Upper Silver Creek Restoration Project
Year 2 Monitoring Report

Burke County, North Carolina

NCDMS Project ID Number – 94645

Catawba River Basin: 03050101-050050

Project Info:	Monitoring Year: 2 of 5 Year of Data Collection: 2016 Year of Completed Construction: 2015 Submission Date: December 2016
Submitted To:	NCDEQ – Division of Mitigation Services 5 Ravenscroft Drive, Suite 102 Asheville, NC 28801 NCDEQ Contract ID No. 003270

Upper Silver Creek Restoration Project
Year 2 Monitoring Report

Burke County, North Carolina

NCDMS Project ID Number – 94645

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NC Professional Engineering License # F-1084

Michael Baker
INTERNATIONAL

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APPENDICES

1.0 EXECUTIVE SUMMARY

Michael Baker Engineering, Inc. (Baker) restored or enhanced 5,186 linear feet (LF) of perennial stream channel along Silver Creek and three unnamed tributaries (UT1,UT2, and UT3); and additionally, Baker restored, enhanced or created approximately 9.14 acres of wetlands that had been previously disturbed in Burke County, NC, (Appendix A). The Upper Silver Creek Stream and Wetland Restoration Project (Site) is located southeast of Morganton, NC, approximately 11 miles southeast of the intersection of Highway 64 and I-40 and to the north of the intersection of Highway 64 and Goldmine Road. The Site is located in the NC Division of Water Resources (NCDWR) sub-basin 03-08-31 and the NCDEQ Division of Mitigation Services (NCDMS) Targeted Local Watershed (TLW) 03050101-050050 of the Catawba River Basin. The project involved the restoration and enhancement of a Piedmont/Mountain Mixed Bottomland Hardwood Forest system (NC WAM 2010, Schafale and Weakley 1990) from impairments within the project area due to past agricultural conversion, cattle grazing, gold mining and draining of floodplain wetlands by ditching activities.

The project goals directly addressed stressors identified in the Catawba River Basin Restoration Priority (RBRP) Plan such as degraded riparian conditions, channel modification, and excess sediment and nutrient inputs. The primary restoration goals, as outlined in the approved mitigation plan, are described below:

- Create geomorphically stable stream channels within the Upper Silver Creek project area including headwater tributaries in the Catawba River basin;
- Restore, enhance, and expand wetland functions across the Site;
- Improve and restore hydrologic connections between streams and degraded riparian wetland areas and overall ecosystem functionality;
- Improve water quality within the Upper Silver Creek project area through reduction of bank erosion, improved nutrient and sediment removal, and stabilization of streambanks; and
- Improve aquatic and terrestrial habitat.

To accomplish these goals, we recommended the following actions:

- Restore the existing incised, eroding, and channelized stream by creating a stable channel that has access to its floodplain;
- Improve water quality by establishing buffers for nutrient removal from runoff and by stabilizing stream banks to reduce bank erosion;
- Improve in-stream habitat by providing a more diverse bedform with riffles and pools, creating deeper pools, developing areas that increase oxygenation, providing woody debris for habitat, and reducing bank erosion; and
- Improve terrestrial habitat by planting riparian areas with native vegetation and protecting these areas with a permanent conservation easement. The riparian area will increase storm water runoff filtering capacity, improve bank stability, provide shading to decrease water temperature and improve habitat.

During the winter of 2015/2016, there were a number of high flow events. At least one of those inundated the floodplain, depositing woody debris and other flotsam in wrack lines well away from the top of bank. This flooding caused a number of channel and structure issues that are presented in the CCPV, tables and photos included with the e-file. These were all repaired in March of 2016 and functioned well through the summer with no further problems. Year 2 (MY2) monitoring indicated that the planted acreage was functioning well with no bank, bench or flood plain areas having bare areas of a significant size. The only invasive vegetation with significant coverage was Chinese privet, which was located in the existing forested area on the right bank

of Silver Creek, downstream of the confluence with UT2. We will continue to treat privet within this area with herbicide to minimize the population. We continue to have a minor issue with mowing encroachments. Most of the sites where mowing encroachments occurred last year were avoided this year; however, we still have some mowing affecting the easement and will mark these areas to limit mowing access. We have established and are monitoring fourteen (14) vegetation plots at this site. The average density of total planted stems following the MY2 growing season is 740 stems per acre (n=14), with an additional average 43 volunteer stems per acre. Based on the average density of 740 stems per acre, the Site is on track to meet the established success criteria.

Stream geomorphological stability and performance during MY2 was assessed by surveying sixteen cross-sections, a profile of each channel, evaluating the bed particle size with five riffle pebble counts and by replicating channel location photographs. Channel cross-sections and profiles were similar to what was observed in the past with no major instability identified and the general morphology is responding as designed and meeting project goals. At least one significant flood event, that was greater than bankfull occurred during MY2. This storm event caused valley wide flooding with wrack lines well away from the top of stream banks. Stream pebble data indicated that the shift to smaller particles on Silver Creek and on the three UTs had stabilized at sizes similar to what was seen last year. This indicates a properly functioning system, as there were no mid-channel bars or other sediment transport issues.

Wetland monitoring during MY2 demonstrated that three of the thirteen groundwater monitoring wells located on the Site met the wetland success criteria as stated in the Site Mitigation Plan. The gauges that met success criteria (USAW5, USAW7 and USAW13) demonstrated consecutive hydroperiods of 12 percent or greater, ranging from 26.7 to 37.3 percent of the growing season. The gauges that did not meet success criteria demonstrated consecutive hydroperiods of 12 percent or less, with a range from 2.4 percent to 6.5 percent of the growing season. Rainfall near the project (Morganton, NC) was determined to be at or below the 30th percentile for six of the twelve months of the year. The last half of September, October, and November, were almost completely dry at all four monitoring sites and Burke County was classified as being in a Severe Drought throughout November (NC Drought Management Advisory Council). Therefore, 2016 is considered to be below the normal precipitation range for the growing season. The dry conditions documented in this area are likely the reason that many of our gauges failed to meet the established success criteria.

Summary information/data related to the Site and statistics related to performance of various project and monitoring elements can be found in the tables and figures in the report Appendices. Narrative background and supporting information formerly found in these reports can be found in the Baseline Monitoring Report and in the Mitigation Plan available on the NCDMS website. All raw data supporting the tables and figures in the appendices are available from NCDMS upon request.

2.0 METHODOLOGY

The monitoring plan for the Site includes criteria to evaluate the success of the stream, wetland and vegetation components of the project. The methodology and report template used to evaluate these components adheres to the NCDMS monitoring guidance document dated December 1, 2009 and other mitigation guidance (NCEEP 2009 and USACE 2003), which will continue to serve as the template for subsequent monitoring years. The specific locations of monitoring features: vegetation plots, permanent cross-sections, monitoring wells, flow gauges, and the crest gauge, are shown on the CCPV sheets found in Appendix A.

The Year 2 monitoring data were collected in October and November 2016. Site photographic data was collected in August 2016.

2.1 Vegetation Assessment

In order to determine if vegetation success criteria are achieved, vegetation monitoring quadrants (veg plots) were installed and are monitored across the Site in accordance with the CVS-NCDMS Protocol for Recording Vegetation, Version 4.1 (CVS 2007 and Lee, Peet, Roberts and Wentworth 2007). The vegetation monitoring plots are a minimum of two percent of the planted portion of the Site with 14 plots established randomly within the planted riparian buffer and wetland area, per CVS Monitoring Level 2. No veg plots were established within the undisturbed wooded areas along the right bank of Silver Creek. The size of individual quadrants is 100 square meters for woody (tree) species and 1 square meter for herbaceous vegetation. Herbaceous quadrants were established in one corner of the larger woody plots and are monitored by comparing photographs taken year to year.

Year 2 monitoring found that all vegetation was in good condition. All vegetation monitoring quadrants indicated that vegetation was growing and in good to excellent condition. The average density of planted stems following the Year 2 growing season was 740 stems per acre (n=14). There were also an average of 43 volunteer stems per acre, composed of seven different tree species. With an average density of 740 stems per acre, the Site is on track to meet the minimum interim success criteria of 320 stems per acre by the end of Year 3, and the final success criteria of 260 stems per acre by the end of Year 5.

There was only one Vegetation Problem Area observed during MY2 and it is associated with the invasive species Chinese privet, *Ligustrum sinense*. Our observations indicated that the area of primary infestation by this species was the floodplain along the right bank of Silver Creek, downstream of the confluence with UT2. To control this invasive species, this area will be treated in 2017 during the appropriate treatment window. We identified four Mowing Encroachment Areas. There were two areas along the easement line where the landowner encroached into the easement while attempting to mow outside of the easement line. We think this occurred because he is mowing with a 15 foot wide bush-hog and it crosses the line in a couple of spots were trees (outside the easement) limit its movement. Encroachment in two other areas indicate that the landowner did not understand where the line was located. These areas will be pointed out to the landowner and the easement line at all encroachment areas will be better marked with witness posts before the landowner needs to mow again.

No other areas of concern regarding the existing vegetation was observed along Silver Creek or the tributaries. Year 2 vegetation assessment information is provided in Appendix C.

2.2 Stream Assessment

The Upper Silver Creek Site approach is for restoration of a stable morphology that allows for the transport of water and sediment through the Site and allows stream flows larger than bankfull flows to spread onto the floodplain. Stream monitoring efforts focus on visual observations, a crest gauge to document bankfull flooding events, surveying established stream cross-sections and channel profiles to assess channel stability and pebble counts to assess if proper sediment transport is taking place.

Stream survey data was collected to a minimum of Class C Vertical and Class A Horizontal Accuracy using Leica TS06 Total Station and was georeferenced to the NAD83 State Plane Coordinate System, FIPS3200 in US Survey Feet, which was derived from the As-built Survey. This survey system collects point data with an accuracy of less than one tenth of a foot.

2.2.1 Morphologic Parameters and Channel Stability

Cross-sections were classified using the Rosgen Stream Classification System (Rosgen 1994) and all cross-sections were evaluated to determine if they meet design expectations. Cross-sections were also compared to the baseline cross-section plots to evaluate change between construction and the MY2 survey. Morphological survey data is presented in Appendix D.

A longitudinal profile was surveyed for the entire length of each channel to document changes from the as-built baseline conditions during the first year of monitoring. The survey was tied to a permanent benchmark and measurements included thalweg, water surface, and top of low bank. Each of these measurements was taken at the head of each feature (e.g., riffle, pool) and at the maximum pool depth.

Stream geomorphological stability and performance during MY2 was assessed by surveying sixteen (16) cross-sections (7 on Silver Creek, 2 on UT1, 2 on UT2 and 5 on UT3) and a profile of these channels as described above. The bed particle size was evaluated with five riffle pebble counts (2 on Silver Creek and 1 on each of the tributaries) and by observation and replicating channel location photographs. Cross-sections of all the channels were very similar to past years especially at riffle cross-sections. Most pool cross-sections showed some level of deposition. This was likely due to prevailing severe to extreme drought conditions that existed during the 4 to 5 months preceding our survey. There was little change from past profile surveys and profiles of each channel do not indicate any instability issues.

The Visual Morphological Stability Assessment indicates that the Site is stable and performing at 100 percent for all parameters on all reaches. Flooding at this site during MY2, as described below, caused bank scour (8 locations) and damage to structures (5 locations) at the site. The locations, descriptions and photos of this damage are included in the Stream Problem Areas Table on the MY2 data electronic file. These sites were repaired in March 2016 and have functioned well during the rest of MY2. Overall, channel morphology is responding as designed and meeting project goals.

Pebble count data for MY2 indicates that the shift to smaller particles on Silver Creek and on the three UTs has stabilized at sizes similar to what was seen last year. This indicates that smaller native bed material is being transported into project reaches and has shifted pebble size classes away from the constructed riffle particle sizes, seen in the As-built data. This indicates a properly functioning system, as there were no mid-channel bars or other sediment transport issues.

2.2.2 Hydrology

Two crest gauges were installed on the floodplain at this site, at the bankfull elevation. One is located along the left top of bank on Silver Creek, at approximately Station 19+00, and the second is on the left top of bank of UT3, at approximately Station 9+50. Crest gauges on Silver Creek and on UT3 recorded water levels of approximately 15 inches and 5 inches above bankfull, respectively. Physical indicators of bankfull flows, such as wrack lines and debris on the bank, were observed throughout the reach. We present at least five possible high water events, which could have caused the high flow recorded on project site crest gauges and shown in Table 9, the bankfull verification information. The most significant flow recorded was on December 29, 2015 and this storm event most likely caused valley wide flooding and the evidence of flooding that we observed in February. Crest gauge readings are presented in Appendix D.

2.2.3 Photographic Documentation

Reference transects were photographed at each permanent cross-section. The survey tape was centered in the photograph of the bank. The water line was located in the lower area of the frame, and as much of the bank as possible included in each photograph. Photographs were also taken at specific photo points established along each channel during baseline reporting. Photographs from these points will be replicated each year and used to document changes along the channel. Points were selected to include grade control structures as well as other structural components installed during construction. Annual photographs from the established photo points are shown in Appendix D and do not indicate any stability issues at the site and no failing structures.

2.3 Wetland Assessment

Thirteen automated groundwater-monitoring stations were installed in the wetland restoration area in order to document the hydrologic conditions during the monitoring period. The installations followed USACE protocols (USACE 1997). Groundwater data collected during Year 2 monitoring are located in Appendix E.

To meet the hydrologic success criteria, the monitoring gauge data must show that for each normal rainfall year within the monitoring period, the Site has been inundated or saturated for a certain hydroperiod. Success criteria for wetland hydrology will be based on standards for atypical wetland areas (USACE, 2005). Criteria have been met when the wetland is saturated within 12 inches of the soil surface for 12 percent of the growing season when rainfall amounts approximate normal conditions. Alternatively, when dry conditions prevail, we may use the fourteen (14) or more consecutive days during the growing season when antecedent precipitation has been drier than normal for a minimum frequency of 5 years in 10 to 50 percent of the monitoring period (USACE, 1987 and 2005).

Visual monitoring of wetland areas will be conducted annually. Photographs will be used to visually document system performance and identify areas of low stem density, invasive species vegetation, beaver activity, or other areas of concern. Reference stations will be photographed each year for a minimum of five years following construction. Photographs will be taken from a height of approximately five to six feet. Permanent well markers were established and used to ensure that the same locations (and view directions) on the Site are documented in each monitoring period.

Wetland monitoring during MY2 demonstrated that three of the thirteen groundwater monitoring wells located on the Site met the wetland success criteria as stated in the Site Mitigation Plan. The gauges that met success criteria (USAW5, USAW7 and USAW13) demonstrated consecutive hydroperiods of 12 percent or greater, these ranged from 26.7 to 37.3 percent of the growing season. The gauges that did not meet success criteria (USAW1, USAW2, USAW3, USAW4, USAW6, USAW8, USAW9, USAW10, USAW11, and USAW12) demonstrated consecutive hydroperiods of 12 percent or less, with a range from 2.4 percent to 6.5 percent of the growing season. The rain data for the region (Figure 8) shows that rainfall throughout the year was, at times, well below average. Baker will continue to monitor the groundwater hydrology of the Site during Monitoring Year 3.

To evaluate annual rainfall in the project vicinity we utilized four USGS data recording stations that are within close proximity (11.3 to 15.7 miles from the site) to the project site. The CHRONOS stations that were used in the previous report had recorded several gaps in the data, and two were offline at the time this report was developed. The data from these stations was not sufficient to use in this yearly analysis of rainfall for the county, so the USGS stations were used instead. These data indicate that 2016 was relatively dry through winter, spring and summer with the exception of April and August, which were both above normal. Many of the months, especially later in the year, were exceptionally dry and were well below the 30th percentile. Rainfall near the project (Morganton, NC) was determined to be at or below the 30th percentile for six of the twelve months of the year. The last half of September, October, and November, were almost completely dry at all four monitoring sites and the region was classified as being in an Extreme Drought. Therefore, 2016 is considered to be below the normal range for the growing season. The dry conditions documented in this area are likely the reason that many of our gauges failed to meet the established success criteria.

3.0 REFERENCES

Carolina Vegetation Survey (CVS) and NC Ecosystem Enhancement Program (NCEEP). 2007. CVS-NCEEP Data Entry Tool v. 2.3.1. University of North Carolina, Raleigh, NC.

Lee, M., Peet R., Roberts, S., Wentworth, T. 2007. CVS-NCEEP Protocol for Recording Vegetation, Version 4.1.

North Carolina Ecosystem Enhancement Program (NCEEP). 2009. Guidance and Content Requirements for EEP Monitoring Reports Version 1.2.1. December 1, 2009.

Rosgen, D. L. 1994. A Classification of Natural Rivers. Catena 22:169-199.

Schafale, M. P., and A. S. Weakley. 1990. Classification of the natural communities of North Carolina, third approximation. North Carolina Natural Heritage Program. Division of Parks and Recreation, NCDENR. Raleigh, NC.

United States Army Corps of Engineers (USACE). 1987. Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. Environmental Laboratory. US Army Engineer Waterways Experiment Station. Vicksburg, MS.

____. 1997. Corps of Engineers Wetlands Research Program. Technical Note VN-rs-4.1. Environmental Laboratory. U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

____. 2003. Stream Mitigation Guidelines, April 2003, U.S. Army Corps of Engineers. Wilmington District.

____. 2005. "Technical Standard for Water-Table Monitoring of Potential Wetland Sites," WRAP Technical Notes Collection (ERDC TN-WRAP-05-2), U.S. Army Engineer Research and Development Center. Vicksburg, MS.

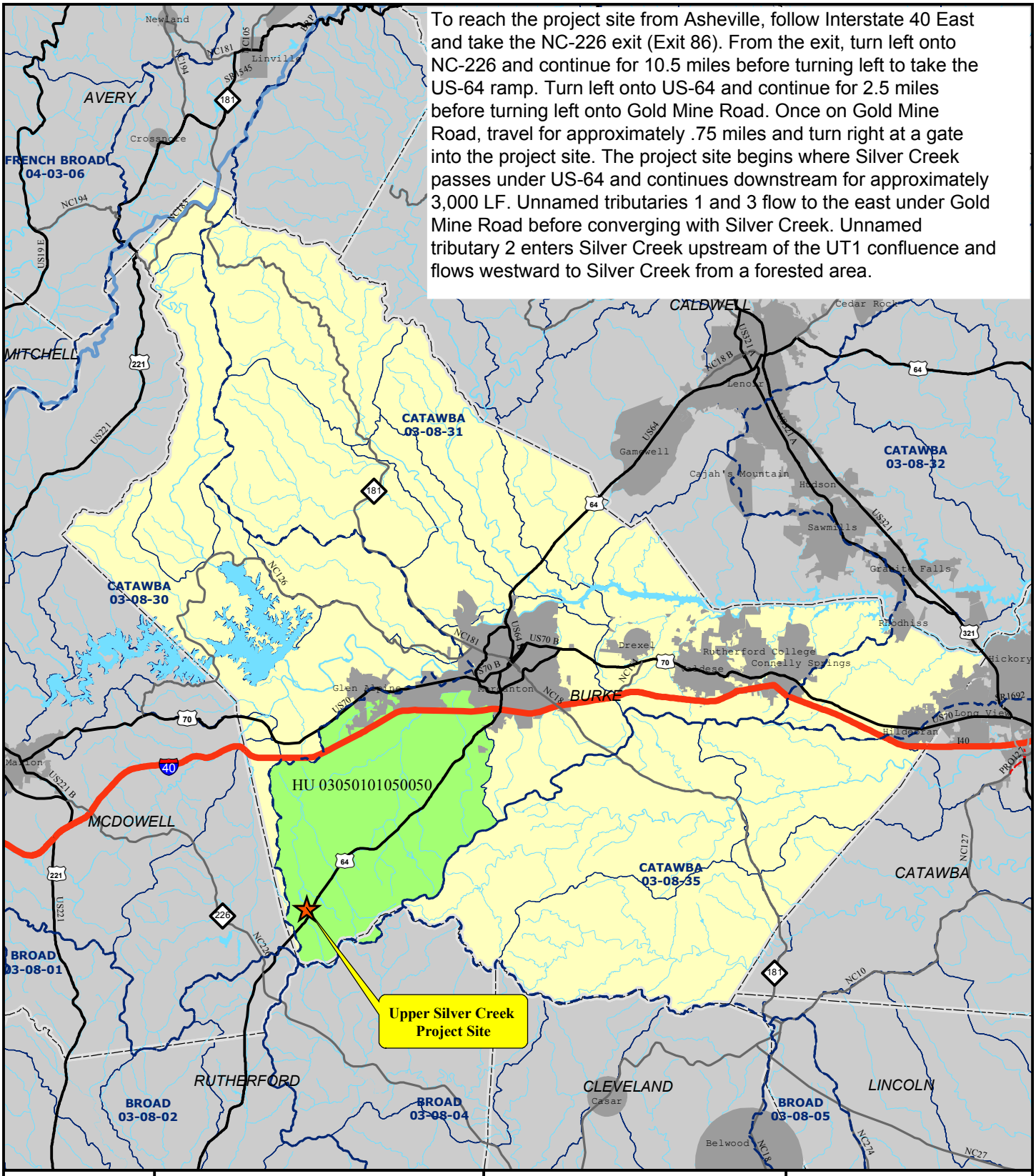
Appendix A

General Figures and Plan Views

Includes:

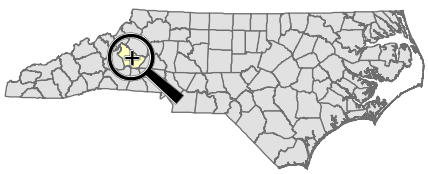
Figure 1. Project Vicinity Map and Directions
Figure 2. Current Condition Plan View (CCPV) – Overview Map
Figure 2A. CCPV North half of Project
Figure 2B. CCPV South half of Project

To reach the project site from Asheville, follow Interstate 40 East and take the NC-226 exit (Exit 86). From the exit, turn left onto NC-226 and continue for 10.5 miles before turning left to take the US-64 ramp. Turn left onto US-64 and continue for 2.5 miles before turning left onto Gold Mine Road. Once on Gold Mine Road, travel for approximately .75 miles and turn right at a gate into the project site. The project site begins where Silver Creek passes under US-64 and continues downstream for approximately 3,000 LF. Unnamed tributaries 1 and 3 flow to the east under Gold Mine Road before converging with Silver Creek. Unnamed tributary 2 enters Silver Creek upstream of the UT1 confluence and flows westward to Silver Creek from a forested area.



Division of Mitigation Services

Map Inset



LEGEND:

- NCDWQ Sub-basin
- Counties
- USGS Hydrologic Unit
- Project Hydrologic Unit
- Burke County

0 1 2 4 Miles

Figure 1. Project Vicinity Map

Upper Silver Creek
NCDMWS Project #94645
Monitoring Year 2 Report
Burke County, NC

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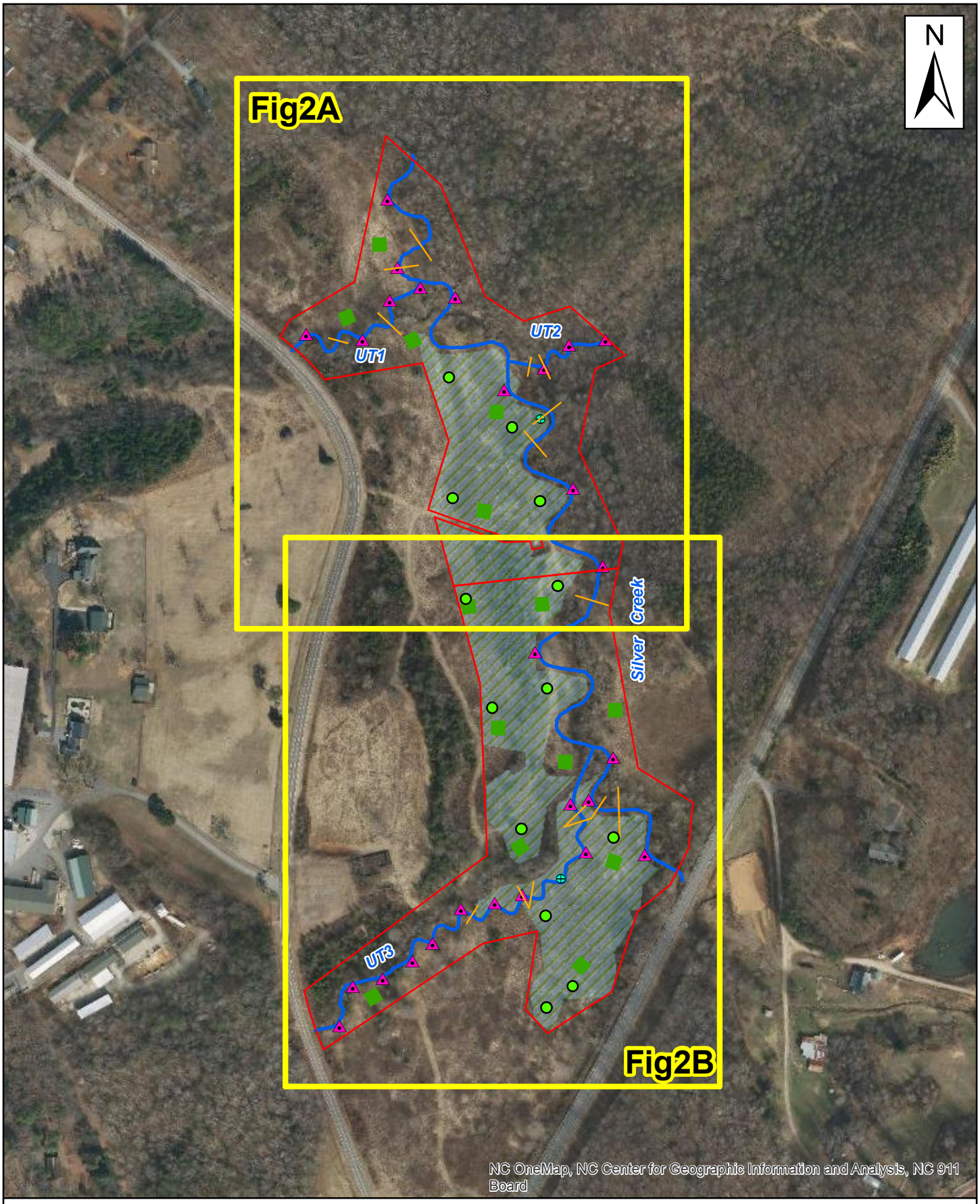

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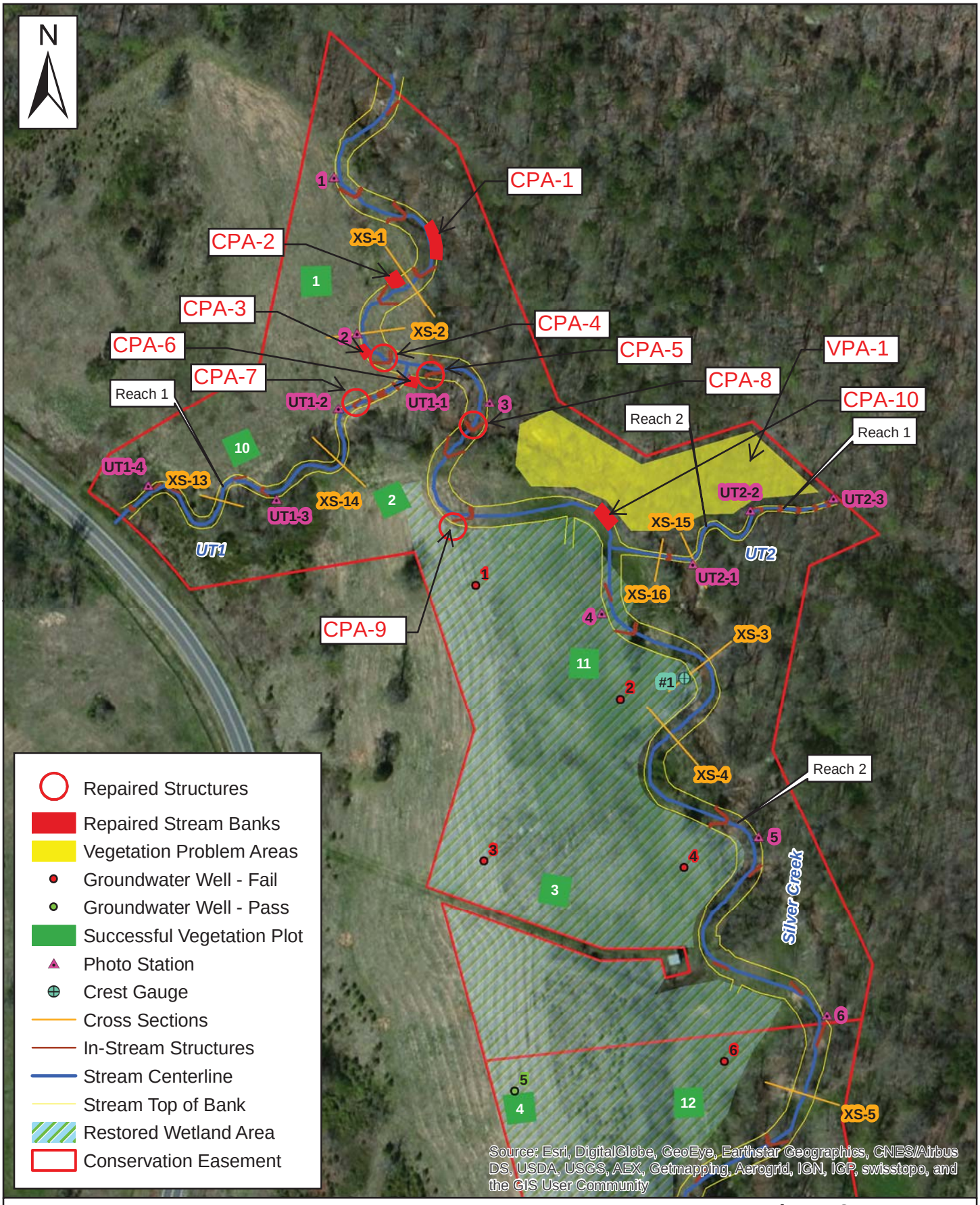
0 250 500 Feet

DMS Project # 94645

Figure 2
Current Conditions Plan View - MY2
Overview Map
Upper Silver Creek Site



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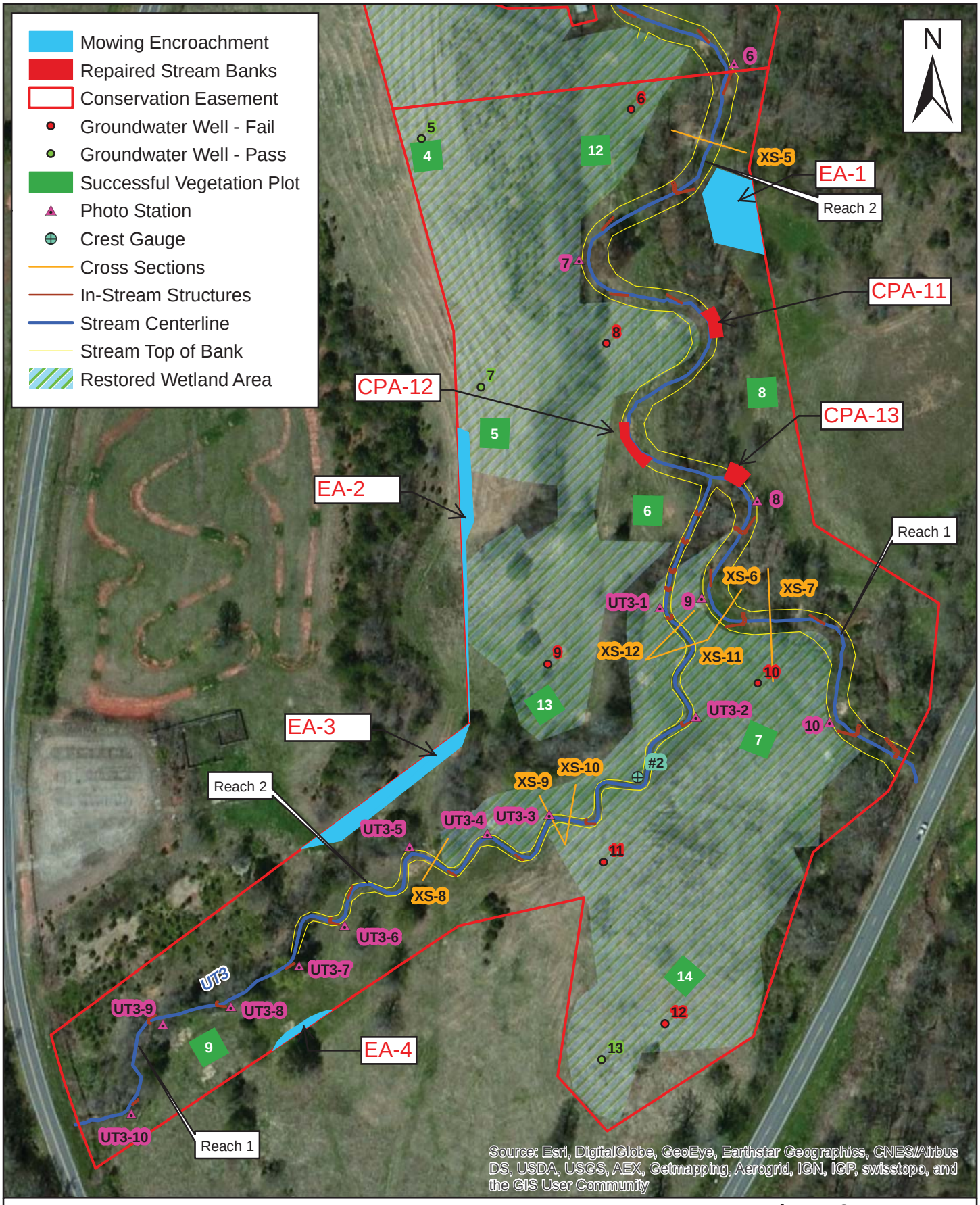
0 100 200 300 Feet

DMS Project # 94645

Figure 2A
Current Conditions Plan View
Monitoring Year 2
Upper Silver Creek Site



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0 100 200 300 Feet

DMS Project # 94645

Figure 2B
Current Conditions Plan View
Monitoring Year 2
Upper Silver Creek Site

Appendix B
General Project Tables

Includes:

Table 1. Project Components and Mitigation Credits

Figure 3. U. Silver Cr. Project Asset Map

Table 2. Project Activity and Reporting History

Table 3. Project Contacts

Table 4. Project Attributes

Table 1. Project Components and Mitigation Credits

Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Mitigation Credits

	Stream		Riparian Wetland			Non-riparian Wetland			Buffer	Nitrogen Nutrient Offset	Phosphorus Nutrient Offset
Type	R	EII	R	E	C	R	E	C			
Totals	4,843 SMU	137 SMU	4.67 WMU	1.43 WMU	0.33 WMU	0.21 WMU	0.21 WMU				

Project Components

Project Component or Reach ID	Stationing/ Location	Existing Footage/ Acreage	Approach	Restoration/ Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio
STREAMS						
Silver Creek		2643 LF				
Reach 1	0+32 to 8+70		Restoration - PII	838 SMU	838 LF	1:1
Reach 2	8+70 to 30+48		Restoration - PI	2,178 SMU	2178 LF	1:1
UT1		478 LF				
Reach 1	0+07 to 5+02		Restoration - PI	495 SMU	495 LF	1:1
UT2		187 LF				
Reach 1	0+00 to 1+03		Restoration - PI	103 SMU	103 LF	1:1
Reach 2	1+03 to 3+10		Restoration - PI	207 SMU	207 LF	1:1
UT3		1,162 LF				
Reach 1	0+00 to 3+43		Enhancement I	137 SMU	343 LF	2.5:1
Reach 2	3+43 to 13+65		Restoration - PI	1,022 SMU	1,022 LF	1:1
WETLANDS	See plan sheets					
JDW1a (NR)		0.42 AC	Enhancement	0.21 WMU	0.42 AC	2:1
JDW1b (Ri)		1.01 AC	Enhancement	0.51 WMU	1.01 AC	2:1
JDW2 (Ri)		0.51 AC	Enhancement	0.25 WMU	0.51 AC	2:1
JDW3 (Ri)		0.03 AC	Enhancement	0.02 WMU	0.03 AC	2:1
JDW4 (Ri)		0.24 AC	Enhancement	0.12 WMU	0.24 AC	2:1
JDW5 (Ri)		0.81 AC	Enhancement	0.40 WMU	0.81 AC	2:1
JDW6 (Ri)		0.25 AC	Enhancement	0.13 WMU	0.25 AC	2:1
R1A (NR)		0	Restoration	0.06 WMU	0.06 AC	1:1
R1B (NR)		0	Restoration	0.15 WMU	0.15 AC	1:1
R2 (Ri)		0	Restoration	1.22 WMU	1.22 AC	1:1
R3 (Ri)		0	Restoration	0.18 WMU	0.18 AC	1:1
R4 (Ri)		0	Restoration	0.44 WMU	0.44 AC	1:1
R5 (Ri)		0	Restoration	1.29 WMU	1.29 AC	1:1
R6 (Ri)		0	Restoration	1.54 WMU	1.54 AC	1:1
C1 (Ri)		0	Creation	0.33 WMU	0.99 AC	3:1

