FINAL
YEAR 3 (2016) ANNUAL MONITORING REPORT
BEAR CREEK (PHILLIPS SITE) RESTORATION PROJECT

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

Data Collection – January-September 2016

Cape Fear River Basin
Cataloging Unit 03030003

SUBMITTED TO/PREPARED FOR:

North Carolina Department of Environmental Quality
Division of Mitigation Services
217 West Jones Street, Suite 3000A
Raleigh, North Carolina 27603

SUBMITTED BY:

Axiom Environmental, Inc.

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

October 2016

TABLE OF CONTENTS

APPENDICES

1.0 PROJECT SUMMARY

The North Carolina Department of Environmental Quality- Division of Mitigation Services (DMS) 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 and Table 4, Appendix A). Land use at the Site, prior to mitigation activities, was primarily comprised of open pasture used for livestock grazing with a few small areas of mixed hardwood forest. Site streams were impaired by historical and current land management practices, which included timber harvesting, pasture conversion, channelization, and livestock grazing. The easement boundary currently has no signage or marking. Completed project activities, reporting history, completion dates, project contacts, and project attributes are summarized in Tables 1-4 (Appendix A). This report (compiled based on the NC Division of Mitigation Services (NCDMS) *Procedural Guidance and Content Requirements for DMS Monitoring Reports* Version 1.5 dated 6/8/12) summarizes data for Year 3 (2016) monitoring.

The Site is located in the *Upper and Middle Rocky River Local Watershed Plan* (LWP) area (http://portal.ncdenr.org/c/document_library/get_file?uuid=bcd905ef-bbfb-42bb-84a4-d69f39fd3b03&groupId=60329). 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 NCDMS's *Cape Fear River Basin Restoration Priorities (RBRP) 2009* (http://portal.ncdenr.org/c/document_library/get_file?uuid=864e82e8-725c-415e-8ed9-c72dfcb55012&groupId=60329) and is identified in the *Upper Rocky River Local Watershed Plan Detailed Assessment and Targeting of Management Report* (http://portal.ncdenr.org/web/eep/lwps?p_p_id=20&p_p_lifecycle=1&p_p_state=exclusive&p_p_mode=view&_20_struts_action=%2Fdocument_library%2Fget_file&_20_folderId=2806346&_20_name=DLFE-57173.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 removing excess sediment,
- Improve stream bank stability,
- Increase dissolved oxygen concentrations,
- Improve in-stream habitat,
- Restore terrestrial habitat, and
- Improve aesthetics.

The project goals were addressed through the following project objectives.

- Cattle were removed from streams and runoff is filtered through buffer zones. Flood flows are 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 were stabilized by increasing woody root mass on banks and reducing channel incision. Storm flow containing grit and fine sediments is 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 were stabilized using bioengineering, natural channel design techniques, and grading to reduce bank angles and bank height.
- In-stream structures promote aeration of water.
- In-stream structures were 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 were restored with native vegetation as part of the project. Native vegetation will provide cover and food for terrestrial creatures.
- Native plant species were planted, invasive species were treated, and eroding and unstable areas were 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.

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

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. Stream survey 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.

Stream Areas of Concern

Two stream areas of concern were observed during monitoring year 3 (2016). Area of Concern #1 was observed during the previous two monitoring years, and it remains concerning during monitoring year 3 (2016). The right bank of the Unnamed Tributary to Bear Creek has failed causing the water to leave the stream channel and scour a new, smaller channel during heavy flow events. The bank and new channel appear unstable and are void of vegetation. Area of Concern #2 consists of bank scour in the inner bend of a pool caused by instream vegetation that has changed the flow path causing it to undercut the stream bank. These areas of concern are depicted on Figure 2A in Appendix B and will be closely monitored throughout the remainder of the monitoring period.

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 (12) sample vegetation plots (10-meter by 10-meter) were installed and measured within the Site as per guidelines established in *CVS-DMS 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. In addition, a warranty vegetation assessment was completed during year 3 (2016). Twenty (20) temporary plots (25-meter by 4-meter) were established randomly throughout the Site (Figures 2A-2B, Appendix B), and a count of all planted stems within the plots was performed. Vegetation plot and warranty assessment information can be found in Appendix C.

Year 3 (2016) stem count measurements indicate an average of 499 planted stems per acre (excluding livestakes) across the Site, which is above success criteria for monitoring year 3 (2016). Additionally, eleven of the twelve vegetation monitoring plots met success criteria, and seventeen of the twenty warranty assessment plots met success criteria with an average of 459 stems per acre for those plots. Shortly after

construction was complete, several large rain events caused flooding that scoured the floodplain, leaving it bare. Vegetation has established throughout much of the floodplain, but there are still some bare areas. These scoured areas have been depicted on Figures 2A-2B in Appendix B.

Due to poor growth and low stem densities during year 1 (2014), a supplemental planting occurred at the Site in February/March 2015. A total of 2,870 stems were planted site-wide. These trees appear to be vigorous, and stem densities reflect high survival.

3.0 REFERENCES

Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2008. CVS-DMS Protocol for Recording Vegetation. Version 4.2. North Carolina Department of Environmental Quality, Division of Mitigation Services. Raleigh, North Carolina.

North Carolina Division of Mitigation Services (NCDMS). 2005. Upper Rocky River Local Watershed Plan Detailed Assessment and Targeting of Management Report (online) Available: http://portal.ncdenr.org/web/eep/lwps?p_p_id=20&p_p_lifecycle=1&p_p_state=exclusive&p_p_mode=view&_20_struts_action=%2Fdocument_library%2Fget_file&_20_folderId=2806346&_20_name=DLFE-57173.pdf. North Carolina Department of Environmental Quality, Raleigh, North Carolina.

North Carolina Division of Mitigation Services (NCDMS). 2009. Cape Fear River Basin Restoration Priorities 2009 (online). Available: http://portal.ncdenr.org/c/document_library/get_file?uuid=864e82e8-725c-415e-8ed9-c72dfcb55012&groupId=60329. North Carolina Department of Environmental Quality, Raleigh, North Carolina.

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

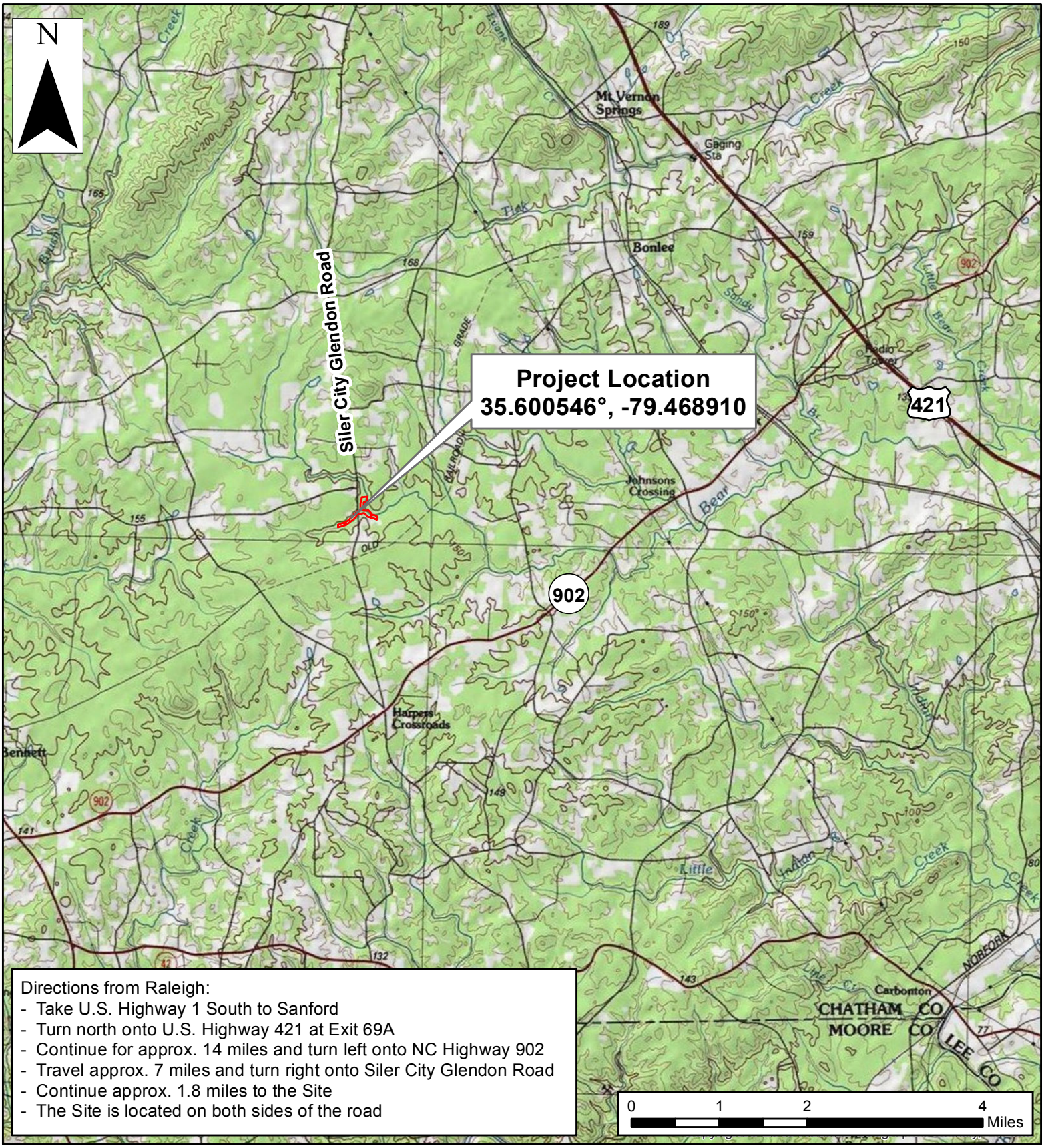
Schafale, M.P. and A.S. Weakley. 1990. Classification of the Natural Communities of North Carolina: Third Approximation. North Carolina Natural Heritage Program, Division of Parks and Recreation, North Carolina Department of Environment, Health, and Natural Resources. Raleigh, North Carolina.

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.

Weather Underground. 2015. Station at Asheboro Airport, North Carolina (online). Available: www.wunderground.com/history/airport/KHBI/ [September 24, 2015]. Weather Underground.

APPENDIX A
PROJECT VICINITY MAP AND BACKGROUND TABLES



Prepared by:	Prepared for:	VICINITY MAP BEAR CREEK (PHILLIPS) DMS PROJECT NUMBER 26 Chatham County, North Carolina	Dwn. by. PHP/KRJ	FIGURE
Axiom Environmental, Inc.	North Carolina Department of Environmental Quality Division of Mitigation Services		Date: Oct. 2015	1
			Project: 12.004.17	

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	September 2014	November 2014
Site-Wide Supplemental Planting	--	February 2015-March 2015
Year 2 Monitoring	September 2015	October 2015
Year 3 Monitoring	September 2016	October 2016
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	Carolina Silvics, Inc. 908 Indian Trail Road Edenton, NC 27932 Mary-Margaret S. McKinney 252-482-8491
As-built Surveyor	Stewart-Proctor Engineering and Surveying 319 Chapanoke Road Raleigh, NC 27603 Herb Proctor 919-779-1855
Baseline Data Collection and Annual Monitoring	Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis 919-215-1693

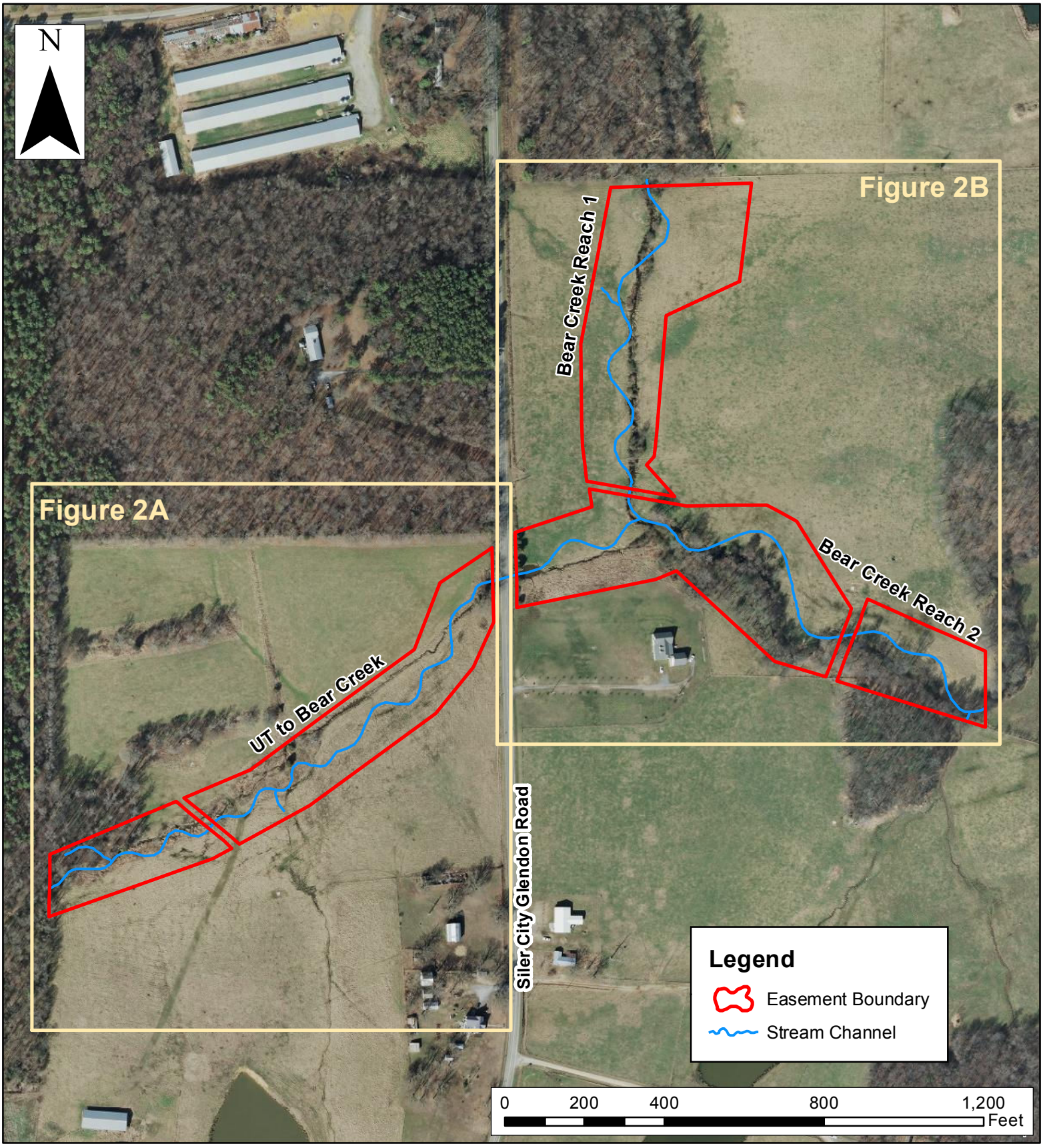
Table 4. Project Attribute Table
Bear Creek (Phillips Site) Restoration Project

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)

