

Annual Monitoring Report

Monitoring Year 3 of 5

FINAL

Middle South Muddy Stream Restoration Site

NCDMS Contract No.: 6783

NCDMS Project No.: 93875

McDowell County, North Carolina

Data Collected: February - November 2018

Date Submitted: November 2018



Submitted to:

North Carolina Division of Mitigation Services

NCDEQ-DMS, 1652 Mail Service Center Raleigh NC 27699-1652

Mitigation Project Name Middle South Muddy Creek
 DMS ID 93875
 River Basin Catawba
 Cataloging Unit 03050101

County McDowell
 Date Project Instituted 10/1/2010
 Date Prepared 5/22/2018

USACE Action ID 2011-02233
 NCDWR Permit No 2012-0383

Credit Release Milestone	Stream Credits					Wetland Credits								
	Scheduled Releases (Stream)	Warm	Cool	Cold	Anticipated Release Year (Stream)	Actual Release Date (Stream)	Scheduled Releases (Forested)	Riparian Riverine	Riparian Non-riverine	Non-riparian	Scheduled Releases (Coastal)	Coastal	Anticipated Release Year (Wetland)	Actual Release Date (Wetland)
Potential Credits (Mitigation Plan)		3,280.800												
Potential Credits (As-Built Survey)		4,072.470												
Potential Credits (IRT Approved)		3,280.800												
1 (Site Establishment)	N/A				N/A	N/A	N/A				N/A		N/A	N/A
2 (Year 0 / As-Built)	30%	1,221.741			2016	8/11/2016	30%				30%		N/A	N/A
3 (Year 1 Monitoring)	10%	328.080			2017	8/8/2017	10%				10%		N/A	N/A
IRT Adjustment*		-237.500				8/8/2017								
4 (Year 2 Monitoring)	10%	328.080			2018	4/25/2018	10%				15%		N/A	N/A
5 (Year 3 Monitoring)	10%				2019		10%				20%		N/A	N/A
6 (Year 4 Monitoring)	10%				2020		10%				10%		N/A	N/A
7 (Year 5 Monitoring)	15%				2021		10%				15%		N/A	N/A
Stream Bankfull Standard	15%	492.120			2018	4/25/2018	N/A				N/A			
Total Credits Released to Date		2,132.521												

*NOTE: Adjustment required due to IRT concerns on how the as-built credits were calculated

DEBITS (released credits only)

	Ratios															
	1	1.5	2.5	5	1	3	2	5	1	3	2	5	1	3	2	5
	Stream Restoration	Stream Enhancement I	Stream Enhancement II	Stream Preservation	Riparian Restoration	Riparian Creation	Riparian Enhancement	Riparian Preservation	Nonriparian Restoration	Nonriparian Creation	Nonriparian Enhancement	Nonriparian Preservation	Coastal Marsh Restoration	Coastal Marsh Creation	Coastal Marsh Enhancement	Coastal Marsh Preservation
IRT Adjusted As-Built Amounts (feet and acres)	1,990,000	171,000	24,000	5,836,000												
IRT Adjusted As-Built Amounts (mitigation credits)	1,990,000	114,000	9,600	1,167,200												
Percentage Released	65%	65%	65%	65%												
Released Amounts (feet / acres)	1,293,500	111,150	15,600	3,793,400												
Released Amounts (credits)	1,293,500	74,100	6,240	758,680												
NCDWR Permit	USACE Action ID	Project Name														
1999-0337	1999-30776	NCDOT TIP R-2248AC / AD / BA - Charlotte Outer Loop														
1999-0337	1999-30776	NCDOT TIP R-2248AC / AD / BA - Charlotte Outer Loop														
2006-1179	2006-30760	Lenoir Wai-Mart														
2000-1195	2006-32521-360	Charlotte Douglas Airport Parallel Runway														
1999-0337	1999-30776	NCDOT TIP R-2248AC / AD / BA - Charlotte Outer Loop														
1999-0337	1999-30776	NCDOT TIP R-2248AC / AD / BA - Charlotte Outer Loop														
1998-1268	1998-30188	NCDOT TIP U-2211A - Widening of SR 1001														
2000-1232	2000-31430	NCDOT TIP R-2206A - NC 16 Widening														
1999-0337	1999-30776	NCDOT TIP R-2248AC / AD / BA - Charlotte Outer Loop														
1999-0337	1999-30776	NCDOT TIP R-2248AC / AD / BA - Charlotte Outer Loop														
2003-0249	2003-30598	Berewick Residential Community														
2003-1080	2003-31287	Northlake Centre Parkway														
2003-0870	2003-30960	Gilead Ridge Subdivision														
2004-1583	2003-31252	Paddy Creek Dam Improvements														
2006-0799	2006-30620	Paradise Harbor														
2005-0653	2006-32267-349	Woodburn Crossing														
2005-0007	2005-30965	Mirror Lake Estates														
2007-0936	2007-01932-390	Lakeview Road Site														
2001-1231	2001-31321	NCDOT TIP R-2248BB / C / D - Charlotte Outer Loop														

Middle South Muddy

Remaining Amounts (feet / acres)	0.000	0.000	0.000	0.000															
Remaining Amounts (credits)	0.000	0.000	0.000	0.000															

Contingencies (if any): None



Signature of Wilmington District Official Approving Credit Release

9/6/18

Date

- 1 - For NCDMS, no credits are released during the first milestone
- 2 - For NCDMS projects, the second credit release milestone occurs automatically when the as-built report (baseline monitoring report) has been made available to the NCIRT by posting it to the NCDMS Portal, provided the following criteria have been met:
 - 1) Approval of the final Mitigation Plan
 - 2) Recordation of the preservation mechanism, as well as a title opinion acceptable to the USACE covering the property
 - 3) Completion of all physical and biological improvements to the mitigation site pursuant to the mitigation plan
 - 4) Receipt of necessary DA permit authorization or written DA approval for projects where DA permit issuance is not required
- 3 - A 15% reserve of credits is to be held back until the bankfull event performance standard has been met

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November 28, 2018

Matthew Reid
Project Manager
DENR Division of Mitigation Services
5 Ravenscroft Dr., #102
Asheville, NC 28801

Subject: Revisions to Middle South Muddy Restoration Monitoring Year 3 (MY3) Report; NCDMS Project #93875

Dear Mr. Reid,

The North Carolina Division of Mitigation Services contracted the services of Equinox to compile and report on the MY3 conditions of the Middle South Muddy Restoration project. Comments provided by NCDMS on November 27th, 2018 are listed below with red text indicating how each was addressed:

Section 1.4.2 Stream Geomorphology

- Report indicates structure at STA: 108+83 was noted in previous monitoring efforts as being stressed and removed in subsequent years because it has remained stable. Intense tropical storms and hurricanes in 2018 have caused some localized erosion around this structure. DMS will continue to monitor this structure throughout the upcoming year to document and changes. Additional live stakes may be installed to help stabilize the area this winter. **This area will continue to be monitored in future site visits. Equinox will keep DMS apprised of any trends towards instability.**

Section 1.4.3 Stream Hydrology

- Please add a short discussion regarding the two continuous stage recorders installed on Iva Branch and the results. One gauge was installed in the perennial section and one was installed on the intermittent section to document 30 consecutive days of flow. The gauge in the perennial section has successfully demonstrated continuous flow, while the gauge in the intermittent section does not show signs of surface flow. DMS recognized that credit may not be realized for the dry section.. **An additional paragraph has been added to Section 1.4.3 Stream Hydrology describing the continuous stage records on Iva Branch and the results for MY3.**

CCPV

- Please add the locations of the two continuous gauges on Iva Branch. **The continuous stage recorders have been added to the CCPV.**

Photo Points

- Photo point descriptions for photo stations 17, 18, and 20 all reference Sta: 300+50. Please update with the correct stationing. **Photo stations 17, 18, and 20 have been updated with the correct stationing 302+13, 302+82, and 304+20.**

Table 11a

- Please confirm that the MY3 (2018) BHRs have been calculated based on the attached DMS technical guidance. Please add a note on the table that beginning in MY3, the bankfull elevation and channel cross section

dimensions are calculated using a fixed Abkf as described in the Standard Measurement of the BHR Monitoring Parameter provided by NCIRT and NCDMS (9/2018). **BHRs have been calculated according to the guidance starting in MY3. A note has been added to the bottom of Table 11a**

Appendix E Hydrologic Data

- Please include the continuous stage recorder data for the two gauges on Iva Branch. **The two continuous stage recorder plots have been added to Appendix E.**

The Equinox project manager for this project is Mr. Drew Alderman. His contact is as follows:

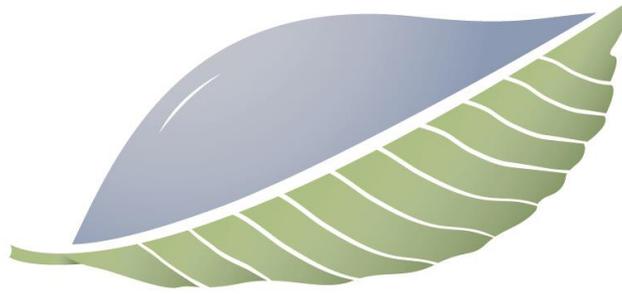
Natural Resource Specialist
Equinox
37 Haywood Street
Asheville, NC 28801
Office: 828-253-6856 ext. 213
Fax: 828-253-8256

Sincerely,



Drew Alderman

Prepared by:



EQUINOX

balance through proper planning

37 Haywood Street, Suite 100
Asheville, North Carolina 28801

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1.0 PROJECT SUMMARY

1.1. Goals and Objectives

The following goals were established to guide the restoration process for the project as outlined in the Final Mitigation Plan:

- Improve local water quality within the restored channel reaches as well as the downstream watercourses through: (a) the reduction of current channel sediment loads by restoring appropriately sized channels with stable beds and banks, (b) the reduction of nutrient loads from adjacent agricultural fields with a restored riparian buffer, and (c) the reduction of water temperatures provided through shading of the channel by canopy species along with the resultant increase in oxygen content.
- Improve local aquatic and terrestrial habitat and diversity within the restored channels and their vicinity through: (a) the restoration of appropriate bed form to provide habitat for fish, amphibian, and benthic species, (b) the restoration of a suitable riparian buffer corridor in order to provide both vertical and horizontal structure and connectivity with adjacent upland areas, and (c) the restoration of understory and canopy species in order to provide forage, cover, and nesting for a variety of mammals, reptiles, and avian species.
- Preclude land disturbing activities including the construction of additional infrastructure, future mining activities and agricultural practices including cattle grazing and the application of pesticides and fertilizer within the riparian buffer area by providing a permanent conservation easement.

The following objectives were proposed for accomplishing the above listed goals as outlined in the Final Mitigation Plan:

- Provide approximately 3,281 stream mitigation units (SMU's) through Priority I and II restoration of approximately 1,989 linear feet of stream, enhancement of approximately 196 linear feet of stream, and preservation of approximately 5,836 linear feet of stream threatened by mining activities.
- Restore natural stable channel morphology and proper sediment transport capacity.
- Create and/or improve bed form diversity and improve aquatic and benthic macroinvertebrate habitat.
- Construct a floodplain bench that is accessible at the proposed bankfull discharge.
- Improve channel and stream bank stabilization by integrating in-stream structures and native bank vegetation.
- Provide approximately 5.87 acres of riparian buffer restoration by establishing a native forested and herbaceous riparian buffer plant community with a minimum width of 30 feet from the edge of the restored channels. This new community will be established in conjunction with the eradication of any existing exotic and/or undesirable plant species.
- Construct barricades on an existing dirt road network on the Haney Tract to prevent future vehicular trespassing.

1.2. Success Criteria

1.2.1. Morphological Parameters and Channel Stability

Restored and enhanced streams should demonstrate morphologic stability to be considered successful. Stability does not equate to an absence of change, but rather to sustainable rates of change or stable patterns of variation. Restored streams often demonstrate some level of initial adjustment in the several months that follow construction and some change/variation subsequent to that period is also to be

expected. However, the observed change should not be unidirectional such that it represents a robust trend. If some trend is evident, it should be very modest or indicate migration to a stable form.

Dimension - Cross-section measurements should indicate little change from the as-built cross-sections. If changes do occur, they will be evaluated to determine whether the adjustments are associated with increased stability or whether they indicate movement towards an unstable condition.

Pattern and Profile – Measurements and calculated values should indicate stability with little deviation from as-built conditions and established morphological ranges from the restored stream type. Annual measurements should indicate stable bed form features with little change from the as-built survey. The pools should maintain their depth with flatter water surface slopes, while riffles should remain shallower and steeper.

Substrate - Calculated D_{50} and D_{84} values should indicate coarser size class distribution of bed materials in riffles and finer size class distribution in pools. Generally, it is anticipated that the bed material will coarsen over time.

Sediment Transport - Depositional features should be consistent with a stable stream that is effectively managing its sediment load. Point bar and inner berm features, if present, should develop without excessive encroachment of the channel. Lateral and mid-channel bar features should typically not be present and if so only in isolated instances. Bar features may be more prevalent in sand bed channels but should be transient in nature and should occupy no more than 20% of the cross-sectional area.

1.2.2. Surface Water Hydrology

Monitoring of stream surface water stages should indicate recurrence of bankfull flows on average every 1 to 2 years. At a minimum, throughout the monitoring period, the surface water stage should achieve bankfull or greater elevations at least twice. The bankfull events must occur during separate monitoring years.

1.2.3. Vegetation

Riparian vegetation monitoring shall be conducted for a minimum of five years to ensure that success criteria are met per USACE guidelines. Accordingly, success criteria will consist of a minimum survival of 320 stems per acre by the end of the Year 3 monitoring period and a minimum of 260 stems per acre at the end of Year 5. If monitoring indicates either that the specified survival is not being met or the development of detrimental conditions (i.e., invasive species, diseased vegetation), appropriate corrective actions will be developed and implemented.

1.3. Project Setting and Background

The Middle South Muddy Stream Restoration Site (MSM) is located in the Catawba River Basin (NCDWQ sub-basin 03-08-30 and HUC 03050101040020) approximately 9.5 miles southeast of Marion, NC in southeast McDowell County at latitude 35.5635° N and longitude 81.9249° W. MSM is comprised of two tracts, the Middle South Muddy Creek tract, which encompasses approximately 5.87 acres of predominately agricultural and forested land, and the 41.05 acre Haney Preservation Tract, which is predominately forested. The Middle South Muddy Creek Tract consists of portions of three streams, Iva Branch (462 feet), Sprouse Branch (635 feet), and South Muddy Creek (1,088 feet). The Haney Tract consists of approximately 5,836 linear feet of stream. The tract is comprised of portions of South Muddy Creek and approximately four tributaries, including Jackson Branch and Moores Branch. MSM is located

within the Muddy Creek Local Watershed planning area and the Site's watershed was identified as a Targeted Local Watershed (TLW) in DMS' 2009 Upper Catawba River Basin Restoration Priority report (RBRP).

Historic land use at MSM consisted primarily of agriculture, livestock grazing, and mining operations. Livestock previously had unrestricted access to the majority of the streams on site, resulting in significant local disturbance to stream banks (Table 4). Additional land use practices, including the maintenance and removal of riparian vegetation, and the relocating, dredging, and straightening of on-site streams contributed to the degraded water quality and unstable channel characteristics on the site.

During the Asbuilt Baseline Monitoring Report, stream lengths in the Haney Tract was increased by 3,960 LF from the approved Mitigation Plan length of 5,836 LF to a total of 9,796 LF. The increase in length was due to mapping of streams within the conservation easement during the Asbuilt Baseline Monitoring field work data collection stage. Upon verification, DMS determined that many of the included streams have been highly manipulated by past land use (mining) and were not candidates for preservation credit. These streams (UT1-8 and UT-10) were removed by DMS from credit calculations. DMS and IRT viewed the remaining streams within the easement (UT9, UT11, Jackson Branch, Moores Branch and South Muddy Creek). These streams were impacted less by past use and both DMS and IRT agreed they would be suitable for preservation credit. In lieu of breaking out stream reaches and applying different rations for preservation credit based on quality and function, the IRT and DMS agreed that reverting to the approved Mitigation Plan preservation length assets would be acceptable. The MY2 Monitoring Report has been updated to reflect the change in the preservation assets for the Haney Tract to 5,836 LF at a 5:1 ratio for a total of 1,167 SMUs as found in the Mitigation Plan. The total number of SMUs for the Middle South Muddy site has also been changed to 3,281 SMUs to reflect the Mitigation Plan as well.

1.4. Project Performance

Monitoring Year 3 (MY3) data was collected from February to October 2018. Monitoring activities included visual assessment of all reaches and the surrounding easement, collection of images at 31 permanent photo stations, inventory of five permanent vegetation monitoring plots, surveying of 10 cross-sections, conducting three pebble counts, and collection of longitudinal profile survey data for approximately 2,166 linear feet of stream channel.

Summary information/data related to the occurrence of items such as beaver or encroachment and statistics related to performance of various project and monitoring elements can be found in 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 (formerly Mitigation Plan) and in the Mitigation Plan (formerly Restoration Plan) documents available on the NCDMS website (<http://portal.NCDEQ.org/web/eep>). All raw data supporting the tables and figures in the appendices is available from DMS upon request.

1.4.1. Vegetation

Visual assessment of vegetation outside of the monitoring plots (Appendix B – Table 6) indicates that the herbaceous vegetation is becoming established throughout the project. A few small areas of invasive exotic vegetation were noted (n = 3) totaling .01 acre. The site will continue to be monitored for invasive exotic vegetation. Monitoring of the permanent vegetation plots (n = 5; VP) was completed in September 2018. Summary tables and photographs associated with MY3 vegetation monitoring are located in Appendix C. MY3 monitoring data indicates that all vegetation plots met the MY3 interim success criteria of 320 planted stems per acre. Planted stem densities among plots ranged from 324 to 607 planted

stems per acre with an annual mean of 461 planted stems per acre across all plots. A total of 10 species were documented within the plots. When volunteer stems are included, the mean annual total stems per acre rose to 785 and ranged between 405 and 1,497 stems per acre.

1.4.2. Stream Geomorphology

Visual assessment of the stream channel was performed to document signs of instability, such as eroding banks, structural instability, or excessive sedimentation. One problem area was noted on South Muddy Creek during MY3 associated with the structure at STA 108+83. Displacement of backfill material has exposed the backer log and filter fabric which has resulted in piping through the structure. While the structure has remained stable, at high flows the thalweg has been redirected at the left bank, scouring out approximately 25 feet of bank downstream. A smaller area of erosion totaling approximately 10 feet was also noted just downstream on the right descending bank (Table 5 and Figure 2). On Iva Branch, the boulder step structure at STA 303+67, has failed (Figure 2). High flows with contributing runoff from the BMP just upstream have scoured around the LDB of the arm of the top 3 boulder arches undermining the structure. Material from the pools of the boulder steps has migrated downstream to fill in the riffle at STA 303+75 (Figure 2, Appendix D Iva Branch Longitudinal Profile). The boulder arches located at STA 301+94 and 303+07 in the upstream portions of Iva Branch remain relatively intact however, the material from these structures has also migrated into the downstream riffle, causing aggradation at STA 302+25 and 303+25 (Figure 2, Appendix D Iva Branch Longitudinal Profile). These problem areas on Iva Branch are not new to MY3, but rather systemic issues from intermittent and flashy flows. All of these areas listed above will be monitored during future site visits for signs of deterioration.

Geomorphic data for MY3 was collected from March through October 2018. Summary tables and cross-section data plots related to stream morphology are located in Appendix D. Noticeable change in the cross-section data between MY2 and MY3 occurred mostly at cross-sections four through seven located on South Muddy Creek (Appendix D, Table 11a/b). Large deposits of sand along the bankfull bench have lowered the bankfull width by 1.6 feet on cross-section four, 2.2 feet on cross-section five, 5.0 feet on cross-section six, and 4.1 feet on cross-section seven. Riffle dimensions remained relatively similar between MY2 and MY3 on Sprouse Branch. The most notable change was that the width/depth ratio decreased by 4.5. Riffle dimensions on Iva Branch also remained stable from MY2 to MY3. No notable changes for Iva Branch can be reported, please refer to Table 11b and cross-sectional overlays for cross-sectional data.

Generally, South Muddy Creek longitudinal profile data (Appendix B, Table 11b) indicated relatively little change in riffle and pool dimensions between MY2 and MY3. The most notable change took place at STA 103+01 where a debris jam caused scour in the subsequent pool, lowering the bed elevation 3.0 ft. This change has created great habitat and has reverted this section of stream back to baseline conditions. Profile dimensions for Sprouse Branch changed slightly between MY2 and MY3. Two areas, STA 204+22 and STA 206+87, were identified as riffles during previous monitoring reports, during MY3 monitoring slight bed scour has changed these areas to a step pool sequence anchored by log structures. For the purposes of dimensioning they have been changed to steps for MY3. Another small change was noted at STA 206+08 where bed scour has caused the preceding pool to increase in length, turning the subsequent riffle into a glide. These changes are reflected in Table 11b, where the total number of riffles have changed from 9 to 6. While the total number of riffles changed, dimensions remained relatively similar to MY2 dimensions. The most substantial change was that the total percentage of Sprouse Branch that is characterized as a riffle has decreased by 11%, while the total percentage of the reach is characterized as a step increased by 6%. The longitudinal profile for Iva Branch also saw a few changes from MY2 to M3 (Table 11b). The structure at STA 303+67 has remained unstable and multiple steps

have been removed creating one large pool rather than a step pool sequence. Bed material from this area has been deposited downstream causing aggradation in the subsequent riffle. This change increased the total percent of the reach characterized by as a pool by 4% and decreased the percentage of steps by 4%. For the first time since baseline conditions, Iva Branch had water present upstream of the culvert. Water surface slopes were generated for both Upper and Lower Iva Branch.

1.4.3. Stream Hydrology

Since project completion in December 2015, four bankfull events have been documented on all reaches of the Middle South Muddy Project. Based on precipitation data, the suspected dates are February 2nd, 2016 (MY1), October 23rd, 2017 (MY2), February 11th, 2018 (MY3), and October 18th, 2018 (MY3). The crest gauge on South Muddy Creek was damaged during multiple events this year therefore no crest gauge readings could be recorded for that reach. The crest gauge was reconfigured during the MY3 final walkthrough in November and will be monitored in subsequent site visits.

Two continuous stage recorders were installed during MY0 on Iva Branch to document surface flow. One gauge was installed in the perennial section and another was installed on the intermittent section to document 30 consecutive days of flow. The gauge in the perennial section has successfully demonstrated continuous flow, while the gauge in the intermittent section does not show signs of surface flow. During the MY3 monitoring year the intermittent section only saw approximately seven days of consecutive surface flow while the perennial section shows multiple stretches of 30+ days of flow during MY3 monitoring (Appendix E). The continuous stage recorders will be monitored in subsequent site visits.

