YEAR 2 MONITORING REPORT

ROSES CREEK STREAM MITIGATION SITE
Burke County, North Carolina
NC DMS Project No. 96309

Prepared for:

NCDEQ Division of Mitigation Services (DMS)
217 West Jones St., Suite 3000A
Raleigh, North Carolina 27603

Construction Completed: May 2016
Morphology Data Collected: June 1, 2017
Vegetation Data Collected: August 14, 2017
Submitted: December 2017

Prepared by:

HDR | ICA
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Raleigh, North Carolina 27601
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919.232.6642 (fax)

I HEREBY CERTIFY THAT THE DOCUMENT CONTAINED HEREIN, ROSES CREEK YEAR 2 MONITORING REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION.

SIGNED SEALED, AND DATED THIS 26TH DAY OF DECEMBER 2017.

Chris L. Smith, PE

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1.0 PROJECT SUMMARY

The following report summarizes the vegetation establishment and stream stability for Year 2 monitoring for the Roses Creek Site (hereafter referred to as the "Site") in Burke County, North Carolina.

1.1 Goals and Objectives

Primary goals for the Site, as detailed in the Roses Creek Stream Mitigation Site Mitigation Plan (ICA Engineering 2015) include:

1. Reducing water quality stressors and providing/enhancing flood attenuation.
2. Restoring and enhancing aquatic, semi-aquatic and riparian habitat.
3. Restoring and enhancing habitat connectivity with adjacent natural habitats.

The following objectives accomplish the goals listed above:

1. Reducing water quality stressors and providing/enhancing flood attenuation through:
    a. Restoring the existing degraded, straightened and incised/entrenched streams as primarily a Priority 1 restoration where bankfull and larger flows can access the floodplain allowing nutrients, sedimentation, trash and debris from upstream runoff to settle from floodwaters to the extent practical. Restoring a stable dimension, pattern, and profile will ensure the channel will transport and attenuate watershed flows and sediment loads without aggrading or degrading.
    b. Restore channel banks by relocating the channel, excavating bankfull benches, placing in-stream structures to reduce shearing forces on outside meander bends, and planting native vegetative species to provide soil stability, thus reducing stream bank stressors.
    c. Reducing point source (i.e. cattle and equipment crossings) and non-point source (i.e. stormwater runoff through pastures) pollution associated with on-site agricultural operations (hay production and cattle) by exclusionary fencing from the stream and riparian buffer and by eliminating all stream crossings from the easement.
    d. Plant a vegetative buffer on stream banks and adjacent floodplains to treat nutrient enriched surface runoff from adjacent pastureland associated with on-site agricultural operations.
    e. Restoring riparian buffers adjacent to the streams that are currently maintained for hay production that will attenuate floodwaters, in turn reducing stressors from upstream impacts.
2. Restoring and enhancing aquatic, semi-aquatic and riparian habitat through:
    a. Restoration of a sinuous gravel bed channel that promotes a stable bed form, and accommodates benthic macroinvertebrate and fish propagation. Additionally, woody materials such as log structures, overhanging planted vegetation and toe wood/brush toe in submerged water will provide a diversity of shading, bed form and foraging opportunities for aquatic organisms.
    b. Restoring native vegetation to the stream channel banks and the adjacent riparian corridor, that is currently grass dominated, will diversify flora and create a protected habitat corridor, which will provide an abundance of available foraging and cover habitat for a multitude of amphibians, reptiles, mammals and birds.
3. Restoring and enhancing habitat connectivity with adjacent natural habitats through:
    a. Planting the riparian buffer with native vegetation.

b. Protection of the restored community will ensure a protected wildlife corridor between the Site and the upstream and downstream mature riparian buffers and upland habitats.
c. Converting approximately 15 acres from existing agricultural land to riparian buffer protected by permanent conservation easement.

1.2 Success Criteria

Monitoring of restoration efforts will be performed until success criteria are fulfilled. Monitoring includes stream channel/hydraulics and vegetation. In general, the restoration success criteria, and required remediation actions, are based on the Stream Mitigation Guidelines (USACE et al. 2003) and the Ecosystem Enhancement Program Monitoring Requirements and Performance Standards for stream and/or Wetland Mitigation (NCEEP 2011). Project success criteria are further detailed in the Baseline Monitoring Document & As-Built Baseline Report (HDR|ICA 2016).

1.3 Background Summary

The North Carolina Department of Environmental Quality Division of Mitigation Services (DMS) contracted HDR|ICA to restore 4,746 linear feet of Roses Creek and three of its unnamed tributaries within the Site to assist in fulfilling stream mitigation needs in the watershed. The Site is located approximately 12 miles northwest of downtown Morganton in Burke County, NC. The Site contains Roses Creek and three unnamed headwater tributaries of Roses Creek (UT 1, UT 2 and UT 3). The Site is located within the 03050101060030 14-digit Hydrologic Unit, which is also a DMS Targeted Hydrologic Unit for Cataloging Unit 03050101 of the Catawba River Basin. Roses Creek is classified as a Water Supply Watershed (WS-III), as it is part of the headwaters that feed Lake Rhodhiss. The Site is comprised of one property owned by Robert B. Sisk and Martha M. Sisk (PIN # 1767479652) (known as the Sisk Farm). Additional information concerning project history is presented in Table 2.

1.4 Vegetation

Many of the planted stems observed in Year 1 were not expected to survive based on their poor health, as noted in the Year 1 Monitoring Report. The entire site was replanted in February 2017, by Land Mechanics Designs to mitigate the expected loss of planted stems. The additional stems have not been enough to help a large majority of the plots meet criteria. Bare root plants have underperformed over the past monitoring year. When only taking planted stems into account, 10 of 17 plots have failed to meet Year 3 criteria of 320 stems per acre. The site as a whole also fails to meet Year 3 criteria, averaging 283 planted stems per acre. However, when including natural recruits 14 of the 17 plots meet Year 3 success criteria and the site as whole meets criteria at 762 stems per acre.

Planted stems along UT 1 and UT 2 have been heavily browsed upon by deer. Deer trails were noted through Plot 1 and while all the planted stems in this plot were either dead or missing, stems in the surrounding area showed signs of browsing. A large deer bed was discovered at the center of Plot 2 and only one stem has survived after supplemental planting.

Supplemental planting for the Site is scheduled for Winter of 2018 as part of the corrective action plan developed to address planted stem mortality. Supplemental planting will include species that are less desirable to deer to increase the planted stem survivability. The corrective action plan separates the Site into 6 zones, to identify low stem density areas within the site. Figure 7.1 and Tables 13 and 13a depict each planting zone and corresponding species list and planting densities (Appendix F).

Five areas of thin grass are present on-site. The total acreage of bare areas is 0.44 (2.8% of planted acreage). These areas will be closely monitored but are expected to fill in over time. If these areas do not improve additional seeding may be required.

No areas of encroachment or invasive species were noted on site.

1.5 Stream Stability

Roses Creek and its tributaries have remained in stable, functioning condition over the past monitoring year. Cross Section dimensions along Roses Creek and UT 3 remain consistent with baseline surveys. Cross Sections 7, 8, 9, and 10 have decreased in depth and area. These cross sections are located along UT 1 and UT 2, which both currently have thick vegetation in the channel that is trapping sediment and reducing the channel area. Coir logs have been utilized at the upstream end of UT 2 to prevent further sediment from running off the pasture access road into the stream. The tributaries will continue to be monitored closely and as they experience heavier flows it is expected that the sediment will flush out.

Woody vegetation has established along the stream banks. Live stakes that were supplemented in the winter of 2017 appear to be healthy and natural recruits were observed growing along the bank.

Near the confluence of UT 2 and Roses Creek, a small conveyance was created to drain standing water in the floodplain that was encroaching upon the land owner's driveway. This conveyance was lined with rock along the bottom and common rush (Juncus effusus) was planted at the outlet to prevent any erosion to the bank of Roses Creek. Coir fiber matting, straw, and a native seed mixture was applied to the surrounding area to stabilize of any bare soil.

At the upstream end of UT2 thick vegetation along the toe of the channel has trapped fine sediment resulting in aggradation along the channel invert. As a result of the aggradation, flow has been deflected into the floodplain in some areas along the upstream half of the tributary. Coir logs have been installed along the downstream side of the road crossing at the top of UT 2 to prevent sediment from the road washing into the channel during heavy rain events. This aggradation does not appear to be causing any additional problems and it is expected that the sediment will flush itself out over time.

Two holes along the bank of Roses Creek were repaired at the downstream end of the project. One of the holes was converted into a floodplain interceptor lined with rock and common rush to prevent further erosion to the bank. Two areas of minor bank erosion are present along the banks of Roses Creek at stations 36+33 and 37+31. It is expected these areas will stabilize over time as herbaceous vegetation establishes along the banks. A small scour pool has developed

immediately downstream of a rock step structure at station 37+25. HDR│ICA will continue to monitor these areas closely over the next monitoring year.

A large tree stump has washed downstream into the project area indicating that the site has experienced heavy flows over the past year. The stump has not caused any damage but its effect on the stream will continue to be monitored by HDR│ICA. Wrack lines were noted along the top of bank on the main channel. The crest gauge at the downstream end of the main channel indicates that Roses Creek overtopped its banks at least one time during the first half of the monitoring year. A second bankfull event was also documented by the landowner in October 2017. Crest gauge records are provided in Appendix E.

Based on water level data obtained using the Hobo U20 pressure transducers installed in the bottom of each tributary, all three have indicated consistent flow throughout the past monitoring year. It is worth noting that there is a brief period of data missing during the month of May 2017 due to a computer software malfunction. Water level data is provided in Appendix E as well.

Bank pins were examined during morphological surveys and were not exposed.

A pebble count was conducted on site indicating that particle size is consistent with baseline with an average D50 of 48.80 mm.

2.0 METHODOLOGY

Year 2 monitoring surveys were completed using a Total Station. Each cross section was marked with a rebar monument at their beginning and ending points. The rebar has been located vertically and horizontally in NAD 83-State Plane. Surveying these monuments throughout the Site ensured proper orientation. The survey data was imported into MicroStation for verification. RIVERMorph was used to analyze cross section data. Tables and figures were created using MicroStation, ArcGIS, and Microsoft Excel. A pebble count was conducted and analyzed in RIVERMorph.

Vegetation monitoring was completed using CVS level II methods for 17, 100 square meter vegetation plots (Lee et al. 2006). The taxonomic standard for vegetation used for this document was Flora of the Southern and Mid-Atlantic States (Weakley 2011).

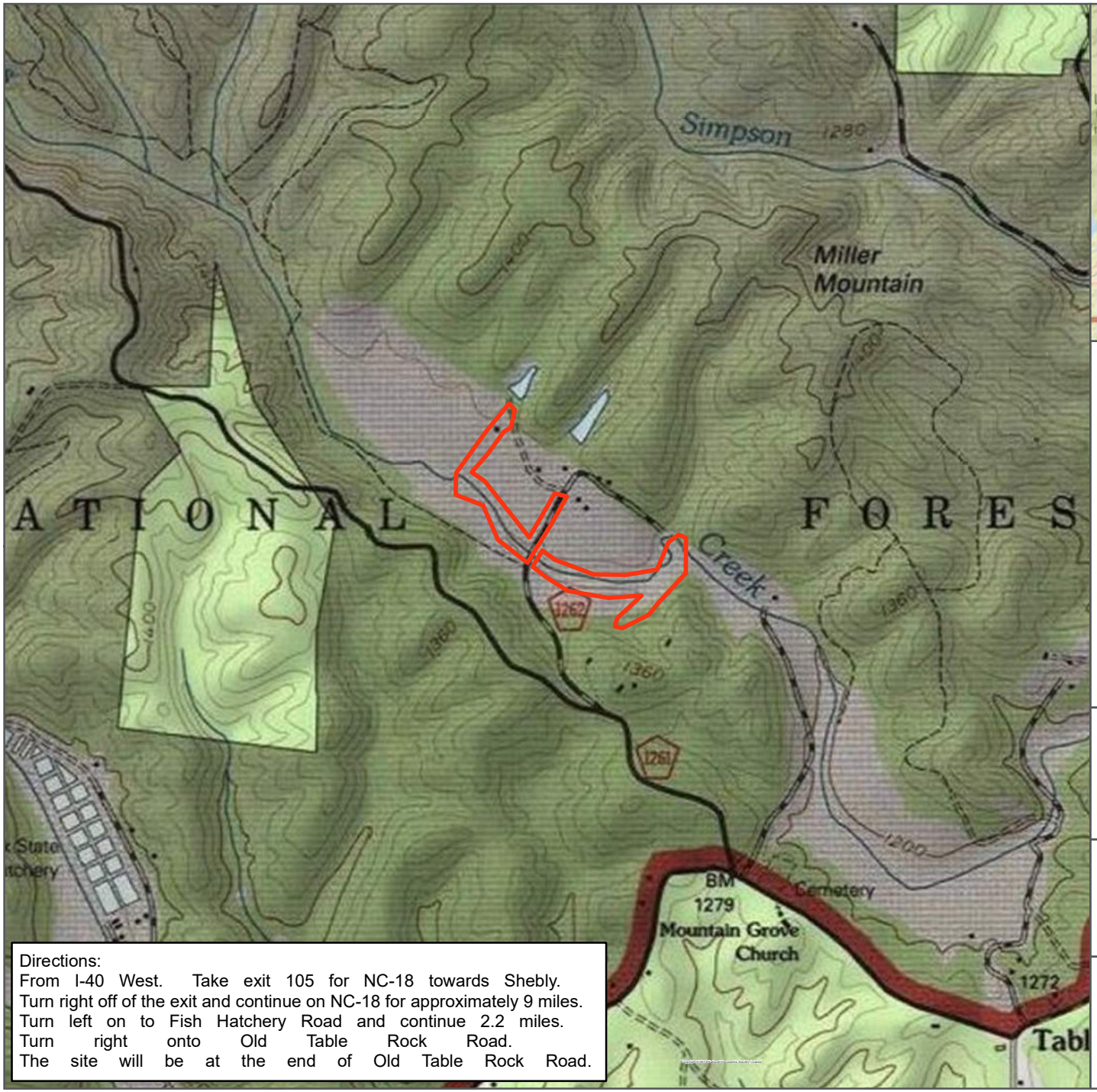
3.0 REFERENCES

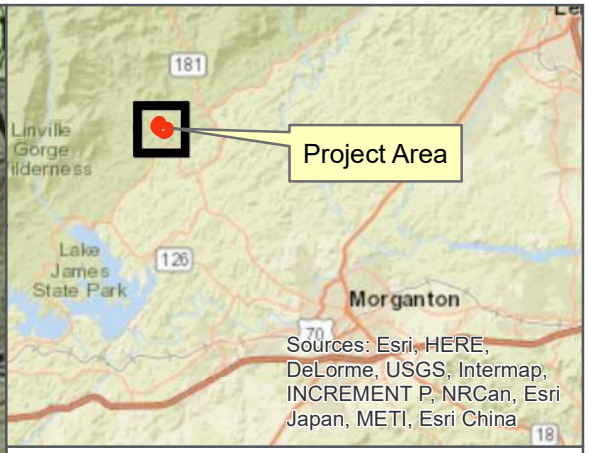
Lee, Michael T., R. K. Peet, S. D. Roberts, and T. R. Wentworth. 2006. CVS-EEP Protocol for Recording Vegetation, Version 4.0 (http://cvs.bio.unc.edu/methods.htm).

Weakley, Alan S. 2011. Flora of the Southern and Mid-Atlantic States (online). Available: http://www.herbarium.unc.edu/FloraArchives/WeakleyFlora_2011-May-nav.pdf [May 15, 2011]. University of North Carolina Herbarium, North Carolina Botanical Garden, University of North Carolina, Chapel Hill, North Carolina.

APPENDICES

Appendix A. Project Vicinity Map and Background Tables





Legend

Project Easement

The subject project site is an environmental restoration site of the NCDEQ Divison of Mitigation Services (DMS) and is encompassed by a recorded conservation easement, but is bordered by land under private ownership. Therefore access by the general public is not permitted. Access by authorized personnel of state and federal agencies or their designees/contractors involved in the development, monitoring, and stewardship of the restoration site is permitted within the terms and timeframes of their defined, pre-approved roles. Any intended site visitation or activity by any person outside of these previously sanctioned activities/roles requires prior coordination with DMS.

