MY-5				
Dimension and Substrate - Riffle Only	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD	Min	Mean	Med	Max	SD
BF Width (ft)	11.4	12.0	12.0	12.5	0.8																								
Floodprone Width (ft)		80																											
BF Mean Depth (ft)	0.9	1.0	1.0	1.0	0.1																								
BF Max Depth (ft)	1.4	1.5	1.5	1.6	0.1																								
BF Cross Sectional Area (ft^2)	10.0	10.9	10.9	11.8	1.3																								
Width/Depth Ratio	12.5	12.6	12.6	12.7	0.1																								
Entrenchment Ratio	6.4	6.7	6.7	7.0	0.4																								
Bank Height Ratio		1.0																											
Profile - Unnamed Tributary																													
Riffle length (ft)	9	35	29	92	21																								
Riffle slope (ft/ft)	0.0006	0.0081	0.0063	0.0189	0.0059																								
Pool length (ft)	4.0	23.0	19.0	73.0	15.0																								
Pool Max depth (ft)	2.3	2.6	2.3	2.8																									
Pool spacing (ft)	13.0	69.0	74.0	121.0	30.0																								
Pattern																													
Channel Beltwidth (ft)	68			77																									
Radius of Curvature (ft)	27			47																									
Rc:Bankfull width (ft/ft)	2			3.5																									
Meander Wavelength (ft)	79			165																									
Meander Width ratio	5			5.7																									
Additional Reach Parameters																													
Rosgen Classification	C-Type																												
Channel Thalweg Length (ft)	1971																												
Sinuosity	1.2																												
Water Surface Slope (Channel) (ft/ft)	0.0041																												
BF slope (ft/ft)	----																												
Ri%/RU%P%G%/S%	44	13	33	10																									
SC%/SA%/G%/C%/B%BE%																													
d16/d35/d50/d84/d95																													
% of Reach with Eroding Banks																													
Channel Stability or Habitat Metric																													
Biological or Other																													

River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 1, Riffle (Reach 2 Downstream)
Drainage Area (sq mi):	4.99
Date:	3/10/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.00	95.09
2.36	95.17
4.32	94.79
5.75	94.13
7.52	93.65
8.67	93.25
9.99	92.95
11.07	92.88
12.39	92.65
16.58	92.47
19.72	92.52
22.17	92.58
23.85	92.41
24.89	92.61
25.44	92.93
27.11	93.57
29.46	94.49
30.34	94.83
31.89	95.14
33.05	95.28
34.78	95.21

SUMMARY DATA	
Bankfull Elevation:	95.1
Bankfull Cross-Sectional Area:	52.9
Bankfull Width:	29.0
Flood Prone Area Elevation:	97.8
Flood Prone Width:	250.0
Max Depth at Bankfull:	2.7
Mean Depth at Bankfull:	1.8
W / D Ratio:	15.9
Entrenchment Ratio:	8.6
Bank Height Ratio:	1.0

Stream Type	C

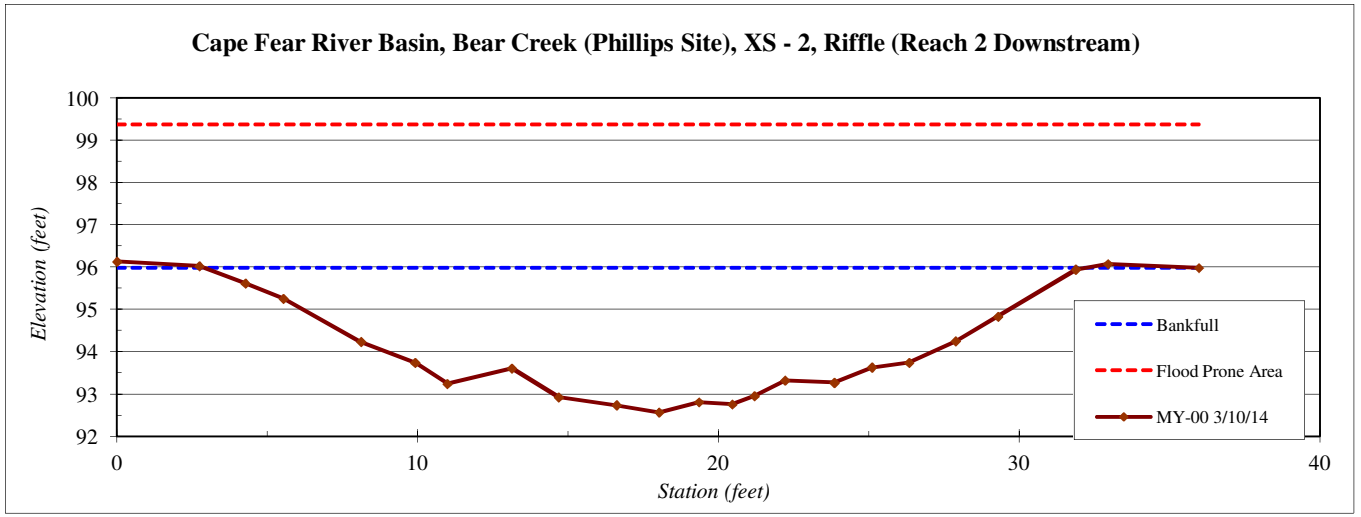


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 2, Riffle (Reach 2 Downstream)
Drainage Area (sq mi):	4.99
Date:	3/10/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.00	96.13
2.74	96.02
4.26	95.61
5.53	95.25
8.11	94.23
9.91	93.73
10.98	93.24
13.12	93.60
14.68	92.92
16.61	92.73
18.02	92.57
19.34	92.81
20.45	92.75
21.19	92.95
22.21	93.32
23.85	93.27
25.10	93.63
26.33	93.74
27.88	94.25
29.29	94.83
31.87	95.94
32.94	96.08
35.96	95.98

SUMMARY DATA	
Bankfull Elevation:	96.0
Bankfull Cross-Sectional Area:	61.1
Bankfull Width:	29.3
Flood Prone Area Elevation:	99.4
Flood Prone Width:	250.0
Max Depth at Bankfull:	3.4
Mean Depth at Bankfull:	2.1
W / D Ratio:	14.1
Entrenchment Ratio:	8.5
Bank Height Ratio:	1.0