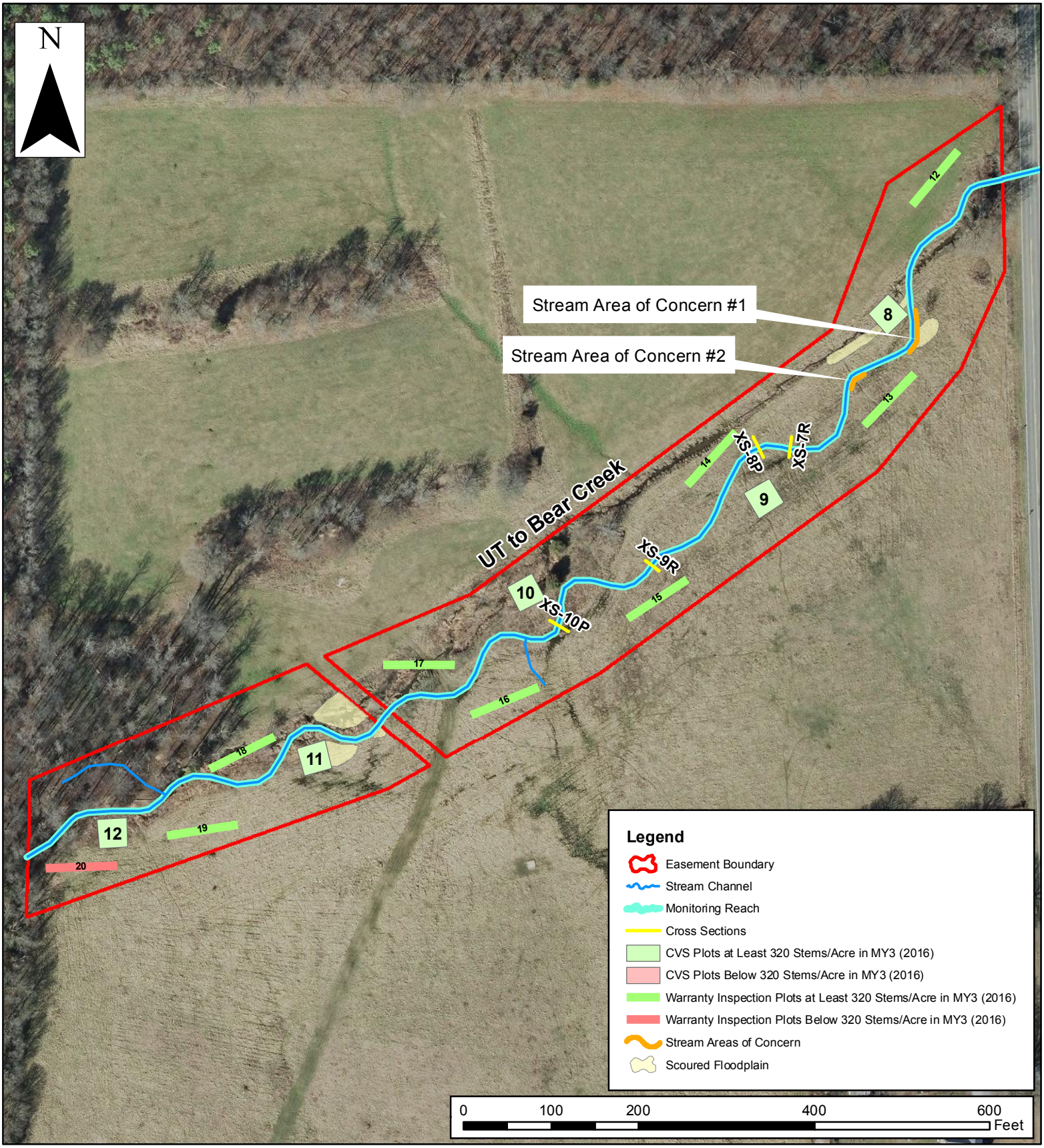
APPENDIX B

VISUAL ASSESSMENT DATA

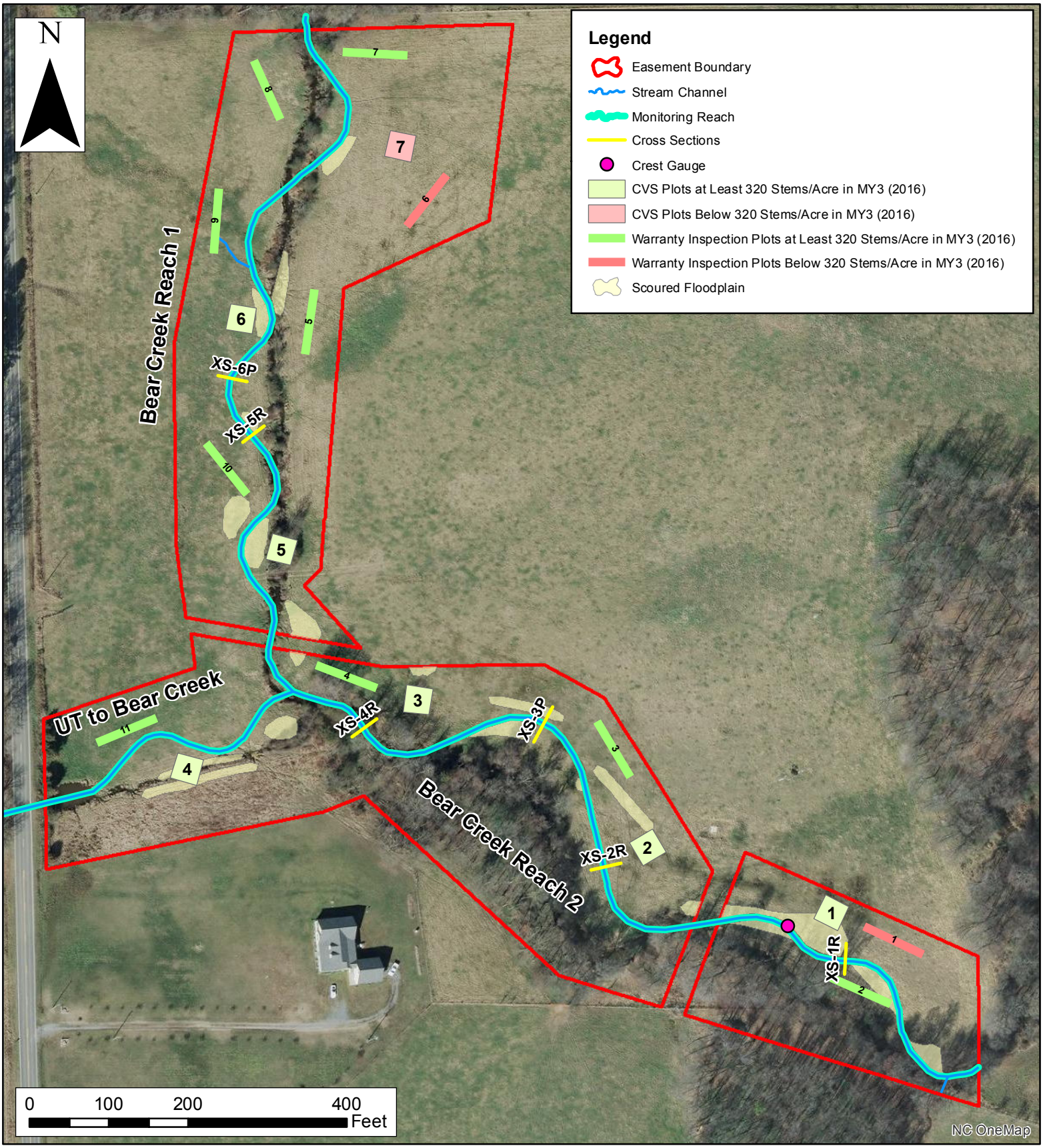
Figures 2 and 2A-2B. Current Conditions Plan View (CCPV)
Tables 5A-5C. Visual Stream Morphology Stability Assessment
Table 6. Vegetation Condition Assessment
Vegetation Plot Photographs



Prepared by: Axiom Environmental, Inc.	Prepared for: North Carolina Department of Environmental Quality, Division of Mitigation Services	CURRENT CONDITIONS PLAN VIEW BEAR CREEK (PHILLIPS) DMS PROJECT NUMBER 26 Chatham County, North Carolina	Dwn. by. PHP/KRJ Date: Sept 2016 Project: 12.004.17	FIGURE 2



Prepared by: Axiom Environmental, Inc.	Prepared for: North Carolina Department of Environmental Quality Division of Mitigation Services	CURRENT CONDITIONS PLAN VIEW BEAR CREEK (PHILLIPS) DMS PROJECT NUMBER 26 Chatham County, North Carolina	Dwn. by. PHP/KRJ Date: Sept 2016 Project: 12.004.17	FIGURE 2A



Prepared by: Axiom Environmental, Inc.	Prepared for: North Carolina Department of Environmental Quality, Division of Mitigation Services	CURRENT CONDITIONS PLAN VIEW BEAR CREEK (PHILLIPS) DMS PROJECT NUMBER 26 Chatham County, North Carolina	Dwn. by. PHP/KRJ Date: Sept 2016 Project: 12.004.17	FIGURE 2B

Table 5A **Visual Stream Morphology Stability Assessment**
Reach ID **Bear Creek - Reach 1 (Upstream)**
Assessed Length **966**

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

Table 5B **Visual Stream Morphology Stability Assessment**
Reach ID **Bear Creek - Reach 2 (Downstream)**
Assessed Length **1179**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	10	10			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	10	10			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	10	10			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	10	10			100%			
		2. Thalweg centering at downstream of meander (Glide)	9	9			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100%			100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	0	0	100%	0	0	100%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	15	15			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	15	15			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	15	15			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	15	15			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	15	15			100%			

Table 5C **Visual Stream Morphology Stability Assessment**
Reach ID **UT to Bear Creek**
Assessed Length **1937**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. **Vertical Stability** (Riffle and Run units)	1. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars)			0	0	100%			
		2. Degradation - Evidence of downcutting			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	24	24			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	24	24			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	24	24			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	24	24			100%			
		2. Thalweg centering at downstream of meander (Glide)	24	24			100%			
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			2	35	99%			99%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%			100%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%			100%
				Totals	2	35	99%	0	0	99%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	30	30			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	30	30			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	30	30			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in EEP monitoring guidance document)	30	30			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	30	30			100%			

BEAR CREEK (PHILLIPS)

Table 6 Vegetation Condition Assessment

Planted Acreage[1] **14.42**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of planted woody and herbaceous material on floodplain	0.1 acres	Yellow Polygon	26	0.65	4.5%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on visual observations and MY2 stem count criteria.	0.1 acres	N/A	0	0.00	0.0%
			Total		0.65	4.5%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	0.25 acres	N/A	0	0.00	0.0%
			Cumulative Total	0	0.65	4.5%

Easement Acreage[2] **14.42**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern[4]	N/A	1000 SF	N/A	0	0.00	0.0%
5. Easement Encroachment Areas[3]	N/A	none	N/A	0	0.00	0.0%

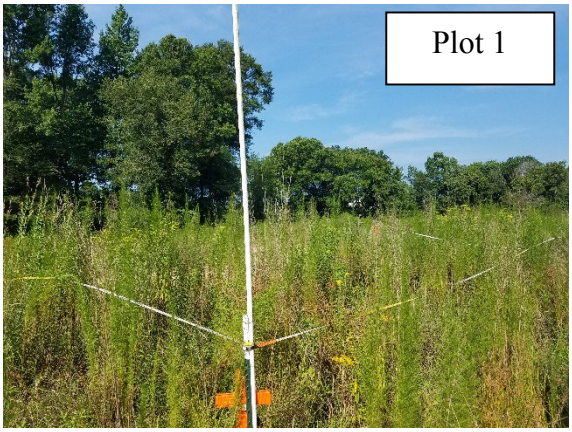
1 = Enter the planted acreage within the easement. This number is calculated as the easement acreage minus any existing mature tree stands that were not subject to supplemental planting of the understory, the channel acreage, crossings or any other elements not directly planted as part of the project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

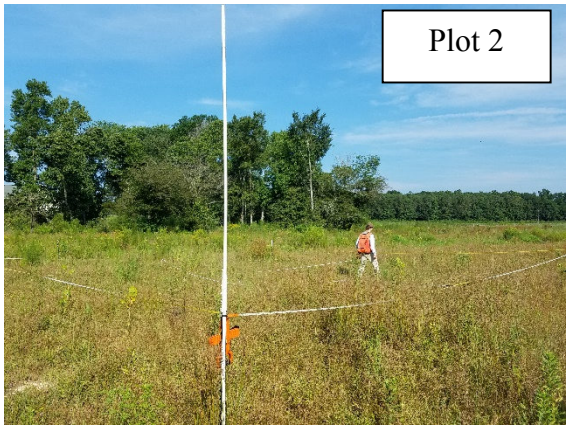
2 = The acreage within the easement boundaries.

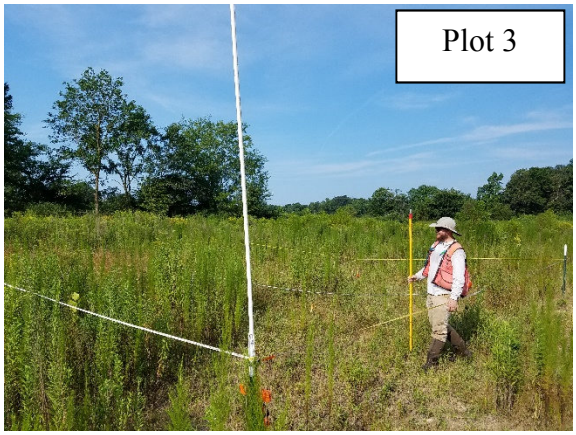
3 = Encroachment may occur within or outside of planted areas and will therefore be calculated against the overall easement acreage. In the event a polygon is cataloged into items 1, 2 or 3 in the table and is the result of encroachment, the associated acreage should be tallied in the relevant item (i.e.,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

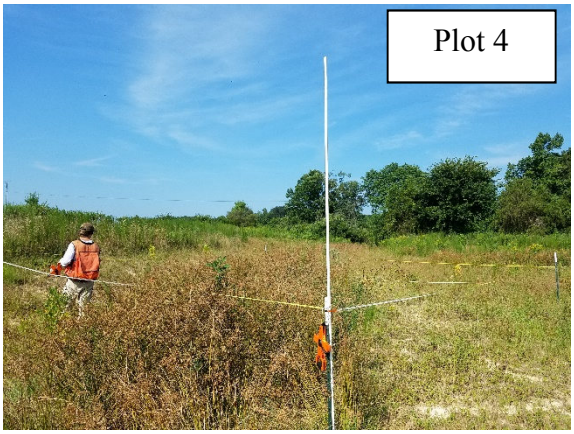
4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody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

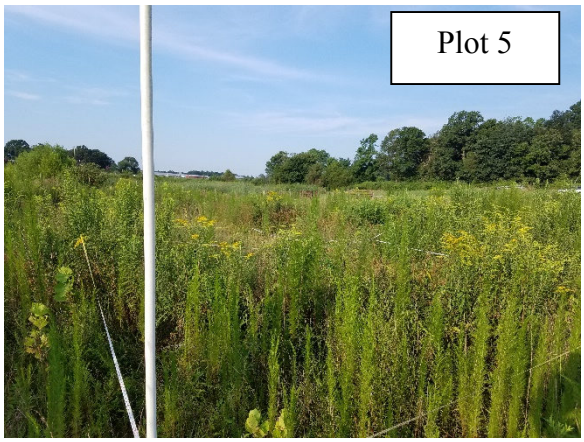
Bear Creek (Phillips Site)
Vegetation Monitoring Photographs
Taken July 2016

