FINAL

ANNUAL MONITORING REPORT
YEAR 3 (2014)
MILL CREEK STREAM/WETLAND RESTORATION SITE
RANDOLPH COUNTY, NORTH CAROLINA
(EEP Project No. 253, Contract No. 004803)
Construction Completed March 2011

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

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

Axiom Environmental, Inc.

Ecosystem Enhancement PROGRAM

October 2014

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Appendices

1.0 EXECUTIVE SUMMARY

The Mill Creek Stream and Wetland Restoration Site (hereafter referred to as the "Site") is situated within US Geological Survey (USGS) hydrologic unit 03040103 of the Yadkin River Basin and NC Division of Water Quality (NCDWQ) Priority Sub-basin 03-07-09. The Site is located in Randolph County, approximately 11 miles southwest of the City of Asheboro, North Carolina. The Site is encompassed within a 129.2-acre easement located in a 288-acre tract owned by Amy Grissom. Historically, the downstream portion of the Site (west of Lassiter Mill Rd – SR 1107) was used for agriculture and livestock production. Livestock were removed and part of the land become fallow while the remainder is used for hay production or has been recently planted and burned by the North Carolina Wildlife Resources Commission (NCWRC) as part of an ecosystem restoration initiative for the entire property. Prior livestock activity had compromised the riparian buffer along many of the project reaches. The upstream portion of the Site (east of Lassiter Mill Rd) is primarily forested. Riparian vegetation in this area is comprised mainly of mature deciduous trees. This report (compiled based on the NC Ecosystem Enhancement Program (NCEEP) *Procedural Guidance and Content Requirements for EEP Monitoring Reports* Version 1.4 dated 11/7/11) summarizes data for Year 3 (2014) monitoring.

The project goals outlined in the approved *Mill Creek Restoration Plan* [NCEEP 2008] included the following.

- Improve water quality within the Unnamed Tributary (UT) 2, UT 5, and Mill Creek watersheds by reducing sediment and nutrient inputs, increasing dissolved oxygen concentrations, improving stream stability, and wetland filtering.
- Improve water quantity within the UT2, UT 5, and Mill Creek watersheds by improving ground water recharge, restoring hydrologic connections, and reconnecting channels with floodplains.
- Improve aquatic and terrestrial habitat within the UT2, UT 5, and Mill Creek watersheds by improving substrate and in-stream cover, reducing water temperature by increasing shading, improving terrestrial habitat, and improving overall aesthetics.
- Increase animal and vegetation biodiversity within the Site by connecting riparian buffer improvements associated with the NCEEP's Mill Creek project with a NCWRC native piedmont prairie grass restoration project located outside of the NCEEP's conservation easement boundaries.

These goals were accomplished through the implementation of the following objectives as outlined in the *Mill Creek Restoration Plan* [NCEEP 2008].

- Permanently protect stream channels through a conservation easement.
- Restore perennial stream channel.
- Enhance perennial and intermittent stream channel.
- Preserve perennial channel.
- Create wetland.
- Restore UT2 to its original drainage path to the Uwharrie River below the breached dam.
- Create a new channel below UT5's breached dam that flows along the fall of the valley to reduce toe-of-slope erosion on the left bank

- Improve floodplain functionality by matching the floodplain elevation with bankfull stage or by creating a bench to open the floodplain in areas where the channel is incised.
- Establish native stream bank and floodplain vegetation in the permanent conservation easement.
- Improve aquatic and riparian habitat by creating deeper pools and areas of re-aeration, planting a riparian buffer, and reducing bank erosion.

During Year 3 (2014) monitoring eight vegetation plots were monitored. Vegetation from all eight plots averaged 369 planted stems-per-acre (excluding livestakes). Five of the eight plots met or exceeded the success criteria of 320 planted stems-per-acre (minimum stem count after 3 years). When including naturally recruited stems of appropriate species such as winged elm (*Ulmus alata*) and American elm (*Ulmus americana*) Plot 3 were well-above 320 stems-per-acre.

Planted woody vegetation throughout the Site is somewhat sparse due to competition from herbaceous plants. Herbaceous vegetation has become more established along excavated benches; however, woody stems are still minimal. In the upstream portions of UT2 and UT4, sweetgum (*Liquidambar styraciflua*) saplings have established and are particularly dense. Two areas of concern were observed. These are described in the table below and are identified on Figures 2A and 2B (Appendix B).

Vegetation Areas of Concern

Map Identifier	Feature/Issue
Veg Area of Concern #1	Dense sweet gum (*Liquidambar styraciflua*) and blackberry (*Rubus* sp.) community outcompeting planted stems on the upstream portion of UT2
Veg Area of Concern #2	Dense sweet gum (*Liquidambar styraciflua*) population mostly between UT4 and Mill Creek

Visual assessment and geomorphic surveys completed for the Site indicate that project reaches were performing within established success criteria ranges as shown below. No significant bank erosion was recorded, and geomorphic measurements are within the range of the design parameters. Two areas of concern were observed along stream monitoring reaches within the sites. The table below describes the issues and each area is identified on Figures 2A and 2B (Appendix B).

Stream Areas of Concern

Map Identifier	Feature/Issue
Stream Area of Concern #1	Cross vane at bottom of Mill Creek has been compromised due to high flows of the Uwharrie River. Structure is intact but adjacent banks have been eroded causing water to flow around arms and pipe underneath headers
Stream Area of Concern #2	Sixth upstream cross vane in series of drop structures has failed completely, upstream and downstream structures are intact and functioning. Failure likely due to localized heavy rain event between June and September 2014.

Stream Success Criteria (from approved *Mill Creek Restoration Plan, Final Report* [EEP 2008]):

- Success is defined as little change in as-built cross-sections. If changes do take place they should be evaluated to determine if they represent a movement toward a more unstable condition (e.g., down-cutting or erosion) or a movement toward increased stability.
- Cross-sections shall be classified using the Rosgen Stream Classification System, and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.
- The longitudinal profiles should show that bedform features are remaining stable (i.e., they are not aggrading or degrading). Pools should remain deep with flat water surface slopes, and the riffles should remain steeper and shallower than the pools. Bedforms observed should be consistent with those observed for channels of the design stream type.
- A minimum of two bankfull events must occur in separate years within the five-year monitoring.

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 NCEEPs website. All raw data supporting the tables and figures in the appendices is available from NCEEP upon request.

2.0 METHODOLOGY

2.1 Vegetation Assessment

Eight vegetation plots were established and marked after construction with five-foot metal t-post demarking the corners with a ten-foot, three-quarter inch PVC at the origin. The plots are 10 meters square and are located randomly within the Site. These plots were surveyed in July for the year 3 (2014) monitoring season using the *CVS-EEP Protocol for Recording Vegetation, Levels 1-2 Plot Sampling Only, Version 4.2* (Lee et al. 2008) (http://cvs.bio.unc.edu/methods.htm); results are included in Appendix C. The taxonomic standard for vegetation used for this document was *Flora of the Southern and Mid-Atlantic States* (Weakley 2012).

2.2 Stream Assessment

Annual stream monitoring was conducted in July for the year 3 (2014) monitoring season. Measurements were taken using a Topcon GTS 303 total station and Recon data collector. The raw total station file was processed using Carlson Survey Software into a Computer Aided Design (CAD) file. Coordinates were exported as a text/ASCII file to Microsoft Excel for processing and presentation of data. Pebble counts were completed using the modified Wolman method (Rosgen 1993).

Eight permanent cross-sections, six riffle and two pool, were established and will be used to evaluate stream dimension; locations are depicted on Figures 2A-2B (Appendix B). Cross-sections are permanently monumented with 5-foot metal t-posts at each end point. Cross-sections were surveyed to provide a detailed measurement of the stream and banks including points on the adjacent floodplain, top of bank, bankfull, breaks in slope, edge of water, and thalweg. Data were used to calculate width-depth ratios, entrenchment ratios, and bank height ratios for each cross-section. In addition, pebble counts were completed at cross-sections 3 and 6, and photographs will be taken at each permanent cross-section annually.

Three crest gauges are located within the Site monitoring reaches (on UT-2, UT-5, and Mill Creek within the lower, downstream one third of each reach). Crest gauges are PVC with granulated cork, mounted to a post driven into the channel. Crest gauges will be checked for overbank events during each monitoring visit.

Three stream monitoring reaches were established and will be used to evaluate stream pattern and longitudinal profile; locations are depicted on Figures 2A-2B (Appendix B). Measurements of channel pattern will include belt-width, meander length, and radius of curvature (only in year one). Subsequently, data will be used to calculate meander-width ratios. Longitudinal profile measurements will include average water surface slopes, facet slopes, and pool-to-pool spacing. Thirteen permanent photo points were established throughout the restoration reach; locations are depicted on Figures 2A-2B (Appendix B). In addition, visual stream morphology stability assessments will be completed in each of the three monitoring reaches annually to assess the channel bed, banks, and in-stream structures.

3.0 REFERENCES

Ecosystem Enhancement Program (EEP). Unpublished. Procedural Guidance and Content Requirements for EEP Monitoring Projects, Version 1.4, dated 11/07/11. NC Department of Environment and Natural Resources. Available online at http://portal.ncdenr.org/c/document_library/get_file?p_l_id=1169848&folderId=2288101&name=DLFE-39268.pdf.

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APPENDIX A

PROJECT VICINITY MAP AND BACKGROUND TABLES

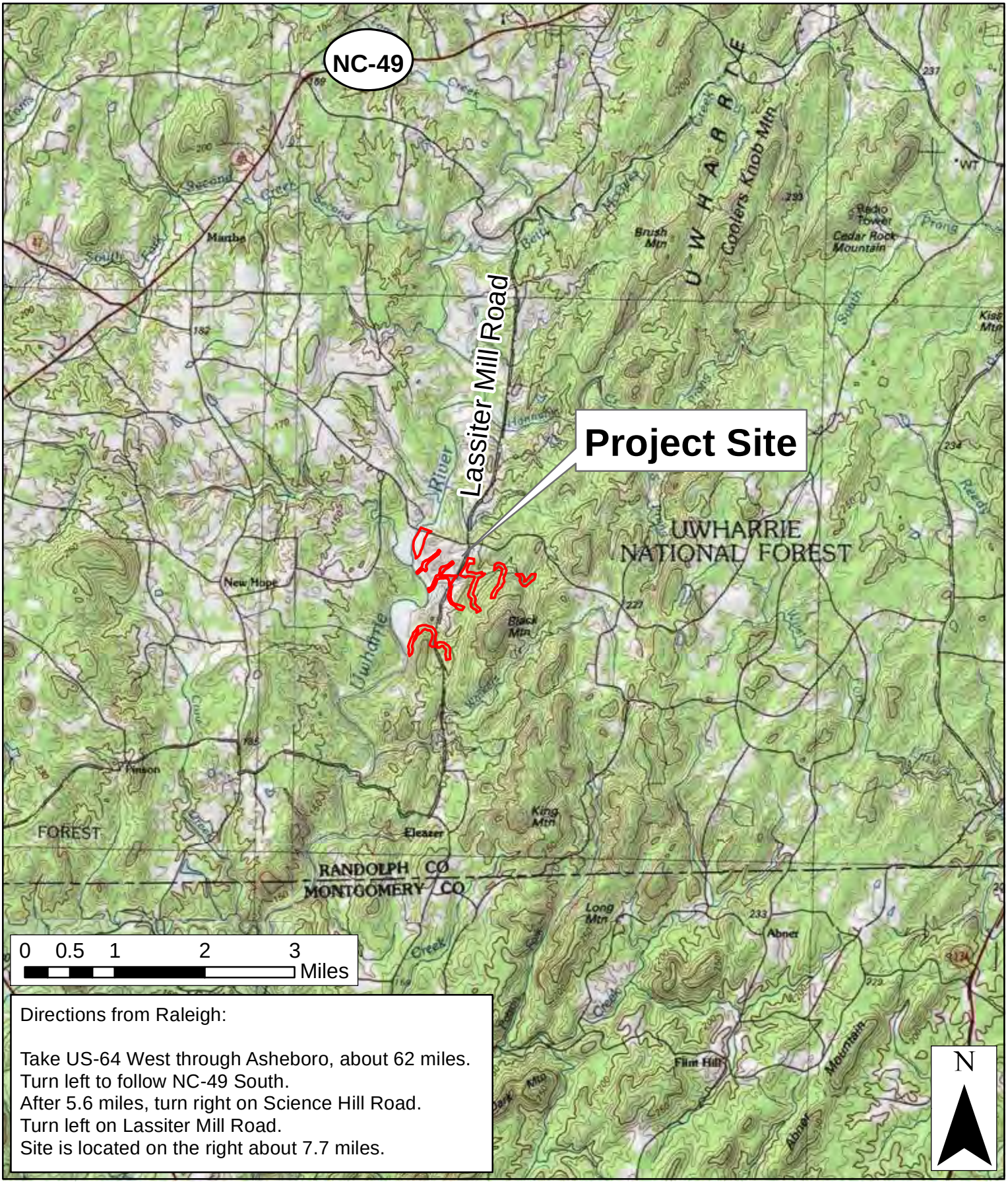
Figure 1. Site Location Map

Table 1. Project Components and Mitigation Credits

Table 2. Project Activity and Reporting History

Table 3. Project Contacts Table

Table 4. Project Baseline Information and Attributes Table



Directions from Raleigh:

Take US-64 West through Asheboro, about 62 miles.
Turn left to follow NC-49 South.
After 5.6 miles, turn right on Science Hill Road.
Turn left on Lassiter Mill Road.
Site is located on the right about 7.7 miles.