2.0 METHODS

The visual assessment of the project was performed at the beginning and end of each monitoring year. Permanent photo station photos were taken during the initial visual assessment when leaf-off conditions exist. Additional photos of vegetation or stream problem areas were taken as needed.

Geomorphic measurements were taken during low flow conditions using a Nikon® NPR 332 Total Station. Three-dimensional coordinates associated with cross-section and profile data were collected in the field and geo-referenced (NAD83 State Plane feet FIPS 3200). Morphological data were collected at 10 cross-sections. Survey data was imported into CAD, ArcGIS®, and Microsoft Excel® for data processing and analysis. Channel substrate was characterized using a Wolman Pebble Count as outlined in Harrelson et al. (1994) and processed using Microsoft Excel.

Vegetation success is being monitored at 5 permanent monitoring plots. Vegetation monitoring follows the CVS-EEP Level 2 Protocol for Recording Vegetation, version 4.2 (Lee et al. 2008) and includes analysis of species composition and density of planted species. Data is processed using the CVS data entry tool. In the field, the four corners of each plot were permanently marked with rebar and photos of each plot are taken from the origin each monitoring year.

Precipitation data was reported from the NCCRONOS station NGRF in Marion, NC. Bankfull events were documented with two crest gauges, one located on South Muddy Creek and another on Sprouse Branch. Crest gauges will be monitored semi-annually. The height of the corklines was recorded and cross-referenced with known bankfull elevations at each crest gauge.

3.0 REFERENCES

- Equinox Environmental. 2008. Muddy Creek Local Watershed Plan. Report prepared for North Carolina Department of Environment and Natural Resources, Division of Water Quality. September.
- Harrelson, Cheryl, C. Rawlins and J. Potyondy. 1994. Stream Channel Reference Sites: An Illustrated Guide to Field Technique. Gen. Tech. Rep. RM-245. Rocky Mountain Forest and Range Experiment Station. USDA Forest Service. Fort Collins, Colorado
- North Carolina Ecosystem Enhancement Program (EEP). February 2009. Upper Catawba River Basin Restoration Priorities 2009. https://ncdenr.s3.amazonaws.com/s3fs-public/PublicFolder/Work%20With/Watershed%20Planners/Upper_Catawba_RBRP_2009.pdf.
- Lee, M.T., R.K. Peet, S.D. Roberts, and T.R. Wentworth. 2008. CVS-EEP Protocol for Recording Vegetation. Version 4.2. <http://cvs.bio.unc.edu/methods.htm>; accessed November 2008.
- Wolf Creek Engineering. 2012. Final Mitigation Plan Middle South Muddy Creek Restoration. Prepared for North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program. Final Mitigation Plan, Middle South Muddy Restoration, McDowell County. EEP Project No: 93875

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Appendix A
General Tables and Figures

Driving Directions: From Asheville drive east on I-40 and take exit 83. Turn right onto Ashworth Road, after 0.9 miles turn right onto US-221. Follow US-221 for 4.5 miles then turn left onto Polly Spout Road. After 1.7 miles turn left onto Vein Mountain Road. Follow Vein Mountain Road for 2.6 miles and then turn right onto Brackett Town Road. The Middle South Mitigation Site will be on the left after about 1 mile.

The subject project site is an environmental restoration site of the NCDMS and encompassed by a recorded conservation easement, but is bordered by land with private ownership. Accessing the site may require traversing areas near or along the easement boundary and therefore access to the general public is not permitted. Access by authorized personnel of state and federal agencies or their designee/contractors involved in the development, oversight, and stewardship of the restoration site is permitted within the terms and timeframes of their defined role. Any intended site visitation or activity by any person outside of these previously sanctioned roles and activities requires prior coordination with NCDMS.

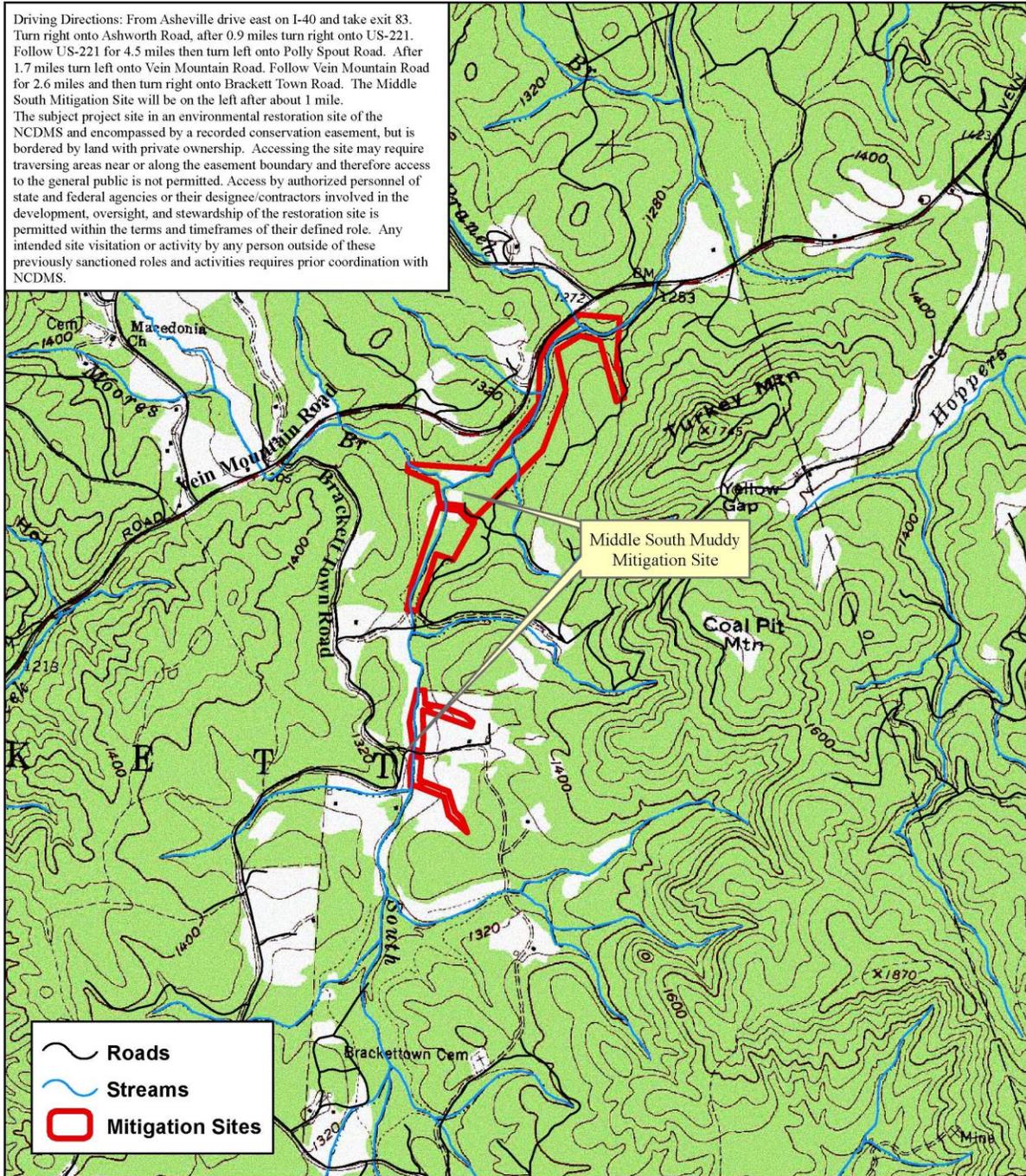


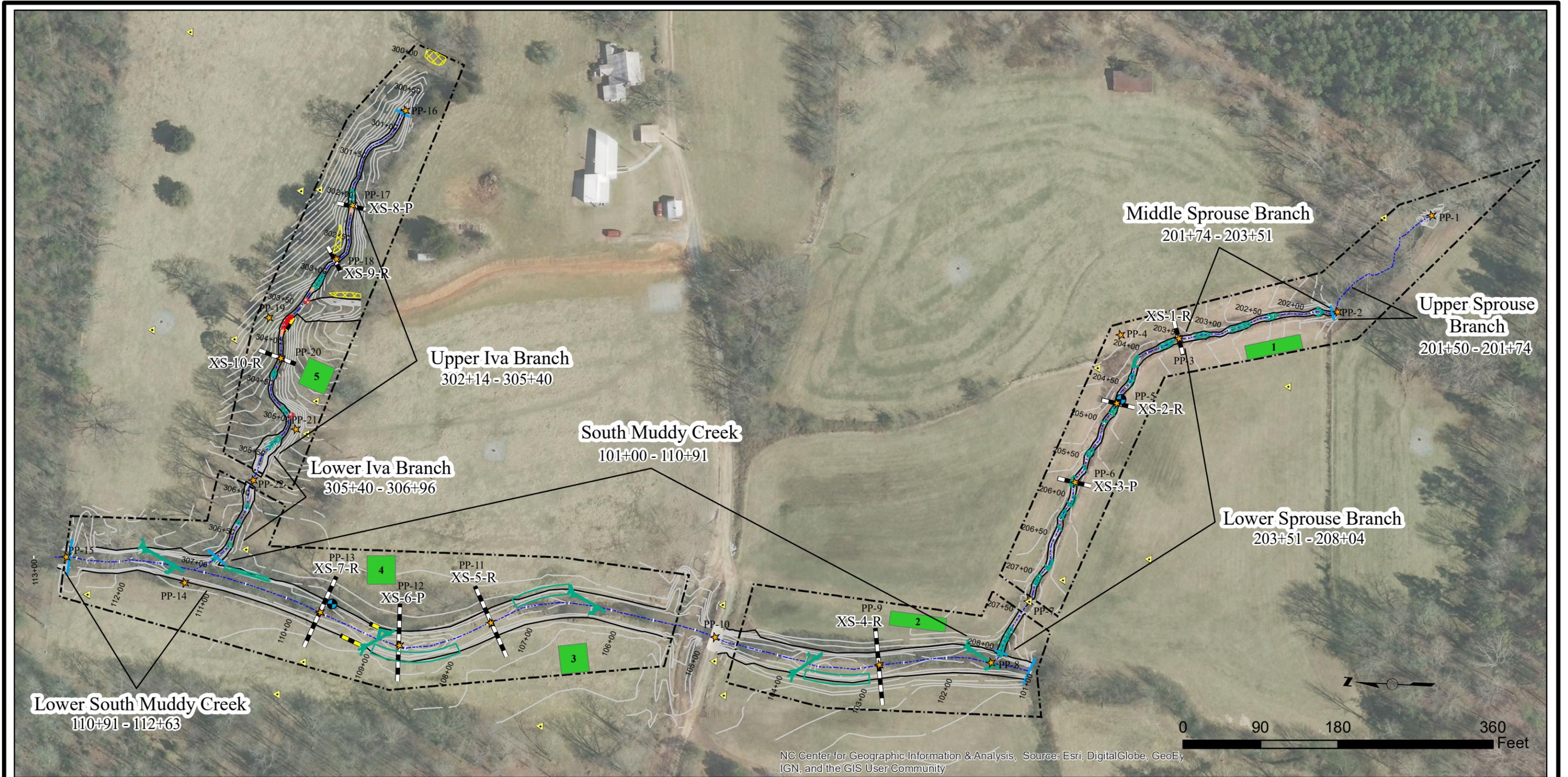
Figure 1
Middle South Muddy Mitigation Site
Vicinity Map

0 0.25 0.5 1 Miles

EQUINOX

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Figure 2. Integrated Current Condition Plan View



NC Center for Geographic Information & Analysis, Source: Esri, DigitalGlobe, GeoEye, IGN, and the GIS User Community

<p>Prepared for</p> 	<p>Middle South Muddy Stream Restoration Project Monitoring Year 3 McDowell County, NC NCDMS Contract No.: 00006783 November 2018 Sheet 1 of 2</p>	<ul style="list-style-type: none"> Easement Cross-Section Structure Long Pro Start/End Photo Point Crest Gauge Control Point Continuous Stage Recorder 	<ul style="list-style-type: none"> Thalweg Top of Bank Contour (1 ft) <p>Vegetation Plots</p> <ul style="list-style-type: none"> Vegetation Plot Criteria Met <p>Invasive-Exotic Vegetation</p> <ul style="list-style-type: none"> Present <p>Stream Problem Areas</p> <ul style="list-style-type: none"> Aggradation Bank Erosion Failed Structure 	<ul style="list-style-type: none"> Hook-Log Run Hook Run Boulder-Arch Boulder-Arch with Log Armored Riffle 	<ul style="list-style-type: none"> Log Vane with Hook Log Sill Log Sill no Baffle Brush Toe 	<p>Notes: 1) Baseline Data Provided by Turner Land Surveying</p>	<p>Prepared by</p> 
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Figure 2. Integrated Current Condition Plan View



Prepared for



Middle South Muddy
Stream Restoration Project
Monitoring Year 3
McDowell County, NC
NCDMS Contract No.: 00006783
November 2018
Sheet 2 of 2

- Easement
- Cross-Section
- Long Pro Start/End
- Photo Point
- Crest Gauge
- Control Point
- Preservation Streams
- Top of Bank
- Contour (1 ft)

- Hook-Log Run
- Hook Run
- Boulder-Arch
- Boulder-Arch with Log
- Armored Riffle
- Log Vane with Hook
- Log Sill
- Log Sill no Baffle
- Brush Toe

Notes:

1) Baseline Data Provided by Turner Land Surveying

Prepared by



Table 1. Project Mitigation Components and Summation									
Middle South Muddy Stream Restoration Site									
Mitigation Credits									
	Stream		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen	Phosphorous Nutrient Offset
	R	RE	R	RE	R	RE		Nutrient Offset	
Type									
Totals	2,114	1,167							
Project Components									
Project Component -or- Reach ID	Stationing/Location		Existing Footage/Acreage	Restoration Footage or Acreage	Restoration -or- Restoration Equivalent	Approach (PI, PII etc.)	Mitigation Ratio	Mitigation Credits	Footage Excluded due to Easement Crossing/ Break
South Muddy Creek	101+00 – 110+91		931	916	R	PII	1:1	916	75
Lower South Muddy Creek	110+91 – 112+63		177	172	R	EI	1.5:1	115	-
Upper Sprouse Branch	201+50 – 201+74		24	24	R	EII	2.5:1	10	-
Middle and Lower Sprouse Branch	201+74– 208+04		598	611	R	PII	1:1	611	19
Upper and Lower Iva Branch	302+14 – 306+96		471	462	R	PI	1:1	462	20
Haney Tract			5,836	5,836	RE	Preservation	5:1	1,167	-
Component Summation									
Restoration Level	Stream	Riparian Wetland		Non-riparian Wetland	Buffer	Upland			
	(linear feet)	(acres)		(acres)	(square feet)	(acres)			
		Riverine	Non-Riverine						
Restoration	1,989								
Enhancement									
Enhancement I	172								
Enhancement II	24								
Creation									
Preservation	5,836								
High Quality Preservation									
BMP Elements									
Element	Location	Purpose/Function			Notes				
FB	Entire Site	Protect Stream Channel							
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; FB = Forested Buffer									

Table 2. Project Activity and Reporting History Middle South Muddy Stream Restoration Site		
Activity or Report	Data Collection Complete	Completion or Delivery
Mitigation Plan	Feb - 2012	Mar - 2012
Final Design - Construction Plans	N/A	Nov - 2012
Construction	N/A	Dec - 2015
Permanent Seed Mix Applied	-	Mar - 2016
Live Stake Plantings	-	Mar - 2016
Baseline Monitoring Document (Year 0 Monitoring - Baseline)	May - 2016	June -2016
Year 1 Monitoring	Dec - 2016	Jan - 2017
Year 1 Geomorphology Monitoring	Dec - 2016	-
Year 1 Vegetation Monitoring	Oct - 2016	-
Year 2 Monitoring	Oct - 2017	Nov - 2017
Year 2 Geomorphology Monitoring	June - 2017	-
Year 2 Vegetation Monitoring	Sept - 2017	-
Year 3 Monitoring	Nov - 2018	Nov - 2018
Year 3 Vegetation Monitoring	Sept - 2018	-
Year 3 Geomorphology Monitoring	Oct - 2018	-
Year 4 Monitoring		
Year 5 Monitoring		

Table 3. Project Contacts	
Middle South Muddy Stream Restoration Site	
Prime Contractor	North Carolina Division of Mitigation Services 217 W Jones Street Suite 3000a Raleigh, North Carolina 27603 Matthew Reid (828) 231-7812
Designer	Wolf Creek Engineering 12 1/2 Wall Street Suite C Asheville, North Carolina 28801 S. Grant Ginn (828) 449-1930
Construction Contractor	River Works, Inc 6105 Chapel Hill Road Raleigh, North Carolina 27607 Jon Harrell (919) 710-3326
Seeding Contractor	River Works, Inc 6105 Chapel Hill Road Raleigh, North Carolina 27607 Jon Harrell (919) 710-3326
Planting Contractor	River Works, Inc 6105 Chapel Hill Road Raleigh, North Carolina 27607 Jon Harrell (919) 710-3326
As-built Surveys	Turner Land Surveying 3719 Benson Drive Raleigh, North Carolina 27609 David Turner (919) 827-0745
Seeding Mix Source	Green Resource 5204 Highreen Court Colfax, North Carolina 27235 (336) 855-6363
Live Stakes	Foggy Mountain Nursery 797 Helton Creek Road Lansing, North Carolina (336) 384-5323
Monitoring Performers (MY0-MY3) 2016 - 2018	Equinox Environmental 37 Haywood St. Asheville, North Carolina 28801 Drew Alderman (828) 253-6856

Table 4. Project Baseline Information and Attributes			
Project Information			
Project Name	Middle South Muddy Creek		
County	McDowell		
Project Area (acres)	5.87		
Project Coordinates (latitude and longitude)	35.5635° N , 81.9249° W		
Project Watershed Summary Information			
Physiographic Province	Blue Ridge		
River Basin	Catawba River		
USGS Hydrologic Unit 8-digit	3050101	USGS Hydrologic Unit 14-digit	03050101040020
DWR Sub-basin	03-08-30		
Project Drainage Area (acres)	2,893		
Project Drainage Area Percentage of Impervious Area	> 1%		
CGIA Land Use Classification	2.03.01.01		
Reach Summary Information			
Parameters	South Muddy Creek	Iva Branch	Sprouse Branch
Length of reach (linear feet)	1,108	471	622
Valley classification (Rosgen)	Valley Type VIIIb	Valley Type II	Valley Type II
Drainage area (acres)	3,002	27	29
NCDWQ stream identification score	44	31	34
NCDWQ Water Quality Classification	C	C	C
Morphological Description (stream type) (Rosgen)	G4	G5	G5
Evolutionary trend (Rosgen)	F4	G5	G5
Underlying mapped soils	Iotla, Hayesville Clay	Iotla, Hayesville Clay	Iotla, Hayesville Clay
Drainage class	Poorly drained	Poorly drained	Poorly drained
Soil Hydric status	Non-hydric	Non-hydric	Non-hydric
Slope	0.40%	4.60%	2.20%
FEMA classification	Limited Detail	N/A	N/A
Native vegetation community	Agricultural	Agricultural	Agricultural
Percent composition of exotic invasive vegetation	<1%	<1%	<1%
Wetland Summary Information			
Parameters	Wetland 1	Wetland 2	Wetland 3
Size of Wetland (acres)	-	-	-
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)	-	-	-
Mapped Soil Series	-	-	-
Drainage class	-	-	-
Soil Hydric Status	-	-	-
Source of Hydrology	-	-	-
Hydrologic Impairment	-	-	-
Native vegetation community	-	-	-
Percent composition of exotic invasive vegetation	-	-	-
Regulatory Considerations			
Regulation	Applicable?	Resolved?	Supporting Documentation
Waters of the United States – Section 404	Yes	Yes	NW 27 (2011-02233)
Waters of the United States – Section 401	Yes	Yes	401 Certification (DWR# 12-0383)
Endangered Species Act	No	N/A	ERTR
Historic Preservation Act	No	N/A	ERTR
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (CAMA)	No	N/A	
FEMA Floodplain Compliance	Yes	Yes	Case #: 14-04-0367R
Essential Fisheries Habitat	No	N/A	

Appendix B
Visual Assessment Data

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**Table 5. Visual Stream Morphology Stability Assessment
Middle South Muddy Stream Restoration Site - South Muddy Creek
Assessed Length 1,088 feet**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run Units)	1. <u>Aggradation</u> - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars).			0	0	100%			
		2. <u>Degradation</u> - Evidence of downcutting.			0	0	100%			
	2. Riffle Condition	1. <u>Texture/Substrate</u> - Riffle maintains coarser substrate.	5	5			100%			
		3. Meander Pool Condition	1. <u>Depth</u> Sufficient (Max Pool Depth : Mean Bankfull Depth \geq 1.6).	5			5			
	4. Thalweg Position	2. <u>Length</u> appropriate (>30% of centerline distance between tail of upstream riffle and head of downstream riffle).	5	5			100%			
		1. Thalweg centering at upstream of meander bend (Run).	5	5			100%			
		2. Thalweg centering at downstream of meander bend (Glide).	5	5			100%			
2. Bank	1. Scoured / Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.					2	36	98%	0
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does <u>NOT</u> include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse.			0	0	100%	0	0	100%
Totals					2	36	99%	0	0	93%
3. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	5	5			100%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	5	5			100%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	5	5			100%			
	3. Bank Protection	Bank erosion within the structures extent of influence does <u>NOT</u> exceed 15%.	5	5			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth Ratio \geq 1.6. Rootwads/logs providing some cover at base-flow.	5	5			100%			

**Table 5 Cont'd. Visual Stream Morphology Stability Assessment
Middle South Muddy Stream Restoration Project - Sprouse Branch
Assessed Length 611 feet**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run Units)	1. <u>Aggradation</u> - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars).			0	0	100%			
		2. <u>Degradation</u> - Evidence of downcutting.			0	0	100%			
	2. Riffle Condition	1. <u>Texture/Substrate</u> - Riffle maintains coarser substrate.	14	14		100%				
	3. Meander Pool Condition	1. <u>Depth</u> Sufficient (Max Pool Depth : Mean Bankfull Depth \geq 1.6).	16	16		100%				
		2. <u>Length</u> appropriate (>30% of centerline distance between tail of upstream riffle and head of downstream riffle).	16	16		100%				
	4. Thalweg Position	1. Thalweg centering at upstream of meander bend (Run).	16	16		100%				
2. Thalweg centering at downstream of meander bend (Glide).		16	16	100%						
2. Bank	1. Scoured / Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does <u>NOT</u> include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse.			0	0	100%	0	0	100%
Totals					0	0	100%	0	0	100%
3. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	18	18		100%				
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	18	18		100%				
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	18	18		100%				
	3. Bank Protection	Bank erosion within the structures extent of influence does <u>NOT</u> exceed 15%.	18	18		100%				
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth Ratio \geq 1.6. Rootwads/logs providing some cover at base-flow.	18	18		100%				