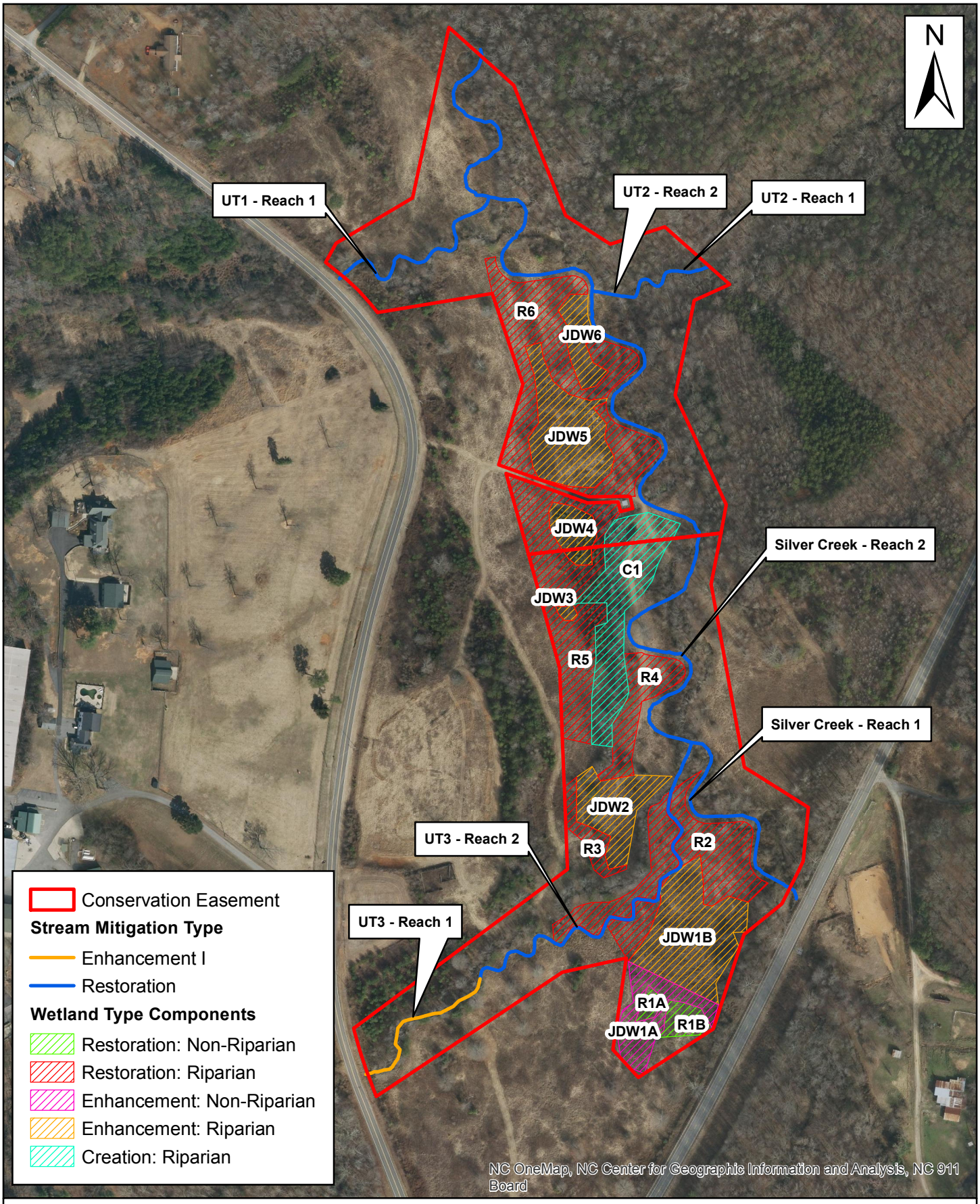
Component Summation

Restoration Level	Stream (LF)	Riparian Wetland (AC)		Non-riparian Wetland (AC)	Buffer (SF)	Upland (AC)
		Riverine	Non-Riverine			
Restoration	4,843	4.67		0.21		
Enhancement I		2.85		0.42		
Enhancement II	343					
Creation		0.99				
Preservation						
High Quality Preservation						

BMP Elements

Element		Location	Purpose/Function	Notes

BMP Elements: BR= Bioretention Cell; SF= Sand Filter; SW= Stormwater Wetland; WDP= Wet Detention Pond; DDP= Dry Detention Pond; FS= Filter Strip; S= Grassed Swale; LS= Level Spreader; NI=Natural Infiltration Area



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0 250 500 Feet

DMS Project # 94645

Figure 3
U. Silver Cr. Project Asset Map
Upper Silver Creek Site

Table 2. Project Activity and Reporting History
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Activity or Report	Scheduled Completion	Data Collection Complete	Actual Completion or Delivery
Mitigation Plan Prepared	Jan-13	N/A	Jan-13
Mitigation Plan Amended	Sep-13	N/A	Sep-13
Mitigation Plan Approved	Oct-13	N/A	Oct-13
Final Design – (at least 90% complete)	N/A	N/A	May-14
Construction Begins	N/A	N/A	May-14
Temporary S&E mix applied to entire project area	N/A	N/A	Dec-14
Permanent seed mix applied to entire project area	N/A	N/A	Dec-14
Planting of live stakes	Winter 2015	N/A	Feb-15
Planting of bare root trees	N/A	N/A	Feb-15
End of Construction	N/A	N/A	Dec-14
Survey of As-built conditions (Year 0 Monitoring-baseline)	N/A	Mar-15	Jul-15
Repair of 3 piping structures	N/A	N/A	Aug-15
Mitigation Plan Addendum	N/A	N/A	Dec-15
Year 1 Monitoring	Dec-15	Dec-15	Apr-16
Repair of channel problem areas resulting from flooding	N/A	N/A	Mar-16
Year 2 Monitoring	Dec-16	Nov-16	Dec-16
Year 3 Monitoring	Dec-17	N/A	N/A
Year 4 Monitoring	Dec-18	N/A	N/A
Year 5 Monitoring	Dec-19	N/A	N/A

Table 3. Project Contacts Table	
Upper Silver Creek Restoration Project: DMS Project ID No. 94645	
Designer	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201 Asheville, NC 28806 Contact: Micky Clemmons, Tel. 828-412-6100
Construction Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Planting Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Seeding Contractor	
River Works, Inc.	6105 Chapel Hill Road Raleigh, NC 27607 Contact: Phillip Todd, Tel. 919-582-3575
Seed Mix Sources	Green Resources (seed), Tel. 336-855-6363
Nursery Stock Suppliers	Mellow Marsh Farm (trees), 919-742-1200 ArborGen Inc. (trees), 843-528-3204 Dykes and Son (trees), 931-668-8833
Monitoring Performers	
Michael Baker Engineering, Inc.	797 Haywood Rd Suite 201 Asheville, NC 28806
	Contact:
Stream Monitoring Point of Contact	Micky Clemmons, Tel. 828-412-6100
Vegetation Monitoring Point of Contact	Micky Clemmons, Tel. 828-412-6100
Wetland Monitoring Point of Contact	Micky Clemmons, Tel. 828-412-6100

Table 4. Project Attributes			
Upper Silver Creek Restoration Project: DMS Project ID No. 94645			
Project Information			
Project Name	Upper Silver Creek Mitigation Project		
County	Burke		
Project Area (acres)	22.0		
Project Coordinates (latitude and longitude)	35.6078 N, -81.81742 W		
Watershed Summary Information			
Physiographic Province	Blue Ridge (borders Piedmont)		
River Basin	Catawba		
USGS Hydrologic Unit 8-digit and 14-digit	03050101 / 03050101050050		
DWR Sub-basin	03-08-31		
Project Drainage Area (AC)	Mainstem 2.7 - 3.3, UT1 0.28, UT2 0.05, UT3 0.17		
Project Drainage Area Percentage of Impervious Area	<2%		
USGA Land Use Classification	Deciduous Forest (64%)	Woody Wetlands (1%)	
	Evergreen Forest (3%)	Developed, Open Space (5%)	
	Shrub/Scrub (5%)	Pasture/Hay (14%)	
	Grassland/Herbaceous (6%)		
NCDMS Land Use Classification for Silver Creek Watershed	Forest (59%)		
	Agriculture (23%)		
	Impervious Cover (2.9%)		
Stream Reach Summary Information			
Parameters	**Mainstem - Reach 1**	**Mainstem - Reach 2**	
Length of Reach (LF)	838	2,178	
Valley Classification (Rosgen)	VIII	VIII	
Drainage Area (AC)	1,746	2,147	
NCDWR Stream Identification Score	49.5	49.5	
NCDWR Water Quality Classification	C	C	
Morphological Description (Rosgen stream type)	E	E	
	Incised channel, little connection to floodplain	Incised channel, little connection to floodplain	
Evolutionary Trend	E→G, E→C/F	E→G, E→C/F	
Underlying Mapped Soils	AaA, FnA, UnB		
Drainage Class	Somewhat poorly to well drained	Somewhat poorly to well drained	
Soil Hydric Status	Site-specific	Site-specific	
Average Channel Slope (ft/ft)	0.004	0.004	
FEMA Classification	Zone AE	Zone AE	
Native Vegetation Community	Piedmont/Mtn. Mixed Bottomland Hardwoods	Piedmont/Mtn. Mixed Bottomland Hardwoods	
Percent Composition of Exotic/Invasive Vegetation	10%	5%	
Parameters	**UT1 - Reach 1**	**UT2 - Reach 1**	**UT2 - Reach 2**
Length of Reach (LF)	495	103	207
Valley Classification (Rosgen)	III	III	III
Drainage Area (AC)	177	32	32
NCDWR Stream Identification Score	47.5	45	45
NCDWR Water Quality Classification	C	C	C
Morphological Description (Rosgen stream type)	Gc	channelized B	channelized B
	Incised channel, little connection to floodplain	channelized/ditched channel	channelized/ditched channel
Evolutionary Trend	Gc→F	B→F→C	B→F→C
Underlying Mapped Soils	AaA, FnA	UnB	UnB, FnA
Drainage Class	Somewhat poorly to well drained	Somewhat poorly to well drained	Somewhat poorly to well drained
Soil Hydric Status	Site-specific	Site-specific	Site-specific
Average Channel Slope (ft/ft)	0.016	0.037	0.037
FEMA Classification	N/A	N/A	N/A
Native Vegetation Community	Piedmont Dry-Mesic Oak and Hardwoods to Mixed Bottomland Hardwoods	Piedmont/Mtn. Mixed Bottomland Hardwoods	Piedmont/Mtn. Mixed Bottomland Hardwoods
Percent Composition of Exotic/Invasive Vegetation	5%	2%	2%

Parameters	UT3 - Reach 1	UT3 - Reach 1
Length of Reach (LF)	342	1,006
Valley Classification (Rosgen)	III	III
Drainage Area (AC)	123	123
NCDWR Stream Identification Score	49.75	49.75
NCDWR Water Quality Classification	C	C
Morphological Description (Rosgen stream type)	B/E	E
	Aggrading at upper end then stable to incising at lower end	Incised channel, little connection to floodplain
Evolutionary Trend	B/E→G	E→G
Underlying Mapped Soils	AaA	AaA, FnA
Drainage Class	Somewhat poorly to well drained	Somewhat poorly to well drained
Soil Hydric Status	Site-specific	Site-specific
Average Channel Slope (ft/ft)	0.015	0.015
FEMA Classification	N/A	N/A
Native Vegetation Community	Piedmont Dry-Mesic Oak and Hardwoods	Piedmont/Mtn. Mixed Bottomland Hardwoods
Percent Composition of Exotic/Invasive Vegetation	2%	2%

Wetland Summary Information

Parameters	JDW1	JDW2	JDW3	JDW4	JDW5	JDW6
Size of Wetland (AC)	1.43	0.51	0.03	0.24	0.81	0.3
Wetland Type	Riparian	Riparian	Riparian	Riparian	Riparian	Riparian
Mapped Soil Series	FnA	FnA	FnA	FnA	FnA	FnA
Drainage Class	Somewhat poorly to well drained	Somewhat poorly to well drained	Somewhat poorly to well drained	Somewhat poorly to well drained	Somewhat poorly to well drained	Somewhat poorly to well drained
Soil Hydric Status	Site-specific	Site-specific	Site-specific	Site-specific	Site-specific	Site-specific
Source of Hydrology	Hillslope seepage; Baseflow; Overbank Flooding	Hillslope seepage; Baseflow; Overbank Flooding	Hillslope seepage; Baseflow; Overbank Flooding	Hillslope seepage; Baseflow; Overbank Flooding	Hillslope seepage; Baseflow; Overbank Flooding	Hillslope seepage; Baseflow; Overbank Flooding
Hydrologic Impairment	Partially	Yes	No	Partially	Partially	Partially
Native Vegetation Community	Piedmont/Mountain Mixed Bottomland Hardwood Forest. Successional Deciduous Forest Land was once also present near Wetlands 2 & 5.					
Percent Composition of Exotic/Invasive Vegetation	~30%	~55%	~10%	~40%	~55%	~35%

Regulatory Considerations

Regulation	Applicable	Resolved	Supporting Documentation
Waters of the United States – Section 404	Yes	Yes	Categorical Exclusion
Waters of the United States – Section 401	Yes	Yes	Categorical Exclusion
Endangered Species Act	Yes	Yes	Categorical Exclusion
Historic Preservation Act	Yes	Yes	Categorical Exclusion
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (CAMA)	No	N/A	N/A
FEMA Floodplain Compliance	Yes	Yes	Categorical Exclusion
Essential Fisheries Habitat	No	N/A	N/A

Notes:
1. See Figure 2.3 of Mitigation Plan for key to soil series symbols.
2. All wetlands had been disturbed to some degree at the time the project was initiated. As a result, only remnants of native vegetative communities exist in the wetland areas.
3. Fescue is considered as invasive vegetation; it and other field grasses were the dominant nonnative wetland vegetation observed.
4. USGS Land Use Data (2001) used rather than CGIA Land Use Classification data which is more outdated (1996).
5. Source: Upper Catawba River Basin Restoration Priorities (NCEEP 2009) (https://deq.nc.gov/about/divisions/mitigation-services/dms-planning/watershed-planning-documents/catawba-river-basin)

Appendix C

Vegetation Assessment Data

Includes:

Table 5. Vegetation Plot Mitigation Success Summary

Table 6. CVS Vegetation Metadata Table

Table 7. Stem Count Arranged by Plot and Species

Figure 4. Vegetation Monitoring Plot Photos

Table 5. Vegetation Plot Mitigation Success Summary (per acre)				
Plot #	**Stream/ Wetland Stems[2]**	**Volunteers[3]**	**Total[4]**	**Success Criteria Met?**
1	1214	0	1214	Yes
2	1174	81	1255	Yes
3	567	0	567	Yes
4	809	0	809	Yes
5	850	0	850	Yes
6	647	40	687	Yes
7	607	0	607	Yes
8	526	40	566	Yes
9	486	0	486	Yes
10	769	81	850	Yes
11	728	283	1011	Yes
12	769	81	850	Yes
13	647	0	647	Yes
14	567	0	567	Yes
Project Avg	**740**	**43**	**783**	

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

Exceeds requirements by 10%

Table 6. Vegetation Metadata
Upper Silver Creek Stream and Wetland Restoration - Project 94645

Report Prepared By	Russell Myers
Date Prepared	11/17/2016 14:25
database name	MY2_94645_UpperSilver_cvs-eep-entrytool-v2.3.1.mdb
database location	L:\projects\120598-Upr-Silver-FD\Monitoring\YR2 Monitoring\2.0 - Monitoring Data\App C - Vegetation Data\E-File
computer name	ASHELCTOMSIC
file size	63246336
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.
Planted 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.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	94645
project Name	Upper Silver Creek
Description	Full Delivery stream and wetland restoration site
River Basin	Broad
length(ft)	5,169'
stream-to-edge width (ft)	Minimum of 30 feet
area (sq m)	62,321 sq. m.
Required Plots (calculated)	14
Sampled Plots	14

Table 7. Stem Count Arranged by Plot and Species
Project: Upper Silver Creek, DMS Project #94645.

			Current Plot Data (MY2 2016)																				
			94645-01-0001			94645-01-0002			94645-01-0003			94645-01-0004			94645-01-0005			94645-01-0006			94645-01-0007		
Scientific Name	Common Name	Species Type	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T
Acer rubrum	red maple	Tree	1		1	6		6				1		1									
Alnus serrulata	hazel alder	Shrub																					
Betula nigra	river birch	Tree							2		2	1		1				1		1	3		3
Carpinus caroliniana	American hornbeam	Tree	1		1	3		3				1		1	1		1				1		1
Cornus amomum	silky dogwood	Shrub							1		1	3		3	6		6	4		4	2		2
Corylus cornuta	beaked hazelnut	Shrub Tree																1		1			
Diospyros virginiana	common persimmon	Tree	1		1							1		1									
Fraxinus pennsylvanica	green ash	Tree							2		2				8		8	1	1	2	1		1
Liriodendron tulipifera	tuliptree	Tree	1		1	2		2				1		1									
Platanus occidentalis	American sycamore	Tree	9		9	4	2	6	5		5	7		7	4		4	3		3	4		4
Quercus	oak	Tree																					
Quercus lyrata	overcup oak	Tree																					
Quercus michauxii	swamp chestnut oak	Tree				6		6	1		1	2		2	2		2	3		3	4		4
Quercus nigra	water oak	Tree							3		3												
Quercus phellos	willow oak	Tree	2		2	3		3				3		3				3		3			
Unknown		Shrub or Tree				1		1															
Vaccinium corymbosum	highbush blueberry	Shrub				1		1															
Viburnum dentatum	southern arrowwood	Shrub	15		15	3		3															
		Stem count	30	0	30	29	2	31	14	0	14	20	0	20	21	0	21	16	1	17	15	0	15
		size (ares)	1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	7	0	7	9	1	9	6	0	6	9	0	9	5	0	5	7	1	7	6	0	6
		Stems per ACRE	1214	0	1214	1174	81	1255	567	0	567	809	0	809	850	0	850	647	40	688	607	0	607

P = Planted
V = Volunteer
T = Total

This color indicates that the number includes volunteer stems.
Indicates that the stems per Acre exceeds requirements by 10%
Indicates that the stems per Acre exceeds requirements, but by less than 10%

Table 7. Stem Count Arranged by Plot, continued.
Project: Upper Silver Creek, DMS Project #94645.

			Current Plot Data (MY2 2016)																				
			94645-01-0008			94645-01-0009			94645-01-0010			94645-01-0011			94645-01-0012			94645-01-0013			94645-01-0014		
Scientific Name	Common Name	Species Type	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T
Acer rubrum	red maple	Tree	3		3								1	1	2		2						
Alnus serrulata	hazel alder	Shrub														1	1						
Betula nigra	river birch	Tree										3		3	6		6	2		2	1		1
Carpinus caroliniana	American hornbeam	Tree				1		1	1		1				2	1	3						
Cornus amomum	silky dogwood	Shrub										10	5	15	3		3	3		3			
Corylus cornuta	beaked hazelnut	Shrub Tree																					
Diospyros virginiana	common persimmon	Tree	1		1																		
Fraxinus pennsylvanica	green ash	Tree													2		2				4		4
Liriodendron tulipifera	tuliptree	Tree	1		1				2	1	3												
Platanus occidentalis	American sycamore	Tree	4	1	5	2		2	4	1	5	1	1	2	2		2	2		2	3		3
Quercus	oak	Tree																			1		1
Quercus lyrata	overcup oak	Tree													1		1						
Quercus michauxii	swamp chestnut oak	Tree	2		2				1		1	1		1				8		8	2		2
Quercus nigra	water oak	Tree																					
Quercus phellos	willow oak	Tree				5		5	11		11	2		2	1		1				2		2
Unknown		Shrub or Tree				3		3				1		1				1		1	1		1
Vaccinium corymbosum	highbush blueberry	Shrub																					
Viburnum dentatum	southern arrowwood	Shrub	2		2	1		1															
		Stem count	13	1	14	12	0	12	19	2	21	18	7	25	19	2	21	16	0	16	14	0	14
		size (ares)	1			1			1			1			1			1			1		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.02			0.02		
		Species count	6	1	6	5	0	5	5	2	5	6	3	7	8	2	9	5	0	5	7	0	7
		Stems per ACRE	526	40	567	486	0	486	769	81	850	728	283	1012	769	81	850	647	0	647	567	0	567

P = Planted
V = Volunteer
T = Total

This color indicates that the number includes volunteer stems.
Indicates that the stems per Acre exceeds requirements by 10%
Indicates that the stems per Acre exceeds requirements, but by less than 10%

Table 7. Stem Count Arranged by Plot, continued.
Project: Upper Silver Creek, DMS Project #94645.

			Annual Means															
			MY0 (2015)*			MY1 (2015)			MY2 (2016)			MY3 (2017)			MY4 (2018)			MY5 (2019)		
Scientific Name	Common Name	Species Type	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T	P	V	T
Acer rubrum	red maple	Tree	12		12	14		14	13	1	14									
Alnus serrulata	hazel alder	Shrub	1		1	1		1		1	1									
Betula nigra	river birch	Tree	8		8	21		21	19		19									
Carpinus caroliniana	American hornbeam	Tree	9		9	11		11	11	1	12									
Cornus amomum	silky dogwood	Shrub	16		16	32		32	32	5	37									
Corylus cornuta	beaked hazelnut	Shrub Tree	1		1	1		1	1		1									
Diospyros virginiana	common persimmon	Tree	3		3	3		3	3		3									
Fraxinus pennsylvanica	green ash	Tree	12		12	19		19	18	1	19									
Liriodendron tulipifera	tuliptree	Tree	10		10	12		12	7	1	8									
Platanus occidentalis	American sycamore	Tree	47		47	60		60	54	5	59									
Quercus	oak	Tree				2		2	1		1									
Quercus lyrata	overcup oak	Tree				1		1	1		1									
Quercus michauxii	swamp chestnut oak	Tree	19		19	33		33	32		32									
Quercus nigra	water oak	Tree	4		4	4		4	3		3									
Quercus phellos	willow oak	Tree	17		17	32		32	32		32									
Unknown		Shrub or Tree	6		6	10		10	7		7									
Vaccinium corymbosum	highbush blueberry	Shrub	1		1	1		1	1		1									
Viburnum dentatum	southern arrowwood	Shrub	21		21	21		21	21		21									
		Stem count	187	0	187	278	0	278	256	15	271	0		0	0		0	0		0
		size (ares)	9			14			14			14			14			14		
		size (ACRES)	0.22			0.35			0.35			0.35			0.35			0.35		
		Species count	16	0	16	18	0	18	17	7	18	0		0	0		0	0		0
		Stems per ACRE	841	0	841	804	0	804	740	43	783	0		0	0		0	0		0

P = Planted
V = Volunteer
T = Total

This color indicates that the number includes volunteer stems.
Indicates that the stems per Acre exceeds requirements by 10%
Indicates that the stems per Acre exceeds requirements, but by less than 10%

* MY0 included 9 vegetation plots. However upon review it was discovered that we needed to have 14 vegetation plots to meet guidelines. Five additional plots were added in the fall of 2015 and the MY1 and later means inlcude these additional plots.

Figure 3. Upper Silver Creek - Vegetation Plot Photos, DMS Project #94645

Photo 1. Vegetation Plot 1 – Tree photo (November 1, 2016).

Photo 2. Vegetation Plot 1 – Herbaceous photo (November 1, 2016).

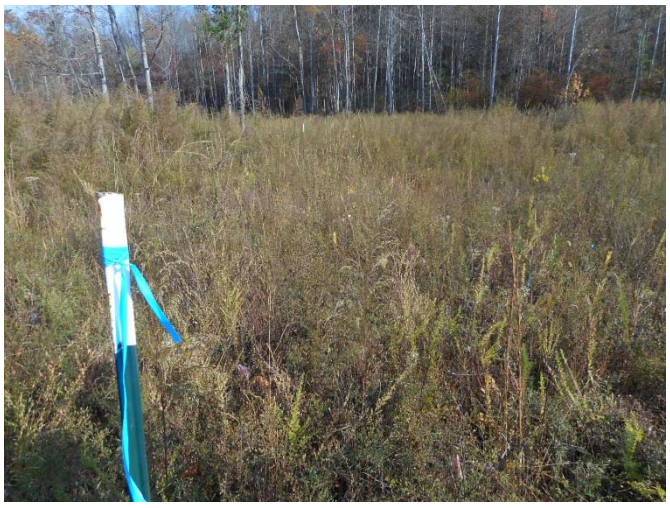


Photo 3. Vegetation Plot 2 – Tree photo (November 1, 2016).

Photo 4. Vegetation Plot 2 – Herbaceous photo (November 1, 2016).

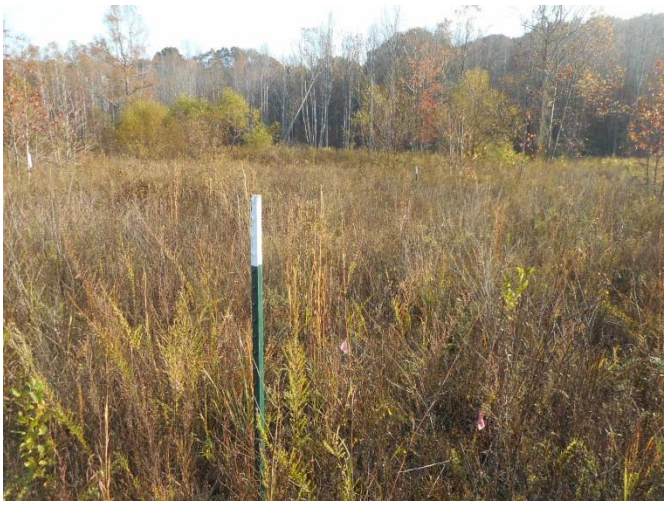


Photo 5. Vegetation Plot 3 – Tree photo (November 1, 2016).

Photo 6. Vegetation Plot 3 – Herbaceous photo (November 1, 2016).

Photo 7. Vegetation Plot 4 – Tree photo (November 1, 2016).

Photo 8. Vegetation Plot 4 – Herbaceous photo (November 1, 2016).

Photo 9. Vegetation Plot 5 – Tree photo (November 1, 2016).

Photo Point 10, Vegetation Plot 5 – Herbaceous photo (November 1, 2016).

Photo 11. Vegetation Plot 6 – Tree photo (November 1, 2016).

Photo 12. Vegetation Plot 6 – Herbaceous photo (November 1, 2016).

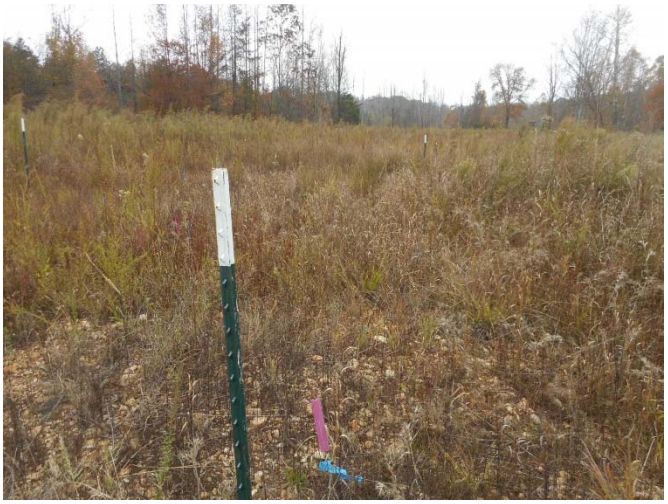


Photo 13. Vegetation Plot 7 – Tree photo (November 1, 2016).

Photo 14. Vegetation Plot 7 – Herbaceous photo (November 1, 2016).

Photo 15. Vegetation Plot 8 – Tree photo (November 1, 2016).

Photo 16. Vegetation Plot 8 – Herbaceous photo (November 1, 2016).

Photo 17. Vegetation Plot 9 – Tree photo (November 1, 2016).

Photo 18. Vegetation Plot 9 – Herbaceous photo (November 1, 2016).

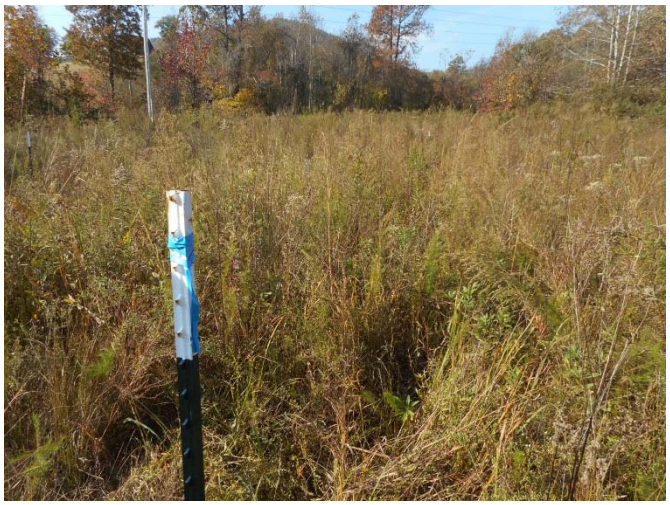


Photo 19. Vegetation Plot 10 – Tree photo (November 1, 2016).

Photo 20. Vegetation Plot 10 – Herbaceous photo (November 1, 2016).

Photo 21. Vegetation Plot 11 – Tree photo (November 1, 2016).

Photo 22. Vegetation Plot 11 – Herbaceous photo (November 1, 2016).

Photo 23. Vegetation Plot 12 – Tree photo (November 1, 2016).

Photo 24. Vegetation Plot 12 – Herbaceous photo (November 1, 2016).

Photo 25. Vegetation Plot 13 – Tree photo (November 1, 2016).

Photo 26. Vegetation Plot 13 – Herbaceous photo (November 1, 2016).

Photo 27. Vegetation Plot 14 – Tree photo (November 1, 2016).

Photo 28. Vegetation Plot 14 – Herbaceous photo (November 1, 2016).

Appendix D

Stream Assessment Data

Includes:

Figure 5. Upper Silver Creek Stream Photos by Channel and Station – MY2 (2016)

Photo 1. Mainstem Photo Point 1 – Station 29+26
(August 30, 2016) downstream view from left bank.

Photo 2. Mainstem Photo Point 1 – Station 29+26
(August 30, 2016) upstream view from left bank.

Photo 3. Mainstem Photo Point 2 – Station 26+44
(August 30, 2016) downstream view from left bank.

Photo 4. Mainstem Photo Point 2 – Station 26+44
(August 30, 2016) upstream from left bank.

Photo 5. Mainstem Photo Point 3 – Station 24+70
(August 30, 2016) upstream from right bank.

Photo 6. Mainstem Photo Point 3 – Station 24+70
(August 30, 2016) downstream from right bank.

Photo 7. Mainstem Photo Point 4 (PP4) – Station 20+30 (August 30, 2016) downstream from left bank.

Photo 8. Mainstem Photo Point 4 (PP4) – Station 20+30 (August 30, 2016) upstream from left bank.

Photo 9. Mainstem Photo Point 5 – Station 16+03 (August 30, 2016) upstream from right bank.

Photo 10, Mainstem Photo Point 5 – Station 16+03 (August 30, 2016) downstream from right bank.

Photo 11. Mainstem Photo Point 6 – Station 13+03 (August 30, 2016) upstream from right bank.

Photo 12. Mainstem Photo Point 5 – Station 13+03 (August 30, 2016) downstream from right bank.

Photo 13. Mainstem Photo Point 7 – Station 10+11 (August 30, 2016) downstream from left bank.

Photo 14. Mainstem Photo Point 7 – Station 10+11 (August 30, 2016) upstream from left bank.

Photo 15. Mainstem Photo Point 8 – Station 5+06 (August 30, 2016) upstream from right bank.

Photo 16. Mainstem Photo Point 8 – Station 5+06 (August 30, 2016) downstream from right bank.

Photo 17. Mainstem Photo Point 9 – Station 3+87 (August 30, 2016) downstream from left bank.

Photo 18. Mainstem Photo Point 9 – Station 3+87 (August 30, 2016) upstream from left bank.

Photo 19. Mainstem Photo Point 10 – Stat. 1+22
(August 30, 2016) downstream from left bank.

Photo 20. Mainstem Photo Point 10 – Stat. 1+22
(August 30, 2016) upstream from left bank.

Unnamed Tributary 1 Photos - Monitoring Year 1

Photo 21. UT1 Photo Point 1 – Station 4+82
(August 30, 2016) upstream from left bank.

Intentionally Left Blank

Photo 22. UT1 Photo Point 2 – Station 4+07
(August 30, 2016) downstream from left bank.

Photo 23. UT1 Photo Point 2 – Station 4+07
(August 30, 2016) upstream from left bank.

Photo 24. UT1 Photo Point 3 – Station 2+55
(August 30, 2016) upstream from right bank.

Photo 25. UT1 Photo Point 3 – Station 2+55
(August 30, 2016) downstream from right bank.

Photo 26. UT1 Photo Point 4 – Station 0+55
(August 30, 2016) downstream from left bank.

Photo 27. UT1 Photo Point 4 – Station 0+55
(August 30, 2016) upstream from left bank.

Unnamed Tributary 2, Photos – Monitoring Year 1 (2016)

Photo 28. UT2 Photo Point 1 – Station 2+15
(August 30, 2016) downstream from left bank.

Photo 29. UT2 Photo Point 1 – Station 2+15
(August 30, 2016) upstream from left bank.

Photo 30. UT2 Photo Point 2 – Station 0+96
(August 30, 2016) upstream from right bank.

Photo 31. UT2 Photo Point 2 – Station 0+96
(August 30, 2016) downstream from right bank.

Photo 32. UT2 Photo Point 3 – Station 0+02
(August 30, 2016) downstream from right bank.

Photo 33. UT2 Photo Point 3 – Station 0+02
(August 30, 2016) upstream from right bank.

Unnamed Tributary 3, Photos – Monitoring Year 2 (2016)

Photo 34. UT3 Photo Point 1 – Station 12+10
(August 30, 2016) downstream from left bank.

Photo 35. UT3 Photo Point 1 – Station 12+10
(August 30, 2016) upstream from left bank.

Photo 36. UT3 Photo Point 2 – Station 10+66
(August 30, 2016) upstream from right bank.

Photo 37. UT3 Photo Point 2 – Station 10+66
(August 30, 2016) downstream from right bank.

Photo 38. UT3 Photo Point 3 – Station 8+10
(August 30, 2016) downstream from left bank.

Photo 39. UT3 Photo Point 3 – Station 8+10
(August 30, 2016) upstream from left bank.

Photo 40. UT3 Photo Point 4 – Station 7+05
(August 30, 2016) downstream from left bank.

Photo 41. UT3 Photo Point 4 – Station 7+05
(August 30, 2016) upstream from left bank.

Photo 42. UT3 Photo Point 5 – Station 5+95
(August 30, 2016) downstream from left bank.

Photo 43. UT3 Photo Point 5 – Station 5+95
(August 30, 2016) upstream from left bank.

Photo 44. UT3 Photo Point 6 – Station 4+55
(August 30, 2016) upstream from right bank.

Photo 45. UT3 Photo Point 6 – Station 4+55
(August 30, 2016) downstream from right bank.

Photo 46. UT3 Photo Point 7 – Station 3+60
(August 30, 2016) upstream to structure.

Photo 47. UT3 Photo Point 8 – Station 2+70
(August 30, 2016) upstream to structure.

Photo 48. UT3 Photo Point 9 – Station 1+90
(August 30, 2016) upstream to structure.

Photo 49. UT3 Photo Point 10 – Station 0+60
(August 30, 2016) downstream to structure.