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SITE LOCATION MAP
MILL CREEK SITE
EEP PROJECT NUMBER 253
Randolph County, North Carolina

Dwn. by.
KRJ

Date:
October 2012

Project:
12-004.10

FIGURE
1

Table 1. Project Components and Mitigation Credits
Mill Creek Stream and Wetland Restoration Site (EEP Project Number 253)

Mitigation Credits					
	Stream		Riparian Wetland		Buffer
Type	Restoration	Restoration Equivalent	Restoration	Restoration Equivalent	
Totals	3862	2970	--	0.4	--

Projects Components							
Project Component/ Reach ID	Station Range	Existing Linear Footage/ Acreage	Priority Approach	Restoration/ Restoration Equivalent	Restoration Linear Footage/ Acreage	Mitigation Ratio	Comment
Mill Creek		2214	EI/II	Enhancement I Enhancement II	1460 754	1:1.5 1:2.5	
UT 1		1799	EII	Enhancement II	1199	1:2.5	Upper 600 feet is an ephemeral ditch and not counted towards credit.
UT 2		1703	R/EII	Restoration Enhancement II	875 1012	1:1 1:2.5	
UT 4		2350	EII/Pres	Enhancement II Preservation	541 1809	1:2.5 1:5	
UT 5		1289	R/EI/EII	Restoration Enhancement I Enhancement II	108 250 842	1:1 1:1.5 1:2.5	
UT 6		954	Pres	Preservation	NA	1:5	Channel is ephemeral and has not been counted towards credit.
UT 7		2529	Pres	Preservation	2529	1:5	
UT 8		2003	Pres	Preservation	2003	1:5	
UT 9		5239	Pres	Preservation	5239	1:5	
Mill Creek 2		998	Pres	Preservation	998	1:5	
Mill Creek 3		785	Pres	Preservation	785	1:5	
Mill Creek 4		1485	Pres	Preservation	1485	1:5	
Wetland 1 (along UT2)		0.9		Creation	0.9	1:3	
Wetland 2 (along UT 5)		0.2		Creation	0.2	1:3	

Component Summation			
Restoration Level	Stream (linear footage)	Riparian Wetland (acres)	Buffer (square footage)
Restoration	983		
Enhancement (Level I)	1710		
Enhancement (Level II)	4348		
Preservation	14848		
Creation		1.1	
Totals	**21889**	**1.1**	
Mitigation Units	**6832 SMUs**	**0.4**	

Table 2. Project Activity and Reporting History
Mill Creek Stream and Wetland Restoration Site (EEP Project Number 253)

Elapsed Time Since Grading Complete: 3 years 11 months
Elapsed Time Since Planting Complete: 2 years 9 months
Number of Reporting Years: 3

Activity or Deliverable	Data Collection Complete	Completion or Delivery
Restoration Plan		March 2008
Final Design – Construction Plans		February 2010
Construction		October 2010
Temporary S&E mix applied to entire project area		December 2011
Permanent seed mix applied to entire project area		December 2011
As-built Construction Drawings		March 2011
Year 1 Monitoring (2012)	November 2012	February 2013
Year 2 Monitoring (2013)	October 2013	November 2013
Year 3 Monitoring (2014)	September 2014	September 2014
Year 4 Monitoring (2015)		
Year 5 Monitoring (2016)		

Table 3. Project Contacts Table
Mill Creek Stream and Wetland Restoration Site (EEP Project Number 253)

Designer	Michael Baker Engineering, Inc. Cary, NC Kevin Tweedy 919-463-5488
Construction, Planting, and Seeding Contractor	Wright Contracting, LLC Lawndale, NC 704-692-4633
Surveyor	Turner Land Surveying, PLLC 3201 Glenridge Drive Raleigh, NC 27604 David Turner 919-875-1378
Seed Mix Source	Unknown
Years 1-5 Monitoring Performers	Axiom Environmental, Inc. 218 Snow Avenue Raleigh, NC 27603 Grant Lewis 919-215-1693

Table 4. Project Baseline Information and Attributes
Mill Creek Stream and Wetland Restoration Site (EEP Project Number 253)

Project Information			
Project Name	Mill Creek Restoration Site		
Project County	Randolph		
Project Area (Acres)	29.91		
Project Coordinates (NAD83 2007)	658,598.39, 1,711,005.01		
Project Watershed Summary Information			
Physiographic Region	Piedmont		
Ecoregion	Carolina Slate Belt		
Project River Basin	Yadkin		
USGS 8-digit HUC	03040103		
USGS 14-digit HUC	03040103050080		
NCDWQ Subbasin	03-07-09		
Project Drainage Area (Sq. Mi.)	1.95		
Project Drainage Area Impervious Surface	<5%		
Watershed Type	Rural		
Reach Summary Information			
Parameters	**Mill Creek**	**UT 2**	**UT 5**
Restored/Enhanced Length (Linear Feet)	2214	1887	1200
Drainage Area (Square Miles)	1.33	0.08	0.06
NCDWQ Index Number	13-2-(1.5)		
NCDWQ Classification	C		
Valley Type/Morphological Description	VIII/B- and E-type		
Dominant Soil Series	Badin-Tarrus complex		
Drainage Class	Well drained		
Soil Hydric Status	Nonhydric		
Slope	0.009 – 0.0432		
FEMA Classification	Zone AE		
Native Vegetation Community	100		
Percent Composition of Exotic Invasives	< 5% much young Privet sprouting		
Regulatory Considerations			
Regulation	**Applicable**		
Waters of the U.S. –Sections 404 and 401	Yes-Received Appropriate Permits		
Endangered Species Act	No effect		
Historic Preservation Act	No effect		
CZMA/CAMA	No		
FEMA Floodplain Compliance	Yes-Received a No Rise Certification		
Essential Fisheries Habitat	No		

APPENDIX B

VISUAL ASSESSMENT DATA

Figures 2 and 2A-2B. Current Conditions Plan View

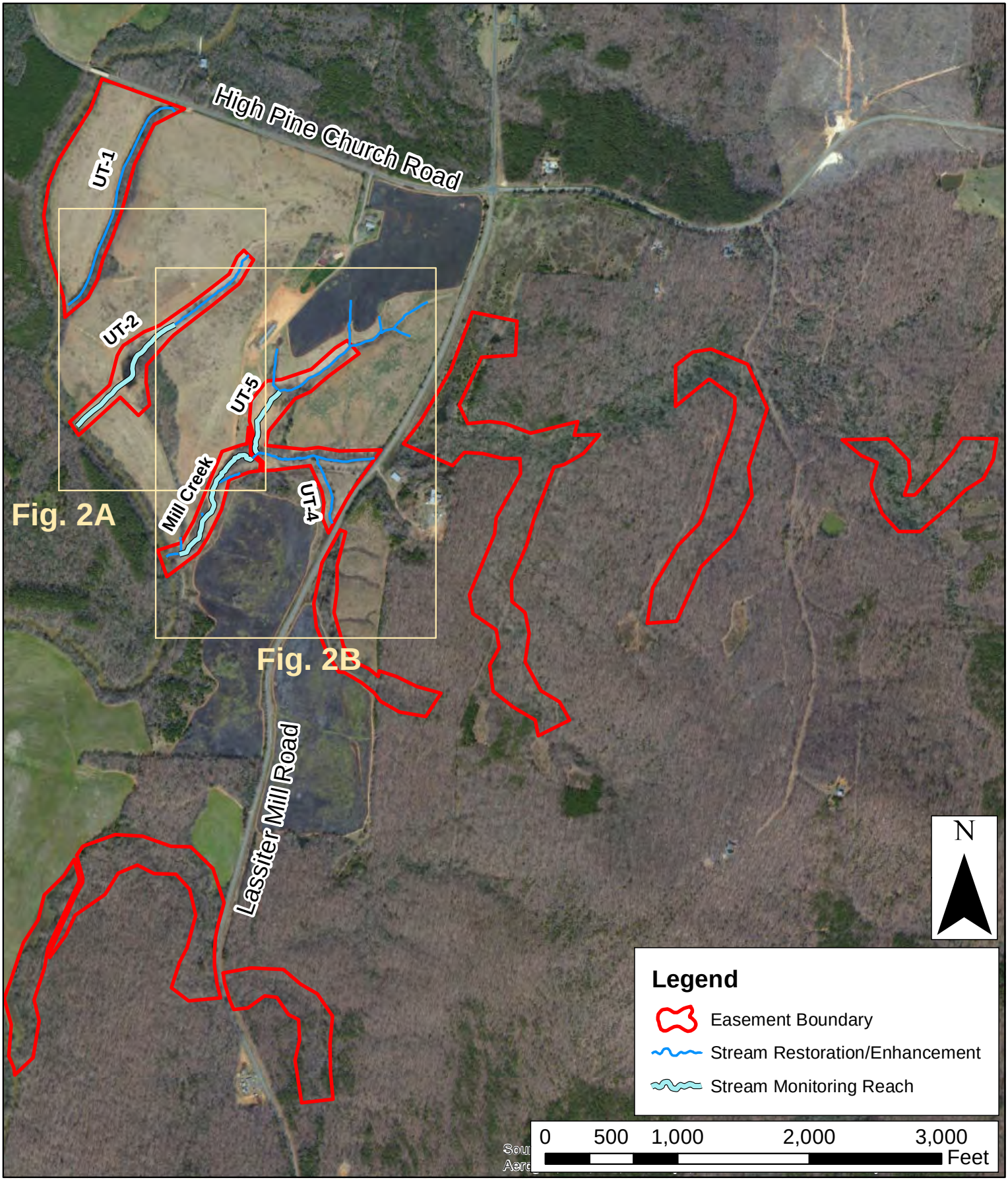
Tables 5A-5C. Visual Stream Morphology Stability Assessment

Table 6. Vegetation Condition Assessment

Stream Fixed-Station Photographs

Vegetation Monitoring Photographs

Main Tributary Structure Photographs



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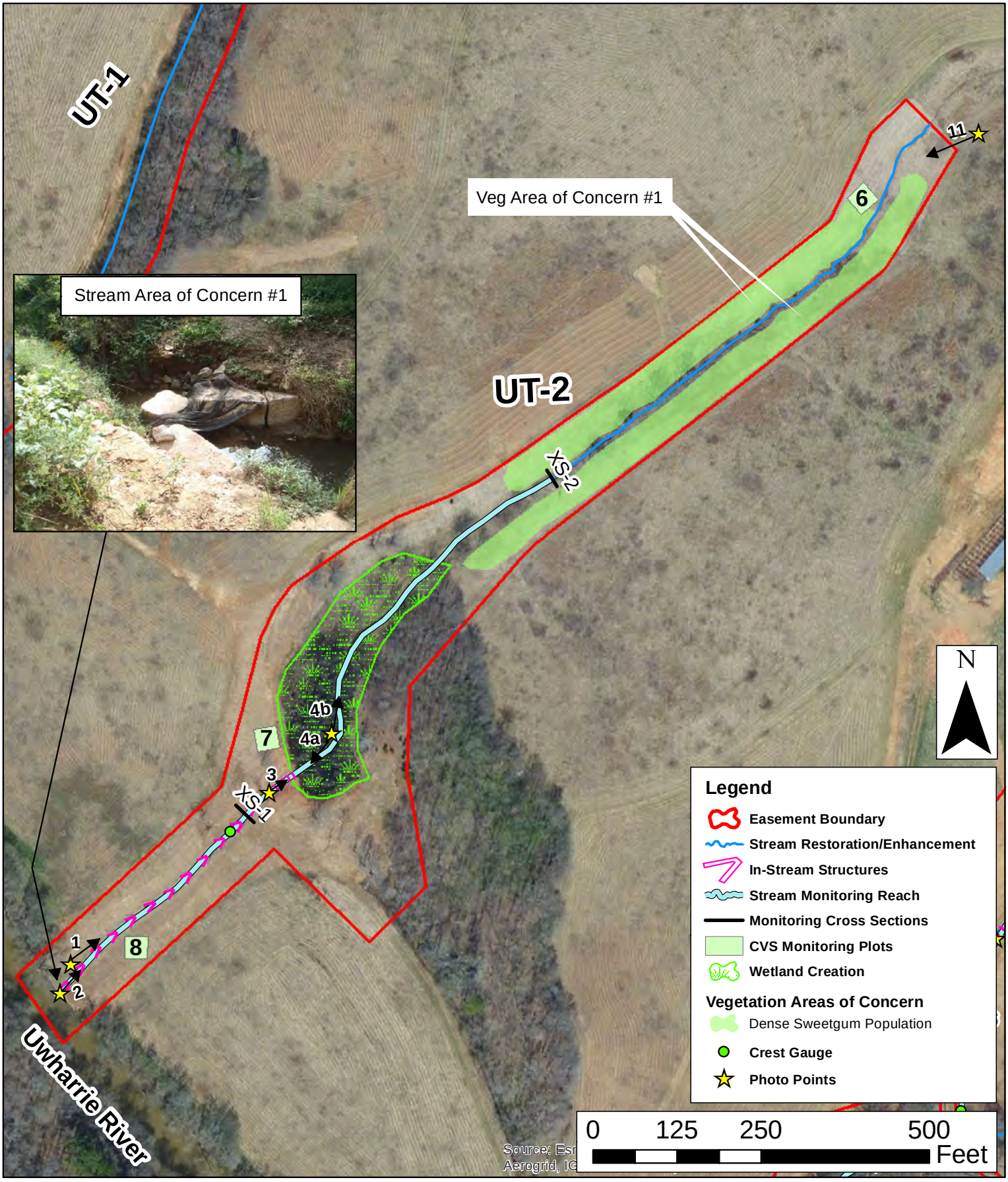
CURRENT CONDITIONS PLAN VIEW
MILL CREEK SITE
EEP PROJECT NUMBER 253
Randolph County, North Carolina