ROSES CREEK STREAM MITIGATION SITE

VICINITY MAP
BURKE COUNTY, NC

N

0 1,000 2,000 4,000 Feet

FIGURE 1

PATH: Z:\ROSES_CREEK\5.0_PROJECT_DEVELOPMENT\5.2_WORK_IN_PROGRESS\DOCS\MONITORING\YEAR 1\APPENDIX A_VICINITY MAP AND BACKGROUND TABLES\VICINITY MAP.MXD - USER: ADIGERON - DATE: 11/13/2017

Map Produced 12/2/2016

Table 1. Project Components and Mitigation Credits

Roses Creek, Burke County DMS Project No. 96309									
Credit Summary									
	Stream SMU		Riparian Wetland WMU		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	5,009.6								
Project Components									
Project Component or Reach ID	Stationing/ Location		Existing Footage/ Acreage	Approach (PI, PII, etc.)	Restoration or Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio	SMU	
Roses Creek	10+00-41+81		3,643	PI	Restoration	3,181	1:1	3,121.0*	
Roses Creek	41+81-42+19		38	-	EII	38	2.5:1	15.2	
UT 1	10+00-12+54; 16+11-16+46		267	PI	Restoration	289	1:1	289.0	
UT 1	12+54-16+11; 16+46-19+30		641	-	EII	641	2.5:1	256.4	
UT 2	10+00-17+07		610	PI	Restoration	707	1:1	707.0	
UT 3	10+00-16+21		558	PI	Restoration	621	1:1	621.0	
Total	NA		5,757	PI	Restoration/ EII	5,477	1-2.5:1	5,009.6	

* Stream Mitigation Units decreased by 60 to account for break in easement at the stream crossing on Sisk Farm Road

Component Summation						
Restoration Level	Stream (linear feet)	Riparian Wetland (acres)		Non-Riparian Wetland (acres)	Buffer (square feet)	Upland (acres)
		Riverine	Non-Riverine			
Restoration	4,798					
Enhancement II	679					

Table 2. Project Activity and Reporting History

Activity or Report	Data Collection Complete	Completion or Delivery
Mitigation Plan	September 2015	September 2015
Final Design – Construction Plans	September 2015	March 2016
Construction	February 25, 2016	May 18, 2016
Temporary S&E Mix Applied to Entire Project Area	---	May 18, 2016
Permanent Seed Mix Applied to Entire Project Area	---	May 18, 2016
Bare Root, Containerized, and B&B plantings for Entire Project Area	---	May 27, 2016
Mitigation Plan/As-built (Year 0 Monitoring-Baseline)	May 2016	July 2016
Year 1 Monitoring	November 2016	January 2017
Stream Morphology	November 2016	--
Vegetation	August 2016	--
Year 2 Monitoring	August 2017	November 2017
Stream Morphology	June 2017	--
Vegetation	August 2017	--
Year 3 Monitoring		
Stream Morphology		
Vegetation		
Year 4 Monitoring		
Stream Morphology		
Vegetation		
Year 5 Monitoring		
Stream Morphology		
Vegetation		
Year 6 Monitoring		
Stream Morphology		
Vegetation		
Year 7 Monitoring		
Stream Morphology		
Vegetation		

Table 3. Project Contacts Table

Designer Primary project design POC	ICA Engineering 555 Fayetteville Street, Suite 900 Raleigh, North Carolina 27601 Chris Smith (919) 851-6066
Construction Contractor Construction Contractor POC	Land Mechanic Designs, Inc. 126 Circle G Lane Willow Spring, NC 27592 Lloyd Glover (919) 639-6132
Planting Contractor Planting Contractor POC	Land Mechanic Designs, Inc. 126 Circle G Lane Willow Spring, NC 27592 Lloyd Glover (919) 639-6132
Seeding Contractor Seeding Contractor POC	Land Mechanic Designs, Inc. 126 Circle G Lane Willow Spring, NC 27592 Lloyd Glover (919) 639-6132
Seed Mix Sources	Green Resources – Triangle Office
Nursery Stock Suppliers	1) Dykes and Son Nursery, McMinnville, TN 2) Foggy Mountain Nursery (live stakes)
Monitoring Performers	HDR|ICA Engineering Inc. 555 Fayetteville Street, Suite 900 Raleigh, North Carolina 27601 Ben Furr (919) 232-6600
Stream Monitoring POC	HDR|ICA Engineering Inc. 555 Fayetteville Street, Suite 900 Raleigh, North Carolina 27601 Ben Furr (919) 232-6600
Vegetation Monitoring POC	HDR|ICA Engineering Inc. 555 Fayetteville Street, Suite 900 Raleigh, North Carolina 27601 Ben Furr (919) 232-6600

Table 4. Project Information

Project Information				
Project Name		Roses Creek Stream Mitigation Site		
County		Burke		
Project Area (acres)		17.3		
Project Coordinates (latitude and longitude)		35.850953,-81.819541		
Project Watershed Summary Information				
Physiographic Province		Piedmont / Mountain		
River Basin		Catawba		
USGS Hydrologic Unit 8-digit	03050101	USGS Hydrologic Unit 14-digit	03050101060030	
NCDWQ Sub-basin		03-08-31		
Project Drainage Area (acres)		Roses: 3,309, UT 1: 35, UT 2: 47, UT 3: 10		
Project Drainage Area Percentage of Impervious Area		<1%		
CGIA Land Use Classification		Agricultural/Pasture		
Ecoregion		Northern Inner Piedmont		
Geological Unit		Zabg: Alligator Back Formation; Gneiss		
Reach Summary Information				
Parameters	**Roses Creek**	**UT 1**	**UT 2**	**UT 3**
Length of reach (linear feet)	3,681 existing	900 existing	610 existing	558 existing
Valley Classification	VIII	VIII	VIII	VIII
Drainage Area (acres)	3,309	35	47	13
NCDWQ Stream Identification Score	56	30	33.5	34
NCDWQ Water Quality Classification	WS-III; Tr	WS-III; Tr	WS-III; Tr	WS-III; Tr
Morphological Description (stream type)	E4, B4, and F4	B5, F5	B5	B5, G5
Evolutionary Trend	Simon's Stages: Premodified » Constructed » Degradation and Widening	Could maintain a B type channel in majority of reach Or F » B	G » B/E	G » B

Regulatory Considerations (cont.)			
Coastal Zone Management (CZMA)/ Coastal Area Management Act (CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	Yes	Yes	CLOMR/LOMR
Essential Fisheries Habitat	No	N/A	N/A

Appendix B. Visual Assessment Data

Figure 2.0 – 2.8. Current Condition Plan View

DMS PROJECT #: 96309

CONTRACT: ROSES CREEK

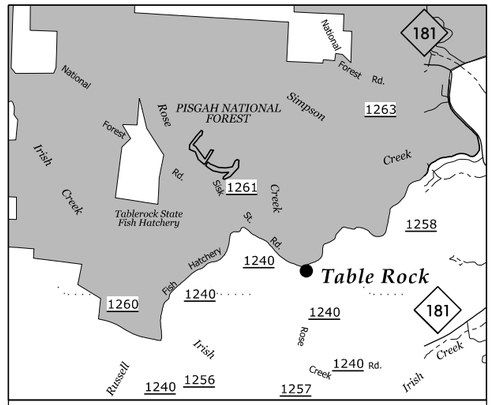
CURRENT CONDITIONS PLAN VIEW (CCPV)
ROSES CREEK

STATE		SHEET NO.
N.C.	ROSES CREEK	1

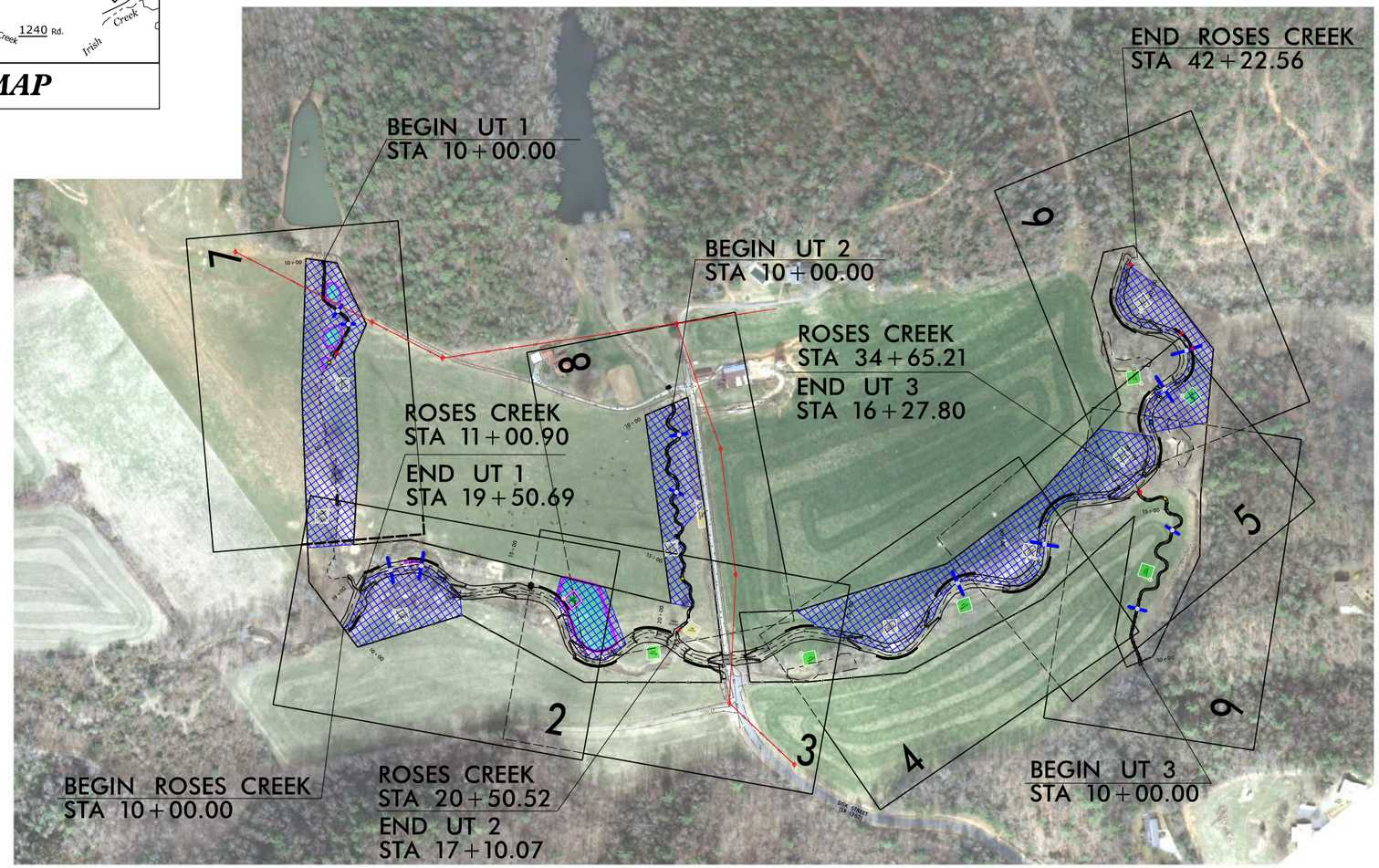
LOCATION: BURKE COUNTY, NORTH CAROLINA

LAT: 35°51'01" N **LONG: –81°49'11" W**

TYPE OF WORK: CCPV PLANS – YEAR 2



VICINITY MAP



YEAR 2 CONDITIONS

- FALLEN TREE
- STUMP

BANK/BED CONDITION

- MINOR EROSION
- DEPOSITION (SILT)
- WRACK LINES
- HOLE
- SCOUR

VEGETATION PROBLEM AREAS

- THIN GRASS
- LOW STEM DENSITY AREAS

VEGETATION PLOT CONDITIONS

- CRITERIA MET
- CRITERIA UNMET

NOTE:
650/650 – REPRESENTS TOTAL STEMS PER ACRE /PLANTED STEMS PER ACRE

LEGEND

- 15+00 — ASBUILT ALIGNMENTS & STATIONING
- THALWEG
- BANKFULL
- EPHEMERAL POOL
- CONSERVATION EASEMENT
- POWERLINE
- FENCE
- XS-1 — CROSS–SECTION LOCATION
- FM — FLOW METER
- CREST GAUGE
- PHOTO POINT & DIRECTION
- WLB — EXISTING WETLANDS
- 10 x 10 VEG PLOT
- 5 x 20 VEG PLOT
- BRUSH TOE
- ROCK L–VANE
- ROCK CROSS VANE
- ROCK STEP STRUCTURE w/ BOULDERS
- ROCK STEP STRUCTURE w/ CLASS B RIP RAP
- ROCK /LOG CROSS VANE
- FLOODPLAIN INTERCEPTOR

GRAPHIC SCALES

50 25 0 50 100
PLANS

10 5 0 10 20
PROFILE (HORIZONTAL)

20 10 0 20 40
PROFILE (VERTICAL)

DESIGN DATA

ROSES CREEK			UT 1			UT 2			UT 3		
DESIGN STREAM TYPE	=	C4	DESIGN STREAM TYPE	=	C5	DESIGN STREAM TYPE	=	C5	DESIGN STREAM TYPE	=	C5
BANKFULL AREA (FT^2) CROSS–SECTIONED	=	66.4	BANKFULL AREA (FT^2) CROSS–SECTIONED	=	2.1	BANKFULL AREA (FT^2) CROSS–SECTIONED	=	2.1	BANKFULL AREA (FT^2) CROSS–SECTIONED	=	2.6
BANKFULL WIDTH (FT)	=	30.5	BANKFULL WIDTH (FT)	=	5.0	BANKFULL WIDTH (FT)	=	5.0	BANKFULL WIDTH (FT)	=	5.5
MAX DEPTH (FT)	=	2.72	MAX DEPTH (FT)	=	0.58	MAX DEPTH (FT)	=	0.58	MAX DEPTH (FT)	=	0.63
WIDTH /DEPTH RATIO	=	14.0	WIDTH /DEPTH RATIO	=	13.0	WIDTH /DEPTH RATIO	=	13.0	WIDTH /DEPTH RATIO	=	13.1
DRAINAGE AREA (MI^2)	=	5.17	DRAINAGE AREA (MI^2)	=	0.06	DRAINAGE AREA (MI^2)	=	0.07	DRAINAGE AREA (MI^2)	=	0.02
BANKFULL SLOPE(FT/FT)	=	0.0062	BANKFULL SLOPE(FT/FT)	=	0.0021	BANKFULL SLOPE(FT/FT)	=	0.0021	BANKFULL SLOPE(FT/FT)	=	0.0021

PROJECT LENGTH

		PROPOSED DESIGN STREAM LENGTH		ASBUILT STREAM LENGTH	
ROSES CREEK	=	3,219.20	FT	3,222.56	FT
UT 1	=	930.38	FT	950.69	FT
UT 2	=	707.59	FT	710.07	FT
UT 3	=	621.03	FT	627.80	FT

CHRISTOPHER L. SMITH
PROJECT MANAGER

Prepared in the Office of:

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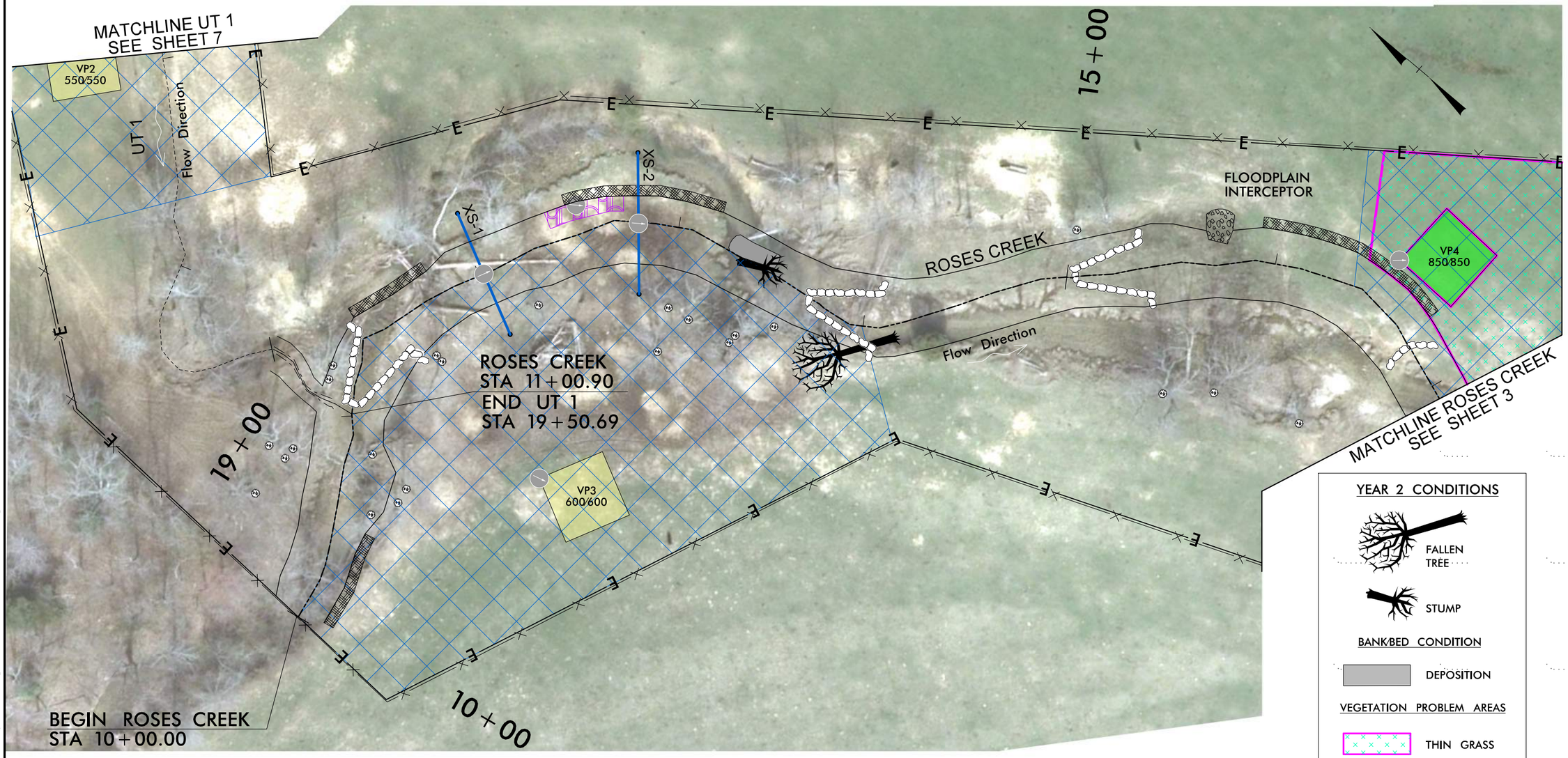
Suite 900
Raleigh, NC 27601
NC License No: F–0258

NC

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 2



LEGEND

- 15+00 — ASBUILT ALIGNMENTS & STATIONING
- THALWEG
- BANKFULL
- EPHEMERAL POOL
- E — CONSERVATION EASEMENT
- FENCE
- PHOTO POINT & DIRECTION
- XS-1 — CROSS–SECTION LOCATION
- 10 x 10 VEG PLOT
- 5 x 20 VEG PLOT
- BRUSH TOE
- CREST GAUGE
- ROCK L–VANE
- ROCK CROSS VANE
- ROCK STEP STRUCTURE w/ BOULDERS
- ROCK STEP STRUCTURE w/ CLASS B RIP RAP
- FLOODPLAIN INTERCEPTOR

YEAR 2 CONDITIONS

- FALLEN TREE
- STUMP

BANK/BED CONDITION

- DEPOSITION

VEGETATION PROBLEM AREAS

- THIN GRASS
- WRACK LINES
- LOW STEM DENSITY AREAS

VEGETATION PLOT CONDITIONS

- CRITERIA MET
- CRITERIA UNMET

NOTE:
650/650 – REPRESENTS TOTAL STEMS PER ACRE /PLANTED STEMS PER ACRE

ICA Engineering, Inc.
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Raleigh, NC 27601
NC License No: F-0258