Stream Type	C

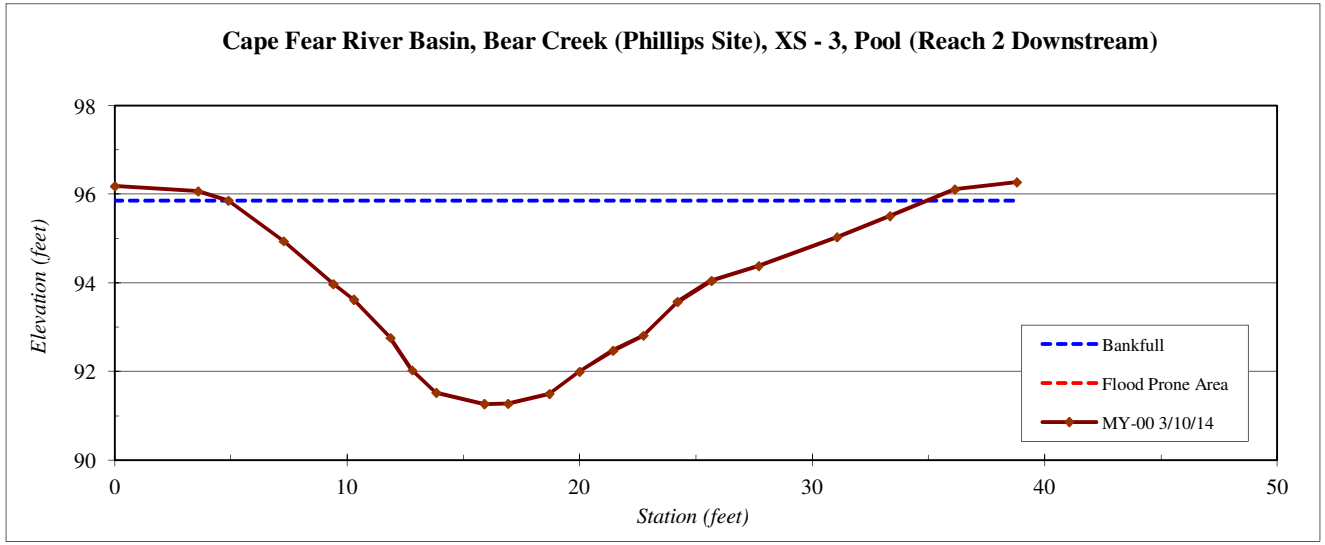


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 3, Pool (Reach 2 Downstream)
Drainage Area (sq mi):	4.99
Date:	3/10/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.0	96.2
3.6	96.1
4.9	95.9
7.3	94.9
9.4	94.0
10.3	93.6
11.9	92.8
12.8	92.0
13.8	91.5
15.9	91.3
16.9	91.3
18.7	91.5
20.0	92.0
21.4	92.47
22.7	92.81
24.2	93.57
25.7	94.04
27.7	94.38
31.1	95.03
33.3	95.51
36.1	96.11
38.8	96.27

SUMMARY DATA	
Bankfull Elevation:	95.9
Bankfull Cross-Sectional Area:	70.0
Bankfull Width:	30.1
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	4.6
Mean Depth at Bankfull:	2.3
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	1.0

Stream Type	C

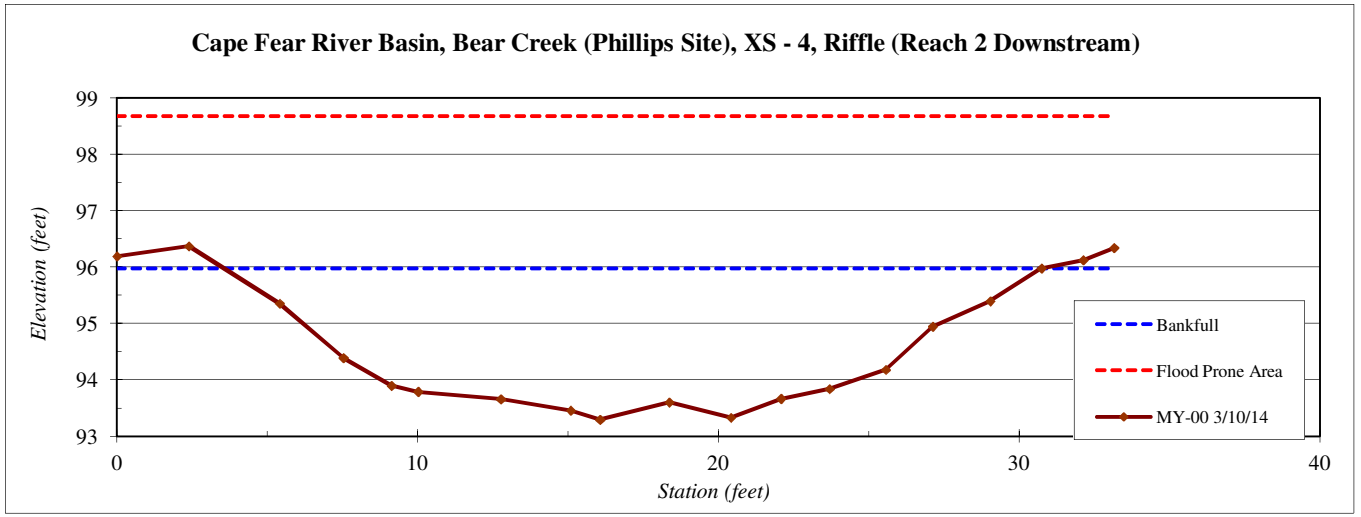


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 4, Riffle (Reach 2 Downstream)
Drainage Area (sq mi):	4.99
Date:	3/10/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.00	96.19
2.39	96.37
5.41	95.35
7.53	94.39
9.13	93.89
10.01	93.79
12.76	93.66
15.08	93.46
16.06	93.29
18.36	93.60
20.41	93.33
22.08	93.66
23.69	93.84
25.56	94.18
27.12	94.94
29.03	95.40
30.74	95.98
32.12	96.12
33.15	96.34

SUMMARY DATA	
Bankfull Elevation:	96.0
Bankfull Cross-Sectional Area:	48.8
Bankfull Width:	27.2
Flood Prone Area Elevation:	98.7
Flood Prone Width:	250.0
Max Depth at Bankfull:	2.7
Mean Depth at Bankfull:	1.8
W / D Ratio:	15.2
Entrenchment Ratio:	9.2
Bank Height Ratio:	1.0