Dwn. by. KRJ	FIGURE
Date: September 2014	2
Project: 12-004.10	



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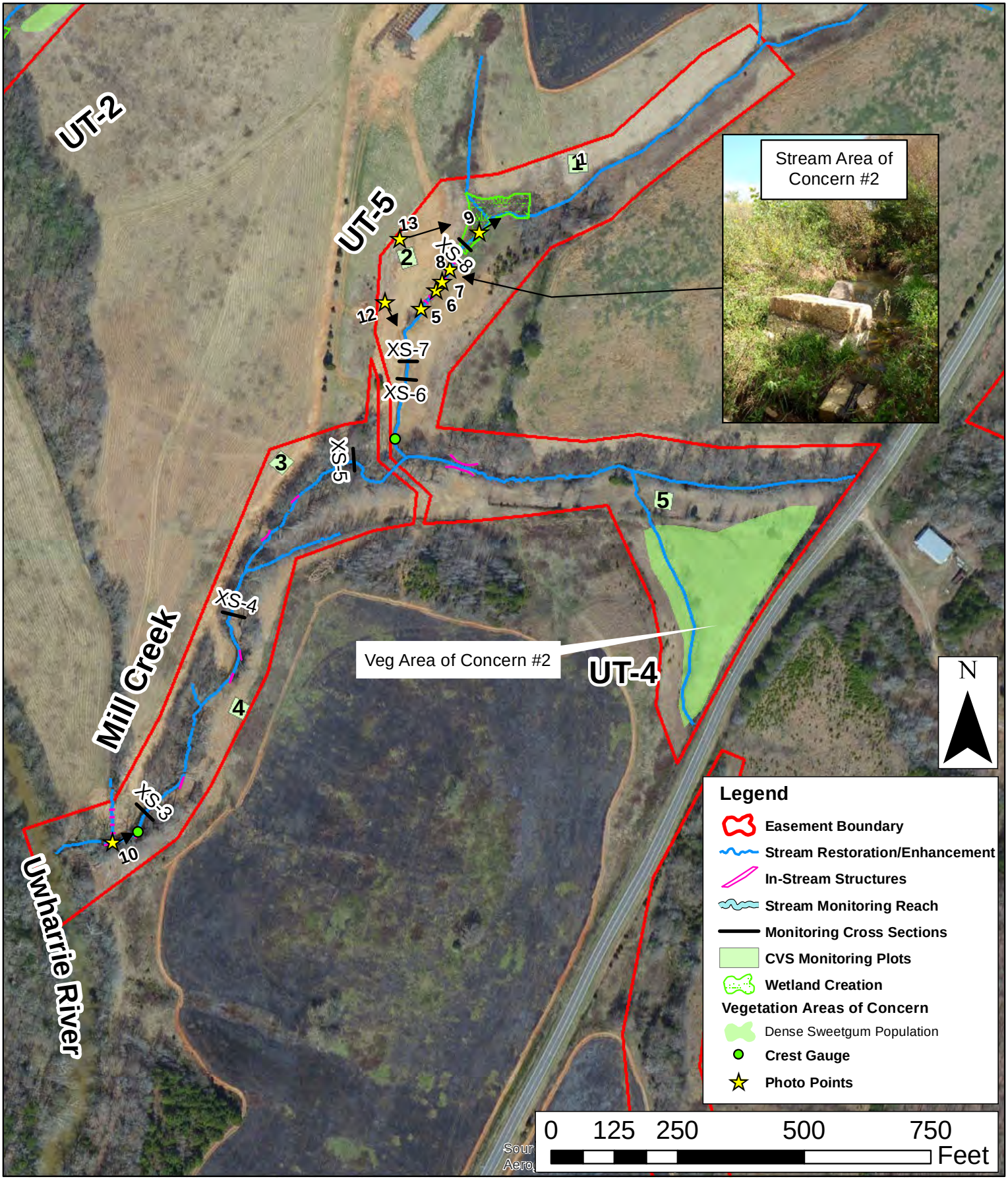
MONITORING PLAN VIEW
MILL CREEK SITE
EEP PROJECT NUMBER 253
Randolph County, North Carolina

Dwn. by.
KRJ

Date:
September 2014

Project:
12-004.10

FIGURE
2A



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CURRENT CONDITIONS PLAN VIEW
MILL CREEK SITE
EEP PROJECT NUMBER 253
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Dwn. by. KRJ	FIGURE
Date: September 2014	2B
Project: 12-004.10	

Table 5A **Visual Stream Morphology Stability Assessment**
Reach ID **Reach 1 Mill Creek**
Assessed Length **986**

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	14	14			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	17	17			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	100	100			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	100	100			100%			
		2. Thalweg centering at downstream of meander (Glide)	100	100			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.	8	8			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	8	8			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	8	8			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)	8	8			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	8	8			100%			

Table 5B **Visual Stream Morphology Stability Assessment**
Reach ID **UT2**
Assessed Length **1065**

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	19	19			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	19	19			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	100	100			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	100	100			100%			
		2. Thalweg centering at downstream of meander (Glide)	100	100			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	16			94%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	16	16			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	15	16			94%			
	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)	16	16			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	16			94%			

Table 5C **Visual Stream Morphology Stability Assessment**
Reach ID **UT5**
Assessed Length **544**

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	13	13			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	25	25			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	100	100			100%			
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	100	100			100%			
		2. Thalweg centering at downstream of meander (Glide)	100	100			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.	9	10			90%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	9	10			90%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	9	10			90%			
	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)	10	10			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	10	10			100%			

Table 6 — Vegetation Condition Assessment

Mill Creek Property

Planted Acreage[1] **29.91**

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 stream banks and bench.	0.1 acres	Tan	0	0.00	0.0%
2. Low Stem Density Areas	None	0.1 acres	none	0	0.00	0.0%
2B. Low Planted Stem Density Areas	Low planted stem densities due to thick sweet gum (*Liquidambar styraciflua*) and blackberry (*Rubus* sp.)	0.1 acres	none	2	2.95	9.9%
			Total	2	2.95	9.9%
3. Areas of Poor Growth Rates or Vigor	None	0.25 acres	N/A	0	0.00	0.0%
			Cumulative Total	0	0.00	0.0%

Easement Acreage[2] **129.2**

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

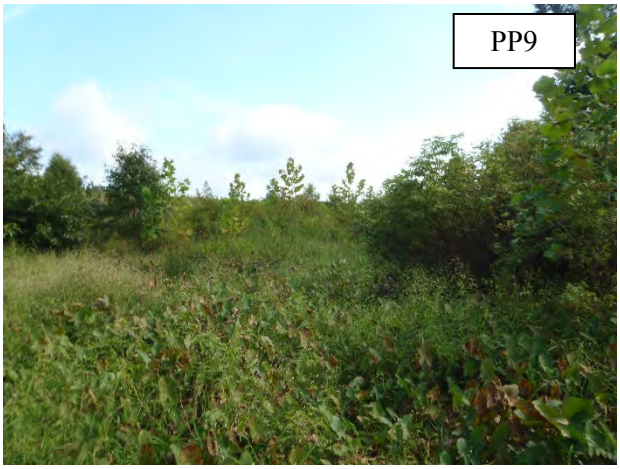
2 = The acreage within the easement boundaries.

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.

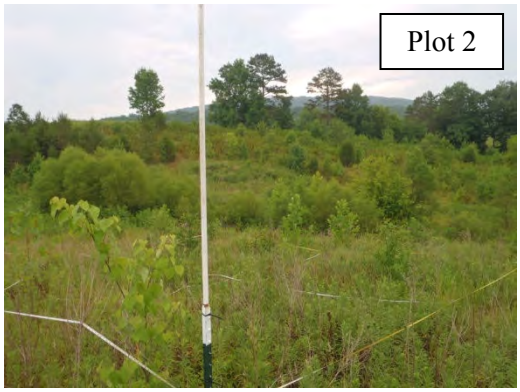
4 = Invasives may occur in or out of planted areas, but still within the easement and will therefore be calculated against the overall easement acreage. Invasives of concern/interest are listed below. The list of high concern spcies are those with the potential to directly outcompete native, young, woody 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 EEP such as species present, their coverage, distribution relative to native biomass, and the practicality of treatment. For example, even modest amounts of Kudzu or Japanese Knotweed early in the projects history will warrant control, but potentially large coverages of Microstegium in the herb layer will not 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.

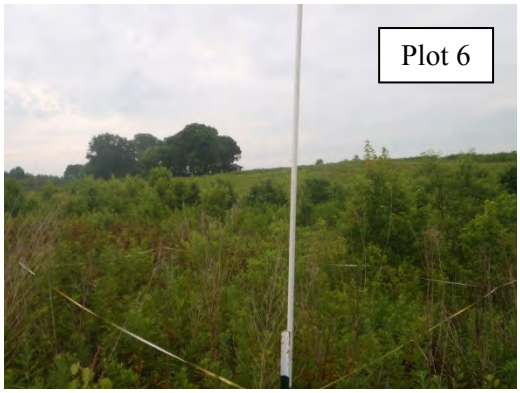
Mill Creek
Stream Fixed-Station Photographs
Taken September 2014

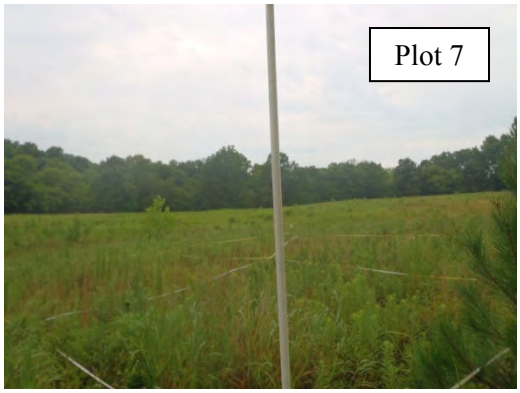
Mill Creek
Stream Fixed-Station Photographs
Taken September 2014

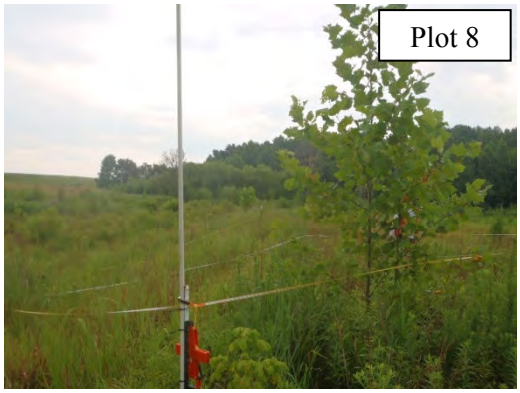


Mill Creek
Vegetation Monitoring Photographs
Taken July 2014









Mill Creek
Main Tributary Structure Photographs
Taken May 2014

APPENDIX C

VEGETATION PLOT DATA

Table 7. Vegetation Plot Criteria Attainment

Table 8. CVS Vegetation Plot Metadata

Table 9. Total and Planted Stems by Plot and Species

Table 7. Vegetation Plot Criteria Attainment
Mill Creek Restoration Site (EEP Project Number 253)

Vegetation Plot ID	Vegetation Survival Threshold Met?	Tract Mean
1	No	63%
2	Yes	
3	No*	
4	Yes	
5	Yes	
6	No	
7	Yes	
8	Yes	

*Based on planted stems alone, theis plot doesn't meet success criteria; however, when including naturally recruited stems of appropriate species such as American elm (*Ulmus americana*) and winged elm (*Ulmus alata*) this plot was well-above 320 stems per acre.