ROSES CREEK RESTORATION PROJECT
STREAM
BURKE COUNTY, NORTH CAROLINA

GRAPHIC SCALE
50 25 0 25
PLANS

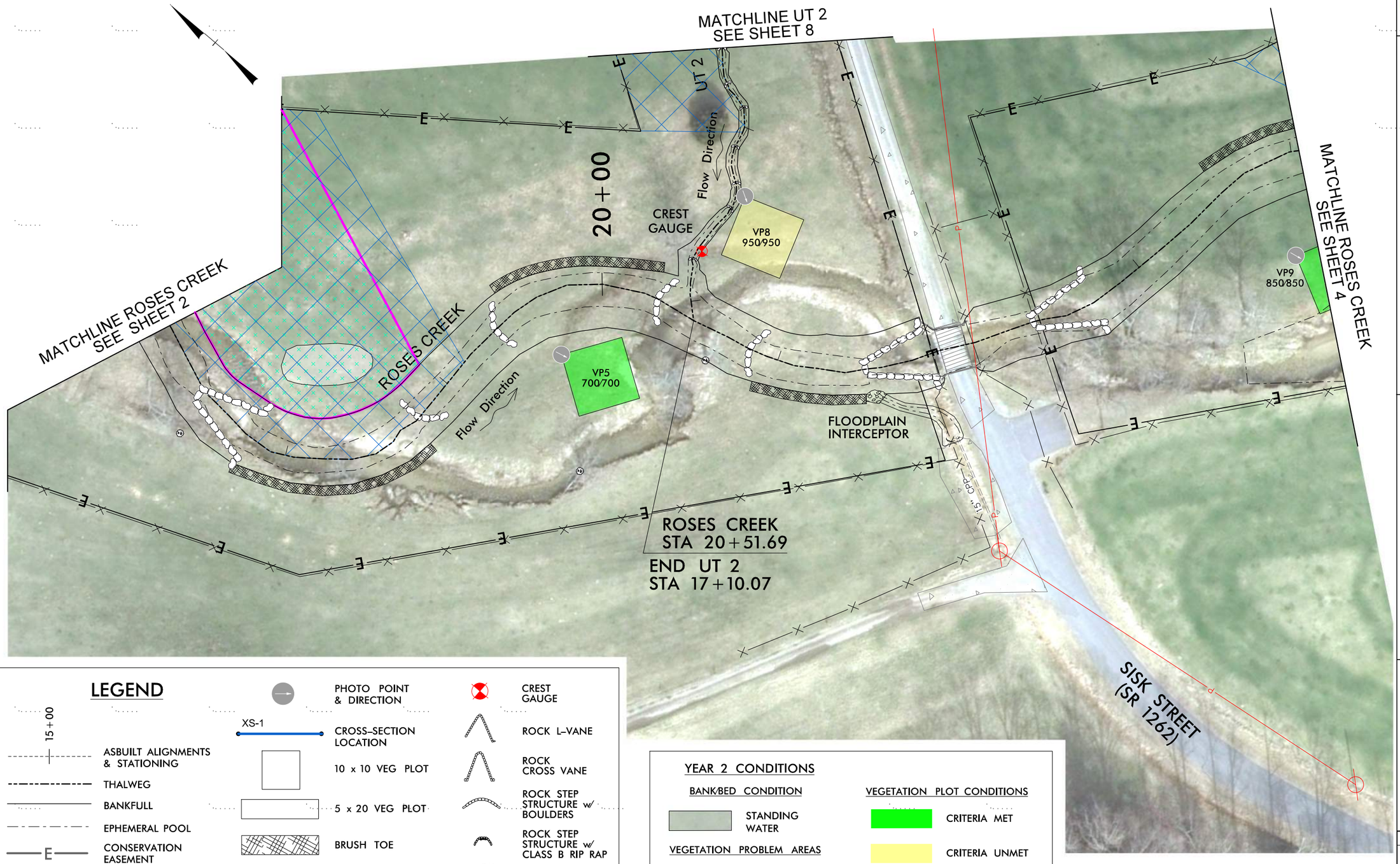
DATE: 09-13-17

CCPV
YEAR 2

SHEET
2

EEP# 96309

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 2



LEGEND

- 15+00 — ASBUILT ALIGNMENTS & STATIONING
- THALWEG
- BANKFULL
- EPHEMERAL POOL
- E — CONSERVATION EASEMENT
- FENCE
- PHOTO POINT & DIRECTION
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- ROCK CROSS VANE
- ROCK STEP STRUCTURE w/ BOULDERS
- ROCK STEP STRUCTURE w/ CLASS B RIP RAP
- FLOODPLAIN INTERCEPTOR

YEAR 2 CONDITIONS

BANK/BED CONDITION
- STANDING WATER

VEGETATION PROBLEM AREAS
- THIN GRASS
- LOW STEM DENSITY AREAS

VEGETATION PLOT CONDITIONS
- CRITERIA MET
- CRITERIA UNMET

NOTE:
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ICA Engineering, Inc.
555 Fayetteville Street,
Suite 900
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ROSES CREEK
STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

GRAPHIC SCALE
50 25 0 25
PLANS

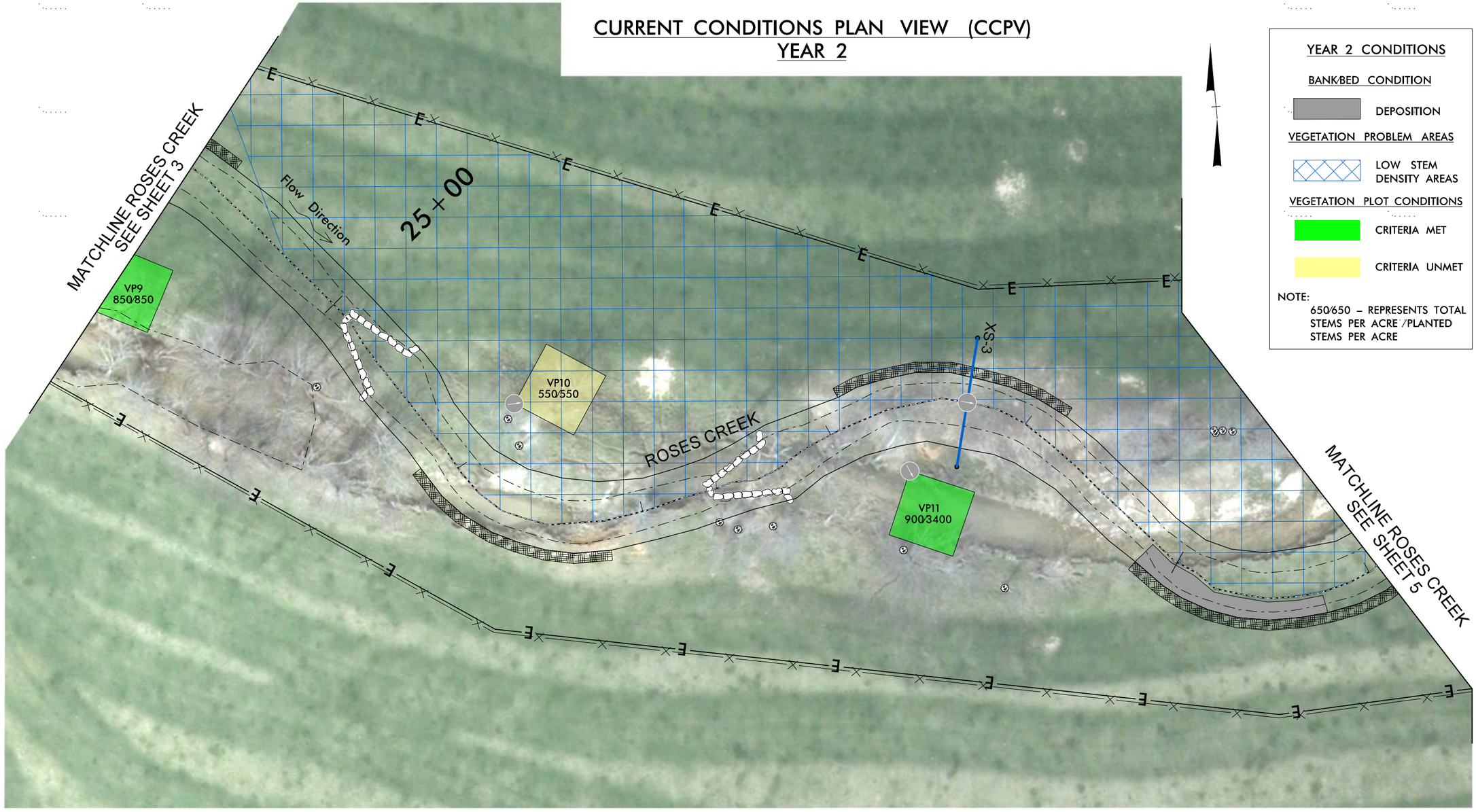
DATE: 09-13-17

CCPV
YEAR 2

SHEET
3

EEP# 96309

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 2



YEAR 2 CONDITIONS

BANK/BED CONDITION

DEPOSITION

VEGETATION PROBLEM AREAS

LOW STEM DENSITY AREAS

VEGETATION PLOT CONDITIONS

CRITERIA MET

CRITERIA UNMET

NOTE:
650/650 – REPRESENTS TOTAL STEMS PER ACRE /PLANTED STEMS PER ACRE

LEGEND

15+00 ASBUILT ALIGNMENTS & STATIONING

THALWEG

BANKFULL

EPHEMERAL POOL

E CONSERVATION EASEMENT

FENCE

PHOTO POINT & DIRECTION

XS-1 CROSS–SECTION LOCATION

10 x 10 VEG PLOT

5 x 20 VEG PLOT

BRUSH TOE

CREST GAUGE

ROCK L–VANE

ROCK CROSS VANE

ROCK STEP STRUCTURE w/ BOULDERS

ROCK STEP STRUCTURE w/ CLASS B RIP RAP

FLOODPLAIN INTERCEPTOR

ICA Engineering, Inc.
555 Fayetteville Street,
Suite 900
Raleigh, NC 27601
NC License No: F-0258

ROSES CREEK
STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 09–13–17

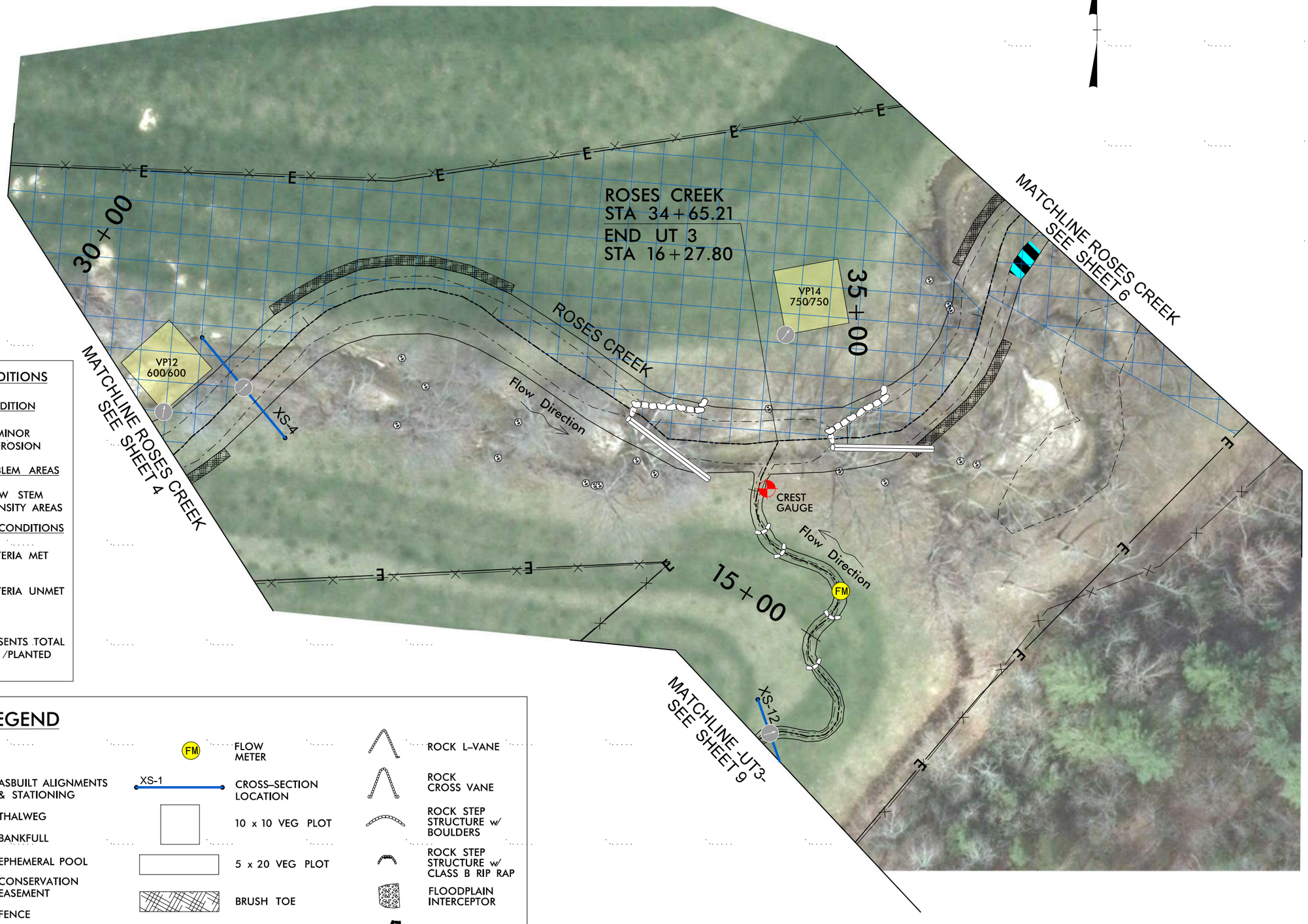
CCPV
YEAR 2

SHEET
4

EEP# 96309

$$$$$$$SYSTIME$$$$$$
Z:\Roses_Creek\6.0_CAD_BIM\6.2_Work_In_Progress\stream\Proj\Monitoring Plans\Year 2\RosesCrk_psh_04.dgn
ICA ENGINEERING, INC.

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 2



YEAR 2 CONDITIONS

BANK/BED CONDITION

MINOR EROSION

VEGETATION PROBLEM AREAS

LOW STEM DENSITY AREAS

VEGETATION PLOT CONDITIONS

CRITERIA MET

CRITERIA UNMET

NOTE:
650/650 – REPRESENTS TOTAL STEMS PER ACRE /PLANTED STEMS PER ACRE

LEGEND

- 15+00 — ASBUILT ALIGNMENTS & STATIONING
- THALWEG
- BANKFULL
- EPHEMERAL POOL
- E — CONSERVATION EASEMENT
- FENCE
- CREST GAUGE
- FM — FLOW METER
- XS-1 — CROSS-SECTION LOCATION
- 10 x 10 VEG PLOT
- 5 x 20 VEG PLOT
- BRUSH TOE
- PHOTO POINT & DIRECTION
- ROCK L-VANE
- ROCK CROSS VANE
- ROCK STEP STRUCTURE w/ BOULDERS
- ROCK STEP STRUCTURE w/ CLASS B RIP RAP
- FLOODPLAIN INTERCEPTOR
- ROCK /LOG CROSS VANE

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ROSES CREEK RESTORATION PROJECT
STREAM
BURKE COUNTY, NORTH CAROLINA

GRAPHIC SCALE
50 0 25
PLANS

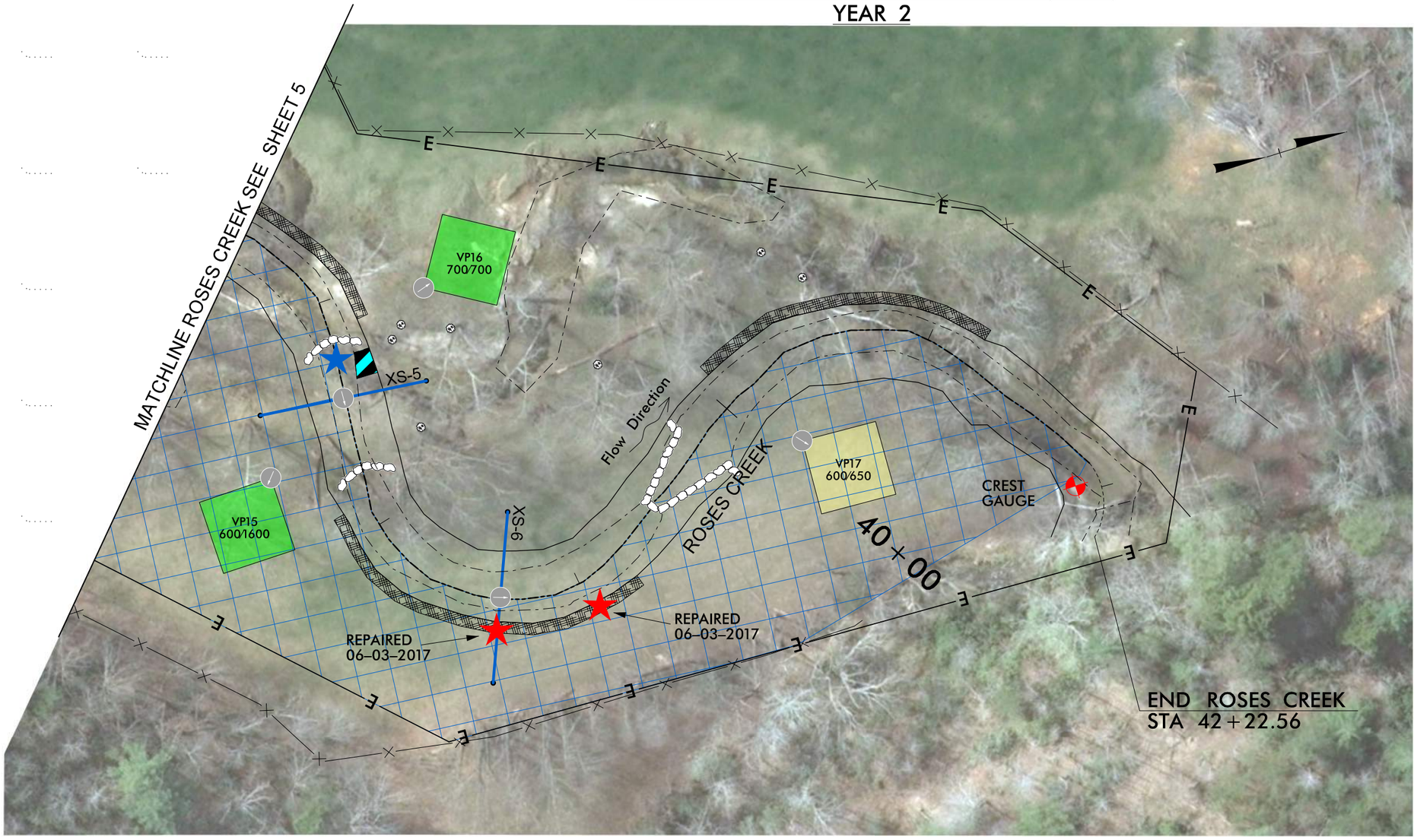
DATE: 09-13-17

CCPV
YEAR 2

SHEET
5

EEP# 96309

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 2



LEGEND

- 15+00 — STATIONING
- ASBUILT ALIGNMENTS & STATIONING
- THALWEG
- BANKFULL
- EPHEMERAL POOL
- CONSERVATION EASEMENT
- FENCE
- XS-1 — CROSS-SECTION LOCATION
- 10 x 10 VEG PLOT
- 5 x 20 VEG PLOT
- BRUSH TOE
- PHOTO POINT & DIRECTION
- CREST GAUGE
- ROCK L-VANE
- ROCK CROSS VANE
- ROCK STEP STRUCTURE w/ BOULDERS
- ROCK STEP STRUCTURE w/ CLASS B RIP RAP
- FLOODPLAIN INTERCEPTOR