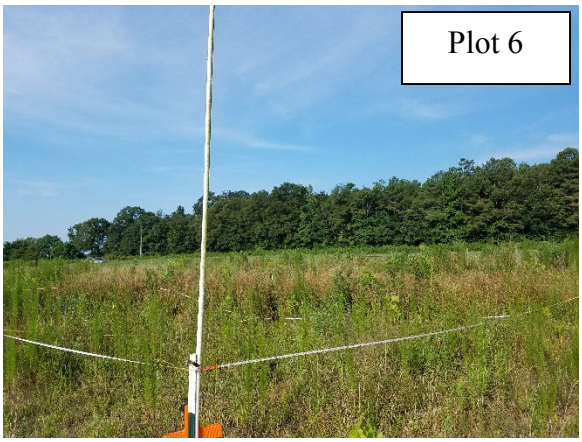




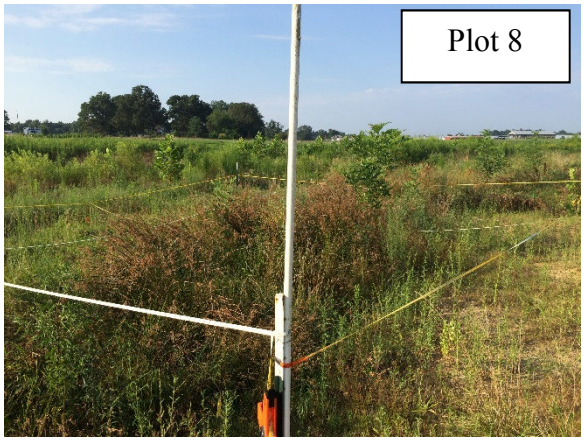


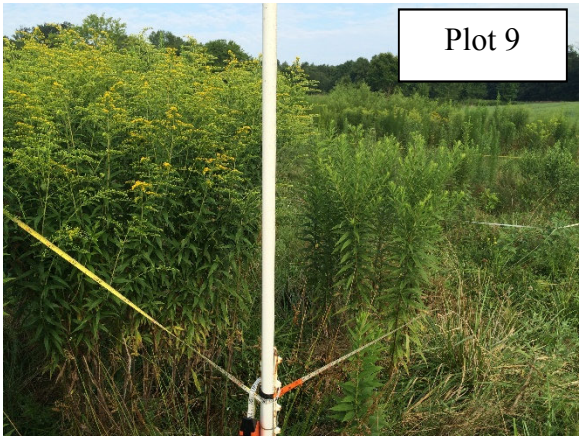


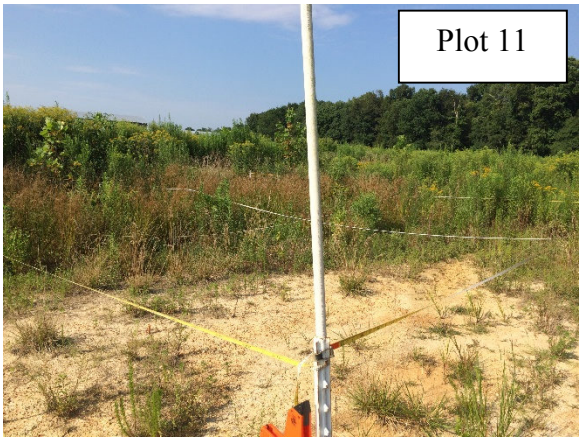


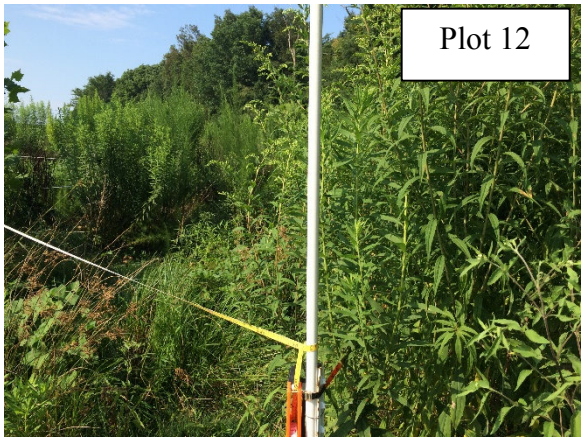


Bear Creek (Phillips Site)
Vegetation Monitoring Photographs
Taken July 2016
(continued)









APPENDIX C

VEGETATION PLOT DATA

Table 7. 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 8. Vegetation Plot Success by Plot Type
Bear Creek (Phillips Site) (#26)

Plot #	Riparian Buffer Stems[1]	Stream/ Wetland Stems[2]	Live Stakes	Invasives	Volunteers[3]	Total[4]
1	n/a	14	0	0	12	**26**
2	n/a	14	0	0	2	**16**
3	n/a	12	0	0	4	**16**
4	n/a	8	0	0	1	**9**
5	n/a	13	0	0	2	**15**
6	n/a	16	0	0	2	**18**
7	n/a	7	0	0	4	**11**
8	n/a	17	0	0	2	**19**
9	n/a	13	0	0	6	**19**
10	n/a	13	0	0	4	**17**
11	n/a	11	0	0	6	**17**
12	n/a	10	0	0	6	**16**

Stem Class	**characteristics**
[1]Buffer Stems	Native planted hardwood trees. Does NOT include shrubs. No pines. No vines.
[2]Stream/ Wetland Stems	Native planted woody stems. Includes shrubs, does NOT include live stakes. No vines
[3]Volunteers	Native woody stems. Not planted. No vines.
[4]Total	Planted + volunteer native woody stems. Includes live stakes. Excl. exotics. Excl. vines.

Table 9. Total and Planted Stems By Plot and Species
DMS Project Code 26. Project Name: Bear Creek (Phillips Site)

			Current Plot Data (MY3 2016)																					
			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
Acer negundo	boxelder	Tree																					1			
Acer rubrum	red maple	Tree			4																					
Baccharis halimifolia	eastern baccharis	Shrub			1						3												1			
Betula nigra	river birch	Tree	1	1	1							1	1	1	1	1	1	3	3	3	2	2	2	1	1	1
Carpinus caroliniana	American hornbeam	Tree	1	1	1																					
Carya	hickory	Tree																		1						
Celtis laevigata	sugarberry	Tree															1									
Cercis canadensis	eastern redbud	Tree																					1			
Diospyros virginiana	common persimmon	Tree																			1	1	1			
Fraxinus pennsylvanica	green ash	Tree	3	3	3	3	3	3	3	3	3	1	1	1	2	2	2	2	2	2	1	1	1	7	7	7
Liquidambar styraciflua	sweetgum	Tree			5																					
Liriodendron tulipifera	tuliptree	Tree	2	2	2	1	1	1				1	1	1												
Photinia pyrifolia	red chokeberry	Shrub	1	1	1	3	3	3							1	1	1							2	2	2
Pinus taeda	loblolly pine	Tree						2						1			1			1						2
Platanus occidentalis	American sycamore	Tree	1	1	1	5	5	5	1	1	1	2	2	2	5	5	5	6	6	6	1	1	1	2	2	2
Quercus	oak	Tree	1	1	1																					
Quercus michauxii	swamp chestnut oak	Tree	3	3	3	2	2	2	6	6	6				2	2	2	2	2	2	2	2	2	3	3	3
Quercus phellos	willow oak	Tree	1	1	1							1	1	1	1	1	1	1	1	1				2	2	2
Salix nigra	black willow	Tree			1																					
Ulmus americana	American elm	Tree			1				1	1	2	1	1	1	1	1	1	2	2	2			1			
Viburnum	viburnum	Shrub																								
Viburnum dentatum	southern arrowwood	Shrub							1	1	1	1	1	1												
	Stem count		14	14	26	14	14	16	12	12	16	8	8	9	13	13	15	16	16	18	7	7	11	17	17	19
	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		9	9	14	5	5	6	5	5	6	7	7	8	7	7	9	6	6	8	5	5	9	6	6	7
	Stems per ACRE		566.6	566.6	1052	566.6	566.6	647.5	485.6	485.6	647.5	323.7	323.7	364.2	526.1	526.1	607	647.5	647.5	728.4	283.3	283.3	445.2	688	688	768.9

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%

Table 9. Total and Planted Stems By Plot and Species (continued)
DMS Project Code 26. Project Name: Bear Creek (Phillips Site)

			Current Plot Data (MY3 2016)												Annual Means											
			026-01-0009			026-01-0010			026-01-0011			026-01-0012			MY3 (2016)			MY2 (2015)			MY1 (2014)			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	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer negundo	boxelder	Tree															1									
Acer rubrum	red maple	Tree															4									
Baccharis halimifolia	eastern baccharis	Shrub			1			1			3						10			1						
Betula nigra	river birch	Tree	2	2	2	3	3	3	6	6	6	2	2	2	22	22	22	15	15	15	14	14	14	26	26	26
Carpinus caroliniana	American hornbeam	Tree													1	1	1									
Carya	hickory	Tree															1									
Celtis laevigata	sugarberry	Tree															1									
Cercis canadensis	eastern redbud	Tree															1									
Diospyros virginiana	common persimmon	Tree													1	1	1	1	1	1						
Fraxinus pennsylvanica	green ash	Tree	4	4	4	2	2	2							28	28	28	28	28	28	18	18	18	18	18	18
Liquidambar styraciflua	sweetgum	Tree			2									5			12			2			3			
Liriodendron tulipifera	tuliptree	Tree	1	1	1	1	1	1							6	6	6	9	9	9				1	1	1
Photinia pyrifolia	red chokeberry	Shrub													7	7	7	7	7	7	7	7	7	8	8	8
Pinus taeda	loblolly pine	Tree						3									10			1						
Platanus occidentalis	American sycamore	Tree				2	2	2	2	2	2	3	3	3	30	30	30	20	20	20	19	19	19	22	22	22
Quercus	oak	Tree	1	1	1										2	2	2	2	2	2	5	5	5	56	56	56
Quercus michauxii	swamp chestnut oak	Tree	2	2	2				1	1	1	2	2	2	25	25	25	26	26	26	7	7	7	3	3	3
Quercus phellos	willow oak	Tree				3	3	3	2	2	2	2	2	2	13	13	13	17	17	17	15	15	15	2	2	2
Salix nigra	black willow	Tree															1									
Ulmus americana	American elm	Tree	3	3	6	1	1	1			3	1	1	2	10	10	20	17	17	17	5	5	6			
Viburnum	viburnum	Shrub																1	1	1	1	1	1	4	4	4
Viburnum dentatum	southern arrowwood	Shrub				1	1	1							3	3	3	2	2	2	2	2	2	1	1	1
		Stem count	13	13	19	13	13	17	11	11	17	10	10	16	148	148	199	145	145	149	93	93	97	141	141	141
		size (ares)	1			1			1			1			12			12			12			12		
		size (ACRES)	0.02			0.02			0.02			0.02			0.30			0.30			0.30			0.30		
		Species count	6	6	8	7	7	9	4	4	6	5	5	6	12	12	21	12	12	15	10	10	11	10	10	10
		Stems per ACRE	526.1	526.1	768.9	526.1	526.1	688	445.2	445.2	688	404.7	404.7	647.5	499.1	499.1	671.1	489	489	502.5	313.6	313.6	327.1	475.5	475.5	475.5

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%

Table 10. Vegetation Warranty Assessment Plot Data
Bear Creek (Phillips Site) Restoration Project

Warranty Plot #	Stem Count	Stems Per Acre
1	7	283.40
2	9	364.37
3	13	526.32
4	13	526.32
5	13	526.32
6	7	283.40
7	13	526.32
8	12	485.83
9	11	445.34
10	16	647.77
11	15	607.29
12	14	566.80
13	15	607.29
14	9	364.37
15	16	647.77
16	10	404.86
17	12	485.83
18	8	323.89
19	9	364.37
20	5	202.43
	Total Stems	459.51

Appendix D.
Stream Geomorphology Data

Tables 11a-11f. Baseline Stream Data Summary
Tables 12a-12f. Monitoring Data-Dimensional Data Summary
Cross-section Plots
Longitudinal Profile Plots
Substrate Plots

Table 11a. Baseline Stream Data Summary (Bear Creek Reach 1)
Bear Creek (Phillips Site) Restoration Project - DMS 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 pattern 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 pattern 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 11b. Baseline Stream Data Summary (Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)
Bear Creek (Phillips Site) Restoration Project - DMS 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 11c. Baseline Stream Data Summary (Bear Creek Reach 2)
Bear Creek (Phillips Site) Restoration Project - DMS 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 11d. Baseline Stream Data Summary (Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)
Bear Creek (Phillips Site) Restoration Project - DMS 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 11e. Baseline Stream Data Summary (UT to Bear Creek)
Bear Creek (Phillips Site) Restoration Project - DMS 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 pattern 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 pattern 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 11f. Baseline Stream Data Summary (Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)
Bear Creek (Phillips Site) Restoration Project - DMS 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 12a. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)
Bear Creek (Phillips Site) Restoration Project - DMS Project Number 26

Parameter	Cross Section 1 (Reach 2 - Downstream) Riffle							Cross Section 2 (Reach 2 - Downstream) Riffle							Cross Section 3 (Reach 2 - Downstream) Pool							Cross Section 4 (Reach 2 - Downstream) 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	28.5	26.3	25.9				29.3	29.4	28.8	28.2				30.1	32.2	30.4	29.5				27.2	27.4	29.0	31.5			
Floodprone Width (ft) (approx)	250.0	250.0	250.0	250.0				250.0	250.0	250.0	250.0				NA	NA	NA	NA				250.0	250.0	250.0	250.0			
BF Mean Depth (ft)	1.8	1.8	1.7	1.7				2.1	1.9	2.0	2.0				2.3	2.3	2.2	2.3				1.8	1.8	1.9	1.7			
BF Max Depth (ft)	2.7	2.6	2.4	2.3				3.4	3.1	3.2	3.3				4.6	4.7	4.5	4.5				2.7	2.8	2.9	2.9			
BF Cross Sectional Area (ft^2)	52.9	51.3	44.3	43.5				61.1	57.3	57.2	56.9				70.0	72.7	67.7	67.3				48.8	50.4	54.1	54.9			
Width/Depth Ratio	15.9	15.8	15.7	15.4				14.1	15.1	14.5	14.0				NA	NA	NA	NA				15.2	14.9	15.5	18.1			
Entrenchment Ratio	8.6	8.8	9.5	9.7				8.5	8.5	8.7	8.9				NA	NA	NA	NA				9.2	9.1	8.6	7.9			
Bank Height Ratio	1.0	1.0	1.0	1.0				1.0	1.0	1.0	1.0				1.0	1.0	1.0	1.0				1.0	1.0	1.0	1.0			
d50 (mm)	22.7	26.5	25.7	21.1				45.0	39.6	49.1	30.1				----	----	----	----				22.8	8.7	34.3	33.4			