Table 8. CVS Vegetation Plot Metadata
Mill Creek Restoration Site (EEP Project Number 253)

Report Prepared By	Corri Faquin
Date Prepared	7/18/2014 14:28
database name	Axiom-EEP-2014-A-v2.3.1.mdb
database location	\\AE-SBS\RedirectedFolders\KJernigan\Desktop
computer name	KEENAN-PC
file size	41754624
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
ALL Stems by Plot and spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	253
project Name	Mill Creek
Description	Stream Enhancement and Restoration
River Basin	Yadkin
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	8

Table 9. Total and Planted Stems by Plot and Species
EEP Project Code 253. Project Name: Mill Creek

			Current Plot Data (MY3 2014)																						Annual Means								
			253-01-0001			253-01-0002			253-01-0003			253-01-0004			253-01-0005			253-01-0006			253-01-0007			253-01-0008			MY3 (2014)			MY2 (2013)			MY1 (2012)		
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	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer negundo	boxelder	Tree												7														7			7			15
Acer rubrum	red maple	Tree									3																	3			3			
Baccharis halimifolia	eastern baccharis	Shrub																								2			2			1			1
Betula nigra	river birch	Tree							2	2	2	3	3	3	2	2	3				2	2	2	1	1	1	10	10	11	9	9	9	8	8	8
Carpinus caroliniana	American hornbeam	Tree							1	1	1						10										1	1	11			8			27
Carya	hickory	Tree															8												8						3
Cercis canadensis	eastern redbud	Tree				1	1	1																			1	1	1	1	1	1	1	1	1
Cornus amomum	silky dogwood	Shrub				1	1	1	1	1	1				2	2	2	2	2	2	2	2	2	1	1	1	9	9	9	9	9	9	9	9	9
Diospyros virginiana	common persimmon	Tree				3	3	3	1	1	2				1	1	2							1	1	2	6	6	9	4	4	6	2	2	2
Fraxinus pennsylvanica	green ash	Tree	1	1	1							1	1	2			2	1	1	1				2	2	2	5	5	8	2	2	4	2	2	2
Liquidambar styraciflua	sweetgum	Tree									2			1						6						1			10			13			16
Liriodendron tulipifera	tuliptree	Tree												2															2						2
Nyssa	tupelo	Tree				1	1	1	1	1	1																2	2	2	3	3	3	3	3	3
Pinus taeda	loblolly pine	Tree									2																		2						
Platanus occidentalis	American sycamore	Tree				2	2	2							1	1	1				2	2	2	3	3	4	8	8	9	8	8	9	7	7	10
Quercus	oak	Tree										2	2	2													2	2	2	2	2	2	2	2	2
Quercus falcata	southern red oak	Tree				1	1	1																			1	1	1	1	1	1	1	1	1
Quercus michauxii	swamp chestnut oak	Tree				2	2	2																3	3	3	5	5	5	2	2	2	2	2	2
Quercus nigra	water oak	Tree	1	1	1										1	1	1				1	1	1				3	3	3	3	3	3	2	2	2
Quercus phellos	willow oak	Tree										2	2	2	2	2	2	1	1	1							5	5	5	5	5	5	5	5	5
Quercus rubra	northern red oak	Tree										5	5	5				1	1	1	2	2	2	1	1	1	9	9	9	9	9	9	7	7	7
Rhus copallinum	flameleaf sumac	shrub																		2									2						
Robinia	locust																1												1						
Robinia pseudoacacia	black locust	Tree																														1			
Sambucus canadensis	Common Elderberry	Shrub													3	3	3										3	3	3	3	3	3	3	3	3
Ulmus	elm	Tree																																	14
Ulmus alata	winged elm	Tree									50																		50			46			22
Ulmus americana	American elm	Tree									3															3			6			3			
Viburnum dentatum	southern arrowwood	Shrub													2	2	2							1	1	1	3	3	3	2	2	2	3	3	3
		Stem count	2	2	2	11	11	11	6	6	67	13	13	24	14	14	37	5	5	13	9	9	9	13	13	21	73	73	184	63	63	150	57	57	160
		size (ares)	1			1			1			1			1			1			1			1			8			8			8		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.20			0.20			0.20		
		Species count	2	2	2	7	7	7	5	5	10	5	5	8	8	8	12	4	4	6	5	5	5	8	8	11	16	16	27	15	15	23	15	15	23
		Stems per ACRE	80.94	80.94	80.94	445.2	445.2	445.2	242.8	242.8	2711	526.1	526.1	971.2	566.6	566.6	1497	202.3	202.3	526.1	364.2	364.2	364.2	526.1	526.1	849.8	369.3	369.3	930.8	318.7	318.7	758.8	288.3	288.3	809.4

Color for Density

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

PnoLS = Planted excluding livestakes
P-all = Planting including livestakes
T = All planted and natural recruits including livestakes
T includes natural recruits

APPENDIX D

STREAM SURVEY DATA

Cross-section Plots

Longitudinal Profile Plots

Substrate Plots

Tables 10a-b. Baseline Stream Data Summary

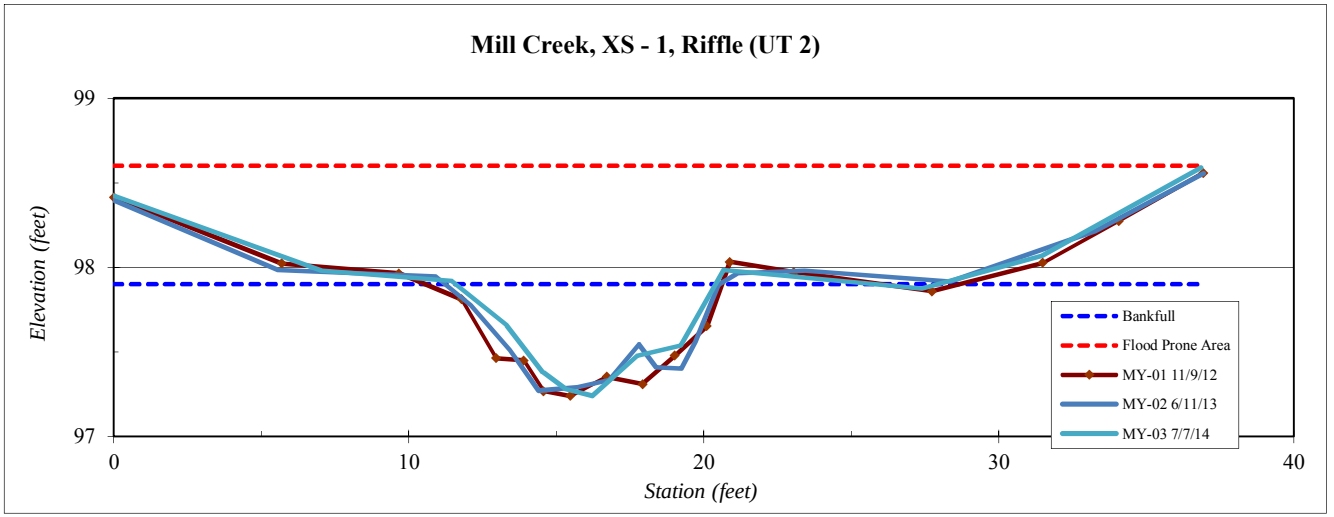
Tables 11a-b. Monitoring Data

River Basin:	Yadkin
Site	Mill Creek
XS ID	XS - 1, Riffle (UT 2)
Drainage Area (sq mi):	0.08
Date:	7/7/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.00	98.42
7.05	97.98
11.46	97.92
13.31	97.66
14.56	97.38
15.30	97.28
16.22	97.24
17.73	97.48
19.22	97.54
20.68	97.98
27.39	97.87
31.46	98.07
36.86	98.59

SUMMARY DATA	
Bankfull Elevation:	97.9
Bankfull Cross-Sectional Area:	3.3
Bankfull Width:	8.8
Flood Prone Area Elevation:	98.6
Flood Prone Width:	35.0
Max Depth at Bankfull:	0.7
Mean Depth at Bankfull:	0.4
W / D Ratio:	23.5
Entrenchment Ratio:	4.0
Bank Height Ratio:	1.0

Stream Type	B/C

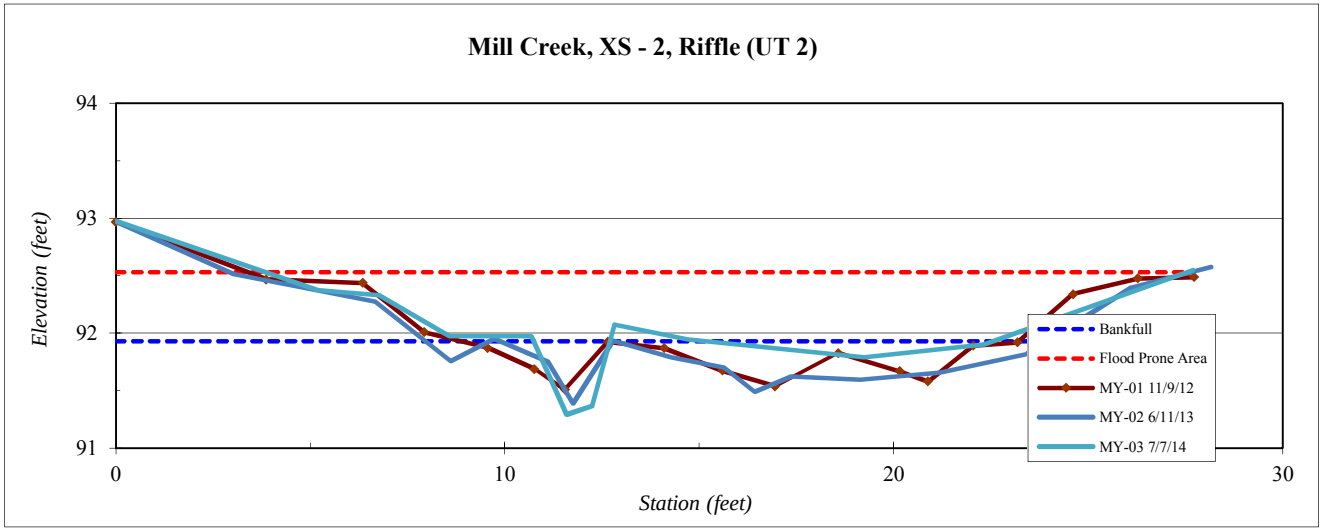


River Basin:	Yadkin
Site	Mill Creek
XS ID	XS - 2, Riffle (UT 2)
Drainage Area (sq mi):	0.08
Date:	7/7/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.00	92.97
5.18	92.37
6.76	92.33
8.58	91.98
10.68	91.98
11.59	91.29
12.25	91.36
12.82	92.07
14.70	91.94
19.24	91.79
22.31	91.90
27.69	92.54

SUMMARY DATA	
Bankfull Elevation:	91.9
Bankfull Cross-Sectional Area:	1.3
Bankfull Width:	9.4
Flood Prone Area Elevation:	92.5
Flood Prone Width:	21.0
Max Depth at Bankfull:	0.6
Mean Depth at Bankfull:	0.1
W / D Ratio:	68.0
Entrenchment Ratio:	2.2
Bank Height Ratio:	1.0

Stream Type	B/C

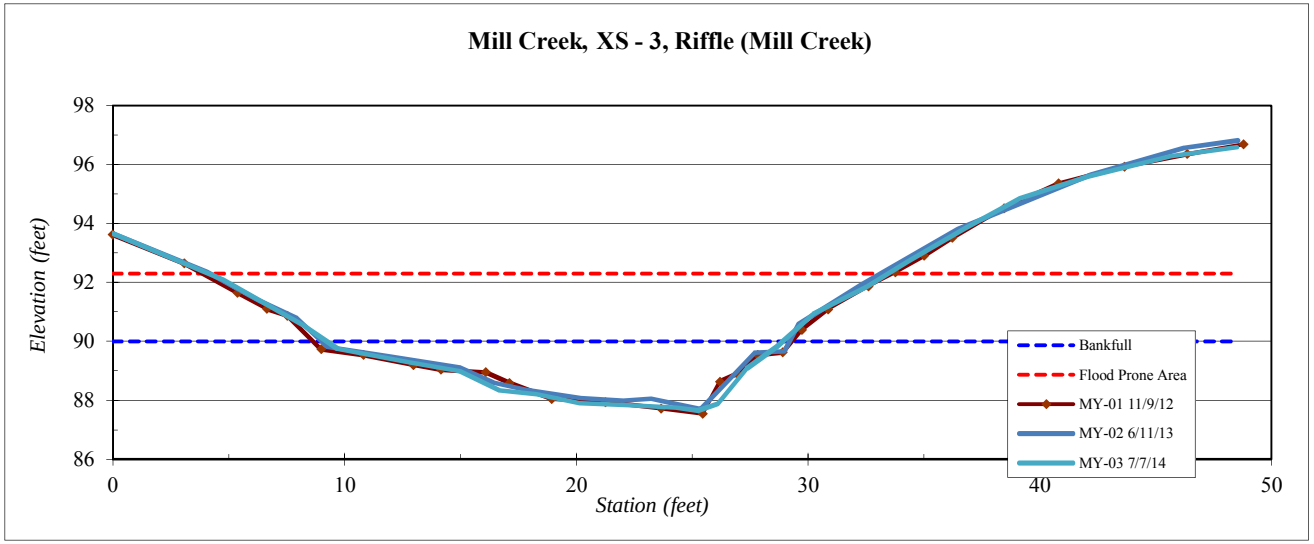


River Basin:	Yadkin
Site	Mill Creek
XS ID	XS - 3, Riffle (Mill Creek)
Drainage Area (sq mi):	1.33
Date:	7/7/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.00	93.65
4.75	92.10
8.22	90.56
9.69	89.75
12.76	89.28
14.98	89.00
16.69	88.35
18.29	88.20
20.15	87.91
22.20	87.83
24.30	87.74
25.25	87.65
26.10	87.88
27.36	89.07
28.6	89.81
30.2	90.94
32.5	91.86
34.3	92.73
36.8	93.83
39.1	94.86
42.1	95.59
45.7	96.28
48.5	96.59