**Table 5 Cont'd. Visual Stream Morphology Stability Assessment
Middle South Muddy Stream Restoration Project - Iva Branch
Assessed Length 462 feet**

Major Channel Category	Channel Sub-Category	Metric	Number Stable, Performing as Intended	Total Number in As-built	Number of Unstable Segments	Amount of Unstable Footage	% Stable, Performing as Intended	Number with Stabilizing Woody Vegetation	Footage with Stabilizing Woody Vegetation	Adjusted % for Stabilizing Woody Vegetation
1. Bed	1. Vertical Stability (Riffle and Run Units)	1. <u>Aggradation</u> - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars).			3	15	96%			
		2. <u>Degradation</u> - Evidence of downcutting.			0	0	100%			
	2. Riffle Condition	1. <u>Texture/Substrate</u> - Riffle maintains coarser substrate.	9	9			100%			
		3. Meander Pool Condition	1. <u>Depth</u> Sufficient (Max Pool Depth : Mean Bankfull Depth \geq 1.6).	9	9					
	4. Thalweg Position	2. <u>Length</u> appropriate (>30% of centerline distance between tail of upstream riffle and head of downstream riffle).	9	9			100%			
		1. Thalweg centering at upstream of meander bend (Run).	9	9			100%			
		2. Thalweg centering at downstream of meander bend (Glide).	9	9			100%			
2. Bank	1. Scoured / Eroding	Bank lacking vegetative cover resulting simply from poor growth and/or scour and erosion.			1	15	98%	0	0	98%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does <u>NOT</u> include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse.			0	0	100%	0	0	100%
Totals					1	15	98%	0	0	98%
3. Engineered Structures	1. Overall Integrity	Structures physically intact with no dislodged boulders or logs.	9	10			90%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	9	10			90%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	9	10			90%			
	3. Bank Protection	Bank erosion within the structures extent of influence does <u>NOT</u> exceed 15%.	9	10			90%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth Ratio \geq 1.6. Rootwads/logs providing some cover at base-flow.	9	10			90%			

**Table 6. Vegetation Condition Assessment
Middle South Muddy Stream Restoration Site**

Planted Acreage: 5.87					
Vegetation Category	Definitions	CCPV Depiction	Number of Polygons	Combined Acreage	% of Planted Acreage
1. Bare Areas	Very limited cover of both woody and herbaceous material.	N/A	0	0.00	0%
2. Low Stem Density Areas	Woody stem densities clearly below target levels based on M Y3, 4, or 5 stem count criteria.	N/A	0	0.00	0%
Totals			0	0.00	0%
3. Areas of Poor Growth Rates or Vigor	Areas with woody stems of a size class that are obviously small given the monitoring year.	N/A	0	0.00	0%
Cumulative Totals			0	0.00	0%
Easement Acreage: 5.87					
Vegetation Category	Definitions	CCPV Depiction	Number of Polygons	Combined Acreage	% of Easement Acreage
4. Invasive Areas of Concern	Areas or points (if too small to render as polygons at map scale).	Cross Hatch (Red - Dense/Yellow - Present)	3	0.01	<1%
5. Easement Encroachment Areas	Areas or points (if too small to render as polygons at map scale).	N/A	0	0.00	0%

N/A - Item does not apply.



Upper Sprouse Branch – Permanent Photo Station 1
Looking Downstream



Upper Sprouse Branch – Permanent Photo Station 2
Looking Downstream



Lower Sprouse Branch – Permanent Photo Station 3
Looking Downstream at Cross-Section 1



Lower Sprouse Branch – Permanent Photo Station 4
Looking Downstream, Northwest- 292 degrees



Lower Sprouse Branch – Permanent Photo Station 4
Looking Upstream; South 182 degrees



Lower Sprouse Branch – Permanent Photo Station 5
Looking Downstream at Cross-Section 2



Lower Sprouse Branch – Permanent Photo Station 6
Looking Downstream at Cross-Section 3



Lower Sprouse Branch – Permanent Photo Station 7
Looking Upstream from Crossing



Lower Sprouse Branch – Permanent Photo Station 8
Station 101+50 - Looking Upstream at Confluence with South Muddy



South Muddy Creek – Permanent Photo Station 8
Station 101+50 - Looking Downstream



South Muddy Creek – Permanent Photo Station 8
Station 101+50 - Looking Upstream



South Muddy Creek – Permanent Photo Station 9
Station 102+75 - Looking Downstream at Cross-Section 4



South Muddy Creek – Permanent Photo Station 10
Station 104+75 - Looking Upstream from Bridge



South Muddy Creek – Permanent Photo Station 10
Station 104+75 - Looking Downstream from Bridge



South Muddy Creek – Permanent Photo Station 11
Station 107+45 - Looking Downstream at Cross-Section 5



South Muddy Creek – Permanent Photo Station 12
Station 108+58- Looking Downstream at Cross-Section 6



South Muddy Creek – Permanent Photo Station 13
Station 109+58 - Looking Downstream at Cross-Section 7



Lower South Muddy Creek – Permanent Photo Station 14
Station 111+20 - Looking Upstream



Lower South Muddy Creek – Permanent Photo Station 14
Station 111+20 - Looking Downstream



Lower Iva Branch – Permanent Photo Station 14
Station 111+20 - Looking Upstream from Confluence



Lower South Muddy Creek – Permanent Photo Station 15
Station 112+62 - Looking Upstream



Upper Iva Branch – Permanent Photo Station 16
Station 300+50 - Looking Downstream



Upper Iva Branch – Permanent Photo Station 17
Station 302+13 - Looking Downstream at Cross-Section 8



Upper Iva Branch – Permanent Photo Station 18
Station 302+82 - Looking Downstream at Cross-Section 9



Upper Iva Branch – Permanent Photo Station 19
Station 303+75 - Looking Upstream



Upper Iva Branch – Permanent Photo Station 20
Station 304+20 - Looking Downstream at Cross-Section 10



Upper Iva Branch – Permanent Photo Station 21
Station 305+10 - Looking Upstream



Lower Iva Branch – Permanent Photo Station 22
Station 305+85 - Looking Upstream from Crossing



Haney Tract – Permanent Photo Station 23
Looking Downstream South Muddy Creek



Haney Tract – Permanent Photo Station 24
Looking Upstream South Muddy Creek



Haney Tract – Permanent Photo Station 24
Looking Downstream South Muddy Creek



Haney Tract – Permanent Photo Station 25
Looking Downstream Tributary to South Muddy Creek



Haney Tract – Permanent Photo Station 26
Looking Upstream South Muddy Creek



Haney Tract – Permanent Photo Station 26
Looking Downstream South Muddy Creek



Haney Tract – Permanent Photo Station 26
Looking Upstream Tributary to South Muddy Creek



Haney Tract – Permanent Photo Station 27
Looking Upstream South Muddy Creek



Haney Tract – Permanent Photo Station 27
Looking Downstream South Muddy Creek



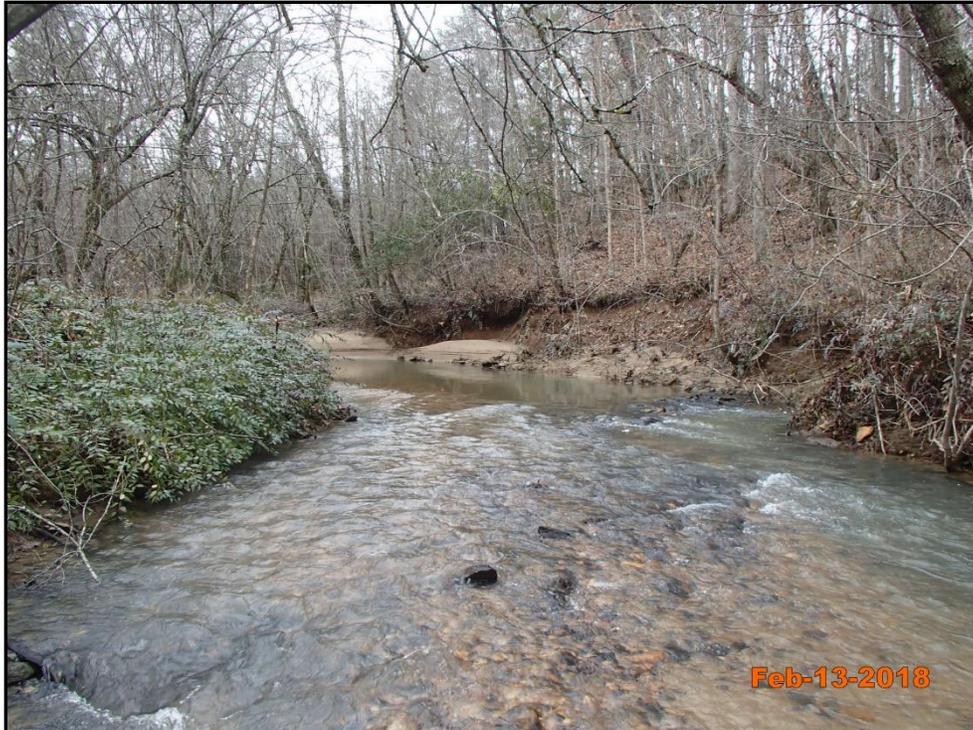
Haney Tract – Permanent Photo Station 28
Looking Upstream South Muddy Creek



Haney Tract – Permanent Photo Station 28
Looking Downstream South Muddy Creek



Haney Tract – Permanent Photo Station 28
Looking Upstream Tributary to South Muddy Creek



Haney Tract – Permanent Photo Station 29
Looking Upstream South Muddy Creek



Haney Tract – Permanent Photo Station 30
Looking Downstream Tributary to South Muddy Creek



Haney Tract – Permanent Photo Station 31
Looking Upstream Tributary to South Muddy Creek

Problem Area Photos



Failed Structure – Iva Branch STA 303+67 (looking upstream)



Failed Structure – Iva Branch STA 303+67 (looking upstream)

Problem Area Photos



Aggradation– Iva Branch STA 303+75 (looking downstream)



Bank Scour LDB– South Muddy Creek 109+00 (looking upstream)

Problem Area Photos



Bank Scour RDB– South Muddy Creek 109+00 (looking upstream)

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Appendix C

Vegetation Plot Data

Table 7. Vegetation Plot Criteria Attainment		
Middle South Muddy Stream Restoration Site		
Vegetation Plot ID	Vegetation Survival Threshold Met?	Tract Mean
1	Yes	100%
2	Yes	
3	Yes	
4	Yes	
5	Yes	

Table 8. CVS Vegetation Plot Metadata Middle South Muddy Stream Restoration Site	
Report Prepared By	Owen Carson
Date Prepared	9/5/2018 11:09
database name	Equinox_2018_A_MiddleSouthMuddy_MY3.mdb
database location	Z:\ES\NRI&M\EEP Monitoring\Middle South Muddy\MY3-2018\Data\Veg
computer name	FIELD-PC
file size	60526592
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	natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY-----	
Project Code	93875
project Name	Middle South Middy
Description	
River Basin	Catawba
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	5

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Table 9. Total Planted Stem Counts (Stems by Plot) Middle Suth Muddy Stream Restoration Project																		
Scientific Name	Common Name	Species Type	Current Plot Data (MY3 2018)															
			Plot 1			Plot 2			Plot 3			Plot 4			Plot 5			
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	
<i>Acer rubrum</i>	Red Maple	Tree														2		
<i>Acer rubrum var. rubrum</i>	Red Maple	Tree	2	2	2	1	1	1					1	1	1	7	7	7
<i>Betula nigra</i>	River Birch	Tree	2	2	2	3	3	3	1	1	1	2	2	2				
<i>Carpinus caroliniana</i>	American Hornbeam	Tree														2	2	2
<i>Cercis canadensis</i>	Eastern Redbud	Tree				1	1	1										
<i>Fraxinus pennsylvanica</i>	Green Ash	Tree	2	2	2	3	3	3	4	4	4	2	2	2				
<i>Platanus occidentalis</i>	American Sycamore	Tree	4	4	4	7	7	7	1	1	1	6	6	18	2	2	17	
<i>Platanus occidentalis var. occidentalis</i>	Sycamore, Plane-tree	Tree																
<i>Rhus aromatica</i>	Fragrant Sumac	Shrub												2			9	
<i>Rhus copallinum</i>	Flameleaf Sumac	Shrub																
<i>Rhus glabra</i>	Smooth Sumac	Shrub																
<i>Ulmus americana</i>	American Elm	Tree							2	2	2				2	2	2	
Stem count			10	10	10	15	15	15	8	8	10	11	11	25	13	13	37	
size (ares)			1			1			1			1			1			
size (ACRES)			0.02			0.02			0.02			0.02			0.02			
Species count			4	4	4	5	5	5	4	4	5	4	4	5	4	4	5	
Stems per ACRE			405	405	405	607	607	607	324	324	405	445	445	1012	526	526	1497	

¹PnoLS: No livestakes included in tally; P-all: All planted stems included in tally; T: Total stems including recruitment.

Table 9 Cont'd. Total Planted Stem Counts (Annual Means) Middle South Muddy Stream Restoration Project														
Scientific Name	Common Name	Species Type	Annual Means											
			MY3 (2018)			MY2 (2017)			MY1 (2016)			MY0 (2016)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
<i>Acer rubrum</i>	Red Maple	Tree			2									
<i>Acer rubrum var. rubrum</i>	Red Maple	Tree	11	11	11	11	11	11	11	11	11	11	11	11
<i>Betula nigra</i>	River Birch	Tree	8	8	8	7	7	7	7	7	7	5	5	5
<i>Carpinus caroliniana</i>	American Hornbeam	Tree	2	2	2	4	4	4	4	4	4	5	5	5
<i>Cercis canadensis</i>	Eastern Redbud	Tree	1	1	1	1	1	1	1	1	1	1	1	1
<i>Fraxinus pennsylvanica</i>	Green Ash	Tree	11	11	11	11	11	11	11	11	11	11	11	11
<i>Platanus occidentalis</i>	American Sycamore	Tree	20	20	47	20	20	20	20	20	20	20	20	20
<i>Platanus occidentalis var. occidentalis</i>	Sycamore, Plane-tree	Tree												19
<i>Rhus aromatica</i>	Fragrant Sumac	Shrub			11									
<i>Rhus copallinum</i>	Flameleaf Sumac	Shrub									11			
<i>Rhus glabra</i>	Smooth Sumac	Shrub						12						
<i>Ulmus americana</i>	American Elm	Tree	4	4	4	4	4	4	6	6	6	7	7	7
Stem count			57	57	97	58	58	89	60	60	71	60	60	60
size (ares)			5			5			5			5		
size (ACRES)			0.12			0.12			0.12			0.12		
Species count			7	7	9	7	7	9	7	7	8	7	7	7
Stems per ACRE			461	461	785	469	469	720	486	486	575	486	486	486

¹PnoLS: No livestakes included in tally; P-all: All planted stems included in tally; T: Total stems including recruitment.

Color for Density

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

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Middle South Muddy - Vegetation Monitoring Plot 1
September 3rd, 2018



Middle South Muddy - Vegetation Monitoring Plot 2
September 3rd, 2018



Middle South Muddy - Vegetation Monitoring Plot 3
September 3rd, 2018



Middle South Muddy - Vegetation Monitoring Plot 4
September 3rd, 2018



Middle South Muddy - Vegetation Monitoring Plot 5
September 3rd, 2018

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Appendix D
Stream Geomorphology Data

Table 10. Baseline Stream Data Summary
Middle South Muddy - South Muddy Creek / Lower South Muddy Creek (1,088 feet)

Parameter	Regional Curve			Pre-Existing Condition							Reference Reach Data						Design			As-Built / Baseline					
	LL	UL	Eq.	Min	Mean	Med	Max	SD	N	Min	Mean	Med	Max	SD	N	Min	Mean	Max	Min	Mean	Med	Max	SD	N	
Dimension & Substrate - Rifle																									
Bankfull Width (ft)	-	30.7	-	-	-	-	-	-	-	19.4	-	-	36.6	-	-	-	30.8	-	30.7	31.1	31.0	31.6	0.5	3	
Floodprone Width (ft)				-	-	-	-	-	-	30.0	-	-	65.0	-	-	-	65.0	-	65.0	84.7	88.0	101.0	18.2	3	
Bankfull Mean Depth (ft)	-	1.8	-	-	-	-	-	-	-	1.6	-	-	1.6	-	-	-	1.7	-	1.6	1.9	1.9	2.1	0.3	3	
Bankfull Max Depth (ft)				-	-	-	-	-	-	2.0	-	-	2.2	-	-	-	2.2	-	2.3	2.7	2.8	2.9	0.4	3	
Bankfull Cross Sectional Area (ft ²)		51.7		-	-	-	-	-	-	30.2	-	-	36.6	-	-	-	52.2	-	50.5	58.1	59.0	64.9	7.2	3	
Width/Depth Ratio				-	-	-	-	-	-	12.3	-	-	14.9	-	-	-	18.1	-	14.8	16.8	15.9	19.8	2.6	3	
Entrenchment Ratio				-	-	-	-	-	-	1.3	-	-	2.8	-	-	-	2.1	-	2.1	2.7	2.8	3.3	0.6	3	
Bank Height Ratio				-	-	-	-	-	-	1.0	-	-	1.2	-	-	-	1.0	-	1.0	1.0	1.0	1.0	0.0	3	
d50 (mm)				-	-	-	-	-	-	29.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Profile																									
Rifle Length (ft)				-	-	-	-	-	-	17.7	-	-	64.0	-	-	-	-	-	54.4	109.6	85.4	229.5	68.9	5	
Rifle Slope (ft/ft)				-	-	-	-	-	-	0.77	-	-	3.60	-	-	-	-	-	0.001	0.003	0.003	0.005	0.001	5	
Pool Length (ft)				-	-	-	-	-	-	12.0	-	-	36.0	-	-	-	-	-	34.8	50.8	51.3	66.3	12.4	5	
Pool Max Depth (ft)				-	-	-	-	-	-	2.3	-	-	2.9	-	-	-	3.3	-	3.2	4.6	4.5	6.0	0.9	6	
Pool Spacing (ft)				-	-	-	-	-	-	97.5	-	-	193.0	-	-	154.5	-	220.7	112.6	196.3	187.9	323.2	89.4	5	
Pattern																									
Channel Belt Width (ft)				-	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-	63.72	86.44	92.6	103	20.34	3	
Radius of Curvature (ft)				-	-	-	-	-	-	32.0	-	-	514.0	-	-	-	61.0	-	102.1	114.7	120.1	121.8	10.9	3	
Rc: Bankfull Width (ft)				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.3	3.7	3.9	3.9	0.4	3	
Meander Wavelength (ft)				-	-	-	-	-	-	300.0	-	-	-	-	-	-	-	-	466.5	495.0	497.3	521.1	27.4	3	
Meander Width Ratio				-	-	-	-	-	-	4.3	-	-	-	-	-	-	-	3.2	-	2.0	2.8	3.0	0.7	3	
Substrate, Bed and Transport Parameters																									
Ri% / Ru% / P% / G% / S%																								55% / 11% / 26% / 8% / 0%	
SC% / Sa% / G% / C% / B% / Be%																									1% / 8% / 72% / 17% / 1% / 1%
d16 / d35 / d50 / d84 / d95 / d ₉₀ / d ₉₅ / d ₉₈ / d ₉₉ (mm)																									7.2 / 20 / 29 / 42 / 69 / 120 / - / -
Reach Shear Stress (Competency) lb/ft ²																									0.857
Max Part Size (mm) Mobilized at Bankfull																									760
Stream Power (Transport Capacity) W/m ²																									-
Additional Reach Parameters																									
Drainage Area (mi ²)																									3.33
Impervious Cover Estimate (%)																									4.7
Rosgen Classification																									-
Bankfull Velocity (fps)																									C4
Bankfull Discharge (cfs)																									-
Valley Length (ft)																									550
Channel Thalweg Length (ft)																									600
Sinuosity																									1.10
Water Surface Slope (ft/ft)																									1.136
Bankfull Slope (ft/ft)																									1,161
Bankfull Floodplain Area (acres)																									1,163
Proportion Over Wide (%)																									1.03
Entrenchment Class (ER Range)																									0.003
Incision Class (BHR Range)																									0.003
BEHI																									0.002
Channel Stability or Habitat Metric																									-
Biological or Other																									-

- Information unavailable.

Non-Applicable.