Table 8. Visual Morphological Stability Assessment
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Silver Creek, Reach 1 (838 LF)

Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
A. Riffles	1. Present?	4	4	0	100	
	2. Armor stable (e.g. no displacement)?	4	4	0	100	
	3. Facet grades appears stable?	4	4	0	100	
	4. Minimal evidence of embedding/fining?	4	4	0	100	
	5. Length appropriate?	4	4	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	4	4	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	4	4	0	100	
	3. Length appropriate?	4	4	0	100	**100%**
C. Thalweg	1. Upstream of pool (structure) centering? (%)	100	100	0	100	
	2. Downstream of pool (structure) centering? (%)	100	100	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	4	4	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	4	4	0	100	
	3. Apparent Rc within spec?	4	4	0	100	
	4. Sufficient floodplain access and relief?	4	4	0	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	838	838	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	838	838	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	6	6	0	100	
	2. Height appropriate?	6	6	0	100	
	3. Angle and geometry appear appropriate?	6	6	0	100	
	4. Free of piping or other structural failures?	6	6	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	4	4	0	100	
	2. Footing stable?	4	4	0	100	**100%**

Silver Creek, Reach 2 (2,178 LF)

Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
A. Riffles	1. Present?	17	17	0	100	
	2. Armor stable (e.g. no displacement)?	17	17	0	100	
	3. Facet grades appears stable?	17	17	0	100	
	4. Minimal evidence of embedding/fining?	17	17	0	100	
	5. Length appropriate?	17	17	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	16	16	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	16	16	0	100	
	3. Length appropriate?	16	16	0	100	**100%**
C. Thalweg	1. Upstream of pool (structure) centering? (%)	100	100	0	100	
	2. Downstream of pool (structure) centering? (%)	100	100	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	16	16	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	16	16	0	100	
	3. Apparent Rc within spec?	16	16	0	100	
	4. Sufficient floodplain access and relief?	16	16	0	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	2,178	2,178	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	2,178	2,178	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	21	21	0	100	
	2. Height appropriate?	21	21	0	100	
	3. Angle and geometry appear appropriate?	21	21	0	100	
	4. Free of piping or other structural failures?	21	21	3	100	**100%**
G. Wads/ Boulders	1. Free of scour?	14	14	0	100	
	2. Footing stable?	14	14	0	100	**100%**

UT1 (502 LF)

Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
A. Riffles	1. Present?	7	7	0	100	
	2. Armor stable (e.g. no displacement)?	7	7	0	100	
	3. Facet grades appears stable?	7	7	0	100	
	4. Minimal evidence of embedding/fining?	7	7	0	100	
	5. Length appropriate?	7	7	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	10	10	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	10	10	0	100	
	3. Length appropriate?	10	10	0	100	**100%**
C. Thalweg[1]	1. Upstream of pool (structure) centering? (%)	100	100	0	100	
	2. Downstream of pool (structure) centering? (%)	100	100	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	7	7	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	7	7	0	100	
	3. Apparent Rc within spec?	7	7	0	100	
	4. Sufficient floodplain access and relief?	7	7	0	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	502	502	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	502	502	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	11	11	0	100	
	2. Height appropriate?	11	11	0	100	
	3. Angle and geometry appear appropriate?	11	11	0	100	
	4. Free of piping or other structural failures?	11	11	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	**100%**

Table 8. Visual Morphological Stability Assessment - Continued
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
UT2, Reach 1 (103 LF)						
A. Riffles	1. Present?	4	4	0	100	
	2. Armor stable (e.g. no displacement)?	4	4	0	100	
	3. Facet grades appears stable?	4	4	0	100	
	4. Minimal evidence of embedding/fining?	4	4	0	100	
	5. Length appropriate?	4	4	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	5	5	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	5	5	0	100	
	3. Length appropriate?	5	5	0	100	**100%**
C. Thalweg	1. Upstream of pool (structure) centering? (%)	100	100	0	100	
	2. Downstream of pool (structure) centering? (%)	100	100	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	N/A	N/A	N/A	100	
	2. Of those eroding, # w/concomitant point bar formation?	N/A	N/A	N/A	100	
	3. Apparent Rc within spec?	N/A	N/A	N/A	100	
	4. Sufficient floodplain access and relief?	N/A	N/A	N/A	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	103	103	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	103	103	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	5	5	0	100	
	2. Height appropriate?	5	5	0	100	
	3. Angle and geometry appear appropriate?	5	5	0	100	
	4. Free of piping or other structural failures?	5	5	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	**N/A**
UT2, Reach 2 (207 LF)						
Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
A. Riffles	1. Present?	4	4	0	100	
	2. Armor stable (e.g. no displacement)?	4	4	0	100	
	3. Facet grades appears stable?	4	4	0	100	
	4. Minimal evidence of embedding/fining?	4	4	0	100	
	5. Length appropriate?	4	4	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	3	3	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	3	3	0	100	
	3. Length appropriate?	3	3	0	100	**100%**
C. Thalweg	1. Upstream of pool (structure) centering? (%)	100	100	0	100	
	2. Downstream of pool (structure) centering? (%)	100	100	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	3	3	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	3	3	0	100	
	3. Apparent Rc within spec?	3	3	0	100	
	4. Sufficient floodplain access and relief?	3	3	0	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	207	207	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	207	207	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	1	1	0	100	
	2. Height appropriate?	1	1	0	100	
	3. Angle and geometry appear appropriate?	1	1	0	100	
	4. Free of piping or other structural failures?	1	1	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	**N/A**

Table 8. Visual Morphological Stability Assessment - Continued
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

UT3 Reach 1 (343 LF) (Enhancement II reach)

Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
A. Riffles	1. Present?	N/A	N/A	N/A	N/A	
	2. Armor stable (e.g. no displacement)?	N/A	N/A	N/A	N/A	
	3. Facet grades appears stable?	N/A	N/A	N/A	N/A	
	4. Minimal evidence of embedding/fining?	N/A	N/A	N/A	N/A	
	5. Length appropriate?	N/A	N/A	N/A	N/A	**N/A**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	N/A	N/A	N/A	N/A	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	N/A	N/A	N/A	N/A	
	3. Length appropriate?	N/A	N/A	N/A	N/A	**N/A**
C. Thalweg	1. Upstream of pool (structure) centering? (%)	N/A	N/A	N/A	N/A	
	2. Downstream of pool (structure) centering? (%)	N/A	N/A	N/A	N/A	**N/A**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	N/A	N/A	N/A	N/A	
	2. Of those eroding, # w/concomitant point bar formation?	N/A	N/A	N/A	N/A	
	3. Apparent Rc within spec?	N/A	N/A	N/A	N/A	
	4. Sufficient floodplain access and relief?	N/A	N/A	N/A	N/A	**N/A**
E. Bed General	1. General channel bed aggradation areas (bar formation)	343	343	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	343	343	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	3	3	0	100	
	2. Height appropriate?	3	3	0	100	
	3. Angle and geometry appear appropriate?	3	3	0	100	
	4. Free of piping or other structural failures?	3	3	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	N/A	N/A	N/A	N/A	
	2. Footing stable?	N/A	N/A	N/A	N/A	**N/A**

UT3 Reach 2 (1,022 LF)

Feature Category	Metric (per As-Built and reference baselines)	(# Stable) Number Performing as Intended	Total number per As-Built	Total Number / feet in unstable state	% Performing in Stable Condition	Feature Perfomance Mean or Total
A. Riffles	1. Present?	22	22	0	100	
	2. Armor stable (e.g. no displacement)?	22	22	0	100	
	3. Facet grades appears stable?	22	22	0	100	
	4. Minimal evidence of embedding/fining?	22	22	0	100	
	5. Length appropriate?	22	22	0	100	**100%**
B. Pools	1. Present? (e.g. not subject to severe aggradation or migration?)	21	21	0	100	
	2. Sufficiently deep (Max Pool D:Mean Bkf >1.6?)	21	21	0	100	
	3. Length appropriate?	21	21	0	100	**100%**
C. Thalweg	1. Upstream of pool (structure) centering?	100	100	0	100	
	2. Downstream of pool (structure) centering?	100	100	0	100	**100%**
D. Meanders	1. Outer bend in state of limited/controlled erosion?	17	17	0	100	
	2. Of those eroding, # w/concomitant point bar formation?	17	17	0	100	
	3. Apparent Rc within spec?	17	17	0	100	
	4. Sufficient floodplain access and relief?	17	17	0	100	**100%**
E. Bed General	1. General channel bed aggradation areas (bar formation)	1,022	1,022	0	100	
	2. Channel bed degradation - areas of increasing down-cutting or head cutting?	1,022	1,022	0	100	**100%**
F. Vanes, Rock/Log Drop Structures	1. Free of back or arm scour?	15	15	0	100	
	2. Height appropriate?	15	15	0	100	
	3. Angle and geometry appear appropriate?	15	15	0	100	
	4. Free of piping or other structural failures?	15	15	0	100	**100%**
G. Wads/ Boulders	1. Free of scour?	4	4	0	100	
	2. Footing stable?	4	4	0	100	**100%**

Table 9. Verification of Bankfull or Greater than Bankfull Events
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Date of Data Collection	Date of Event	Method of Data Collection	Gauge Watermark Height (inches)*	
			Silver Creek Station 19+00	UT3 Station 8+10
2/29/2016	See table below	Crest gauge	15.0"	5.0"

* height indicates the highest position of cork shavings on the dowel and the height above bankfull, as 0" on the dowel is set at bankfull.

Dates of high flows during the winter of 2015 - 2016.

Date	Discharge (cfs)	Gage Height (ft)	Mean Discharge (cfs) of daily means for 56 yrs	Mean Gage Height (ft) of daily means for 56 yrs
11/19/2015	1,170	3.18	56	0.86
12/2/2015	1,700	4.11	76	1.00
12/24/2015	1,710	2.99	99	1.20
12/29/2015	2,690	4.5	78	1.02
2/3/2016	2,470	3.14	127	1.07

Data from Cleveland Co. NC, USGS Gage 02152100 First Broad River Near Casar, NC

Photo 1. Silver Creek crest gauge staff showing cork deposition in red circle at 15.0 above the bottom of the staff, which is at the bankfull elevation.

Photo 2. UT3 crest gauge staff showing cork deposition in red circle at 5.0 ft above the bottom of the staff, which is at the bankfull elevation.

Photo 3. Silver Creek stream bank showing accumulated debris of wrack line and bent over vegetation well above bankfull. Verifies crest gauge measurement.

Photo 4. Stream bank along UT3 showing accumulated debris along wrack line in vegetation well above bankfull. Verifies crest gauge measurements.

Photo 5. Floodplain along Silver Creek showing accumulated debris of wrack line indicating high flows that were out of bank and filling the valley.

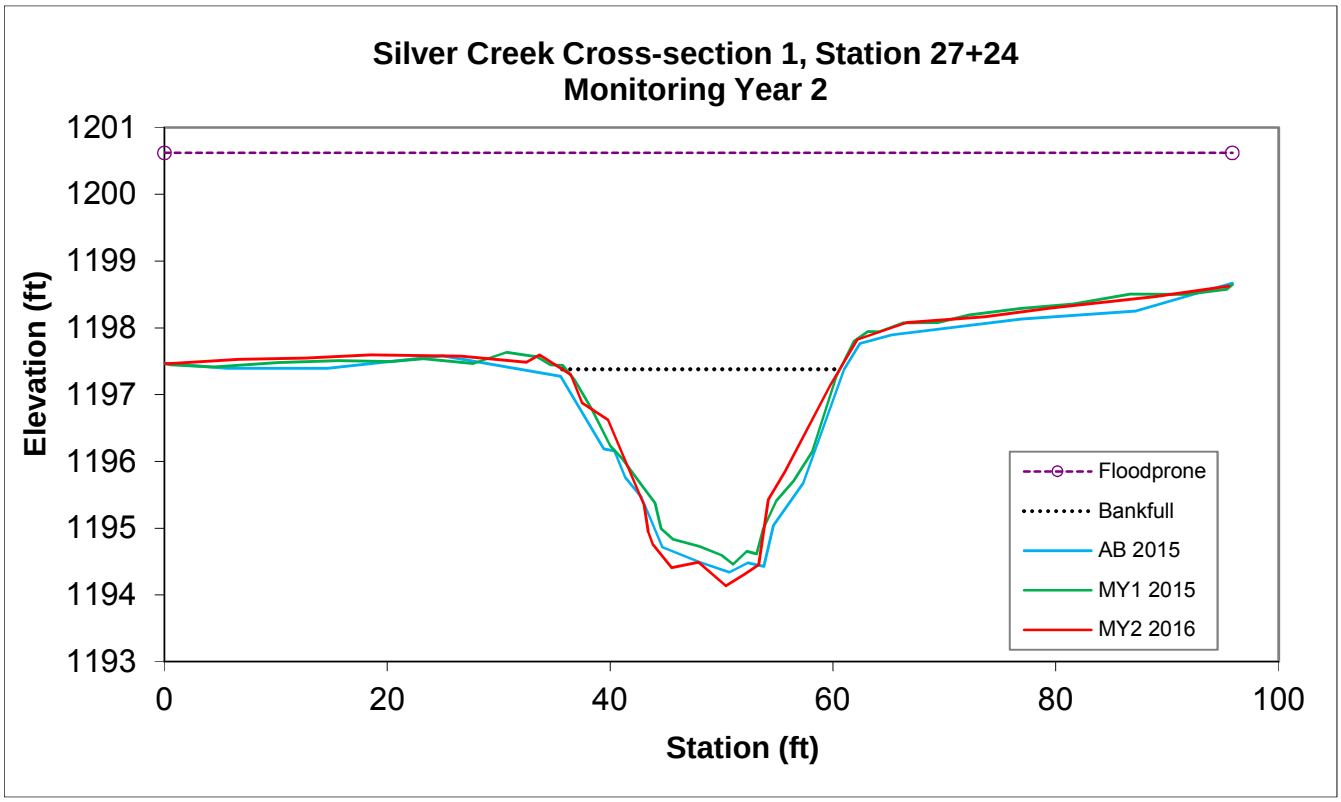
Photo 6. Stream bank along Silver Creek showing accumulated debris at the top of bank where flood waters were leaving the channel.

Figure 6. Cross-sections with Annual Overlays

Permanent Cross-section 1
(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	45	24.91	1.81	3.24	13.77	1.1	3.8	1197.38	1197.6



Looking at the Left Bank

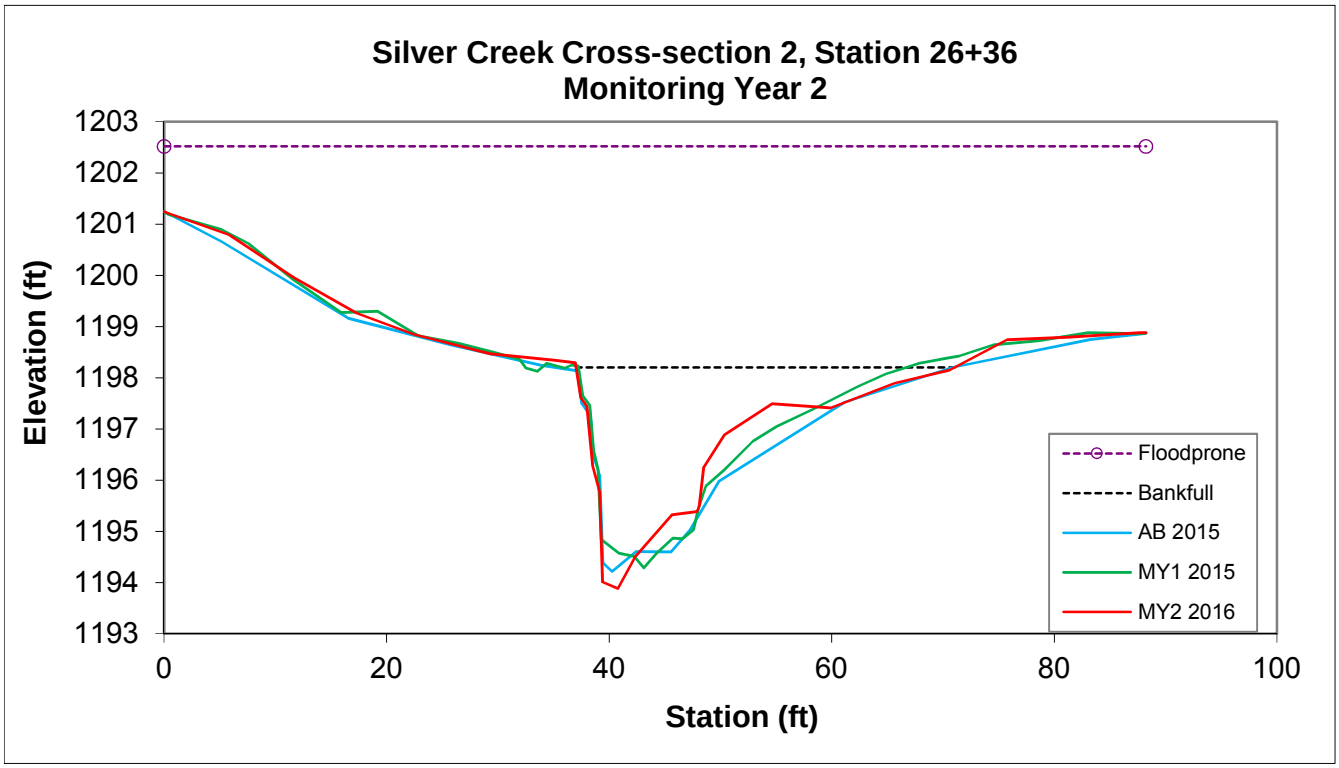
Looking at the Right Bank

Permanent Cross-section 2

(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		49.6	34.01	1.46	4.32	23.3	1	2.6	1198.2	1198.29



Looking at the Left Bank

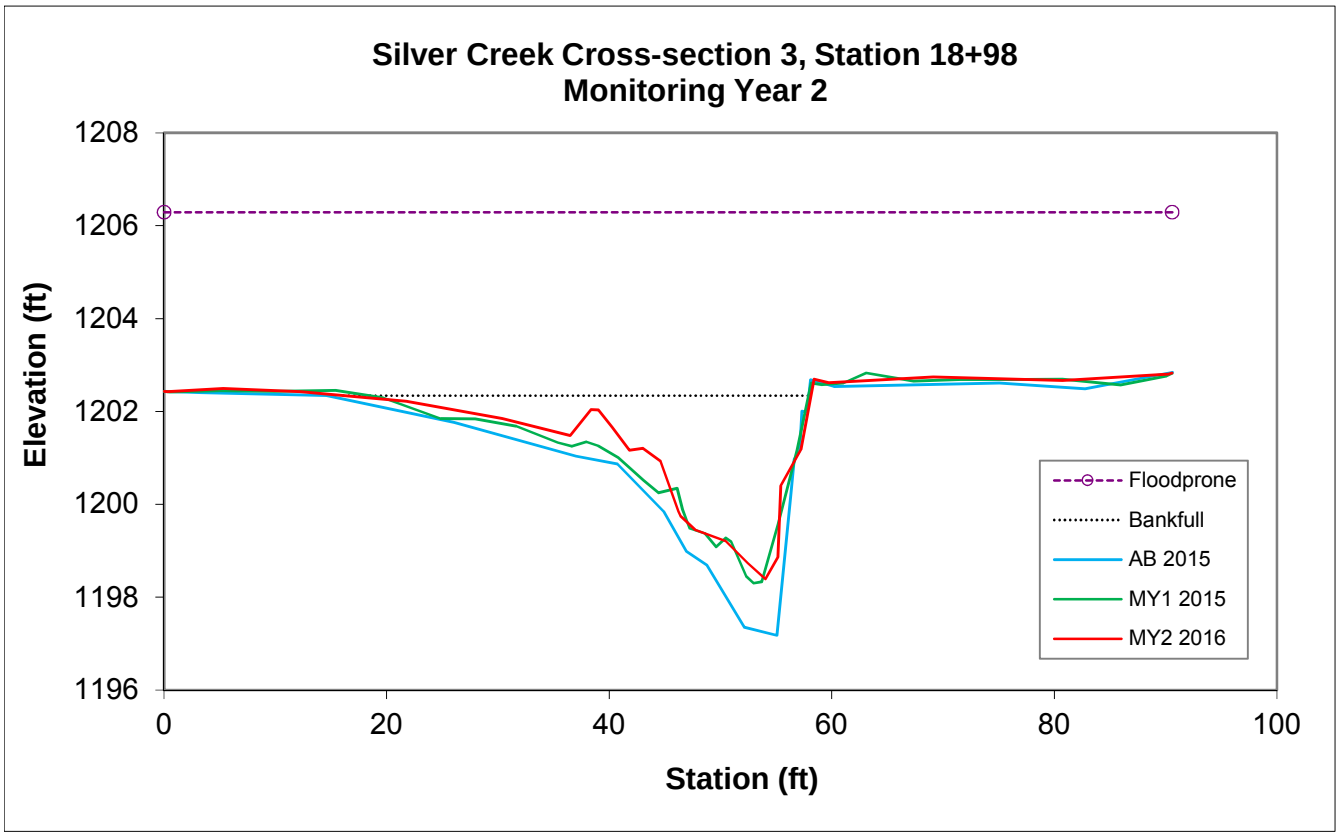
Looking at the Right Bank

Permanent Cross-section 3

(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		50.2	42.01	1.19	3.95	35.15	0.9	2.2	1202.34	1202.03



Looking at the Left Bank

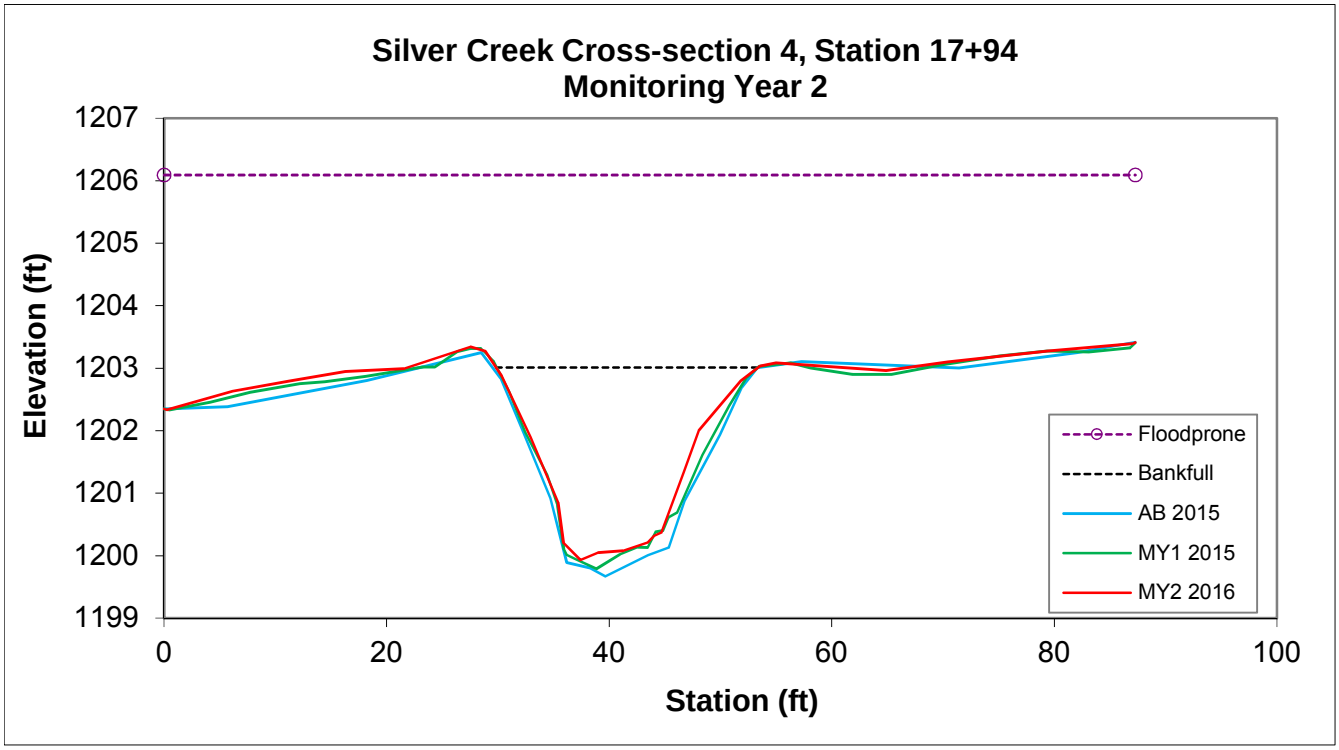
Looking at the Right Bank

Permanent Cross-section 4

(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	41.1	23.52	1.75	3.08	13.46	1	3.7	1203.01	1203.09



Looking at the Left Bank

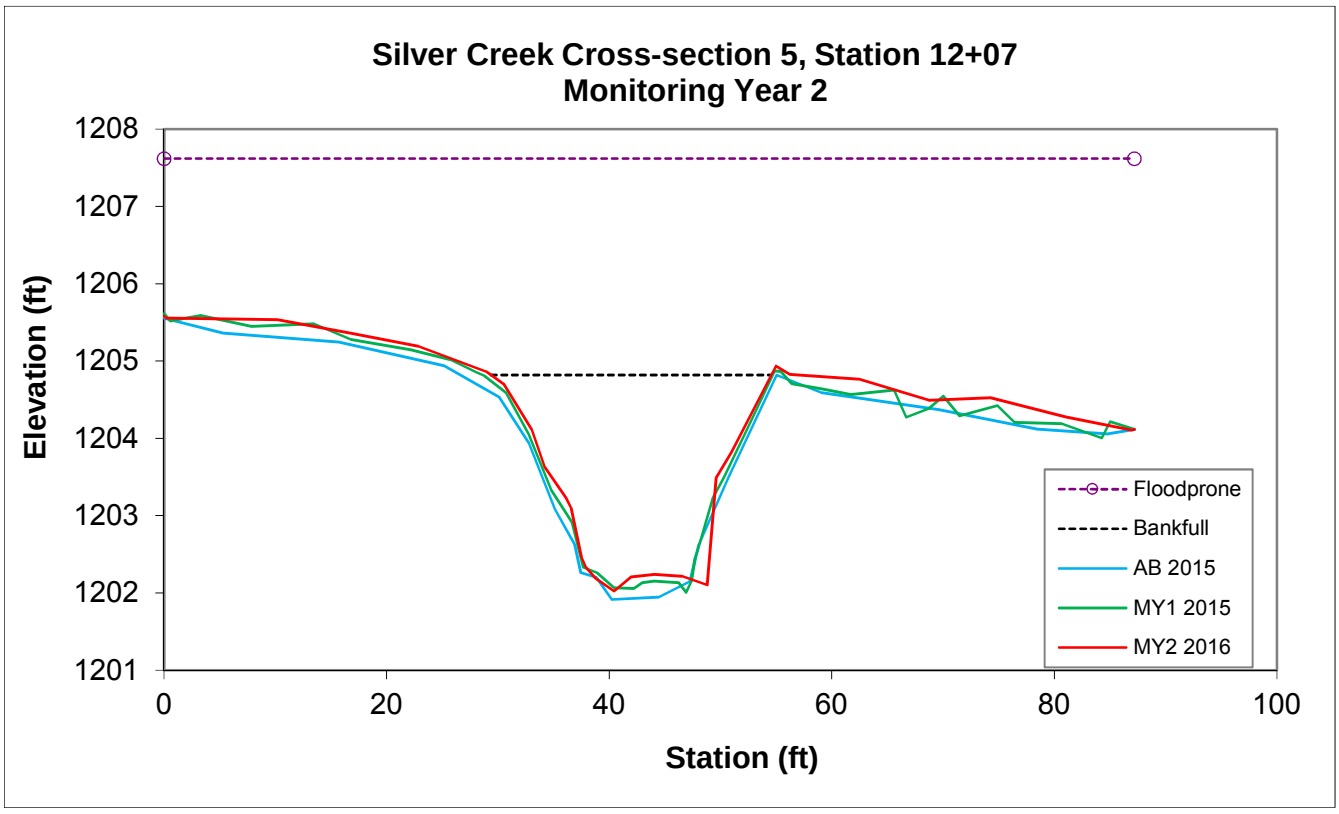
Looking at the Right Bank

Permanent Cross-section 5

(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	42.3	25.21	1.68	2.8	15.04	1	3.5	1204.82	1204.7



Looking at the Left Bank

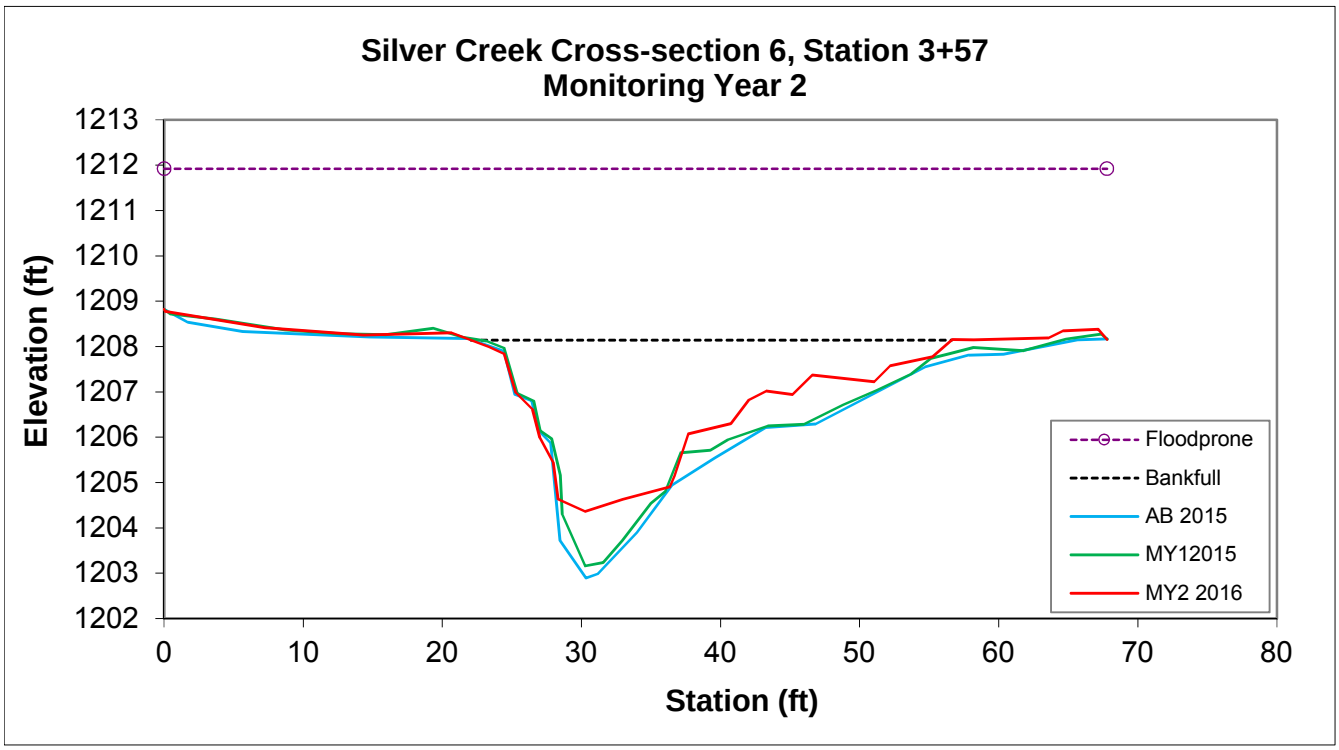
Looking at the Right Bank

Permanent Cross-section 6

(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		58.3	34.57	1.69	3.78	20.5	1	2	1208.14	1208.15



Looking at the Left Bank

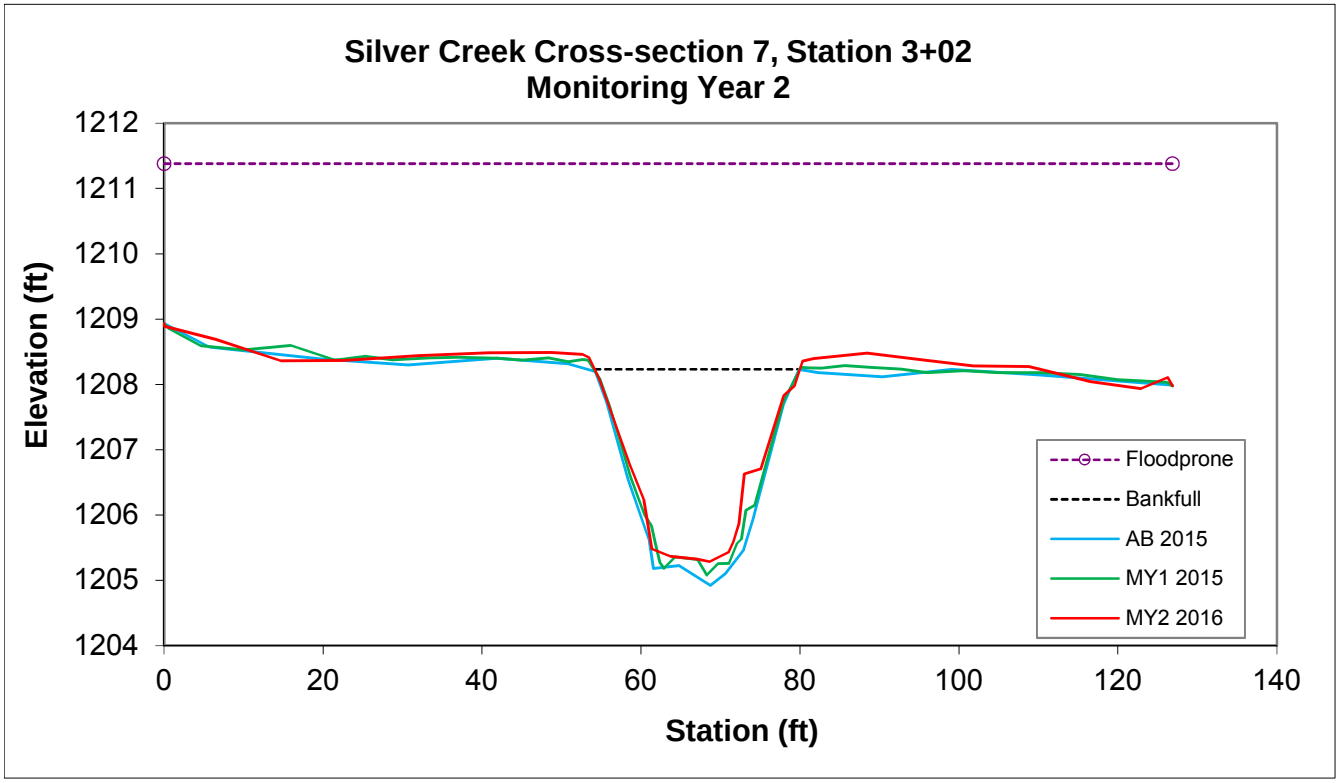
Looking at the Right Bank

Permanent Cross-section 7

(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	47.6	25.82	1.84	2.95	14.02	1	4.9	1208.23	1208.36



Looking at the Left Bank

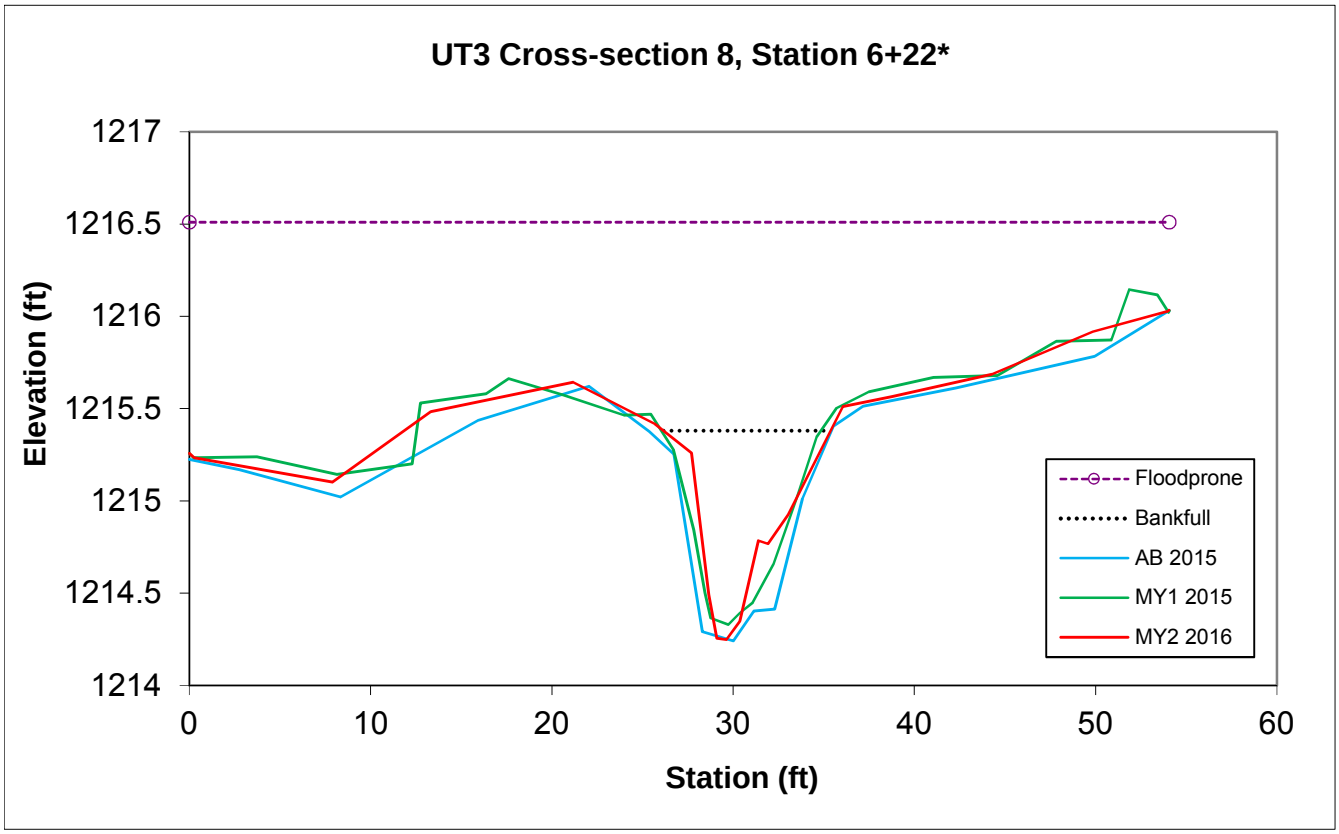
Looking at the Right Bank

Permanent Cross-section 8

(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	4.7	9.22	0.51	1.13	18.05	1	5.9	1215.38	1215.42



Looking at the Left Bank

Looking at the Right Bank

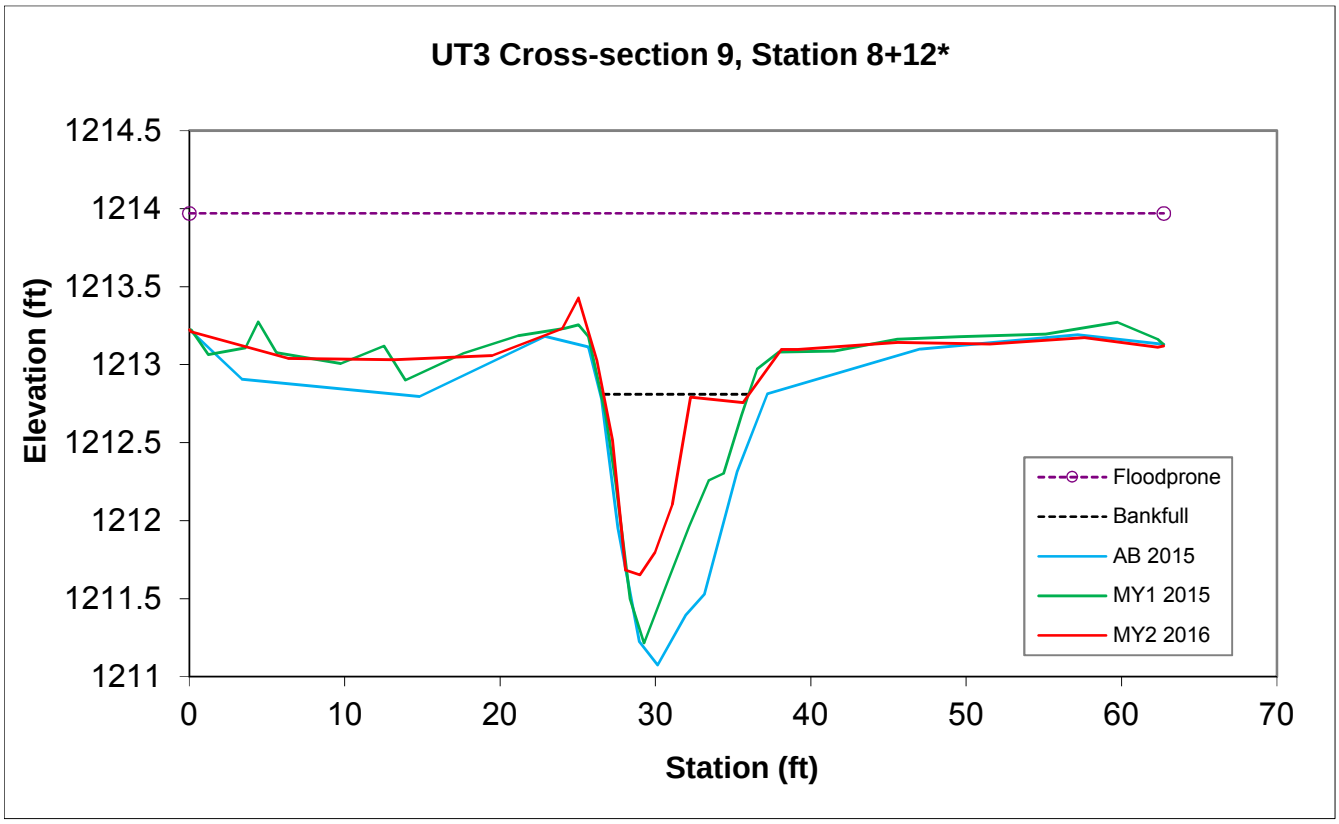
* Note: Stationing for Cross-section 8 has been changed to 6+22; this was the surveyed location last year and this year and is changed from what is shown in the As-built survey and the MY1 report.