YEAR 2 CONDITIONS

BANK/BED CONDITION

- MINOR EROSION
- HOLE
- SCOUR

VEGETATION PROBLEM AREAS

- LOW STEM DENSITY AREAS

VEGETATION PLOT CONDITIONS

- CRITERIA MET
- CRITERIA UNMET

NOTE:
650/650 – REPRESENTS TOTAL STEMS PER ACRE /PLANTED STEMS PER ACRE

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ROSES CREEK RESTORATION PROJECT
STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

GRAPHIC SCALE
50 25 0 25
PLANS

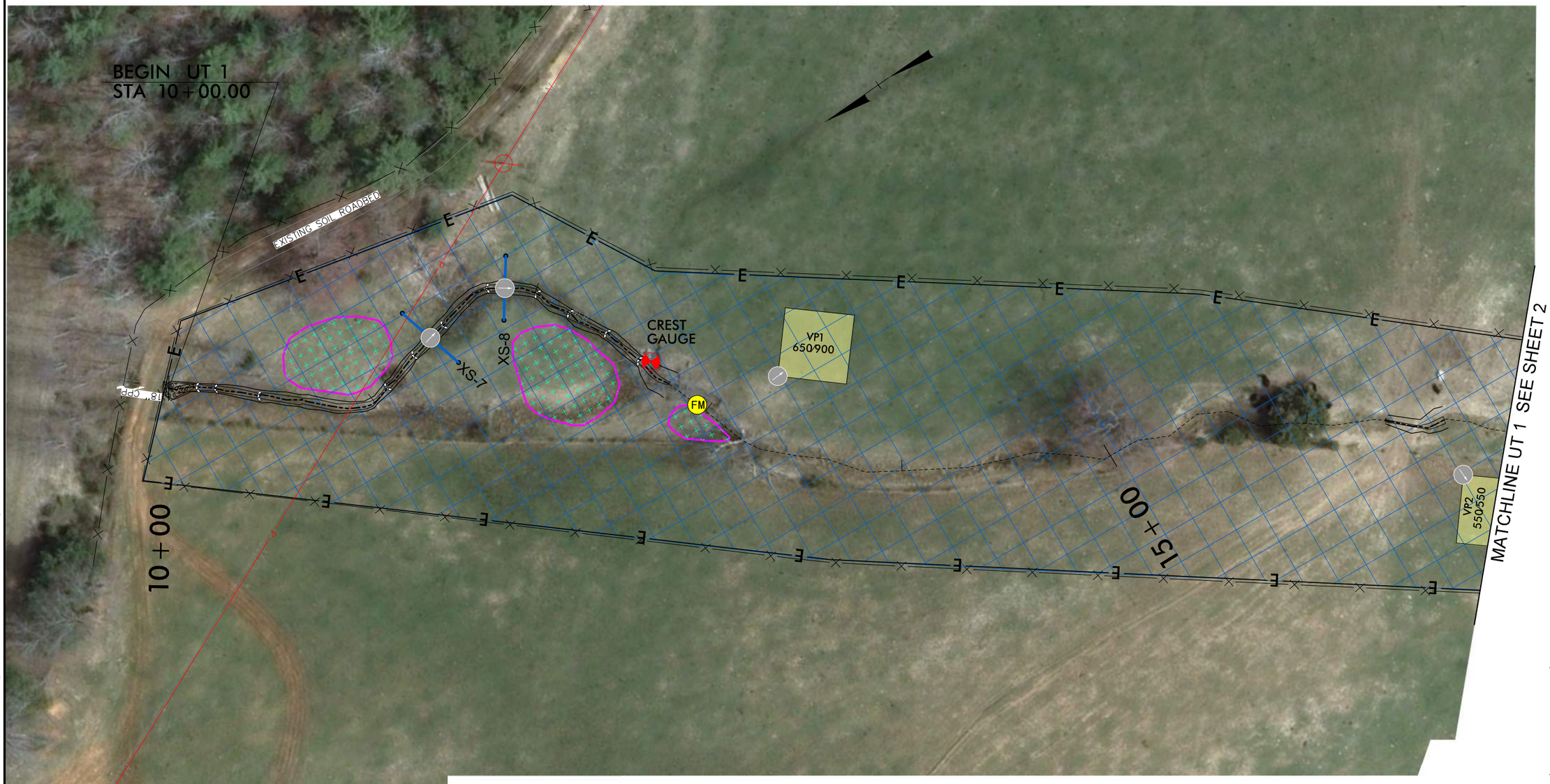
DATE: 09-13-17

CCPV YEAR 2

SHEET 6

EEP# 96309

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 2



YEAR 2 CONDITIONS

VEGETATION PROBLEM AREAS

- THIN GRASS
- LOW STEM DENSITY AREAS

VEGETATION PLOT CONDITIONS

- CRITERIA MET
- CRITERIA UNMET

NOTE:
650/650 – REPRESENTS TOTAL STEMS PER ACRE /PLANTED STEMS PER ACRE

LEGEND

- 15+00 — ASBUILT ALIGNMENTS & STATIONING
- THALWEG
- BANKFULL
- EPHEMERAL POOL
- E — CONSERVATION EASEMENT
- FENCE
- XS-1 — CROSS-SECTION LOCATION
- 10 x 10 VEG PLOT
- FM — FLOW METER
- POWER LINE
- PHOTO POINT & DIRECTION
- CREST GAUGE
- ROCK STEP STRUCTURE w/ CLASS B RIP RAP
- FLOODPLAIN INTERCEPTOR

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 06-07-17

CCPV YEAR 2

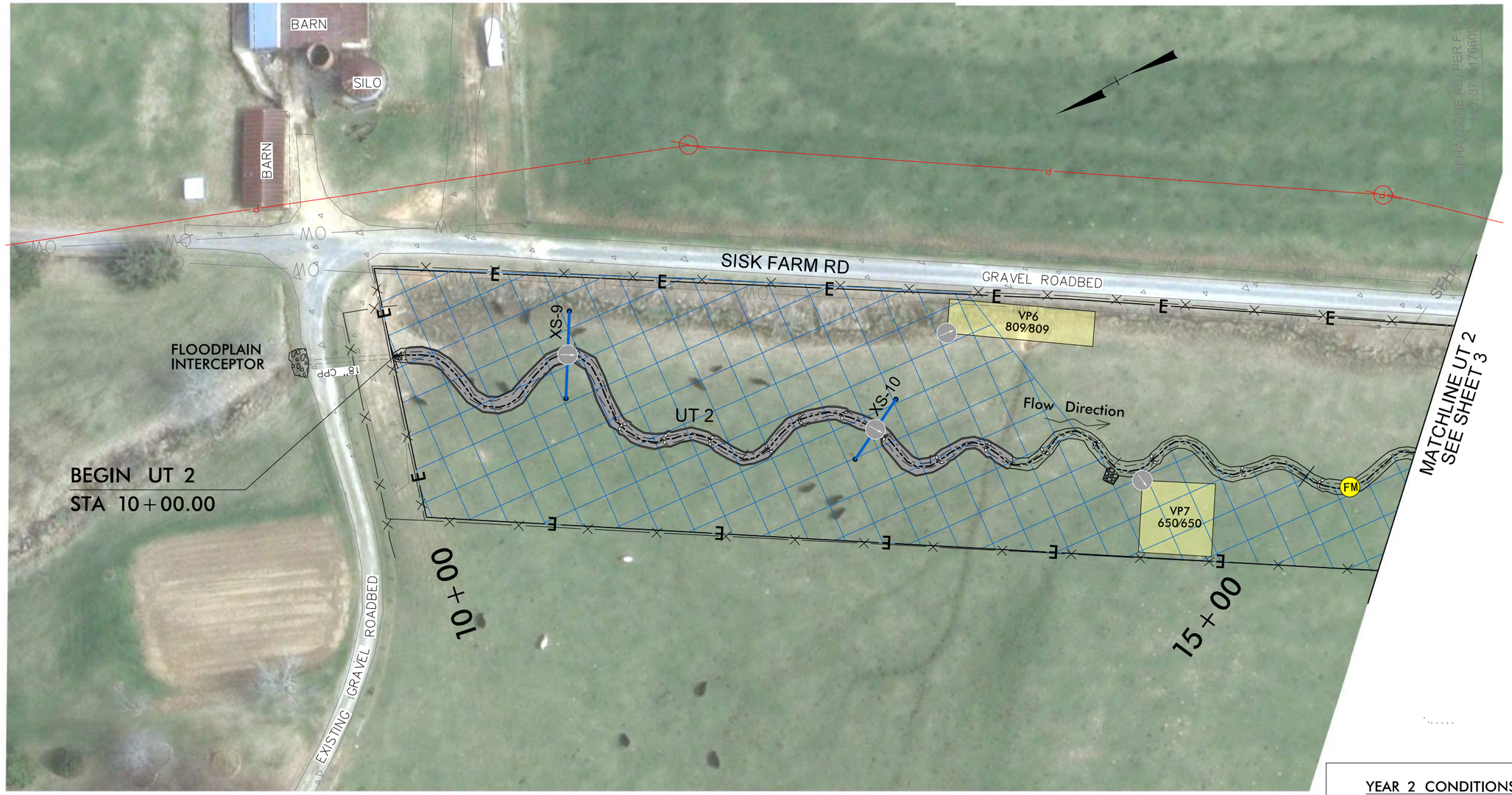
SHEET 7

EEP# 96309

ROSES CREEK STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

ICA Engineering, Inc.
555 Fayetteville Street, Suite 900
Raleigh, NC 27601
NC License No: F-0258

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 2



LEGEND

- ASBUILT ALIGNMENTS & STATIONING (15+00)
- THALWEG
- BANKFULL
- EPHEMERAL POOL
- CONSERVATION EASEMENT (E)
- FENCE
- CROSS-SECTION LOCATION (XS-1)
- 10 x 10 VEG. PLOT
- 5 x 20 VEG PLOT
- FLOW METER (FM)
- PHOTO POINT & DIRECTION
- CREST GAUGE
- BRUSH TOE
- ROCK STEP STRUCTURE w/ CLASS B RIP RAP
- FLOODPLAIN INTERCEPTOR
- POWER LINE

YEAR 2 CONDITIONS

BANK/BED CONDITION
- DEPOSITION (SILT)

VEGETATION PROBLEM AREAS
- LOW STEM DENSITY AREAS

VEGETATION PLOT CONDITIONS
- CRITERIA MET
- CRITERIA UNMET

NOTE:
650/650 – REPRESENTS TOTAL STEMS PER ACRE /PLANTED STEMS PER ACRE

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ROSES CREEK RESTORATION PROJECT
STREAM
BURKE COUNTY, NORTH CAROLINA

GRAPHIC SCALE
50 25 0 25
PLANS

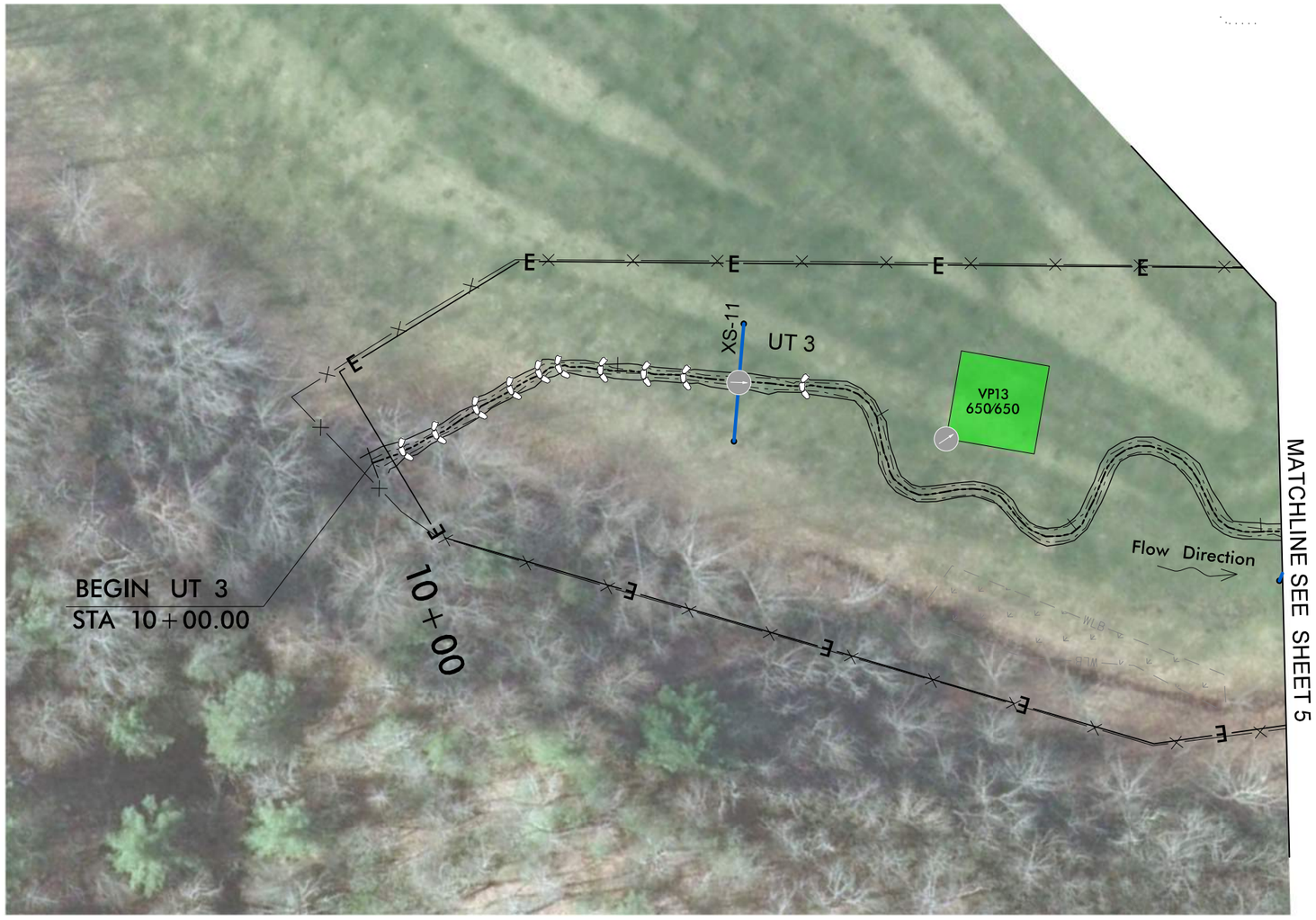
DATE: 09-13-17

CCPV
YEAR 2

SHEET
8

EEP# 96309

CURRENT CONDITIONS PLAN VIEW (CCPV)
YEAR 2



YEAR 2 CONDITIONS

VEGETATION PLOT CONDITIONS

- CRITERIA MET
- CRITERIA UNMET

NOTE:
650/650 – REPRESENTS TOTAL STEMS PER ACRE /PLANTED STEMS PER ACRE

LEGEND

- 15+00 — ASBUILT ALIGNMENTS & STATIONING
- THALWEG
- BANKFULL
- EPHEMERAL POOL
- E — CONSERVATION EASEMENT
- FENCE
- PHOTO POINT & DIRECTION
- XS-1 — CROSS–SECTION LOCATION
- 10 x 10 VEG PLOT
- WLB — EXISTING WETLANDS
- ROCK STEP STRUCTURE w/ CLASS B RIP RAP
- FLOODPLAIN INTERCEPTOR

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ROSES CREEK
STREAM RESTORATION PROJECT
BURKE COUNTY, NORTH CAROLINA

GRAPHIC SCALE
50 25 0 25
PLANS

DATE: 09–13–17

CCPV
YEAR 2

SHEET
9

EEP# 96309

$$$$$$$SYSTIME$$$$$$
Z:\Roses_Creek\6.0_CAD_BIM\6.2_Work_In_Progress\stream\Proj\Monitoring Plans\Year 2\RosesCrk_psh_09.dgn
ICA ENGINEERING INC

Table 5: Visual Stream Morphology Stability Assessment
Reach ID: Roses Creek
Assessed Length: 3,121 FT