Stream Type	C

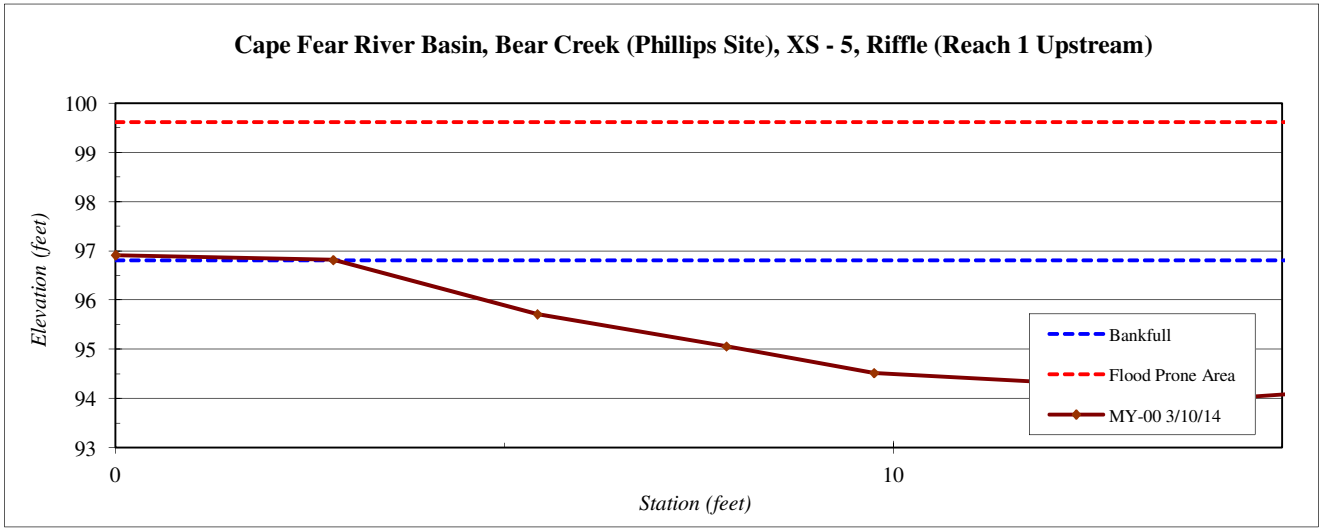


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 5, Riffle (Reach 1 Upstream)
Drainage Area (sq mi):	4.08
Date:	3/10/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.00	96.92
2.80	96.81
5.42	95.71
7.85	95.06
9.75	94.52
12.07	94.32
13.21	94.12
14.60	94.04
17.47	94.34
20.44	94.42
22.88	95.62
25.48	96.48
26.71	96.86
29.66	96.86

SUMMARY DATA	
Bankfull Elevation:	96.8
Bankfull Cross-Sectional Area:	42.3
Bankfull Width:	23.8
Flood Prone Area Elevation:	99.6
Flood Prone Width:	250.0
Max Depth at Bankfull:	2.8
Mean Depth at Bankfull:	1.8
W / D Ratio:	13.4
Entrenchment Ratio:	10.5
Bank Height Ratio:	1.0

Stream Type	C

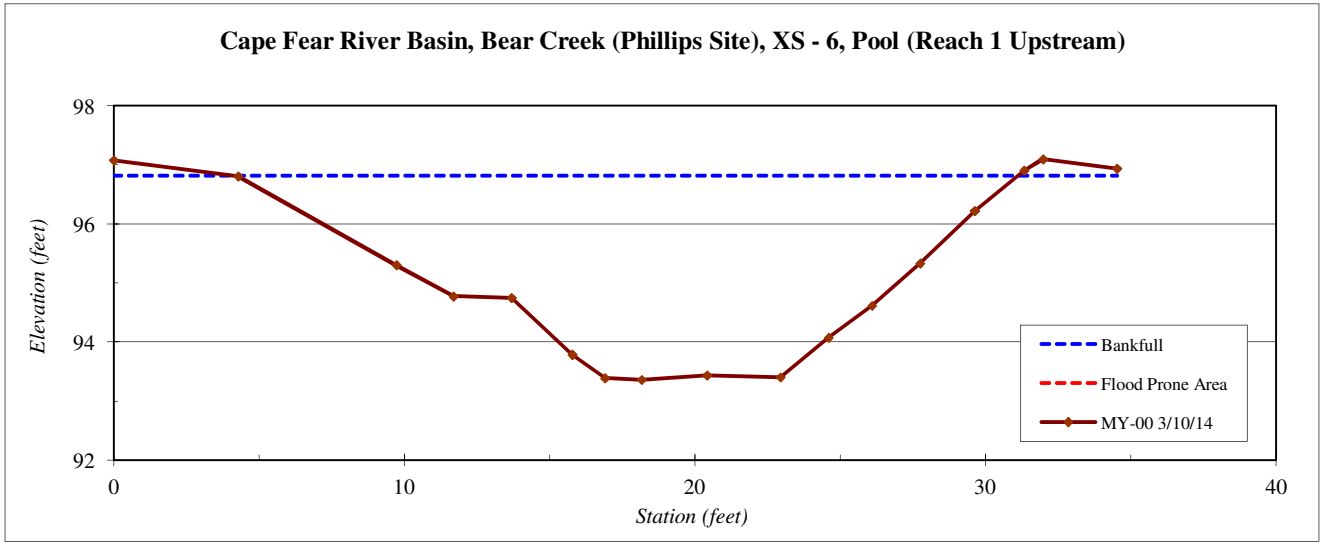


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 6, Pool (Reach 1 Upstream)
Drainage Area (sq mi):	4.08
Date:	3/10/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.0	97.1
4.3	96.8
9.7	95.3
11.7	94.8
13.7	94.7
15.8	93.8
16.9	93.4
18.2	93.4
20.4	93.4
22.9	93.4
24.6	94.1
26.1	94.6
27.7	95.3
29.6	96.22
31.3	96.90
32.0	97.09
34.5	96.94

SUMMARY DATA	
Bankfull Elevation:	96.8
Bankfull Cross-Sectional Area:	55.4
Bankfull Width:	26.9
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.4
Mean Depth at Bankfull:	2.1
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	1.0

Stream Type	C

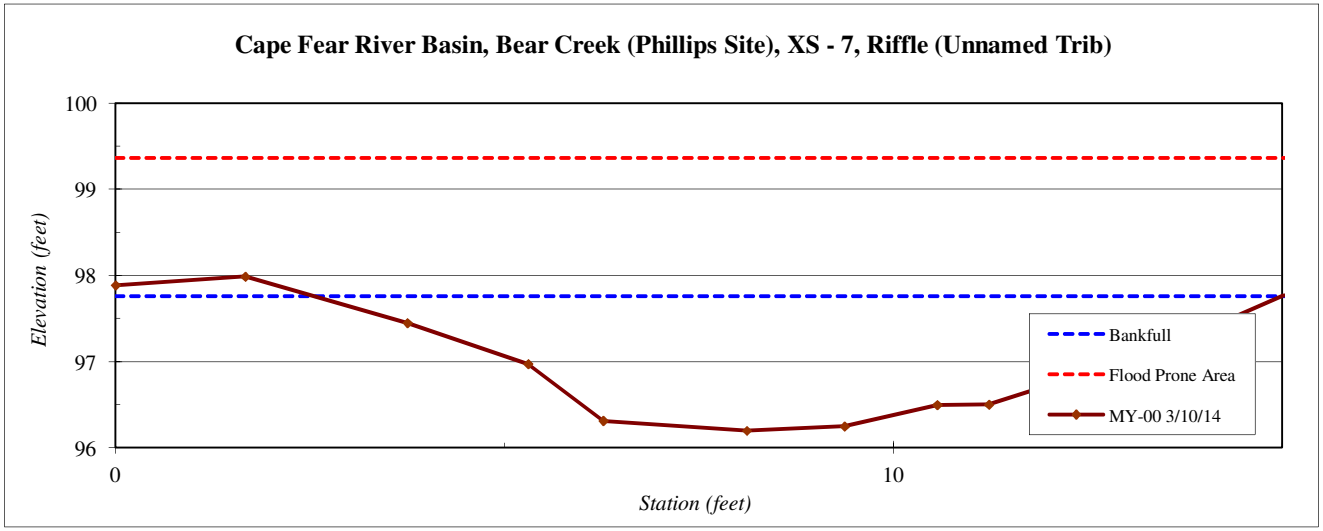


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 7, Riffle (Unnamed Trib)
Drainage Area (sq mi):	0.88
Date:	3/10/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.00	97.89
1.67	97.99
3.75	97.45
5.30	96.97
6.27	96.31
8.11	96.20
9.37	96.25
10.56	96.50
11.23	96.50
12.95	97.00
14.22	97.46
15.01	97.77
16.68	97.90