Table 12b. Monitoring Data - Stream Reach Data Summary
Bear Creek (Phillips Site) Restoration Project - DMS 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	27.4	28.4	28.5	29.4	1	26.3	28.0	28.8	29	1.5	25.9	28.5	28.2	31.5	2.8									
Floodprone Width (ft)		250					250				.	250					250												
BF Mean Depth (ft)	1.8	1.9	1.8	2.1	0.2	1.8	1.8	1.8	1.9	0.1	1.7	1.9	1.9	2.0	0.2	1.7	1.8	1.7	2.0	0.2									
BF Max Depth (ft)	2.7	2.9	2.7	3.4	0.4	2.6	2.8	2.8	3.1	0.3	2.4	2.8	2.9	3.2	0.4	2.3	2.8	2.9	3.3	0.5									
BF Cross Sectional Area (ft^2)	48.8	54.3	52.9	61.1	6.3	50.4	53.0	51.3	57.3	3.8	44.3	51.9	54.1	57.2	6.7	43.5	51.8	54.9	56.9	7.2									
Width/Depth Ratio	14.0	15.1	15.0	16.1	1.1	15.2	15.5	15.5	15.8	0.3	14.4	15.0	15.3	15.5	0.6	14.1	16.0	15.2	18.5	2.3									
Entrenchment Ratio	8.5	8.8	8.6	9.2	0.4	8.5	8.8	8.8	9.1	0.3	8.6	8.9	8.7	9.5	0.5	7.9	8.8	8.9	9.7	0.9									
Bank Height Ratio		1.0					1.0					1.0					1.0												
Profile - Downstream Reach 2																													
Riffle length (ft)	19	45	41	78	19	18	60	52	127	37	9	52	52	106	31	20	44	37	84	20									
Riffle slope (ft/ft)	0.0005	0.0052	0.0037	0.0091	0.0033	0.0000	0.0048	0.0051	0.0088	0.0030	13.1970	0.0043	0.0034	0.0078	0.0025	0.0016	0.0058	0.0044	0.0108	0.0032									
Pool length (ft)	8	33	39	48	14	11	32	36	42	11	13	33	33	56	12	9	35	35	60	15									
Pool Max depth (ft)		4.6					4.7					3.5					4.5												
Pool spacing (ft)	68	107	102	150	30	82	122	100	215	48	74	123	102	197	45	72	107	99	157	31									
..																													
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					C-Type					C-Type					C-Type													
Channel Thalweg Length (ft)	946					939					999.8					1017													
Sinuosity	1.2					1.2					1.2					1.2													
Water Surface Slope (Channel) (ft/ft)	0.0019					0.002					0.0017					0.0023													
BF slope (ft/ft)	----					----					----					----													
Ri%/RU%P%G%/S%	47	16	21	16		50	14	27	9		42	18	27	13		41	14	32	13										
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 12c. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)
Bear Creek (Phillips Site) Restoration Project - DMS 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	24.1	24.1	24.6				26.9	29.1	28.1	29.2			
Floodprone Width (ft) (approx)	250.0	250.0	250.0	250.0				NA	NA	NA	NA			
BF Mean Depth (ft)	1.8	1.7	1.7	1.7				2.1	1.9	1.9	1.9			
BF Max Depth (ft)	2.8	2.7	2.6	2.7				3.4	3.5	3.5	3.4			
BF Cross Sectional Area (ft^2)	42.3	41.5	41.6	40.8				55.4	56.3	52.6	55.3			
Width/Depth Ratio	13.4	14.0	14.0	14.8				NA	NA	NA	NA			
Entrenchment Ratio	10.5	10.4	10.4	10.2				NA	NA	NA	NA			
Bank Height Ratio	1.0	1.0	1.0	1.0				1.0	1.0	1.0	1.0			
d50 (mm)	9.4	13.3	9.9	8.0				----	----	----	----			

Table 12d. Monitoring Data - Stream Reach Data Summary
Bear Creek (Phillips Site) Restoration Project - DMS 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					24.1					24.1					24.6												
Floodprone Width (ft)			250					250					250					250.0												
BF Mean Depth (ft)			1.8					1.7					1.7					1.7												
BF Max Depth (ft)			2.8					2.7					2.6					2.7												
BF Cross Sectional Area (ft^2)			42.3					41.5					41.6					40.8												
Width/Depth Ratio			13.3					14.0					11.7					14.8												
Entrenchment Ratio			10.5					10.4					10.4					10.2												
Bank Height Ratio			1.0					1.0					1.0					1.0												
Profile - Reach 1 - Upstream																														
Riffle length (ft)	18	57	45	118	35	18	68	41	156	52	12.8	66.7	48	156.5	48.7	30	56	44	102	27										
Riffle slope (ft/ft)	0.0004	0.0053	0.0047	0.0107	0.0039	0.0000	0.0061	0.0035	0.0266	0.0090	0.0000	0.0048	0.0045	0.0016	0.0006	0.0000	0.0042	0.0035	0.0087	0.0030										
Pool length (ft)	5	26	20	64	18	15	35	29	69	21	17	39	35	69	22	17	44	31	109	33										
Pool Max depth (ft)		3.4					3.5					3.5					3.5												
Pool spacing (ft)	60	115	116	198	42	66	147	127	283	76	63	148	120	302	86	71	127	113	199	50										
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					C-Type					C-Type					C-Type														
Channel Thalweg Length (ft)	1088					1073					1175.4					1162														
Sinuosity	1.2					1.2					1.2					1.2														
Water Surface Slope (Channel) (ft/ft)	0.0017					0.0014					0.0014					0.002														
BF slope (ft/ft)	----					----					----					----														
Ri%/RU%P%G%/S%	37	15	24	9		50	15	22	12		46	16	26	10		44	11	34	11											
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 12e. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)
Bear Creek (Phillips Site) Restoration Project - DMS 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	11.7	11.9	12.2				16.3	15.2	18.4	17.0				11.4	11.4	10.5	10.5				14.2	16.3	14.7	13.8			
Floodprone Width (ft) (approx)	80.0	80.0	80.0	80.0				NA	NA	NA	NA				80.0	80.0	80.0	80.0				NA	NA	NA	NA			
BF Mean Depth (ft)	0.9	0.9	1.0	1.0				1.4	1.5	1.3	1.4				0.9	0.9	0.8	0.8				1.3	1.2	1.3	1.2			
BF Max Depth (ft)	1.6	1.6	1.5	1.6				2.8	3.0	3.0	3.0				1.4	1.4	1.3	1.4				2.3	2.3	2.3	2.2			
BF Cross Sectional Area (ft^2)	11.8	11.1	11.8	11.6				22.2	23.0	23.2	23.3				10.0	9.9	8.5	8.3				18.4	19.0	18.7	16.5			
Width/Depth Ratio	13.2	12.3	12.0	12.8				NA	NA	NA	NA				13.0	13.1	12.9	13.3				NA	NA	NA	NA			
Entrenchment Ratio	6.4	6.8	6.7	6.6				NA	NA	NA	NA				7.0	7.0	7.6	7.6				NA	NA	NA	NA			
Bank Height Ratio	1.0	1.0	1.0	1.0				1.0	1.0	1.0	1.0				1.0	1.0	1.0	1.0				1.0	1.0	1.0	1.0			
d50 (mm)	4.3	9.4	5.7	4.9				----	----	----	----				25.7	24.2	18.8	17.3				----	----	----	----			

Table 12f. Monitoring Data - Stream Reach Data Summary
Bear Creek (Phillips Site) Restoration Project - DMS 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	11.4	11.6	11.6	11.7	0.2	10.5	11.2	11.2	11.9	1	10.5	11.4	11.4	12.2	1.2										
Floodprone Width (ft)		80					80					80					80													
BF Mean Depth (ft)	0.9	1.0	1.0	1.0	0.1	0.9	1.0	1.0	1.0	0.1	0.8	0.9	0.9	1.0	0.1	0.8	0.9	0.9	1.0	0.1										
BF Max Depth (ft)	1.4	1.5	1.5	1.6	0.1	1.4	1.5	1.5	1.6	0.1	1.3	1.4	1.4	1.5	0.1	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	9.9	10.5	10.5	11.1	0.8	8.5	10.2	10.2	11.8	2.3	8.3	10.0	10.0	11.6	2.3										
Width/Depth Ratio	12.5	12.6	12.6	12.7	0.1	11.7	12.2	12.2	12.7	0.7	11.9	12.5	12.5	13.1	0.9	12.2	12.7	12.7	13.1	0.7										
Entrenchment Ratio	6.4	6.7	6.7	7.0	0.4	6.8	6.9	6.9	7.0	0.1	6.7	7.2	7.2	7.6	0.6	6.6	7.1	7.1	7.6	0.8										
Bank Height Ratio		1.0					1.0					1.0					1.0													
Profile - Unnamed Tributary																														
Riffle length (ft)	9	35	29	92	21	9	32	27	99	21	8	33	27.1	97.3	20.9	6	28	23	95	21										
Riffle slope (ft/ft)	0.0006	0.0081	0.0063	0.0189	0.0059	NA*	NA*	NA*	NA*	NA*	0.0000	0.0075	0.0071	0.0253	0.0063	0.0000	0.0086	0.0064	0.0260	0.01										
Pool length (ft)	4	23	19	73	15	4	21	17	47	12	2	22	17	67	14	7	25	21	72	15										
Pool Max depth (ft)	2.3	2.6	2.3	2.8		2.3	2.7	2.7	3.0		2.3	2.7	2.7	3.0		2.2	2.6	2.6	3.0	0.6										
Pool spacing (ft)	13	69	74	121	30	16	68	72	127	26	31	77	78	129	23	16	70	70	143	31										
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					C-Type					C-Type					C-Type														
Channel Thalweg Length (ft)	1971					1999					2013.7					2004														
Sinuosity	1.2					1.2					1.2					1.2														
Water Surface Slope (Channel) (ft/ft)	0.0041					NA*					0.0036					0.0044														
BF slope (ft/ft)	----					----					----					----														
Ri%/RU%P%G%/S%	44	13	33	10		46	12	30	12		43	12	30	15		37	16	35	12											
SC%/SA%/G%/C%/B%BE%																														
d16/d35/d50/d84/d95																														
% of Reach with Eroding Banks																														
Channel Stability or Habitat Metric																														
Biological or Other																														

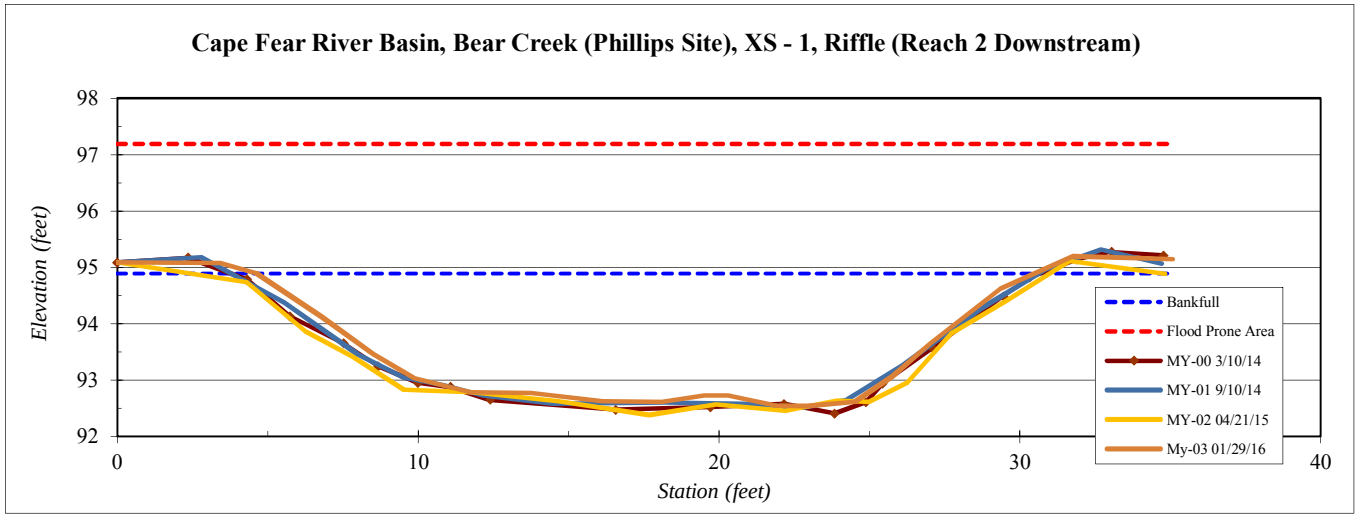
NA* No water in channel during field surveys.

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:	1/29/2016
Field Crew:	Perkinson, Keith

Station	Elevation
0.00	95.08
3.44	95.08
4.62	94.89
6.79	94.13
8.51	93.45
9.88	93.03
11.76	92.78
13.64	92.77
13.75	92.77
16.12	92.62
18.12	92.61
19.52	92.73
20.31	92.72
21.91	92.55
22.94	92.54
24.52	92.61
25.77	93.07
27.04	93.66
29.36	94.63
31.79	95.20
35.09	95.15

SUMMARY DATA	
Bankfull Elevation:	94.9
Bankfull Cross-Sectional Area:	43.5
Bankfull Width:	25.9
Flood Prone Area Elevation:	97.2
Flood Prone Width:	250.0
Max Depth at Bankfull:	2.3
Mean Depth at Bankfull:	1.7
W / D Ratio:	15.4
Entrenchment Ratio:	9.7
Bank Height Ratio:	1.0

Stream Type	C

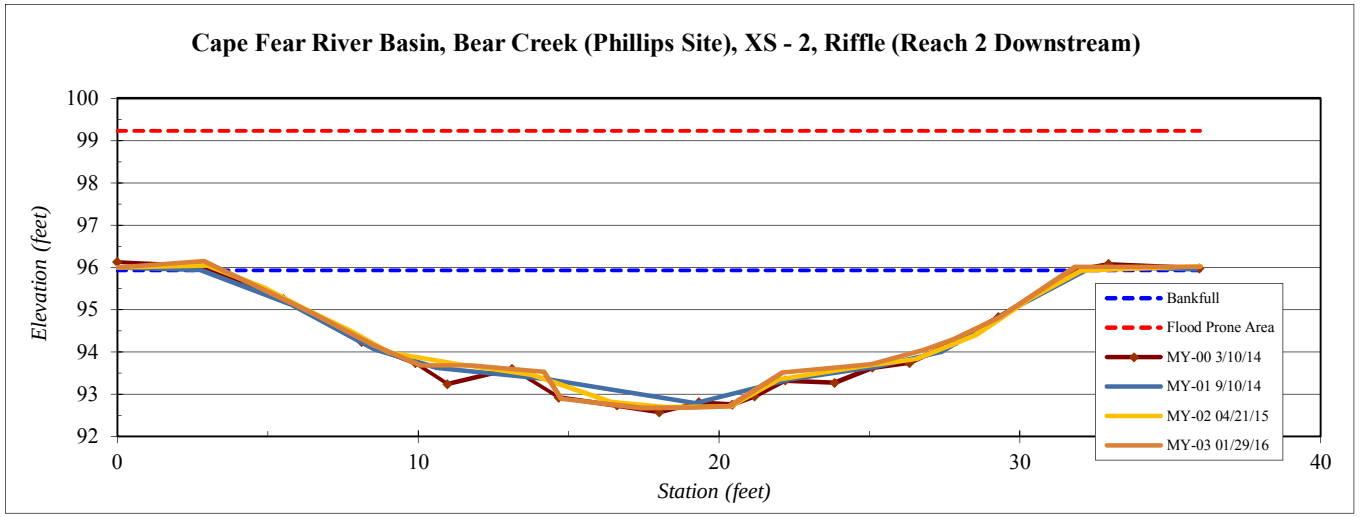


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 2, Riffle (Reach 2 Downstream)
Drainage Area (sq mi):	4.99
Date:	1/29/2016
Field Crew:	Perkinson, Keith