SUMMARY DATA	
Bankfull Elevation:	90.0
Bankfull Cross-Sectional Area:	27.9
Bankfull Width:	19.7
Flood Prone Area Elevation:	92.3
Flood Prone Width:	30.0
Max Depth at Bankfull:	2.3
Mean Depth at Bankfull:	1.4
W / D Ratio:	13.9
Entrenchment Ratio:	1.5
Bank Height Ratio:	1.3

Stream Type	B

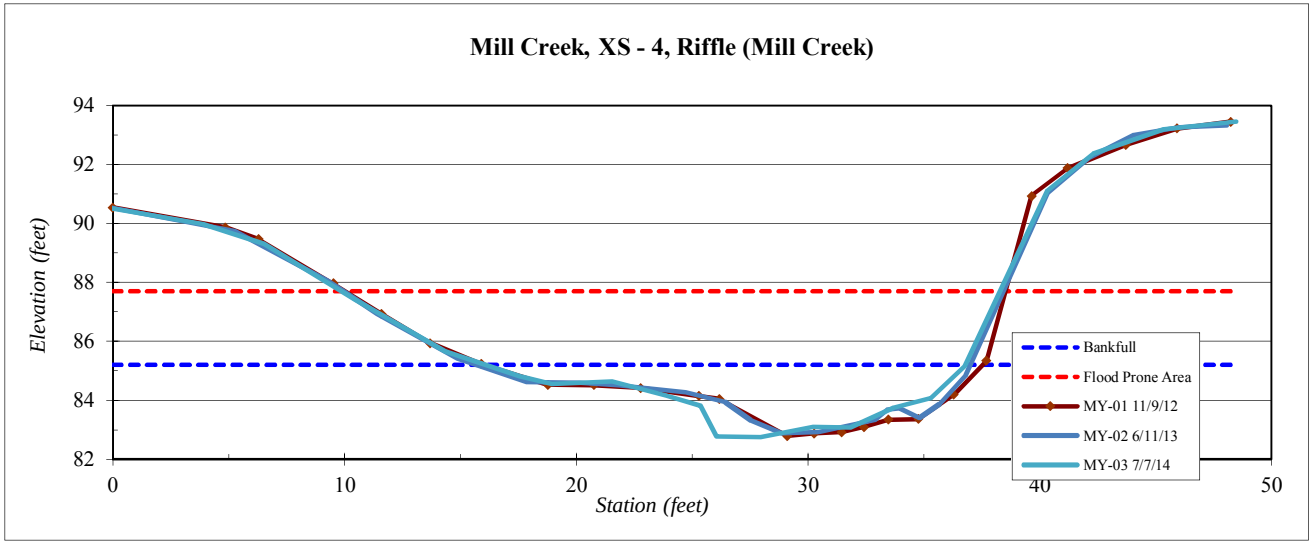


River Basin:	Yadkin
Site	Mill Creek
XS ID	XS - 4, Riffle (Mill Creek)
Drainage Area (sq mi):	1.33
Date:	7/7/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.00	90.52
3.88	89.99
6.51	89.31
10.44	87.42
14.33	85.67
17.56	84.82
18.95	84.56
21.56	84.65
23.87	84.16
25.36	83.82
26.05	82.78
27.96	82.75
30.22	83.09
31.83	83.07
33.7	83.76
35.3	84.09
36.8	85.15
40.3	91.12
42.3	92.38
45.4	93.19
48.5	93.46

SUMMARY DATA	
Bankfull Elevation:	85.2
Bankfull Cross-Sectional Area:	26.9
Bankfull Width:	20.7
Flood Prone Area Elevation:	87.7
Flood Prone Width:	28.0
Max Depth at Bankfull:	2.5
Mean Depth at Bankfull:	1.3
W / D Ratio:	15.9
Entrenchment Ratio:	1.4
Bank Height Ratio:	2.8

Stream Type	B

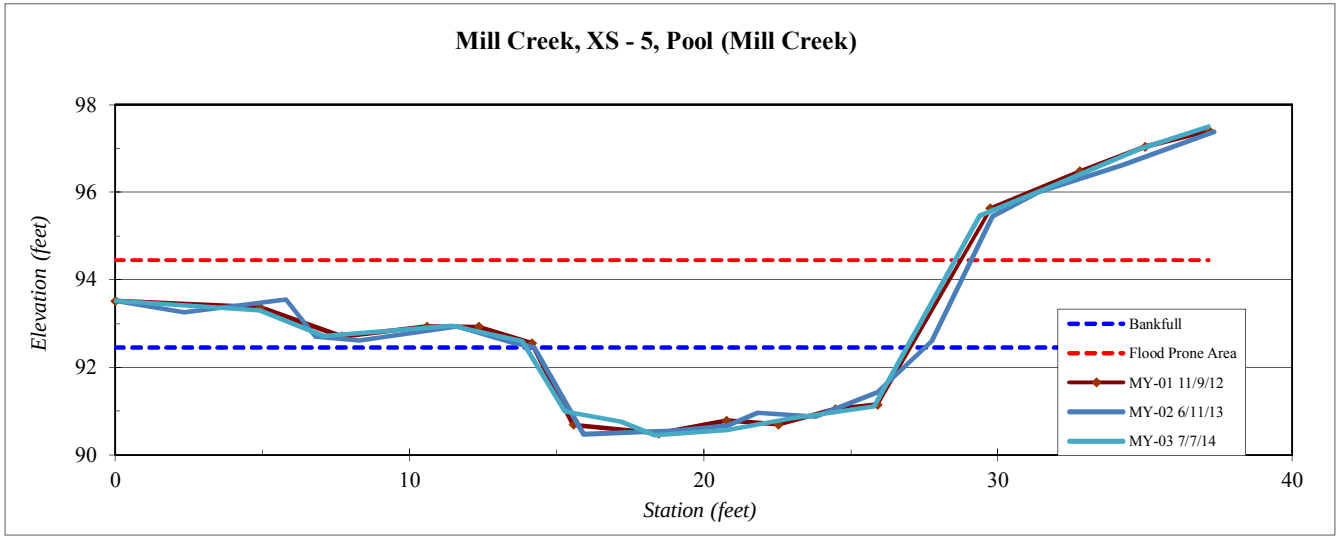


River Basin:	Yadkin
Site	Mill Creek
XS ID	XS - 5, Pool (Mill Creek)
Drainage Area (sq mi):	1.33
Date:	7/7/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.0	93.5
4.9	93.3
7.1	92.7
11.4	92.9
13.8	92.6
15.3	91.0
17.2	90.8
18.3	90.4
20.8	90.6
22.9	90.8
25.8	91.1
29.4	95.5
32.0	96.2
34.8	96.98
37.2	97.50

SUMMARY DATA	
Bankfull Elevation:	92.5
Bankfull Cross-Sectional Area:	19.6
Bankfull Width:	12.9
Flood Prone Area Elevation:	---
Flood Prone Width:	---
Max Depth at Bankfull:	2.0
Mean Depth at Bankfull:	1.5
W / D Ratio:	---
Entrenchment Ratio:	---
Bank Height Ratio:	1.0

Stream Type	B/C

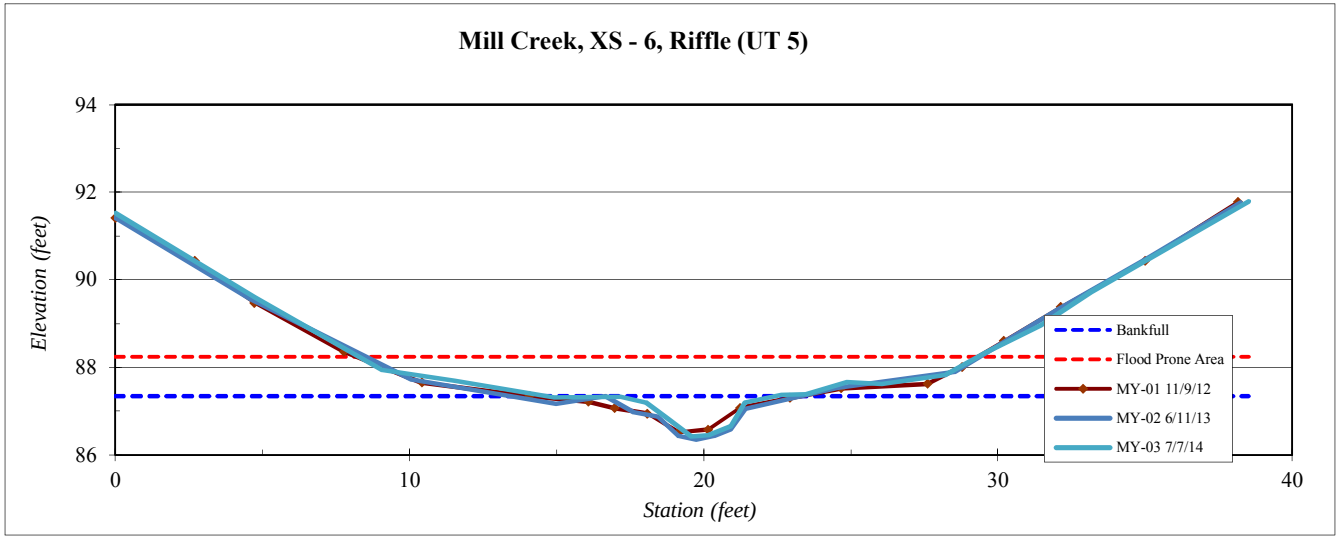


River Basin:	Yadkin
Site	Mill Creek
XS ID	XS - 6, Riffle (UT 5)
Drainage Area (sq mi):	0.06
Date:	7/7/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.0	91.5
4.7	89.6
9.1	87.9
11.5	87.7
14.9	87.3
17.2	87.3
18.0	87.2
18.8	86.8
19.6	86.4
20.2	86.4
20.9	86.7
21.4	87.2
22.6	87.4
23.5	87.38
24.9	87.67
26.1	87.62
28.2	87.82
29.6	88.34
31.5	88.97
33.2	89.72
38.5	91.79

SUMMARY DATA	
Bankfull Elevation:	87.3
Bankfull Cross-Sectional Area:	2.3
Bankfull Width:	5.3
Flood Prone Area Elevation:	88.2
Flood Prone Width:	23.0
Max Depth at Bankfull:	0.9
Mean Depth at Bankfull:	0.4
W / D Ratio:	12.2
Entrenchment Ratio:	4.3
Bank Height Ratio:	1.0

Stream Type	B/C

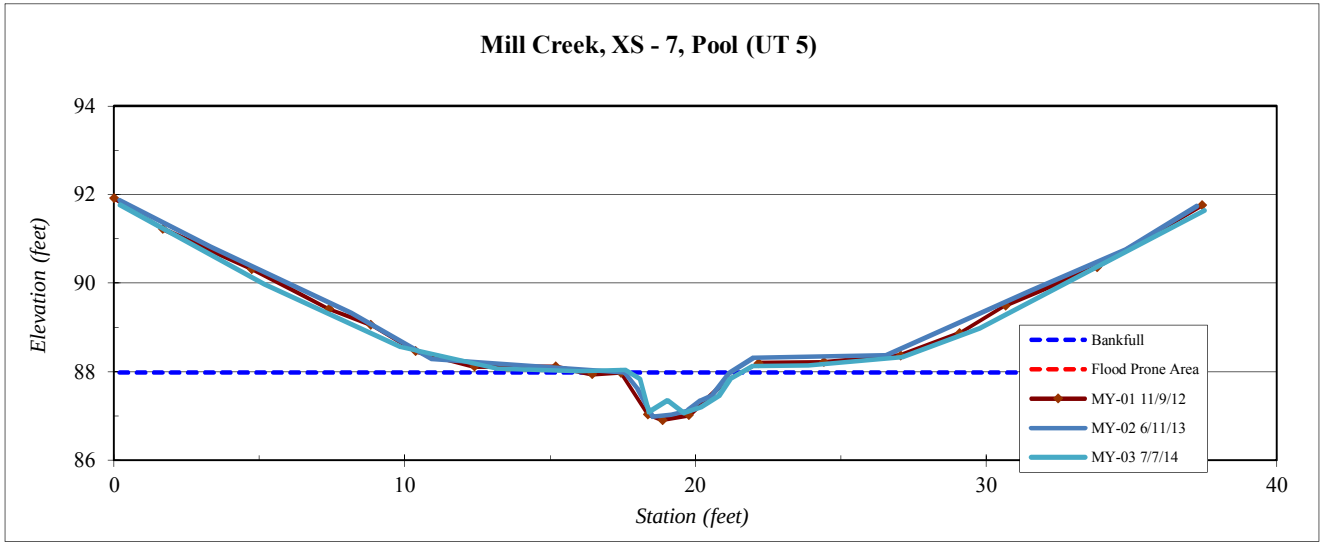


River Basin:	Yadkin
Site	Mill Creek
XS ID	XS - 7, Pool (UT 5)
Drainage Area (sq mi):	0.06
Date:	7/7/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.2	91.8
5.2	90.0
9.9	88.6
13.2	88.1
16.0	88.0
17.6	88.0
18.1	87.8
18.4	87.1
19.0	87.3
19.6	87.1
20.2	87.2
20.8	87.5
21.2	87.8
22.0	88.13
23.9	88.14
27.1	88.33
29.8	88.98
37.5	91.63