Permanent Cross-section 9

(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		4.3	9.36	0.46	1.16	20.37	1.2	6.7	1212.81	1213.1



Looking at the Left Bank

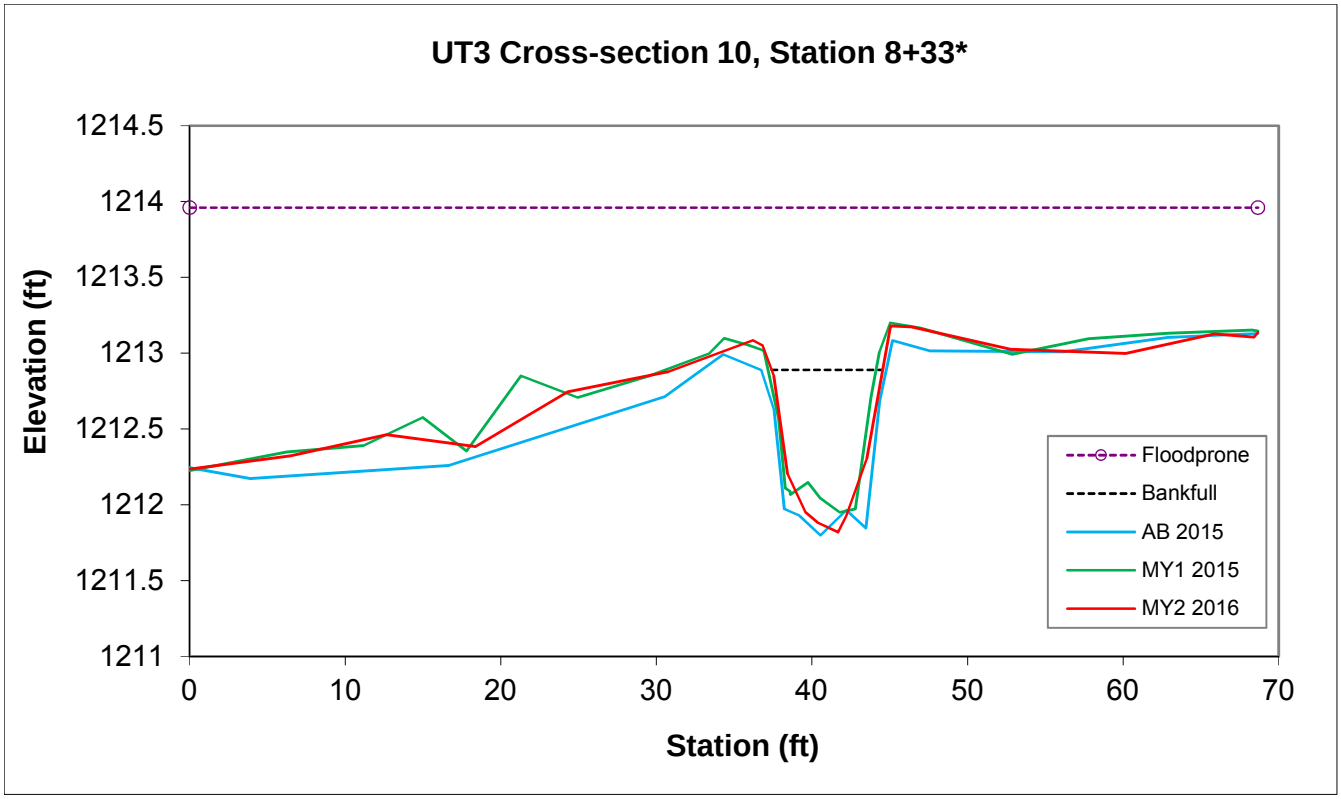
Looking at the Right Bank

* Note: Stationing for Cross-section 9 is being changed to 8+12 which is the surveyed location for the last two years and changes from what was indicated in the As-built survey and the MY1 report.

Permanent Cross-section 10
(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	5.31	7.19	0.74	1.08	9.7	1.1	9.6	1212.9	1213.08



Looking at the Left Bank

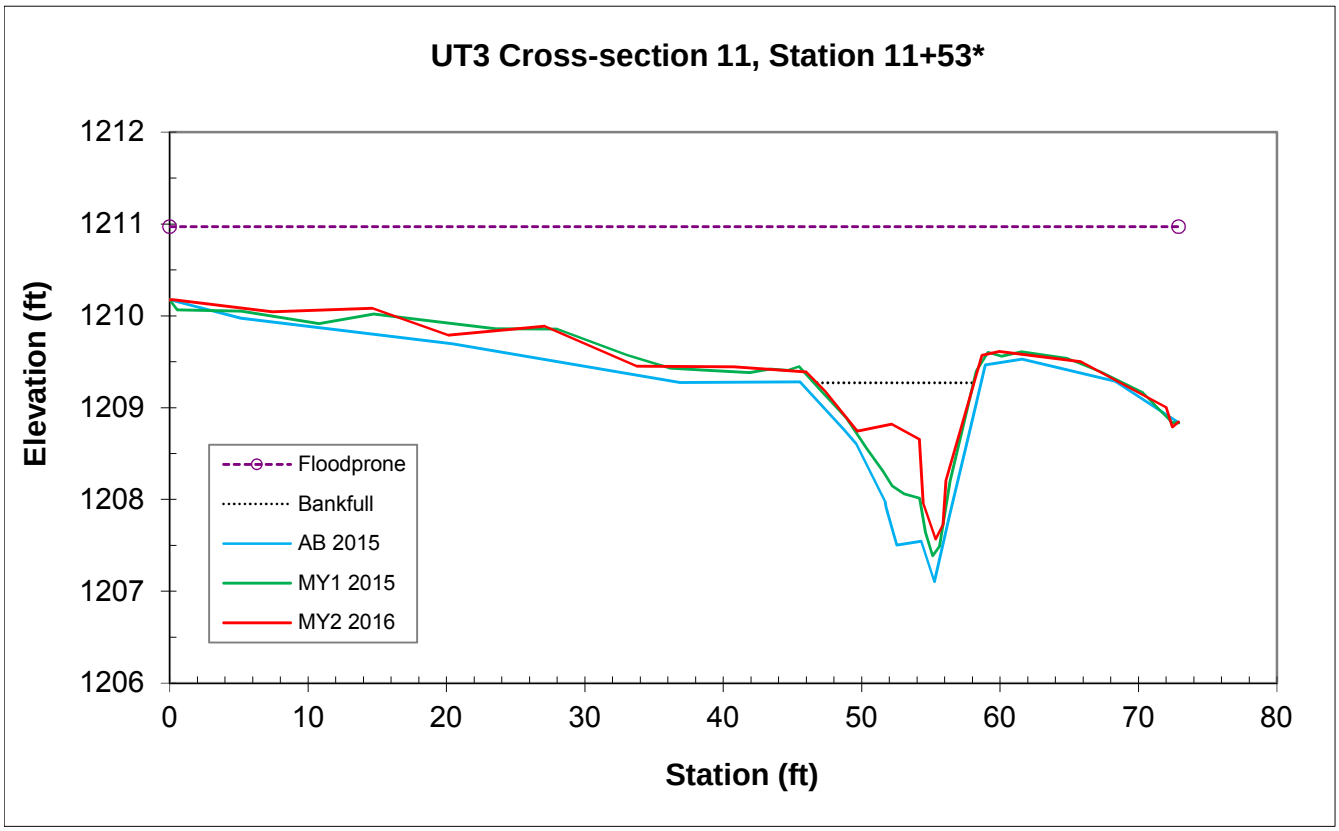
Looking at the Right Bank

* Note: Stationing for Cross-section 10 is being changed to 8+33 which is the surveyed location for the last two years and changes from what was indicated in the As-built survey and the MY1 report.

Permanent Cross-section 11
(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		6.9	11.35	0.61	1.7	18.73	1.1	6.4	1209.27	1209.39



Looking at the Left Bank

Looking at the Right Bank

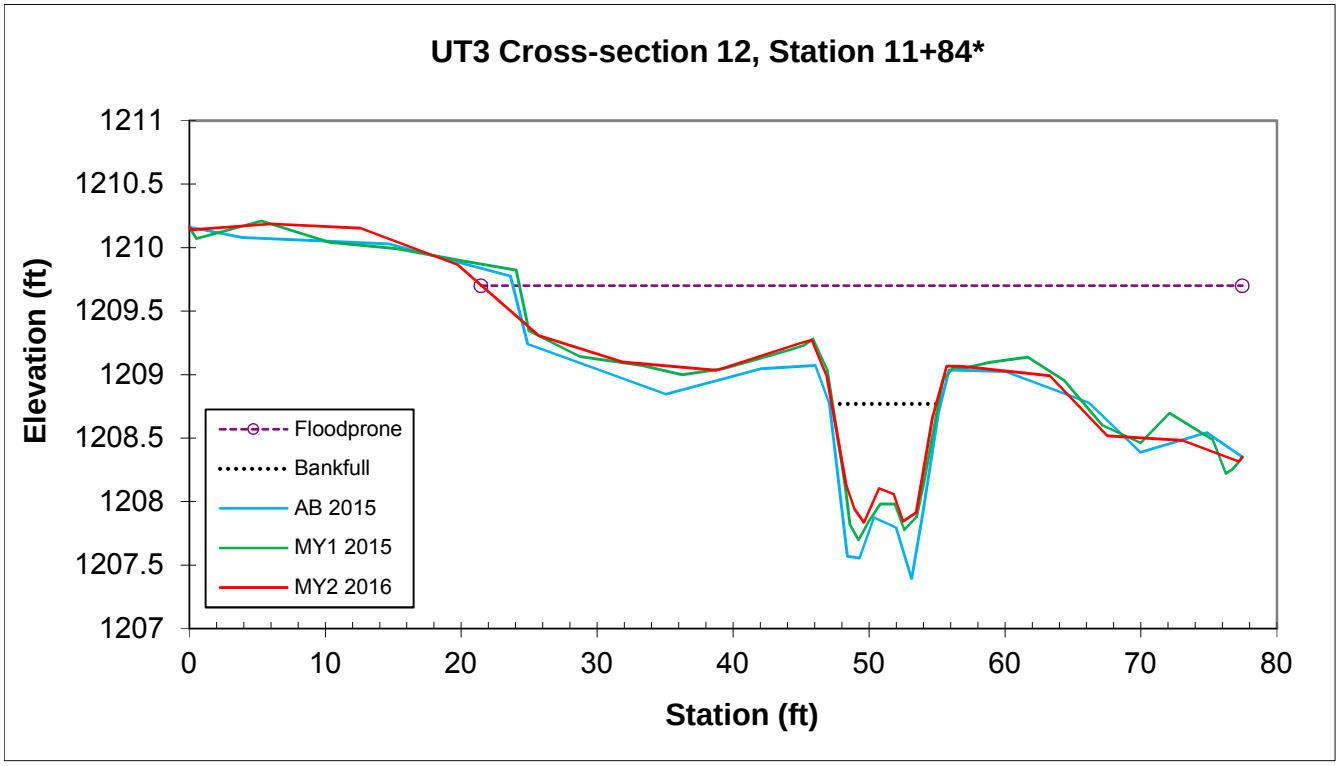
* Note: Stationing for Cross-section 11 is being changed to 11+53 which is the surveyed location for the last two years and changes from what was indicated in the As-built survey and the MY1 report.

Permanent Cross-section 12

(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	E	5	7.69	0.66	0.93	11.72	1.3	7.3	1208.77	1209.07



Looking at the Left Bank

Looking at the Right Bank

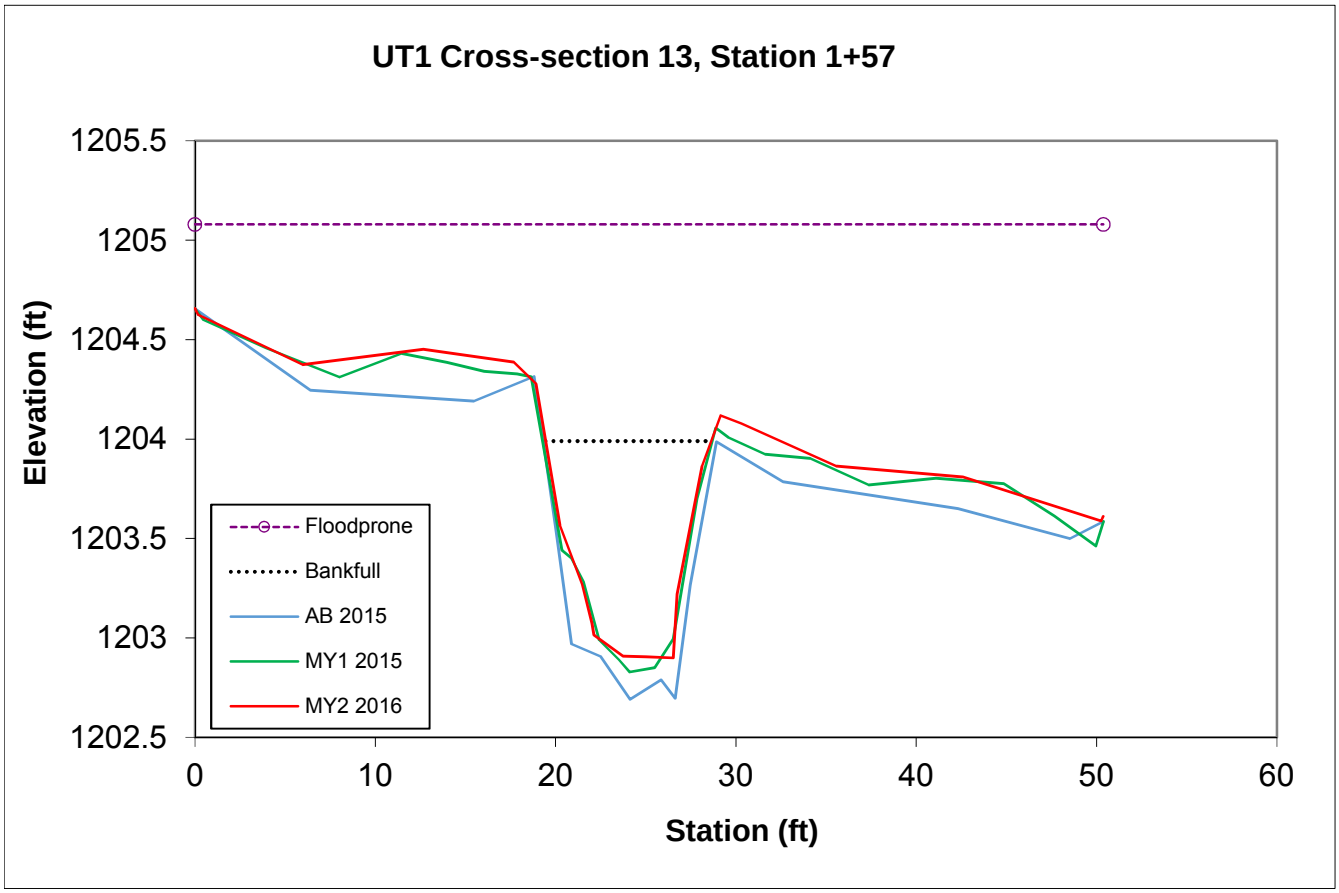
* Note: Stationing for Cross-section 11 is being changed to 11+53 which is the surveyed location for the last two years and changes from what was indicated in the As-built survey and the MY1 report.

Permanent Cross-section 13

(MY2 Data - collected November, 2016)

Based on fixed baseline bankfull

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	7	9.2	0.76	1.09	12.15	1.1	5.5	1203.99	1204.12



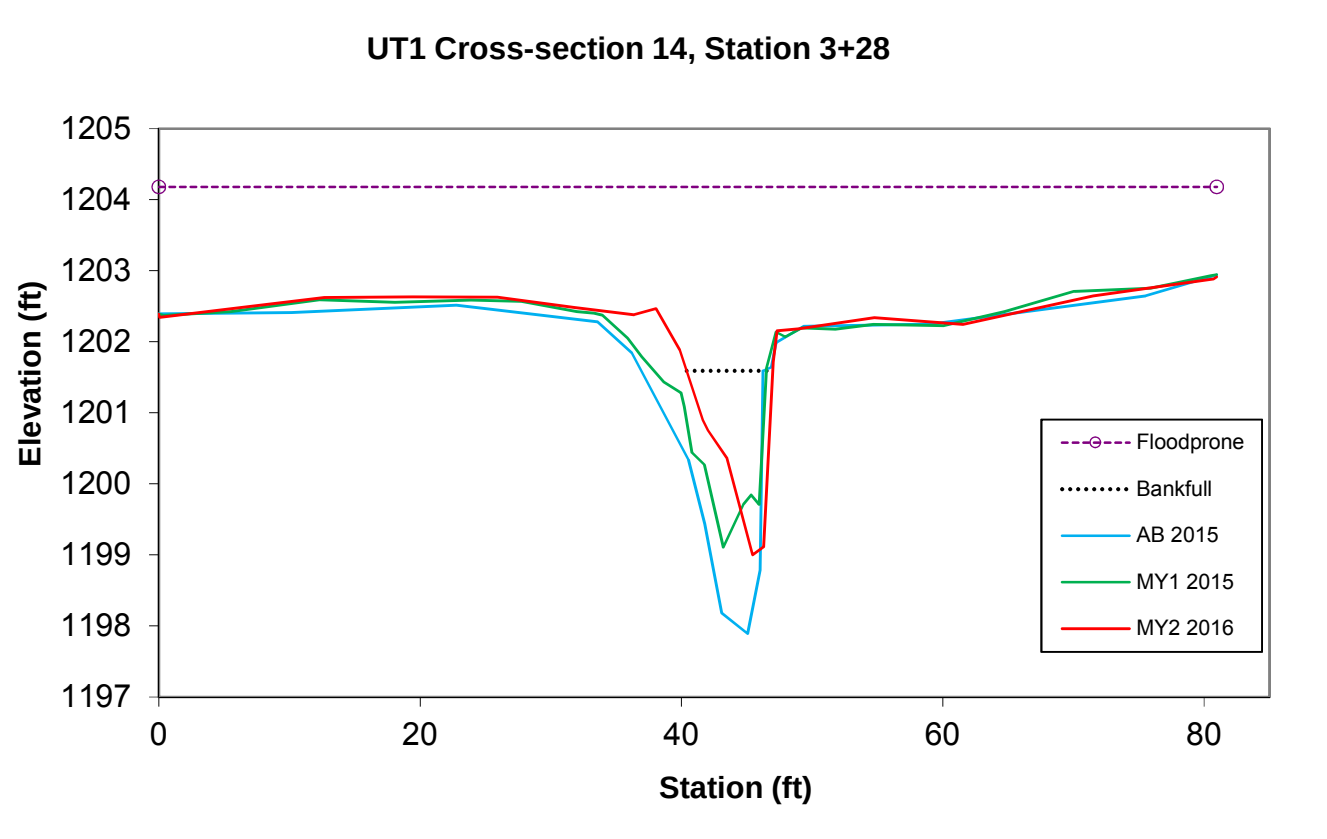
Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 14
(MY2 Data - collected November, 2016)

Based on fixed baseline bankfull

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		9	6.59	1.36	2.59	4.84	1.2	12.3	1201.59	1202.16



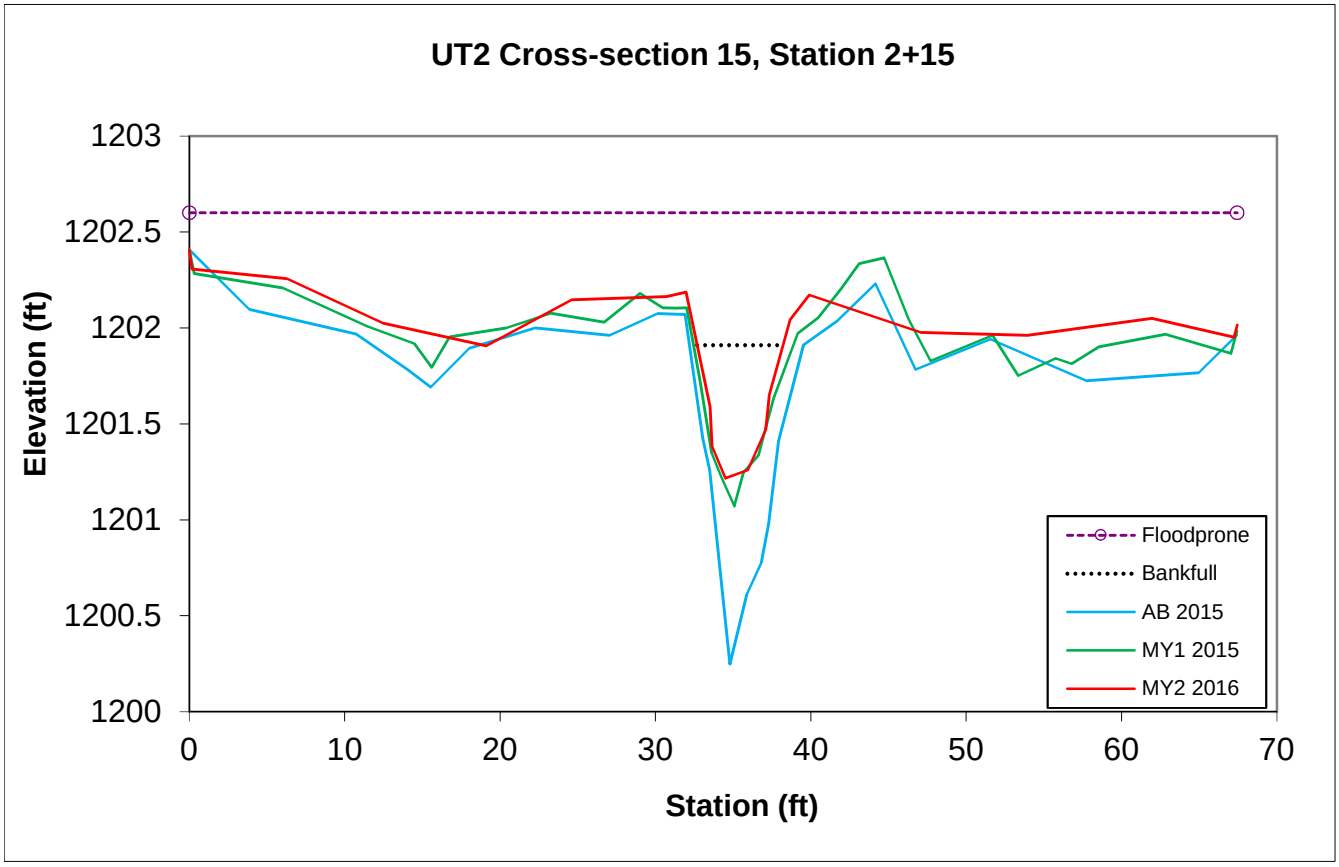
Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 15
(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Pool		2.5	5.55	0.45	0.69	12.28	1.4	12.1	1201.91	1202.17



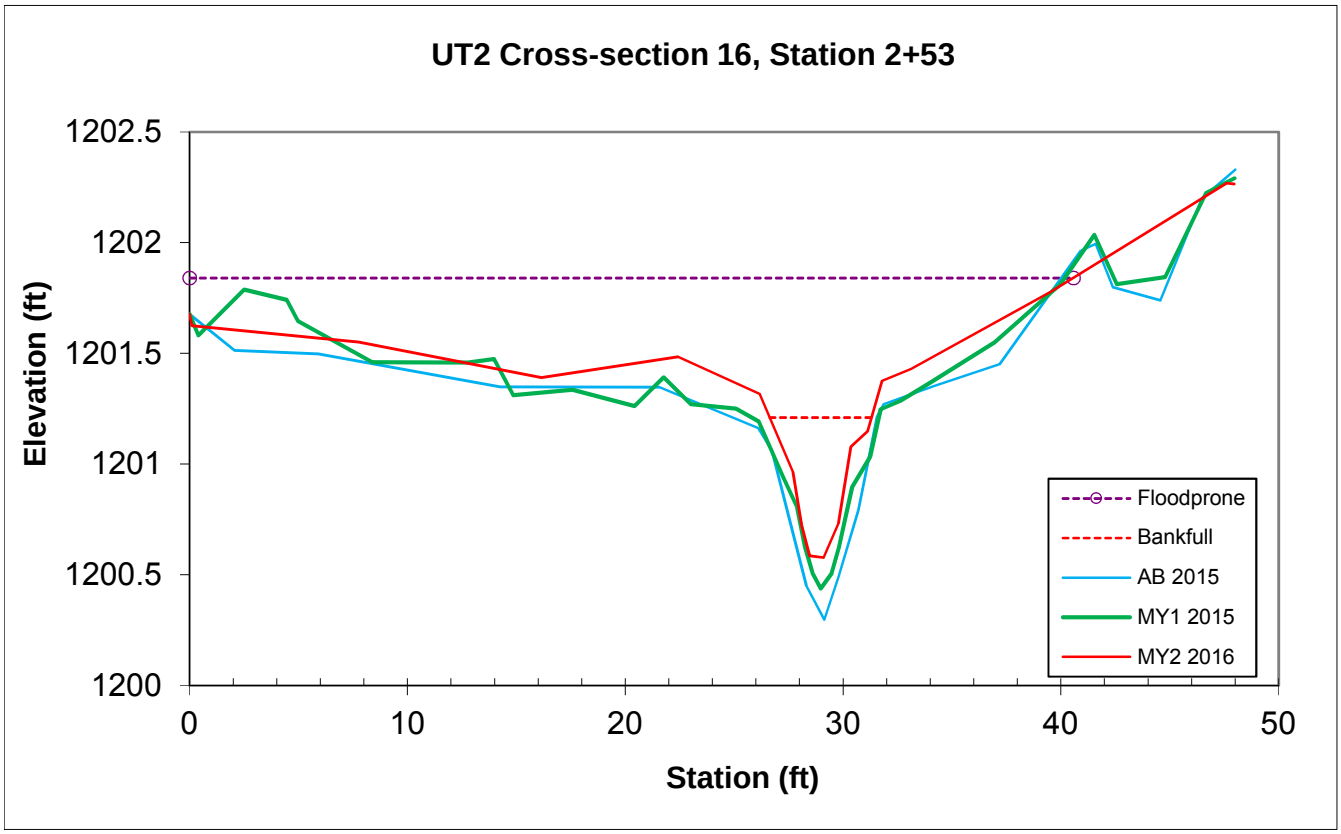
Looking at the Left Bank

Looking at the Right Bank

Permanent Cross-section 16
(MY2 Data - collected November, 2016)

Based on fixed baseline BKF

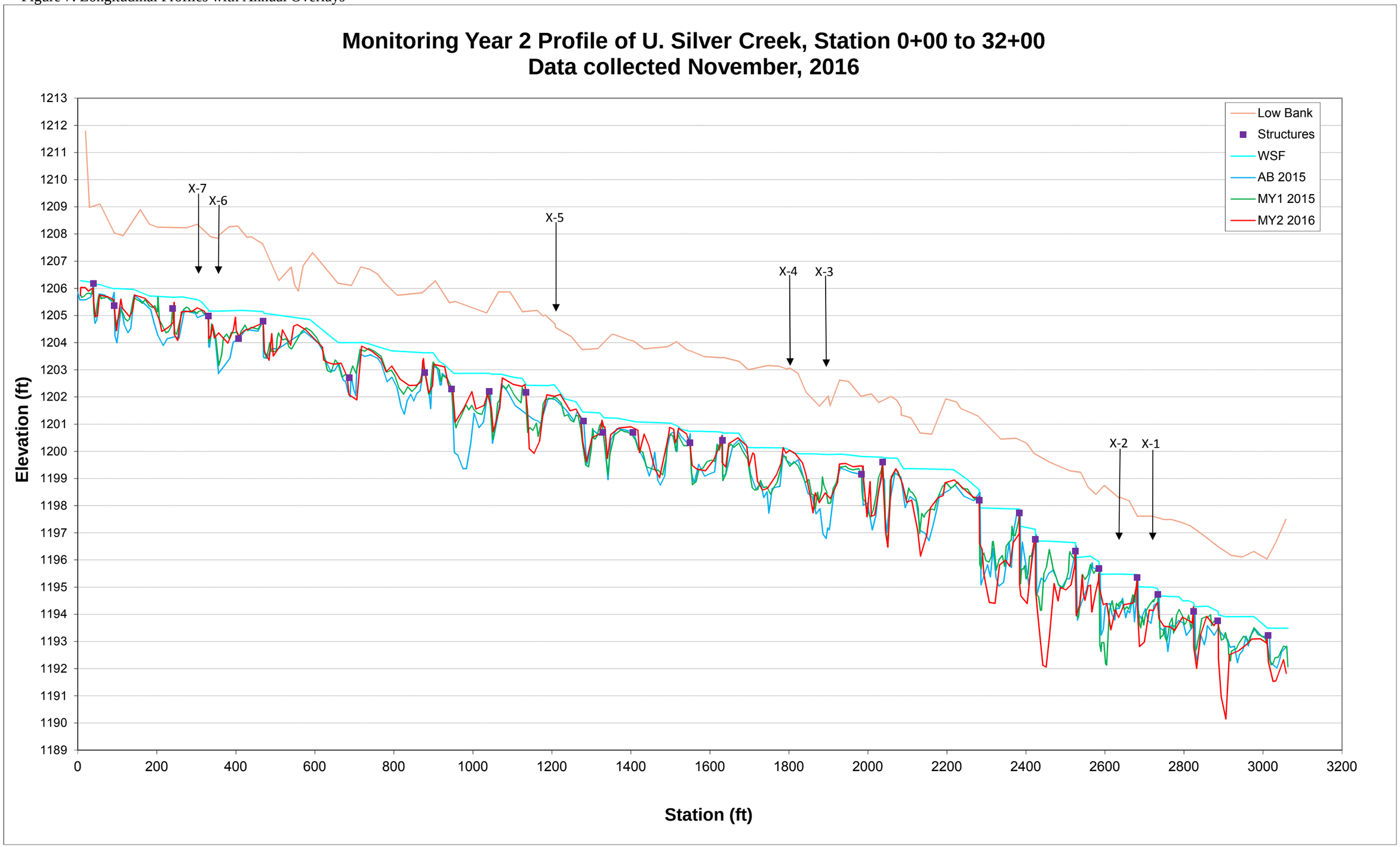
Feature	Stream Type	BKF Area	BKF Width	BKF Depth	Max BKF Depth	W/D	BH Ratio	ER	BKF Elev	TOB Elev
Riffle	C	1.5	4.68	0.32	0.63	14.47	1.2	8.7	1201.21	1201.32



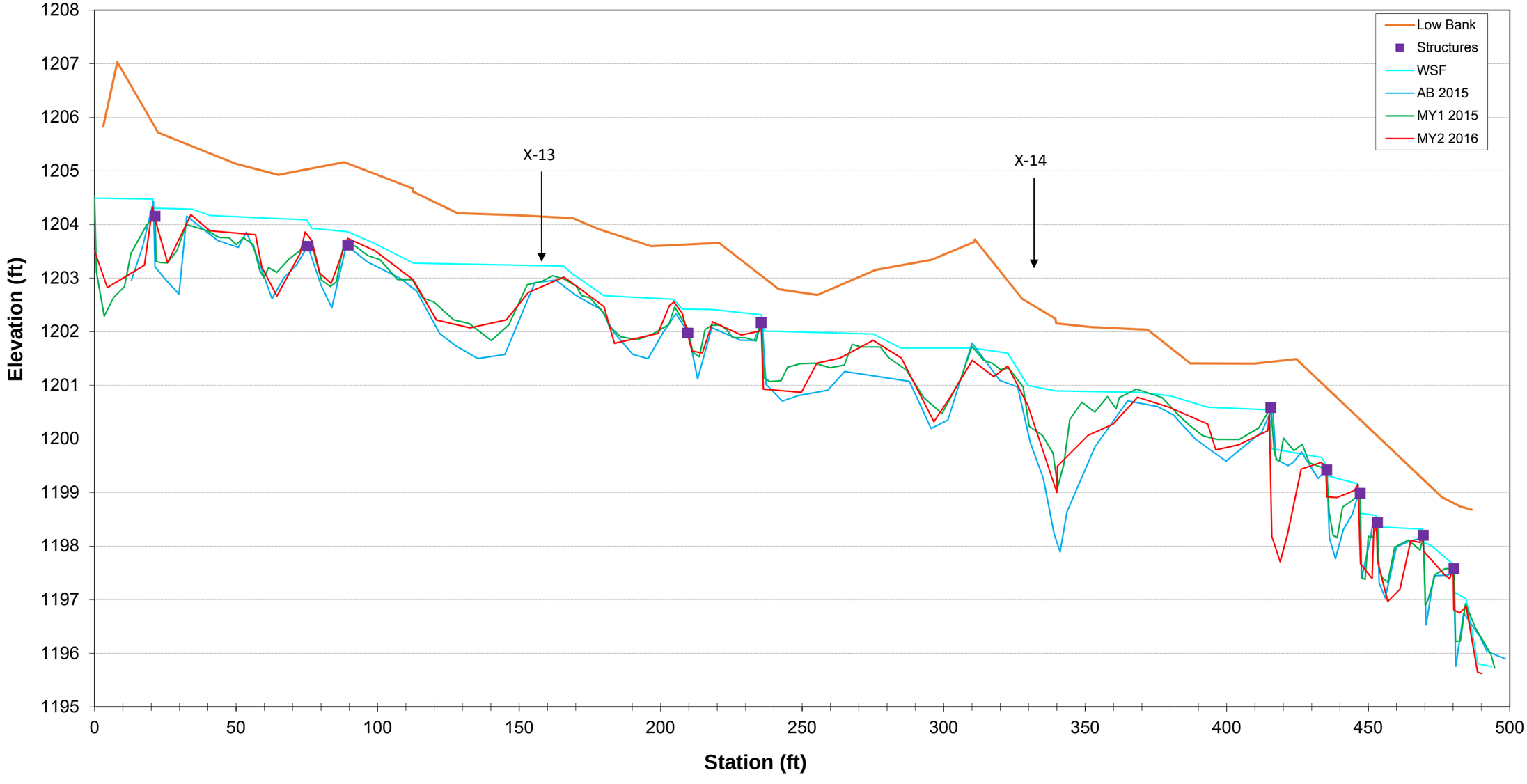
Looking at the Left Bank

Looking at the Right Bank

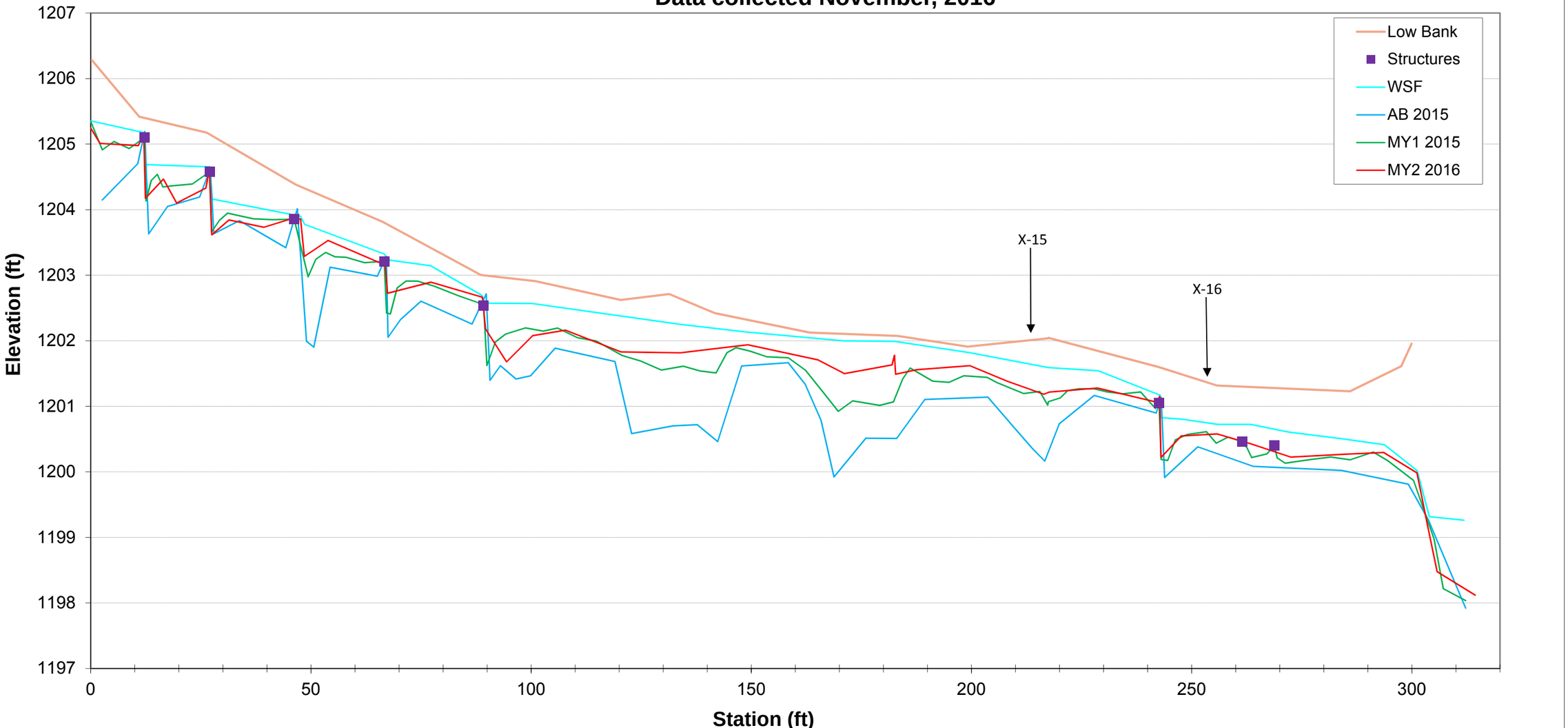
Figure 7. Longitudinal Profiles with Annual Overlays