SUMMARY DATA	
Bankfull Elevation:	97.8
Bankfull Cross-Sectional Area:	11.8
Bankfull Width:	12.5
Flood Prone Area Elevation:	99.4
Flood Prone Width:	80.0
Max Depth at Bankfull:	1.6
Mean Depth at Bankfull:	0.9
W / D Ratio:	13.2
Entrenchment Ratio:	6.4
Bank Height Ratio:	1.0

Stream Type	C

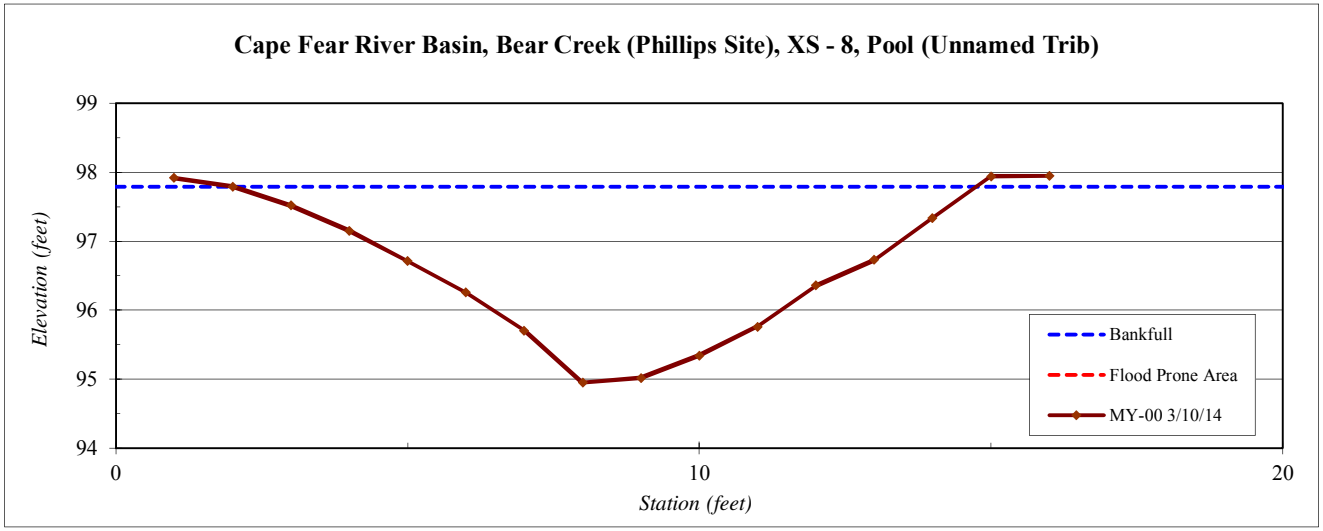


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 8, Pool (Unnamed Trib)
Drainage Area (sq mi):	0.88
Date:	3/10/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.00	97.92
2.31	97.79
4.03	97.52
4.87	97.15
5.94	96.71
6.83	96.26
7.79	95.71
8.84	94.95
10.10	95.02
11.21	95.34
12.43	95.76
14.13	96.36
15.13	96.73
17.13	97.34
19.16	97.94
21.7	97.95

SUMMARY DATA	
Bankfull Elevation:	97.8
Bankfull Cross-Sectional Area:	22.2
Bankfull Width:	16.3
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	2.8
Mean Depth at Bankfull:	1.4
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	1.0

Stream Type	C

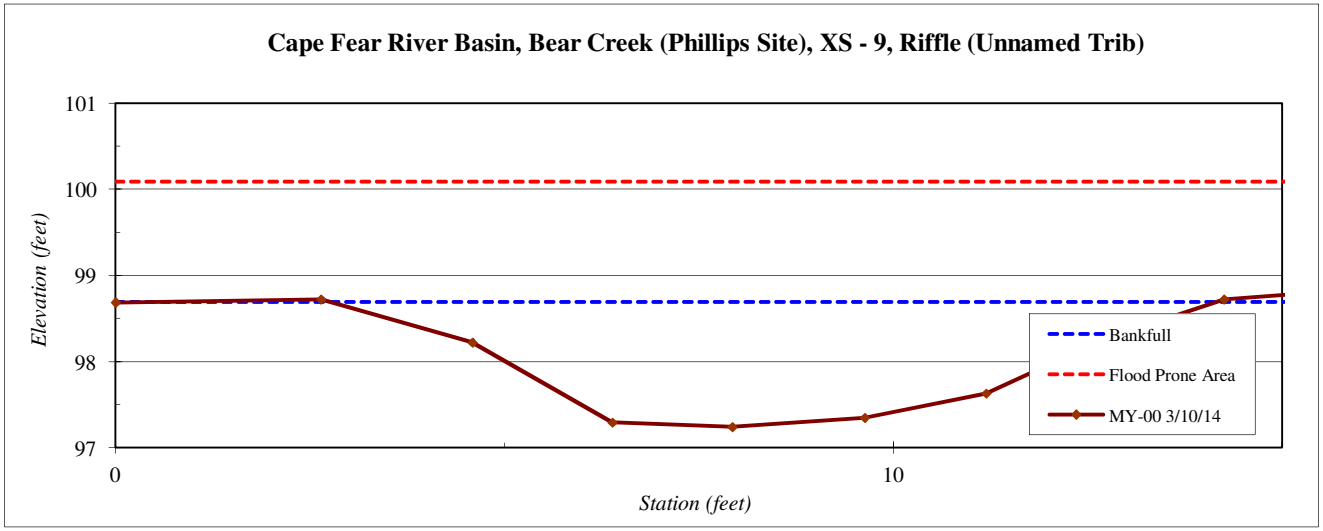


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 9, Riffle (Unnamed Trib)
Drainage Area (sq mi):	0.88
Date:	3/10/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.00	98.69
2.64	98.72
4.59	98.22
6.39	97.29
7.93	97.24
9.63	97.35
11.19	97.63
12.71	98.26
14.25	98.72
15.68	98.82
17.11	98.87