Station	Elevation
0.00	95.99
2.87	96.15
6.44	94.94
8.50	94.17
10.09	93.68
11.78	93.67
14.17	93.53
14.74	92.89
17.43	92.67
19.11	92.68
20.34	92.71
22.13	93.51
25.08	93.71
26.81	94.04
27.80	94.31
29.32	94.82
31.86	96.02
36.00	96.02

SUMMARY DATA	
Bankfull Elevation:	95.9
Bankfull Cross-Sectional Area:	56.9
Bankfull Width:	28.2
Flood Prone Area Elevation:	99.2
Flood Prone Width:	250.0
Max Depth at Bankfull:	3.3
Mean Depth at Bankfull:	2.0
W / D Ratio:	14.0
Entrenchment Ratio:	8.9
Bank Height Ratio:	1.0

Stream Type	C

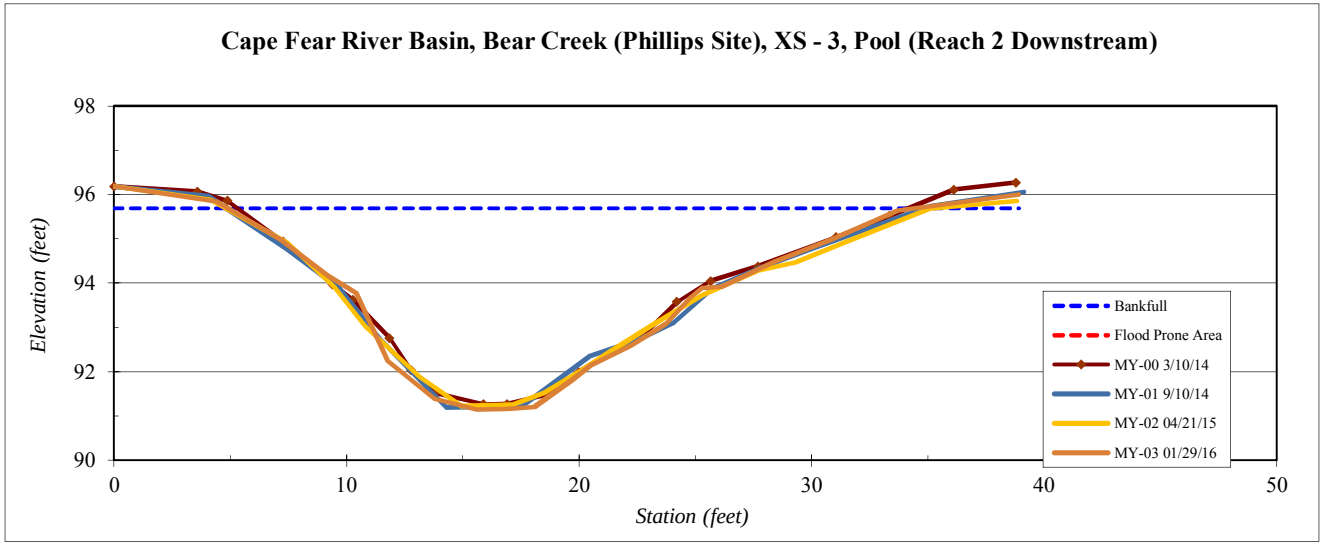


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 3, Pool (Reach 2 Downstream)
Drainage Area (sq mi):	4.99
Date:	1/29/2016
Field Crew:	Perkinson, Keith

Station	Elevation
0.0	96.2
4.4	95.8
7.2	95.0
9.2	94.2
10.4	93.8
11.8	92.2
13.8	91.4
15.6	91.1
16.9	91.2
18.1	91.2
19.7	91.8
20.6	92.2
22.2	92.6
23.7	93.09
24.8	93.65
25.3	93.89
26.1	93.92
28.4	94.48
30.9	94.99
33.7	95.64
38.9	96.00

SUMMARY DATA	
Bankfull Elevation:	95.7
Bankfull Cross-Sectional Area:	67.3
Bankfull Width:	29.5
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	4.5
Mean Depth at Bankfull:	2.3
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	1.0

Stream Type	C

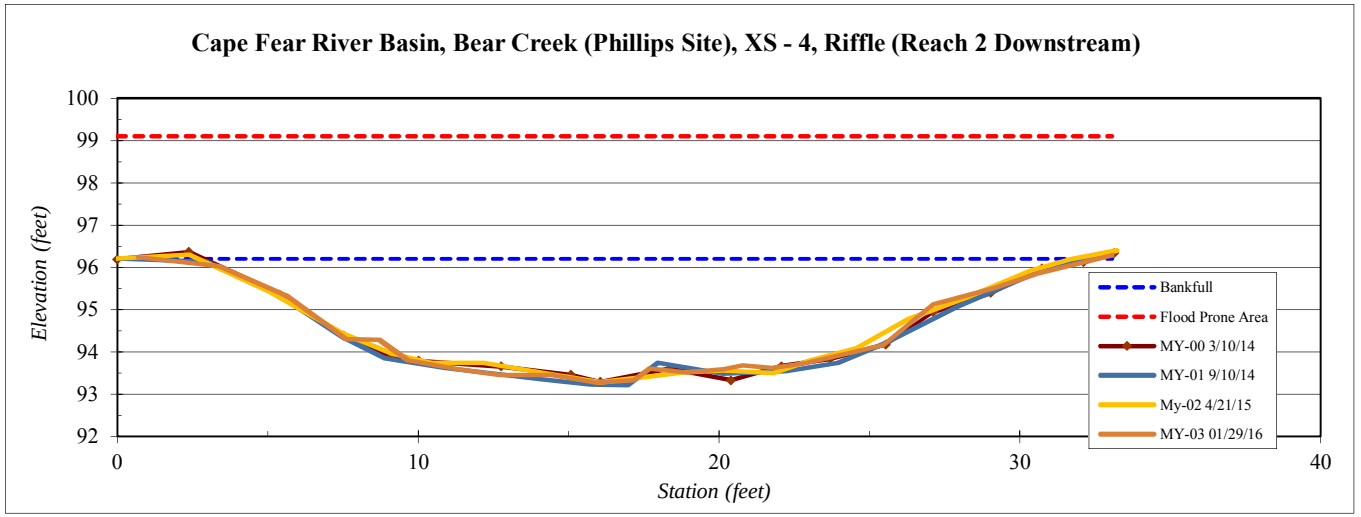


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 4, Riffle (Reach 2 Downstream)
Drainage Area (sq mi):	4.99
Date:	1/29/2016
Field Crew:	Perkinson, Keith

Station	Elevation
0.70	96.23
3.39	96.03
5.61	95.33
7.61	94.30
8.70	94.28
9.66	93.80
11.33	93.58
12.71	93.46
14.44	93.45
15.94	93.27
17.19	93.34
17.70	93.61
18.93	93.52
20.15	93.59
20.79	93.68
21.76	93.62
22.83	93.73
24.50	93.99
25.48	94.16
27.12	95.11
29.18	95.51
30.63	95.86
33.07	96.29

SUMMARY DATA	
Bankfull Elevation:	96.2
Bankfull Cross-Sectional Area:	54.9
Bankfull Width:	31.5
Flood Prone Area Elevation:	99.1
Flood Prone Width:	250.0
Max Depth at Bankfull:	2.9
Mean Depth at Bankfull:	1.7
W / D Ratio:	18.1
Entrenchment Ratio:	7.9
Bank Height Ratio:	1.0

Stream Type	C

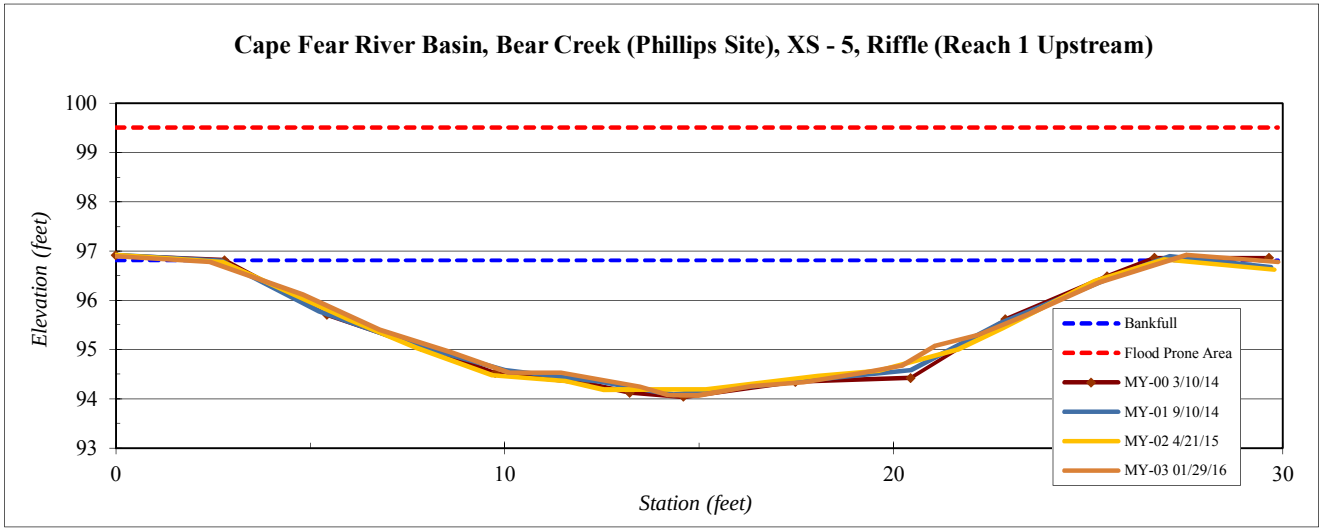


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 5, Riffle (Reach 1 Upstream)
Drainage Area (sq mi):	4.08
Date:	1/29/2016
Field Crew:	Perkinson, Keith

Station	Elevation
0.00	96.90
2.43	96.77
4.80	96.11
6.78	95.40
8.61	94.95
10.10	94.53
11.44	94.54
13.49	94.25
14.21	94.07
14.97	94.07
16.34	94.25
17.67	94.34
19.12	94.51
20.21	94.67
21.07	95.08
22.2	95.30
23.4	95.71
25.3	96.37
27.53	96.92
29.88	96.78

SUMMARY DATA	
Bankfull Elevation:	96.8
Bankfull Cross-Sectional Area:	40.8
Bankfull Width:	24.6
Flood Prone Area Elevation:	99.5
Flood Prone Width:	250.0
Max Depth at Bankfull:	2.7
Mean Depth at Bankfull:	1.7
W / D Ratio:	14.8
Entrenchment Ratio:	10.2
Bank Height Ratio:	1.0

Stream Type	C

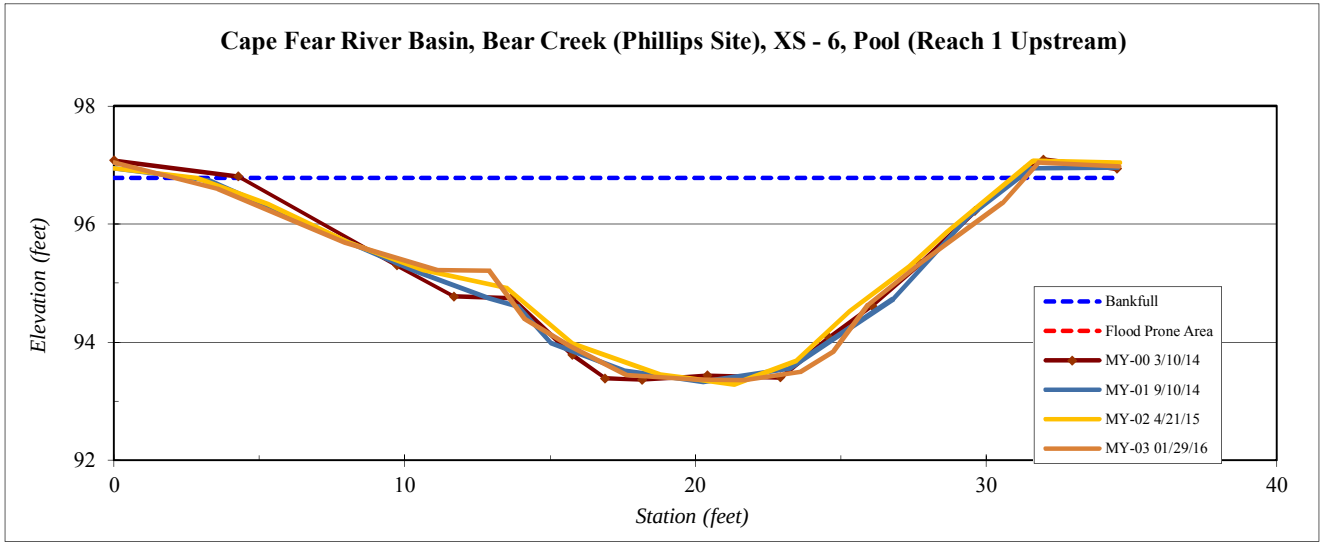


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 6, Pool (Reach 1 Upstream)
Drainage Area (sq mi):	4.08
Date:	1/29/2016
Field Crew:	Perkinson, Keith

Station	Elevation
0.0	97.0
3.6	96.6
7.9	95.7
11.1	95.2
12.9	95.2
14.1	94.4
15.7	93.9
17.6	93.4
20.0	93.4
21.7	93.4
23.6	93.5
24.8	93.8
26.0	94.6
27.8	95.35
29.4	95.91
30.6	96.36
31.8	97.04
34.6	96.97

SUMMARY DATA	
Bankfull Elevation:	96.8
Bankfull Cross-Sectional Area:	55.3
Bankfull Width:	29.2
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.4
Mean Depth at Bankfull:	1.9
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	1.0