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
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			1	5	99.8%
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	17	17			100%
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	18	18			100%
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	18	18			100%
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	17	17			100%
		2. Thalweg centering at downstream of meander (Glide)	17	17			100%
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			2	30	99.9%
	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%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%
				Totals	0	0	100.0%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	19	19			100%
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	19	19			100%
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	19	19			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)	19	19			100%
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	19	19			100%

Table 5a: Visual Stream Morphology Stability Assessment Reach ID: UT1 Assessed Length: 234 LF							
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**
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	N/A	N/A			100%
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	2	2			100%
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	2	2			100%
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	3	3			100%
		2. Thalweg centering at downstream of meander (Glide)	3	3			100%
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100.0%
	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%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%
				Totals	0	0	100.0%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	12	12			100%
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	12	12			100%
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	12	12			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)	12	12			100%
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	12	12			100%

Table 5b: Visual Stream Morphology Stability Assessment
Reach ID: UT2
Assessed Length: 707 LF

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
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)			1	341	52%
		2. Degradation - Evidence of downcutting			0	0	100%
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate	22	22			100%
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6)	21	21			100%
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	21	21			100%
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	22	22			100%
		2. Thalweg centering at downstream of meander (Glide)	22	22			100%
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100.0%
	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%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%
				Totals	0	0	100.0%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	21	21			100%
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	21	21			100%
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	21	21			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)	21	21			100%
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	21	21			100%

Table 5c: Visual Stream Morphology Stability Assessment
Reach ID: UT3
Assessed Length: 620 LF

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
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)	12	12			100%
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstrem riffle)	13	13			100%
	4.**Thalweg Position**	1. Thalweg centering at upstream of meander bend (Run)	13	13			100%
		2. Thalweg centering at downstream of meander (Glide)	13	13			100%
2. Bank	**1. Scoured/Eroding**	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion			0	0	100.0%
	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%
	3. Mass Wasting	Bank slumping, calving, or collapse			0	0	100%
				Totals	0	0	100.0%
3. Engineered Structures	**1. Overall Integrity**	Structures physically intact with no dislodged boulders or logs.	14	14			100%
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	14	14			100%
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	14	14			100%
	3. Bank Protection	Bank erosion within the structures extent of influence doesnot exceed 15%. (See guidance for this table in EEP monitoring guidance document)	14	14			100%
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth ratio ≥ 1.6 Rootwads/logs providing some cover at base-flow.	14	14			100%

Table 6. Vegetation Condition Assessment

Planted Acreage **15.81**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	0.44 Acres	Pink polygons filled with green x's	4	0.42	2.7%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on MY3, 4, or 5 stem count criteria.	0.1 Acres	Blue cross hatch pattern	6	8	48.7%
			Total			
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	The entire site is experiencing low stem vigor.	The entire site is experiencing low stem vigor.	1	15.81	100%
			Cumulative Total			

Easement Acreage **17.33**

Vegetation Category	Definitions	Mapping Threshold	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale).	None	N/A	N/A	N/A	N/A
5. Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale).	None	N/A	N/A	N/A	N/A

Figures 3.1 - 3.22. Vegetation Plot and Problem Area Photos

3.1 Vegetation Plot 1

3.2 Vegetation Plot 2

3.3 Vegetation Plot 3

3.4 Vegetation Plot 4

3.5 Vegetation Plot 5

3.6 Vegetation Plot 6

3.7 Vegetation Plot 7

3.8 Vegetation Plot 8

3.9 Vegetation Plot 9

3.10 Vegetation Plot 10

3.11 Vegetation Plot 11

3.12 Vegetation Plot 12

3.13 Vegetation Plot 13

3.14 Vegetation Plot 14

3.15 Vegetation Plot 15

3.16 Vegetation Plot 16

3.17 Vegetation Plot 17

3.18 Stump washed into project area STA 13+40 (Roses Creek)

3.19 Conveyance created at STA 20+75 (Roses Creek)

3.20 Scour below rock step structure STA 37+25 (Roses Creek)

3.21 Minor erosion at rock step structure STA 37+27 (Roses Creek)

3.22 Repaired hole converted to a floodplain interceptor STA 38+69 (Roses Creek)

Appendix C. Vegetation Plot Data

Table 7.

DMS Project Code 96309. Project Name: Roses Creek

			Current Plot Data (MY2 2017)																									
			96309-WFW-0001			96309-WFW-0002			96309-WFW-0003			96309-WFW-0004			96309-WFW-0005			96309-WFW-0006			96309-WFW-0007			96309-WFW-0008			96309-WFW-0009		
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
Alnus serrulata	hazel alder	Shrub																						2	2	2			10
Betula nigra	river birch	Tree							1	1	1				1	1	2							1	1	1	1	1	21
Carya glabra	pignut hickory	Tree																									1	1	1
Cephalanthus occidentalis	common buttonbush	Shrub																											
Cornus alternifolia	alternateleaf dogwood	Tree																											
Cornus amomum	silky dogwood	Shrub				1	1	1	2	2	2	2	2	2	1	1	1	5	5	5	1	1	1	4	4	4			
Cornus florida	flowering dogwood	Tree																											
Diospyros virginiana	common persimmon	Tree			20																								
Fraxinus nigra	black ash	Tree													2	2	2												
Fraxinus pennsylvanica	green ash	Tree						1	1	1	1	4	4	4	2	2	2	2	2	2	3	3	3				2	2	2
Lindera benzoin	northern spicebush	Shrub																											
Liquidambar styraciflua	sweetgum	Tree																					1						
Liriodendron tulipifera	tuliptree	Tree							2	2	3												1				1	1	1
Platanus occidentalis	American sycamore	Tree							1	1	1	6	6	8	3	3	8				2	2	2	4	4	4	2	2	3
Populus heterophylla	swamp cottonwood	Tree																											
Prunus serotina	black cherry	Tree																											
Quercus michauxii	swamp chestnut oak	Tree																											
Quercus nigra	water oak	Tree																											
Quercus phellos	willow oak	Tree																											
Salix nigra	black willow	Tree																											
Ulmus americana	American elm	Tree																											
		Stem count	0	0	20	1	1	2	7	7	8	12	12	14	9	9	15	7	7	7	6	6	8	11	11	11	7	7	38
		size (ares)	1			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			0.02		
		Species count	0	0	1	1	1	2	5	5	5	3	3	3	5	5	5	2	2	2	3	3	5	4	4	4	5	5	6
		Stems per ACRE	0	0	809.4	40.47	40.47	80.94	283.3	283.3	323.7	485.6	485.6	566.6	364.2	364.2	607	283.3	283.3	283.3	242.8	242.8	323.7	445.2	445.2	445.2	283.3	283.3	1538

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%

Table 7a.

DMS Project Code 96309. Project Name: Roses Creek

			Current Plot Data (MY2 2017)																						Annual Means								
			96309-WFW-0010			96309-WFW-0011			96309-WFW-0012			96309-WFW-0013			96309-WFW-0014			96309-WFW-0015			96309-WFW-0016			96309-WFW-0017			MY2 (2017)			MY1 (2016)			MY0 (2016)		
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
Alnus serrulata	hazel alder	Shrub																									2	2	12						
Betula nigra	river birch	Tree			1	1	1	21	1	1	21	1	1	2			20			20			20	1	1	21	8	8	151	19	19	19	26	26	26
Carya glabra	pignut hickory	Tree				1	1	1																			2	2	2						
Cephalanthus occidentalis	common buttonbush	Shrub																												4	4	4	5	5	5
Cornus alternifolia	alternateleaf dogwood	Tree																												1	1	1	2	2	2
Cornus amomum	silky dogwood	Shrub	1	1	1	1	1	1	1	1	1	2	2	2				1	1	1	2	2	2	2	2	2	26	26	26	35	35	35	54	54	54
Cornus florida	flowering dogwood	Tree																			1	1	1				1	1	1						
Diospyros virginiana	common persimmon	Tree																								2			22						
Fraxinus nigra	black ash	Tree																									2	2	2	9	9	9	9	9	9
Fraxinus pennsylvanica	green ash	Tree	2	2	2	4	4	4	2	2	2	6	6	6				4	4	6	1	1	1	2	2	2	35	35	38	56	56	56	74	74	74
Lindera benzoin	northern spicebush	Shrub																			1	1	2				1	1	2						
Liquidambar styraciflua	sweetgum	Tree																					2						3						
Liriodendron tulipifera	tuliptree	Tree				1	1	1			2				1	1	1	1	1	1			1				6	6	11	11	11	11	12	12	12
Platanus occidentalis	American sycamore	Tree				3	3	3	1	1	1	4	4	5	2	2	3	1	1	1			1	2	2	2	31	31	42	49	49	49	59	59	59
Populus heterophylla	swamp cottonwood	Tree																			3	3	3				3	3	3						
Prunus serotina	black cherry	Tree																1	1	1							1	1	1						
Quercus michauxii	swamp chestnut oak	Tree																												2	2	2	2	2	2
Quercus nigra	water oak	Tree																												1	1	1	1	1	1
Quercus phellos	willow oak	Tree																												47	47	47	68	68	68
Salix nigra	black willow	Tree															1				1	1	3				1	1	4	4	4	4	7	7	7
Ulmus americana	American elm	Tree																												4	4	4	7	7	7
		Stem count	3	3	4	11	11	31	5	5	27	13	13	15	3	3	25	8	8	30	9	9	36	7	7	29	119	119	320	242	242	242	326	326	326
		size (ares)	1			1			1			1			1			1			1			1			17			17			17		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.02			0.42			0.42			0.42		
		Species count	2	2	3	6	6	6	4	4	5	4	4	4	2	2	4	5	5	6	6	6	10	4	4	5	13	13	15	13	13	13	13	13	13
		Stems per ACRE	121.4	121.4	161.9	445.2	445.2	1255	202.3	202.3	1093	526.1	526.1	607	121.4	121.4	1012	323.7	323.7	1214	364.2	364.2	1457	283.3	283.3	1174	283.3	283.3	761.8	576.1	576.1	576.1	776	776	776

Color for Density

Exceeds requirements by 10%

Exceeds requirements, but by less than 10%

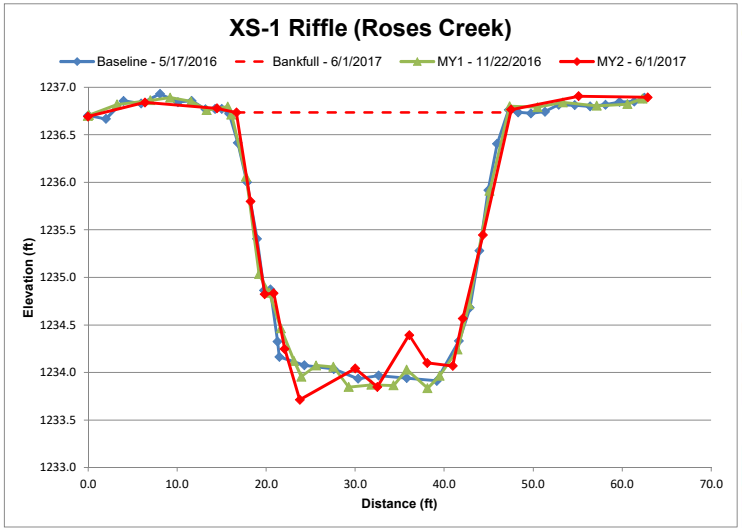
Fails to meet requirements, by less than 10%

Fails to meet requirements by more than 10%

Appendix D. Stream Survey Data

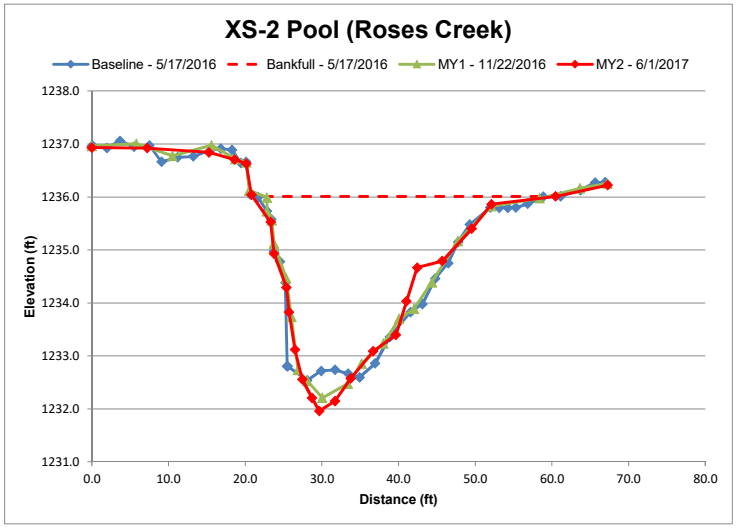
Figures 4.1 – 4.12. Cross Section Plots

River Basin	Catawba
Watershed	03050101060030
XS ID	XS 1 (Roses Creek)
Drainage Area (Acres)	3,309
Date	6/1/2017
Field Crew	Bill Wollman, Alex DiGeronimo



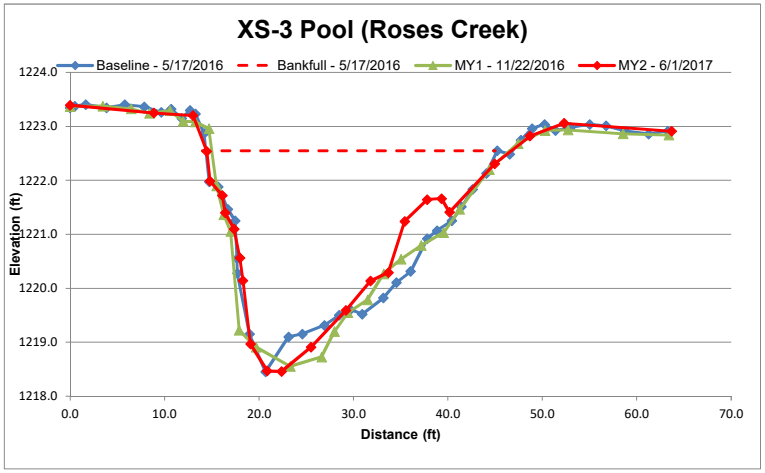
	Cross Section 1 (Riffle)							
Dimension and substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Based on fixed baseline bankfull elevation								
Bankfull Width (ft)	33.80	31.10	30.73					
Floodprone Width (ft)	508.32	508.32	508.32					
Bankfull Mean Depth (ft)	2.00	2.20	2.19					
Bankfull Max Depth (ft)	2.81	2.89	3.01					
Bankfull Cross Sectional Area (ft^2)	67.70	68.28	67.22					
Bankfull Width/Depth Ratio	16.90	14.14	14.03					
Bankfull Entrenchment Ratio	15.04	16.35	16.54					
Bankfull Bank Height Ratio	1.00	1.00	1.00					

River Basin	Catawba
Watershed	03050101060030
XS ID	XS 2 (Roses Creek)
Drainage Area (Acres)	3,309
Date	6/1/2017
Field Crew	Bill Wollman, Alex DiGeronimo



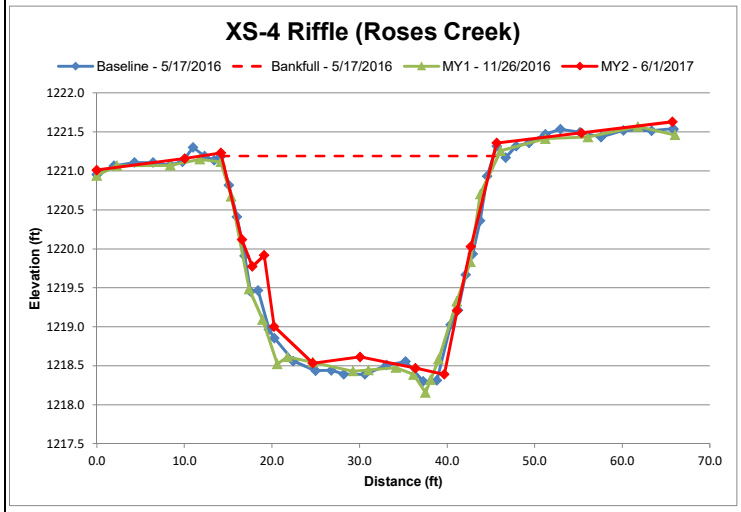
	Cross Section 2 (Pool)							
Dimension and substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Based on fixed baseline bankfull elevation								
Bankfull Width (ft)	38.53	37.04	39.49					
Floodprone Width (ft)								
Bankfull Mean Depth (ft)	1.73	1.75	1.65					
Bankfull Max Depth (ft)	3.47	3.80	4.05					
Bankfull Cross Sectional Area (ft^2)	66.48	64.97	65.02					
Bankfull Width/Depth Ratio								
Bankfull Entrenchment Ratio								
Bankfull Bank Height Ratio								

River Basin	Catawba
Watershed	03050101060030
XS ID	XS 3 (Roses Creek)
Drainage Area (Acres)	3,309
Date	6/1/2017
Field Crew	Bill Wollman, Alex DiGeronimo



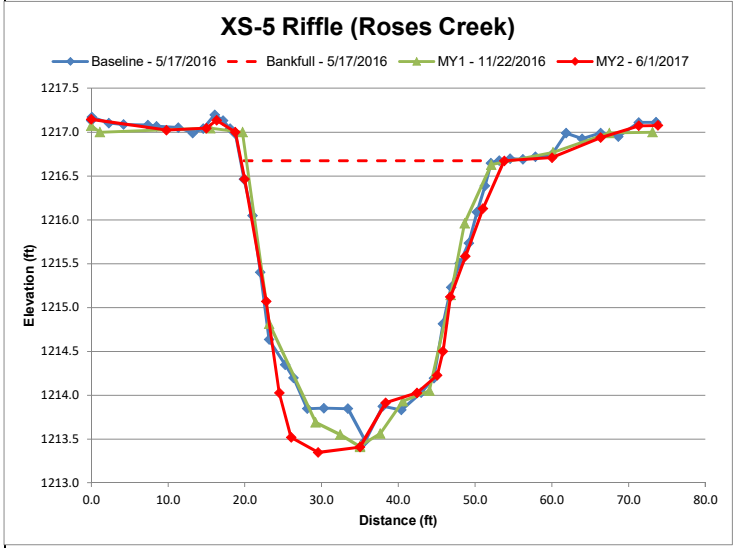
	Cross Section 3 (Pool)							
Dimension and substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Based on fixed baseline bankfull elevation								
Bankfull Width (ft)	32.44	31.58	32.26					
Floodprone Width (ft)								
Bankfull Mean Depth (ft)	2.19	2.32	2.07					
Bankfull Max Depth (ft)	4.10	3.99	4.09					
Bankfull Cross Sectional Area (ft^2)	71.10	73.39	66.76					
Bankfull Width/Depth Ratio								
Bankfull Entrenchment Ratio								
Bankfull Bank Height Ratio								