SUMMARY DATA	
Bankfull Elevation:	98.7
Bankfull Cross-Sectional Area:	10.0
Bankfull Width:	11.4
Flood Prone Area Elevation:	100.1
Flood Prone Width:	80.0
Max Depth at Bankfull:	1.4
Mean Depth at Bankfull:	0.9
W / D Ratio:	13.0
Entrenchment Ratio:	7.0
Bank Height Ratio:	1.0

Stream Type	C

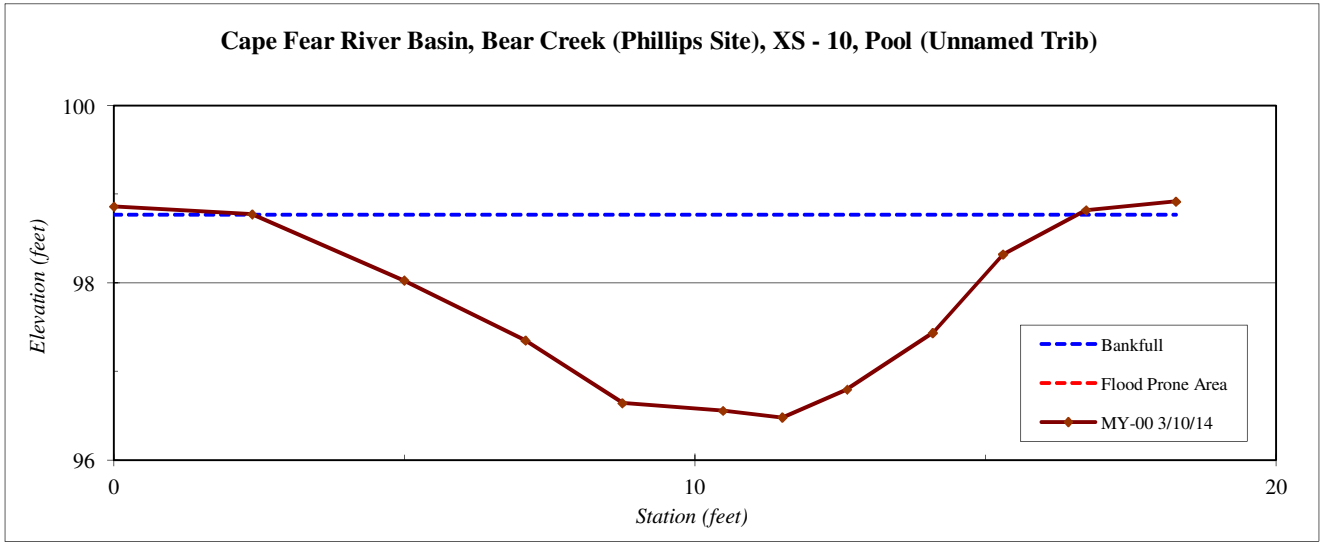


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 10, Pool (Unnamed Trib)
Drainage Area (sq mi):	0.88
Date:	3/10/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.0	98.9
2.4	98.8
5.0	98.0
7.1	97.4
8.7	96.6
10.5	96.6
11.5	96.5
12.6	96.8
14.1	97.4
15.3	98.3
16.7	98.8
18.3	98.9

SUMMARY DATA	
Bankfull Elevation:	98.8
Bankfull Cross-Sectional Area:	18.4
Bankfull Width:	14.2
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	2.3
Mean Depth at Bankfull:	1.3
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	1.0

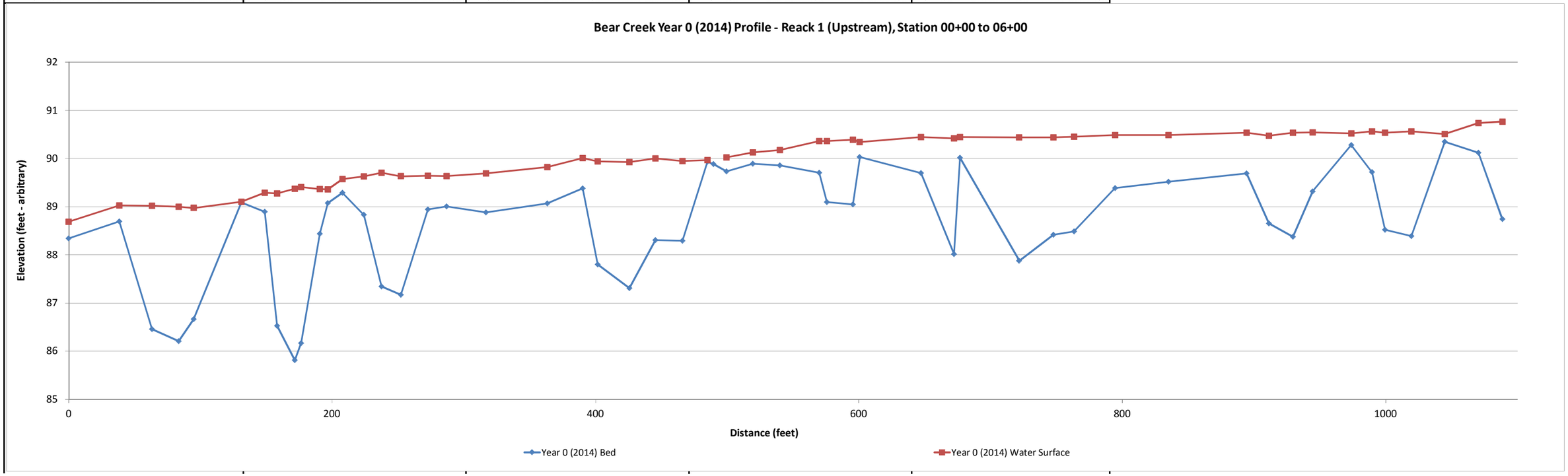
Stream Type	C



Project Name	Bear Creek - Profile
Reach	Reach 1 (Upstream) Station 00+00 - 11+00
Feature	Profile
Date	3/10/14
Crew	Perkinson, Jernigan

	2014	2014	2015	2016	2017
Avg. Water Surface Slope	0.0017				
Riffle Length	57				
Avg. Riffle Slope	0.0053				
Pool Length	26				
Pool to Pool Spacing	115				