Stream Type	C

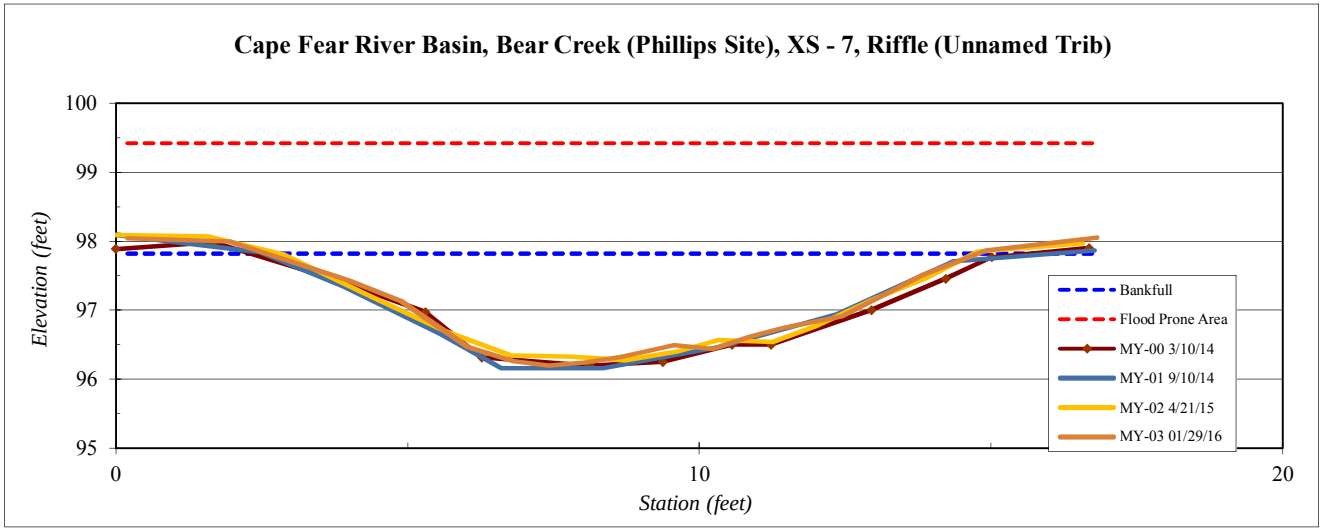


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 7, Riffle (Unnamed Trib)
Drainage Area (sq mi):	0.88
Date:	1/29/2016
Field Crew:	Perkinson, Keith

Station	Elevation
0.20	98.04
1.95	98.00
3.99	97.43
4.89	97.14
6.04	96.46
6.81	96.26
7.41	96.19
8.06	96.24
8.68	96.32
9.57	96.49
10.23	96.44
10.86	96.61
11.44	96.74
12.44	96.91
13.05	97.17
13.8	97.51
14.9	97.86
16.8	98.05

SUMMARY DATA	
Bankfull Elevation:	97.8
Bankfull Cross-Sectional Area:	11.6
Bankfull Width:	12.2
Flood Prone Area Elevation:	99.4
Flood Prone Width:	80.0
Max Depth at Bankfull:	1.6
Mean Depth at Bankfull:	1.0
W / D Ratio:	12.8
Entrenchment Ratio:	6.6
Bank Height Ratio:	1.0

Stream Type	C

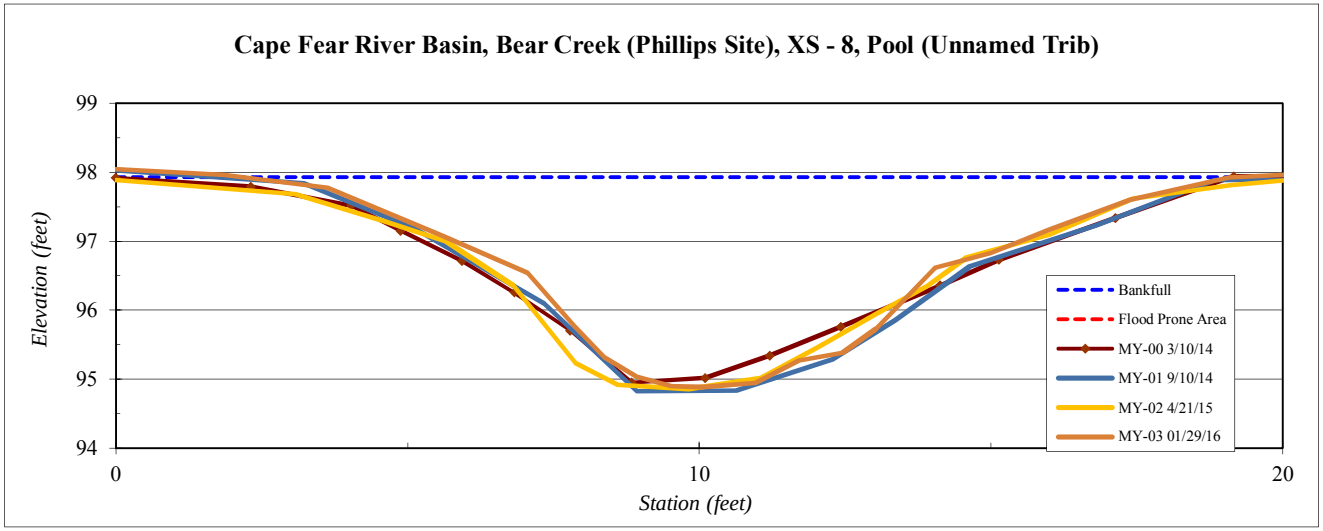


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 8, Pool (Unnamed Trib)
Drainage Area (sq mi):	0.88
Date:	1/29/2016
Field Crew:	Perkinson, Keith

Station	Elevation
0.00	98.05
1.85	97.96
3.62	97.78
5.62	97.07
7.06	96.54
7.86	95.77
8.37	95.32
8.92	95.04
9.52	94.90
10.06	94.88
10.96	94.95
11.71	95.27
12.45	95.39
13.03	95.74
14.05	96.61
15.0	96.83
16.0	97.17
17.4	97.60
19.08	97.93
22.04	98.04

SUMMARY DATA	
Bankfull Elevation:	97.9
Bankfull Cross-Sectional Area:	23.3
Bankfull Width:	17.0
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.0
Mean Depth at Bankfull:	1.4
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	1.0

Stream Type	C

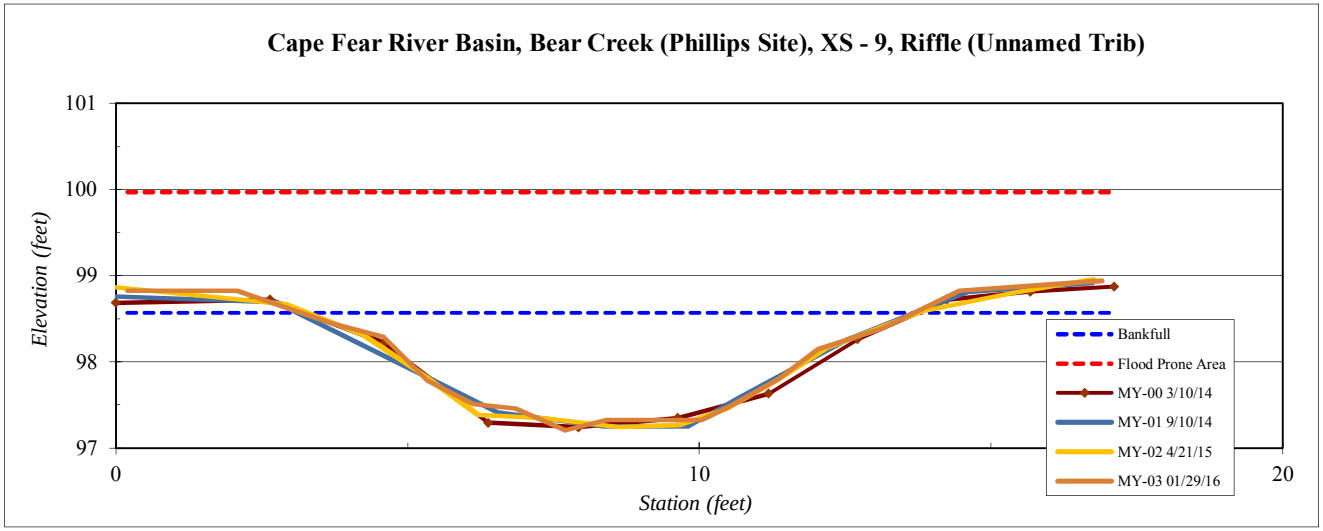


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 9, Riffle (Unnamed Trib)
Drainage Area (sq mi):	0.88
Date:	1/29/2016
Field Crew:	Perkinson, Keith

Station	Elevation
0.20	98.82
2.07	98.82
3.70	98.45
4.58	98.29
5.33	97.78
6.12	97.51
6.85	97.46
7.71	97.20
8.40	97.33
9.15	97.32
10.04	97.33
10.53	97.49
11.36	97.80
12.05	98.15
13.14	98.39
14.5	98.82
16.9	98.94

SUMMARY DATA	
Bankfull Elevation:	98.6
Bankfull Cross-Sectional Area:	8.3
Bankfull Width:	10.5
Flood Prone Area Elevation:	100.0
Flood Prone Width:	80.0
Max Depth at Bankfull:	1.4
Mean Depth at Bankfull:	0.8
W / D Ratio:	13.3
Entrenchment Ratio:	7.6
Bank Height Ratio:	1.0

Stream Type	C

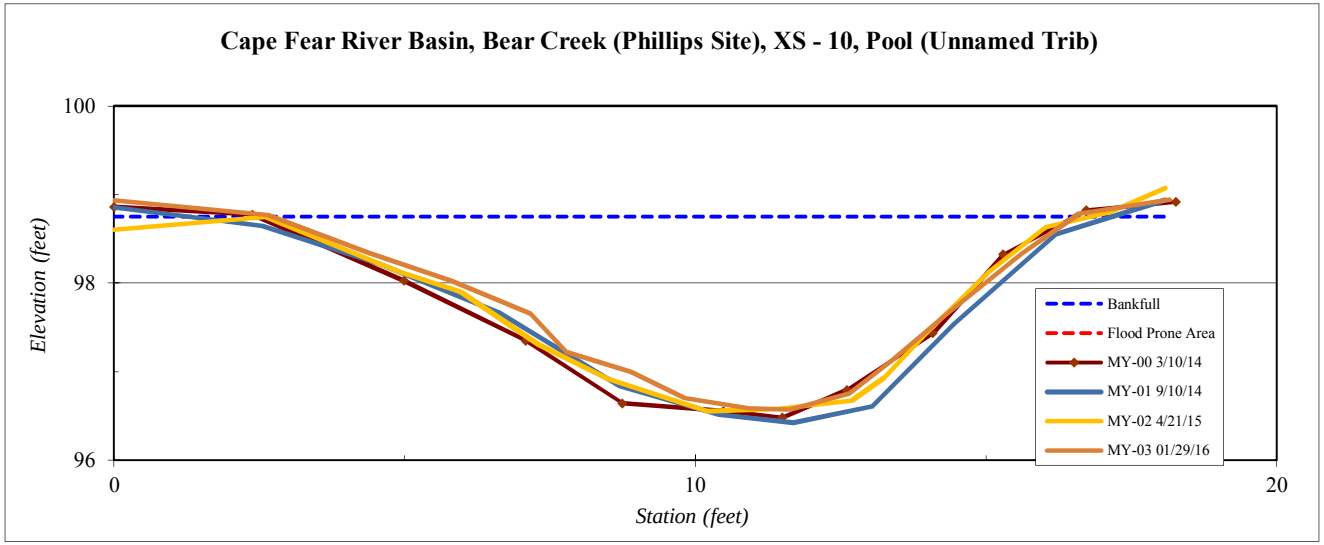


River Basin:	Cape Fear
Site Name	Bear Creek (Phillips Site)
XS ID	XS - 10, Pool (Unnamed Trib)
Drainage Area (sq mi):	0.88
Date:	1/29/2016
Field Crew:	Perkinson, Keith

Station	Elevation
0.0	98.9
2.7	98.8
4.4	98.3
5.8	98.0
7.2	97.7
7.8	97.2
8.9	97.0
9.8	96.7
10.9	96.6
11.6	96.6
12.6	96.8
13.4	97.1
14.3	97.6
15.6	98.34
16.6	98.78
18.2	98.94

SUMMARY DATA	
Bankfull Elevation:	98.8
Bankfull Cross-Sectional Area:	16.5
Bankfull Width:	13.8
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	2.2
Mean Depth at Bankfull:	1.2
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	1.0

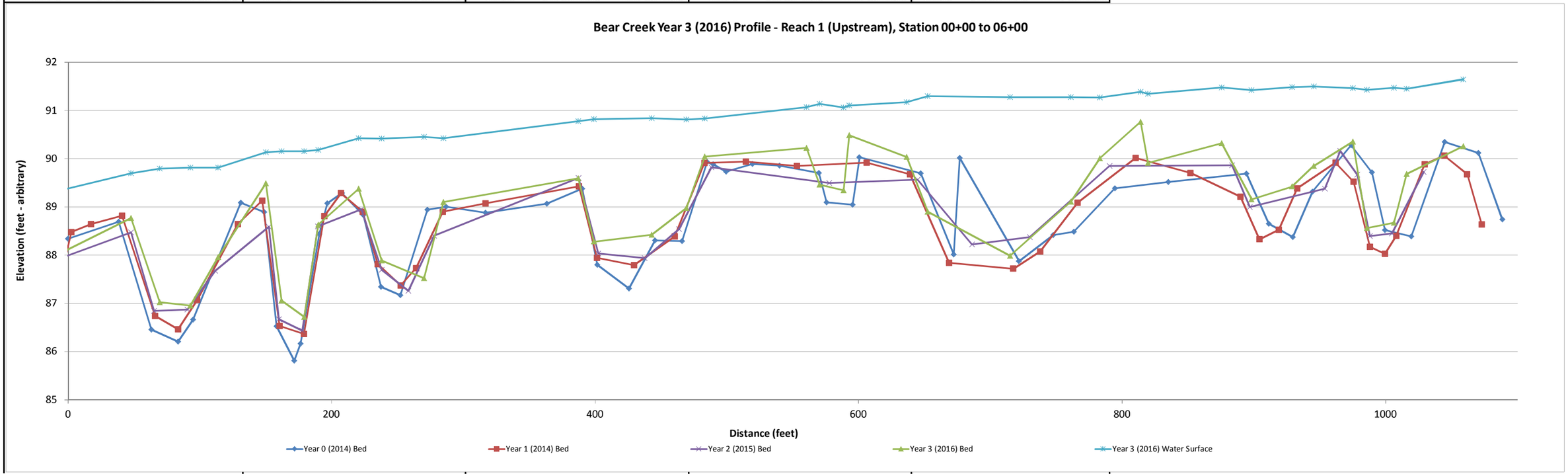
Stream Type	C



Project Name	Bear Creek - Profile
Reach	Reach 1 (Upstream) Station 00+00 - 11+00
Feature	Profile
Date	1/29/16
Crew	Perkinson, Keith

	2014	2014	2015	2016	2017
Avg. Water Surface Slope	0.0017	0.0014	0.0019	0.0020	
Riffle Length	57	68	67	56	
Avg. Riffle Slope	0.0053	0.0061	0.0048	0.0042	
Pool Length	26	35	39	44	
Pool to Pool Spacing	115	147	148	127	