SUMMARY DATA	
Bankfull Elevation:	88.0
Bankfull Cross-Sectional Area:	2.2
Bankfull Width:	3.8
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	0.9
Mean Depth at Bankfull:	0.6
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	1.0

Stream Type	B/C

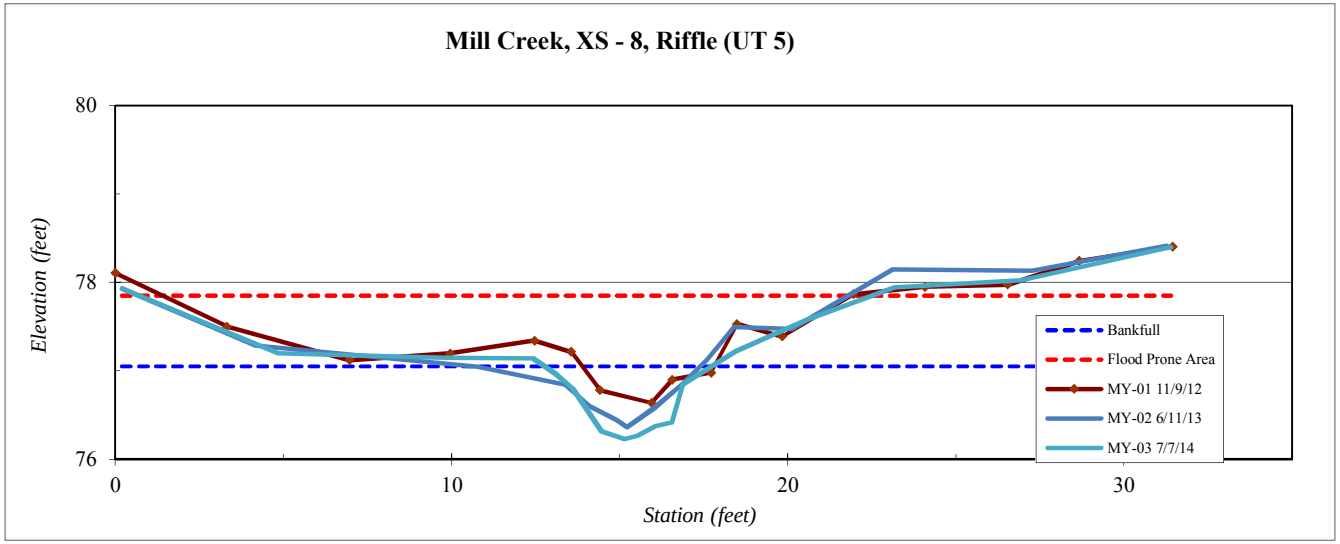


River Basin:	Yadkin
Site	Mill Creek
XS ID	XS - 8, Riffle (UT 5)
Drainage Area (sq mi):	0.06
Date:	7/7/2014
Field Crew:	Perkinson, Jernigan

Station	Elevation
0.2	77.9
4.8	77.2
9.8	77.1
12.4	77.1
13.1	77.0
13.6	76.8
14.5	76.3
15.2	76.2
15.5	76.3
16.1	76.4
16.6	76.4
16.9	76.8
18.5	77.2
20.5	77.57
23.2	77.95
26.9	78.02
31.4	78.40

SUMMARY DATA	
Bankfull Elevation:	77.1
Bankfull Cross-Sectional Area:	2.3
Bankfull Width:	5.0
Flood Prone Area Elevation:	77.9
Flood Prone Width:	20.0
Max Depth at Bankfull:	0.8
Mean Depth at Bankfull:	0.5
W / D Ratio:	10.9
Entrenchment Ratio:	4.0
Bank Height Ratio:	1.0

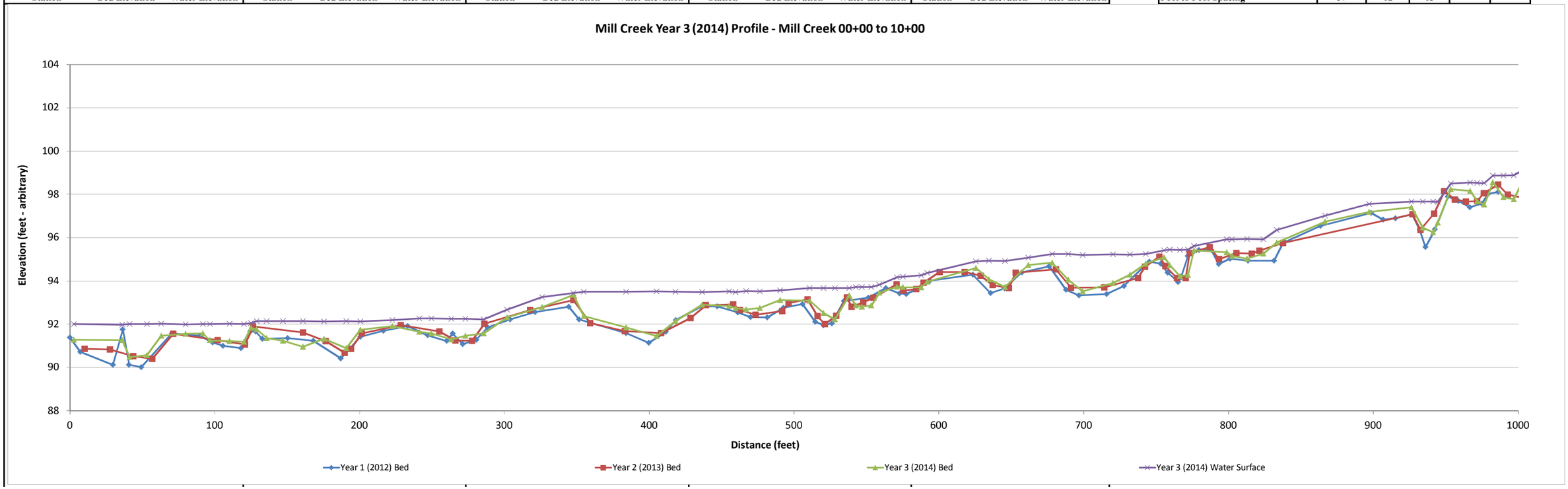
Stream Type	C/B



Project Name	Mill Creek - Profile
Reach	Mill Creek Station 00+00 - 10+00
Feature	Profile
Date	7/7/14
Crew	Perkinson, Jernigan

2012 Year 1 Monitoring \Survey			2013 Year 2 Monitoring \Survey			2014 Year 3 Monitoring \Survey			2015 Year 4 Monitoring \Survey			2016 Year 5 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**

	2012	2013	2014	2015	2016
Avg. Water Surface Slope	0.0074	0.0062	0.0072		
Riffle Length	23	42	28		
Avg. Riffle Slope	0.0118	0.0108	0.0107		
Pool Length	34	33	38		
Pool to Pool Spacing	57	62	63		

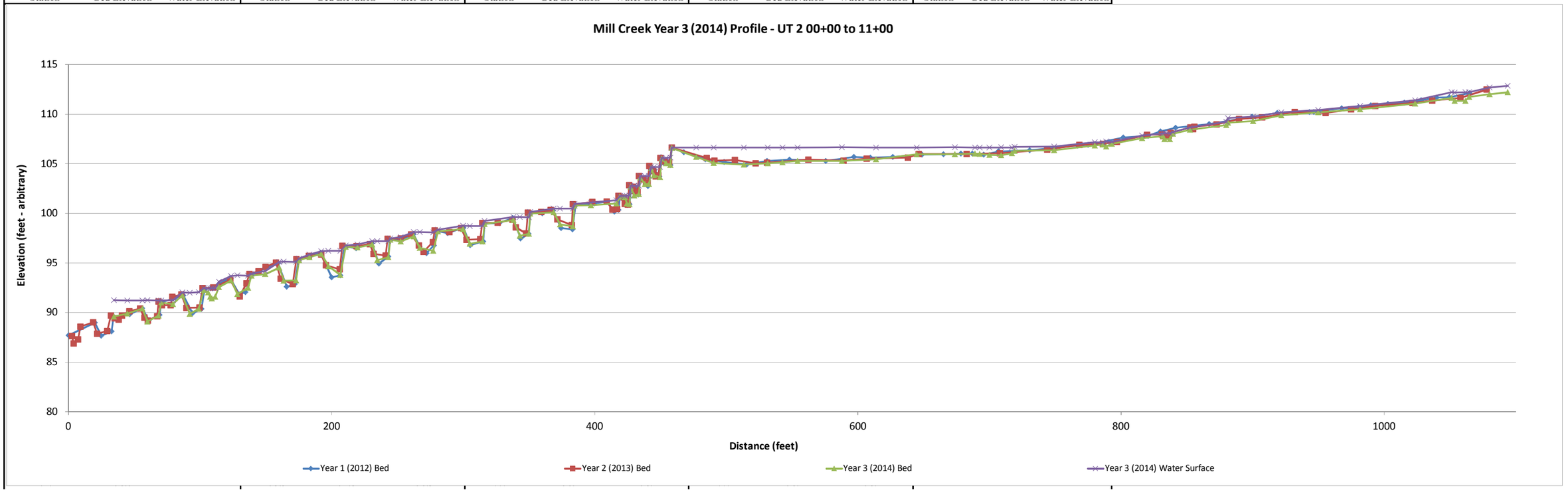


Project Name	Mill Creek - Profile
Reach	UT 2 Station 00+00 - 11+00
Feature	Profile
Date	7/7/14
Crew	Perkinson, Jernigan

2012 Year 1 Monitoring \Survey			2013 Year 2 Monitoring \Survey			2014 Year 3 Monitoring \Survey			2015 Year 4 Monitoring \Survey			2016 Year 5 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**

	2012	2013	2014	2015	2016
Avg. Water Surface Slope	**	0.0249	0.0204		
Riffle Length	20	15	20		
Avg. Riffle Slope	**	0.0325	0.0239		
Pool Length	15	11	14		
Pool to Pool Spacing	34	23	36		

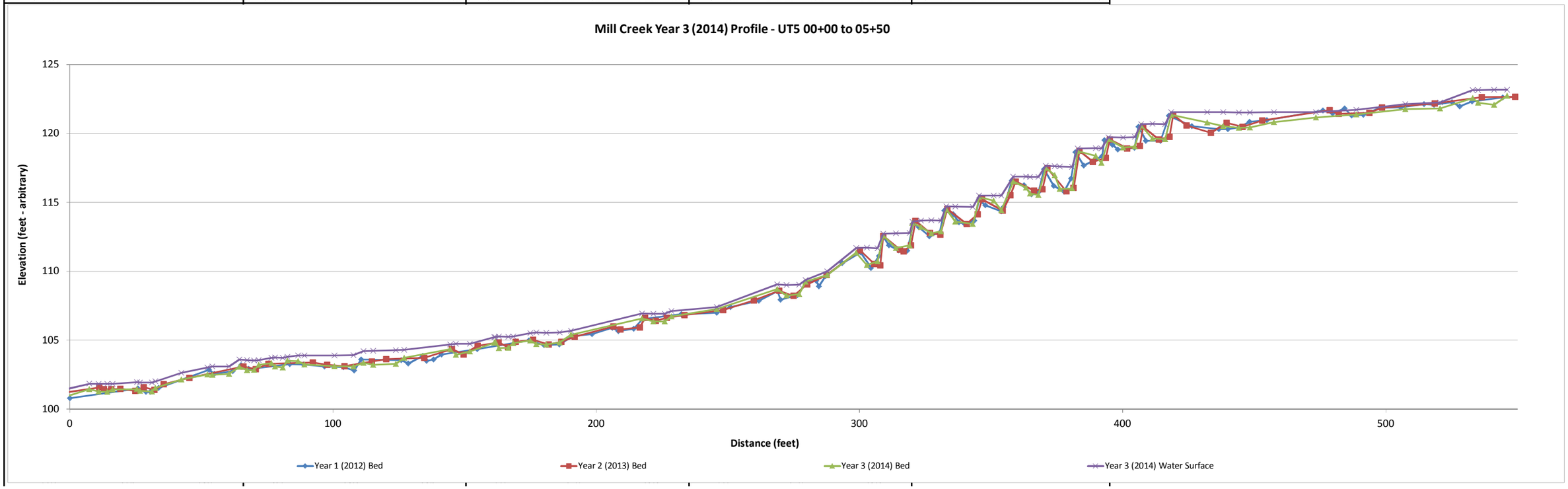
** No water in channel during field measurments.