Table 10 Cont'd. Baseline Stream Data Summary																								
Middle South Muddy - Middle Sprouse Branch (177 feet)																								
Parameter	Regional Curve			Pre-Existing Condition						Reference Reach Data						Design			As-Built / Baseline					
Dimension & Substrate - Rifle	LL	UL	Eq.	Min	Mean	Med	Max	SD	N	Min	Mean	Med	Max	SD	N	Min	Mean	Max	Min	Mean	Med	Max	SD	N
Bankfull Width (ft)	-	4.8	-	-	-	-	-	-	-	23.4	-	-	24.7	-	-	-	4.8	-	-	-	-	-	-	-
Floodprone Width (ft)				-	-	-	-	-	-	43.0	-	-	52.0	-	-	-	15.0	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	-	0.5	-	-	-	-	-	-	-	1.3	-	-	1.5	-	-	-	0.3	-	-	-	-	-	-	-
Bankfull Max Depth (ft)				-	-	-	-	-	-	1.8	-	-	2.2	-	-	-	0.5	-	-	-	-	-	-	-
Bankfull Cross Sectional Area (ft ²)		0.5		-	-	-	-	-	-	33.4	-	-	34.6	-	-	-	1.6	-	-	-	-	-	-	-
Width/Depth Ratio				-	-	-	-	-	-	15.8	-	-	18.4	-	-	-	14.1	-	-	-	-	-	-	-
Entrenchment Ratio				-	-	-	-	-	-	1.8	-	-	2.2	-	-	-	3.2	-	-	-	-	-	-	-
Bank Height Ratio				-	-	-	-	-	-	1.4	-	-	1.6	-	-	-	1.0	-	-	-	-	-	-	-
d50 (mm)				-	-	-	-	-	-	45.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Profile																								
Rifle Length (ft)				-	-	-	-	-	-	20.0	-	-	40.0	-	-	-	-	-	15.2	20.0	16.1	28.8	7.6	3
Rifle Slope (ft/ft)				-	-	-	-	-	-	1.500	-	-	4.300	-	-	-	-	-	0.005	0.007	0.008	0.010	0.002	3
Pool Length (ft)				-	-	-	-	-	-	6.0	-	-	42.0	-	-	-	-	-	3.7	9.2	8.2	16.5	5.3	4
Pool Max Depth (ft)				-	-	-	-	-	-	2.3	-	-	2.3	-	-	-	0.8	-	1.6	2.0	1.8	2.7	0.5	4
Pool Spacing (ft)				-	-	-	-	-	-	51.0	-	-	113.0	-	-	15.9	-	22.7	43.0	49.1	44.4	60.1	9.5	3
Pattern																								
Channel Belt Width (ft)				-	-	-	-	-	-	43.0	-	-	-	-	-	-	-	-	7.1	7.9	7.8	8.9	0.9	3
Radius of Curvature (ft)				-	-	-	-	-	-	44.0	-	-	103.0	-	-	-	-	-	8.2	15.0	14.0	23.8	6.9	4
Rc: Bankfull Width (ft)				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7	3.1	2.9	5.0	1.4	4
Meander Wavelength (ft)				-	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-	20.4	26.3	27.1	30.7	4.5	4
Meander Width Ratio				-	-	-	-	-	-	1.8	-	-	-	-	-	-	-	-	1.5	1.7	1.6	1.9	0.2	3
Substrate, Bed and Transport Parameters																								
Ri% / Ru% / P% / G% / S%										-			-											39% / 0% / 24% / 8% / 29%
SC% / Sa% / G% / C% / B% / Be%										-			1% / 10% / 48% / 41% / 0% / 1%											
d16 / d35 / d50 / d84 / d95 / di ^p / di ⁹⁵ (mm)										-			5.2 / 22 / 45 / 75 / 130 / 190 / - / -											
Reach Shear Stress (Competency) lb/ft ²													1.947											-
Max Part Size (mm) Mobilized at Bankfull													91											-
Stream Power (Transport Capacity) W/m ²													-											-
Additional Reach Parameters																								
Drainage Area (mi ²)													2.77											0.03
Impervious Cover Estimate (%)													-											-
Rosgen Classification													B4											B5
Bankfull Velocity (fps)													6.1											-
Bankfull Discharge (cfs)													210.0											-
Valley Length (ft)													380											187
Channel Thalweg Length (ft)													400											177
Sinuosity													1.1											1.06
Water Surface Slope (ft/ft)													-											0.031
Bankfull Slope (ft/ft)													-											0.029
Bankfull Floodplain Area (acres)													-											-
Proportion Over Wide (%)													-											-
Entrenchment Class (ER Range)													-											-
Incision Class (BHR Range)													-											-
BEHI													-											-
Channel Stability or Habitat Metric													-											-
Biological or Other													-											-

- Information unavailable.

Non-Applicable.

**Table 10 Cont'd. Baseline Stream Data Summary
Middle South Muddy - Lower Sprouse Branch (434 feet)**

Parameter	Regional Curve			Pre-Existing Condition						Reference Reach Data						Design			As-Built / Baseline						
	LL	UL	Eq.	Min	Mean	Med	Max	SD	N	Min	Mean	Med	Max	SD	N	Min	Mean	Max	Min	Mean	Med	Max	SD	N	
Dimension & Substrate - Rifle																									
Bankfull Width (ft)	-	5.3	-	-	-	-	-	-	-	23.4	-	-	24.7	-	-	-	5.2	-	5.1	5.3	5.3	5.4	0.2	2	
Floodprone Width (ft)				-	-	-	-	-	-	43.0	-	-	52.0	-	-	-	15.0	-	14.0	19.0	19.0	24.0	3.5	2	
Bankfull Mean Depth (ft)	-	0.5	-	-	-	-	-	-	-	1.3	-	-	1.5	-	-	-	0.4	-	0.3	0.3	0.3	0.3	0.0	2	
Bankfull Max Depth (ft)				-	-	-	-	-	-	1.8	-	-	2.2	-	-	-	0.6	-	0.6	0.6	0.6	0.6	0.0	2	
Bankfull Cross Sectional Area (ft ²)		2.2		-	-	-	-	-	-	33.4	-	-	34.6	-	-	-	1.9	-	1.7	1.7	1.7	1.8	0.0	2	
Width/Depth Ratio				-	-	-	-	-	-	15.8	-	-	18.4	-	-	-	14.3	-	15.1	15.9	15.9	16.7	1.1	2	
Entrenchment Ratio				-	-	-	-	-	-	1.8	-	-	2.2	-	-	-	2.9	-	2.6	3.6	3.6	4.5	1.3	2	
Bank Height Ratio				-	-	-	-	-	-	1.4	-	-	1.6	-	-	-	1.0	-	1.0	1.0	1.0	1.0	0.0	2	
d50 (mm)				-	-	-	-	-	-	45.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Profile																									
Rifle Length (ft)				-	-	-	-	-	-	20.0	-	-	40.0	-	-	-	-	-	6.0	16.2	14.2	32.2	9.3	9	
Rifle Slope (ft/ft)				-	-	-	-	-	-	1.5	-	-	4.3	-	-	-	-	-	0.003	0.011	0.011	0.025	0.007	9	
Pool Length (ft)				-	-	-	-	-	-	6.0	-	-	42.0	-	-	-	-	-	3.4	8.7	9.0	12.1	3.1	11	
Pool Max Depth (ft)				-	-	-	-	-	-	2.3	-	-	2.3	-	-	-	0.8	-	1.3	1.8	1.8	2.3	0.3	11	
Pool Spacing (ft)				-	-	-	-	-	-	51.0	-	-	113.0	-	-	-	18.1	-	25.8	19.0	32.9	32.2	55.1	10.5	10
Pattern																									
Channel Belt Width (ft)				-	-	-	-	-	-	43.0	-	-	-	-	-	-	-	-	10.1	10.4	10.4	10.6	0.3	3	
Radius of Curvature (ft)				-	-	-	-	-	-	44.0	-	-	103.0	-	-	-	-	-	8.8	10.6	10.6	12.5	1.9	4	
Rc: Bankfull Width (ft)				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7	2.0	2.0	2.4	0.4	4	
Meander Wavelength (ft)				-	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-	33.2	38.1	38.5	42.9	3.5	5	
Meander Width Ratio				-	-	-	-	-	-	1.8	-	-	-	-	-	-	-	3.1	1.9	2.0	2.0	2.0	0.0	3	
Substrate, Bed and Transport Parameters																									
Ri% / Ru% / P% / G% / S%										-			-						41%	6%	27%	9%	17%		
SC% / Sa% / G% / C% / B% / Be%										-			1%	10%	48%	41%	0%	1%							
d16 / d35 / d50 / d84 / d95 / di ^p / di ⁹⁵ (mm)										-			5.2	22	45	75	130	190	-	-					
Reach Shear Stress (Competency) lb/ft ²													1.947												
Max Part Size (mm) Mobilized at Bankfull													91												
Stream Power (Transport Capacity) W/m ²													-												
Additional Reach Parameters																									
Drainage Area (mi ²)													2.77						0.04						
Impervious Cover Estimate (%)													-						-						
Rosgen Classification													B4						B5					B5	
Bankfull Velocity (fps)													6.1						-						
Bankfull Discharge (cfs)													210.0						-						
Valley Length (ft)													380.0						422						
Channel Thalweg Length (ft)													400.0						453					453	
Sinuosity													1.1						1.07					1.07	
Water Surface Slope (ft/ft)													-						0.014					0.017	
Bankfull Slope (ft/ft)													-						0.014					0.017	
Bankfull Floodplain Area (acres)													-						-					-	
Proportion Over Wide (%)													-						-					-	
Entrenchment Class (ER Range)													-						-					-	
Incision Class (BHR Range)													-						-					-	
BEHI													-						-					-	
Channel Stability or Habitat Metric													-						-					-	
Biological or Other													-						-					-	

- Information unavailable.

Non-Applicable.

**Table 10 Cont'd. Baseline Stream Data Summary
Middle South Muddy - Upper Iva Branch (326 feet)**

Parameter	Regional Curve			Pre-Existing Condition							Reference Reach Data							Design			As-Built / Baseline					
	LL	UL	Eq.	Min	Mean	Med	Max	SD	N	Min	Mean	Med	Max	SD	N	Min	Mean	Max	Min	Mean	Med	Max	SD	N		
Dimension & Substrate - Riffle																										
Bankfull Width (ft)	-	4.8	-	-	-	-	-	-	-	23.4	-	-	24.7	-	-	-	4.8	-	4.6	4.9	4.9	5.3	0.5	2		
Floodprone Width (ft)				-	-	-	-	-	-	43.0	-	-	52	-	-	-	15.0	-	14.0	15.5	15.5	17.0	2.1	2		
Bankfull Mean Depth (ft)	-	0.5	-	-	-	-	-	-	-	1.3	-	-	1.5	-	-	-	0.3	-	0.4	0.4	0.4	0.4	0.0	2		
Bankfull Max Depth (ft)				-	-	-	-	-	-	1.8	-	-	2.2	-	-	-	0.5	-	0.6	0.6	0.6	0.7	0.1	2		
Bankfull Cross Sectional Area (ft ²)		1.8		-	-	-	-	-	-	33.4	-	-	34.6	-	-	-	1.6	-	1.9	2.0	2.0	2.1	0.1	2		
Width/Depth Ratio				-	-	-	-	-	-	15.8	-	-	18.4	-	-	-	14.1	-	11.0	12.2	12.2	13.3	1.6	2		
Entrenchment Ratio				-	-	-	-	-	-	1.8	-	-	2.2	-	-	-	3.2	-	3.0	3.1	3.1	3.2	0.1	2		
Bank Height Ratio				-	-	-	-	-	-	1.4	-	-	1.6	-	-	-	1.0	-	1.0	1.0	1.0	1.0	0.0	2		
d50 (mm)				-	-	-	-	-	-	45.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Profile																										
Riffle Length (ft)				-	-	-	-	-	-	20.0	-	-	40.0	-	-	-	-	-	26.7	48.8	40.1	90.6	24.6	5		
Riffle Slope (ft/ft)				-	-	-	-	-	-	1.50	-	-	4.30	-	-	-	-	-	0.001	0.004	0.002	0.009	0.003	5		
Pool Length (ft)				-	-	-	-	-	-	6.0	-	-	42.0	-	-	-	-	-	2.1	2.8	2.7	3.4	0.6	4		
Pool Max Depth (ft)				-	-	-	-	-	-	2.3	-	-	2.3	-	-	-	0.8	-	0.5	0.8	0.8	1.2	0.3	4		
Pool Spacing (ft)				-	-	-	-	-	-	51.0	-	-	113.0	-	-	15.9	-	22.7	47.1	55.5	59.0	60.4	7.3	3		
Pattern																										
Channel Belt Width (ft)				-	-	-	-	-	-	43.0	-	-	-	-	-	-	-	-	11.9	14.8	14.8	17.6	4.0	2		
Radius of Curvature (ft)				-	-	-	-	-	-	44.0	-	-	103.0	-	-	-	-	-	7.6	9.4	8.4	13.2	2.6	4		
Rc: Bankfull Width (ft)				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5	1.9	1.7	2.7	0.5	4		
Meander Wavelength (ft)				-	-	-	-	-	-	100.0	-	-	-	-	-	-	-	-	43.2	48.1	47.7	53.8	5.0	4		
Meander Width Ratio				-	-	-	-	-	-	1.8	-	-	-	-	-	-	-	-	2.5	-	2.4	3.0	3.0	3.5	0.8	2
Substrate, Bed and Transport Parameters																										
Ri% / Ru% / P% / G% / S%																								80% / 0% / 4% / 2% / 14%		
SC% / Sa% / G% / C% / B% / Be%																									1% / 10% / 48% / 41% / 0% / 1%	
d16 / d35 / d50 / d84 / d95 / di ^p / di ⁹⁵ (mm)																									5.2 / 22 / 45 / 75 / 130 / 190 / - / -	
Reach Shear Stress (Competency) lb/ft ²													1.947												-	
Max Part Size (mm) Mobilized at Bankfull													91												-	
Stream Power (Transport Capacity) W/m ²																									-	
Additional Reach Parameters																										
Drainage Area (mi ²)													2.77												0.03	
Impervious Cover Estimate (%)																									-	
Rosgen Classification													B4												B5	
Bankfull Velocity (fps)													6.1												-	
Bankfull Discharge (cfs)													210.0												-	
Valley Length (ft)													380												424	
Channel Thalweg Length (ft)													400												326	
Sinuosity													1.10												1.09	
Water Surface Slope (ft/ft)																									0.058	
Bankfull Slope (ft/ft)																									0.058	
Bankfull Floodplain Area (acres)																									0.056	
Proportion Over Wide (%)																									0.056	
Entrenchment Class (ER Range)																									-	
Incision Class (BHR Range)																									-	
BEHI																									-	
Channel Stability or Habitat Metric																									-	
Biological or Other																									-	

- Information unavailable.

Non-Applicable.

**Table 10 Cont'd. Baseline Stream Data Summary
Middle South Muddy - Lower Iva Branch (136 feet)**

Parameter	Regional Curve			Pre-Existing Condition							Reference Reach Data							Design			As-Built / Baseline				
Dimension & Substrate - Riffle	LL	UL	Eq.	Min	Mean	Med	Max	SD	N	Min	Mean	Med	Max	SD	N	Min	Mean	Max	Min	Mean	Med	Max	SD	N	
Bankfull Width (ft)	-	5.6	-	-	-	-	-	-	-	23.4	-	-	24.7	-	-	-	5.5	-	-	-	-	-	-	-	
Floodprone Width (ft)				-	-	-	-	-	-	43.0	-	-	52	-	-	-	15.0	-	-	-	-	-	-	-	
Bankfull Mean Depth (ft)	-	0.5	-	-	-	-	-	-	-	1.3	-	-	1.5	-	-	-	0.4	-	-	-	-	-	-	-	
Bankfull Max Depth (ft)				-	-	-	-	-	-	1.8	-	-	2.2	-	-	-	0.6	-	-	-	-	-	-	-	
Bankfull Cross Sectional Area (ft ²)		2.4		-	-	-	-	-	-	33.4	-	-	34.6	-	-	-	2.1	-	-	-	-	-	-	-	
Width/Depth Ratio				-	-	-	-	-	-	15.8	-	-	18.4	-	-	-	14.4	-	-	-	-	-	-	-	
Entrenchment Ratio				-	-	-	-	-	-	1.8	-	-	2.2	-	-	-	2.7	-	-	-	-	-	-	-	
Bank Height Ratio				-	-	-	-	-	-	1.4	-	-	1.6	-	-	-	1.0	-	-	-	-	-	-	-	
d50 (mm)				-	-	-	-	-	-	45.0	-	-	-	-	-										
Profile																									
Riffle Length (ft)				-	-	-	-	-	-	20.0	-	-	40.0	-	-	-	-	9.4	11.8	11.8	14.3	3.5	2		
Riffle Slope (ft/ft)				-	-	-	-	-	-	1.50	-	-	4.30	-	-	-	-	0.010	0.021	0.021	0.033	0.016	2		
Pool Length (ft)				-	-	-	-	-	-	6.0	-	-	42.0	-	-	-	-	5.8	9.4	9.4	12.9	3.3	4		
Pool Max Depth (ft)				-	-	-	-	-	-	2.3	-	-	2.3	-	-	-	0.9	-	1.0	1.1	1.1	1.2	0.1	4	
Pool Spacing (ft)				-	-	-	-	-	-	51.0	-	-	113.0	-	-	-	19.3	-	27.5	20.8	25.9	20.8	36.1	8.9	3
Pattern																									
Channel Belt Width (ft)				-	-	-	-	-	-	43.0	-	-	-	-	-	-	-	8.9	9.6	9.6	10.3	1.0	2		
Radius of Curvature (ft)				-	-	-	-	-	-	44.0	-	-	103.0	-	-	-	-	12.2	12.5	12.5	12.8	0.4	2		
Rc: Bankfull Width (ft)				-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.2	2.3	2.3	2.3	0.1	2		
Meander Wavelength (ft)				-	-	-	-	-	-	100.0	-	-	-	-	-	-	-	23.0	27.4	25.5	33.6	5.6	3		
Meander Width Ratio				-	-	-	-	-	-	1.8	-	-	-	-	-	-	2.2	-	1.6	1.7	1.7	1.9	0.2	2	
Substrate, Bed and Transport Parameters																									
Ri% / Ru% / P% / G% / S%																								24% / 17% / 38% / 20% / 0%	
SC% / Sa% / G% / C% / B% / Be%																								1% / 10% / 48% / 41% / 0% / 1%	
d16 / d35 / d50 / d84 / d95 / di ⁹⁰ / di ⁹⁵ (mm)																								5.2 / 22 / 45 / 75 / 130 / 190 / - / -	
Reach Shear Stress (Competency) lb/ft ²																								1.947	
Max Part Size (mm) Mobilized at Bankfull																								91	
Stream Power (Transport Capacity) W/m ²																								-	
Additional Reach Parameters																									
Drainage Area (mi ²)																								2.77	
Impervious Cover Estimate (%)																								0.046	
Rosgen Classification																								B4	
Bankfull Velocity (fps)																								B5	
Bankfull Discharge (cfs)																								6.1	
Valley Length (ft)																								210.0	
Channel Thalweg Length (ft)																								380.0	
Sinuosity																								151	
Water Surface Slope (ft/ft)																								400.0	
Bankfull Slope (ft/ft)																								156	
Bankfull Floodplain Area (acres)																								1.10	
Proportion Over Wide (%)																								1.02	
Entrenchment Class (ER Range)																								1.03	
Incision Class (BHR Range)																								0.026	
BEHI																								0.026	
Channel Stability or Habitat Metric																								0.032	
Biological or Other																								0.035	

- Information unavailable.

Non-Applicable.

**Table 11a. Baseline Morphology & Hydraulic Monitoring Summary
Middle South Muddy Stream Restoration Site**

Dimension	Cross-Section 1 (Riffle) Lower Sprouse Branch						Cross-Section 2 (Riffle) Lower Sprouse Branch						Cross-Section 3 (Pool) Lower Sprouse Branch						Cross-Section 4 (Riffle) South Muddy Creek						Cross-Section 5 (Riffle) South Muddy Creek					
	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
Record Elevation (datum) Used	1,278.1	1,278.1	1,278.1	1,278.2			1,275.8	1,275.8	1,275.8	1,276.0			1,273.7	1,273.7	1,273.7	1,273.8			1,269.4	1,269.4	1,269.4	1,269.5			1,267.9	1,267.9	1,267.9	1,268.1		
Low Bank Height Elevation (datum) Used	-	-	-	1,278.1			-	-	-	1,275.9			-	-	-	1,273.7			-	-	-	1,269.4			-	-	-	1,268.4		
Bankfull Width (ft)	5.4	6.1	6.3	5.5			5.1	5.3	5.4	6.3			6.1	6.8	6.8	8.0			31.6	32.6	31.8	30.2			30.7	30.6	31.8	29.6		
Floodprone Width (ft)	14.0	14.0	14.0	14.0			23.0	23.0	23.0	23.0			32.0	32.0	32.0	32.0			65.0	65.0	65.0	65.0			101.0	101.0	101.0	101.0		
Bankfull Mean Depth (ft)	0.3	0.2	0.2	0.3			0.3	0.2	0.2	0.3			1.0	0.9	0.9	0.7			1.6	1.7	1.7	1.7			1.9	1.9	1.9	2.0		
Bankfull Max Depth (ft)	0.6	0.5	0.4	0.5			0.6	0.5	0.5	0.7			1.5	1.6	1.7	1.3			2.3	2.6	2.6	2.8			2.8	2.8	3.0	3.3		
Bankfull Cross Sectional Area (ft ²)	1.8	1.5	1.5	1.8			1.7	1.3	1.2	1.7			5.9	6.3	6.3	5.9			50.5	54.1	52.8	50.5			59.0	57.9	61.3	59.0		
Bankfull Width/Depth Ratio	16.7	25.4	25.8	17.4			15.1	21.5	23.7	23.3			6.3	7.5	7.3	10.9			19.8	19.7	19.1	18.0			15.9	16.2	16.4	14.9		
Bankfull Entrenchment Ratio	2.6	2.3	2.2	2.5			4.5	4.3	4.3	3.7			5.3	4.7	4.7	4.0			2.1	2.0	2.0	2.2			3.3	3.3	3.2	3.4		
Bankfull Bank Height Ratio*	1.0	0.9	0.9	0.9			1.0	1.0	0.9	0.9			1.0	1.1	1.0	0.9			1.0	0.9	1.0	1.0			1.0	1.0	1.1	1.1		
Low Top of Bank Height Depth (ft)	-	-	-	0.4			-	-	-	0.6			-	-	-	1.2			-	-	-	2.7			-	-	-	3.6		
d50 (mm)	N/A	N/A	N/A	N/A			N/A	N/A	N/A	N/A			N/A	N/A	N/A	N/A			N/A	14.0	27.0	27.0			N/A	18.0	15.0	16.0		
Dimension	Cross-Section 6 (Pool) South Muddy Creek						Cross-Section 7 (Riffle) South Muddy Creek						Cross-Section 8 (Pool) Upper Iva Branch						Cross-Section 9 (Riffle) Upper Iva Branch						Cross-Section 10 (Riffle) Upper Iva Branch					
	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5	Base	MY1	MY2	MY3	MY4	MY5
Record Elevation (datum) Used	1,268.0	1,268.0	1,268.0	1,268.1			1,267.3	1,267.3	1,267.3	1,267.5			1,286.1	1,286.1	1,286.1	1,286.2			1,285.3	1,285.3	1,285.3	1,285.2			1,277.1	1,277.1	1,277.1	1,277.2		
Low Bank Height Elevation (datum) Used	-	-	-	1,268.5			-	-	-	1,267.4			-	-	-	1,286.0			-	-	-	1,285.2			-	-	-	1,277.2		
Bankfull Width (ft)	35.3	35.9	36.7	31.7			31.0	31.2	34.0	29.9			5.5	5.8	5.6	7.2			4.6	4.2	4.1	6.0			5.3	5.6	5.8	4.2		
Floodprone Width (ft)	166.0	166.0	166.0	166.0			88.0	88.0	88.0	88.0			17.0	17.0	17.0	17.0			14.0	14.0	14.0	14.0			17.0	17.0	17.0	17.0		
Bankfull Mean Depth (ft)	2.4	2.4	2.4	2.7			2.1	2.2	2.0	2.2			1.0	1.0	1.0	0.8			0.4	0.4	0.5	0.3			0.4	0.3	0.4	0.5		
Bankfull Max Depth (ft)	4.0	3.9	3.9	4.3			2.9	3.0	3.1	3.4			1.8	1.7	1.7	1.6			0.7	0.6	0.8	0.7			0.6	0.6	0.6	0.8		
Bankfull Cross Sectional Area (ft ²)	85.7	86.3	89.2	85.7			64.9	67.7	67.9	64.3			5.7	5.6	5.6	5.7			1.9	1.8	2.1	1.9			2.1	1.9	2.5	2.1		
Bankfull Width/Depth Ratio	14.5	14.9	15.1	11.7			14.8	14.4	17.0	13.9			5.4	6.1	5.5	9.0			11.0	9.8	8.0	18.7			13.3	16.7	13.3	8.4		
Bankfull Entrenchment Ratio	4.7	4.6	4.5	5.2			2.8	2.8	2.6	2.9			3.1	2.9	3.1	2.4			3.0	3.3	3.5	2.3			3.2	3.0	3.0	4.0		
Bankfull Bank Height Ratio*	1.0	1.0	1.0	1.1			1.0	0.9	0.9	1.0			1.0	0.9	1.0	0.8			1.0	1.0	0.9	0.9			1.0	1.0	1.0	1.0		
Low Top of Bank Height Depth (ft)	-	-	-	4.7			-	-	-	3.3			-	-	-	1.3			-	-	-	0.7			-	-	-	0.8		
d50 (mm)	N/A	N/A	N/A	N/A			N/A	0.91	1.3	18.0			N/A	N/A	N/A	N/A			N/A	N/A	N/A	N/A			N/A	N/A	N/A	N/A		

N/A - Item does not apply.