River Basin	Catawba
Watershed	03050101060030
XS ID	XS 4 (Roses Creek)
Drainage Area (Acres)	3,309
Date	6/1/2017
Field Crew	Bill Wollman, Alex DiGeronimo



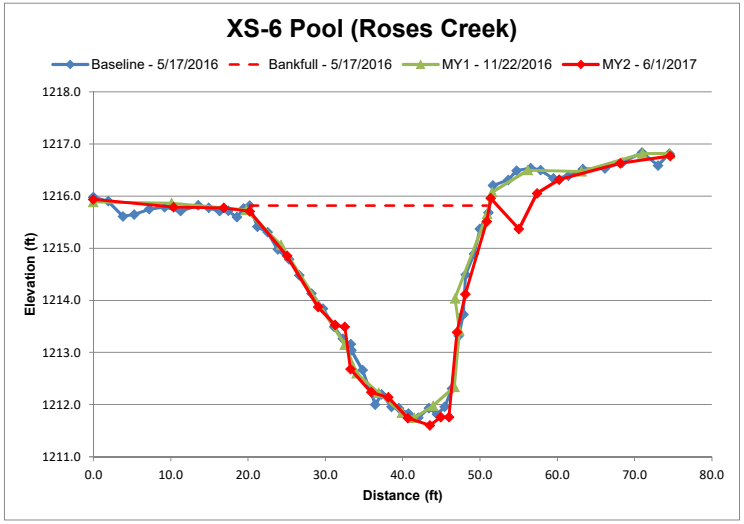
	Cross Section 4 (Riffle)							
Dimension and substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Based on fixed baseline bankfull elevation								
Bankfull Width (ft)	31.11	31.66	31.03					
Floodprone Width (ft)	696.00	696.00	696.00					
Bankfull Mean Depth (ft)	2.19	2.16	2.08					
Bankfull Max Depth (ft)	2.89	3.03	2.80					
Bankfull Cross Sectional Area (ft^2)	68.21	68.41	64.61					
Bankfull Width/Depth Ratio	14.21	14.66	14.92					
Bankfull Entrenchment Ratio	22.37	21.98	22.43					
Bankfull Bank Height Ratio	1.00	1.00	1.00					

River Basin	Catawba
Watershed	03050101060030
XS ID	XS 5 (Roses Creek)
Drainage Area (Acres)	3,309
Date	6/1/2017
Field Crew	Bill Wollman, Alex DiGeronimo



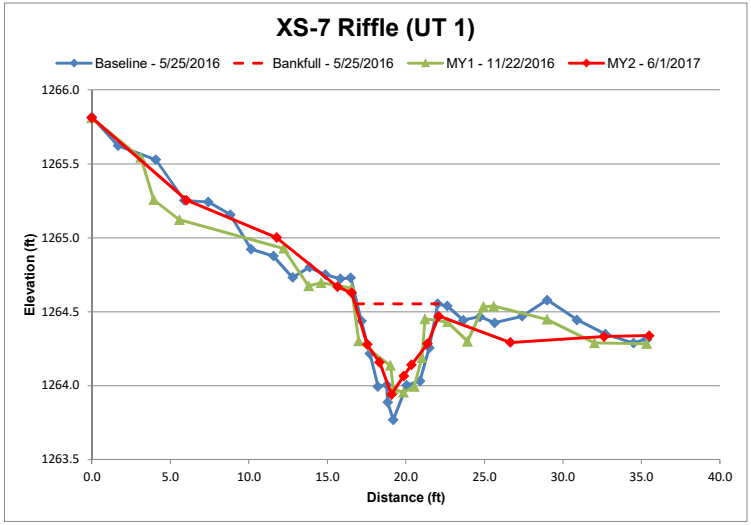
	Cross Section 5 (Riffle)							
Dimension and substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Based on fixed baseline bankfull elevation								
Bankfull Width (ft)	32.56	32.99	34.06					
Floodprone Width (ft)	563.60	563.60	563.60					
Bankfull Mean Depth (ft)	2.13	2.25	2.22					
Bankfull Max Depth (ft)	3.16	3.23	3.29					
Bankfull Cross Sectional Area (ft^2)	69.41	74.12	75.52					
Bankfull Width/Depth Ratio	15.29	14.66	15.34					
Bankfull Entrenchment Ratio	17.31	17.08	16.55					
Bankfull Bank Height Ratio	1.00	1.00	1.00					

River Basin	Catawba
Watershed	03050101060030
XS ID	XS 6 (Roses Creek)
Drainage Area (Acres)	3,309
Date	6/1/2017
Field Crew	Bill Wollman, Alex DiGeronimo



	Cross Section 6 (Pool)							
Dimension and substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Based on fixed baseline bankfull elevation								
Bankfull Width (ft)	31.02	31.30	30.99					
Floodprone Width (ft)								
Bankfull Mean Depth (ft)	2.37	2.23	2.32					
Bankfull Max Depth (ft)	4.07	3.98	4.11					
Bankfull Cross Sectional Area (ft^2)	73.63	69.77	71.83					
Bankfull Width/Depth Ratio								
Bankfull Entrenchment Ratio								
Bankfull Bank Height Ratio								

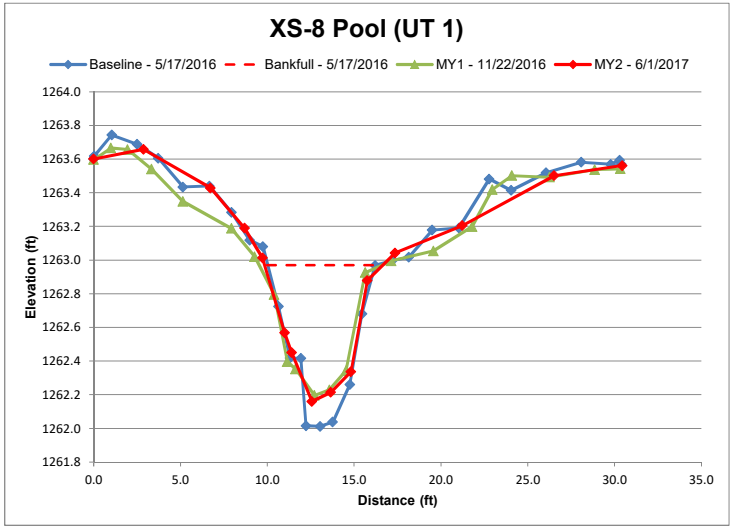
River Basin	Catawba
Watershed	03050101060030
XS ID	XS 7 (UT 1)
Drainage Area (Acres)	38.40
Date	6/1/2017
Field Crew	Bill Wollman, Alex DiGeronimo



	Cross Section 7 (Riffle)							
Dimension and substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Based on fixed baseline bankfull elevation								
Bankfull Width (ft)	5.12	4.46	5.31					
Floodprone Width (ft)	91.80	91.80	91.80					
Bankfull Mean Depth (ft)	0.45	0.41	0.35					
Bankfull Max Depth (ft)	0.78	0.59	0.61					
Bankfull Cross Sectional Area (ft^2)	2.30	1.82	1.86					
Bankfull Width/Depth Ratio	11.38	10.88	15.17					
Bankfull Entrenchment Ratio	17.93	20.58	17.29					
Bankfull Bank Height Ratio	1.00	1.00*	1.00*					

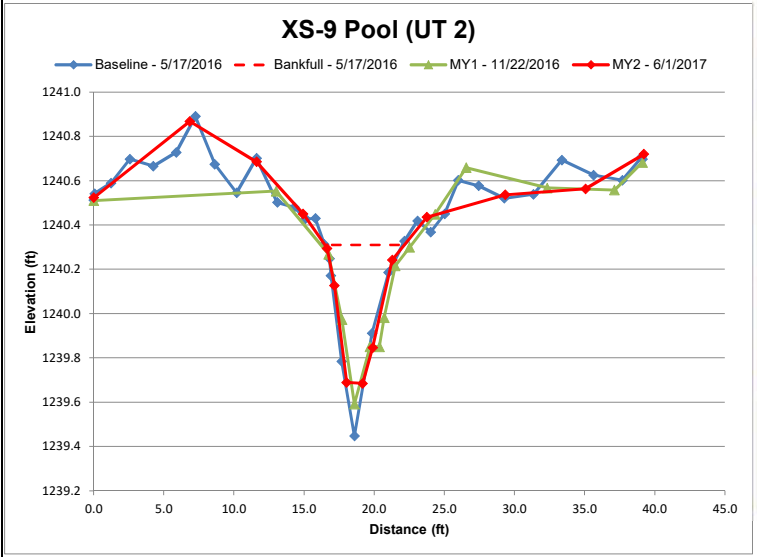
*Bankfull Bank Height Ratio set to a default value of 1.00. Values less than 1.00 do not occur in nature.

River Basin	Catawba
Watershed	03050101060030
XS ID	XS 8 (UT 1)
Drainage Area (Acres)	38.40
Date	6/1/2017
Field Crew	Bill Wollman, Alex DiGeronimo



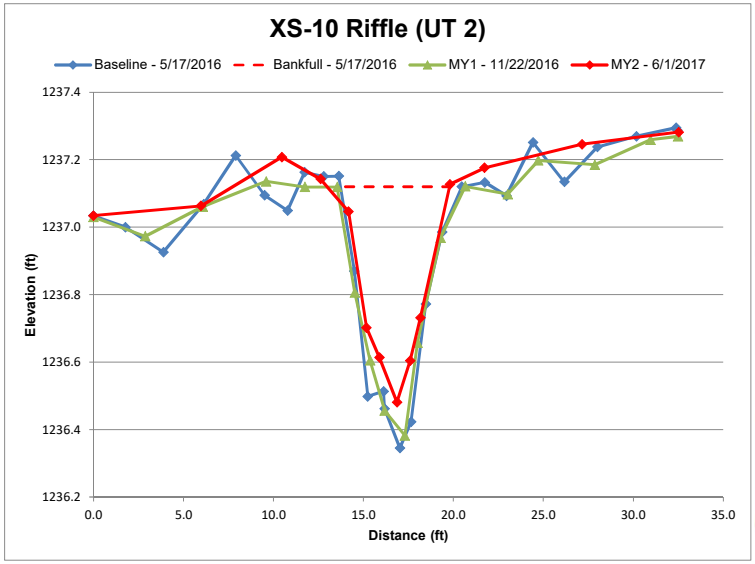
	Cross Section 8 (Pool)							
Dimension and substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Based on fixed baseline bankfull elevation								
Bankfull Width (ft)	6.24	7.07	6.80					
Floodprone Width (ft)								
Bankfull Mean Depth (ft)	0.58	0.44	0.47					
Bankfull Max Depth (ft)	0.96	0.77	0.81					
Bankfull Cross Sectional Area (ft^2)	3.64	3.10	3.23					
Bankfull Width/Depth Ratio								
Bankfull Entrenchment Ratio								
Bankfull Bank Height Ratio								

River Basin	Catawba
Watershed	03050101060030
XS ID	XS 9 (UT 2)
Drainage Area (Acres)	44.80
Date	6/1/2017
Field Crew	Bill Wollman, Alex DiGeronimo



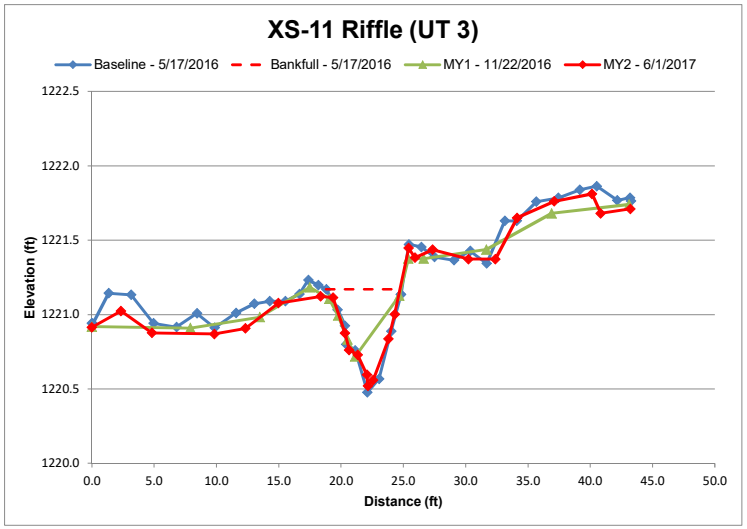
	Cross Section 9 (Pool)							
Dimension and substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Based on fixed baseline bankfull elevation								
Bankfull Width (ft)	5.56	6.43	5.69					
Floodprone Width (ft)								
Bankfull Mean Depth (ft)	0.37	0.31	0.33					
Bankfull Max Depth (ft)	0.86	0.72	0.63					
Bankfull Cross Sectional Area (ft^2)	2.07	1.97	1.90					
Bankfull Width/Depth Ratio								
Bankfull Entrenchment Ratio								
Bankfull Bank Height Ratio								

River Basin	Catawba
Watershed	03050101060030
XS ID	XS 10 (UT 2)
Drainage Area (Acres)	44.80
Date	6/1/2017
Field Crew	Bill Wollman, Alex DiGeronimo



	Cross Section 10 (Riffle)							
Dimension and substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Based on fixed baseline bankfull elevation								
Bankfull Width (ft)	6.70	7.10	6.79					
Floodprone Width (ft)	93.36	93.36	93.36					
Bankfull Mean Depth (ft)	0.42	0.38	0.32					
Bankfull Max Depth (ft)	0.77	0.74	0.64					
Bankfull Cross Sectional Area (ft^2)	2.79	2.69	2.17					
Bankfull Width/Depth Ratio	16.75	18.68	21.22					
Bankfull Entrenchment Ratio	13.93	13.14	13.75					
Bankfull Bank Height Ratio	1.00	1.00	1.01					

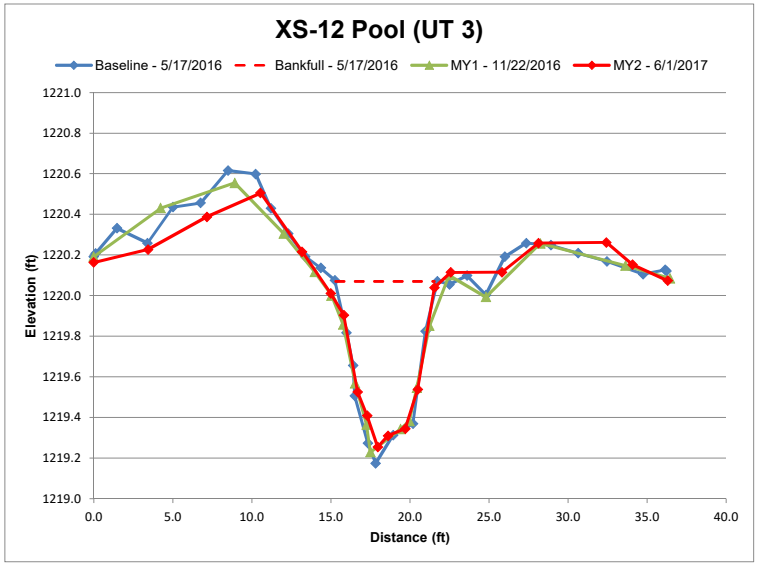
River Basin	Catawba
Watershed	03050101060030
XS ID	XS 11 (UT 3)
Drainage Area (Acres)	12.80
Date	6/1/2017
Field Crew	Bill Wollman, Alex DiGeronimo



	Cross Section 11 (Riffle)							
Dimension and substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Based on fixed baseline bankfull elevation								
Bankfull Width (ft)	6.00	7.28	5.38					
Floodprone Width (ft)	175.41	175.41	175.41					
Bankfull Mean Depth (ft)	0.36	0.21	0.37					
Bankfull Max Depth (ft)	0.69	0.46	0.65					
Bankfull Cross Sectional Area (ft^2)	2.19	1.51	2.01					
Bankfull Width/Depth Ratio	16.67	34.67	14.54					
Bankfull Entrenchment Ratio	29.24	24.09	32.60					
Bankfull Bank Height Ratio	1.00	1.00	1.00*					

*Bankfull Bank Height Ratio set to a default value of 1.00. Values less than 1.00 do not occur in nature.

River Basin	Catawba
Watershed	03050101060030
XS ID	XS 12 (UT 3)
Drainage Area (Acres)	12.80
Date	6/1/2017
Field Crew	Bill Wollman, Alex DiGeronimo



	Cross Section 12 (Pool)							
Dimension and substrate	**Base**	**MY1**	**MY2**	**MY3**	**MY4**	**MY5**	**MY6**	**MY7**
Based on fixed baseline bankfull elevation								
Bankfull Width (ft)	6.39	7.93	7.52					
Floodprone Width (ft)								
Bankfull Mean Depth (ft)	0.56	0.46	0.45					
Bankfull Max Depth (ft)	0.90	0.84	0.82					
Bankfull Cross Sectional Area (ft^2)	3.55	3.61	3.40					
Bankfull Width/Depth Ratio								
Bankfull Entrenchment Ratio								
Bankfull Bank Height Ratio								

Table 8. Baseline Stream Data Summary
Roses Creek Mitigation Site
Roses Creek: 3,200 Lf.