Monitoring Year 2, Profile of UT1, Station 0+00 to 5+00
Data collected November, 2016



Monitoring Year 2 Profile of UT2, Station 0+00 to 3+20
Data collected November, 2016



Monitoring Year 2, Profile of UT3, Station 0+00 to 14+00
Data collected November 2016

Figure 8. Pebble Count Plots with Annual Overlays

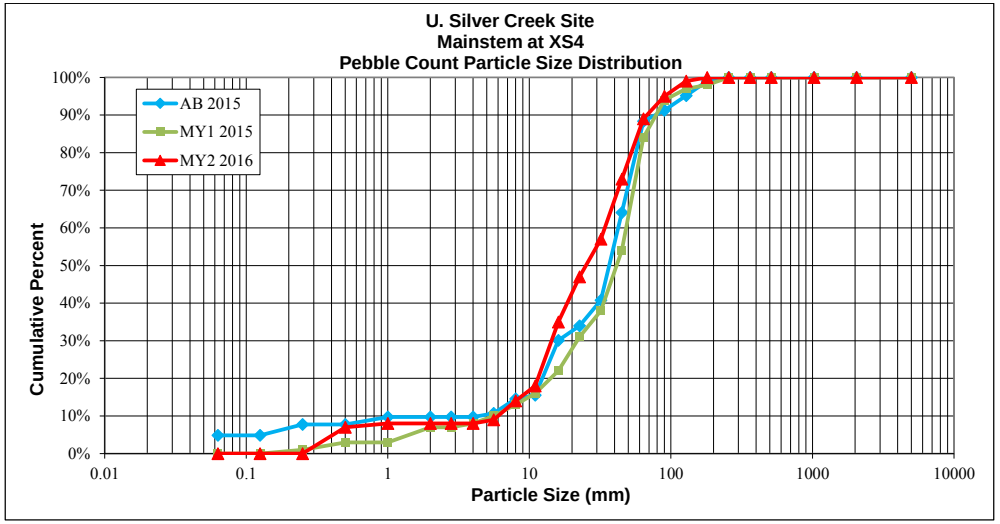
Cross-Section Pebble Count; Monitoring Year 2
U. Silver Creek Mitigation Project, DMS# 94645

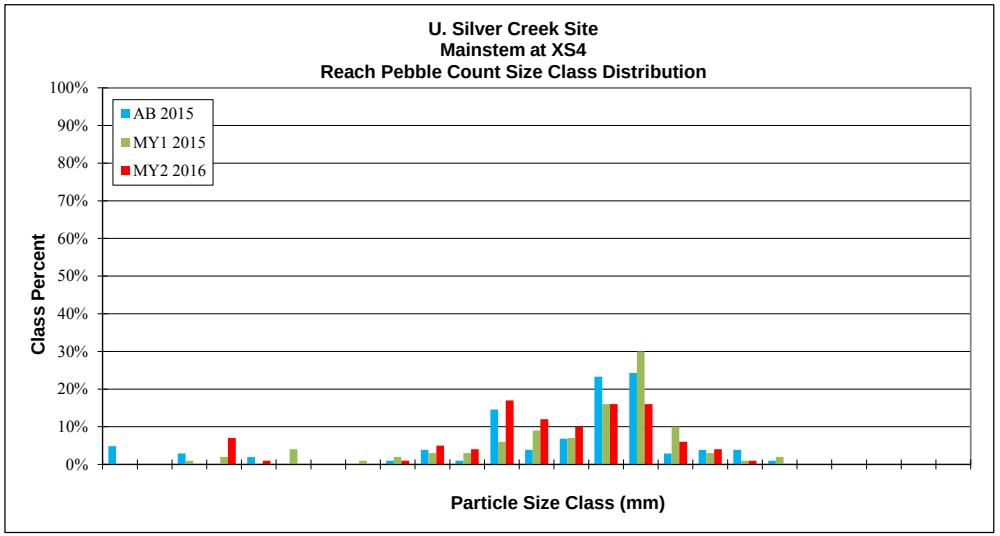
SITE OR PROJECT:	U. Silver Cr
REACH/LOCATION:	Riffle at XS4
FEATURE:	Riffle
DATE:	2-Nov-16

			MY2 2016			Distribution
MATERIAL	**PARTICLE**	**SIZE (mm)**	**Total**	**Class %**	**% Cum**	**Plot Size (mm)**
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125			0%	0.125
	Fine	.125 - .25			0%	0.25
	Medium	.25 - .50	7	7%	7%	0.50
	Coarse	.50 - 1.0	1	1%	8%	1.0
	Very Coarse	1.0 - 2.0			8%	2.0
Gravel	Very Fine	2.0 - 2.8			8%	2.8
	Very Fine	2.8 - 4.0			8%	4.0
	Fine	4.0 - 5.6	1	1%	9%	5.6
	Fine	5.6 - 8.0	5	5%	14%	8.0
	Medium	8.0 - 11.0	4	4%	18%	11.0
	Medium	11.0 - 16.0	17	17%	35%	16.0
	Coarse	16 - 22.6	12	12%	47%	22.6
	Coarse	22.6 - 32	10	10%	57%	32
	Very Coarse	32 - 45	16	16%	73%	45
	Very Coarse	45 - 64	16	16%	89%	64
Cobble	Small	64 - 90	6	6%	95%	90
	Small	90 - 128	4	4%	99%	128
	Large	128 - 180	1	1%	100%	180
	Large	180 - 256			100%	256
Boulder	Small	256 - 362			100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			100	100%		

Largest particle= 130

Summary Data			
Channel materials			
D16 =	9.4	D84 =	57.3
D35 =	16.0	D95 =	90.0
D50 =	25.1	D100 =	128 - 180





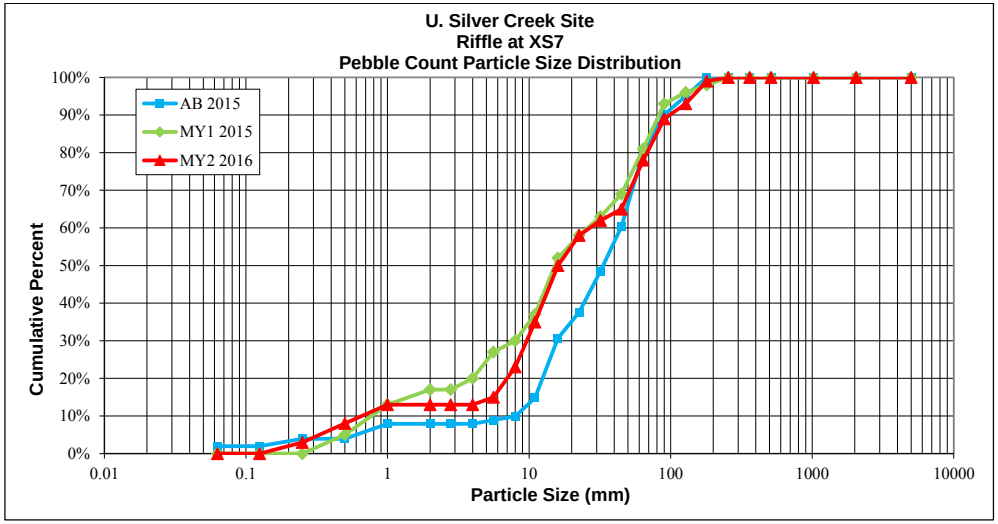
Cross-Section Pebble Count; Monitoring Year 2
U. Silver Creek Mitigation Project, DMS# 94645

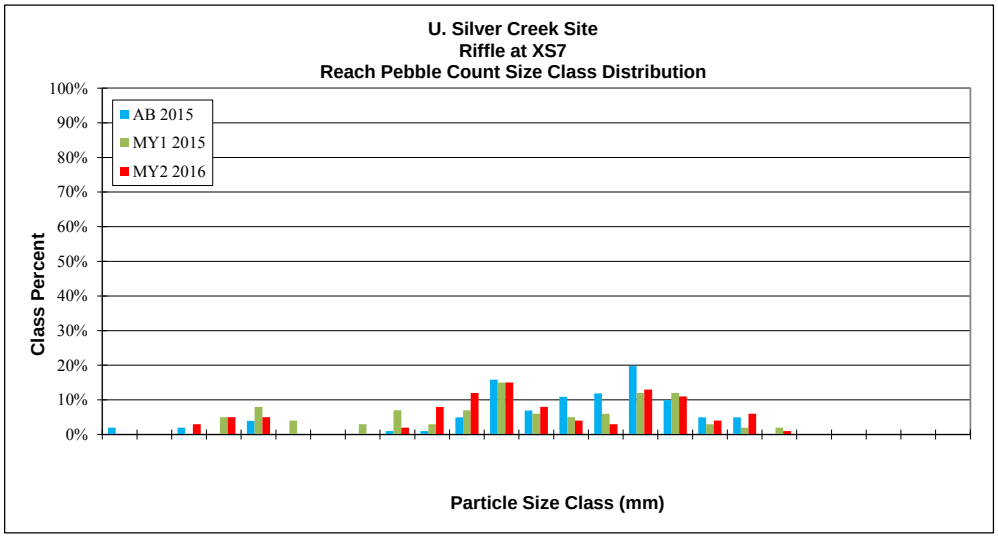
SITE OR PROJECT:	U. Silver Cr
REACH/LOCATION:	Riffle at XS7
FEATURE:	Riffle
DATE:	2-Nov-16

			MY2 2016			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125			0%	0.125
	Fine	.125 - .25	3	3%	3%	0.25
	Medium	.25 - .50	5	5%	8%	0.50
	Coarse	.50 - 1.0	5	5%	13%	1.0
	Very Coarse	1.0 - 2.0			13%	2.0
Gravel	Very Fine	2.0 - 2.8			13%	2.8
	Very Fine	2.8 - 4.0			13%	4.0
	Fine	4.0 - 5.6	2	2%	15%	5.6
	Fine	5.6 - 8.0	8	8%	23%	8.0
	Medium	8.0 - 11.0	12	12%	35%	11.0
	Medium	11.0 - 16.0	15	15%	50%	16.0
	Coarse	16 - 22.6	8	8%	58%	22.6
	Coarse	22.6 - 32	4	4%	62%	32
	Very Coarse	32 - 45	3	3%	65%	45
	Very Coarse	45 - 64	13	13%	78%	64
Cobble	Small	64 - 90	11	11%	89%	90
	Small	90 - 128	4	4%	93%	128
	Large	128 - 180	6	6%	99%	180
	Large	180 - 256	1	1%	100%	256
Boulder	Small	256 - 362			100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			100	100%		

Largest particle= 160

Summary Data			
Channel materials			
D16 =	5.9	D84 =	77.1
D35 =	11.0	D95 =	143.4
D50 =	16.0	D100 =	180 - 256





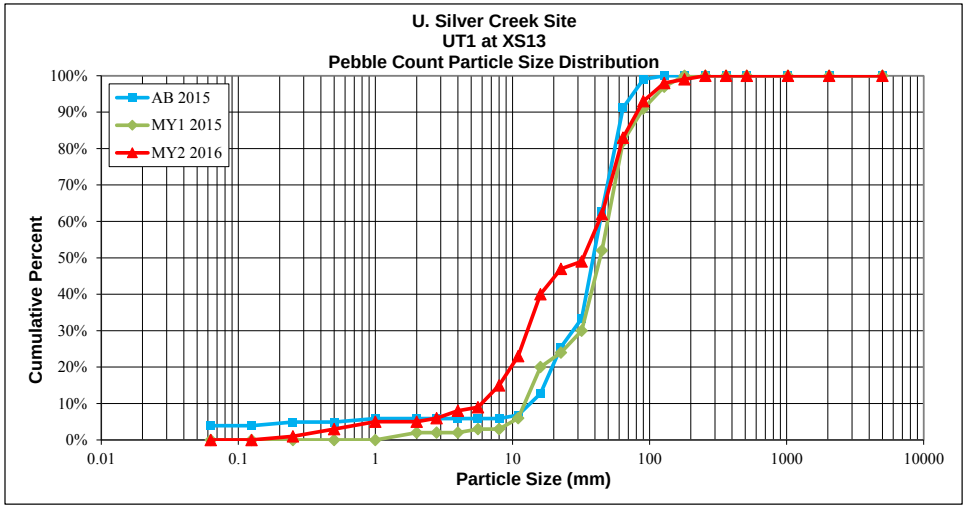
Cross-Section Pebble Count; Monitoring Year 2
U. Silver Creek Mitigation Project, DMS# 94645

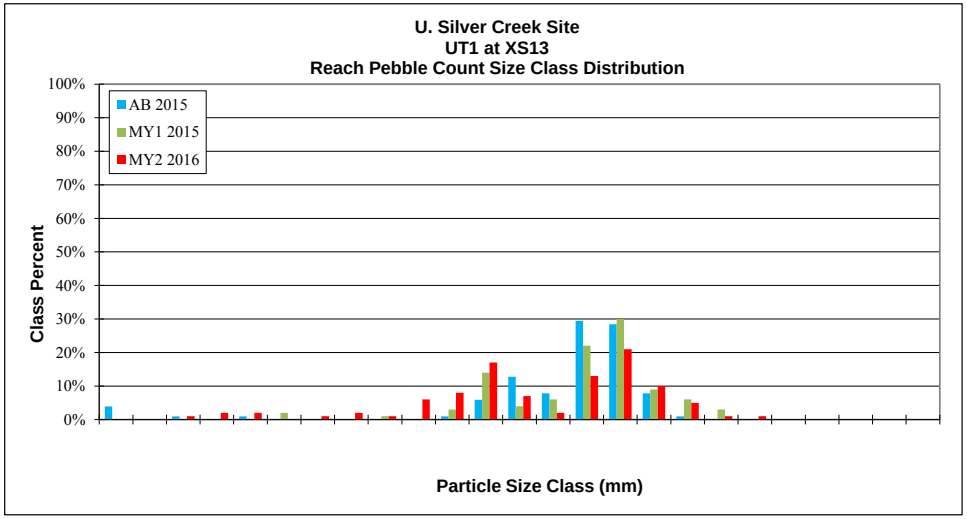
SITE OR PROJECT:	U. Silver Cr
REACH/LOCATION:	UT1 XS13
FEATURE:	Riffle
DATE:	2-Nov-16

			MY2 2016			Distribution
MATERIAL	**PARTICLE**	**SIZE (mm)**	**Total**	**Class %**	**% Cum**	**Plot Size (mm)**
Silt/Clay	Silt / Clay	< .063			0%	0.063
Sand	Very Fine	.063 - .125			0%	0.125
	Fine	.125 - .25	1	1%	1%	0.25
	Medium	.25 - .50	2	2%	3%	0.50
	Coarse	.50 - 1.0	2	2%	5%	1.0
	Very Coarse	1.0 - 2.0			5%	2.0
Gravel	Very Fine	2.0 - 2.8	1	1%	6%	2.8
	Very Fine	2.8 - 4.0	2	2%	8%	4.0
	Fine	4.0 - 5.6	1	1%	9%	5.6
	Fine	5.6 - 8.0	6	6%	15%	8.0
	Medium	8.0 - 11.0	8	8%	23%	11.0
	Medium	11.0 - 16.0	17	17%	40%	16.0
	Coarse	16 - 22.6	7	7%	47%	22.6
	Coarse	22.6 - 32	2	2%	49%	32
	Very Coarse	32 - 45	13	13%	62%	45
	Very Coarse	45 - 64	21	21%	83%	64
Cobble	Small	64 - 90	10	10%	93%	90
	Small	90 - 128	5	5%	98%	128
	Large	128 - 180	1	1%	99%	180
	Large	180 - 256	1	1%	100%	256
Boulder	Small	256 - 362			100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			100	100%		

Largest particle= 210

Summary Data			
Channel materials			
D16 =	8.3	D84 =	66.2
D35 =	14.3	D95 =	103.6
D50 =	32.9	D100 =	180 - 256





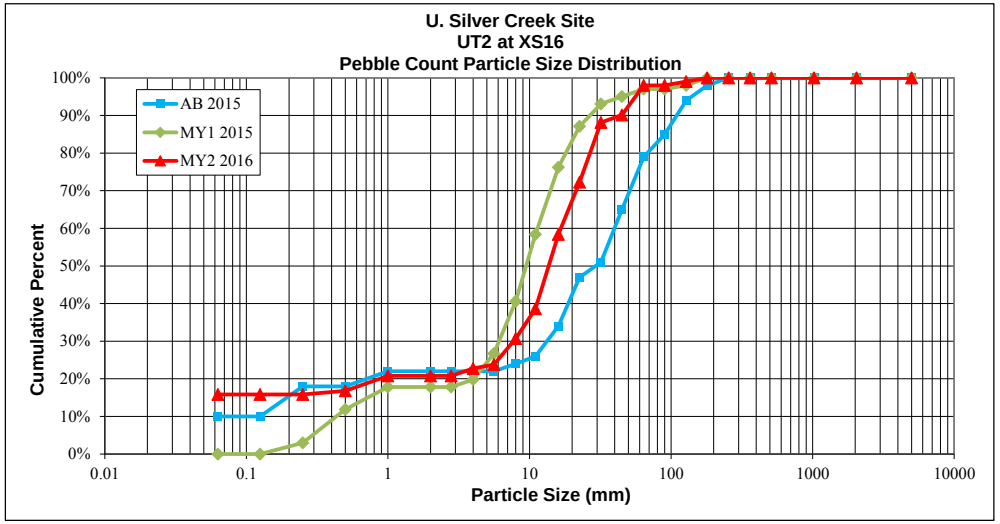
Cross-Section Pebble Count; Monitoring Year 2
U. Silver Creek Mitigation Project, DMS# 94645

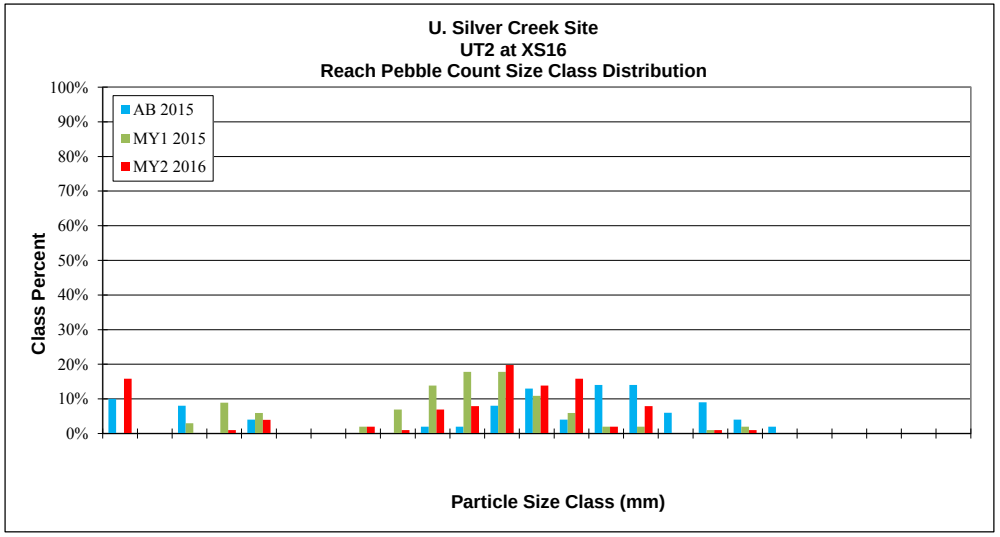
SITE OR PROJECT:	U. Silver Cr
REACH/LOCATION:	UT2 XS16
FEATURE:	Riffle
DATE:	2-Nov-16

			MY2 2016			Distribution
MATERIAL	PARTICLE	SIZE (mm)	Total	Class %	% Cum	Plot Size (mm)
Silt/Clay	Silt / Clay	< .063	16	16%	16%	0.063
Sand	Very Fine	.063 - .125			16%	0.125
	Fine	.125 - .25			16%	0.25
	Medium	.25 - .50	1	1%	17%	0.50
	Coarse	.50 - 1.0	4	4%	21%	1.0
	Very Coarse	1.0 - 2.0			21%	2.0
Gravel	Very Fine	2.0 - 2.8			21%	2.8
	Very Fine	2.8 - 4.0	2	2%	23%	4.0
	Fine	4.0 - 5.6	1	1%	24%	5.6
	Fine	5.6 - 8.0	7	7%	31%	8.0
	Medium	8.0 - 11.0	8	8%	39%	11.0
	Medium	11.0 - 16.0	20	20%	58%	16.0
	Coarse	16 - 22.6	14	14%	72%	22.6
	Coarse	22.6 - 32	16	16%	88%	32
	Very Coarse	32 - 45	2	2%	90%	45
	Very Coarse	45 - 64	8	8%	98%	64
Cobble	Small	64 - 90			98%	90
	Small	90 - 128	1	1%	99%	128
	Large	128 - 180	1	1%	100%	180
	Large	180 - 256			100%	256
Boulder	Small	256 - 362			100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			101	100%		

Largest particle= 165

Summary Data			
Channel materials			
D16 =	0.3	D84 =	29.2
D35 =	9.5	D95 =	56.0
D50 =	13.6	D100 =	128 - 180





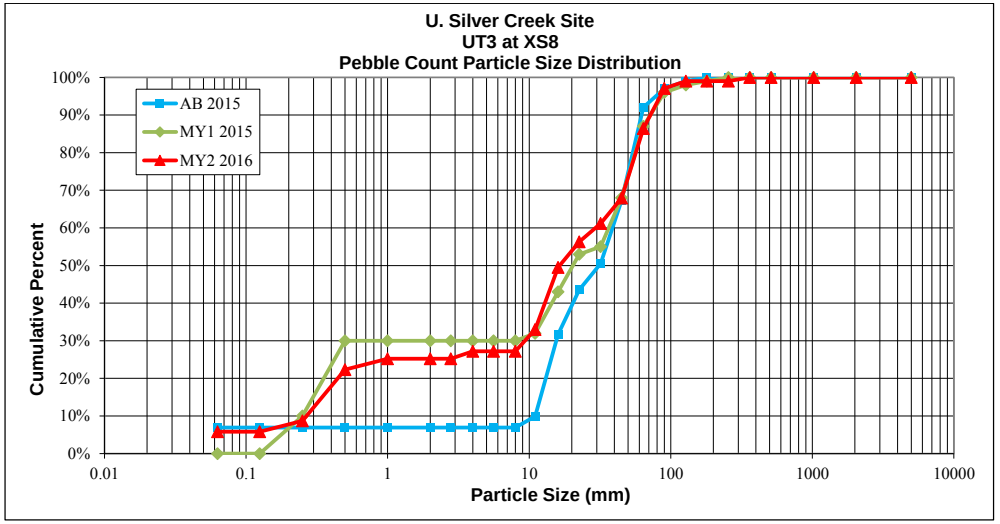
Cross-Section Pebble Count; Monitoring Year 2
U. Silver Creek Mitigation Project, DMS# 94645

SITE OR PROJECT:	U. Silver Cr
REACH/LOCATION:	UT3 XS8
FEATURE:	Riffle
DATE:	2-Nov-16

			MY2 2016			Distribution
MATERIAL	**PARTICLE**	**SIZE (mm)**	**Total**	**Class %**	**% Cum**	**Plot Size (mm)**
Silt/Clay	Silt / Clay	< .063	6	6%	6%	0.063
Sand	Very Fine	.063 - .125			6%	0.125
	Fine	.125 - .25	3	3%	9%	0.25
	Medium	.25 - .50	14	14%	22%	0.50
	Coarse	.50 - 1.0	3	3%	25%	1.0
	Very Coarse	1.0 - 2.0			25%	2.0
Gravel	Very Fine	2.0 - 2.8			25%	2.8
	Very Fine	2.8 - 4.0	2	2%	27%	4.0
	Fine	4.0 - 5.6			27%	5.6
	Fine	5.6 - 8.0			27%	8.0
	Medium	8.0 - 11.0	6	6%	33%	11.0
	Medium	11.0 - 16.0	17	17%	50%	16.0
	Coarse	16 - 22.6	7	7%	56%	22.6
	Coarse	22.6 - 32	5	5%	61%	32
	Very Coarse	32 - 45	7	7%	68%	45
	Very Coarse	45 - 64	19	18%	86%	64
Cobble	Small	64 - 90	11	11%	97%	90
	Small	90 - 128	2	2%	99%	128
	Large	128 - 180			99%	180
	Large	180 - 256			99%	256
Boulder	Small	256 - 362	1	1%	100%	362
	Small	362 - 512			100%	512
	Medium	512 - 1024			100%	1024
	Large-Very Large	1024 - 2048			100%	2048
Bedrock	Bedrock	> 2048			100%	5000
Total % of whole count			103	100%		

Largest particle= 320

Summary Data			
Channel materials			
D16 =	0.4	D84 =	61.1
D35 =	11.5	D95 =	84.2
D50 =	16.4	D100 =	256 - 362



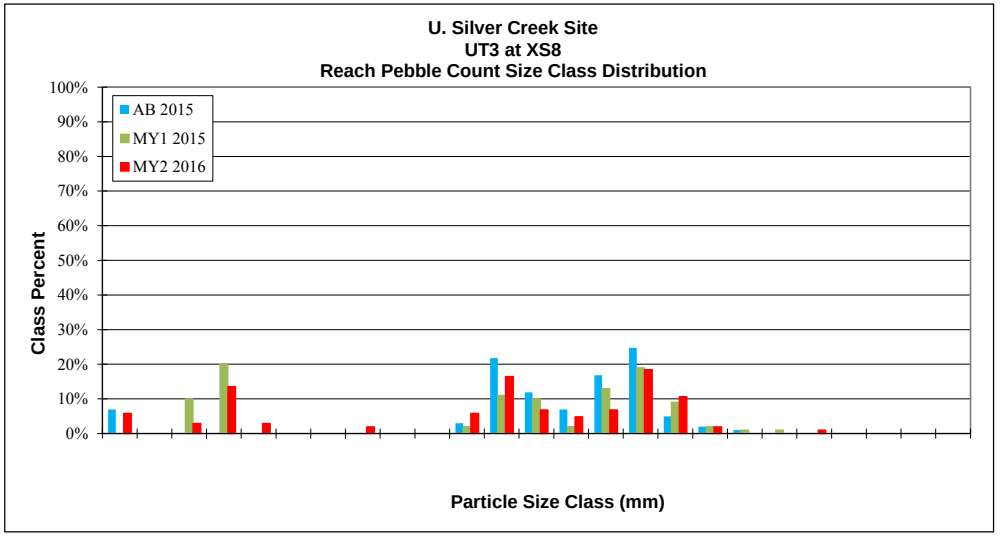


Table 10. Monitoring Year 2 Stream Summary
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Silver Creek Mainstem

Parameter	USGS Gauge	Regional Curve Interval [1,2]			Pre-Existing Condition[1]						Reference Reach Data: Morgan Creek						Design						As-built						MY1						MY2					
Dimension and Substrate - Riffle		NC Mtn.	NC Pied.	Rural	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	29.0	19.0	-	18.5	-	-	21.2	-	7	33.2	-	-	33.5	-	-	-	26.0	-	-	-	-	23.8	27.0	27.5	29.1	2.0	4	23.5	25.0	25.2	26.1	1.0	4	23.5	24.9	25.1	25.8	0.837	4
Floodprone Width (ft)	-	-	-	-	397.0	-	-	453.0	-	7	77.5	-	-	86.8	-	-	397	-	-	453.0	-	-	-	>300	-	-	-	-	-	>300	-	-	-	-	-	>300	-	-	-	-
BF Mean Depth (ft)	-	1.6	2.1	-	2.29			2.93	-	7	2.3	-	-	2.4	-	-	-	2.2	-	-	-	-	1.7	1.9	1.9	2.1	0.18	4	1.7	1.8	1.8	2.0	0.11	4	1.7	1.8	1.8	1.8	0.061	4
BF Max Depth (ft)	-	-	-	-	3.3	-	-	3.9	-	7	2.8	-	-	2.9	-	-	-	3.0	-	-	-	-	2.9	3.1	3.2	3.3	0.2	4	2.8	3.0	3.0	3.2	0.2	4	2.8	3.0	3.0	3.2	0.162	4
BF Cross-sectional Area (ft^2)	-	46.0	45.0	-	46.3	-	-	55.2	-	7	75.1	-	-	79.8	-	-	-	56.0	-	-	-	-	46.9	49.7	48.6	54.5	2.9	4	43.4	45.4	43.8	50.6	3.0	4	41.1	44.0	43.7	47.6	2.513	4
Width/Depth Ratio	-	-	-	-	7.4	-	-	8.8	-	7	14.1	-	-	14.7	-	-	-	12	-	-	-	-	11.8	14.8	15.1	17.3	2.4	4	12.4	13.8	13.6	15.7	1.2	4	13.5	14.1	13.9	15.0	0.593	4
Entrenchment Ratio	-	-	-	-	19.6	-	-	24	-	7	2.3	-	-	2.6	-	-	15.3	-	-	17.4	-	-	3.1	3.7	3.5	4.8	0.7	4	3.3	4.0	3.8	4.9	0.6	4	3.5	4.0	3.8	4.9	0.545	4
Bank Height Ratio	-	-	-	-	1.07	-	-	1.5	-	7	1.0	-	-	1.0	-	-	1	-	-	1.1	-	-	1.0	1.03	1.00	1.1	0.0	4	1.0	1.0	1.0	1.0	0.00	4	0.0	0.8	1.0	1.0	0.433	4
d50 (mm)	-	-	-	-	-	17.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pattern																																								
Channel Beltwidth (ft)	-	-	-	-	45	-	-	106	-	-	-	-	-	-	-	-	104	-	-	208	-	-	99.0	133.3	137.7	157.9	19.24	13	99.0	133.3	137.7	157.9	19.24	13	99.0	133.3	137.7	157.9	19.24	13
Radius of Curvature (ft)	-	-	-	-	16	-	-	62	-	-	-	-	-	-	-	-	47	-	-	73	-	-	52.6	57.2	55.0	67.9	5.03	8	52.6	57.2	55.0	67.9	5.03	8	52.6	57.2	55.0	67.9	5.03	8
Rc:Bankfull width (ft/ft)	-	-	-	-	1	-	-	3.1	-	-	-	-	-	-	-	-	1.8	-	-	2.8	-	-	1.95	2.12	2.04	2.51	0.19	8	1.95	2.12	2.04	2.51	0.19	8	1.95	2.12	2.04	2.51	0.19	8
Meander Wavelength (ft)	-	-	-	-	59	-	-	139	-	-	-	-	-	-	-	-	182	-	-	312	-	-	172.0	225.4	201.7	310.0	49.3	8	172.0	225.4	201.7	310.0	49.3	8	172.0	225.4	201.7	310.0	49.3	8
Meander Width Ratio	-	-	-	-	2.3	-	-	5.4	-	-	-	-	-	-	-	-	7.0	-	-	12.0	-	-	6.4	8.3	7.5	11.5	1.8	8	6.4	8.3	7.5	11.5	1.8	8	6.4	8.3	7.5	11.5	1.8	8
Profile																																								
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	36.7	50.3	44.7	89.4	15.1	10.0	12.1	50.0	47.6	83.8	17.0	16	27.3	56.3	57.2	86.5	16.7	15
Riffle Slope (ft/ft)	-	-	-	-	0.001	-	-	0.108	-	-	0.014	-	-	0.024	-	-	0.005	-	-	0.008	-	-	0.0013	0.0078	0.0067	0.0152	0.0041	10.0	0.0000	0.0076	0.0055	0.0231	0.0073	16	0.0013	0.0058	0.0049	0.0130	0.0036	15
Pool Length (ft)	-	-	-	-	15	-	-	135	-	-	-	-	-	-	-	-	78	-	-	137	-	-	50.4	97.1	94.0	136.6	20.4	16.0	42.7	80.3	87.7	116.8	22.6	14	16.7	80.0	83.7	126.0	26.7	19
Pool Spacing (ft)	-	-	-	-	40	-	-	162	-	-	46	-	-	277	-	-	104	-	-	182	-	-	113.7	145.8	140.1	210.4	29.6	15	42.8	115.2	120.5	191.4	36.6	19	48.1	113.6	116.6	202.2	42.0	20
Pool Max Depth (ft)	-	-	-	-	3.97	-	-	4.08	-	-	4.1	-	-	4.1	-	-	5.5	-	-	7.7	-	-	4.0	4.8	5.2	5.3	0.58	3	3.9	4.3	4.0	5.0	0.48	3	3.8	4.0	4.0	4.3	0.23	3
Pool Volume (ft^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																																								
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-			1.0 / 8.4 / 17 / 43 / 57						- / 1.2 / 3.0 / 77 / 800						-					mean 11.2 / 21.8 / 35.0 / 66.6 /126.9					2		mean 6.4 / 18.8 / 28.3 / 66.9 /107.5					2		mean 7.7 / 13.5 / 20.6 / 67.2 /116.7					2
Reach Shear Stress (competency) lb/ft^2	-	-	-	-	0.035	-	-	1.13	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m^2	-	-	-	-	34	-	-	40	-	-	-	-	-	-	-	-	29	-	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																																								
Drainage Area (SM)	-		3.0		2.73	-	-	3.35	-	-	-	8.4	-	-	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-
Impervious cover estimate (%)	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	-	-	-	-	E	-	-	-	-	-	C4	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-
BF Velocity (fps)	-	-	-	-	2.8	-	-	4.9	-	7	-	7	-	-	-	-	-	4.20	-	-	-	-	-	4.27	-	-	-	-	-	4.21	-	-	-	-	-	4.21	-	-	-	-
BF Discharge (cfs)	-	232.0	196.0	213.2	180		-	240	-	-	-	524	-	-	-	-	-	230.0	-	-	-	-	-	212.2	-	-	-	-	-	229.3	-	-	-	-	-	229.3	-	-	-	-
Valley Length	-	-	-	-	-	1947	-	-	-	-	-	-	-	-	-	-	-	1947.0	-	-	-	-	-	1947.0	-	-	-	-	-	1947.0	-	-	-	-	-	1947.0	-	-	-	-
Channel length (ft^2)	-	-	-	-	-	3179	-	-	-	-	-	-	-	-	-	-	-	3068	-	-	-	-	-	3016	-	-	-	-	-	3016	-	-	-	-	-	3016	-	-	-	-
Sinuosity	-	-	-	-	-	1.63	-	-	-	-	-	-	-	-	-	-	-	1.58	-	-	-	-	-	1.55	-	-	-	-	-	1.55	-	-	-	-	-	1.55	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	0.0040	-	-	-	-	-	0.0070	-	-	-	-	0.003	-	-	0.004	-	-	-	0.0043	-	-	-	-	-	0.0043	-	-	-	-	-	0.0043	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.003	-	-	0.008	-	-	-	0.004	-	-	-	-	-	0.004	-	-	-	-	-	0.004	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	2.1	-	-	-	-	-	-	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1. Harman, W.A., G.D. Jennings, J.M. Patterson, D.R. Clinton, L.O. Slate, A.G. Jessup, J.R. Everhart, and R.E. Smith. 1999. Bankfull hydraulic geometry relationships for North Carolina streams. Wildland Hydrology. AWRA Symposium Proceedings. D.S. Olsen and J.P. Potyondy, eds. American Water Resources Association. June 30-July 2, 1999. Bozeman, MT.
2. Harman, W.A., D.E Wise, M.A. Walker, R. Morris, MA Cantrell, M. Clemmons, G.D. Jennings, D.R. Clinton, J.M. Patterson. 2000. Bankfull Regional Curves for North Carolina Mountain Streams. In: AWRA Conference Proceedings, D.L. Kane, editor. American Water Resources Specialty Conference on Water Resources in Extreme Environments. Anchorage, Alaska.