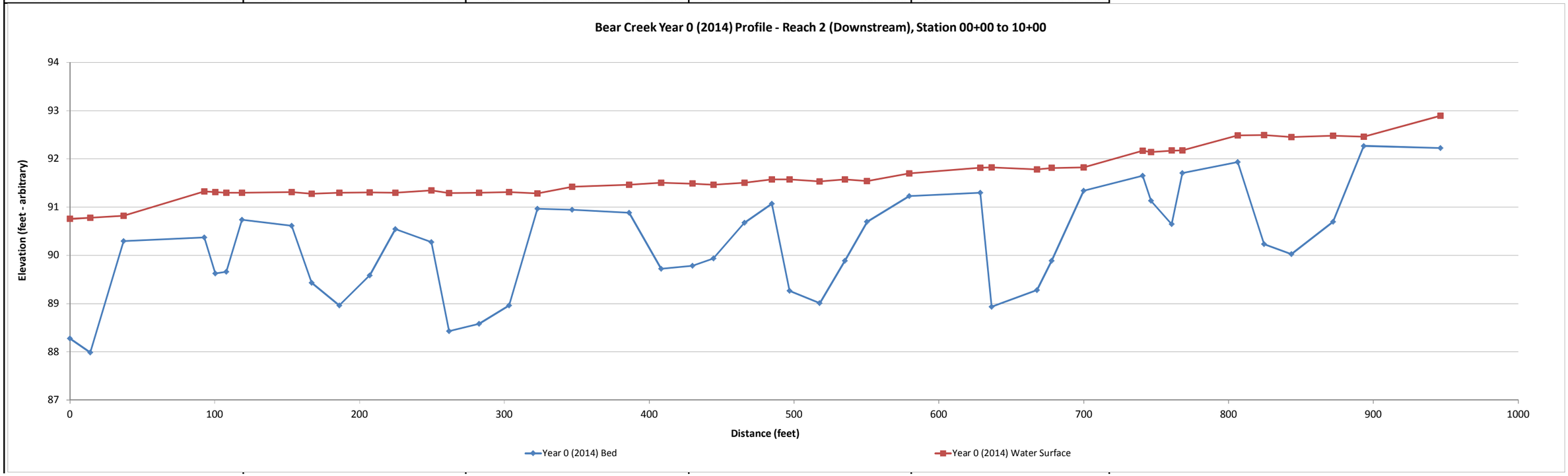
2014 Year 0 Monitoring \Survey			2014 Year 1 Monitoring \Survey			2015 Year 2 Monitoring \Survey			2016 Year 3 Monitoring \Survey			2017 Year 4 Monitoring \Survey		
Station	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**



Project Name	Bear Creek - Profile
Reach	Reach 2 (Downstream) Station 00+00 - 10+00
Feature	Profile
Date	3/10/14
Crew	Perkinson, Jernigan

	2014	2014	2015	2016	2017
Avg. Water Surface Slope	0.0019				
Riffle Length	45				
Avg. Riffle Slope	0.0052				
Pool Length	33				
Pool to Pool Spacing	107				

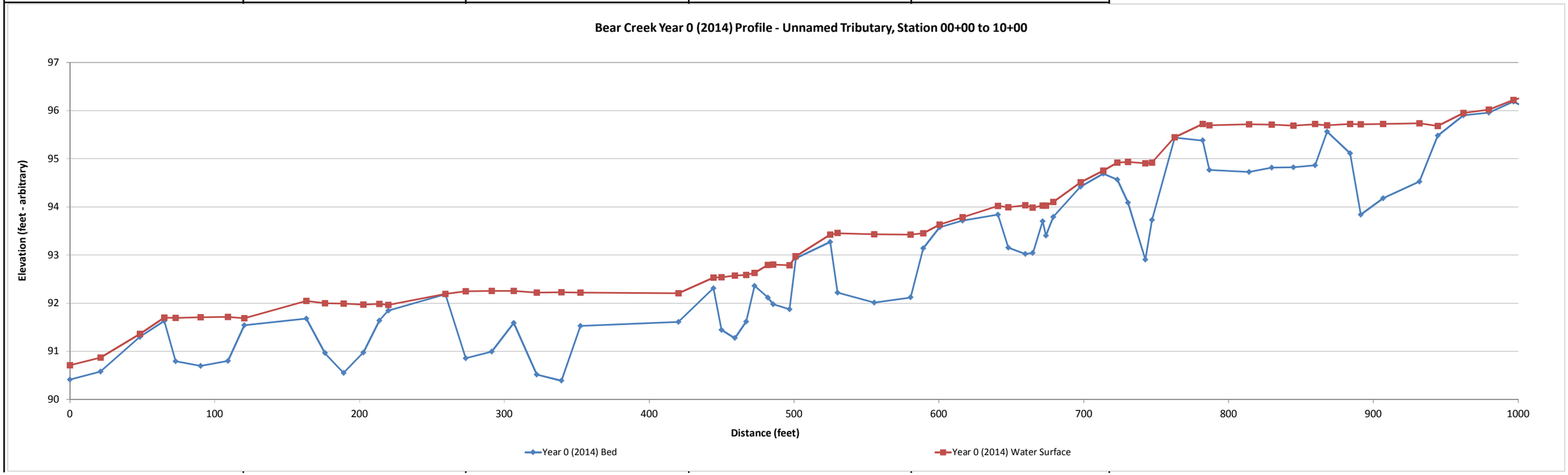
2014 Year 0 Monitoring \Survey			2014 Year 1 Monitoring \Survey			2015 Year 2 Monitoring \Survey			2016 Year 3 Monitoring \Survey			2017 Year 4 Monitoring \Survey		
Station	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**



Project Name	Bear Creek - Profile
Reach	UT to Bear Creek Station 00+00 - 10+00
Feature	Profile
Date	3/10/14
Crew	Perkinson, Jernigan

	2014	2014	2015	2016	2017
Avg. Water Surface Slope	0.0041				
Riffle Length	35				
Avg. Riffle Slope	0.0081				
Pool Length	23				
Pool to Pool Spacing	69				

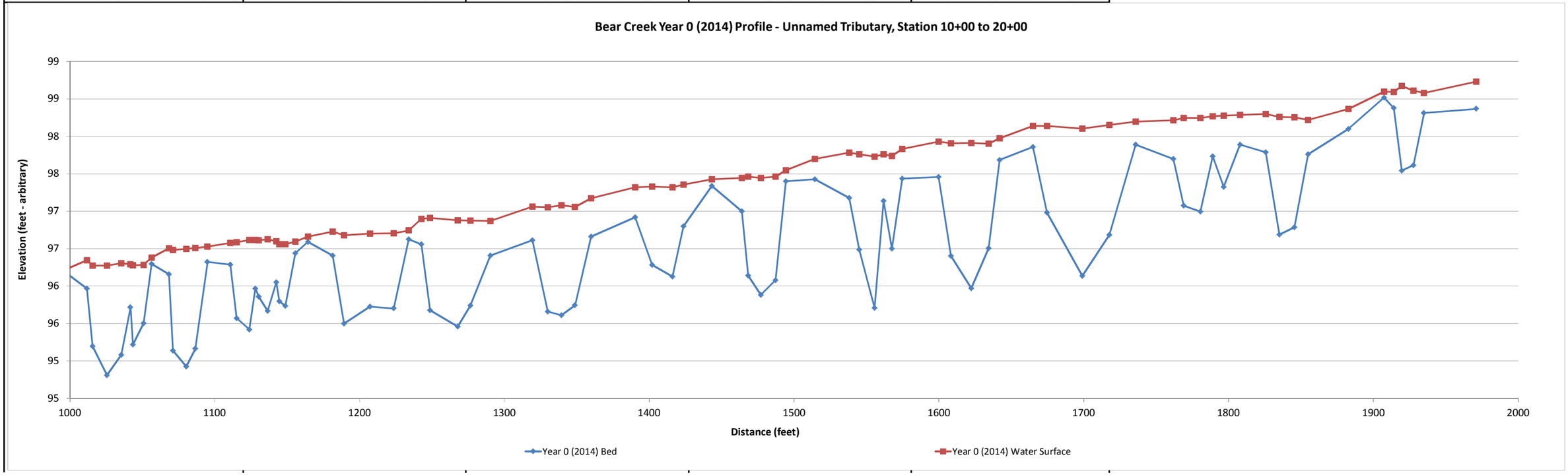
2014 Year 0 Monitoring \Survey			2014 Year 1 Monitoring \Survey			2015 Year 2 Monitoring \Survey			2016 Year 3 Monitoring \Survey			2017 Year 4 Monitoring \Survey		
Station	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**