* Beginning in MY3 (2018), the bankfull elevation and channel cross-section dimensions have been calculated using a fixed Abkf as described in the Standard Measurement of the BHR Monitoring Parameter provided by NCIRT and NCDMS (9/2018)

**Table 11b. Monitoring Data - Stream Reach Data Summary
Middle South Muddy Stream Restoration Site - South Muddy Creek (1,088 feet)**

Parameter	Baseline						MY - 1						MY - 2						MY - 3						MY - 4						MY - 5					
	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
Dimension & Substrate - Riffle																																				
Bankfull Width (ft)	30.7	31.1	31.0	31.6	0.5	3	30.6	31.5	31.2	32.6	1.0	3	31.8	32.5	31.8	34.0	1.3	3	29.6	29.9	29.9	30.2	0.3	3												
Floodprone Width (ft)	65.0	84.7	88.0	101.0	18.2	3	65.0	84.7	88.0	101.0	18.2	3	65.0	84.7	88.0	101.0	18.2	3	65.0	84.7	88.0	101.0	18.2	3												
Bankfull Mean Depth (ft)	1.6	1.9	1.9	2.1	0.3	3	1.7	1.9	1.9	2.2	0.3	3	1.7	1.9	1.9	2.0	0.2	3	1.7	1.9	2.0	2.2	0.2	3												
Bankfull Max Depth (ft)	2.3	2.7	2.8	2.9	0.4	3	2.6	2.8	2.8	3.0	0.2	3	2.6	2.9	3.0	3.1	0.3	3	2.8	3.2	3.3	3.4	0.3	3												
Bankfull Cross-Sectional Area (ft ²)	50.5	58.1	59.0	64.9	7.2	3	54.1	59.9	57.9	67.7	7.0	3	52.8	60.7	61.3	67.9	7.5	3	50.5	57.9	59.0	64.3	6.9	3												
Width/Depth Ratio	14.8	16.8	15.9	19.8	2.6	3	14.4	16.7	16.2	19.7	2.7	3	16.4	17.5	17.0	19.1	1.4	3	13.9	15.6	14.9	18.0	2.2	3												
Entrenchment Ratio	2.1	2.7	2.8	3.3	0.6	3	2.0	2.7	2.8	3.3	0.7	3	2.0	2.6	2.6	3.2	0.6	3	2.2	2.8	2.9	3.4	0.6	3												
Bank Height Ratio	1.0	1.0	1.0	1.0	0.0	3	1.0	1.0	1.0	1.0	0.0	3	1.0	1.0	1.0	1.0	0.0	3	1.0	1.0	1.0	1.1	0.1	3												
Profile																																				
Riffle Length (ft)	54.4	109.6	85.4	229.5	68.9	5	64.1	111.4	90.3	203.5	56.0	5	58.0	108.2	99.1	202.2	57.7	5	70.2	102.6	77.4	206.9	58.7	5												
Riffle Slope (ft/ft)	0.001	0.003	0.003	0.005	0.001	5	0.001	0.005	0.004	0.009	0.003	5	0.001	0.004	0.003	0.008	0.003	5	0.000	0.004	0.001	0.013	0.005	5												
Pool Length (ft)	34.8	50.8	51.3	66.3	12.4	5	17.8	56.4	48.5	96.8	30.1	5	23.4	56.0	56.9	95.7	26.5	5	26.0	55.6	54.3	91.7	24.8	5												
Pool Max Depth (ft)	3.2	4.6	4.5	6.0	0.9	6	3.4	4.1	3.8	5.4	0.8	5	3.7	4.6	4.4	5.8	0.8	5	3.0	4.7	4.6	6.2	1.4	5												
Pool Spacing (ft)	112.6	196.3	187.9	323.2	89.4	5	177.1	247.4	239.1	334.2	68.6	4	179.1	249.1	230.1	357.2	81.2	4	139.1	248.7	229.5	396.8	112.5	4												
Pattern																																				
Channel Belt Width (ft)	63.7	86.4	92.6	103.0	20.34	3																														
Radius of Curvature (ft)	102.1	114.7	120.1	121.8	10.94	3																														
Rc: Bankfull Width (ft/ft)	3.28	3.7	3.86	3.92	0.35	3																														
Meander Wavelength (ft)	466.5	495.0	497.3	521.1	27.38	3																														
Meander Width Ratio	2.0	2.8	3.0	3.3	0.65	3																														
Additional Reach Parameters																																				
Rosgen Classification	C4						C4						C4																							
Channel Thalweg Length (ft)	1,163						1,158						1,174						1,151																	
Sinuosity (ft)	1.03						1.03						1.05						1.03																	
Water Surface Slope (Channel) (ft/ft)	0.003						0.0033						0.0033						0.0027																	
Bankfull Slope (ft/ft)	0.002						0.0029						0.0037						0.0031																	
Ri% / Ru% / P% / G% / S%	55%	11%	26%	8%	0%		56%	6%	28%	9%	0%		54%	10%	28%	8%	0%		53%	11%	29%	8%	0%													

- Information Unavailable

N/A - Information does not apply.

Ri = Riffle / Ru = Run / P = Pool / G = Glide / S = Step

**Table 11b Cont'd. Monitoring Data - Stream Reach Data Summary
Middle South Muddy Stream Restoration Site - Middle Sprouse Branch (177 feet)**

Parameter	Baseline						MY - 1						MY - 2						MY - 3						MY - 4						MY - 5					
	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
Dimension & Substrate - Riffle																																				
Bankfull Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bankfull Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bankfull Cross-Sectional Area (ft ²)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width/Depth Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entrenchment Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Height Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Profile																																				
Riffle Length (ft)	15.2	20.0	16.1	28.8	7.6	3	18.1	27.3	23.6	40.1	11.5	3	16.9	24.0	19.6	35.5	10.0	3	16.3	23.9	18.4	37.0	11.4	3												
Riffle Slope (ft/ft)	0.005	0.007	0.008	0.010	0.002	3	0.003	0.008	0.009	0.013	0.005	3	0.002	0.010	0.011	0.017	0.008	3	0.007	0.010	0.009	0.013	0.003	3												
Pool Length (ft)	3.7	9.2	8.2	16.5	5.3	4	6.5	9.4	9.9	11.5	2.2	4	5.7	8.1	7.4	11.9	2.7	4	6.0	8.5	8.2	11.7	2.4	4												
Pool Max Depth (ft)	1.6	2.0	1.8	2.7	0.5	4	1.1	1.8	1.8	2.4	0.6	4	1.3	1.8	1.7	2.4	0.5	4	1.2	1.5	1.6	1.8	0.2	4												
Pool Spacing (ft)	43.0	49.1	44.4	60.1	9.5	3	52.3	58.9	52.6	71.7	11.1	3	42.4	49.3	47.2	58.3	8.2	3	42.2	48.9	47.8	56.5	7.2	3												
Pattern																																				
Channel Belt Width (ft)	7.1	7.9	7.8	8.9	0.9	3																														
Radius of Curvature (ft)	8.2	15.0	14.0	23.8	6.9	4																														
Rc: Bankfull Width (ft/ft)	1.7	3.1	2.9	5.0	1.4	4																														
Meander Wavelength (ft)	20.4	26.3	27.1	30.7	4.5	4																														
Meander Width Ratio	1.5	1.7	1.6	1.9	0.2	3																														
Additional Reach Parameters																																				
Rosgen Classification				B5						B5						B5						B5														
Channel Thalweg Length (ft)				177						159						160						158														
Sinuosity (ft)				1.01						1.02						1.03						1.02														
Water Surface Slope (Channel) (ft/ft)				0.029						0.028						0.029						0.030														
Bankfull Slope (ft/ft)				0.029						0.025						0.026						0.023														
Ri% / Ru% / P% / G% / S%	39%	0%	24%	8%	29%		44%	0%	20%	7%	28%		46%	0%	21%	7%	27%		45%	0%	21%	5%	28%													

- Information Unavailable

N/A - Information does not apply.

Ri = Riffle / Ru = Run / P = Pool / G = Glide / S = Step

**Table 11b Cont'd. Monitoring Data - Stream Reach Data Summary
Middle South Muddy Stream Restoration Site - Lower Sprouse Branch (434 feet)**

Parameter	Baseline						MY - 1						MY - 2						MY - 3						MY - 4						MY - 5					
	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
Bankfull Width (ft)	5.1	5.3	5.3	5.4	0.2	2	5.3	5.7	5.7	6.1	0.6	2	5.4	5.8	5.8	6.3	0.6	2	5.5	5.9	5.9	6.3	0.5	2												
Floodprone Width (ft)	14.0	19.0	19.0	24.0	3.5	2	14.0	18.5	18.5	23.0	6.4	2	14.0	18.5	18.5	23.0	6.4	2	14.0	18.5	18.5	23.0	6.4	2												
Bankfull Mean Depth (ft)	0.3	0.3	0.3	0.3	0.0	2	0.2	0.2	0.2	0.2	0.0	2	0.2	0.2	0.2	0.2	0.0	2	0.3	0.3	0.3	0.3	0.0	2												
Bankfull Max Depth (ft)	0.6	0.6	0.6	0.6	0.0	2	0.5	0.5	0.5	0.5	0.1	2	0.4	0.5	0.5	0.5	0.1	2	0.5	0.6	0.6	0.7	0.1	2												
Bankfull Cross-Sectional Area (ft ²)	1.7	1.7	1.7	1.8	0.0	2	1.3	1.4	1.4	1.5	0.1	2	1.2	1.4	1.4	1.5	0.2	2	1.7	1.7	1.7	1.8	0.0	2												
Width/Depth Ratio	15.1	15.9	15.9	16.7	1.1	2	21.5	23.4	23.4	25.4	2.8	2	23.7	24.8	24.8	25.8	1.5	2	17.4	20.3	20.3	23.3	4.1	2												
Entrenchment Ratio	2.6	3.6	3.6	4.5	1.3	2	2.3	3.3	3.3	4.3	1.4	2	2.2	3.2	3.2	4.3	1.4	2	2.5	3.1	3.1	3.7	0.8	2												
Bank Height Ratio	1.0	1.0	1.0	1.0	0.0	2	1.0	1.0	1.0	1.0	0.0	2	1.0	1.0	1.0	1.0	0.0	2	0.9	0.9	0.9	0.9	0.0	2												
Profile																																				
Riffle Length (ft)	6.0	16.2	14.2	32.2	9.3	9	7.6	19.1	14.2	39.7	11.0	9	5.3	15.1	10.6	30.2	9.2	9	6.4	16.2	12.2	32.5	10.6	6												
Riffle Slope (ft/ft)	0.003	0.011	0.011	0.025	0.007	9	0.004	0.009	0.009	0.016	0.004	9	0.004	0.012	0.010	0.025	0.007	9	0.007	0.014	0.011	0.030	0.008	6												
Pool Length (ft)	3.4	8.7	9.0	12.1	3.1	11	5.2	10.4	10.4	15.7	3.6	11	3.8	9.3	9.1	15.5	4.2	11	5.4	9.4	9.1	17.8	3.6	11												
Pool Max Depth (ft)	1.3	1.8	1.8	2.3	0.3	11	1.0	1.8	1.9	2.3	0.4	11	1.4	1.7	1.7	2.1	0.3	11	1.2	1.6	1.6	2.0	0.3	11												
Pool Spacing (ft)	19.0	32.9	32.2	55.1	10.5	10	26.3	39.2	38.6	62.5	10.8	10	17.3	32.9	33.0	54.6	10.1	10	19.4	32.8	34.3	55.2	10.9	10												
Pattern																																				
Channel Belt Width (ft)	10.1	10.4	10.4	10.6	0.3	3																														
Radius of Curvature (ft)	8.8	10.6	10.6	12.5	1.9	4																														
Rc: Bankfull Width (ft/ft)	1.7	2.0	2.0	2.4	0.4	4																														
Meander Wavelength (ft)	33.2	38.1	38.5	42.9	3.5	5																														
Meander Width Ratio	1.9	2.0	2.0	2.0	0.0	3																														
Additional Reach Parameters																																				
Rosgen Classification	B5						B5						B5						B5																	
Channel Thalweg Length (ft)	453						465						463						466																	
Sinuosity (ft)	1.07						1.04						1.04						1.04																	
Water Surface Slope (Channel) (ft/ft)	0.017						0.014						0.017						0.018																	
Bankfull Slope (ft/ft)	0.017						0.016						0.020						0.020																	
Ri% / Ru% / P% / G% / S%	41%	6%	27%	9%	17%		41%	6%	27%	9%	16%		39%	6%	29%	10%	16%		28%	8%	29%	12%	22%													

- Information Unavailable

N/A - Information does not apply.

Ri = Riffle / Ru = Run / P = Pool / G = Glide / S = Step

**Table 11b Cont'd. Monitoring Data - Stream Reach Data Summary
Middle South Muddy Stream Restoration Site - Upper Iva Branch (326 feet)**

Parameter	Baseline						MY - 1						MY - 2						MY - 3						MY - 4						MY - 5					
	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
Dimension & Substrate - Riffle																																				
Bankfull Width (ft)	4.6	4.9	4.9	5.3	0.5	2	4.2	4.9	4.9	5.6	1.0	2	4.1	4.9	4.9	5.8	1.2	2	4.2	5.1	5.1	6.0	1.2	2												
Floodprone Width (ft)	14.0	15.5	15.5	17.0	2.1	2	14.0	15.5	15.5	17.0	2.1	2	14.0	15.5	15.5	17.0	2.1	2	14.0	15.5	15.5	17.0	2.1	2												
Bankfull Mean Depth (ft)	0.4	0.4	0.4	0.4	0.0	2	0.3	0.4	0.4	0.4	0.1	2	0.4	0.5	0.5	0.5	0.1	2	0.3	0.4	0.4	0.5	0.1	2												
Bankfull Max Depth (ft)	0.6	0.6	0.6	0.7	0.1	2	0.6	0.6	0.6	0.6	0.1	2	0.6	0.7	0.7	0.8	0.1	2	0.7	0.7	0.7	0.8	0.1	2												
Bankfull Cross-Sectional Area (ft ²)	1.9	2.0	2.0	2.1	0.1	2	1.8	1.9	1.9	1.9	0.0	2	2.1	2.3	2.3	2.5	0.3	2	1.9	2.0	2.0	2.1	0.2	2												
Width/Depth Ratio	11.0	12.2	12.2	13.3	1.6	2	9.8	13.2	13.2	16.7	4.9	2	8.0	10.6	10.6	13.3	3.7	2	8.4	13.6	13.6	18.7	7.3	2												
Entrenchment Ratio	3.0	3.1	3.1	3.2	0.1	2	3.0	3.2	3.2	3.3	0.2	2	3.0	3.2	3.2	3.5	0.4	2	2.3	3.2	3.2	4.0	1.2	2												
Bank Height Ratio	1.0	1.0	1.0	1.0	0.0	2	1.0	1.0	1.0	1.0	0.0	2	1.0	1.0	1.0	1.0	0.0	2	0.9	1.0	1.0	1.0	0.1	2												
Profile																																				
Riffle Length (ft)	26.7	48.8	40.1	90.6	24.6	5	21.8	46.1	37.7	88.5	25.5	5	23.6	46.3	35.6	87.7	25.1	5	26.6	46.6	32.3	83.9	24.6	5												
Riffle Slope (ft/ft)	0.001	0.004	0.002	0.009	0.003	5	0.005	0.007	0.007	0.011	0.002	5	0.006	0.008	0.007	0.011	0.002	5	0.011	0.022	0.023	0.033	0.010	5												
Pool Length (ft)	2.1	2.8	2.7	3.4	0.6	4	3.2	4.5	4.1	6.7	1.7	4	1.6	4.2	4.2	6.9	2.3	4	6.2	6.7	6.3	7.9	0.8	4												
Pool Max Depth (ft)	0.5	0.8	0.8	1.2	0.3	4	0.4	0.5	0.5	0.8	0.2	4	0.3	0.5	0.4	1.0	0.3	4	0.4	0.6	0.4	1.0	0.4	3												
Pool Spacing (ft)	47.1	55.5	59.0	60.4	7.3	3	49.6	54.9	54.9	60.1	5.3	3	48.2	54.8	53.9	62.3	7.1	3	41.3	55.5	43.5	81.7	22.7	3												
Pattern																																				
Channel Belt Width (ft)	11.9	14.8	14.8	17.6	4.0	2																														
Radius of Curvature (ft)	7.6	9.4	8.4	13.2	2.6	4																														
Rc: Bankfull Width (ft/ft)	1.5	1.9	1.7	2.7	0.5	4																														
Meander Wavelength (ft)	43.2	48.1	47.7	53.8	5.0	4																														
Meander Width Ratio	2.4	3.0	3.0	3.5	0.8	2																														
Additional Reach Parameters																																				
Rosgen Classification	B5						B5						B5						B5																	
Channel Thalweg Length (ft)	326						330						328						332																	
Sinuosity (ft)	1.10						1.11						1.11						1.12																	
Water Surface Slope (Channel) (ft/ft)	0.056						-						-						0.0532																	
Bankfull Slope (ft/ft)	0.056						0.0598						0.0595						0.0670																	
Ri% / Ru% / P% / G% / S%	80%	0%	4%	2%	14%		75%	0%	6%	4%	15%		75%	0%	5%	4%	15%		77%	0%	9%	3%	11%													

- Information Unavailable

N/A - Information does not apply.

Ri = Riffle / Ru = Run / P = Pool / G = Glide / S = Step

**Table 11b Cont'd. Monitoring Data - Stream Reach Data Summary
Middle South Muddy Stream Restoration Site - Lower Iva Branch (136 feet)**

Parameter	Baseline						MY - 1						MY - 2						MY - 3						MY - 4						MY - 5					
	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
Dimension & Substrate - Riffle																																				
Bankfull Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Floodprone Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bankfull Max Depth (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bankfull Cross-Sectional Area (ft ²)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Width/Depth Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entrenchment Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Height Ratio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Profile																																				
Riffle Length (ft)	9.4	11.8	11.8	14.3	3.5	2	10.4	16.5	16.5	22.7	8.7	2	11.6	17.2	17.2	22.8	7.9	2	6.7	12.7	12.7	18.7	8.5	2												
Riffle Slope (ft/ft)	0.010	0.021	0.021	0.033	0.016	2	0.005	0.015	0.015	0.026	0.015	2	0.009	0.015	0.015	0.020	0.007	2	0.009	0.022	0.022	0.035	0.019	2												
Pool Length (ft)	5.8	9.4	9.4	12.9	3.3	4	2.9	5.3	5.0	8.3	2.7	4	3.4	5.8	4.9	10.0	3.1	4	3.5	7.1	7.5	9.8	2.9	4												
Pool Max Depth (ft)	1.0	1.1	1.1	1.2	0.1	4	0.6	1.0	1.0	1.5	0.3	4	0.5	1.1	1.0	1.7	0.5	4	0.3	0.9	0.9	1.5	0.5	4												
Pool Spacing (ft)	20.8	25.9	20.8	36.1	8.9	3	18.0	23.4	24.4	27.8	5.0	3	18.9	23.8	25.0	27.6	4.5	3	21.3	25.2	25.5	28.8	3.8	3												
Pattern																																				
Channel Belt Width (ft)	8.9	9.6	9.6	10.3	1.0	2																														
Radius of Curvature (ft)	12.2	12.5	12.5	12.8	0.4	2																														
Rc: Bankfull Width (ft/ft)	2.2	2.3	2.3	2.3	0.1	2																														
Meander Wavelength (ft)	23.0	27.4	25.5	33.6	5.6	3																														
Meander Width Ratio	1.6	1.7	1.7	1.9	0.2	2																														
Additional Reach Parameters																																				
Rosgen Classification				B5						B5						B5						B5														
Channel Thalweg Length (ft)				156						154						159						158														
Sinuosity (ft)				1.03						1.03						1.07						1.06														
Water Surface Slope (Channel) (ft/ft)				0.032						-						-						0.0503														
Bankfull Slope (ft/ft)				0.035						0.0257						0.0326						0.0336														
Ri% / Ru% / P% / G% / S%	24%	17%	38%	20%	0%		43%	17%	28%	14%	0%		45%	14%	30%	11%	0%		34%	13%	38%	16%	0%													

- Information Unavailable

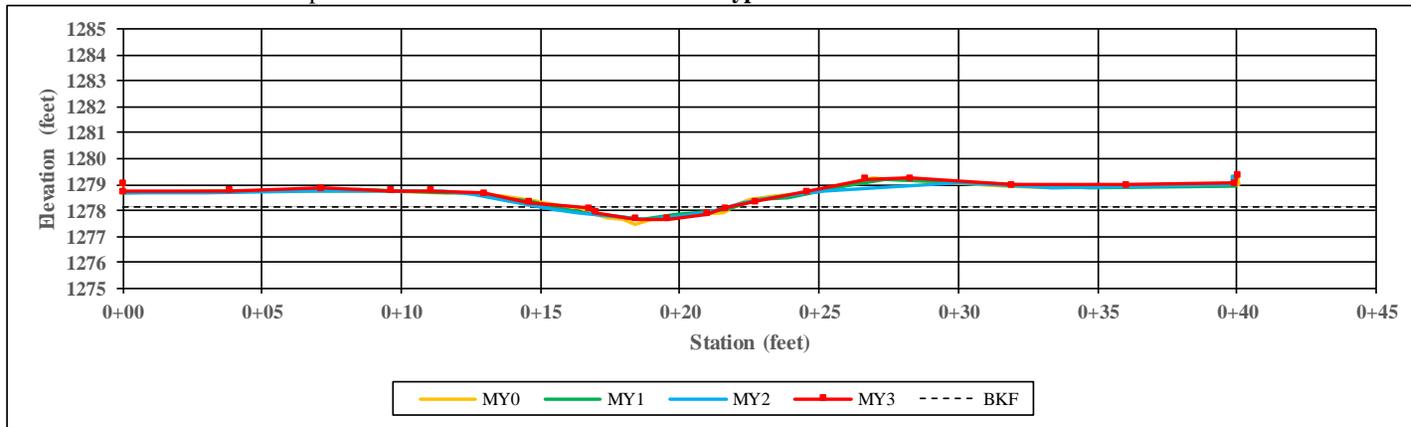
N/A - Information does not apply.