UT1

Parameter	USGS Gauge	Regional Curve Interval [1,2]			Pre-Existing Condition[1]						Reference Reach Data: UT3 upstream of Gold Mine Road						Design						As-built						MY1						MY2					
Dimension and Substrate - Riffle		NC Mtn.	NC Pied.	Rural	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	11.9	6.9	-	6.1	-	-	9.3	-	4	6.3	-	-	7.9	-	-	-	9.5	-	-	-	-	-	9.6	-	-	-	1	-	9.3	-	-	-	1	-	9.2	-	-	-	1
Floodprone Width (ft)	-	-	-	-	10.9	-	-	60.5	-	4	15	-	-	19	-	-	10.9	-	-	60.5	-	-	-	>150	-	-	-	1	-	>150	-	-	-	1	-	>150	-	-	-	1
BF Mean Depth (ft)	-	0.7	1.0	-	0.97	-	-	1.50	-	4	0.7	-	-	0.9	-	-	-	0.95	-	-	-	-	-	0.9	-	-	-	1	-	0.8	-	-	-	1	-	0.8	-	-	-	1
BF Max Depth (ft)	-	-	-	-	1.37	-	-	2.07	-	4	1.0	-	-	1.35	-	-	-	1.2	-	-	-	-	-	1.3	-	-	-	1	-	1.1	-	-	-	1	-	1.1	-	-	-	1
BF Cross-sectional Area (ft^2)	-	9.1	9.0	-	9	-	-	9.07	-	4	5.5	-	-	6.5	-	-	-	9.0	-	-	-	-	-	8.9	-	-	-	1	-	7.0	-	-	-	1	-	7.0	-	-	-	1
Width/Depth Ratio	-	-	-	-	4	-	-	9.6	-	4	7.3	-	-	11.7	-	-	-	10	-	-	-	-	-	10.3	-	-	-	1	-	12.3	-	-	-	1	-	12.2	-	-	-	1
Entrenchment Ratio	-	-	-	-	1.2	-	-	10	-	4	1.9	-	-	3.0	-	-	1.1	-	-	6.4	-	-	-	5.3	-	-	-	1	-	5.2	-	-	-	1	-	5.5	-	-	-	1
Bank Height Ratio	-	-	-	-	1.5	-	-	3.0	-	4	1.0	-	-	1.0	-	-	1.0	-	-	1.0	-	-	-	1.00	-	-	-	1	-	1.00	-	-	-	1	-	1.10	-	-	-	1
d50 (mm)	-	-	-	-	-	18.0	-	-	-	-	-	3.0	-	-	-	-	-	-	-	-	-	-	-	38.8	-	-	-	-	-	43.6	-	-	-	-	-	32.9	-	-	-	1
Pattern																																								
Channel Beltwidth (ft)	-	-	-	-	30	-	-	60	-	-	-	-	-	-	-	-	33	-	-	76	-	-	33.3	49.6	44.6	70.1	13.08	5	33.3	49.6	44.6	70.1	13.08	5	33.3	49.6	44.6	70.1	13.08	5
Radius of Curvature (ft)	-	-	-	-	9	-	-	21	-	-	-	-	-	-	-	-	17	-	-	27	-	-	21.4	23.0	22.6	25.6	1.63	5	21.4	23.0	22.6	25.6	1.63	5	21.4	23.0	22.6	25.6	1.63	5
Rc:Bankfull width (ft/ft)	-	-	-	-	1.2	-	-	2.7	-	-	-	-	-	-	-	-	1.8	-	-	2.8	-	-	2.23	2.40	2.35	2.67	0.17	5	2.23	2.40	2.35	2.67	0.17	5	2.23	2.40	2.35	2.67	0.17	5
Meander Wavelength (ft)	-	-	-	-	92	-	-	138	-	-	45	-	-	75	-	-	67	-	-	114	-	-	69.60	74.40	72.00	81.60	5.18	3	69.60	74.40	72.00	81.60	5.18	3	69.60	74.40	72.00	81.60	5.18	3
Meander Width Ratio	-	-	-	-	12	-	-	18	-	-	1.2	-	-	1.2	-	-	7.0	-	-	12.0	-	-	7.3	7.8	7.5	8.5	0.5	3	7.3	7.8	7.5	8.5	0.5	3	7.3	7.8	7.5	8.5	0.5	3
Profile																																								
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16.1	20.2	19.9	24.9	4.1	4	9.9	18.5	18.1	30.5	6.3	7	9.9	19.2	21.3	30.8	7.2	8
Riffle Slope (ft/ft)	-	-	-	-	0.018	-	-	0.039	-	-	0.013	-	-	0.054	-	-	0.0165	-	-	0.022	-	-	0.0185	0.0304	0.0267	0.0497	0.0122	4	0.0098	0.0207	0.0200	0.0387	0.0107	7	0.0097	0.0317	0.0302	0.0642	0.0162	8
Pool Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26.1	33.8	35.1	41.7	6.6	5	8.6	26.9	32.2	40.6	10.9	9	10.8	25.4	21.8	56.3	13.4	11
Pool Spacing (ft)	-	-	-	-	15	-	-	50	-	-	39.9	-	-	62.3	-	-	38	-	-	67	-	-	23.4	46.0	51.6	60.1	13.3	7	21.9	41.7	40.9	60.7	14.6	9	19.2	36.2	36.8	56.1	12.7	12
Pool Max Depth (ft)	-	-	-	-	2	-	-	2.4	-	-	1.8	-	-	1.8	-	-	1.9	-	-	3.3	-	-	-	1.4	-	-	-	1	-	2.5	-	-	-	1	-	2.6	-	-	-	1
Pool Volume (ft^3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																																								
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-			4.0 / 12 / 18 / 49 / 85				-	-	-	-	-	-	-	-	-	-	-	-			17.5 / 32.6 / 38.8 / 58.6 / 75.6							14.4/ 34.6 / 43.6 / 69.0 / 113.8							8.3/ 14.3 / 32.9 / 66.2 / 103.6				
Reach Shear Stress (competency) lb/ft^2	-	-	-	-	0.1	-	-	1.0	-	-	0.2	-	-	0.6	-	-	-	0.5 - 0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m^2	-	-	-	-	-	32	-	-	-	-	6.5	-	-	28.5	-	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																																								
Drainage Area (SM)	-		0.28			-	-	0.28	-	-	-	0.12	-	-	-	-	0.28	-	-	0.28	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-
Impervious cover estimate (%)	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	-	-	-	-	E, Gc, Bc	-	-	-	-	-	E/Bc	-	-	-	-	-	E (high W/D)	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-
BF Velocity (fps)	-	-	-	-	3.4	-	-	4.6	-	-	2.1	-	3.4	-	-	-	-	3.7	-	-	-	-	-	3.81	-	-	-	-	-	3.48	-	-	-	-	-	3.48	-	-	-	-
BF Discharge (cfs)	-	38.0	36.0	-	31	-	-	41	-	-	-	18	-	-	-	-	-	33.5	-	-	-	-	-	33.9	-	-	-	-	-	24.4	-	-	-	-	-	24.4	-	-	-	-
Valley Length	-	-	-	-	-	371	-	-	-	-	-	-	-	-	-	-	-	367.0	-	-	-	-	-	367.0	-	-	-	-	-	367.0	-	-	-	-	-	367.0	-	-	-	-
Channel length (ft^2)	-	-	-	-	-	524	-	-	-	-	-	134.5	-	-	-	-	-	373	-	-	-	-	-	495	-	-	-	-	-	495	-	-	-	-	-	495	-	-	-	-
Sinuosity	-	-	-	-	-	1.41	-	-	-	-	-	1.05	-	-	-	-	-	1.35	-	-	-	-	-	1.36	-	-	-	-	-	1.36	-	-	-	-	-	1.36	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	0.0160	-	-	-	-	-	0.0189	-	-	-	-	-	0.0150	-	-	-	-		0.0162	-		-	-		0.0162	-		-	-		0.0162	-		-	-
BF slope (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.011	-	-	-	-		0.0161	-		-	-		0.0161	-		-	-		0.0161	-		-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-	-	5.2	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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2. Harman, W.A., D.E Wise, M.A. Walker, R. Morris, MA Cantrell, M. Clemmons, G.D. Jennings, D.R. Clinton, J.M. Patterson. 2000. Bankfull Regional Curves for North Carolina Mountain Streams. In: AWRA Conference Proceedings, D.L. Kane, editor. American Water Resources Specialty Conference on Water Resources in Extreme Environments. Anchorage, Alaska.

Table 10. Monitoring Year 2 Stream Summary
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

UT2

Parameter	USGS Gauge	Regional Curve Interval [1,2]			Pre-Existing Condition[1]						Reference Reach Data – Morgan Creek						Design						As-built						MY1						MY2					
Dimension and Substrate - Riffle		NC Mtn./NC Pied. Rural			Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	6.0	3.1	-	3.1	-	-	3.4	-	2	6.3	-	-	7.9	-	-	-	6.0	-	-	-	-	-	6.6	-	-	-	1	-	5.8	-	-	-	1	-	4.7	-	-	-	1
Floodprone Width (ft)	-	-	-	-	5.1	-	-	6.4	-	2	15	-	-	19	-	-	60		-	120.0	-	-	-	>100	-	-	-	1	-	>100	-	-	-	1	-	>100	-	-	-	1
BF Mean Depth (ft)	-	0.4	0.6	-	0.84	-	-	0.90	-	2	0.7	-	-	0.9	-	-	-	0.5	-	-	-	-	-	0.4	-	-	-	1	-	0.4	-	-	-	1	-	0.3	-	-	-	1
BF Max Depth (ft)	-	-	-	-	1.1	-	-	1.4	-	2	1.0	-	-	1.35	-	-	-	0.6	-	-	-	-	-	0.9	-	-	-	1	-	0.8	-	-	-	1	-	0.6	-	-	-	1
BF Cross-sectional Area (ft²)	-	2.6	2.6	-	2.8	-	-	2.9	-	2	5.5	-	-	6.5	-	-	-	3.0	-	-	-	-	-	2.7	-	-	-	1	-	2.2	-	-	-	1	-	1.5	-	-	-	1
Width/Depth Ratio	-	-	-	-	3.5	-	-	4.0	-	2	7.3	-	-	11.7	-	-	-	12.0	-	-	-	-	-	16.0	-	-	-	1	-	15.7	-	-	-	1	-	14.5	-	-	-	1
Entrenchment Ratio	-	-	-	-	1.6	-	-	1.9	-	2	1.9	-	-	3.0	-	-	10	-	-	20	-	-	-	7.0	-	-	-	1	-	7.1	-	-	-	1	-	8.7	-	-	-	1
Bank Height Ratio	-	-	-	-	2.2	-	-	2.4	-	2	-	-	-	-	-	-	-	1.1	-	-	-	-	-	1.2	-	-	-	1	-	1.0	-	-	-	1	-	1.2	-	-	-	1
d50 (mm)	-	-	-	-	-	18.00	-	-	-	-	-	3.0	-	-	-	-	-	-	-	-	-	-	-	29.3	-	-	-	-	-	9.5	-	-	-	-	-	13.6	-	-	-	1
Pattern																																								
Channel Beltwidth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	30	-	-	30.4	32.6	32.2	35.3	2.02	3	30.4	32.6	32.2	35.3	2.02	3	30.4	32.6	32.2	35.3	2.02	3
Radius of Curvature (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	18	-	-	14.3	15.5	14.4	17.7	1.58	3	14.3	15.5	14.4	17.7	1.58	3	14.3	15.5	14.4	17.7	1.58	3
Rc:Bankfull width (ft/ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0	-	-	3.0	-	-	2.17	2.34	2.18	2.68	0.24	3	2.17	2.34	2.18	2.68	0.24	3	2.17	2.34	2.18	2.68	0.24	3
Meander Wavelength (ft)	-	-	-	-	-	-	-	-	-	-	45	-	-	75	-	-	42	-	-	72	-	-	52.1	54.9	54.9	57.6	2.8	2	52.1	54.9	54.9	57.6	2.8	2	52.1	54.9	54.9	57.6	2.8	2
Meander Width Ratio	-	-	-	-	-	-	-	-	-	-	1.2	-	-	1.2	-	-	7.0	-	-	12.0	-	-	7.9	8.3	8.3	8.7	0.4	2	7.9	8.3	8.3	8.7	0.4	2	7.9	8.3	8.3	8.7	0.4	2
Profile																																								
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.6	20.8	14.3	47.8	13.5	5	8.7	14.5	15.1	17.6	2.6	9	8.5	21.0	13.2	57.3	16.3	8
Riffle Slope (ft/ft)	-	-	-	-	0.014	-	-	0.057	-	-	0.013	-	-	0.054	-	-	0.014	-	-	0.033	-	-	0.0000	0.0131	0.0147	0.0214	0.0081	5	0.0000	0.0130	0.0129	0.0230	0.0072	9	0.0000	0.0132	0.0152	0.0235	0.0068	8
Pool Length (ft)	-	-	-	-	5.2	-	-	12.7	-	-	-	-	-	-	-	-	17.41	-	-	26.03	-	-	7.5	17.3	15.6	28.8	8.0	8	2.9	11.9	9.5	25.7	8.1	9	4.5	11.0	11.0	20.5	5.5	8
Pool Spacing (ft)	-	-	-	-	9.5	-	-	51	-	-	39.9	-	-	62.3	-	-	9	-	-	30	-	-	14.8	28.8	25.2	47.9	11.5	8	14.8	32.9	22.8	73.4	18.9	7	11.7	25.6	26.0	50.7	10.9	9
Pool Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	1.8	-	-	-	-	-	1.4	-	-	-	-	-	1.7	-	-	-	1	-	0.8	-	-	-	1	-	0.8	-	-	-	1
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																																								
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-	5.6 / 13 / 18 / 43 / 60						-	-	-	-	-	-	-	-	-	-	-	-	0.2 / 16.4 / 29.3 / 85.0 / 139.4						0.8 / 6.9 / 9.5 / 20.5 / 44.6						0.3 / 9.5 / 13.6 / 29.2 / 56.0					
Reach Shear Stress (competency) lb/f²	-	-	-	-	-	-	-	-	-	-	0.2	-	-	0.6	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m²	-	-	-	-	45	-	-	51	-	-	6.5	-	-	28.5	-	-	-	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																																								
Drainage Area (SM)	-		0.05		-	0.05	-	-	-	-	-	0.12	-	-	-	-	0.05	-	-	0.05	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-	2.73	-	-	3.35	-	-
Impervious cover estimate (%)	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	-	-	-	-	G/B[3]	-	-	-	-	-	E/Bc	-	-	-	-	-	Cb, C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-	-	C	-	-	-	-
BF Velocity (fps)	-	-	-	-	3.2	-	-	3.9	-	-	2.1	-	3.4	-	-	-	-	3.50	-	-	-	-	-	2.98	-	-	-	-	-	2.92	-	-	-	-	-	2.92	-	-	-	-
BF Discharge (cfs)	-	-	9.5	-	9	-	-	11	-	-	-	18	-	-	-	-	-	10.0	-	-	-	-	-	8.0	-	-	-	-	-	6.4	-	-	-	-	-	6.4	-	-	-	-
Valley Length	-	-	-	-	-	194	-	-	-	-	-	-	-	-	-	-	-	248.0	-	-	-	-	-	248.0	-	-	-	-	-	248.0	-	-	-	-	-	248.0	-	-	-	-
Channel length (ft)[3]	-	-	-	-	-	209	-	-	-	-	-	134.5	-	-	-	-	-	333	-	-	-	-	-	310	-	-	-	-	-	310	-	-	-	-	-	310	-	-	-	-
Sinuosity	-	-	-	-	-	1.08	-	-	-	-	-	1.05	-	-	-	-	-	1.34	-	-	-	-	-	1.2	-	-	-	-	-	1.2	-	-	-	-	-	1.2	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	0.01	-	-	0.17	-	-	-	0.0197	-	-	-	-	0.0070	0.02		0.0310	-	-	0.0101	0.0198	-	0.0295	-	-	-	0.0241	-	-	-	-	-	0.0241	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	0.024	-	-	-	-	-	-	-	-	-	-		0.02			-	-	0.0077	0.0175	-	0.0272	-	-	-	0.0203	-	-	-	-	-	0.0203	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.2	-	-	-	-	-	-	-	-	-	-	-	5.2	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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2. Harman, W.A., D.E Wise, M.A. Walker, R. Morris, MA Cantrell, M. Clemmons, G.D. Jennings, D.R. Clinton, J.M. Patterson. 2000. Bankfull Regional Curves for North Carolina Mountain Streams. In: AWRA Conference Proceedings, D.L. Kane, editor. American Water Resources Specialty Conference on Water Resources in Extreme Environments. Anchorage, Alaska.

UT3

Parameter	USGS Gauge	Regional Curve Interval [1,2]			Pre-Existing Condition[1]						Reference Reach Data – Morgan Creek						Design						As-built						MY1						MY2					
Dimension and Substrate - Riffle		NC Mtn./NC Pied. Rural			Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n	Min	Mean	Med	Max	SD	n
BF Width (ft)	-	9.8	5.5	-	3.7	-	-	5.3	-	2	0.1	-	-	0.1	-	-	-	8.0	-	-	-	-	8.1	8.8	8.2	10.1	0.91	3	7.0	7.9	7.8	8.8	0.76	3	7.2	8.1	7.8	9.2	0.85	3
Floodprone Width (ft)	-	-	-	-	7.7	-	-	48.0	-	-	15.0	-	-	19.0	-	-	-	-	-	-	-	-		>150						>150						>150				3
BF Mean Depth (ft)	-	0.6	0.8	-	1.05	-	-	1.57	-	-	0.70	-	-	0.90	-	-	-	0.8	-	-	-	-	0.7	0.8	0.8	0.9	0.10	3	0.6	0.7	0.7	0.7	0.05	3	0.5	0.7	0.7	0.7	0.11	3
BF Max Depth (ft)	-	-	-	-	1.7	-	-	2.0	-	-	1.0	-	-	1.4	-	-	1.0	-	-	1.1	-	-	1.1	1.2	1.1	1.4	0.13	3	0.9	1.0	1.1	1.1	0.06	3	1.1	1.1	1.1	1.1	0.03	3
BF Cross-sectional Area (ft²)	-	6.4	6.3	-	5.56	-	-	5.93	-	-	5.5	-	-	6.5	-	-	-	6.0	-	-	-	-	6.3	6.7	6.5	7.3	0.43	3	4.8	5.3	5.3	5.8	0.41	3	4.7	5.3	5.3	5.8	0.45	3
Width/Depth Ratio	-	-	-	-	2.4	-	-	5	-	-	7.3	-	-	11.7	-	-	-	8.9	-	-	-	-	9.1	11.6	10.3	15.5	2.75	3	10.2	11.8	10.6	14.5	1.97	3	9.7	12.8	10.6	18.05	3.75	3
Entrenchment Ratio	-	-	-	-	2.1	-	-	9.1	-	-	1.9	-	-	3	-	-	-	-	-	-	-	-	5.4	7.8	8.5	9.4	1.71	3	6.1	7.7	7.0	9.9	1.62	3	5.9	7.5	7.0	9.6	1.5513435	3
Bank Height Ratio	-	-	-	-	1.0	-	-	2.4	-	-	-	-	-	-	-	-	1.0	-	-	1.0	-	-	1.1	1.1	1.1	1.2	0.08	3	1.1	1.2	1.2	1.3	0.08	3	1.0	1.1	1.1	1.3	0.1	3
d50 (mm)	-	-	-	-	-	16.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31.2	-	-	-	-	-	20.4	-	-	-	-	-	16.4	-	-	-	-
Pattern																																								
Channel Beltwidth (ft)	-	-	-	-	44	-	-	94	-	-	-	-	-	-	-	-	25	-	-	56	-	-	36.4	47.0	48.4	57.7	7.21	7	36.4	47.0	48.4	57.7	7.21	7	36.4	47.0	48.4	57.7	7.21	7
Radius of Curvature (ft)	-	-	-	-	11	-	-	30	-	-	-	-	-	-	-	-	13	-	-	21	-	-	14.0	18.8	19.4	25.1	3.72	7	14.0	18.8	19.4	25.1	3.72	7	14.0	18.8	19.4	25.1	3.72	7
Rc:Bankfull width (ft/ft)	-	-	-	-	2.5	-	-	6.7	-	-	-	-	-	-	-	-	1.8	-	-	3	-	-	1.6	2.1	2.2	2.9	0.42	7	1.6	2.1	2.2	2.9	0.42	7	1.6	2.1	2.2	2.9	0.42	7
Meander Wavelength (ft)	-	-	-	-	49	-	-	72	-	-	45	-	-	75	-	-	49	-	-	84	-	-	63.5	74.9	71.7	94.2	10.30	7	63.5	74.9	71.7	94.2	10.30	7	63.5	74.9	71.7	94.2	10.30	7
Meander Width Ratio	-	-	-	-	10.9	-	-	12.8	-	-	6.4	-	-	10.5	-	-	7	-	-	12	-	-	7.2	8.5	8.1	10.7	1.17	7	7.2	8.5	8.1	10.7	1.17	7	7.2	8.5	8.1	10.7	1.17	7
Profile																																								
Riffle Length (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.1	21.1	20.6	28.2	4.50	11	10.8	24.3	21.0	65.2	12.20	15	11.4	27.2	26.7	64.5	11.8	18
Riffle Slope (ft/ft)	-	-	-	-	0.0052	-	-	0.0305	-	-	0.0130	-	-	0.054	-	-	0.0160	-	-	0.022	-	-	0.0	0.0	0.0	0.0	0.01	11	0.0	0.0	0.0	0.0	0.01	15	0.0069	0.0212	0.0170	0.0702	0.0145	18
Pool Length (ft)	-	-	-	-	25	-	-	65	-	-	17.4	-	-	26	-	-	20	-	-	40	-	-	18.4	26.4	25.8	33.5	5.00	11	15.0	25.6	26.1	39.9	7.30	17	13.5	22.8	23.5	34.4	6.2	17
Pool Spacing (ft)	-	-	-	-	40	-	-	140	-	-	39.9	-	-	62.3	-	-	18	-	-	42	-	-	36.3	49.0	47.7	60.7	7.30	15	32.7	52.2	48.6	95.3	13.60	17	22.6	50.0	48.5	94.5	15.0	17
Pool Max Depth (ft)	-	-	-	-	1.8	-	-	1.8	-	-	1.8	-	-	1.8	-	-	1.6	-	-	2.8	-	-	1.7	2.0	2.0	2.2	0.21	2	1.6	1.7	1.7	1.9	0.15	2.0	1.2	1.4	1.4	1.7	0.3	2
Pool Volume (ft³)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Substrate and Transport Parameters																																								
Ri% / Ru% / P% / G% / S%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SC% / Sa% / G% / B% / Be%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
d16 / d35 / d50 / d84 / d95	-	-	-	-	1.0 / 8.4 / 17 / 43 / 57						- / 1.2 / 3.0 / 77 / 800						-						12.2 / 17.6 / 31.2 / 57.0 / 78.3						0.3 / 12.2 / 20.4 / 60.5 / 86.7						0.4 / 11.5 / 16.4 / 61.1 / 84.2					
Reach Shear Stress (competency) lb/f²	-	-	-	-	0.55	-	-	0.8	-	-	-	-	-	-	-	-	-	0.6	-	-	-	-	0.2	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Max part size (mm) mobilized at bankfull (Rosgen Curve)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stream Power (transport capacity) W/m²	-	-	-	-	25	-	-	45	-	-	6.5	-	-	28.5	-	-	-	37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Additional Reach Parameters																																								
Drainage Area (SM)	-		0.17		0.14	-	-	0.17	-	-	-	0.1	-	-	-	-	0.14	-	-	0.17	-	-	0.14	-	-	0.17	-	-	0.14	-	-	0.17	-	-	0.14	-	-	0.17	-	-
Impervious cover estimate (%)	-	-	-	-	-	<5%	-	-	-	-	-	-	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-	-	<5%	-	-	-	-
Rosgen Classification	-	-	-	-	-	E	-	-	-	-	-	E/Bc	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-	-	E	-	-	-	-
BF Velocity (fps)	-	-	-	-	3.9	-	-	4.9	-	-	2.1	-	3.4	-	-	-	-	3.3	-	-	-	-	-	3.43	-	-	-	-	-	3.17	-	-	-	-	-	3.17	-	-	-	-
BF Discharge (cfs)	-	26.0	24.0	-	20	-	-	25	-	-	-	15	-	-	-	-	-	21.7	-	-	-	-	-	23	-	-	-	-	-	16.8	-	-	-	-	-	16.8	-	-	-	-
Valley Length	-	-	-	-	-	1002	-	-	-	-	-	-	-	-	-	-	-	1015	-	-	-	-	-	1015	-	-	-	-	-	1015	-	-	-	-	-	1015	-	-	-	-
Channel length (ft)[3]	-	-	-	-	-	1210	-	-	-	-	-	135	-	-	-	-	-	1332	-	-	-	-	-	1348	-	-	-	-	-	1348	-	-	-	-	-	1348	-	-	-	-
Sinuosity	-	-	-	-	-	1.21	-	-	-	-	-	1.05	-	-	-	-	-	1.31	-	-	-	-	-	1.33	-	-	-	-	-	1.33	-	-	-	-	-	1.33	-	-	-	-
Water Surface Slope (Channel) (ft/ft)	-	-	-	-	-	0.0150	-	-	-	-	-	0.0197	-	-	-	-	-	0.0130	-	-	-	-	-	0.0128	-	-	-	-	-	0.0128	-	-	-	-	-	0.0128	-	-	-	-
BF slope (ft/ft)	-	-	-	-	-	0.012	-	-	-	-	-	-	-	-	-	-	-	0.013	-	-	-	-	-	0.013	-	-	-	-	-	0.013	-	-	-	-	-	0.013	-	-	-	-
Bankfull Floodplain Area (acres)	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BEHI VL% / L% / M% / H% / VH% / E%	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Channel Stability or Habitat Metric	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Biological or Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table 11. Morphology and Hydraulic Monitoring Summary

Upper Silver Creek Restoration Project: DMS Project ID No. 94645

Silver Creek (3,016 LF)																										
	Cross-section X-1, Station 2724.3 (Riffle)							Cross-section X-2, Station 2636.7 (Pool)							Cross-section X-3, Station 1898.2 (Pool)							Cross-section X-4, Station 1793.8 (Riffle)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	29.1	24.6	24.9					35.7	29.5	34.0					43.5	39.5	42.0					23.8	23.5	23.5				
BF Mean Depth (ft)	1.7	1.8	1.8					1.6	1.8	1.5					1.7	1.5	1.2					2.0	1.9	1.8				
Width/Depth Ratio	17.2	13.9	13.8					21.8	16.8	23.3					25.2	27.3	35.2					11.8	12.4	13.5				
BF Cross-sectional Area (ft²)	49.2	43.4	45.0					58.3	51.9	49.6					74.9	57.3	50.2					48.0	44.2	41.1				
BF Max Depth (ft)	3.0	2.9	3.2					4.0	3.9	4.3					5.2	4.0	4.0					3.3	3.2	3.1				
Width of Floodprone Area (ft)	>300	>300	>300					>300	>300	>300					>300	>300	>300					>300	>300	>300				
Entrenchment Ratio	3.3	3.9	3.8					2.5	3.0	2.6					2.1	2.3	2.2					3.7	3.7	3.7				
Bank Height Ratio	1.1	1.0	1.1					1.0	1.0	1.0					0.7	0.7	0.9					1.0	1.0	1.0				
Wetted Perimeter (ft)	32.4	28.1	28.5					38.9	33.0	36.9					46.9	42.4	44.4					27.8	27.3	27.0				
Hydraulic Radius (ft)	1.5	1.5	1.6					1.5	1.6	1.3					1.6	1.4	1.1					1.7	1.6	1.5				
Fixed baseline bankfull elevation	1197.4	1197.4	1197.4					1198.2	1198.2	1198.2					1202.3	1202.3	1202.3					1203.0	1203.0	1203.0				
Based on current/developing bankfull feature																												
BF Width (ft)	29.1	26.2	26.2					35.7	29.5	35.3					43.5	42.6	42.0					23.8	23.5	23.5				
BF Mean Depth (ft)	1.7	1.7	1.8					1.6	1.8	1.5					1.7	1.5	1.2					2.0	1.9	1.8				
Width/Depth Ratio	17.2	15.2	14.4					21.8	16.8	23.5					25.2	29.3	35.2					11.8	12.4	13.5				
BF Cross-sectional Area (ft²)	49.2	45.1	47.6					58.3	51.9	53.1					74.9	61.8	50.2					48.0	44.2	41.1				
BF Max Depth (ft)	3.0	3.0	3.3					4.0	3.9	4.4					5.2	4.2	4.0					3.3	3.2	3.1				
Width of Floodprone Area (ft)	>300	>300	>300					>300	>300	>300					>300	>300	>300					>300	87.3	>300				
Entrenchment Ratio	3.3	3.7	>3.7					2.5	3.0	>2.5					2.1	2.1	2.2					3.7	3.7	3.7				
Bank Height Ratio	1.1	1.0	1					1.0	1.0	1.0					0.7	0.7	0.9					1.0	1.0	1.0				
Wetted Perimeter (ft)	32.4	29.7	29.8					38.9	33.0	38.3					46.9	45.5	44.4					27.8	27.3	27.0				
Hydraulic Radius (ft)	1.5	1.5	1.6					1.5	1.6	1.4					1.6	1.4	1.1					1.7	1.6	1.5				
Cross Sectional Area between end pins (ft²)	-	-						-	-						-	-						-	-					
d50 (mm)	-	-						-	-						-	-						36.6	41.3	25.1				

* Corrected from baseline report.

	Cross-section X-5, Station 1206.9 (Riffle)							Cross-section X-6, Station 357.2 (Pool)							Cross-section 7, Station 302.5 (Riffle)													
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																												
BF Width (ft)	28.4	26.1	25.2					43.5	41.9	34.6					26.6	25.9	25.8											
BF Mean Depth (ft)	1.7	1.7	1.7					1.8	1.8	1.7					2.1	2.0	1.8											
Width/Depth Ratio	17.3	15.7	15.0					23.6	23.9	20.5					13.0	13.3	14.0											
BF Cross-sectional Area (ft²)	46.9	43.4	42.3					80.1	73.5	58.3					54.5	50.6	47.6											
BF Max Depth (ft)	2.9	2.8	2.8					5.3	5.0	3.8					3.3	3.2	3.0											
Width of Floodprone Area (ft)	>300	>300	>300					>300	>300	>300					>300	>300	>300											
Entrenchment Ratio	3.1	3.3	3.5					1.6	1.6	2.0					4.8	4.9	4.9											
Bank Height Ratio	1.0	1.0	1.0					1.0	0.9	1.0					1.0	1.0	1.0											
Wetted Perimeter (ft)	31.7	29.4	28.6					47.2	45.4	38.0					30.7	29.8	29.5											
Hydraulic Radius (ft)	1.5	1.5	1.5					1.7	1.7	1.5					1.8	1.7	1.6											
Fixed baseline bankfull elevation	1208.8	1208.8	1208.8					1208.1	1208.1	1208.1					1208.2	1208.2	1208.2											
Based on current/developing bankfull feature																												
BF Width (ft)	28.4	26.1	25.8					43.5	41.9	34.6					26.6	25.9	26.8											
BF Mean Depth (ft)	1.7	1.7	1.7					1.8	1.8	1.7					2.1	2.0	1.8											
Width/Depth Ratio	17.3	15.7	15.3					23.6	23.9	20.5					13.0	13.3	14.1											
BF Cross-sectional Area (ft²)	46.9	43.4	43.3					80.1	73.5	58.3					54.5	50.6	51.0											
BF Max Depth (ft)	2.9	2.8	2.8					5.3	5.0	3.8					3.3	3.2	3.1											
Width of Floodprone Area (ft)	>300	>300	>300					>300	>300	>300					>300	>300	>300											
Entrenchment Ratio	3.1	3.3	>3.4					1.6	1.6	2.0					4.8	4.9	>4.7											
Bank Height Ratio	1.0	1.0	1.0					1.0	0.9	1.0					1.0	1.0	1.0											
Wetted Perimeter (ft)	31.7	29.4	29.1					47.2	45.4	38.0					30.7	29.8	30.5											
Hydraulic Radius (ft)*	1.5	1.5	1.5					1.7	1.7	1.5					1.8	1.7	1.7											
Cross Sectional Area between end pins (ft²)	-	-						-	-						-	-												
d50 (mm)	-	-						-	-						33.4	15.2	16.0											

Table 11. Morphology and Hydraulic Monitoring Summary

Upper Silver Creek Restoration Project: DMS Project ID No. 94645

UT1 (495 LF)																											
	Cross-section X-13, Station 1+57 (Riffle)							Cross-section X-14, Station 3+28 (Pool)																			
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																											
BF Width (ft)	9.6	9.3	9.2					9.3	8.6	6.6																	
BF Mean Depth (ft)	0.9	0.8	0.8					2.0	1.3	1.4																	
Width/Depth Ratio	10.3	12.3	12.2					4.7	6.8	4.8																	
BF Cross-sectional Area (ft²)	8.9	7.0	7.0					18.5	10.9	9.0																	
BF Max Depth (ft)	1.3	1.1	1.1					3.7	2.5	2.6																	
Width of Floodprone Area (ft)	>150	>150	>150					>150	>150	>150																	
Entrenchment Ratio	5.3	5.4	5.5					8.7	9.4	12.3																	
Bank Height Ratio	1.0	1.1	1.1					1.1	1.2	1.2																	
Wetted Perimeter (ft)	11.5	10.8	10.7					13.3	11.1	9.3																	
Hydraulic Radius (ft)	0.8	0.6	0.7					1.4	1.0	1.0																	
Fixed baseline bankfull elevation	1204.0	1204.0	1204.0					1201.6	1201.6	1201.6																	
Based on current/developing bankfull feature																											
BF Width (ft)	9.6	9.8	10.0					9.3	11.0	8.3																	
BF Mean Depth (ft)	0.9	0.8	0.82					2.0	1.4	1.6																	
Width/Depth Ratio	10.3	12.0	12.1					4.7	8.0	5.3																	
BF Cross-sectional Area (ft²)	8.9	7.9	8.2					18.5	15.0	13.1																	
BF Max Depth (ft)	1.3	1.2	1.2					3.7	2.9	3.2																	
Width of Floodprone Area (ft)	>150	>150	>150					>150	>150	>150																	
Entrenchment Ratio	5.3	5.2	5.1					8.7	7.4	9.7																	
Bank Height Ratio	1.0	1.0	1.0					1.1	1.0	1.0																	
Wetted Perimeter (ft)	11.5	11.4	11.6					13.3	13.7	11.5																	
Hydraulic Radius (ft)	0.8	0.7	0.7					1.4	1.1	1.1																	
Cross Sectional Area between end pins (ft²)	-	-						-	-																		
d50 (mm)	38.8	43.6	32.9					-	-																		

UT2 (310 LF)																											
	Cross-section X-15, Station 2+15 (Pool)							Cross-section X-16, Station 2+53 (Riffle)																			
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																											
BF Width (ft)	7.3	6.4	5.6					6.6	5.8	4.7																	
BF Mean Depth (ft)	0.8	0.5	0.5					0.4	0.4	0.3																	
Width/Depth Ratio	8.9	13.9	12.3					16.0	15.7	14.5																	
BF Cross-sectional Area (ft²)	6.1	3.0	2.5					2.7	2.2	1.5																	
BF Max Depth (ft)	1.7	0.8	0.7					0.9	0.8	0.6																	
Width of Floodprone Area (ft)	>100	>100	>100					>100	>100	>100																	
Entrenchment Ratio	9.2	10.5	12.1					7.0	7.1	8.7																	
Bank Height Ratio	1.1	1.2	1.4					1.2	1.0	1.2																	
Wetted Perimeter (ft)	9.0	7.3	6.5					7.4	6.6	5.3																	
Hydraulic Radius (ft)	0.7	0.4	0.4					0.4	0.3	0.3																	
Fixed baseline bankfull elevation	1201.9	1201.9	1201.9					1201.2	1201.2	1201.2																	
Based on current/developing bankfull feature																											
BF Width (ft)	7.3	8.4	6.4					6.6	5.8	5.5																	
BF Mean Depth (ft)	0.8	0.5	0.5					0.4	0.4	0.4																	
Width/Depth Ratio	8.9	13.9	12.3					16.0	15.7	14.5																	
BF Cross-sectional Area (ft²)	6.1	4	3.3					2.7	2.2	2.1																	
BF Max Depth (ft)	1.7	1.0	0.8					0.9	0.8	0.7																	
Width of Floodprone Area (ft)	>100	>100	>100					>100	>100	>100																	
Entrenchment Ratio	9.2	8.1	10.5					7.0	7.1	8.1																	
Bank Height Ratio	1.1	1.1	1.1					1.2	1.0	1.1																	
Wetted Perimeter (ft)	9.0	9.3	7.5					7.4	6.6	6.2																	
Hydraulic Radius (ft)	0.7	0.4	0.4					0.4	0.3	0.3																	
Cross Sectional Area between end pins (ft²)	-	-						-	-						-							-						
d50 (mm)	-	-						29.3	9.5	13.6					-							-						

Table 11. Morphology and Hydraulic Monitoring Summary
Upper Silver Creek Restoration Project: DMS Project ID No. 94645

UT3 (1,348 LF)																											
	Cross-section X-8, Station 6+22 (Riffle)							Cross-section X-9, Station 8+12 (Pool)							Cross-section X-10, Station 8+33 (Riffle)							Cross-section X-11, Station 11+53 (Pool)						
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																											
BF Width (ft)	10.1	8.8	9.2					10.7	9.5	9.4					8.1	7.0	7.2					13.0	11.5	11.4				
BF Mean Depth (ft)	0.65	0.61	0.5					1.0	0.8	0.5					0.8	0.7	0.7					1.0	0.9	0.6				
Width/Depth Ratio	15.5	14.5	18.1					10.5	11.6	20.4					10.3	10.2	9.7					12.8	13.7	18.7				
BF Cross-sectional Area (ft²)	6.5	5.3	4.7					10.9	7.8	4.3					6.3	4.8	5.3					13.2	9.7	6.9				
BF Max Depth (ft)	1.1	1.1	1.1					1.7	1.6	1.2					1.1	0.9	1.1					2.2	1.9	1.7				
Width of Floodprone Area (ft)	>150	>150	>150					>150	>150	>150					>150	>150	>150					>150	>150	>150				
Entrenchment Ratio	5.4	6.1	5.9					5.8	6.6	6.7					8.5	9.9	9.6					5.6	6.3	6.4				
Bank Height Ratio	1.0	1.1	1.0					1.0	1.2	1.2					1.1	1.2	1.1					1.0	1.1	1.1				
Wetted Perimeter (ft)	11.4	10.0	10.2					12.8	11.1	10.3					9.6	8.3	8.7					15.1	13.2	12.6				
Hydraulic Radius (ft)	0.6	0.5	0.5					0.9	0.7	0.4					0.7	0.6	0.6					0.9	0.7	0.5				
Fixed baseline bankfull elevation	1215.4	1215.4	1215.4					1212.8	1212.8	1212.8					1212.9	1212.9	1212.9					1209.3	1209.3	1209.3				
Based on current/developing bankfull feature																											
BF Width (ft)	10.1	11.7	12.2					10.7	12.1	12.1					8.1	7.5	8.0					13	13.0	12.3				
BF Mean Depth (ft)	0.7	0.5	0.5					1.0	0.9	0.6					0.8	0.8	0.8					1.0	0.9	0.7				
Width/Depth Ratio	15.5	22.0	24.5					10.5	13.8	19.8					10.3	9.8	9.9					12.8	14.2	18.4				
BF Cross-sectional Area (ft²)	6.5	6.2	6.1					10.9	10.6	7.4					6.3	5.7	6.4					13.2	11.9	8.3				
BF Max Depth (ft)	1.1	1.1	1.3					1.7	1.9	1.4					1.1	1.1	1.2					2.2	2.1	1.8				
Width of Floodprone Area (ft)	>150	>150	>150					>150	>150	>150					>150	>150	>150					>150	>150	>150				
Entrenchment Ratio	5.4	4.6	4.4					5.8	5.2	5.2					8.5	9.2	8.6					5.6	5.6	5.9				
Bank Height Ratio	1.0	1	1					1.0	1	1					1.1	1.1	1					1.0	1.0	1				
Wetted Perimeter (ft)	11.4	12.7	13.2					12.7	13.8	13.3					9.7	9.0	9.6					15.0	14.9	13.7				
Hydraulic Radius (ft)	0.6	0.5	0.5					0.9	0.8	0.6					0.7	0.6	0.7					0.9	0.8	0.6				
Cross Sectional Area between end pins (ft²)	-	-						-	-						-	-						-	-					
d50 (mm)	31.2	20.4	16.4					-	-						-	-						-	-					