Project Name	Mill Creek - Profile
Reach	UT 5 Station 00+00 - 05+50
Feature	Profile
Date	7/7/14
Crew	Perkinson, Jernigan

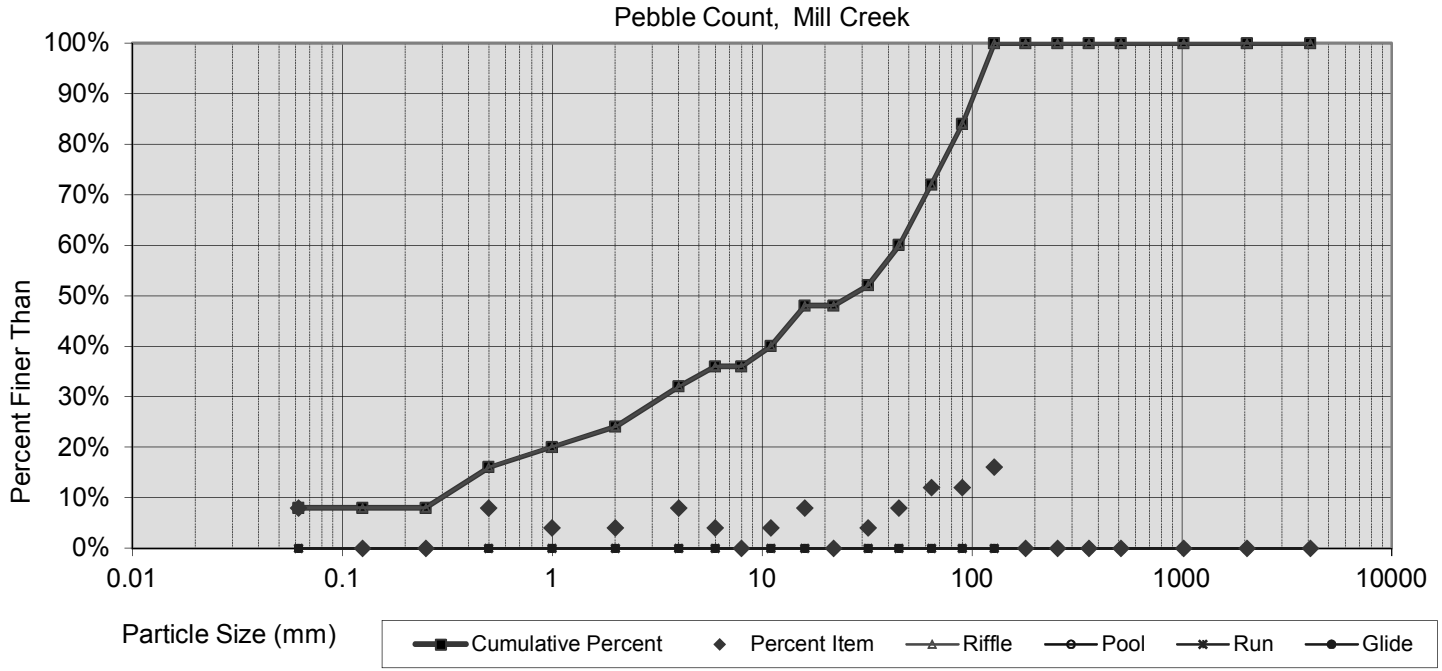
	2012	2013	2014	2015	2016
Avg. Water Surface Slope	0.0201	0.0419	0.0397		
Riffle Length	30	23	15		
Avg. Riffle Slope	0.0235	0.0401	0.0273		
Pool Length	21	13	12		
Pool to Pool Spacing	44	21	23		

2012 Year 1 Monitoring \Survey			2013 Year 2 Monitoring \Survey			2014 Year 3 Monitoring \Survey			2015 Year 4 Monitoring \Survey			2016 Year 5 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**



	Mill Creek
	Yadkin

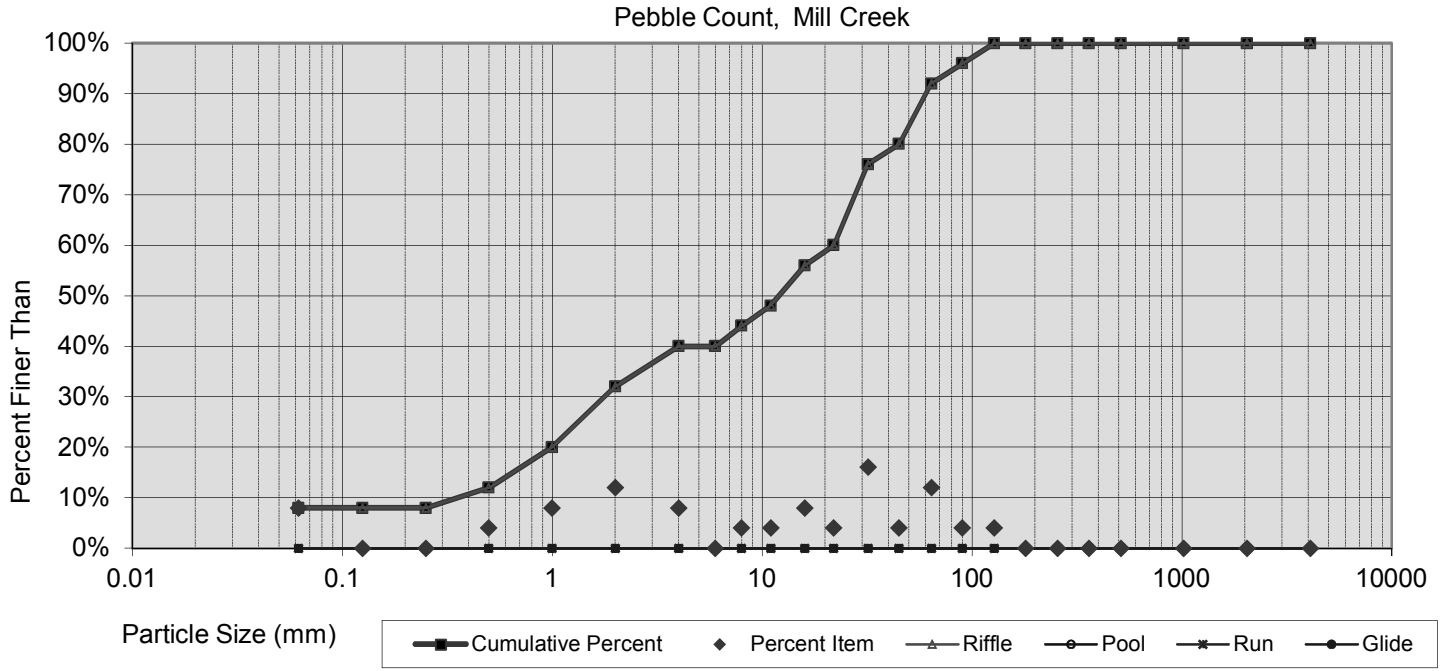
Note:	**Cross Section 3 (Mill Creek)**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.500	5.42	26.5	90	115	8%	16%	48%	28%	0%	0%

	Mill Creek
	Yadkin

Note:	**Cross Section 6 (UT 5)**



Size percent less than (mm)					Percent by substrate type					
D16	D35	D50	D84	D95	silt/clay	sand	gravel	cobble	boulder	bedrock
0.707	2.59	12.1	51	83	8%	24%	60%	8%	0%	0%

Table 10a. Baseline Stream Data Summary - Mill Creek
Mill Creek (EEP Project Number 253)

Parameter	Gauge	Regional Curve			Pre-Existing Condition - Mill Creek					Reference Reach(es) Data - Mickey					Design - Mill Cr			Year 1 (2012) Monitoring - Mill Creek				
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)							25.3								18.2	20.3		20.7			21.5	
Floodprone Width (ft)							37								25	40		22			28	
BF Mean Depth (ft)							1.3								1.4	1.5		1.3			1.3	
BF Max Depth (ft)							1.9								1.7	2.1		2.4			2.5	
BF Cross Sectional Area (ft^2)							27.6										27.6	27.0			27.1	
Width/Depth Ratio							19.8								12.0	15.0		15.8			17.1	
Entrenchment Ratio							1.4								1.4	2.0		1.1			1.3	
Bank Height Ratio							1.8								1.0	1.1		1.0			1.0	
Profile																						
Riffle length (ft)																		4	23	18	61	18
Riffle slope (ft/ft)															0.0099	0.0162		0.0003	0.0132	0.0118	0.0299	0.0091
Pool length (ft)																		17	39	34	92	21
Pool Max depth (ft)															2.8	4.5						
Pool spacing (ft)															27.3	101.7		24	58	57	148	30
Pattern																						
Channel Beltwidth (ft)																		The majority of the channel is Enhacnement with no design channel, or measurable bends.				
Radius of Curvature (ft)																						
Rc:Bankfull width (ft/ft)																						
Meander Wavelength (ft)																						
Meander Width ratio																						
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							B3c/1					B4				B3c/2				B-type		
Bankfull Velocity (fps)							2.6									2.6				2.6		
Bankfull Discharge (cfs)							70.42															
Valley Length (ft)							1460					----										
Channel Thalweg Length (ft)							-----					----				2214				986		
Sinuosity							1.3									1.3				1.3		
Water Surface Slope (ft/ft)							0.009									0.009				0.0074		
BF slope (ft/ft)							-----					-----				-----				----		
Bankfull Floodplain Area (acres)							-----					----				-----				----		
% of Reach with Eroding Banks							-----					-----										
Channel Stability or Habitat Metric							----					-----										
Biological or Other							-----					-----										

Table 10b. Baseline Stream Data Summary (Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)
Mill Creek (EEP Project Number 253)

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	9.8	43.0	90.0	>2048	>2048																						
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 10a. Baseline Stream Data Summary - UT 2
Mill Creek (EEP Project Number 253)

Parameter	Gauge	Regional Curve			Pre-Existing Condition - UT 2					Reference Reach(es) Data - Mickey					Design - UT 2			Year 1 (2012) Monitoring - UT 2				
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)							7.2								6.8	7.5		9.5			15.4	
Floodprone Width (ft)							12								15	25		21			35	
BF Mean Depth (ft)							0.5								0.5	0.6		0.2			0.4	
BF Max Depth (ft)							1.1								0.6	0.8		0.5			0.6	
BF Cross Sectional Area (ft^2)							3.5										3.8	3.6			3.8	
Width/Depth Ratio							14.7								12.0	15.0		24.1			65.6	
Entrenchment Ratio							1.7								2.2	3.3		1.4			3.7	
Bank Height Ratio							1.7								1.0	1.1		1.0			1.0	
Profile																						
Riffle length (ft)																		3	22	20	81	20
Riffle slope (ft/ft)															0.0154	0.0252		**	**	**	**	**
Pool length (ft)																		4	19	15	113	24
Pool Max depth (ft)															1.0	1.8						
Pool spacing (ft)															10.1	37.7		7	37	34	139	33
Pattern																						
Channel Beltwidth (ft)																		The majority of the channel is Enhacnement with no design channel, or measurable bends.				
Radius of Curvature (ft)																						
Rc:Bankfull width (ft/ft)																						
Meander Wavelength (ft)																						
Meander Width ratio																						
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							B5/1					B4				B5/1				B/C-type		
Bankfull Velocity (fps)							2.4									2.2				2.2		
Bankfull Discharge (cfs)							8.4															
Valley Length (ft)							-----					----										
Channel Thalweg Length (ft)							1703					----				875				1065		
Sinuosity							1.1									1.1				1.14		
Water Surface Slope (ft/ft)							0.014									0.014				No water in channel during field survey.		
BF slope (ft/ft)							-----					-----				-----				----		
Bankfull Floodplain Area (acres)							-----					----				-----				----		
% of Reach with Eroding Banks							-----					-----										
Channel Stability or Habitat Metric							----					-----										
Biological or Other							-----					-----										

** No Water in UT During Field Measurements

Table 10b. Baseline Stream Data Summary (Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)
Mill Creek (EEP Project Number 253)

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	0.1	0.6	1.0	5.2	8.5																						
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 10a. Baseline Stream Data Summary - UT 5
Mill Creek (EEP Project Number 253)