Ri = Riffle / Ru = Run / P = Pool / G = Glide / S = Step

Project Name: Middle South Muddy
Reach Name: Lower Sprouse Branch

XS Number: 1
XS Type: Riffle

Station: 203+60



CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Width (ft)	5.4	6.1	6.3	5.5	-	-	-	-
Floodprone Width (ft)	14.0	14.0	14.0	14.0	-	-	-	-
Bankfull Mean Depth (ft)	0.3	0.2	0.2	0.3	-	-	-	-
Bankfull Max Depth (ft)	0.6	0.5	0.4	0.5	-	-	-	-
Bankfull Cross-Sectional Area (ft ²)	1.8	1.5	1.5	1.8	-	-	-	-
Width/Depth Ratio	16.7	25.4	25.8	17.4	-	-	-	-
Entrenchment Ratio	2.6	2.3	2.2	2.5	-	-	-	-
Bank Height Ratio	1.0	0.9	0.9	0.9	-	-	-	-
Low Top of Bank Depth (ft)	-	-	-	0.4	-	-	-	-



Left Descending Bank

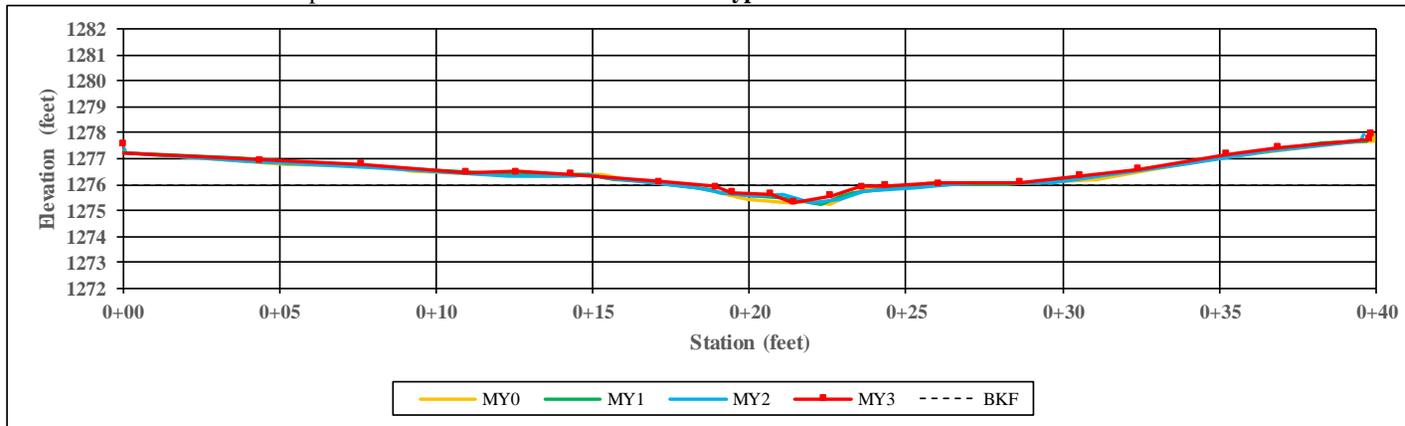


Right Descending Bank

Project Name: Middle South Muddy
Reach Name: Lower Sprouse Branch

XS Number: 2
XS Type: Riffle

Station: 204+72



CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Width (ft)	5.1	5.3	5.4	6.3	-	-	-	-
Floodprone Width (ft)	23.0	23.0	23.0	23.0	-	-	-	-
Bankfull Mean Depth (ft)	0.3	0.2	0.2	0.3	-	-	-	-
Bankfull Max Depth (ft)	0.6	0.5	0.5	0.7	-	-	-	-
Bankfull Cross-Sectional Area (ft ²)	1.7	1.3	1.2	1.7	-	-	-	-
Width/Depth Ratio	15.1	21.5	23.7	23.3	-	-	-	-
Entrenchment Ratio	4.5	4.3	4.3	3.7	-	-	-	-
Bank Height Ratio	1.0	1.0	0.9	0.9	-	-	-	-
Low Top of Bank Depth (ft)	-	-	-	0.6	-	-	-	-



Left Descending Bank

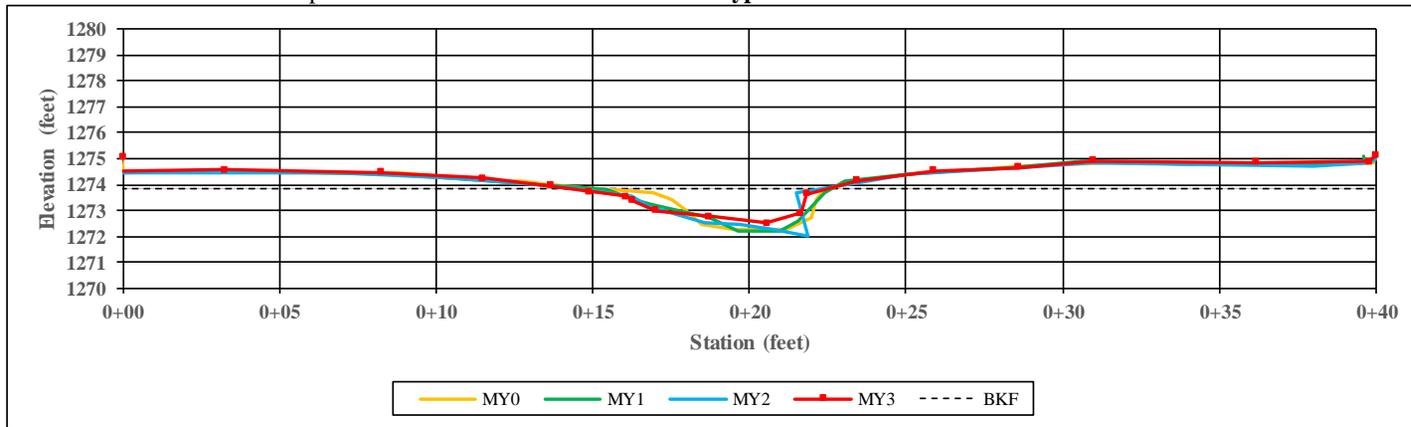


Right Descending Bank

Project Name: Middle South Muddy
Reach Name: Lower Sprouse Branch

XS Number: 3
XS Type: Pool

Station: 205+79



CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Width (ft)	6.1	6.8	6.8	8.0	-	-	-	-
Floodprone Width (ft)	32.0	32.0	32.0	32.0	-	-	-	-
Bankfull Mean Depth (ft)	1.0	0.9	0.9	0.7	-	-	-	-
Bankfull Max Depth (ft)	1.5	1.6	1.7	1.3	-	-	-	-
Bankfull Cross-Sectional Area (ft ²)	5.9	6.3	6.3	5.9	-	-	-	-
Width/Depth Ratio	6.3	7.5	7.3	10.9	-	-	-	-
Entrenchment Ratio	5.3	4.7	4.7	4.0	-	-	-	-
Bank Height Ratio	1.0	1.1	1.0	0.9	-	-	-	-
Low Top of Bank Depth (ft)	-	-	-	1.2	-	-	-	-



Left Descending Bank

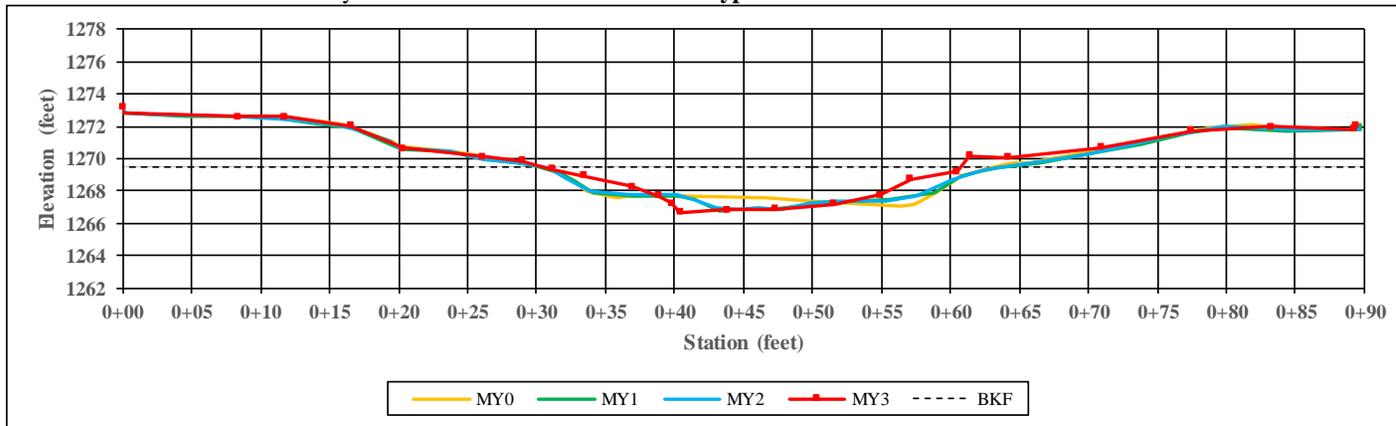


Right Descending Bank

Project Name: Middle South Muddy
Reach Name: South Muddy Creek

XS Number: 4
XS Type: Riffle

Station: 102+79



CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	31.6	32.6	31.8	30.2	-	-	-	-
Floodprone Width (ft)	65.0	65.0	65.0	65.0	-	-	-	-
Bankfull Mean Depth (ft)	1.6	1.7	1.7	1.7	-	-	-	-
Bankfull Max Depth (ft)	2.3	2.6	2.6	2.8	-	-	-	-
Bankfull Cross-Sectional Area (ft ²)	50.5	54.1	52.8	50.5	-	-	-	-
Width/Depth Ratio	19.8	19.7	19.1	18.0	-	-	-	-
Entrenchment Ratio	2.1	2.0	2.0	2.2	-	-	-	-
Bank Height Ratio	1.0	0.9	1.0	1.0	-	-	-	-
Low Top of Bank Depth (ft)	-	-	-	2.7	-	-	-	-



Left Descending Bank

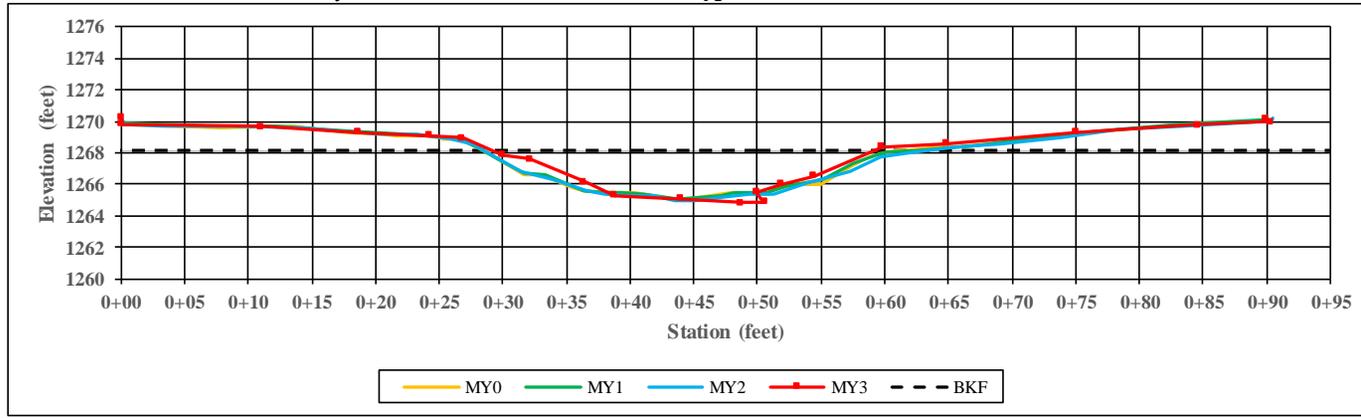


Right Descending Bank

Project Name: Middle South Muddy
Reach Name: South Muddy Creek

XS Number: 5
XS Type: Riffle

Station: 107+45



CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Width (ft)	30.7	30.6	31.8	29.6	-	-	-	-
Floodprone Width (ft)	101.0	101.0	101.0	101.0	-	-	-	-
Bankfull Mean Depth (ft)	1.9	1.9	1.9	2.0	-	-	-	-
Bankfull Max Depth (ft)	2.8	2.8	3.0	3.3	-	-	-	-
Bankfull Cross-Sectional Area (ft ²)	59.0	57.9	61.3	59.0	-	-	-	-
Width/Depth Ratio	15.9	16.2	16.4	14.9	-	-	-	-
Entrenchment Ratio	3.3	3.3	3.2	3.4	-	-	-	-
Bank Height Ratio	1.0	1.0	1.1	1.1	-	-	-	-
Low Top of Bank Depth (ft)	-	-	-	3.6	-	-	-	-



Left Descending Bank

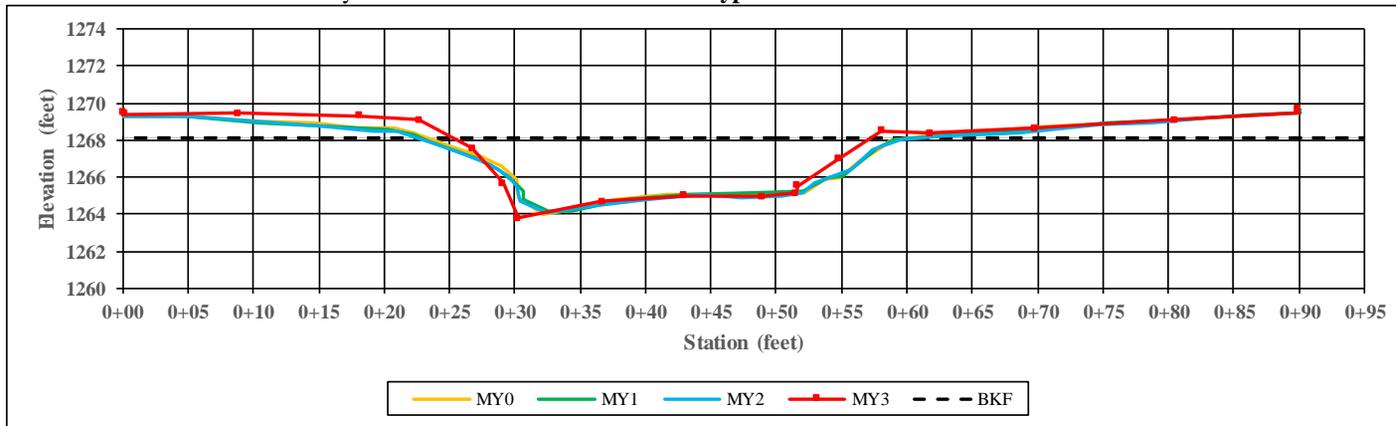


Right Descending Bank

Project Name: Middle South Muddy
Reach Name: South Muddy Creek

XS Number: 6
XS Type: Pool

Station: 108+57



CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	35.3	35.9	36.7	31.7	-	-	-	-
Floodprone Width (ft)	166.0	166.0	166.0	166.0	-	-	-	-
Bankfull Mean Depth (ft)	2.4	2.4	2.4	2.7	-	-	-	-
Bankfull Max Depth (ft)	4.0	3.9	3.9	4.3	-	-	-	-
Bankfull Cross-Sectional Area (ft ²)	85.7	86.3	89.2	85.7	-	-	-	-
Width/Depth Ratio	14.5	14.9	15.1	11.7	-	-	-	-
Entrenchment Ratio	4.7	4.6	4.5	5.2	-	-	-	-
Bank Height Ratio	1.0	1.0	1.0	1.1	-	-	-	-
Low Top of Bank Depth (ft)	-	-	-	4.7	-	-	-	-



Left Descending Bank

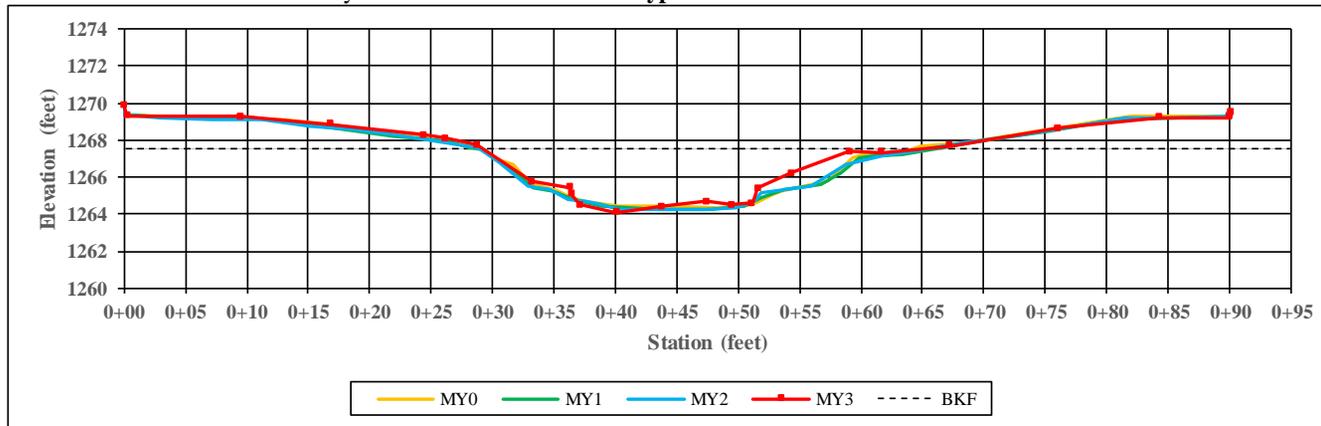


Right Descending Bank

Project Name: Middle South Muddy
Reach Name: South Muddy Creek

XS Number: 7
XS Type: Riffle

Station: 109+57



CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Width (ft)	31.0	31.2	34.0	29.9	-	-	-	-
Floodprone Width (ft)	88.0	88.0	88.0	88.0	-	-	-	-
Bankfull Mean Depth (ft)	2.1	2.2	2.0	2.2	-	-	-	-
Bankfull Max Depth (ft)	2.9	3.0	3.1	3.4	-	-	-	-
Bankfull Cross-Sectional Area (ft ²)	64.9	67.7	67.9	64.7	-	-	-	-
Width/Depth Ratio	14.8	14.4	17.0	13.8	-	-	-	-
Entrenchment Ratio	2.8	2.8	2.6	2.9	-	-	-	-
Bank Height Ratio	1.0	0.9	0.9	1.0	-	-	-	-
Low Top of Bank Depth (ft)	-	-	-	3.3	-	-	-	-



Left Descending Bank

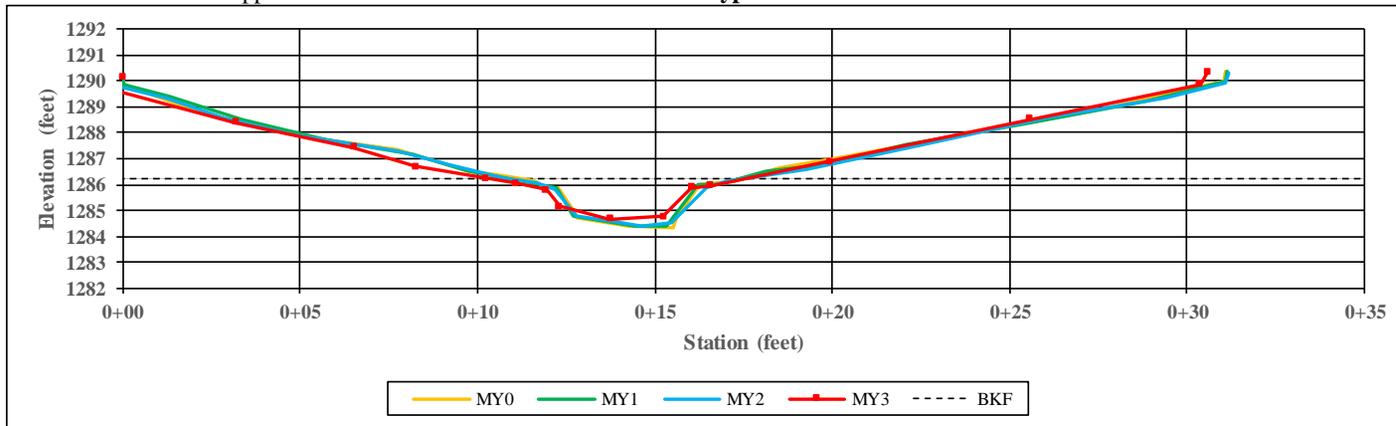


Right Descending Bank

Project Name: Middle South Muddy
Reach Name: Upper Iva Branch

XS Number: 8
XS Type: Pool

Station: 302+13



CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	5.5	5.8	5.6	7.2	-	-	-	-
Floodprone Width (ft)	17.0	17.0	17.0	17.0	-	-	-	-
Bankfull Mean Depth (ft)	1.0	1.0	1.0	0.8	-	-	-	-
Bankfull Max Depth (ft)	1.8	1.7	1.7	1.6	-	-	-	-
Bankfull Cross-Sectional Area (ft ²)	5.7	5.6	5.6	5.7	-	-	-	-
Width/Depth Ratio	5.4	6.1	5.5	9.0	-	-	-	-
Entrenchment Ratio	3.1	2.9	3.1	2.4	-	-	-	-
Bank Height Ratio	1.0	0.9	1.0	0.8	-	-	-	-
Low Top of Bank Depth (ft)	-	-	-	1.3	-	-	-	-