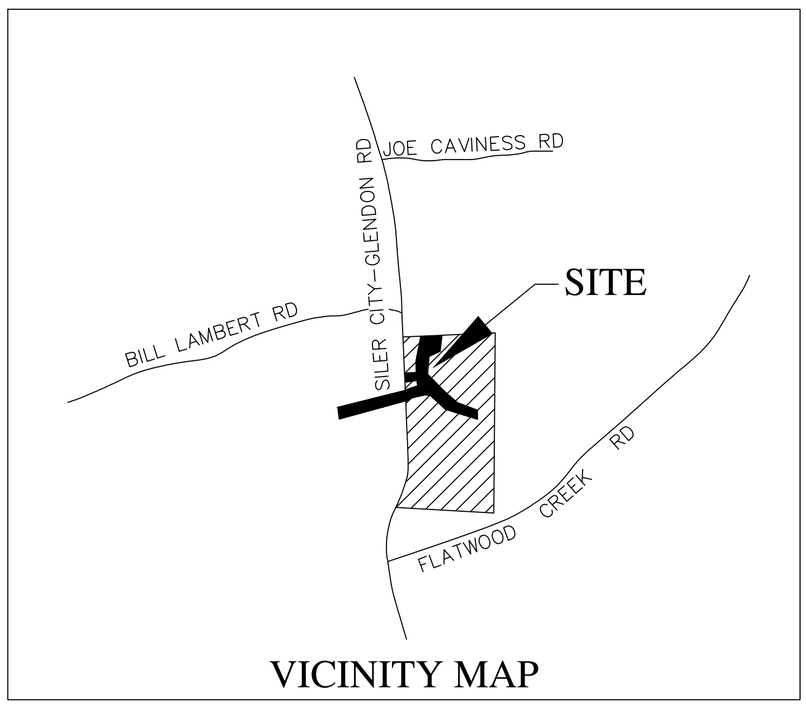
Project Name	Bear Creek - Profile
Reach	UT to Bear Creek Station 10+00 - 20+00
Feature	Profile
Date	3/10/14
Crew	Perkinson, Jernigan

	2014	2014	2015	2016	2017
Avg. Water Surface Slope	0.0041				
Riffle Length	35				
Avg. Riffle Slope	0.0081				
Pool Length	23				
Pool to Pool Spacing	69				

2014 Year 0 Monitoring \Survey			2014 Year 1 Monitoring \Survey			2015 Year 2 Monitoring \Survey			2016 Year 3 Monitoring \Survey			2017 Year 4 Monitoring \Survey		
Station	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**



Appendix E.
As-built Plan Sheets



VICINITY MAP

START REACH 1
200+60

XS - 121532
XS - 121359
XS - 121106
XS - 120977
XS - 120848
XS - 120818
XS - 120750
XS - 120501
XS - 120312
XS - 120007
XS - 119731

NATURAL ROCK

CAPPED REBAR
CONTROL POINT
N.C. GRID COORDS. (NAD 83)
N = 674365.6881 FEET
E = 1861066.8240 FEET
ELEVATION = 484.53 FEET (NAVD 88)

CAPPED REBAR
CONTROL POINT
N.C. GRID COORDS. (NAD 83)
N = 673946.1488 FEET
E = 1861471.7030 FEET
ELEVATION = 482.98 FEET (NAVD 88)

N.C. GRID NORTH (NAD 83)

36" CSP
INV U/S: 468.88
INV D/S: 468.38

TOP OF ROAD
ELEVATION
474.33

60" CSP
INV U/S: 468.10
INV D/S: 468.65

36" CSP
INV U/S: 468.86
INV D/S: 468.64

SOIL
ROAD

END U.T.
120+10.98

120+00

210+62.99
END REACH 1
START REACH 2

48" CSP
INV U/S: 468.08
INV D/S: 467.49

CONC. PAD

TOP OF SOIL
ROAD
ELEVATION
473.48

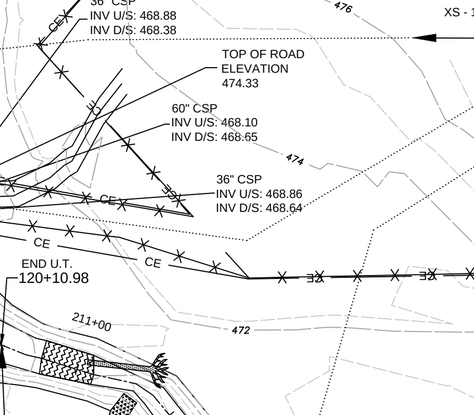
48" CSP
INV U/S: 468.23
INV D/S: 467.67

60" CSP
INV U/S: 467.11
INV D/S: 467.06

END REACH 2
222+51.94

201+00 202+00 203+00 204+00 205+00 206+00 207+00 208+00 209+00 210+00 211+00 212+00 213+00 214+00 215+00 216+00 217+00 218+00 219+00 220+00 221+00 222+00 118+00 119+00

UPPER CROSSING PROFILE
BEAR CREEK STA: 209+82
VERTICAL SCALE: 1" = 5'
HORIZONTAL SCALE: 1" = 50'



LOWER CROSSING PROFILE
BEAR CREEK STA: 217+98
VERTICAL SCALE: 1" = 5'
HORIZONTAL SCALE: 1" = 50'

50 0 25 50 100

1 inch = 50 ft.