Parameter	Regional Curve		Pre-Existing Condition	Reference - Roses Creek Upstream	Design	As-built/Baseline					
Dimension and Substrate - Riffle	Eq. Mountains	Eq. Piedmont	Mean	Mean	Mean	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)	35.00	26.20	41.10	30.50	30.50	31.02	31.98	31.11	33.80	1.58	3.00
Floodprone Width (ft)			78.90	250.00	480.00	394.24	524.76	508.32	671.72	139.47	3.00
Bankfull Mean Depth (ft)	1.80	2.60	1.67	1.88	2.18	2.00	2.19	2.19	2.37	0.19	3.00
Bankfull Max Depth (ft)			2.92	2.71	2.72	2.81	3.26	2.89	4.07	0.71	3.00
Bankfull Cross Sectional Area (ft^2)	66.00	66.10	68.83	57.40	66.40	67.70	69.85	68.21	73.63	3.29	3.00
Width/Depth Ratio			24.60	16.20	14.00	13.09	14.73	14.21	16.90	1.96	3.00
Entrenchment Ratio			1.92	8.20	15.70	12.67	16.45	15.04	21.65	4.65	3.00
Bank Height Ratio			1.80	1.00	1.00	1.00	1.00	1.00	1.00	0.00	3.00
d50 (mm)			61.30	61.30	61.30						
Profile											
Riffle Length (ft)						37.17	64.41	58.40	106.19	18.18	23.00
Riffle Slope (ft/ft)			0.01	0.02	0.03	0.01	0.02	0.02	0.05	0.01	23.00
Pool Length (ft)						17.36	53.01	54.24	93.29	20.18	26.00
Pool Max depth (ft)			4.13	4.70	4.36	3.31	4.50	4.43	6.20	0.80	26.00
Pool Spacing (ft)			37.00 - 171.00	76.9 - 227.9	2.0 - 7.5	86.78	130.47	130.18	210.45	35.20	25.00
Pool Cross Sectional Area (ft^2)											
Pattern											
Channel Beltwidth (ft)			73.00 - 152.00	30.0 - 195.0	61.0 - 195.2						
Radius of Curvature (ft)			28 - 168	30.0 - 178.0	61.0 - 91.5						
Rc: Bankfull Width (ft/ft)			0.7 - 4.1	1.0 - 5.8	2.0 - 3.0						
Meander Wavelength (ft)			200 - 375	60 - 344	61.0 - 344.0						
Meander Width Ratio			1.78 - 3.70	1.0 - 6.4	2.0 - 6.4						
Substrate, bed and transport parameters											
Ri% / P%						35% / 65%					
SC% / Sa% / G% / C% / B% / Be%											
d16 / d35 / d50 / d84 / d95/ di^p / di^{sp} (mm)											
Reach Shear Stress (competency) lb/ft^2											
Max part size (mm) mobilized at bankfull											
Unit Stream Power (transport capacity) lbs/ft.s			3.83		3.83	3.83					
Additional Reach Parameters											
Drainage Area (SM)			5.17	4.66	5.17						
Impervious cover estimate (%)											
Rosgen Classification			B4	C4	C4	C4					
Bankfull Velocity (fps)				5.10	4.80						
Bankfull Discharge (cfs)			300.00	295.00	300.00						
Valley length (ft)			2894.00		2894.00	2894.00					
Channel Thalweg length (ft)			3425.00		3219.00	3219.00					
Sinuosity (ft)			1.18	1.11	1.11	1.11					
Water Surface Slope (Channel) (ft/ft)			0.0099	0.0192	0.0062	0.0059					
BF slope (ft/ft)					0.0062	0.0059					
Bankfull Floodplain Area (acres)											
Proportion over wide (%)											
Entrenchment Class (ER Range)											
Incision Class (BHR Range)											
BEHI VL% / L% / M% / H% / VH% / E%											
Channel Stability or Habitat Metric											
Biological or Other											

Table 8a. Baseline Stream Data Summary
Roses Creek Mitigation Site
UT 1 to Roses Creek: 234 LF

Parameter	Regional Curve		Pre-Existing Condition	Reference - UT West Branch Rocky River	Design	As-built/Baseline					
Dimension and Substrate - Riffle	Eq. Mountains	Eq. Piedmont	Mean	Mean	Mean	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)	6.70	5.30	6.00	4.40	5.00	5.12	5.12	5.12	5.12	0.00	1.00
Floodprone Width (ft)			8.40	27.50	60.00	91.80	91.80	91.80	91.80	0.00	1.00
Bankfull Mean Depth (ft)	0.50	0.70	0.23	0.51	0.38	0.45	0.45	0.45	0.45	0.00	1.00
Bankfull Max Depth (ft)			0.36	1.00	0.58	0.78	0.78	0.78	0.78	0.00	1.00
Bankfull Cross Sectional Area (ft^2)	3.20	3.30	1.39	2.30	2.10	2.30	2.30	2.30	2.30	0.00	1.00
Width/Depth Ratio			26.20	12.80	13.00	11.38	11.38	11.38	11.38	0.00	1.00
Entrenchment Ratio			1.40	6.28	12.00	17.93	17.93	17.93	17.93	0.00	1.00
Bank Height Ratio			6.11	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
d50 (mm)											
Profile											
Riffle Length (ft)						7.20	10.60	9.60	17.00	2.91	12.00
Riffle Slope (ft/ft)			0.0260	0.0033 - 0.0284	0.0021 - 0.0029	0.0201	0.0265	0.0213	0.0799	0.0210	12.00
Pool Length (ft)						3.60	11.89	9.80	37.39	9.23	11.00
Pool Max depth (ft)			Channelized	1.98	0.77	0.49	0.73	0.77	0.96	0.19	11.00
Pool Spacing (ft)			Channelized	10.10 - 41.0	10.0 - 30.0	18.40	24.04	20.90	45.59	8.03	10.00
Pool Cross Sectional Area (ft^2)											
Pattern											
Channel Beltwidth (ft)			Channelized	12.00 - 18.00	10.00 - 30.00						
Radius of Curvature (ft)			Channelized	10.00 - 14.00	12.00 - 15.00						
Rc: Bankfull Width (ft/ft)			Channelized	2.30 - 3.20	2.40 - 3.00						
Meander Wavelength (ft)			Channelized	45.00 - 66.00	20.0 - 55.0						
Meander Width Ratio			Channelized	2.74 - 4.11	2.00 - 6.00						
Substrate, bed and transport parameters											
Ri% / P%						49% / 51%					
SC% / Sa% / G% / C% / B% / Be%											
d16 / d35 / d50 / d84 / d95/ di^{p} / di^{sp} (mm)											
Reach Shear Stress (competency) lb/ft^2											
Max part size (mm) mobilized at bankfull											
Unit Stream Power (transport capacity) lbs/ft.s			0.07		0.07	0.07					
Additional Reach Parameters											
Drainage Area (SM)			0.06	0.07	0.06						
Impervious cover estimate (%)											
Rosgen Classification			F5	C5	C5	C5					
Bankfull Velocity (fps)				1.30	1.10						
Bankfull Discharge (cfs)			2.4	3.00	2.40						
Valley length (ft)			199.00		199.00	199.00					
Channel Thalweg length (ft)			199.00		234.00	234.00					
Sinuosity (ft)			1.00	1.16	1.18	1.18					
Water Surface Slope (Channel) (ft/ft)			0.0260	0.0033 - 0.0284	0.0021	0.0027					
BF slope (ft/ft)					0.0021	0.0027					
Bankfull Floodplain Area (acres)											
Proportion over wide (%)											
Entrenchment Class (ER Range)											
Incision Class (BHR Range)											
BEHI VL% / L% / M% / H% / VH% / E%											
Channel Stability or Habitat Metric											
Biological or Other											

Table 8b. Baseline Stream Data Summary
Roses Creek Mitigation Site
UT 2 to Roses Creek: 707 LF

Parameter	Regional Curve		Pre-Existing Condition	Reference - UT West Branch Rocky River	Design	As-built/Baseline					
Dimension and Substrate - Riffle	Mountains Eq.	Piedmont Eq.	Mean	Mean	Mean	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)	7.10	5.60	4.40	4.40	5.00	6.70	6.70	6.70	6.70	0.00	1.00
Floodprone Width (ft)			8.10	27.50	60.00	32.45	32.45	32.45	32.45	0.00	1.00
Bankfull Mean Depth (ft)	0.50	0.80	0.95	0.51	0.38	0.42	0.42	0.42	0.42	0.00	1.00
Bankfull Max Depth (ft)			1.39	1.00	0.58	0.77	0.77	0.77	0.77	0.00	1.00
Bankfull Cross Sectional Area (ft^2)	3.50	3.70	4.16	2.30	2.10	2.79	2.79	2.79	2.79	0.00	1.00
Width/Depth Ratio			4.60	12.80	13.00	15.95	15.95	15.95	15.95	0.00	1.00
Entrenchment Ratio			1.84	6.28	12.00	4.84	4.84	4.84	4.84	0.00	1.00
Bank Height Ratio			1.70	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
d50 (mm)											
Profile											
Riffle Length (ft)						4.27	13.94	13.33	31.46	6.12	23.00
Riffle Slope (ft/ft)			0.0260	0.0033 - 0.0284	0.0021 - 0.0030	0.0020	0.0025	0.0025	0.0038	0.0006	23.00
Pool Length (ft)						3.73	10.18	8.00	27.19	5.71	24.00
Pool Max depth (ft)			Channelized	1.98	0.77	0.53	0.96	0.92	1.59	0.24	24.00
Pool Spacing (ft)			Channelized	10.10 - 41.00	10.0 - 30.00	7.46	25.57	22.39	57.59	11.77	23.00
Pool Cross Sectional Area (ft^2)											
Pattern											
Channel Beltwidth (ft)			Channelized	12.00 - 18.00	13.70 - 30.00						
Radius of Curvature (ft)			Channelized	10.00 - 14.00	12.00 - 16.00						
Rc: Bankfull Width (ft/ft)			Channelized	2.30 - 3.20	2.40 - 3.20						
Meander Wavelength (ft)			Channelized	45.00 - 66.00	20.00 - 75.50						
Meander Width Ratio			Channelized	2.74 - 4.11	2.70 - 6.00						
Substrate, bed and transport parameters											
Ri% / P%						58% / 42%					
SC% / Sa% / G% / C% / B% / Be%											
d16 / d35 / d50 / d84 / d95/ di^p / di^{sp} (mm)											
Reach Shear Stress (competency) lb/ft^2											
Max part size (mm) mobilized at bankfull											
Unit Stream Power (transport capacity) lbs/ft.s			0.89		0.06	0.06					
Additional Reach Parameters											
Drainage Area (SM)			0.07	0.07	0.07						
Impervious cover estimate (%)											
Rosgen Classification			G5	C5	C5	C5					
Bankfull Velocity (fps)				1.30	1.10						
Bankfull Discharge (cfs)			2.40	3.00	2.40						
Valley length (ft)			575.00		575.00	575.00					
Channel Thalweg length (ft)			575.00		707.00	707.00					
Sinuosity (ft)			1.00	1.16	1.99	1.23					
Water Surface Slope (Channel) (ft/ft)			0.0260	0.0033 - 0.0284	0.0021	0.0023					
BF slope (ft/ft)					0.0021	0.0023					
Bankfull Floodplain Area (acres)											
Proportion over wide (%)											
Entrenchment Class (ER Range)											
Incision Class (BHR Range)											
BEHI VL% / L% / M% / H% / VH% / E%											
Channel Stability or Habitat Metric											
Biological or Other											

Table 8c. Baseline Stream Data Summary
Roses Creek Mitigation Site
UT 3 to Roses Creek: 620 LF

Parameter	Regional Curve		Pre-Existing Condition	Reference - UT West Branch Rocky River	Design	As-built/Baseline					
Dimension and Substrate - Riffle	Mountains Eq.	Piedmont Eq.	Mean	Mean	Mean	Min	Mean	Med	Max	SD	n
Bankfull Width (ft)	4.50	3.50	5.00	4.40	5.50	6.00	6.00	6.00	6.00	0.00	1
Floodprone Width (ft)			44.13	27.50	70.00	175.41	175.41	175.41	175.41	0.00	1
Bankfull Mean Depth (ft)	0.30	0.30	0.26	0.51	0.42	0.36	0.36	0.36	0.36	0.00	1
Bankfull Max Depth (ft)			1.70	1.00	0.63	0.69	0.69	0.69	0.69	0.00	1
Bankfull Cross Sectional Area (ft^2)	1.50	1.60	2.40	2.30	2.60	2.19	2.19	2.19	2.19	0.00	1
Width/Depth Ratio			12.23	12.80	13.10	16.67	16.67	16.67	16.67	0.00	1
Entrenchment Ratio			9.52	6.28	12.70	29.24	29.24	29.24	29.24	0.00	1
Bank Height Ratio			3.33	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1
d50 (mm)											
Profile											
Riffle Length (ft)						4.0	13.7	11.1	46.1	9.2	20
Riffle Slope (ft/ft)			0.0295	0.0033 - 0.0284	0.0029 - 0.0045	0.0025	0.0030	0.0030	0.0035	0.0004	20
Pool Length (ft)						3.2	12.1	8.1	34.6	9.0	20
Pool Max depth (ft)			Channelized	1.98	0.84	0.76	1.49	1.29	2.61	0.61	20
Pool Spacing (ft)			Channelized	10.10 - 41.00	12.7 - 51.70	10.3	25.0	25.8	45.3	9.4	19
Pool Cross Sectional Area (ft^2)											
Pattern											
Channel Beltwidth (ft)			Channelized	12.00 - 18.00	15.10 - 49.50						
Radius of Curvature (ft)			Channelized	10.00 - 14.00	12.70 - 17.60						
Rc: Bankfull Width (ft/ft)			Channelized	2.30 - 3.20	2.30 - 3.20						
Meander Wavelength (ft)			Channelized	45.00 - 66.00	15.10 - 83.10						
Meander Width Ratio			Channelized	2.74 - 4.11	2.70 - 9.00						
Substrate, bed and transport parameters											
Ri% / P%						53% / 47%					
SC% / Sa% / G% / C% / B% / Be%											
d16 / d35 / d50 / d84 / d95/ di^p / di^{sp} (mm)											
Reach Shear Stress (competency) lb/ft^2											
Max part size (mm) mobilized at bankfull											
Unit Stream Power (transport capacity) lbs/ft.s			0.09		0.08	0.08					
Additional Reach Parameters											
Drainage Area (SM)			0.02	0.07	0.02						
Impervious cover estimate (%)											
Rosgen Classification			B5	C5	C5	C5					
Bankfull Velocity (fps)				1.30	1.00						
Bankfull Discharge (cfs)			2.6	3.0	2.6						
Valley length (ft)			422		422	422					
Channel Thalweg length (ft)			422		620	620					
Sinuosity (ft)			1.00	1.16	1.47	1.47					
Water Surface Slope (Channel) (ft/ft)			0.0268	0.0033 - 0.0284	0.0025	0.0037					
BF slope (ft/ft)					0.0025	0.0037					
Bankfull Floodplain Area (acres)											
Proportion over wide (%)											
Entrenchment Class (ER Range)											
Incision Class (BHR Range)											
BEHI VL% / L% / M% / H% / VH% / E%											
Channel Stability or Habitat Metric											
Biological or Other											

Table 9. Morphology and Hydraulic Monitoring Summary (Dimensional Parameters - Cross Section)
Roses Creek Mitigation Site
Roses Creek: 3,200 LF

	Cross Section 1 (Riffle)								Cross Section 2 (Pool)							
Dimension	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Based on fixed baseline bankfull elevation																
Bankfull Width (ft)	33.80	31.10	30.73						38.53	37.04	39.49					
Floodprone Width (ft)	508.32	508.32	508.32													
Bankfull Mean Depth (ft)	2.00	2.20	2.19						1.73	1.75	1.65					
Bankfull Max Depth (ft)	2.81	2.89	3.01						3.47	3.80	4.05					
Bankfull Cross Sectional Area (ft^2)	67.70	68.28	67.22						66.48	64.97	65.02					
Bankfull Width/Depth Ratio	16.90	14.14	14.03													
Bankfull Entrenchment Ratio	15.04	16.35	16.54													
Bankfull Bank Height Ratio	1.00	1.00	1.00													
	Cross Section 3 (Pool)								Cross Section 4 (Riffle)							
Dimension	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Based on fixed baseline bankfull elevation																
Bankfull Width (ft)	32.44	31.58	32.26						31.11	31.66	31.03					
Floodprone Width (ft)									696.00	696.00	696.00					
Bankfull Mean Depth (ft)	2.19	2.32	2.07						2.19	2.16	2.08					
Bankfull Max Depth (ft)	4.10	3.99	4.09						2.89	3.03	2.80					
Bankfull Cross Sectional Area (ft^2)	71.10	73.39	66.76						68.21	68.41	64.61					
Bankfull Width/Depth Ratio									14.21	14.66	14.92					
Bankfull Entrenchment Ratio									22.37	21.98	22.43					
Bankfull Bank Height Ratio									1.00	1.00	1.00					
	Cross Section 5 (Riffle)								Cross Section 6 (Pool)							
Dimension	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Based on fixed baseline bankfull elevation[1]																
Bankfull Width (ft)	32.56	32.99	34.06						31.02	31.30	30.99					
Floodprone Width (ft)	563.60	563.60	563.60													
Bankfull Mean Depth (ft)	2.13	2.25	2.22						2.37	2.23	2.32					
Bankfull Max Depth (ft)	3.16	3.23	3.29						4.07	3.98	4.11					
Bankfull Cross Sectional Area (ft^2)	69.41	74.12	75.52						73.63	69.77	71.83					
Bankfull Width/Depth Ratio	15.29	14.66	15.34													
Bankfull Entrenchment Ratio	17.31	17.08	16.55													
Bankfull Bank Height Ratio	1.00	1.00	1.00													

Table 9a. Morphology and Hydraulic Monitoring Summary (Dimensional Parameters - Cross Section)
Roses Creek Mitigation Site
UT 1 Roses Creek: 234 LF