	Cross-section X-12, Station 11+84 (Riffle)																										
Dimension and substrate	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+
Based on fixed baseline bankfull elevation																											
BF Width (ft)	8.2	7.8	7.7																								
BF Mean Depth (ft)	0.9	0.7	0.7																								
Width/Depth Ratio	9.1	10.6	11.7																								
BF Cross-sectional Area (ft²)	7.3	5.8	5.0																								
BF Max Depth (ft)	1.4	1.1	0.9																								
Width of Floodprone Area (ft)	>150	>150	>150																								
Entrenchment Ratio	9.4	7.0	7.3																								
Bank Height Ratio	1.2	1.3	1.3																								
Wetted Perimeter (ft)	10.0	9.3	9.0																								
Hydraulic Radius (ft)	0.7	0.6	0.6																								
Fixed baseline bankfull elevation	1208.8	1208.8	1208.8																								
Based on current/developing bankfull feature																											
BF Width (ft)	8.2	9.1	9.2																								
BF Mean Depth (ft)	0.9	0.9	0.8																								
Width/Depth Ratio	9.1	10.5	11.1																								
BF Cross-sectional Area (ft²)	7.3	8.0	7.5																								
BF Max Depth (ft)	1.4	1.3	1.2																								
Width of Floodprone Area (ft)	>150	>150	>150																								
Entrenchment Ratio	9.4	8.5	8.5																								
Bank Height Ratio	1.2	1.0	1.0																								
Wetted Perimeter (ft)	10.0	10.9	10.8																								
Hydraulic Radius (ft)	0.7	0.7	0.7																								
Cross Sectional Area between end pins (ft²)	-	-																									
d50 (mm)	-	-																									

Appendix E

Wetland Assessment Data

Includes:

Figure 8. Observed Rainfall verses Historical Average

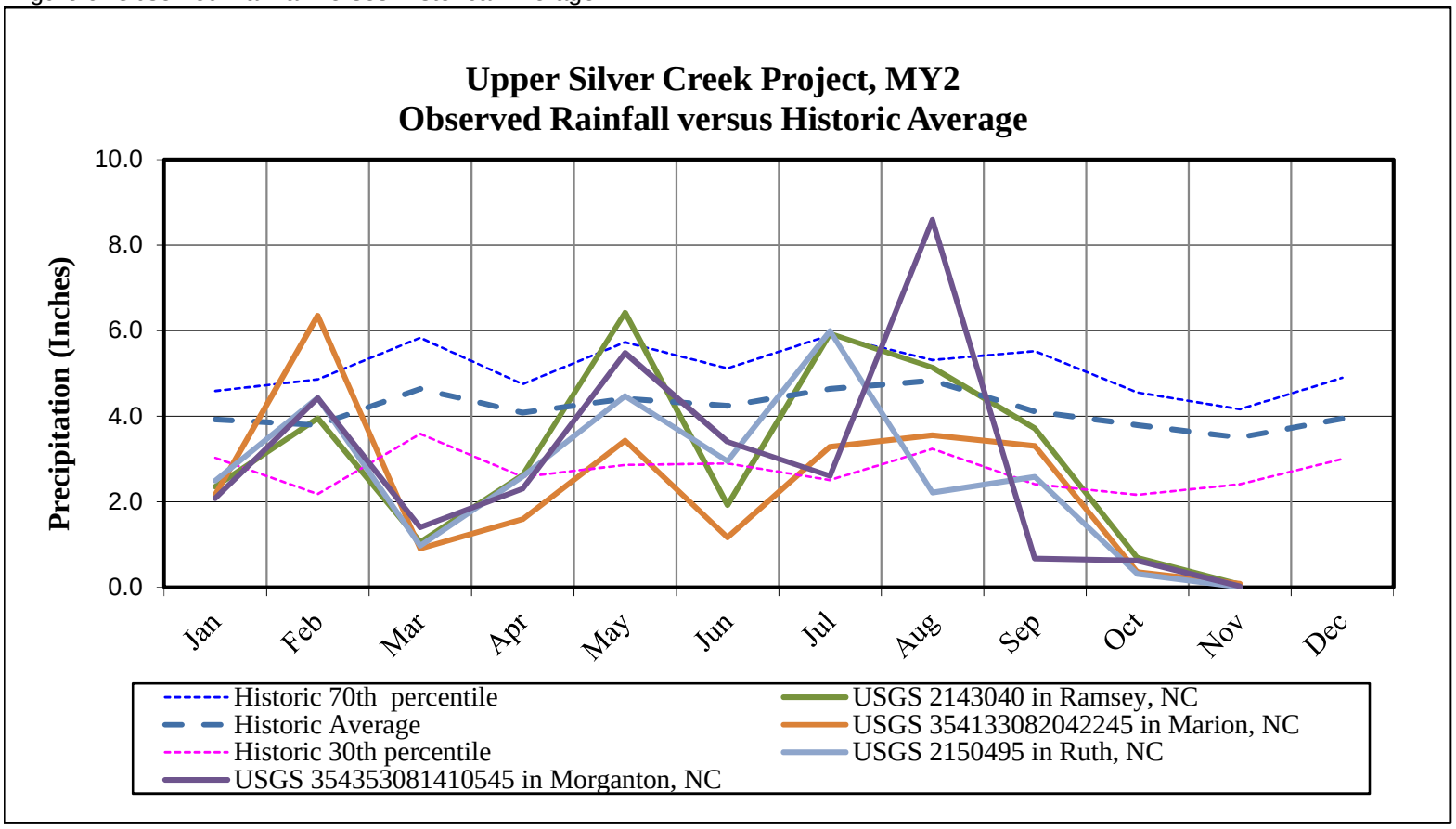
Figure 9. Wetland Gauge Graphs

Table 12. Wetland Gauge Attainment data

Table 12a. Wetland Area Well Success

Figure 10. Wetland Photo Log

Figure 9. Observed Rainfall verses Historical Average



Note: Observed rainfall at four nearby USGS recording stations and historic average in Burke County near the U. Silver Creek project, with 30th and 70th percentiles of monthly averages from 1958 to 2012.

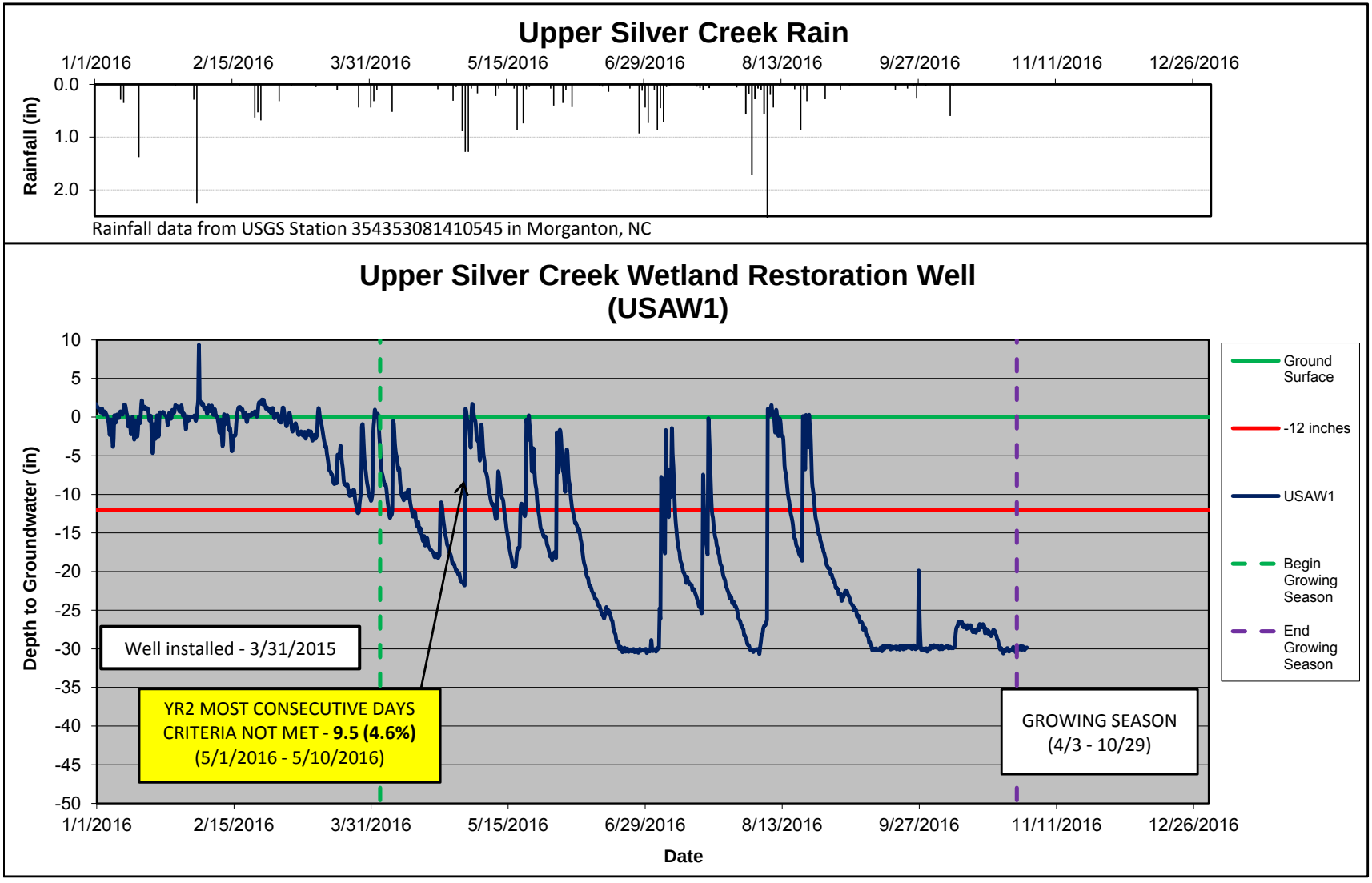
Rainfall data source for Ramsey, NC: http://waterdata.usgs.gov/nwis/uv?site_no=02143040

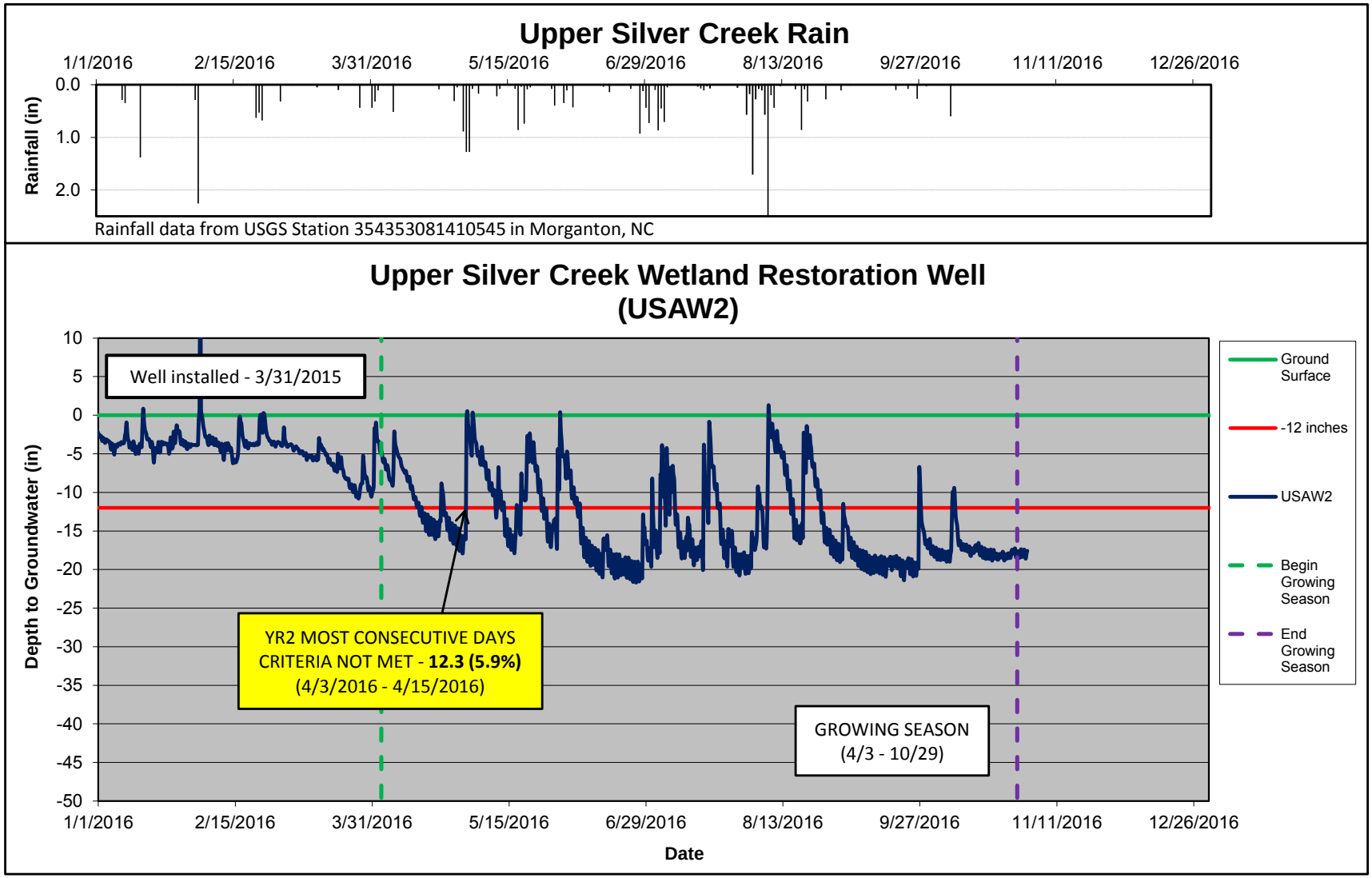
Rainfall data source for Marion, NC: http://waterdata.usgs.gov/nwis/uv?site_no=354133082042245

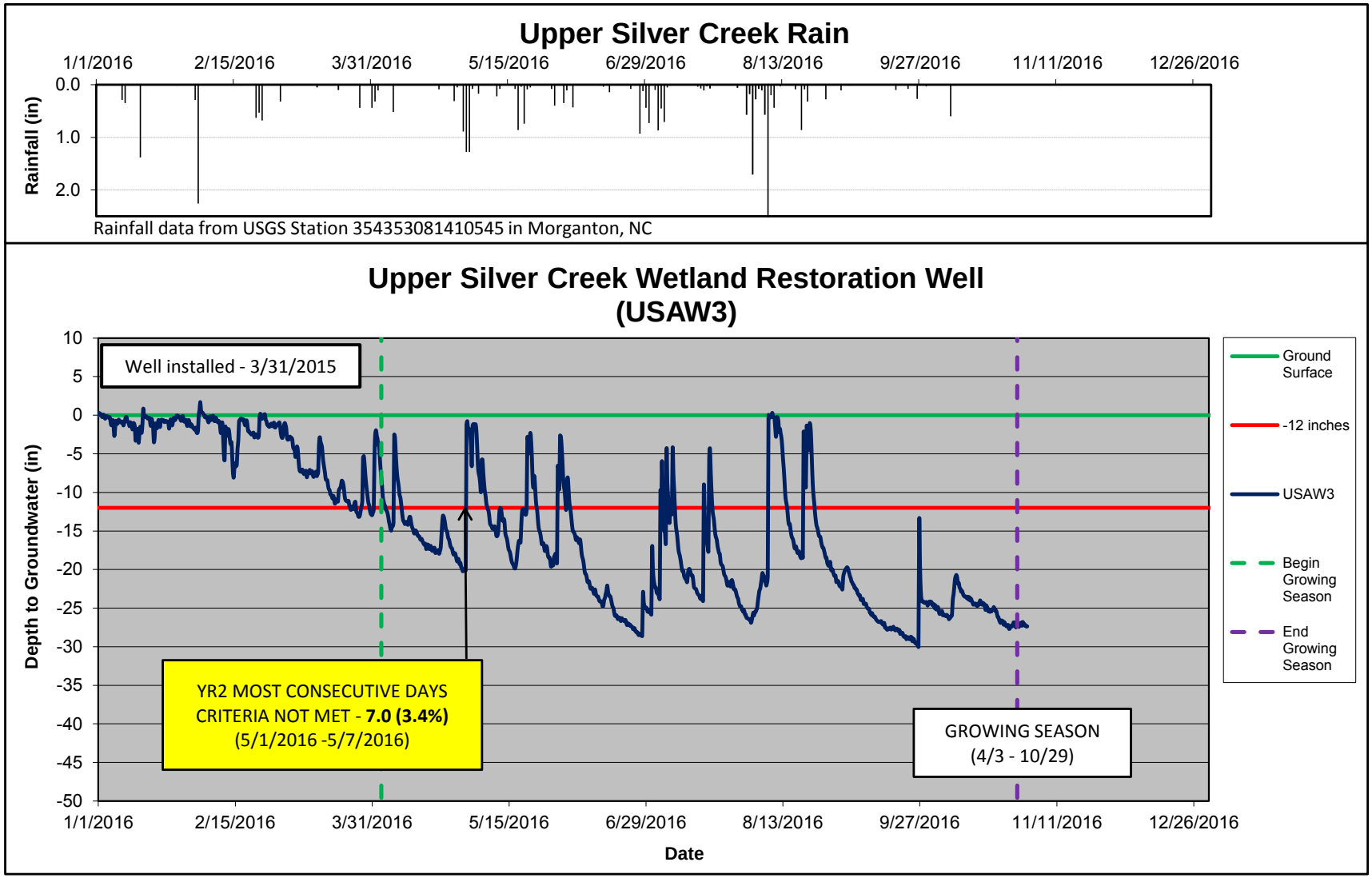
Rainfall data source for Ruth, NC: http://waterdata.usgs.gov/nwis/uv?site_no=02150495

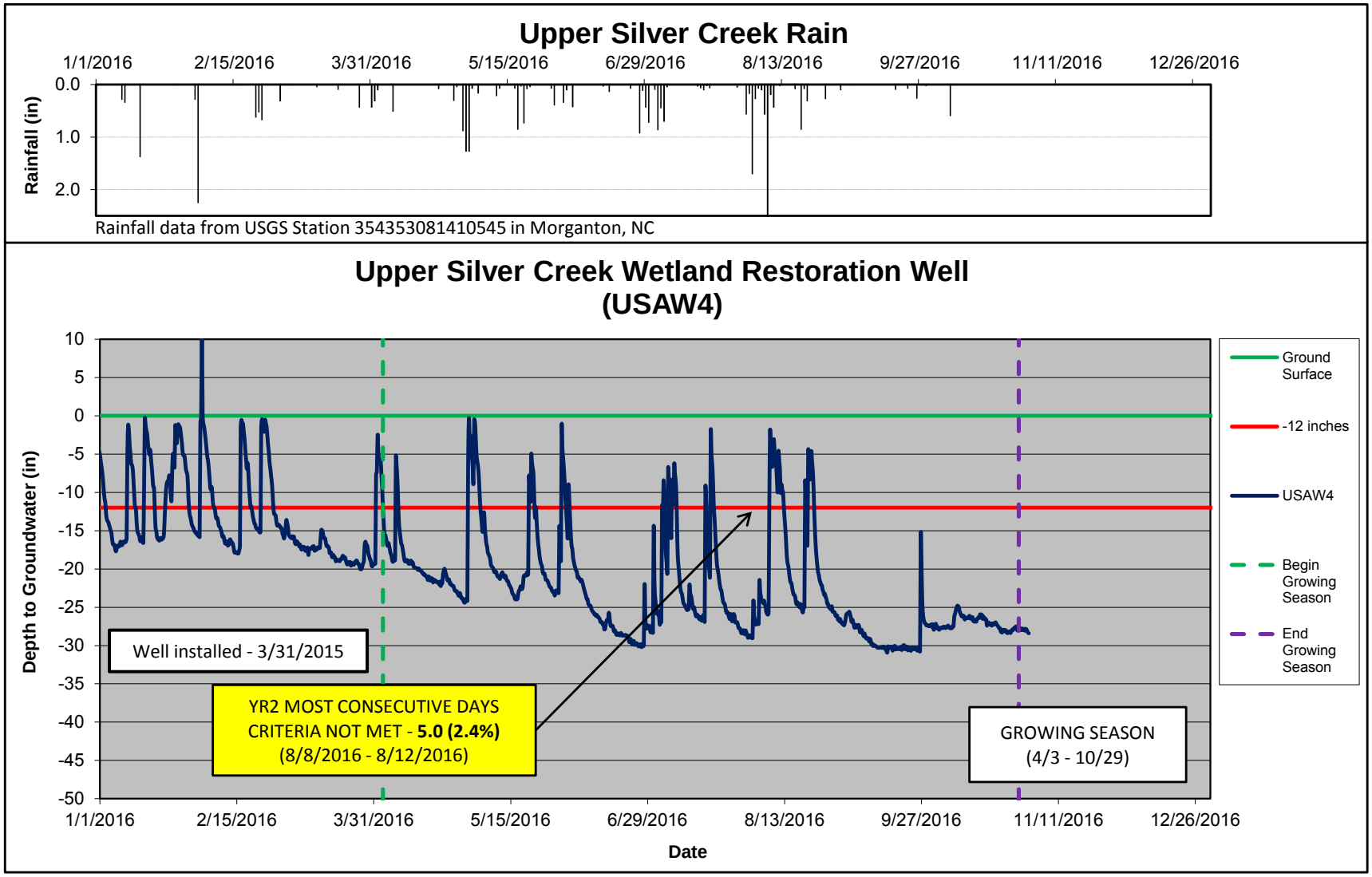
Rainfall data source for Morganton, NC: http://waterdata.usgs.gov/nwis/uv?site_no=354353081410545

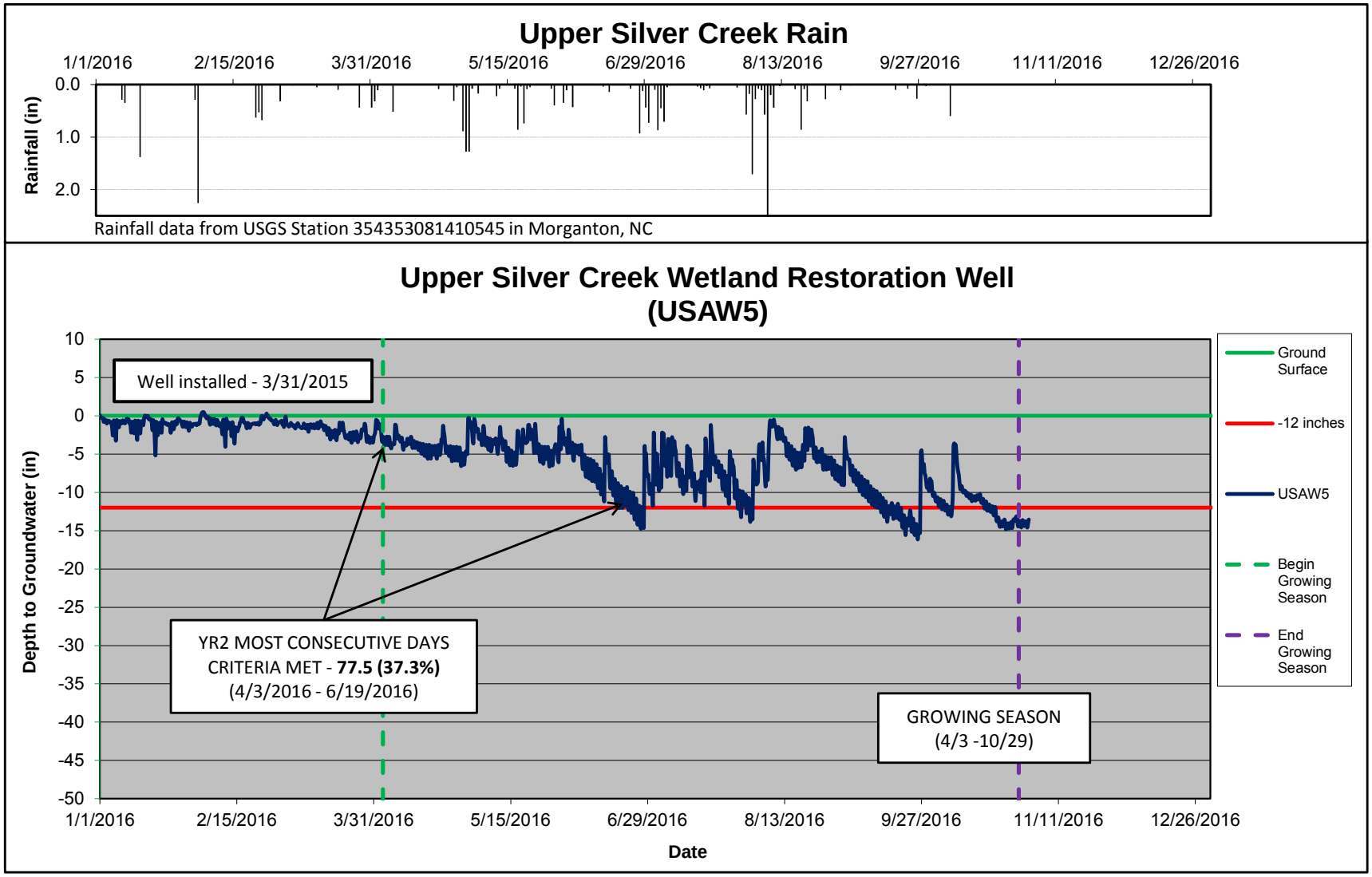
Figure 10. Wetland gauge graphs for each well, showing depth to groundwater and rainfall during MY2.

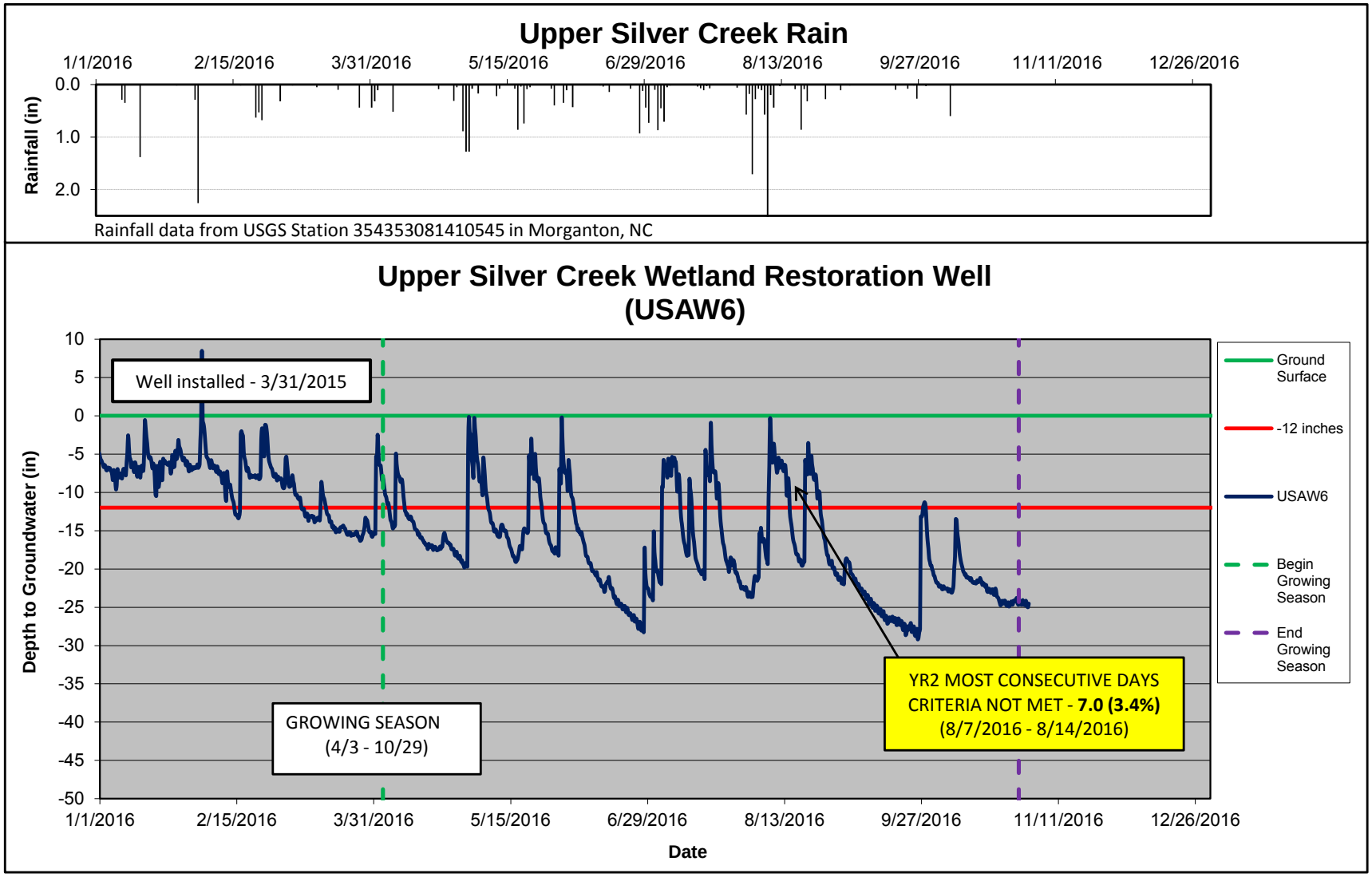


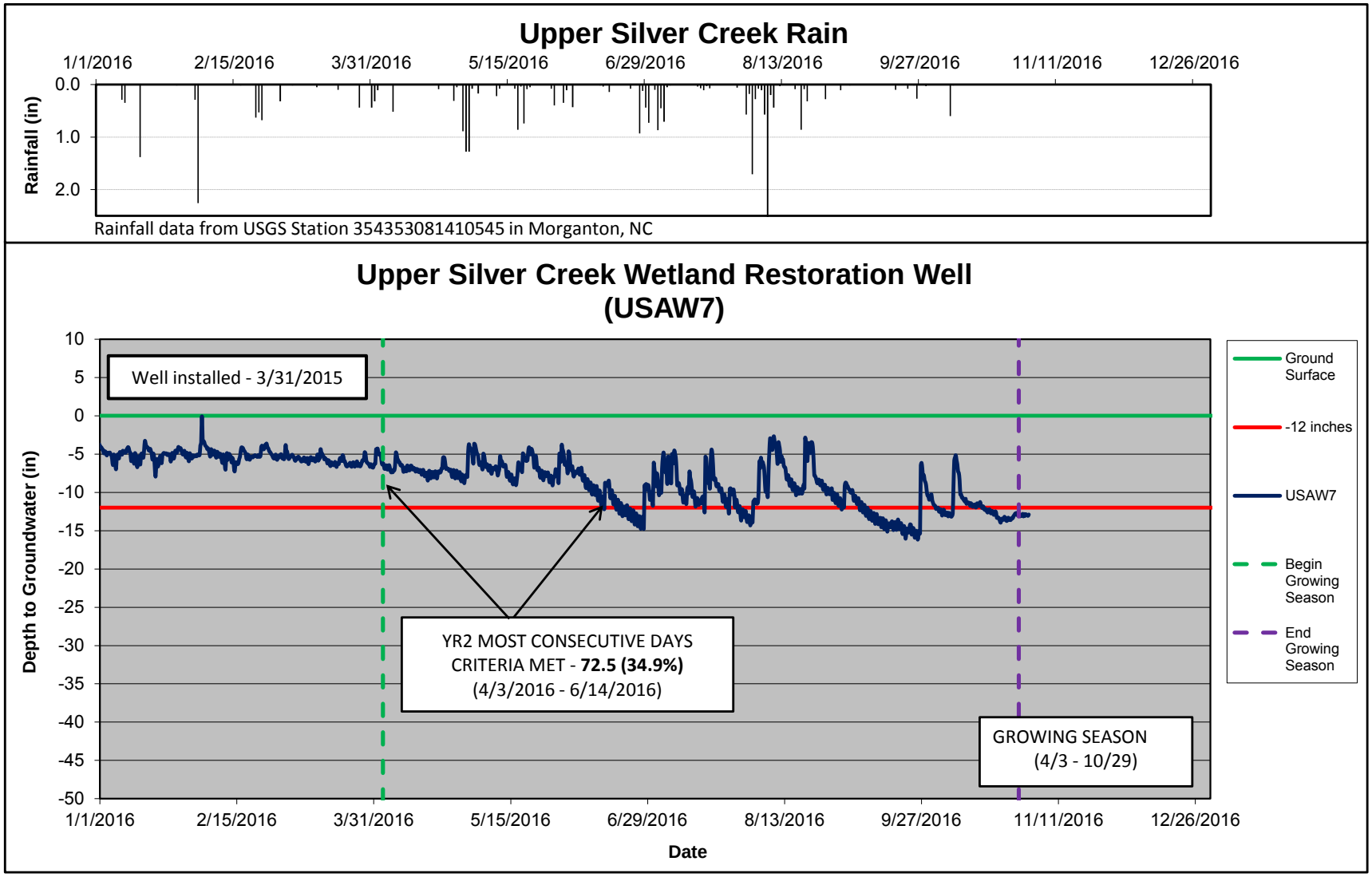

Upper Silver Creek Rain
1/1/2016
2/15/2016
3/31/2016
5/15/2016
6/29/2016
8/13/2016
9/27/2016
11/11/2016
12/26/2016
Rainfall (in)
0.0
1.0
2.0
Rainfall data from USGS Station 354353081410545 in Morganton, NC
Upper Silver Creek Wetland Restoration Well
(USAW2)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well installed - 3/31/2015
YR2 MOST CONSECUTIVE DAYS
CRITERIA NOT MET - 12.3 (5.9%)
(4/3/2016 - 4/15/2016)
GROWING SEASON
(4/3 - 10/29)
Ground Surface
-12 inches
USAW2
Begin Growing Season
End Growing Season
Date

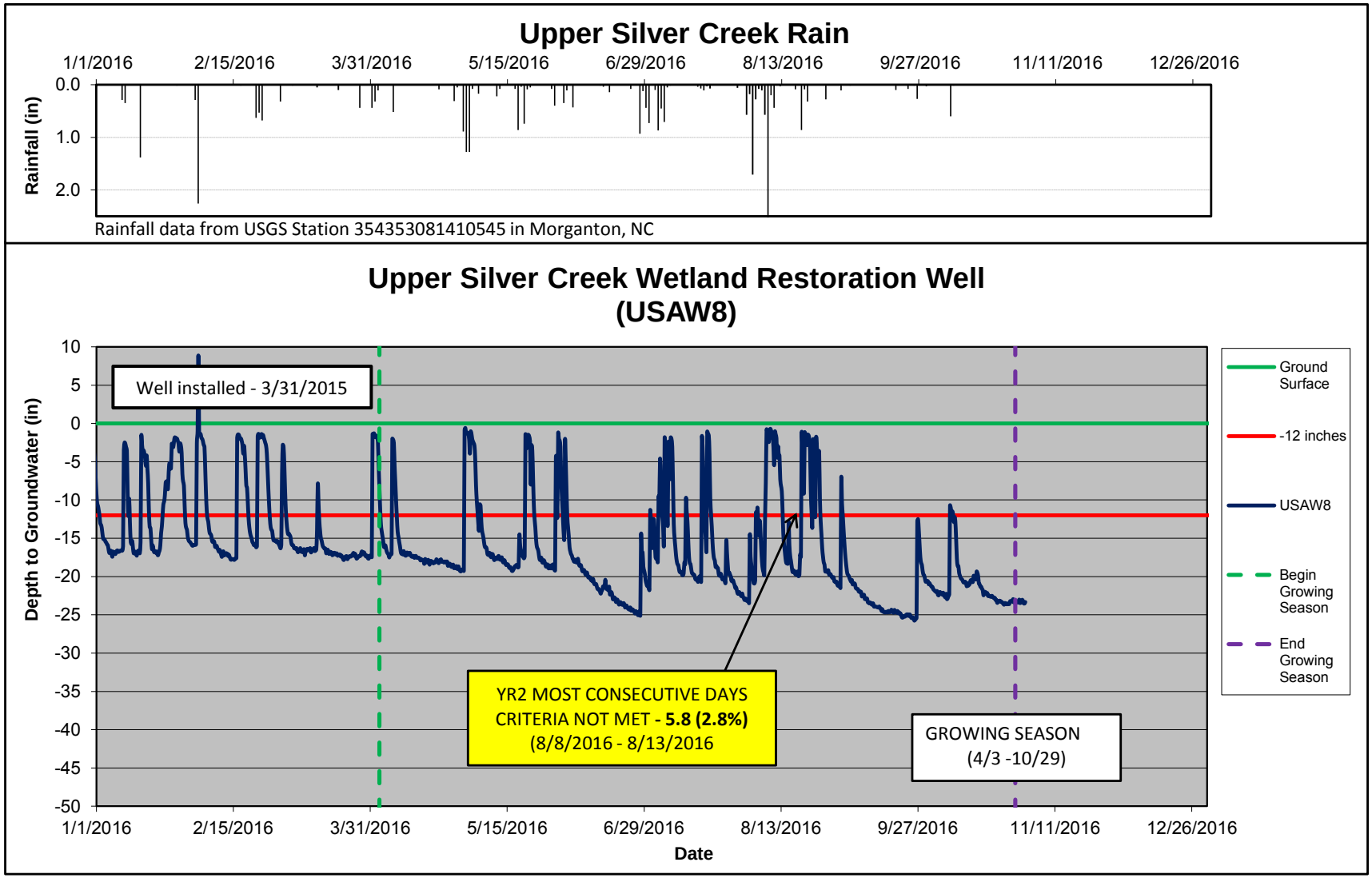

Upper Silver Creek Rain
1/1/2016
2/15/2016
3/31/2016
5/15/2016
6/29/2016
8/13/2016
9/27/2016
11/11/2016
12/26/2016
Rainfall (in)
0.0
1.0
2.0
Rainfall data from USGS Station 354353081410545 in Morganton, NC
Upper Silver Creek Wetland Restoration Well
(USAW3)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well installed - 3/31/2015
YR2 MOST CONSECUTIVE DAYS
CRITERIA NOT MET - 7.0 (3.4%)
(5/1/2016 -5/7/2016)
GROWING SEASON
(4/3 - 10/29)
Ground Surface
-12 inches
USAW3
Begin Growing Season
End Growing Season
Date