Parameter	Gauge	Regional Curve			Pre-Existing Condition - UT 5					Reference Reach(es) Data - Mickey					Design - UT 5			Year 1 (2012) Monitoring - UT 5				
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)							4.9								6.8	7.5		4.5			10.3	
Floodprone Width (ft)							33								15	30		18			22	
BF Mean Depth (ft)							0.6								0.5	0.6		0.3			0.4	
BF Max Depth (ft)							1.4								0.6	0.8		0.6			0.9	
BF Cross Sectional Area (ft^2)							3.1										3.8	1.6			3.5	
Width/Depth Ratio							7.8								12.0	15.0		12.7			30.1	
Entrenchment Ratio							4.0								2.2	4.0		2.1			4.0	
Bank Height Ratio							1.5								1.0	1.1		1.0			1.0	
Profile																						
Riffle length (ft)																		4	18	17	33	8
Riffle slope (ft/ft)															0.0358	0.0585		0.0057	0.0424	0.0268	0.1508	0.0459
Pool length (ft)																		4	13	12	31	6
Pool Max depth (ft)															1.0	1.8						
Pool spacing (ft)															10.1	37.7		7	21	14	50	12
Pattern																						
Channel Beltwidth (ft)																		The majority of the channel is Enhacnement with no design channel, or measurable bends.				
Radius of Curvature (ft)																						
Rc:Bankfull width (ft/ft)																						
Meander Wavelength (ft)																						
Meander Width ratio																						
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							B4/1					B4				B4/1				E-type		
Bankfull Velocity (fps)							2.5									2.5				2.5		
Bankfull Discharge (cfs)							9.6															
Valley Length (ft)							-----					----										
Channel Thalweg Length (ft)							200					----				125				544		
Sinuosity							1.2									1.2				1.17		
Water Surface Slope (ft/ft)							0.0325									0.0381				0.0424		
BF slope (ft/ft)							-----					-----				-----				----		
Bankfull Floodplain Area (acres)							-----					----				-----				----		
% of Reach with Eroding Banks							-----					-----										
Channel Stability or Habitat Metric							----					-----										
Biological or Other							-----					-----										

Table 10b. Baseline Stream Data Summary (Substrate, Bed, Bank, and Hydrologic Containment Parameter Distributions)
Mill Creek (EEP Project Number 253)

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 11a. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters - Cross Sections)
Mill Creek (EEP Project Number 253)

Parameter	Cross Section 1 - UT 2							Cross Section 2 - UT 2							Cross Section 3 - Mill Creek							Cross Section 4 - Mill Creek						
	Riffle							Riffle							Riffle							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)		9.5	9.3	8.8					15.4	15.6	9.4					20.7	20.2	19.7					21.5	21.3	20.7			
Floodprone Width (ft) (approx)		35.0	35.0	35.0					21.0	21.0	21.0					22.0	30.0	30.0					28.0	28.0	28.0			
BF Mean Depth (ft)		0.4	0.4	0.4					0.2	0.2	0.1					1.3	1.2	1.4					1.3	1.2	1.3			
BF Max Depth (ft)		0.6	0.6	0.7					0.5	0.5	0.6					2.5	2.3	2.3					2.4	2.3	2.5			
BF Cross Sectional Area (ft^2)		3.8	3.8	3.3					3.6	3.4	1.3					27.0	25.2	27.9					27.1	26.0	26.9			
Width/Depth Ratio		23.8	22.8	23.5					65.9	71.6	68.0					15.9	16.2	13.9					17.1	17.4	15.9			
Entrenchment Ratio		3.7	3.8	4.0					1.4	1.3	2.2					1.1	1.5	1.5					1.3	1.3	1.4			
Bank Height Ratio		1.0	1.0	1.0					1.0	1.0	1.0					1.3	1.3	1.3					1.0	2.9	2.8			
d50 (mm)		--	--	--					--	--	--					49.1	3.7	26.5					--	--	--			

Parameter	Cross Section 5 - Mill Creek							Cross Section 6 - UT 5							Cross Section 7 - UT 5							Cross Section 8 - UT 5						
	Pool							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)		12.9	13.3	12.9					10.3	6.7	5.3					5.4	3.7	3.8					4.5	6.6	5.0			
Floodprone Width (ft) (approx)		NA	NA	NA					22.0	23.0	23.0					NA	NA	NA					18.0	20.0	20.0			
BF Mean Depth (ft)		1.6	1.4	1.5					0.3	0.5	0.4					0.5	0.6	0.6					0.4	0.3	0.5			
BF Max Depth (ft)		2.1	2.0	2.0					0.9	1.0	0.9					1.1	1.0	0.9					0.6	0.7	0.8			
BF Cross Sectional Area (ft^2)		20.8	19.2	19.6					3.5	3.1	2.3					2.7	2.3	2.2					1.6	1.9	2.3			
Width/Depth Ratio		NA	NA	NA					30.3	14.5	12.2					NA	NA	NA					12.7	22.9	10.9			
Entrenchment Ratio		NA	NA	NA					2.1	3.4	4.3					NA	NA	NA					4.0	3.0	4.0			
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			
d50 (mm)		--	--	--					22.0	10.2	12.1					--	--	--					--	--	--			

Table 11b. Monitoring Data - Stream Reach Data Summary
Mill Creek (EEP Project Number 253)

Parameter	Baseline					MY-1 (Mill Creek)					MY-2 (Mill Creek)					MY-3 (Mill Creek)					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)						20.7			21.5		20.2			21.3		19.7			20.7										
Floodprone Width (ft						22			28		28			30		28			30										
BF Mean Depth (ft)						1.3			1.3		1.2			1.2		1.3			1.4										
BF Max Depth (ft)						2.4			2.5		2.3			2.3		2.3			2.5										
BF Cross Sectional Area (ft²)						27.0			27.1		25.2			26.0		26.9			27.9										
Width/Depth Ratio						15.8			17.1		16.2			17.5		13.9			15.9										
Entrenchment Ratio						1.1			1.3		1.3			1.5		1.4			1.5										
Bank Height Ratio						1.0			1.0		1.3			2.9		1.3			2.8										
Profile - Mill Creek																													
Riffle length (ft						4	23	18	61	18	10	42	28	148	41	4	28	21	93	22									
Riffle slope (ft/ft						0.0003	0.0132	0.0118	0.0299	0.0091	0.0000	0.0108	0.0103	0.0322	0.0103	0.0000	0.0107	0.0120	0.0272	0.0088									
Pool length (ft						17	39	34	92	21	18	33	27	91	19	16	38	30	89	22									
Pool Max depth (ft																													
Pool spacing (ft)						24	58	57	148	30	18	62	55	153	38	21	63	59	135	34									
Pattern - Mill Creek																													
Channel Beltwidth (ft						The majority of the channel is Enhacnement with no design channel, or measurable bends.																							
Radius of Curvature (ft)																													
Rc:Bankfull width (ft/ft)																													
Meander Wavelength (ft																													
Meander Width ratio																													
Additional Reach Parameters																													
Rosgen Classificatior						B-type					B-type					B-type													
Channel Thalweg Length (ft						986					1146					1070													
Sinuosity						1.27					1.27					1.27													
Water Surface Slope (Channel) (ft/ft						0.0074					0.0062					0.0072													
BF slope (ft/ft)						----					----																		
Ri%/RU%P%G%/S%																													
SC%/SA%/G%/C%/B%BE%											12	24	44	20	0	8	16	48	28	0									
d16/d35/d50/d84/d95											0.5	1.9	3.7	76	111	0.5	5.42	26.5	90	115									
% of Reach with Eroding Banks						1					0					0													
Channel Stability or Habitat Metric						----					----					----													
Biological or Other						----					----					----													

** No Water in UT During Field Measurements.

Table 11b. Monitoring Data - Stream Reach Data Summary
Mill Creek (EEP Project Number 253)

Parameter	Baseline					MY-1 (UT 2)					MY-2 (UT 2)					MY-3 (UT 2)					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)						9.5			15.4		9.3			15.6		8.8			9.4											
Floodprone Width (ft						21			35		21			35		21			35										
BF Mean Depth (ft)						0.2			0.4		0.2			0.4		0.1			0.4										
BF Max Depth (ft)						0.5			0.6		0.5			0.6		0.6			0.7										
BF Cross Sectional Area (ft²)						3.6			3.8		3.4			3.8		1.3			3.3										
Width/Depth Ratio						24.1			65.6		22.7			72.4		23.4			65.8										
Entrenchment Ratio						1.4			3.7		1.3			3.8		2.2			4.0										
Bank Height Ratio						1.0			1.0		1.0			1.0		1.0			1.0										
Profile - UT 2																													
Riffle length (ft						3	22	20	81	20	3	15	18	26	8	3	32	20	170	37									
Riffle slope (ft/ft						**	**	**	**	**	0.0000	0.0325	0.0279	0.0692	0.0245	0.0000	0.0239	0.0217	0.0639	0.0194									
Pool length (ft						4	19	15	113	24	4	11	13	18	5	4	21	14	168	34									
Pool Max depth (ft																													
Pool spacing (ft						7	37	34	139	33	8	23	26	36	13	7	47	36	186	48									
Pattern - UT 2																													
Channel Beltwidth (ft						The majority of the channel is Enhacnement with no design channel, or measurable bends.																							
Radius of Curvature (ft																													
Rc:Bankfull width (ft/ft																													
Meander Wavelength (ft																													
Meander Width ratio																													
Additional Reach Parameters																													
Rosgen Classification						B/C-type					B/C-type					B/C-type													
Channel Thalweg Length (ft						1065					1079					1059													
Sinuosity						1.14					1.14					1.14													
Water Surface Slope (Channel) (ft/ft						No water in channel during field survey.					0.0249					0.0204													
BF slope (ft/ft						----					----					----													
Ri%/RU%P%G%/S%																													
SC%/SA%/G%/C%/B%BE%											----	----	----	----	----	----	----	----	----	----									
d16/d35/d50/d84/d95											----	----	----	----	----	----	----	----	----										
% of Reach with Eroding Banks						0					0					0													
Channel Stability or Habitat Metric						----					----					----													
Biological or Other						----					----					----													

** No Water in UT During Field Measurements.

Table 11b. Monitoring Data - Stream Reach Data Summary
Mill Creek (EEP Project Number 253)

Parameter	Baseline					MY-1 (UT 5)					MY-2 (UT 5)					MY-3 (UT 5)					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)						4.5			10.3		6.6			6.7		5.0			5.3											
Floodprone Width (ft						18			22		20			23		20			23										
BF Mean Depth (ft)						0.3			0.4		0.3			0.5		0.4			0.5										
BF Max Depth (ft)						0.6			0.9		0.7			1.0		0.8			0.9										
BF Cross Sectional Area (ft²)						1.6			3.5		1.9			3.1		2.3			2.3										
Width/Depth Ratio						12.7			30.1		14.1			22.8		10.7			12.0										
Entrenchment Ratio						2.1			4.0		3.0			3.5		4.0			4.4										
Bank Height Ratio						1.0			1.0		1.0			1.0		1.0			1.0										
Profile - UT 5																													
Riffle length (ft						4	18	17	33	8	7	23	20	51	13	3	16	9	76	18									
Riffle slope (ft/ft						0.0057	0.0424	0.0268	0.1508	0.0459	0.0072	0.0401	0.0336	0.1237	0.0314	0.0000	0.0289	0.0213	0.1231	0.0305									
Pool length (ft						4	13	12	31	6	7	13	12	28	5	5	12	11	31	7									
Pool Max depth (ft																													
Pool spacing (ft						7	21	14	50	12	8	21	14	47	13	7	23	14	89	18									
Pattern - UT 5																													
Channel Beltwidth (ft						The majority of the channel is Enhacnement with no design channel, or measurable bends.																							
Radius of Curvature (ft																													
Rc:Bankfull width (ft/ft																													
Meander Wavelength (ft																													
Meander Width ratio																													
Additional Reach Parameters																													
Rosgen Classificatior						E-type					E-type					E-type													
Channel Thalweg Length (ft						544					555					548													
Sinuosity						1.17					1.17					1.17													
Water Surface Slope (Channel) (ft/ft						0.0424					0.0419					0.0397													
BF slope (ft/ft)						----					----																		
Ri%/RU%P%G%/S%																													
SC%/SA%/G%/C%/B%BE%											8	20	56	16	0	8	24	60	8	0									
d16/d35/d50/d84/d95											1	3.7	10.2	64	87	0.71	2.59	12.1	51	83									
% of Reach with Eroding Banks						0					0					0													
Channel Stability or Habitat Metric						----					----					----													
Biological or Other						----					----					----													

** No Water in UT During Field Measurements.

APPENDIX E

Table 12. Verification of Bankfull Events

Table 12. Verification of Bankfull Events
Mill Creek Restoration Site (EEP Project Number 253)

Date of Data Collection	Date of Occurrence	Method	Photo (if available)
June 10, 2013	June 7, 2013	Crest gauge observations indicated bankfull event on UT2 and UT5 after 3.64 inches* of rain between June 2 and 7, 2013.	-
November 25, 2013	July 11, 2013	Crest gauge observations indicated a bankfull event 2.06 inches* of rain fall documented between July 10-11, 2013 following a total of 4.31 inches* of rain fall documented to fall during 14 out of the proceeding 15 days (June 25-July 8, 2013).	-
August 18, 2014	March 7, 2014	2.02 inches* of rain fall documented between March 6-7, 2014.	-
August 18, 2014	May 15, 2014	2.08 inches* of rain fall documented on May 15, 2014.	
September 16, 2014	August 1, 2014	Large wrack and debris piles observed on Mill Creek, UT2, and UT5, as well as structure failures on UT2 and UT5 indicating a bankfull event from a localized, heavy rain event.	1-2

*Weather Underground 2013, 2014