Left Descending Bank

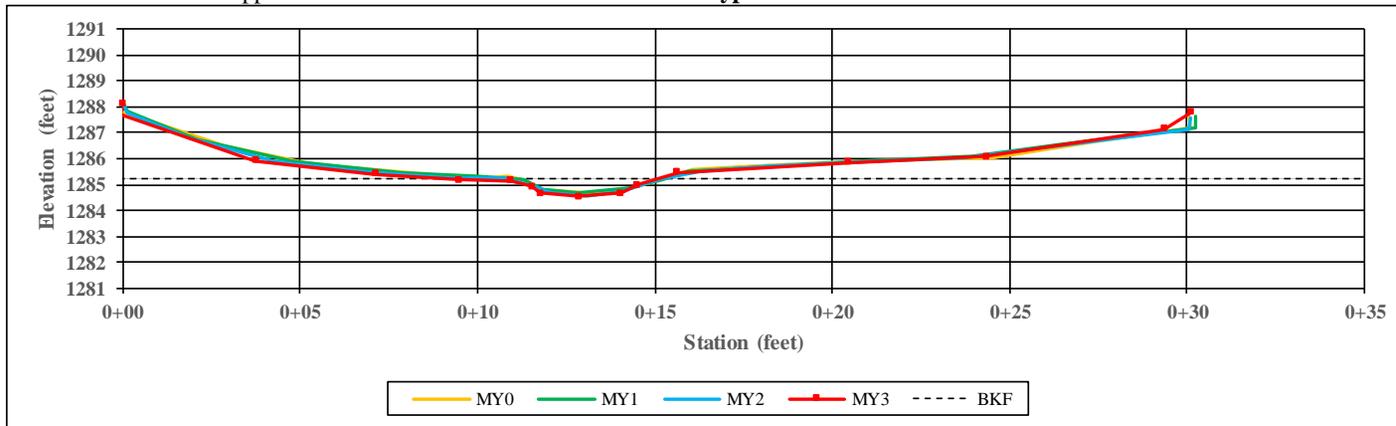


Right Descending Bank

Project Name: Middle South Muddy
Reach Name: Upper Iva Branch

XS Number: 9
XS Type: Riffle

Station: 302+82



CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	4.6	4.2	4.1	6.0	-	-	-	-
Floodprone Width (ft)	14.0	14.0	14.0	14.0	-	-	-	-
Bankfull Mean Depth (ft)	0.4	0.4	0.5	0.3	-	-	-	-
Bankfull Max Depth (ft)	0.7	0.6	0.8	0.7	-	-	-	-
Bankfull Cross-Sectional Area (ft ²)	1.9	1.8	2.1	1.9	-	-	-	-
Width/Depth Ratio	11.0	9.8	8.0	18.7	-	-	-	-
Entrenchment Ratio	3.0	3.3	3.5	2.3	-	-	-	-
Bank Height Ratio	1.0	1.0	0.9	0.9	-	-	-	-
Low Top of Bank Depth (ft)	-	-	-	0.7	-	-	-	-



Left Descending Bank

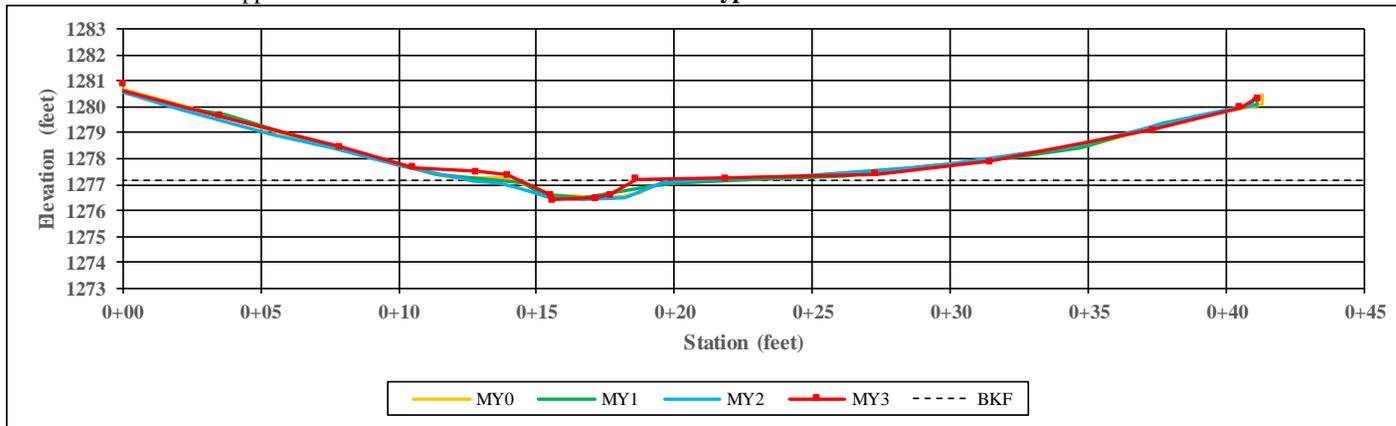


Right Descending Bank

Project Name: Middle South Muddy
Reach Name: Upper Iva Branch

XS Number: 10
XS Type: Riffle

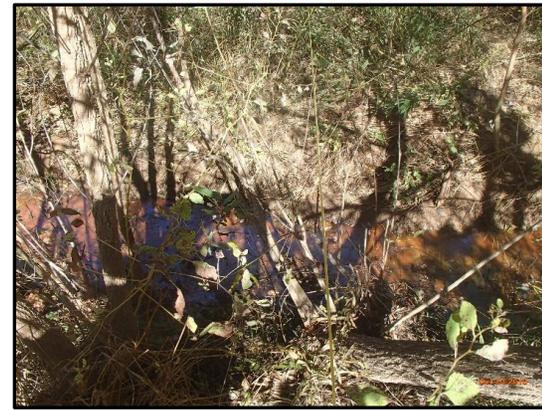
Station: 304+20



CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	5.3	5.6	5.8	4.2	-	-	-	-
Floodprone Width (ft)	17.0	17.0	17.0	17.0	-	-	-	-
Bankfull Mean Depth (ft)	0.4	0.3	0.4	0.5	-	-	-	-
Bankfull Max Depth (ft)	0.6	0.6	0.6	0.8	-	-	-	-
Bankfull Cross-Sectional Area (ft ²)	2.1	1.9	2.5	2.1	-	-	-	-
Width/Depth Ratio	13.3	16.7	13.3	8.4	-	-	-	-
Entrenchment Ratio	3.2	3.0	3.0	4.0	-	-	-	-
Bank Height Ratio	1.0	1.0	1.0	1.0	-	-	-	-
Low Top of Bank Depth (ft)	-	-	-	0.8	-	-	-	-

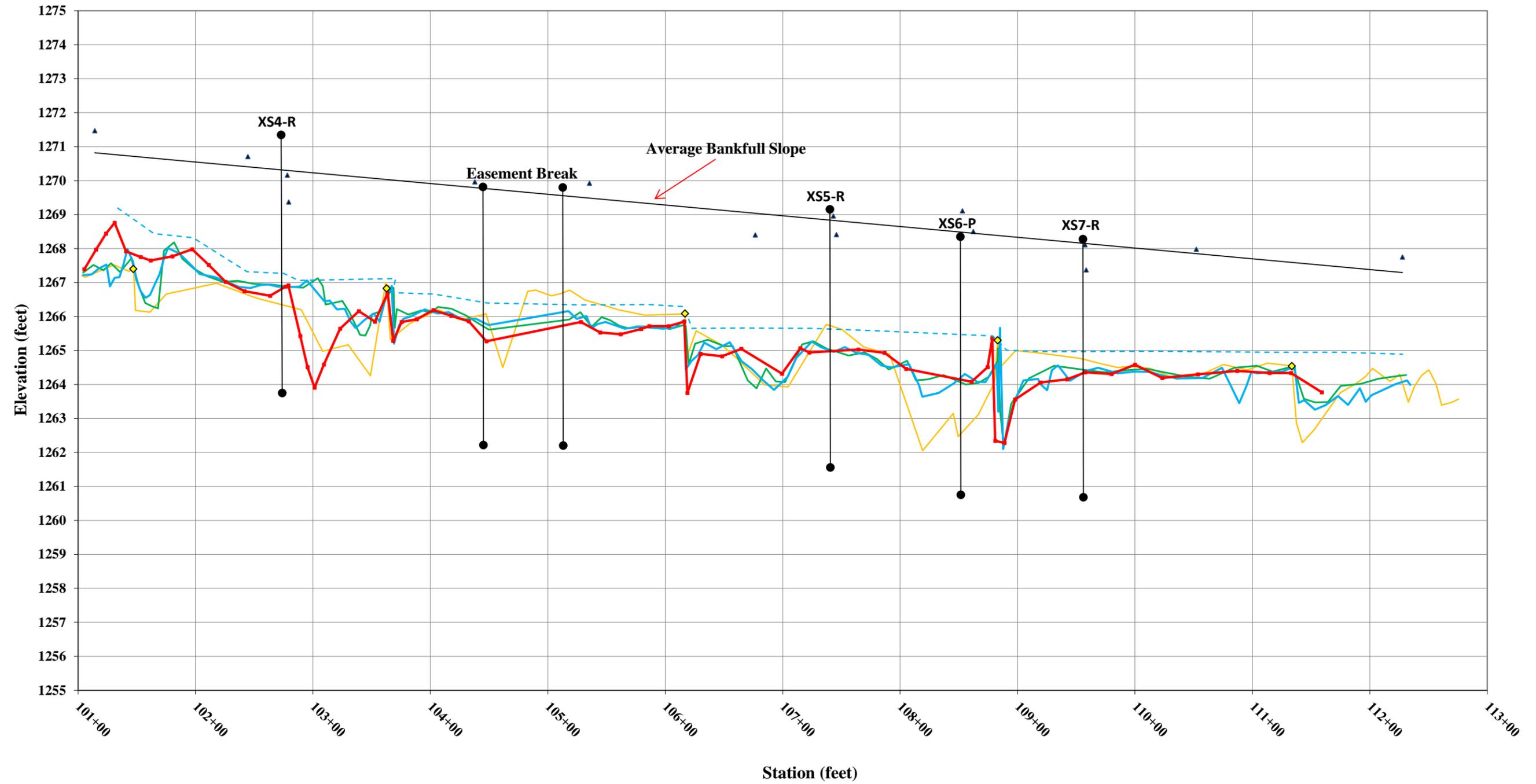


Left Descending Bank



Right Descending Bank

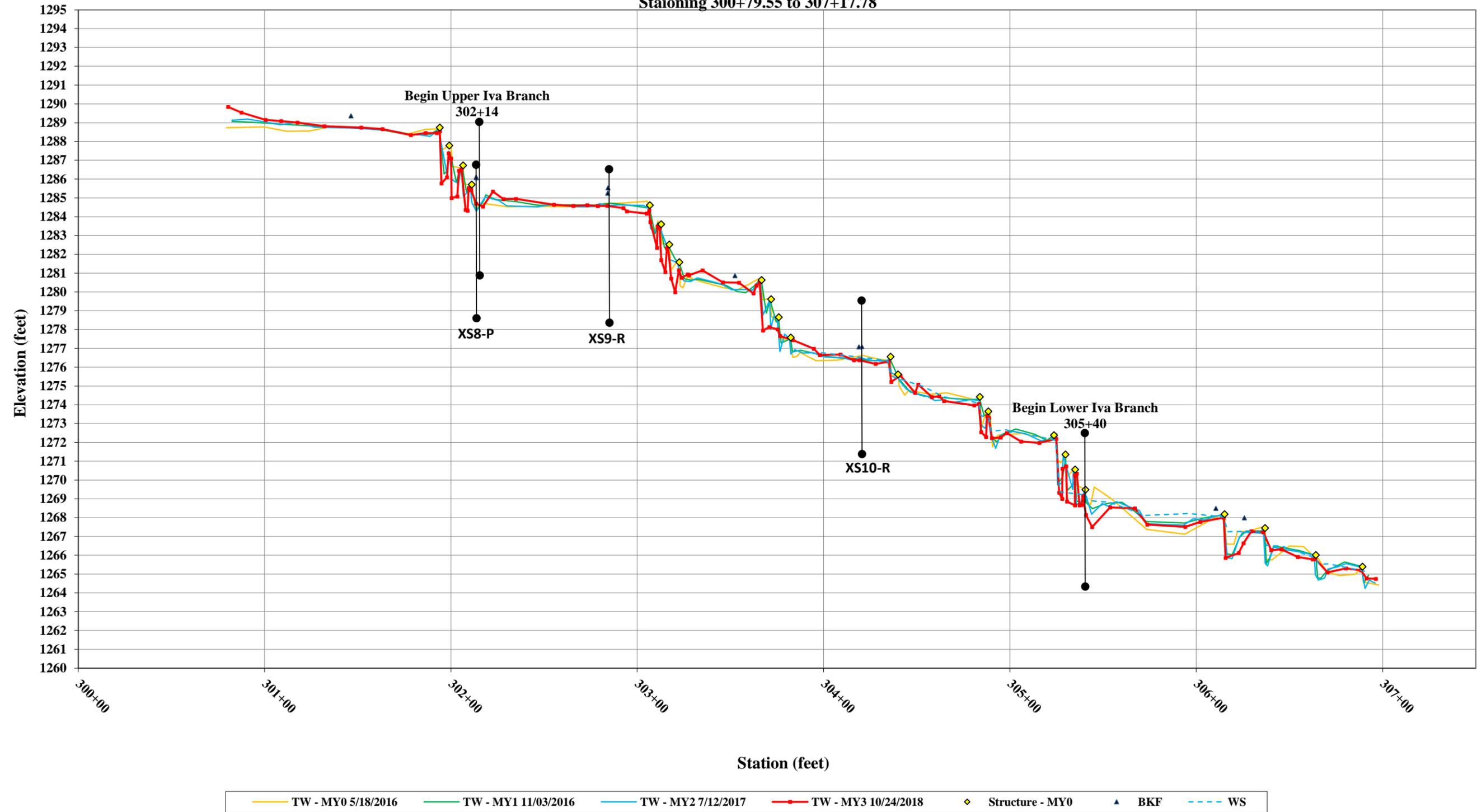
**Middle South Muddy
South Muddy Creek
Longitudinal Profile
Staioning 101+00 to 112+75.16**



Middle South Muddy
 Sprouse Branch
 Longitudinal Profile
 Staioning 201+72.34 to 208+91.81

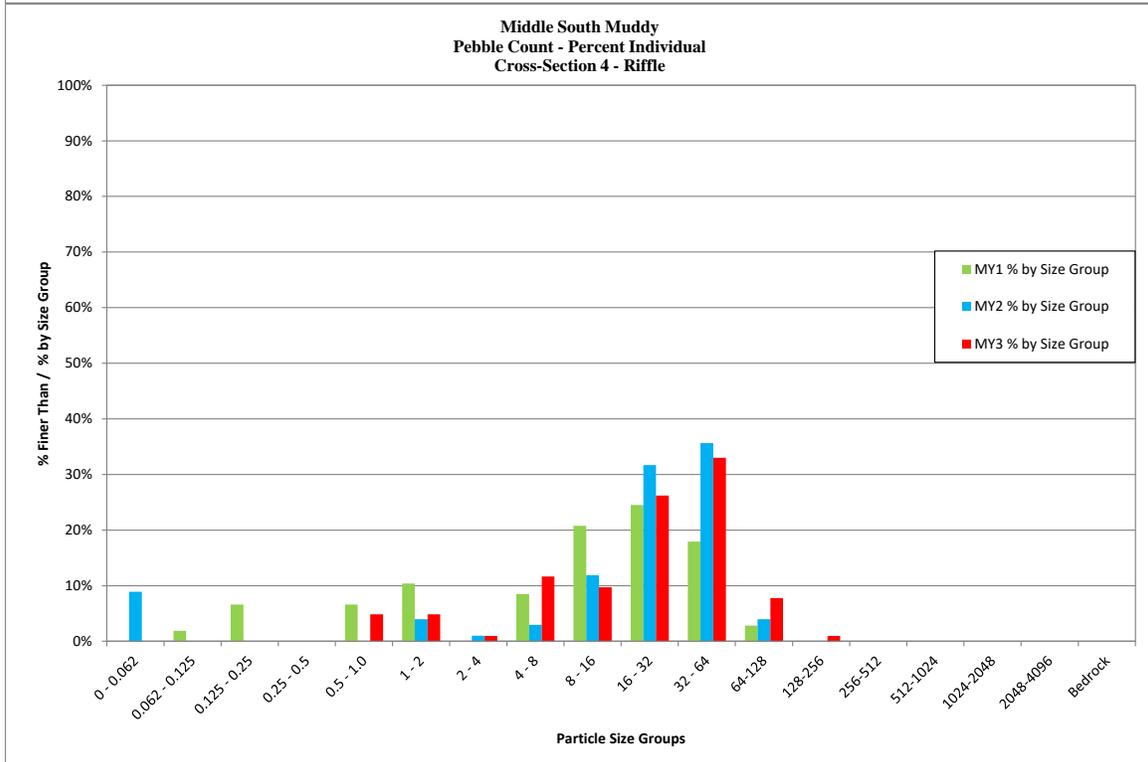
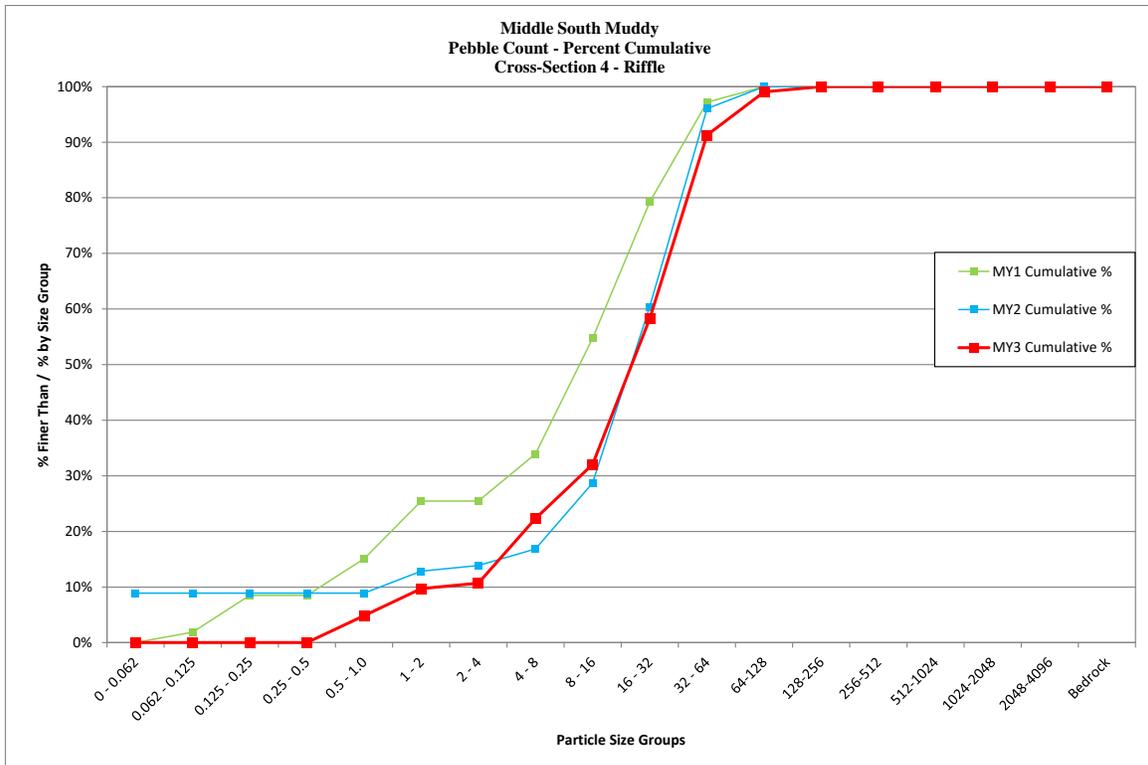