LEGEND

- ROOTWAD
- LOG-VANE
- LOG-SILL
- BOULDER
- RIP-RAP
- RIFFLE
- BRUSH TOE
- FENCE
- CONSERVATION EASEMENT — CE —
- WATER LINE — W — W —
- TREE LINE

NOTES:
-CONSERVATION EASEMENT DRAWN BY RECORDED MAPS.
REFERENCE CHATHAM COUNTRY DEED BOOK 1279, PAGES 487-488
-VERTICAL DATUM USED: NAVD 88
-CROSS SECTIONS SHOWN ARE FROM CONSTRUCTION SPECIFICATIONS AND ARE ARE MAPPED BY GRID COORDINATES GIVEN IN SECTION 1.02

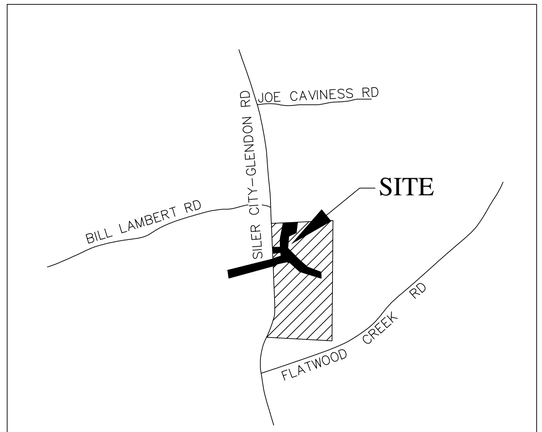
NORTH CAROLINA PROFESSIONAL SEAL L-3621 LAND SURVEYOR HERBERT H. PROCTOR JR.

SHEET 1

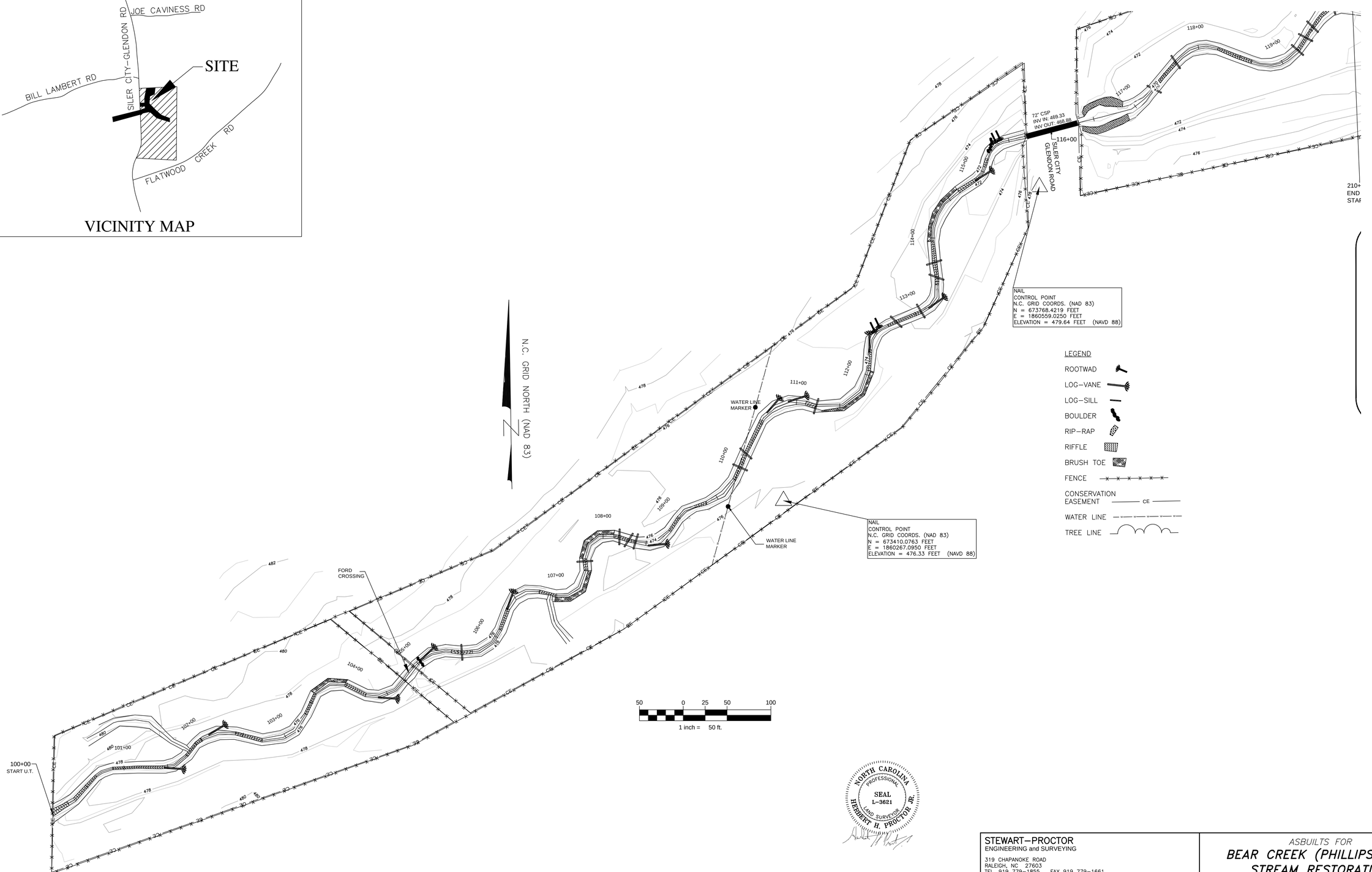
STEWART-PROCTOR
ENGINEERING and SURVEYING
319 CHAPANOKE ROAD
RALEIGH, NC 27603
TEL. 919 779-1855 FAX 919 779-1661

ASBUILTS FOR
BEAR CREEK (PHILLIPS SITE) STREAM RESTORATION

DATE 20AUG2013	SURVEYED BY	JOB	CHATHAM COUNTY	NORTH CAROLINA
SCALE 1"=50'	DRAWN BY			
REVISIONS		DWG. NO.	SCO PROJECT # 09-07726-01A	



VICINITY MAP



LEGEND

- ROOTWAD
- LOG–VANE
- LOG–SILL
- BOULDER
- RIP–RAP
- RIFFLE
- BRUSH TOE
- FENCE
- CONSERVATION EASEMENT — CE —
- WATER LINE
- TREE LINE

NORTH CAROLINA PROFESSIONAL SEAL L-3621 LAND SURVEYOR HERBERT H. PROCTOR JR.

SHEET 2

STEWART–PROCTOR ENGINEERING and SURVEYING 319 CHAPANOKE ROAD RALEIGH, NC 27603 TEL. 919 779–1855 FAX 919 779–1661			ASBUILTS FOR BEAR CREEK (PHILLIPS SITE) STREAM RESTORATION
DATE 20AUG2013	SURVEYED BY	JOB	CHATHAM COUNTY / NORTH CAROLINA
SCALE 1"=50'	DRAWN BY		
REVISIONS		DWG. NO.	SCO PROJECT # 09-07726-01A