	Cross Section 7 (Riffle)								Cross Section 8 (Pool)							
Dimension	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Based on fixed baseline bankfull elevation																
Bankfull Width (ft)	5.12	4.46	5.31						6.24	7.07	6.80					
Floodprone Width (ft)	91.80	91.80	91.80													
Bankfull Mean Depth (ft)	0.45	0.41	0.35						0.58	0.44	0.47					
Bankfull Max Depth (ft)	0.78	0.59	0.61						0.96	0.77	0.81					
Bankfull Cross Sectional Area (ft^2)	2.30	1.82	1.86						3.64	3.10	3.23					
Bankfull Width/Depth Ratio	11.38	10.88	15.17													
Bankfull Entrenchment Ratio	17.93	20.58	17.29													
Bankfull Bank Height Ratio	1.00	1.00	1.00													

Table 9b. Morphology and Hydraulic Monitoring Summary (Dimensional Parameters - Cross Section)
Roses Creek Mitigation Site
UT2 Roses Creek: 707 LF

	Cross Section 9 (Pool)								Cross Section 10 (Riffle)							
Dimension	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Based on fixed baseline bankfull elevation																
Bankfull Width (ft)	5.56	6.43	5.69						6.70	7.10	6.79					
Floodprone Width (ft)									93.36	93.36	93.36					
Bankfull Mean Depth (ft)	0.37	0.31	0.33						0.42	0.38	0.32					
Bankfull Max Depth (ft)	0.86	0.72	0.63						0.77	0.74	0.64					
Bankfull Cross Sectional Area (ft^2)	2.07	1.97	1.90						2.79	2.69	2.17					
Bankfull Width/Depth Ratio									16.75	18.68	21.22					
Bankfull Entrenchment Ratio									13.93	13.14	13.75					
Bankfull Bank Height Ratio									1.00	1.00	1.01					

Table 9c. Morphology and Hydraulic Monitoring Summary (Dimensional Parameters - Cross Section)
Roses Creek Mitigation Site
UT3 Roses Creek: 620 LF

	Cross Section 11 (Riffle)								Cross Section 12 (Pool)							
Dimension	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7	Base	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Based on fixed baseline bankfull elevation																
Bankfull Width (ft)	6.00	7.28	5.38						6.39	7.93	7.52					
Floodprone Width (ft)	175.41	175.41	175.41													
Bankfull Mean Depth (ft)	0.36	0.21	0.37						0.56	0.46	0.45					
Bankfull Max Depth (ft)	0.69	0.46	0.65						0.90	0.84	0.82					
Bankfull Cross Sectional Area (ft^2)	2.19	1.51	2.01						3.55	3.61	3.4					
Bankfull Width/Depth Ratio	16.67	34.67	14.54													
Bankfull Entrenchment Ratio	29.24	24.09	32.60													
Bankfull Bank Height Ratio	1.00	1.00	1.00													

Appendix E. Hydrologic Data

Figures 5.1 - 5.4 Crest Gauge Photos

5.1 Crest Gauge Roses Creek (10/5/2016)

5.2 Crest Gauge UT 1 (10/5/2016)

5.3 Crest Gauge UT 2 (10/5/2016)

5.4 Crest Gauge UT 3 (10/5/2016)

5.5 Crest Gauge Roses Creek (11/22/2016)

5.6 Crest Gauge UT 1 (11/22/2016)

5.7 Crest Gauge UT 2 (11/22/2016)

5.8 Crest Gauge UT 3 (11/22/2016)

5.9 Crest Gauge Roses Creek (6/2/2017)

5.10 Crest Gauge UT 1 (6/2/2017)

5.11 Crest Gauge UT 2 (6/2/2017)

5.12 Crest Gauge UT 3 (6/2/2017)

5.13 Crest Gauge Roses Creek (8/15/2017)

5.14 Crest Gauge UT 1 (8/15/2017)

5.15 Crest Gauge UT 2 (8/15/2017)

5.16 Crest Gauge UT 3 (8/15/2017)

Table 10. Verification of Bankfull Events

Date	Crest Gauge Info		Gauge Reading (ft)	Gauge Elevation (ft)	Crest Elevation (ft)	Bankfull Elevation (ft)	Height above Bankfull (ft)	Photo
	Site	Sta.						
10/5/2016	1	Roses Creek	0.00	1212.11	N/A	1213.93	N/A	5.1
10/5/2016	2	UT 1	0.00	1267.45	N/A	1267.95	N/A	5.2
10/5/2016	3	UT 2	0.35	1227.81	1228.16	1228.19	N/A	5.3
10/5/2016	4	UT 3	0.25	1216.94	1217.19	1217.36	N/A	5.4
11/22/2016	1	Roses Creek	0.00	1212.11	N/A	1213.93	N/A	5.5
11/22/2016	2	UT 1	0.00	1267.45	N/A	1267.95	N/A	5.6
11/22/2016	3	UT 2	0.00	1227.81	N/A	1228.19	N/A	5.7
11/22/2016	4	UT 3	0.35	1216.94	1217.29	1217.36	N/A	5.8
6/2/2017	1	Roses Creek	1.89	1212.11	1214.00	1213.93	0.07	5.9
6/2/2017	2	UT 1	0.80	1267.45	1268.25	1267.95	0.30	5.10
6/2/2017	3	UT 2	1.50	1227.81	1229.31	1228.19	1.12	5.11
6/2/2017	4	UT 3	1.80	1216.94	1218.74	1217.36	1.38	5.12
8/15/2017	1	Roses Creek	0.50	1212.11	1212.61	1213.93	N/A	5.13
8/15/2017	2	UT 1	0.38	1267.45	1267.83	1267.95	N/A	5.14
8/15/2017	3	UT 2	0.85	1227.81	1228.66	1228.19	0.47	5.15
8/15/2017	4	UT 3	1.64	1216.94	1218.58	1217.36	1.22	5.16

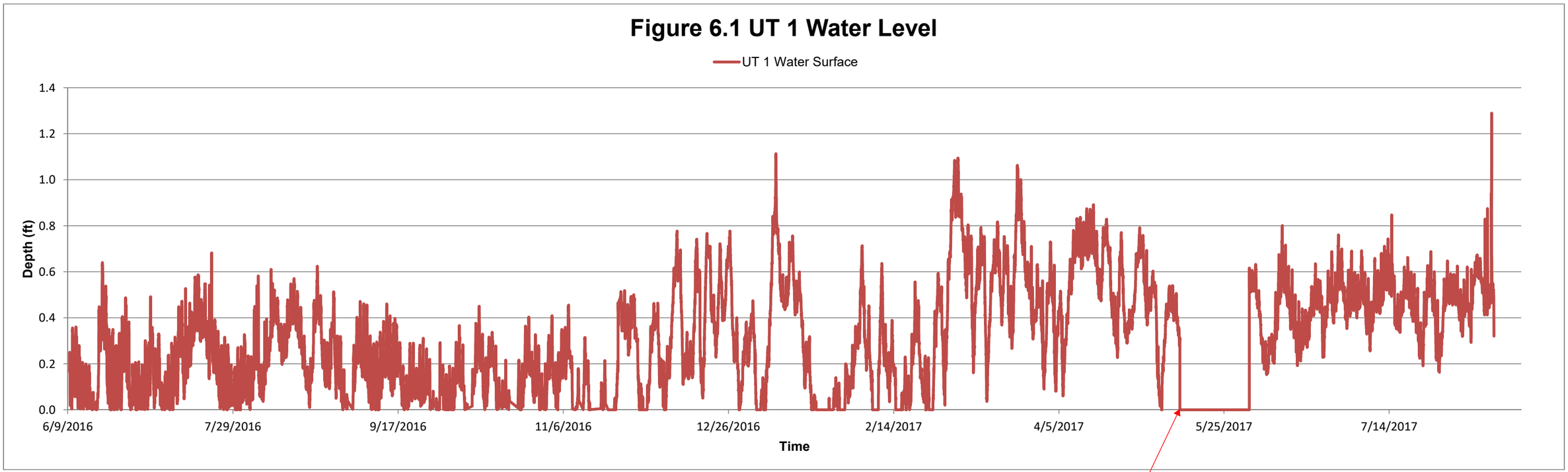
Table 11. Burke County Drought Status

Month	Drought Status
June 2016	Abnormally Dry
July 2016	Abnormally Dry
August 2016	Abnormally Dry
September 2016	Moderate Drought
October 2016	Moderate Drought
November 2016	Severe Drought

Source: NC Drought Management Advisory Council

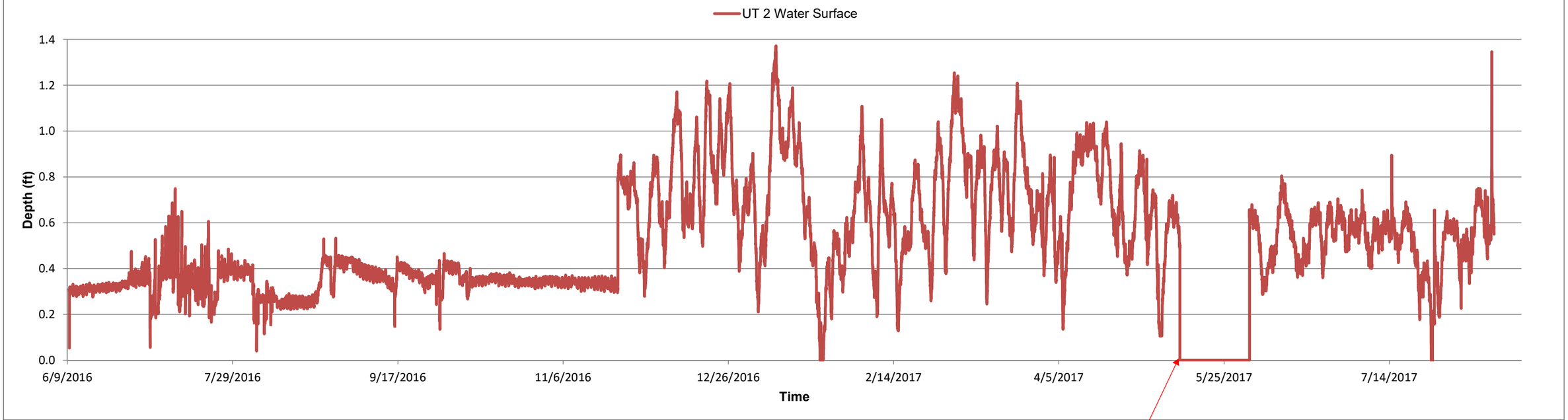
Figure 6.1 – 6.3 Tributary Water Level Gauge Meter Data

Figure 6.1 UT 1 Water Level



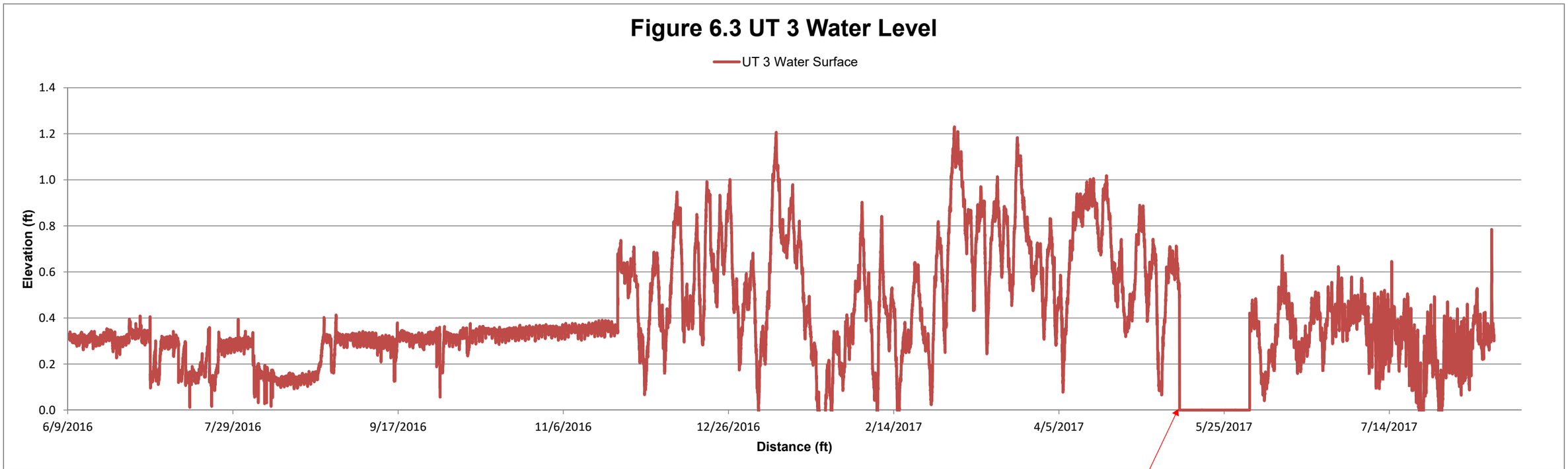
Water level data missing
5/11/2017 - 6/1/2017

Figure 6.2 UT 2 Water Level



Water level data missing
5/11/2017 - 6/1/2017

Figure 6.3 UT 3 Water Level



Water level data missing
5/11/2017 - 6/1/2017

Table 12. Tributary Surface Water Summary (30 Consecutive Days or More)

Tributary	Dates	Number of Consecutive Days with Flow
UT 1	6/25/2016 - 7/27/2016	32
UT 1	2/25/2017 - 5/6/2017	70
UT 1	6/1/2017 - 8/14/2017	74
UT 2	6/9/2016 - 1/22/2017	228
UT 2	1/24/2017 - 5/11/2017	107
UT 2	6/1/2017 – 7/26/2017	55
UT 3	9/1/2016 – 12/30/2017	120
UT 3	2/15/2017 – 5/11/2017	85
UT 3	6/1/2017 – 7/23/2017	52

Appendix F. Corrective Action Plan

Easement Boundary
Restoration
Enhancement II

Vegetation Plot- Criteria Met

No
Yes

Replant Zone

A- 1.8 ac
B- 0.9 ac
C- 0.6 ac
D- 1.4 ac
E- 2.1 ac
F- 0.9 ac

UT 1
UT 2
UT 3
Roses Creek

1.8 ac
0.9 ac
0.6 ac
1 ac
1.4 ac
2.1 ac

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

Roses Creek Replanting Map- 2017

Roses Creek Stream Mitigation Site
Burke County, North Carolina

0 325 650 975 1,300 Feet

HDR | ICA

N W E S

NC

Figure 7.1

Table 13. Planting List for Zone A Through Zone C

Zone A- UT 1	**1.8 AC**	**9 x 9 spacing (542 stems/ac)**	
Common Name	**Scientific Name**	**% Composition**	**# Planted**
Sycamore	*Platanus occidentalis*	15	146
River Birch	*Betula nigra*	15	146
Green Ash	*Fraxinus pennsylvanica*	15	146
Tulip Tree	*Liriodendron tulipifera*	15	146
White Oak	*Quercus alba*	12	117
Northern Red Oak	*Quercus rubra*	12	117
American Elm	*Ulnus american*	6	59
Willow Oak	*Quercus phellos*	5	49
Silky Dogwood	*Cornus amomum*	5	49
		TOTAL	975
Zone B- Roses	**0.9 AC**	**10 x 10 spacing (436 stems/ac)**	
Common Name	**Scientific Name**	**% Composition**	**# Planted**
Sycamore	*Platanus occidentalis*	15	59
River Birch	*Betula nigra*	15	59
Green Ash	*Fraxinus pennsylvanica*	15	59
Tulip Tree	*Liriodendron tulipifera*	15	59
White Oak	*Quercus alba*	12	48
Northern Red Oak	*Quercus rubra*	12	48
American Elm	*Ulnus american*	6	24
Willow Oak	*Quercus phellos*	5	20
Silky Dogwood	*Cornus amomum*	5	20
		TOTAL	396
Zone C- Roses	**.6 AC**	**9 x 9 spacing (542 stems/ac)**	
Common Name	**Scientific Name**	**% Composition**	**# Planted**
Sycamore	*Platanus occidentalis*	15	49
River Birch	*Betula nigra*	15	49
Green Ash	*Fraxinus pennsylvanica*	15	49
Tulip Tree	*Liriodendron tulipifera*	15	49
White Oak	*Quercus alba*	12	39
Northern Red Oak	*Quercus rubra*	12	39
American Elm	*Ulnus american*	6	20
Willow Oak	*Quercus phellos*	5	17
Silky Dogwood	*Cornus amomum*	5	17
		TOTAL	328

Table 13a. Planting List for Zone D Through Zone F

Zone D- Roses	**1.4 AC**	**10 x 10 spacing (436 stems/ac)**	
Common Name	**Scientific Name**	**% Composition**	**# Planted**
Sycamore	*Platanus occidentalis*	15	92
River Birch	*Betula nigra*	15	92
Green Ash	*Fraxinus pennsylvanica*	15	92
Tulip Tree	*Liriodendron tulipifera*	15	92
White Oak	*Quercus alba*	12	74
Northern Red Oak	*Quercus rubra*	12	74
American Elm	*Ulnus american*	6	37
Willow Oak	*Quercus phellos*	5	31
Silky Dogwood	*Cornus amomum*	5	31
		TOTAL	615
Zone E- Roses	**2.1 AC**	**13 x 13 spacing (260 stems/ac)**	
Common Name	**Scientific Name**	**% Composition**	**# Planted**
Sycamore	*Platanus occidentalis*	15	82
River Birch	*Betula nigra*	15	82
Green Ash	*Fraxinus pennsylvanica*	15	82
Tulip Tree	*Liriodendron tulipifera*	15	82
White Oak	*Quercus alba*	12	65
Northern Red Oak	*Quercus rubra*	12	65
American Elm	*Ulnus american*	6	33
Willow Oak	*Quercus phellos*	5	28
Silky Dogwood	*Cornus amomum*	5	28
		TOTAL	547
Zone F- UT 2	**0.9 AC**	**9 x 9 spacing (542 stems/AC)**	
Common Name	**Scientific Name**	**% Composition**	**# Planted**
River Birch	*Betula nigra*	20	97
Green Ash	*Fraxinus pennsylvanica*	20	97
Sycamore	*Platanus occidentalis*	20	97
Button Bush	*Quercus alba*	15	73
Tag Alder	*Alnus serrulata*	15	73
Silky Dogwood	*Cornus amomum*	10	49
		TOTAL	486