**Middle South Muddy
Iva Branch
Longitudinal Profile
Staioning 300+79.55 to 307+17.78**

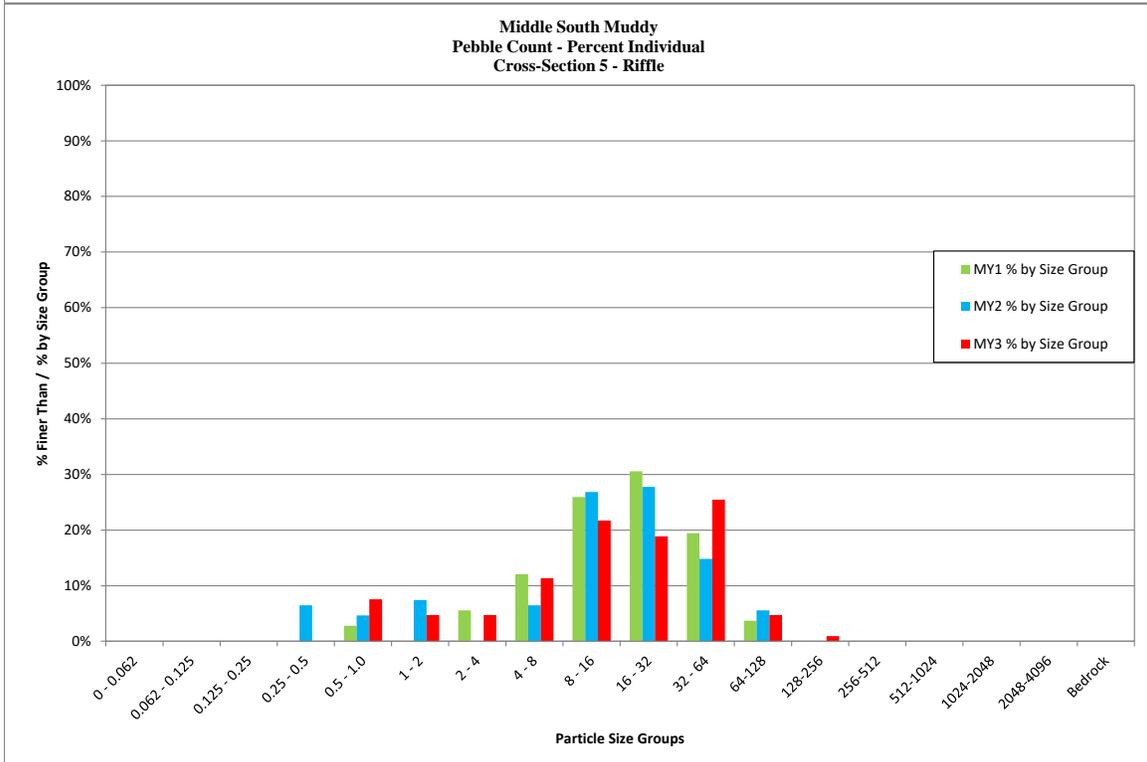
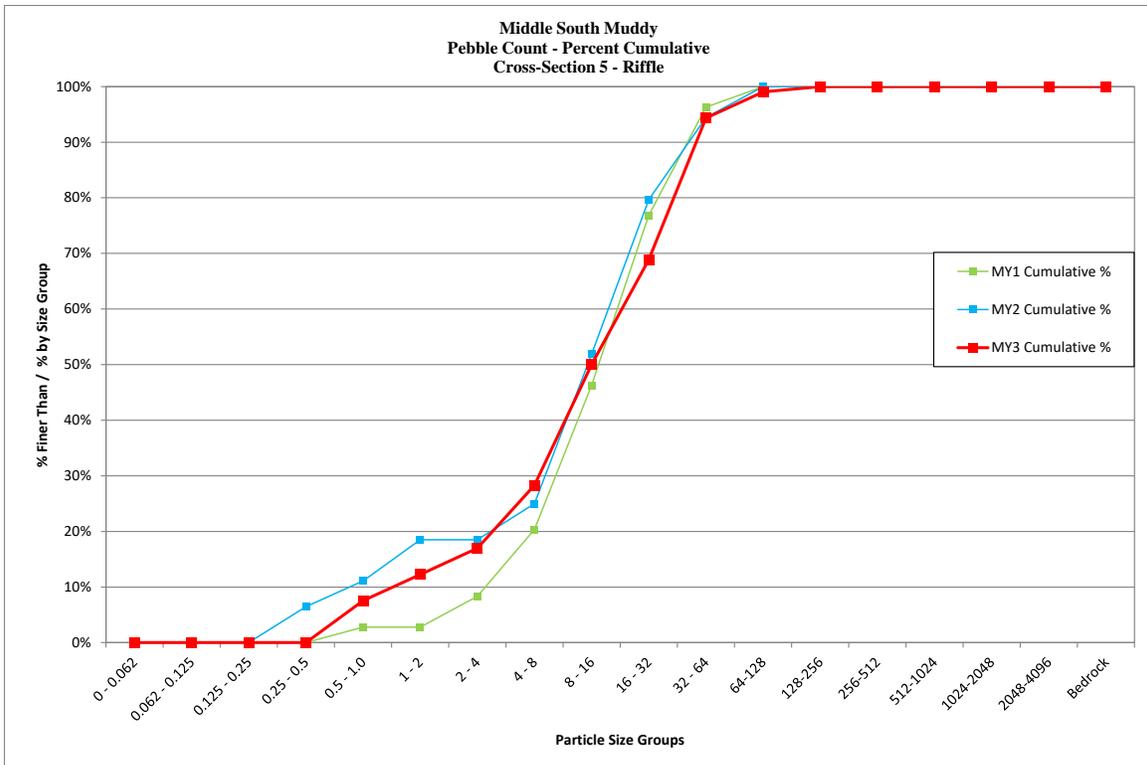


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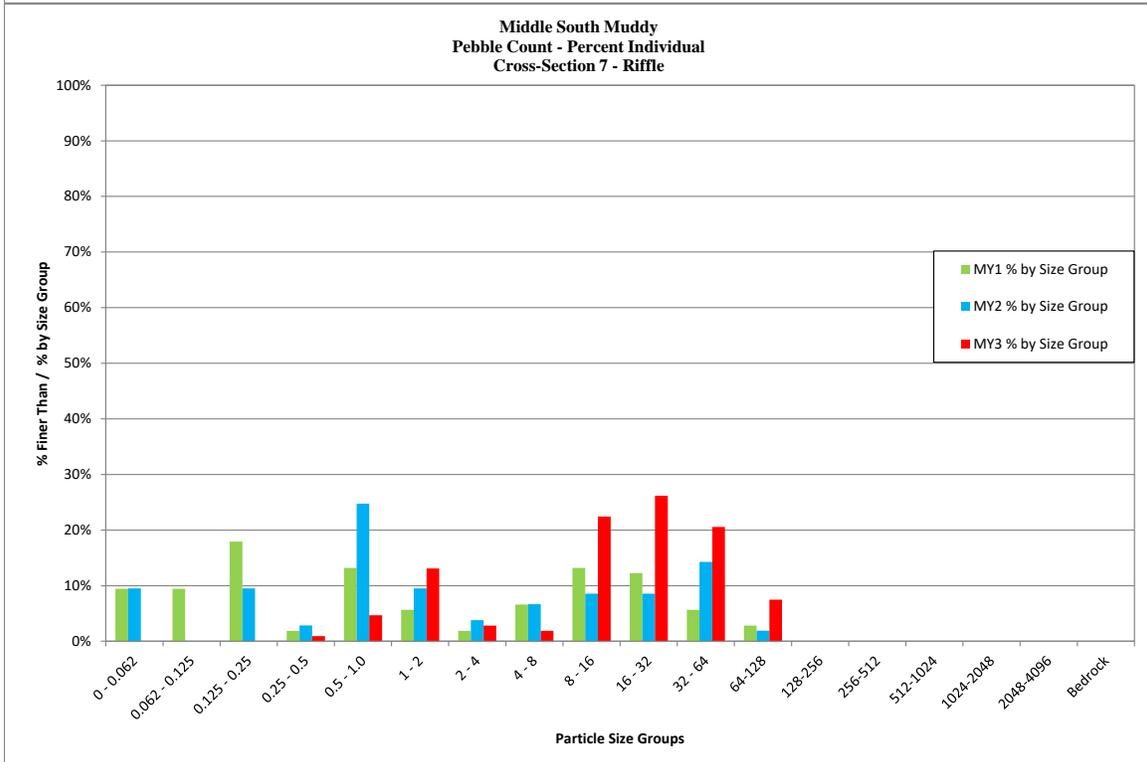
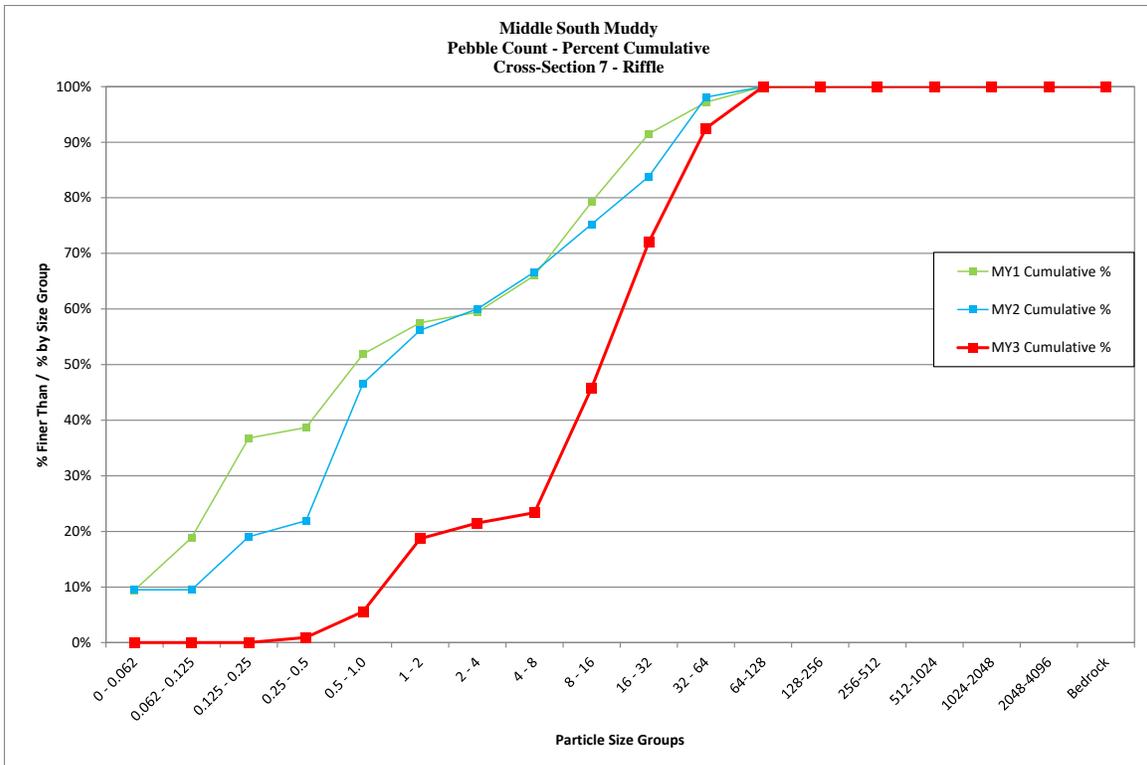
Middle South Muddy			
Cross Section 4 - Riffle			
Monitoring Year - 2018; MY3			
Bed Surface Material Particle Size Class (mm)	Number	% Individual	% Cumulative
0 - 0.062	0	0.0%	0%
0.062 - 0.125	0	0.0%	0%
0.125 - 0.25	0	0.0%	0%
0.25 - 0.5	0	0.0%	0%
0.5 - 1.0	5	4.9%	5%
1 - 2	5	4.9%	10%
2 - 4	1	1.0%	11%
4 - 8	12	11.7%	22%
8 - 16	10	9.7%	32%
16 - 32	27	26.2%	58%
32 - 64	34	33.0%	91%
64-128	8	7.8%	99%
128-256	1	1.0%	100%
256-512	0	0.0%	100%
512-1024	0	0.0%	100%
1024-2048	0	0.0%	100%
2048-4096	0	0.0%	100%
Bedrock	0	0.0%	100%
Total	103	100%	100%
		Summary Data	
		D50	27
		D84	52
		D95	83



Middle South Muddy			
Cross Section 5 - Riffle			
Monitoring Year - 2018; MY3			
Bed Surface Material Particle Size Class (mm)	Number	% Individual	% Cumulative
0 - 0.062	0	0.0%	0%
0.062 - 0.125	0	0.0%	0%
0.125 - 0.25	0	0.0%	0%
0.25 - 0.5	0	0.0%	0%
0.5 - 1.0	8	7.5%	8%
1 - 2	5	4.7%	12%
2 - 4	5	4.7%	17%
4 - 8	12	11.3%	28%
8 - 16	23	21.7%	50%
16 - 32	20	18.9%	69%
32 - 64	27	25.5%	94%
64-128	5	4.7%	99%
128-256	1	0.9%	100%
256-512	0	0.0%	100%
512-1024	0	0.0%	100%
1024-2048	0	0.0%	100%
2048-4096	0	0.0%	100%
Bedrock	0	0.0%	100%
Total	106	100%	100%
		Summary Data	
		D50	16
		D84	48
		D95	68



Middle South Muddy			
Cross Section 7 - Riffle			
Monitoring Year - 2018; MY3			
Bed Surface Material Particle Size Class (mm)	Number	% Individual	% Cumulative
0 - 0.062	0	0.0%	0%
0.062 - 0.125	0	0.0%	0%
0.125 - 0.25	0	0.0%	0%
0.25 - 0.5	1	0.9%	1%
0.5 - 1.0	5	4.7%	6%
1 - 2	14	13.1%	19%
2 - 4	3	2.8%	21%
4 - 8	2	1.9%	23%
8 - 16	24	22.4%	46%
16 - 32	28	26.2%	72%
32 - 64	22	20.6%	93%
64-128	8	7.5%	100%
128-256	0	0.0%	100%
256-512	0	0.0%	100%
512-1024	0	0.0%	100%
1024-2048	0	0.0%	100%
2048-4096	0	0.0%	100%
Bedrock	0	0.0%	100%
Total	107	100%	100%
		Summary Data	
		D50	18
		D84	46
		D95	80



Appendix E

Hydrologic Data

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**Table 12. Verification of Bankfull Events
Middle South Muddy Stream Restoration Project**

South Muddy Creek				
Date of Data Collection	Date of Occurrence	Method	Feet Above Bankfull Elevation	Photo # (if available)
2/25/2016	Unknown ¹	Wrack Lines	Unknown	-
10/27/2017	Unknown ²	Wrack Lines	Unknown	-
2/13/2018	Unknow ³	Wrack Lines	Unknown	1
11/1/2018	Unknow ⁴	Wrack Lines	Unknown	2
Sprouse Branch				
Date of Data Collection	Date of Occurrence	Method	Feet Above Bankfull Elevation	Photo # (if available)
3/23/2016	Unknown ¹	Wrack Lines	Unknown	-
10/27/2017	Unknown ²	Crest Gauge	1.08	-
2/13/2018	Unknow ³	Crest Gauge	0.1	3
11/1/2018	Unknow ⁴	Crest Gauge	0.4	4
Iva Branch				
Date of Data Collection	Date of Occurrence	Method	Feet Above Bankfull Elevation	Photo # (if available)
2/25/2016	Unknown ¹	Wrack Lines	Unknown	-
10/27/2017	Unknown ²	Wrack Lines	Unknown	-
2/13/2018	Unknow ³	Wrack Lines	Unknown	5
11/1/2018	Unknow ⁴	Wrack Lines	Unknown	6

¹Potential Date is 2/2/2016

²Potential Date is 10/23/2017

³Potential Date is 2/11/2018

⁴Potential Date is 10/18/2018

Photo Verification of Bankfull Events



Photo #1 - South Muddy Creek Wrack Lines from bridge looking upstream



Photo #2 - South Muddy Creek Wrack Lines STA 111+25

Photo Verification of Bankfull Events



Photo #3 – Sprouse Branch Crest Gauge at 14 inches (recorded bankfull is 9”)



Photo #4 – Sprouse Branch Crest Gauge at 10 inches (recorded bankfull is at 9”)



Photo #5 – Iva Branch Wrack Lines at STA 305+00



Photo #4 – Iva Branch Wrack Lines at STA 304+25

Figure 3. Daily Precipitation Totals for the Middle South Muddy Stream Restoration Site Project

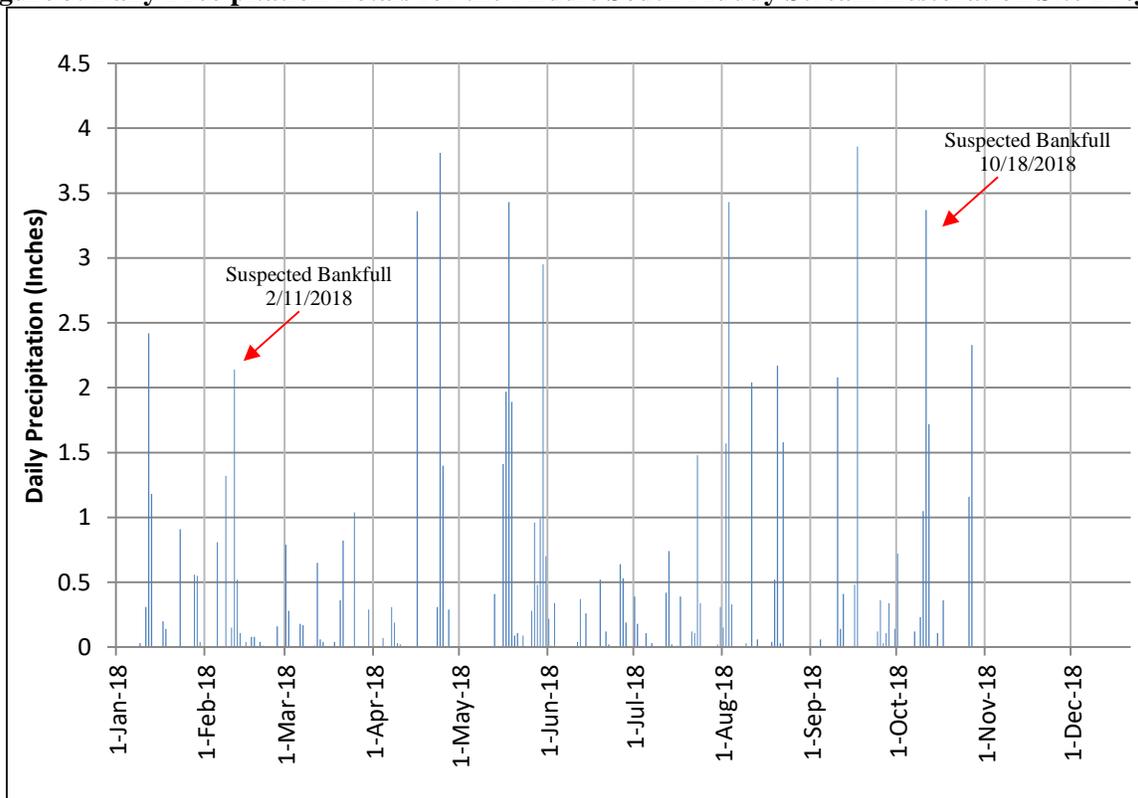
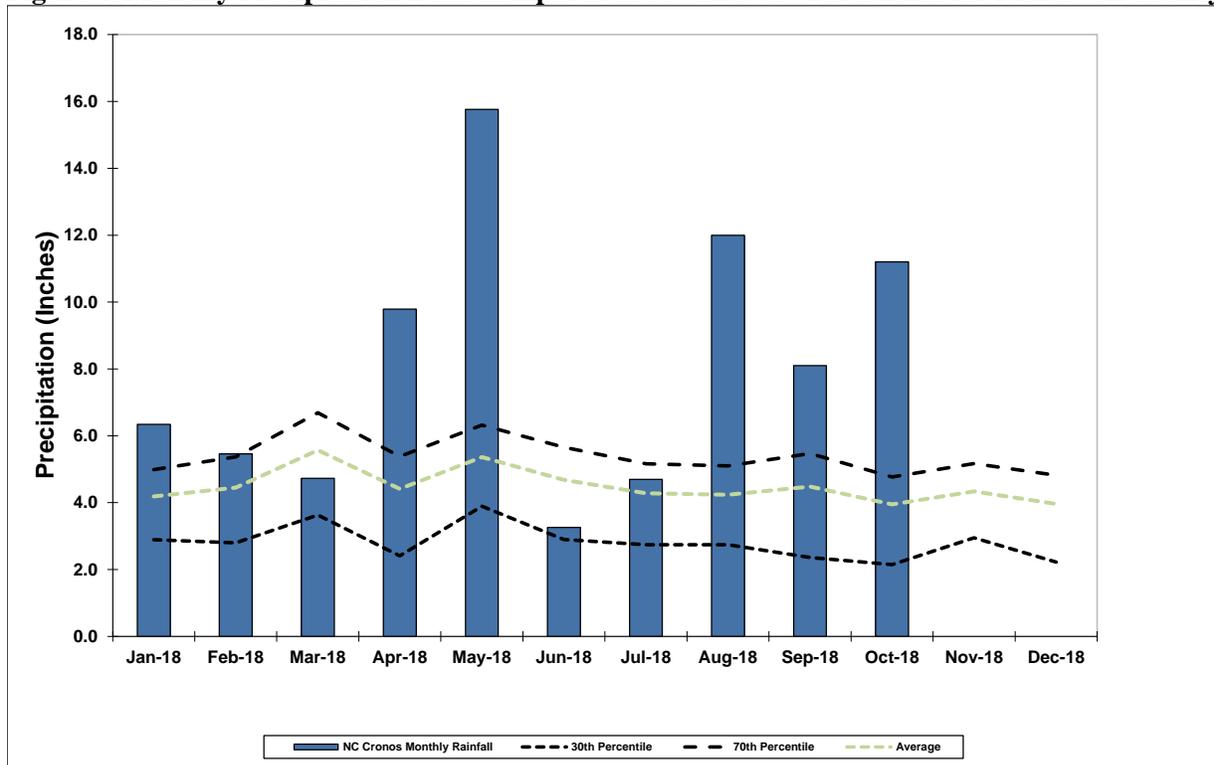
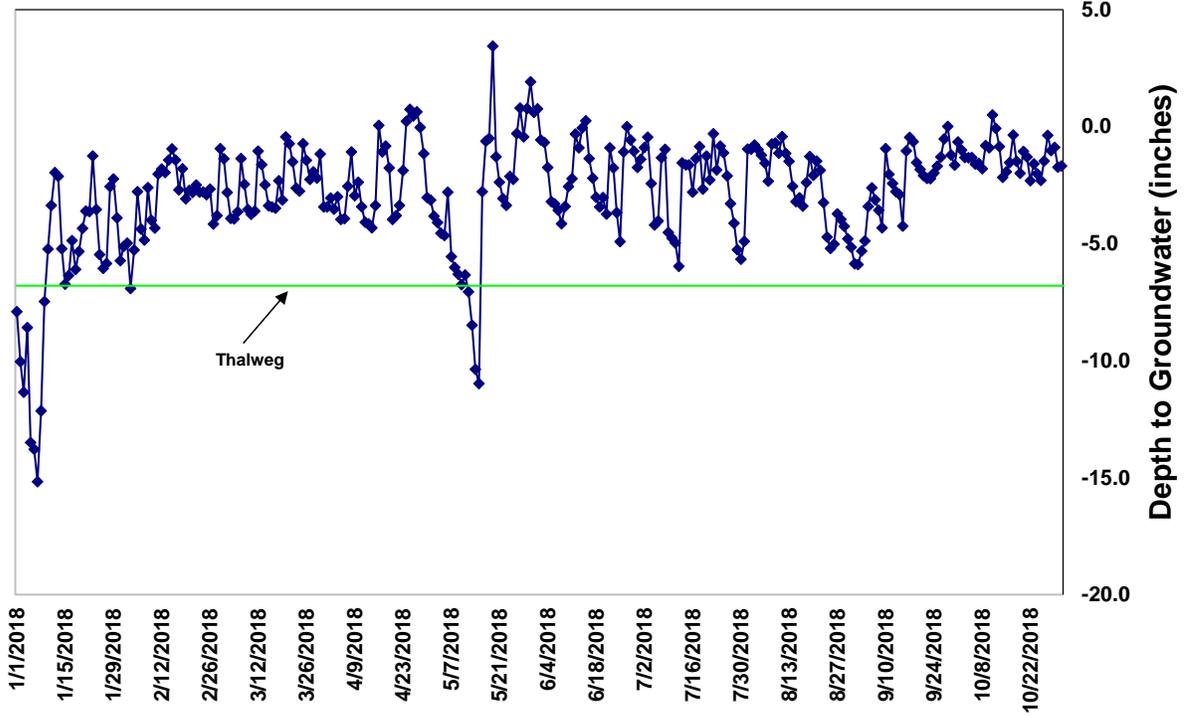


Figure 4. Monthly Precipitation Data Compared to 30th and 70th Percentiles for McDowell County



Middle South Muddy Iva Branch Perennial Gauge



Middle South Muddy Iva Branch Intermittent Gauge