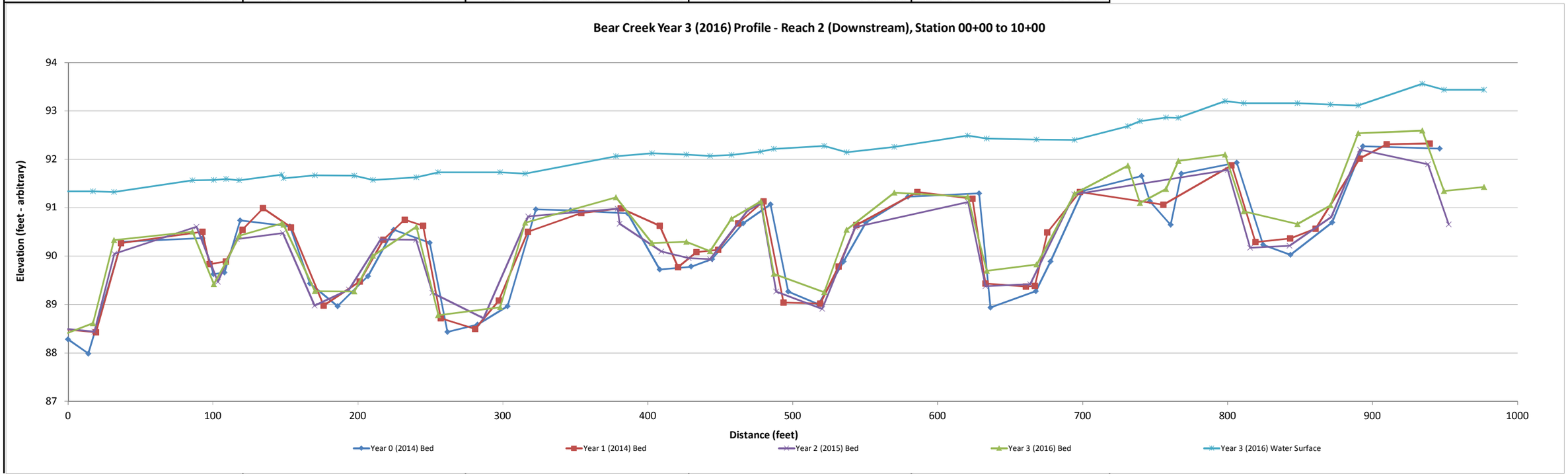
2014 Year 0 Monitoring \Survey			2014 Year 1 Monitoring \Survey			2015 Year 2 Monitoring \Survey			2016 Year 3 Monitoring \Survey			2017 Year 4 Monitoring \Survey		
Station	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**Station**	**Bed Elevation**	**Water Elevation**	**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	1/29/16
Crew	Perkinson, Keith

	2014	2014	2015	2016	2017
Avg. Water Surface Slope	0.0019	0.0020	0.0017	0.0023	
Riffle Length	45	60	52	44	
Avg. Riffle Slope	0.0052	0.0048	0.0043	0.0058	
Pool Length	33	32	33	35	
Pool to Pool Spacing	107	122	123	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**

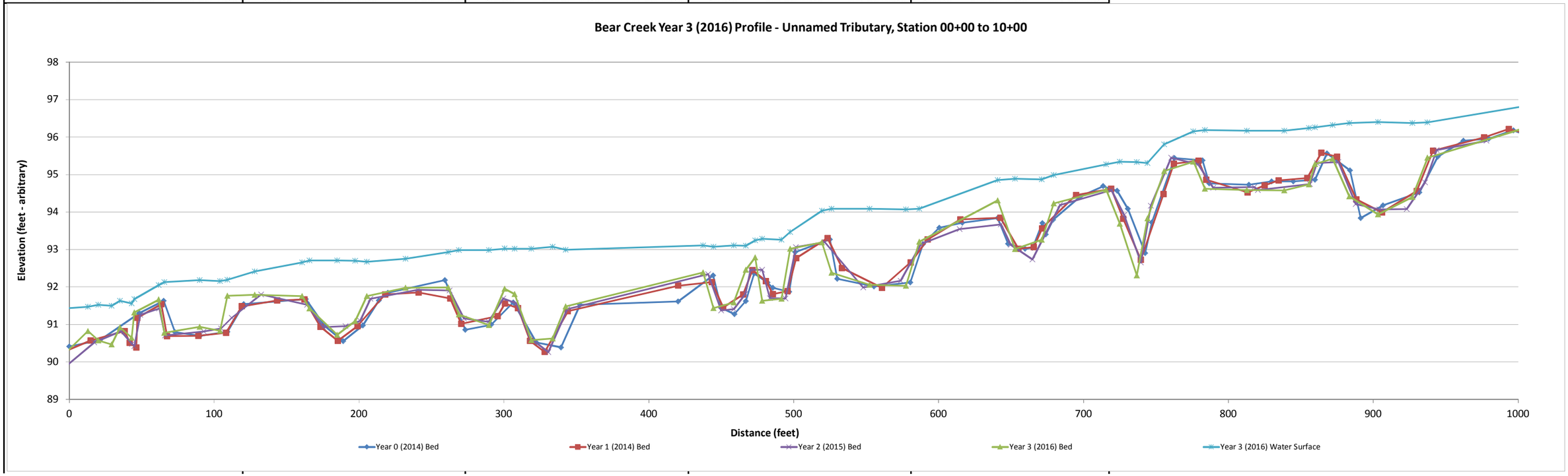


Project Name	Bear Creek - Profile
Reach	UT to Bear Creek Station 00+00 - 10+00
Feature	Profile
Date	1/29/16
Crew	Perkinson, Keith

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**

	2014	2014	2015	2016	2017
Avg. Water Surface Slope	0.0041	NA*	0.0036	0.0044	
Riffle Length	35	32	33	28	
Avg. Riffle Slope	0.0081	NA*	0.0075	0.0086	
Pool Length	23	21	22	25	
Pool to Pool Spacing	69	68	77	70	

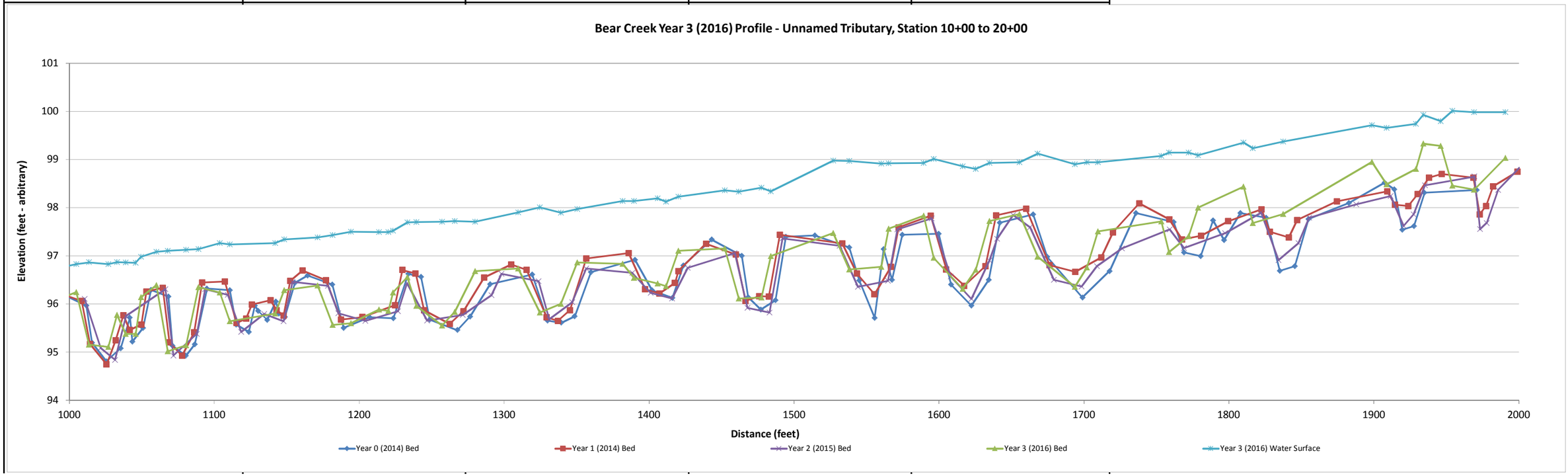
NA* No water in channel during field surveys.



Project Name	Bear Creek - Profile
Reach	UT to Bear Creek Station 10+00 - 20+00
Feature	Profile
Date	1/29/16
Crew	Perkinson, Keith

	2014	2014	2015	2016	2017
Avg. Water Surface Slope	0.0041	NA	0.0036	0.0044	
Riffle Length	35	32	33	28	
Avg. Riffle Slope	0.0081	NA	0.0075	0.0086	
Pool Length	23	21	22	25	
Pool to Pool Spacing	69	68	77	70	

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**



Weighted Pebble Count

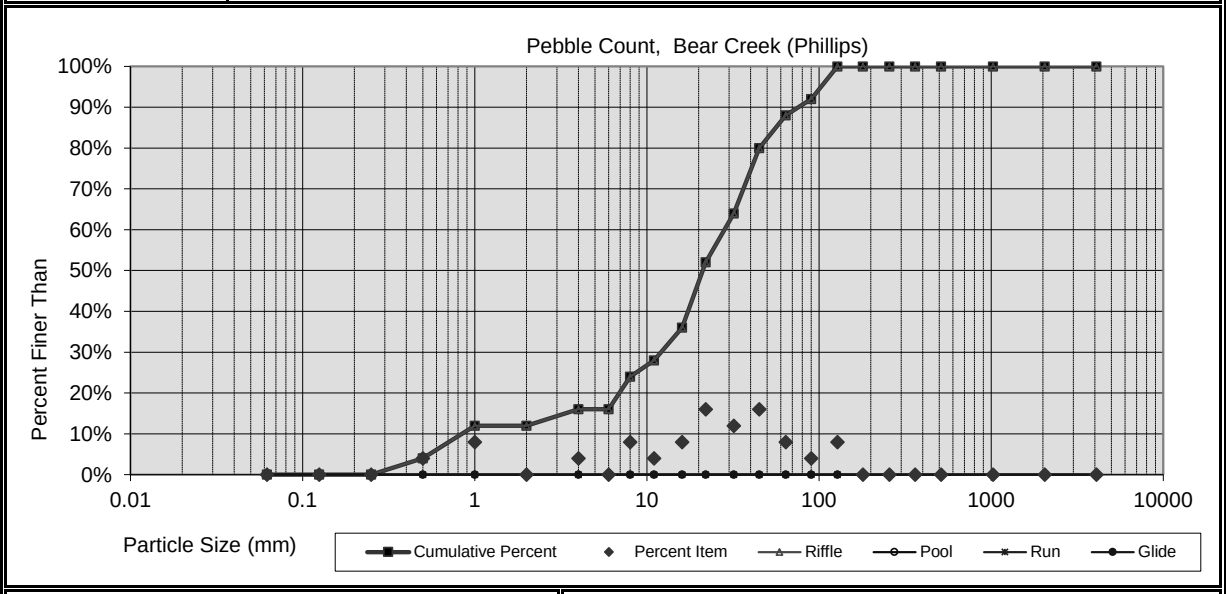
Percent Riffle:	**100**	Percent Run:	
Percent Pool:		Percent Glide:	

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	4.0	# #
coarse sand	0.5	1	8.0	# #
very coarse sand	1	2	0.0	# #
very fine gravel	2	4	4.0	# #
fine gravel	4	6	0.0	# #
fine gravel	6	8	8.0	# #
medium gravel	8	11	4.0	# #
medium gravel	11	16	8.0	# #
coarse gravel	16	22	16.0	# #
coarse gravel	22	32	12.0	# #
very coarse gravel	32	45	16.0	# #
very coarse gravel	45	64	8.0	# #
small cobble	64	90	4.0	# #
medium cobble	90	128	8.0	# #
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:	25	

	Bear Creek (Phillips)
	Cape Fear

Note:	**Cross Section 1 - Mainstem**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
6.000	15.27	21.1	54	103	0%	12%	76%	12%	0%	0%

Weighted Pebble Count

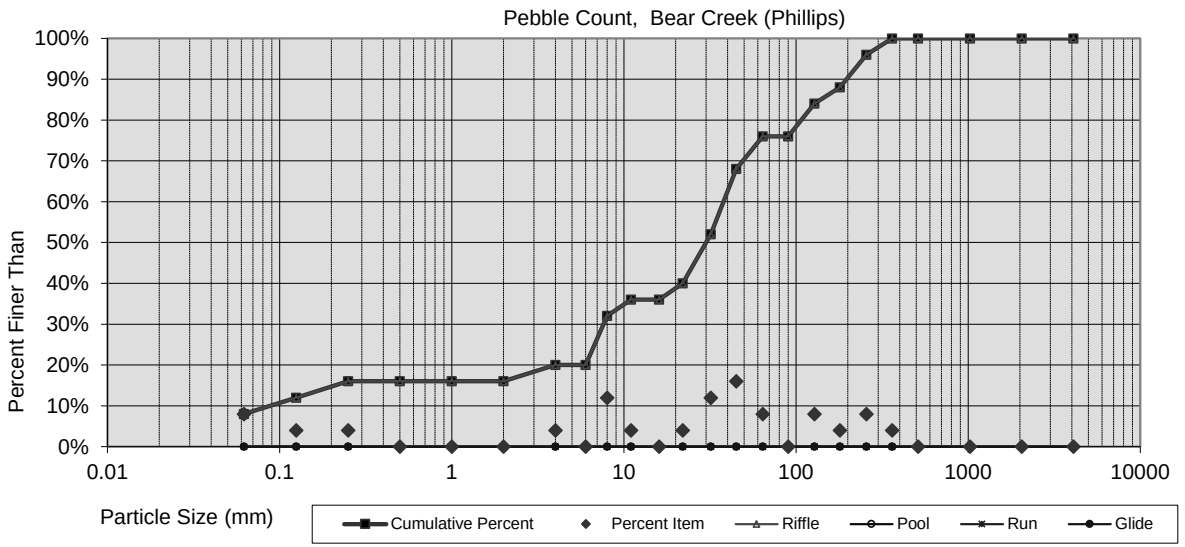
Percent Riffle:	**100**	Percent Run:	
Percent Pool:		Percent Glide:	

Pebble Count,

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	8.0	# #
very fine sand	0.062	0.13	4.0	# #
fine sand	0.13	0.25	4.0	# #
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	4.0	# #
fine gravel	4	6	0.0	# #
fine gravel	6	8	12.0	# #
medium gravel	8	11	4.0	# #
medium gravel	11	16	0.0	# #
coarse gravel	16	22	4.0	# #
coarse gravel	22	32	12.0	# #
very coarse gravel	32	45	16.0	# #
very coarse gravel	45	64	8.0	# #
small cobble	64	90	0.0	# #
medium cobble	90	128	8.0	# #
large cobble	128	180	4.0	# #
very large cobble	180	256	8.0	# #
small boulder	256	362	4.0	# #
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:	25	

	Bear Creek (Phillips)
	Cape Fear

Note:	**Cross Section 2 - Mainstem**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
2.000	10.16	30.1	128	245	8%	8%	60%	20%	4%	0%