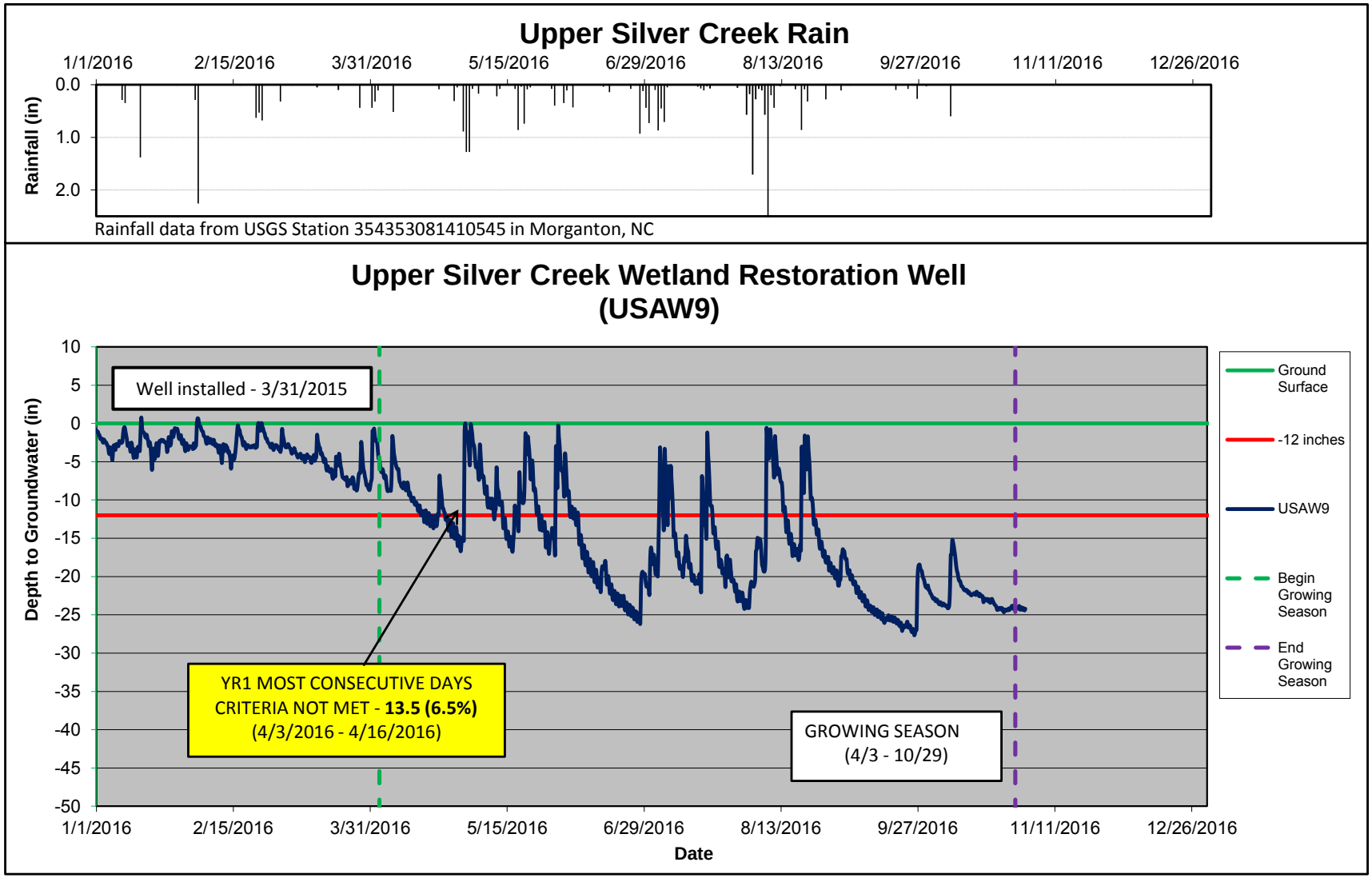

Upper Silver Creek Rain
1/1/2016
2/15/2016
3/31/2016
5/15/2016
6/29/2016
8/13/2016
9/27/2016
11/11/2016
12/26/2016
Rainfall (in)
0.0
1.0
2.0
Rainfall data from USGS Station 354353081410545 in Morganton, NC
Upper Silver Creek Wetland Restoration Well
(USAW4)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well installed - 3/31/2015
YR2 MOST CONSECUTIVE DAYS
CRITERIA NOT MET - 5.0 (2.4%)
(8/8/2016 - 8/12/2016)
GROWING SEASON
(4/3 - 10/29)
Ground Surface
-12 inches
USAW4
Begin Growing Season
End Growing Season
Date

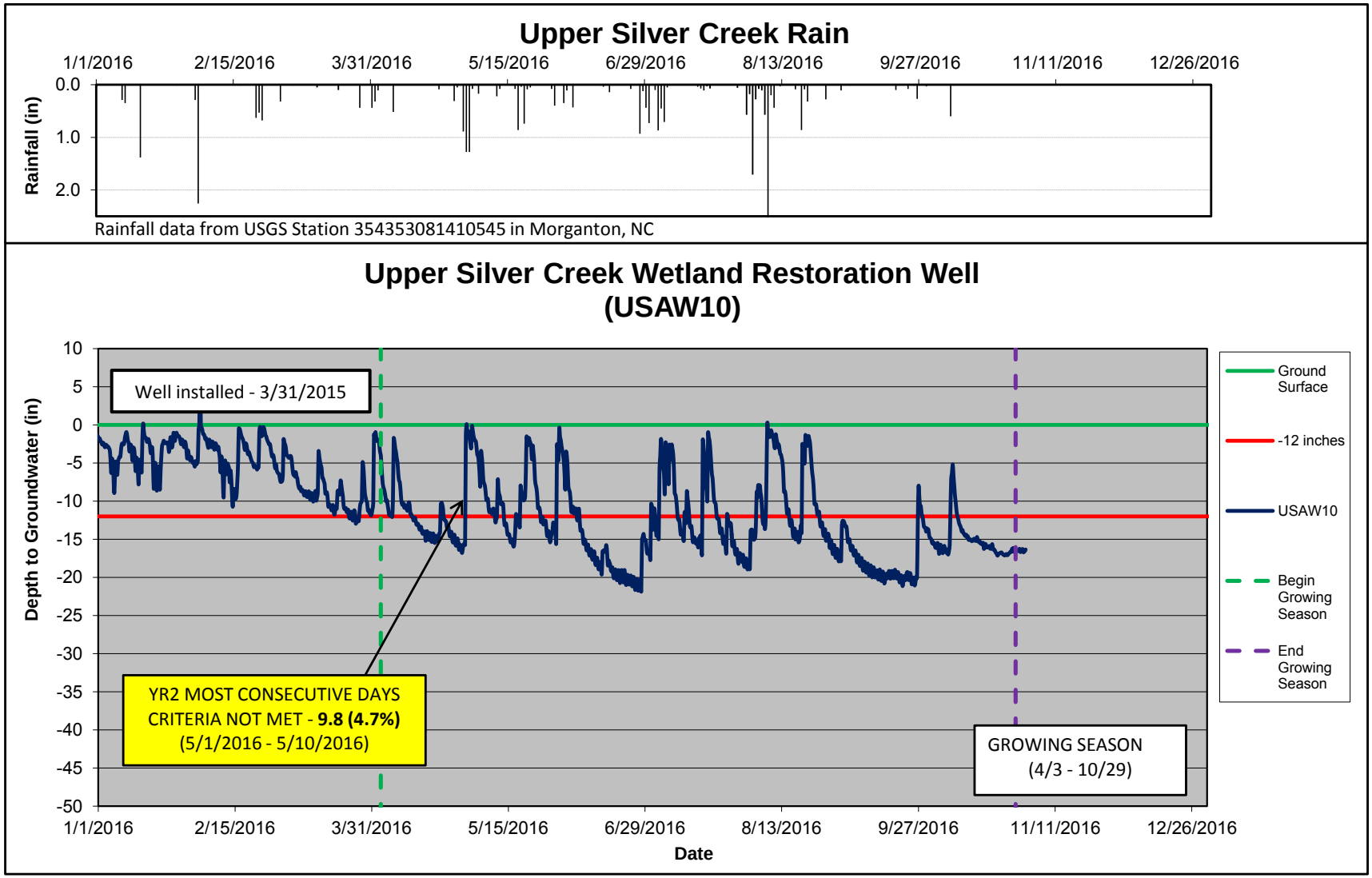

Upper Silver Creek Rain
1/1/2016
2/15/2016
3/31/2016
5/15/2016
6/29/2016
8/13/2016
9/27/2016
11/11/2016
12/26/2016
Rainfall (in)
0.0
1.0
2.0
Rainfall data from USGS Station 354353081410545 in Morganton, NC
Upper Silver Creek Wetland Restoration Well
(USAW5)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well installed - 3/31/2015
YR2 MOST CONSECUTIVE DAYS
CRITERIA MET - 77.5 (37.3%)
(4/3/2016 - 6/19/2016)
GROWING SEASON
(4/3 -10/29)
Ground Surface
-12 inches
USAW5
Begin Growing Season
End Growing Season
Date

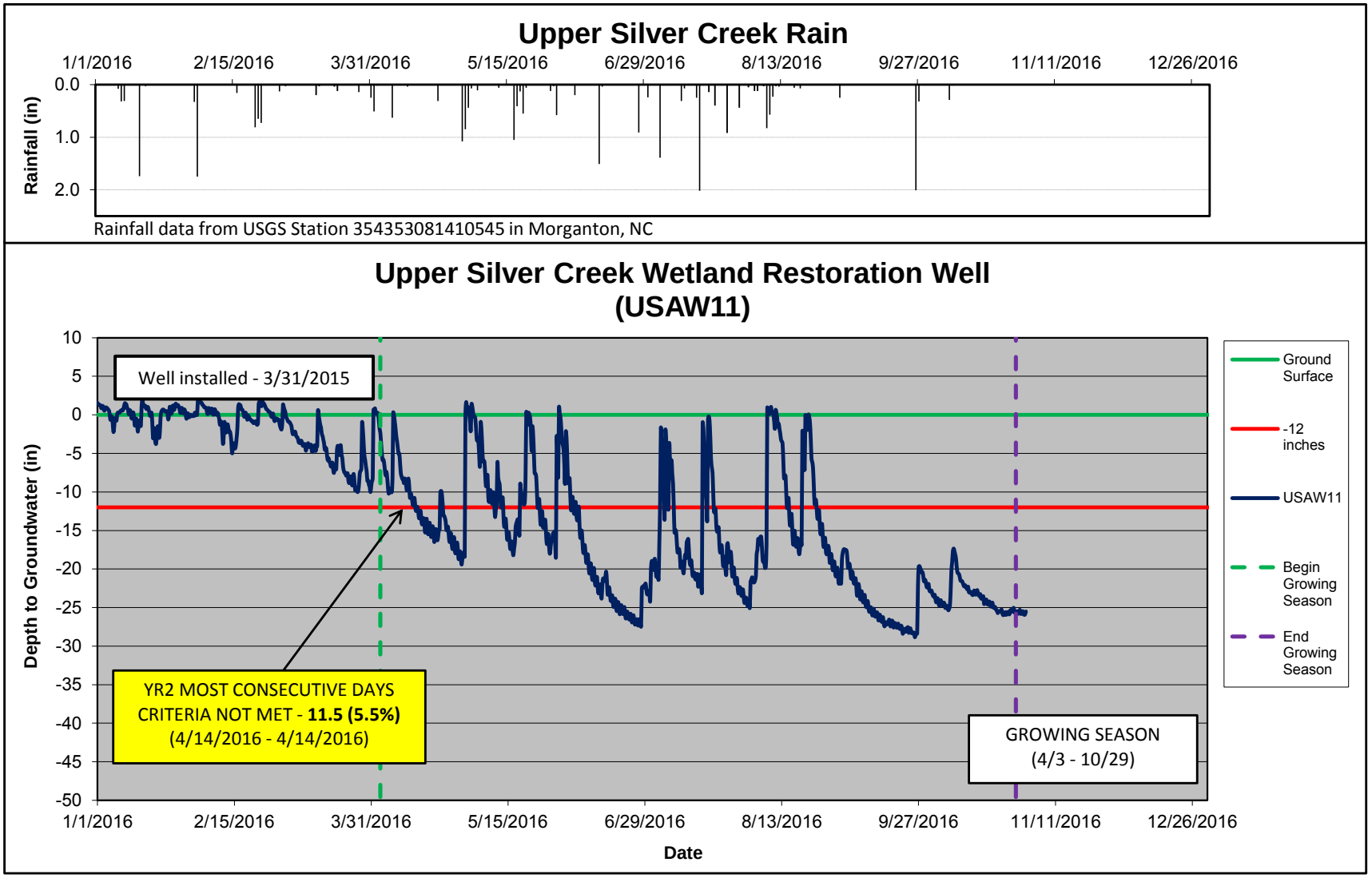

Upper Silver Creek Rain
1/1/2016
2/15/2016
3/31/2016
5/15/2016
6/29/2016
8/13/2016
9/27/2016
11/11/2016
12/26/2016
Rainfall (in)
0.0
1.0
2.0
Rainfall data from USGS Station 354353081410545 in Morganton, NC
Upper Silver Creek Wetland Restoration Well
(USAW6)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well installed - 3/31/2015
GROWING SEASON
(4/3 - 10/29)
YR2 MOST CONSECUTIVE DAYS
CRITERIA NOT MET - 7.0 (3.4%)
(8/7/2016 - 8/14/2016)
Ground Surface
-12 inches
USAW6
Begin Growing Season
End Growing Season
Date

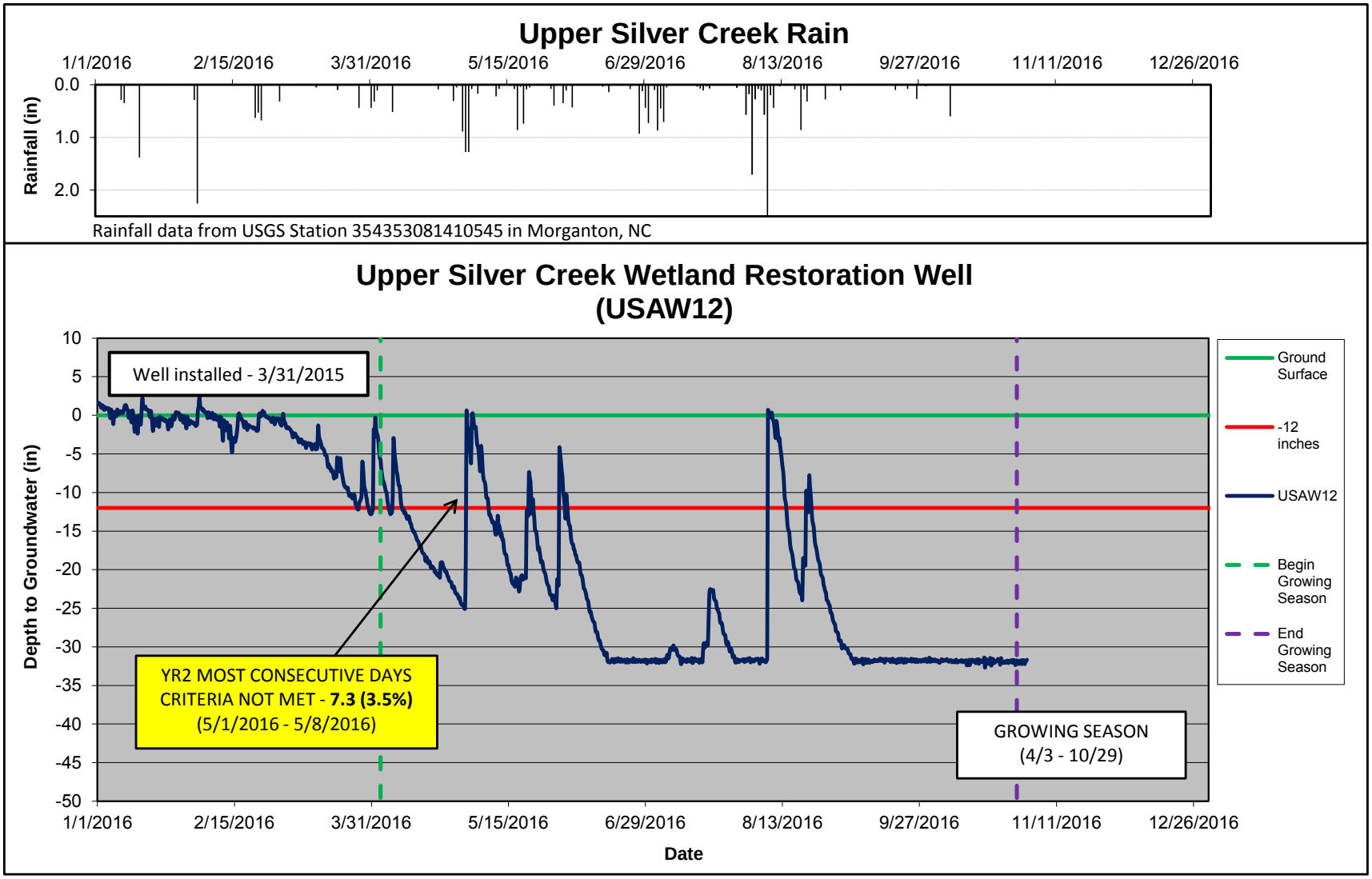

Upper Silver Creek Rain
1/1/2016
2/15/2016
3/31/2016
5/15/2016
6/29/2016
8/13/2016
9/27/2016
11/11/2016
12/26/2016
Rainfall (in)
0.0
1.0
2.0
Rainfall data from USGS Station 354353081410545 in Morganton, NC
Upper Silver Creek Wetland Restoration Well
(USAW7)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well installed - 3/31/2015
YR2 MOST CONSECUTIVE DAYS
CRITERIA MET - 72.5 (34.9%)
(4/3/2016 - 6/14/2016)
GROWING SEASON
(4/3 - 10/29)
Ground Surface
-12 inches
USAW7
Begin Growing Season
End Growing Season
Date


Upper Silver Creek Rain
1/1/2016
2/15/2016
3/31/2016
5/15/2016
6/29/2016
8/13/2016
9/27/2016
11/11/2016
12/26/2016
Rainfall (in)
0.0
1.0
2.0
Rainfall data from USGS Station 354353081410545 in Morganton, NC
Upper Silver Creek Wetland Restoration Well
(USAW8)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well installed - 3/31/2015
YR2 MOST CONSECUTIVE DAYS
CRITERIA NOT MET - 5.8 (2.8%)
(8/8/2016 - 8/13/2016
GROWING SEASON
(4/3 -10/29)
Ground Surface
-12 inches
USAW8
Begin Growing Season
End Growing Season
Date


Upper Silver Creek Rain
1/1/2016
2/15/2016
3/31/2016
5/15/2016
6/29/2016
8/13/2016
9/27/2016
11/11/2016
12/26/2016
Rainfall (in)
0.0
1.0
2.0
Rainfall data from USGS Station 354353081410545 in Morganton, NC
Upper Silver Creek Wetland Restoration Well
(USAW9)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well installed - 3/31/2015
YR1 MOST CONSECUTIVE DAYS
CRITERIA NOT MET - 13.5 (6.5%)
(4/3/2016 - 4/16/2016)
GROWING SEASON
(4/3 - 10/29)
Ground Surface
-12 inches
USAW9
Begin Growing Season
End Growing Season
Date


Upper Silver Creek Rain
1/1/2016
2/15/2016
3/31/2016
5/15/2016
6/29/2016
8/13/2016
9/27/2016
11/11/2016
12/26/2016
Rainfall (in)
0.0
1.0
2.0
Rainfall data from USGS Station 354353081410545 in Morganton, NC
Upper Silver Creek Wetland Restoration Well
(USAW10)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well installed - 3/31/2015
YR2 MOST CONSECUTIVE DAYS
CRITERIA NOT MET - 9.8 (4.7%)
(5/1/2016 - 5/10/2016)
GROWING SEASON
(4/3 - 10/29)
Ground Surface
-12 inches
USAW10
Begin Growing Season
End Growing Season
Date


Upper Silver Creek Rain
1/1/2016
2/15/2016
3/31/2016
5/15/2016
6/29/2016
8/13/2016
9/27/2016
11/11/2016
12/26/2016
Rainfall (in)
0.0
1.0
2.0
Rainfall data from USGS Station 354353081410545 in Morganton, NC
Upper Silver Creek Wetland Restoration Well
(USAW11)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well installed - 3/31/2015
YR2 MOST CONSECUTIVE DAYS
CRITERIA NOT MET - 11.5 (5.5%)
(4/14/2016 - 4/14/2016)
GROWING SEASON
(4/3 - 10/29)
Ground Surface
-12 inches
USAW11
Begin Growing Season
End Growing Season
Date


Upper Silver Creek Rain
1/1/2016
2/15/2016
3/31/2016
5/15/2016
6/29/2016
8/13/2016
9/27/2016
11/11/2016
12/26/2016
Rainfall (in)
0.0
1.0
2.0
Rainfall data from USGS Station 354353081410545 in Morganton, NC
Upper Silver Creek Wetland Restoration Well
(USAW12)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well installed - 3/31/2015
YR2 MOST CONSECUTIVE DAYS
CRITERIA NOT MET - 7.3 (3.5%)
(5/1/2016 - 5/8/2016)
GROWING SEASON
(4/3 - 10/29)
Ground Surface
-12 inches
USAW12
Begin Growing Season
End Growing Season
Date

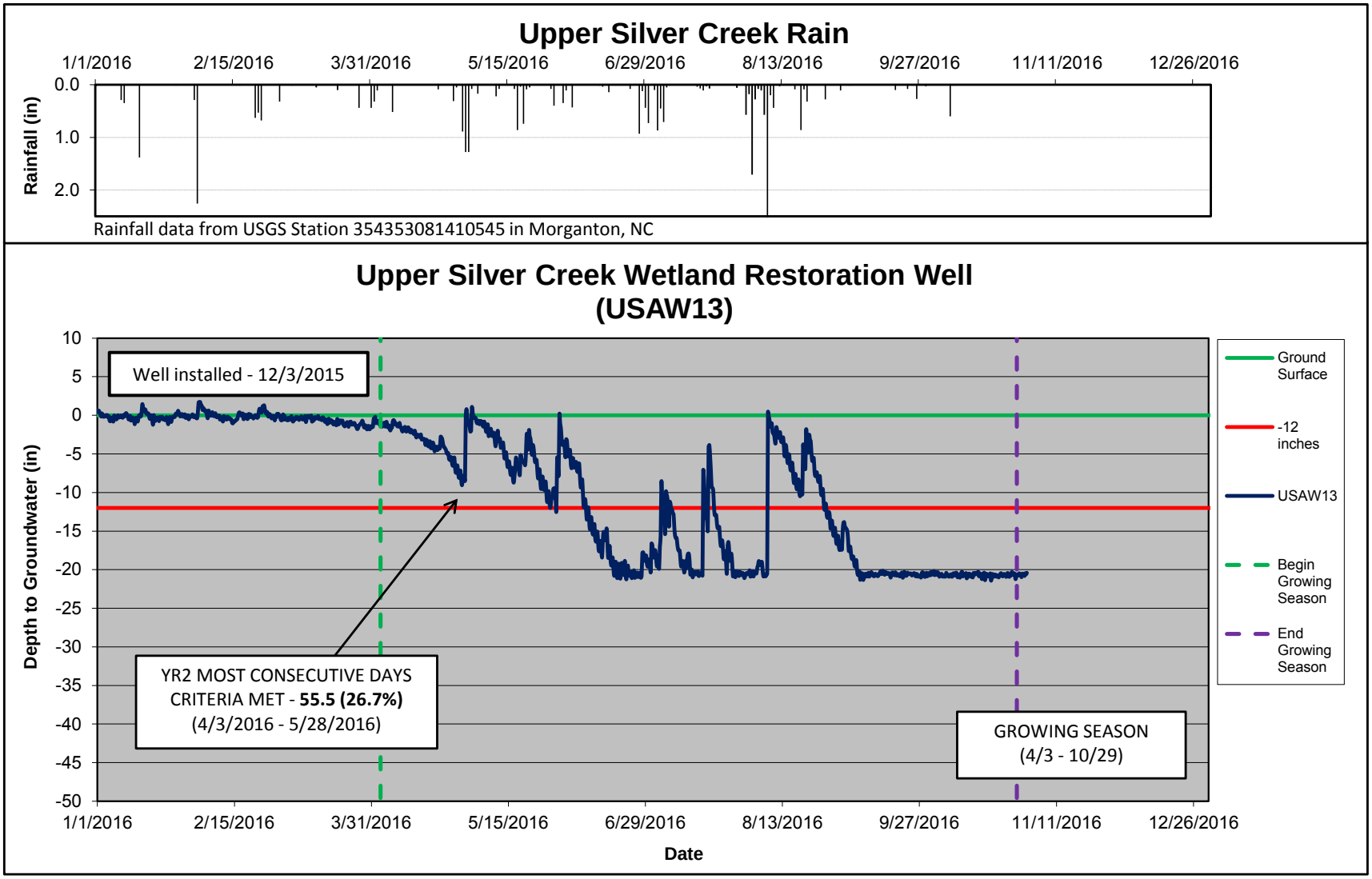

Upper Silver Creek Rain
1/1/2016
2/15/2016
3/31/2016
5/15/2016
6/29/2016
8/13/2016
9/27/2016
11/11/2016
12/26/2016
Rainfall (in)
0.0
1.0
2.0
Rainfall data from USGS Station 354353081410545 in Morganton, NC
Upper Silver Creek Wetland Restoration Well
(USAW13)
Depth to Groundwater (in)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Well installed - 12/3/2015
YR2 MOST CONSECUTIVE DAYS
CRITERIA MET - 55.5 (26.7%)
(4/3/2016 - 5/28/2016)
GROWING SEASON
(4/3 - 10/29)
Ground Surface
-12 inches
USAW13
Begin Growing Season
End Growing Season
Date

Table 12. Wetland gauge attainment data, summary of groundwater gauge results for MY M through 5 at the U. Silver Creek Project Site, DMS Project #94645.

Gauge	Success Criteria Achieved/Max Consecutive Days During Growing Season (Percentage)				
	Monitoring Year 1 (2015)	Monitoring Year 2 (2016)	Monitoring Year 3 (2017)	Monitoring Year 4 (2018)	Monitoring Year 5 (2019)
USAW1	Yes/36.5 days (17.5 %)	No/9.5 days (4.6%)			
USAW2	No/21.8 days (10.5 %)	No/12.3 days (5.9%)			
USAW3	No/20.3 days (9.7 %)	No/7 days (3.4%)			
USAW4	No/5.5 days (2.6 %)	No/5 days (2.4%)			
USAW5	Yes/80.5 days (38.7 %)	Yes/77.5 days (37.3 %)			
USAW6	No/19.5 days (9.4 %)	No/7 days (3.4 %)			
USAW7	Yes/74.5 days (35.8 %)	Yes/72.5 days (34.9 %)			
USAW8	No/2.5 days (1.2 %)	No/5.8 days (2.8 %)			
USAW9	Yes/35.5 days (17.1 %)	No/13.5 days (6.5 %)			
USAW10	No/19.8 days (9.5 %)	No/9.8 days (4.7 %)			
USAW11	No/18.5 days (8.9 %)	No/11.5 days (5.5 %)			
USAW12	No/17.5 days (8.4 %)	No/7.3 days (3.5 %)			
USAW13		Yes/55.5 days (26.7 %)			

Table 12. Wetland Restoration Area Well Success
Upper Silver Creek Restoration Project: Project ID No. 94645

Well ID	*Percentage of Consecutive Days <12 inches from Ground Surface[1]	Most Consecutive Days Meeting Criteria[2]	*Percentage of Cumulative Days <12 inches from Ground Surface[1]	Cumulative Days Meeting Criteria[3]	Number of Instances where Water Table is 12 inches from Ground Surface[4]
Cross-sectional Well Arrays					
USAW1	4.6	9.5	23.1	48.0	15
USAW2	5.9	12.3	32.1	66.8	26
USAW3	3.4	7.0	15.4	32.0	9
USAW4	2.4	5.0	10.7	22.3	9
USAW5	37.3	77.5	86.9	180.8	29
USAW6	3.4	7.0	22.1	46.0	11
USAW7	34.9	72.5	76.6	159.3	17
USAW8	2.8	5.8	16.5	34.3	22
USAW9	6.5	13.5	29.1	60.5	21
USAW10	4.7	9.8	34.0	70.8	22
USAW11	5.5	11.5	27.2	56.5	20
USAW12	3.5	7.3	11.9	24.8	10
USAW13[5]	26.7	55.5	43.5	90.5	11

Notes:

[1]Indicates the percentage of most consecutive number of days within the monitored growing season with a water 12 inches or less from the soil surface.

[2]Indicates the most consecutive number of days within the monitored growing season with a water table 12 inches or less from the soil surface.

[3]Indicates the cumulative number of days within the monitored growing season with a water table 12 inches or less from the soil surface.

[4]Indicates the number of instances within the monitored growing season when the water table rose to 12 inches or less from the soil surface.

[5]USAW13 was installed in December of 2015.

Growing season for Burke County is from April 3 to October 29 and is 208 days long.

Growing season percentage for success is 12% of 208 days = 25 days; where water table is 12 inches or less from the ground surface

HIGHLIGHTED indicates wells that *did not* meet the success criteria for the most consecutive number of days within the monitored growing season with a water 12 inches or less from the soil surface. Following Year 2 of wetland monitoring, ten of thirteen wells did not exhibit a hyrdroperiod of 12% or greater during the growing season. These wells will be observed closely throughout monitoring Year 3.

12 In-Situ groundwater monitoring dataloggers (1-12) were installed on 3/17/2015. Installation of the dataloggers was completed following construction in spring 2015 when groundwater levels are normally closer to the ground surface. USAW13 was installed in December of 2015

Figure 11. U. Silver Creek Wetland Photo Log, MY2 (2016)

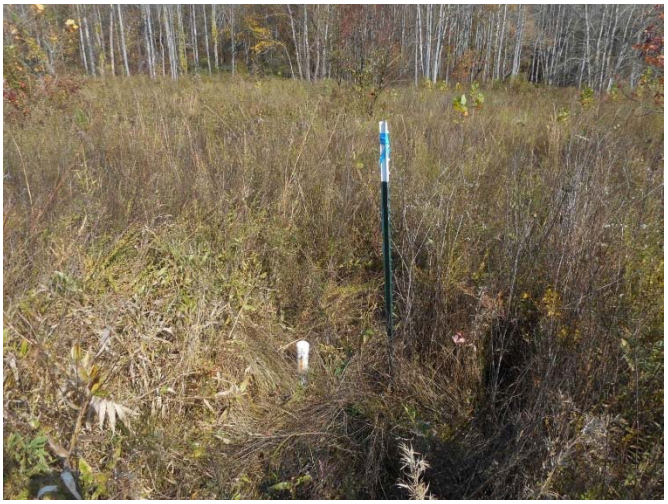


Photo 1. Wetland Photo Point – W1, replicates photo 50 in Baseline Report (November 1, 2016).

Photo 2. Wetland Photo Point – W2, replicates photo 51 in Baseline Report (November 1, 2016).

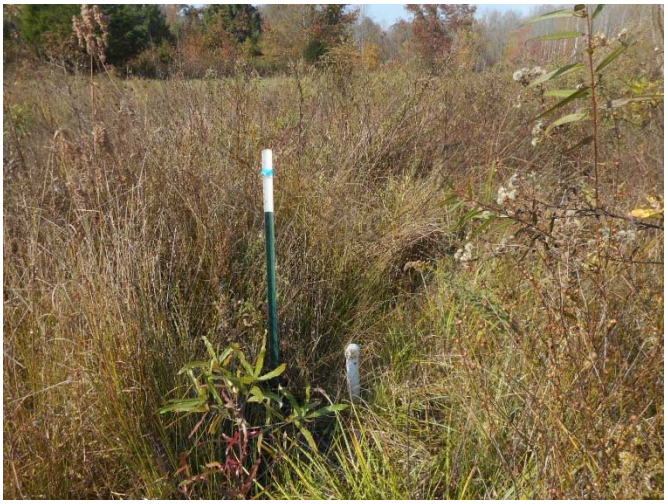


Photo 3. Wetland Photo Point – W3 replicates photo 52 in Baseline Report (November 1, 2016).

Photo 4. Wetland Photo Point – W4, replicates photo 53 in Baseline Report (November 1, 2016).

Photo 5. Wetland Photo Point – W5, replicates photo 54 in Baseline Report (November 1, 2016).

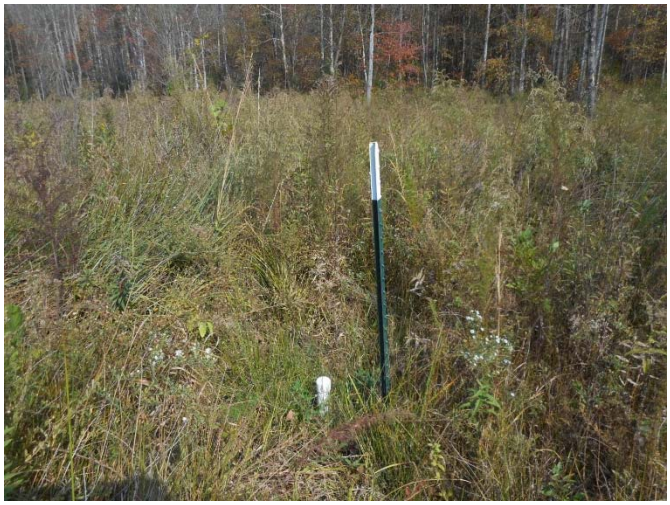


Photo 6. Wetland Photo Point – W6, replicates photo 55 in Baseline Report (November 1, 2016).

Photo 7. Wetland Photo Point – W7, replicates photo 56 in Baseline Report (November 1, 2016).

Photo 8. Wetland Photo Point – W8, replicates photo 57 in Baseline Report (November 1, 2016).

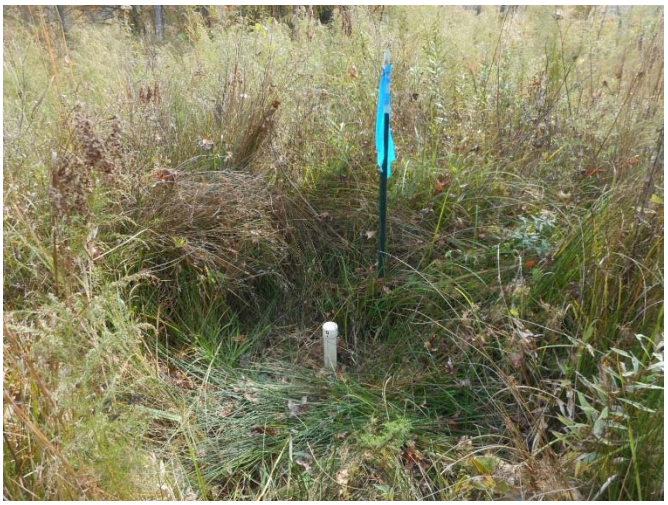


Photo 9. Wetland Photo Point – W9, replicates photo 58 in Baseline Report (November 1, 2016).

Photo 10. Wetland Photo Point – W10, replicates photo 59 in Baseline Report (November 1, 2016).

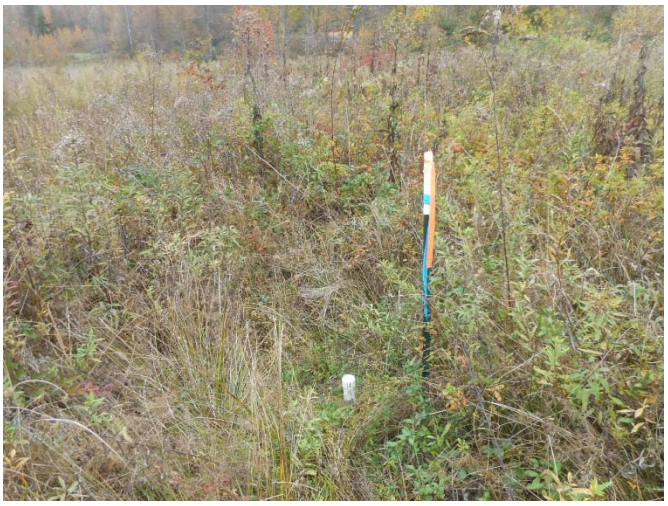


Photo 11. Wetland Photo Point – W11, replicates photo 60 in Baseline Report (November 1, 2016).

Photo 12. Wetland Photo Point – W12, replicates photo 61 in Baseline Report (November 1, 2016).

Photo 13. Wetland Photo Point – W13 added between time of baseline and MY1 survey, (April 1, 2015)