Weighted Pebble Count

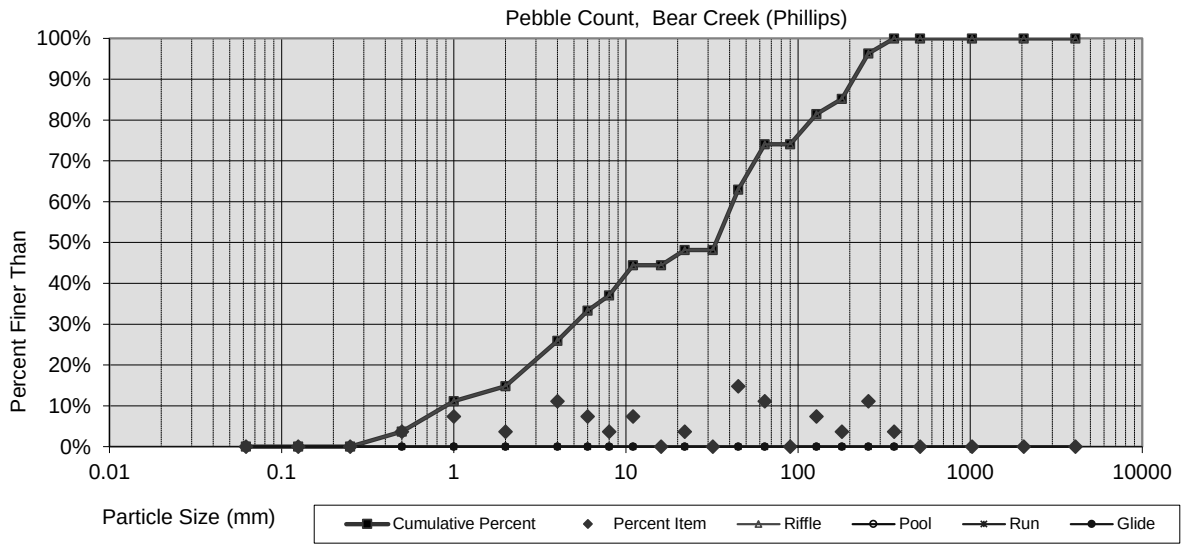
Percent Riffle:	**100**	Percent Run:	
Percent Pool:		Percent Glide:	

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	3.7	# #
coarse sand	0.5	1	7.4	# #
very coarse sand	1	2	3.7	# #
very fine gravel	2	4	11.1	# #
fine gravel	4	6	7.4	# #
fine gravel	6	8	3.7	# #
medium gravel	8	11	7.4	# #
medium gravel	11	16	0.0	# #
coarse gravel	16	22	3.7	# #
coarse gravel	22	32	0.0	# #
very coarse gravel	32	45	14.8	# #
very coarse gravel	45	64	11.1	# #
small cobble	64	90	0.0	# #
medium cobble	90	128	7.4	# #
large cobble	128	180	3.7	# #
very large cobble	180	256	11.1	# #
small boulder	256	362	3.7	# #
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:	27	

	Bear Creek (Phillips)
	Cape Fear

Note:	**Cross Section 4 - Mainstem**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
2.153	6.83	33.4	161	246	0%	15%	59%	22%	4%	0%

Weighted Pebble Count

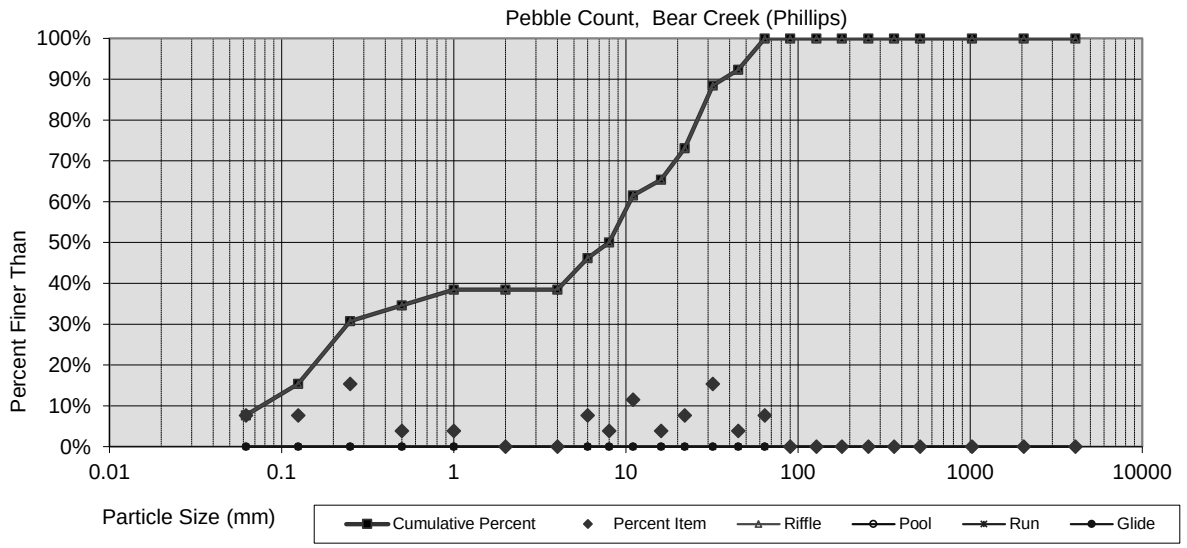
Percent Riffle:	**100**	Percent Run:	
Percent Pool:		Percent Glide:	

Pebble Count,

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	7.7	# #
very fine sand	0.062	0.13	7.7	# #
fine sand	0.13	0.25	15.4	# #
medium sand	0.25	0.5	3.8	# #
coarse sand	0.5	1	3.8	# #
very coarse sand	1	2	0.0	# #
very fine gravel	2	4	0.0	# #
fine gravel	4	6	7.7	# #
fine gravel	6	8	3.8	# #
medium gravel	8	11	11.5	# #
medium gravel	11	16	3.8	# #
coarse gravel	16	22	7.7	# #
coarse gravel	22	32	15.4	# #
very coarse gravel	32	45	3.8	# #
very coarse gravel	45	64	7.7	# #
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:	26	

	Bear Creek (Phillips)
	Cape Fear

Note:	**Cross Section 5 - Mainstem**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.129	0.54	8.0	29	51	8%	31%	62%	0%	0%	0%

Weighted Pebble Count

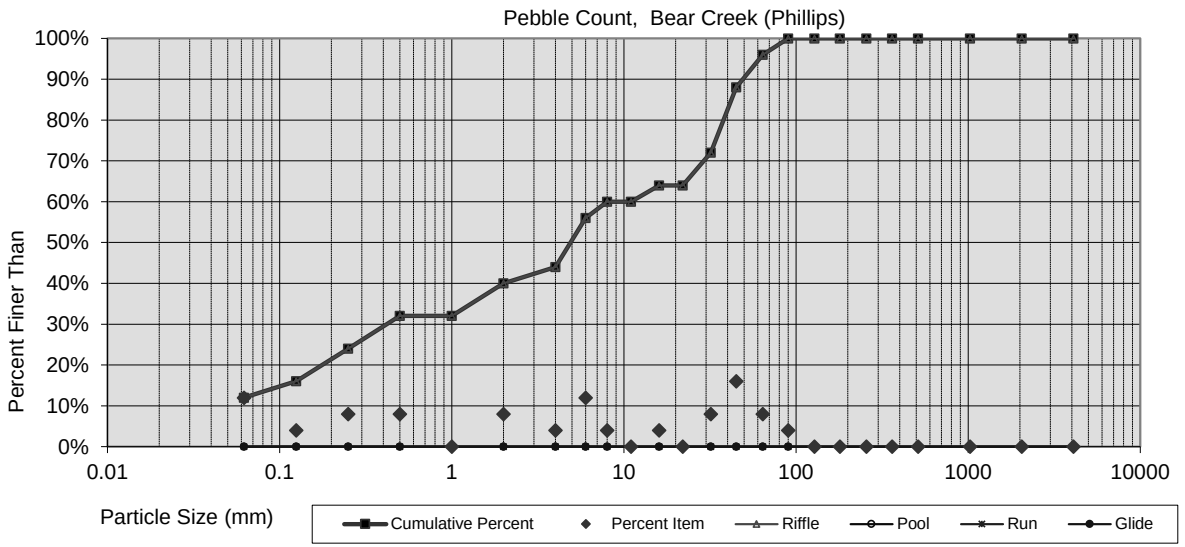
Percent Riffle:	**100**	Percent Run:	
Percent Pool:		Percent Glide:	

Pebble Count,

Material	Size Range (mm)		Total #	
silt/clay	0	0.062	12.0	# #
very fine sand	0.062	0.13	4.0	# #
fine sand	0.13	0.25	8.0	# #
medium sand	0.25	0.5	8.0	# #
coarse sand	0.5	1	0.0	# #
very coarse sand	1	2	8.0	# #
very fine gravel	2	4	4.0	# #
fine gravel	4	6	12.0	# #
fine gravel	6	8	4.0	# #
medium gravel	8	11	0.0	# #
medium gravel	11	16	4.0	# #
coarse gravel	16	22	0.0	# #
coarse gravel	22	32	8.0	# #
very coarse gravel	32	45	16.0	# #
very coarse gravel	45	64	8.0	# #
small cobble	64	90	4.0	# #
medium cobble	90	128	0.0	# #
large cobble	128	180	0.0	# #
very large cobble	180	256	0.0	# #
small boulder	256	362	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:	25	

	Bear Creek (Phillips)
	Cape Fear

Note:	**Cross Section 7 - Tributary 1**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.125	1.30	4.9	41	61	12%	28%	56%	4%	0%	0%

Weighted Pebble Count

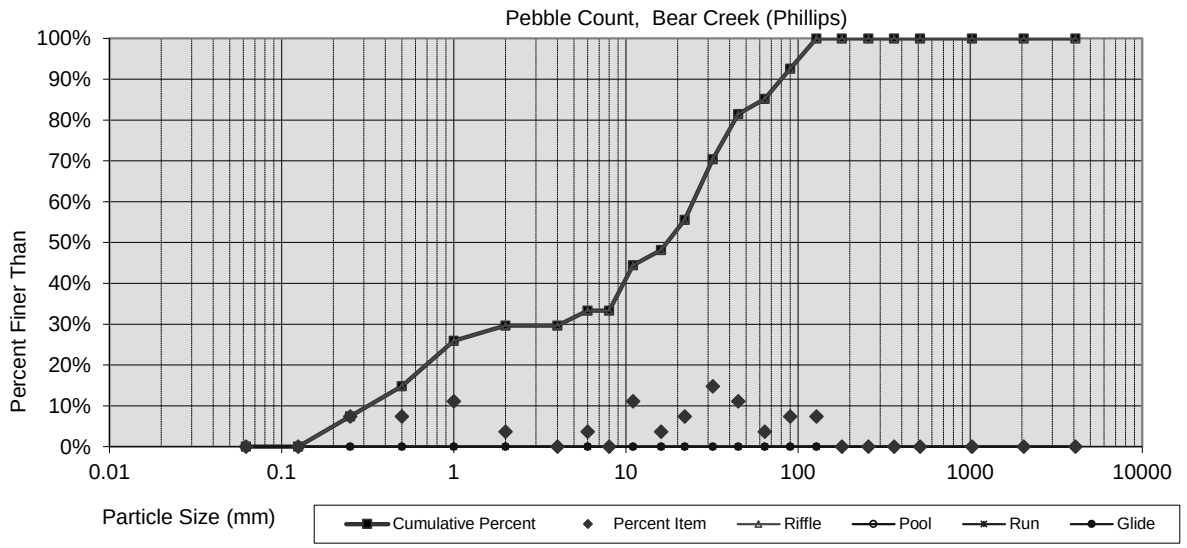
Percent Riffle:	**100**	Percent Run:	
Percent Pool:		Percent Glide:	

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	7.4	# #
medium sand	0.25	0.5	7.4	# #
coarse sand	0.5	1	11.1	# #
very coarse sand	1	2	3.7	# #
very fine gravel	2	4	0.0	# #
fine gravel	4	6	3.7	# #
fine gravel	6	8	0.0	# #
medium gravel	8	11	11.1	# #
medium gravel	11	16	3.7	# #
coarse gravel	16	22	7.4	# #
coarse gravel	22	32	14.8	# #
very coarse gravel	32	45	11.1	# #
very coarse gravel	45	64	3.7	# #
small cobble	64	90	7.4	# #
medium cobble	90	128	7.4	# #
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:	27	

	Bear Creek (Phillips)
	Cape Fear

Note:	**Cross Section 9 - Tributary 1**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.538	8.39	17.3	57	101	0%	30%	56%	15%	0%	0%

Appendix E.
Hydrology Data

Table 13. Verification of Bankfull Events

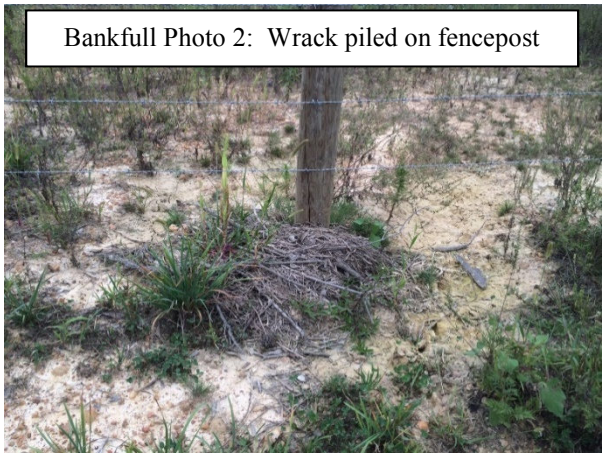
Table 13. Verification of Bankfull Events
Bear Creek (Phillips) Restoration Site (DMS Project Number 26)

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
March 13, 2014	March 7, 2014	Wrack on floodplain and crest gauge data indicate a bankfull event after 1.59 inches* of rain in one day.	1
August 22, 2014	May 15, 2014	Crest gauge data indicates a bankfull event after 2.08 inches* of rain in one day.	--
September 23, 2014	September 4, 2014	Wrack on floodplain and crest gauge data indicate bankfull event after 1.95 inches of rain* in three days.	2
April 20, 2015	April 17, 2015	Wrack and standing water on floodplain and crest gauge data indicate bankfull event after 2.13 inches of rain* in three days.	3
July 14, 2015	June 19, 2015	Wrack on floodplain and crest gauge data indicate bankfull event after 1.95 inches of rain* in two days.	4
September 21, 2015	August 20, 2015	Wrack on floodplain and crest gauge data indicate bankfull event after 2.11 inches of rain* in two days.	--
January 27, 2016	December 23, 2015	Wrack on floodplain and crest gauge data indicate bankfull event after 3.60 inches of rain* in two days.	--
January 27, 2016	December 30, 2015	Wrack on floodplain and crest gauge data indicate bankfull event after 3.59 inches rain* in one day.	5-6
May 17, 2016	May 3, 2016	Wrack on floodplain and crest gauge data indicate bankfull event after 1.99 inches rain* in one day.	7
July 27, 2016	June 15, 2016	Crest gauge data indicates bankfull event after 2.54 inches rain* in one day.	--
September 22, 2016	August 3, 2016	Crest gauge data indicates bankfull event after 2.22 inches of rain* in two days.	--

*Weather Underground 2016

Bankfull Photo 1: Wrack on fence

Bankfull Photo 2: Wrack piled on fencepost



Bankfull Photo 3: Wrack in floodplain

Bankfull Photo 4: Wrack in floodplain

Bankfull Photo 5: Wrack in floodplain

Bankfull Photo 6: Laid back vegetation in floodplain

Bankfull Photo 7: Wrack in floodplain