Annual Monitoring Report

Monitoring Year 5 of 5

Final

Middle South Muddy Stream Restoration Site
NCDMS Contract No.: 6783
NCDMS Project No.: 93875
McDowell County, North Carolina
Data Collected: April - November 2020
Date Submitted: January 2021

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**	**USACE Action ID**	**2011-02233**
DMS ID	**93875**	**DWR Permit**	**2012-0383**
River Basin	**Catawba**	**Date Project Instituted**	**10/1/2010**
Cataloging Unit	**03050101**	**Date Prepared**	**4/20/2020**
County	**McDowell**	**Stream/Wet. Service Area**	**Catawba 03050101**

Signature & Date of Official Approving Credit Release

1 - For NCDMS, no credits are released during the first milestone

2 - For NCDMS projects, the inital credit release milestone occurs automatically when the as-built report (baseline monitoring report) has been made available to the IRT by posting it to the DMS portal, provided the following have been met:

1) Approved of 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 10% reserve of credits is to be held back until the bankfull event performance standard has been met.

Credit Release Milestone	**Warm Stream Credits**						
Project Credits	**Scheduled Releases %**	**Proposed Releases %**	**Proposed Released #**	**Not Approved # Releases**	**Approved Credits**	**Anticipated Release**	**Actual Release**
1 - Site Establishment	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2 - Year 0 / As-Built	30.00%	30.00%	1,221.740	0.000	1,221.740	2016	8/11/2016
3 - Year 1 Monitoring	10.00%	10.00%	328.080	116.920	211.460	2017	8/8/2017
4 - Year 2 Monitoring	10.00%	10.00%	328.080	0.000	328.080	2018	4/25/2018
5 - Year 3 Monitoring	10.00%	10.00%	328.080	0.000	328.080	2019	4/26/2019
6 - Year 4 Monitoring	10.00%	10.00%	328.080	0.000	328.080	2020	4/20/2020
7 - Year 5 Monitoring	15.00%					2021	
Stream Bankfull Standard	15.00%	15.00%	492.120	120.880	371.240	2018	4/25/2018
			Totals	237.800	2,788.680		

Total Gross Credits	3,280.800
Total Unrealized Credits to Date	0.000
Total Released Credits to Date	2,788.680
Total Percentage Released	85.00%
Remaining Unreleased Credits	492.120

Notes

8/8/2017 / 4/25/2018: Adjustment required due to IRT concerns on how the as-built credits were calculated. The preservation component of the project was most affected.

3/15/2019: Due to the implementation of the new DMS database (CRM), some debits were changed from last year's approved credit release ledger.

Contingencies (if any)

Project Quantities

Mitigation Type	**Restoration Type**	**Physical Quantity**
Warm Stream	Restoration	1,990.000
Warm Stream	Enhancement I	171.000
Warm Stream	Enhancement II	24.000
Warm Stream	Preservation	5,836.000

Mitigation Project Name	**Middle South Muddy Creek**	**USACE Action ID**	**2011-02233**
DMS ID	**93875**	**DWR Permit**	**2012-0383**
River Basin	**Catawba**	**Date Project Instituted**	**10/1/2010**
Cataloging Unit	**03050101**	**Date Prepared**	**4/20/2020**
County	**McDowell**	**Stream/Wet. Service Area**	**Catawba 03050101**

Debits

							Stream Restoration Credits	**Stream Restoration Equivalent Credits**
Beginning Balance (mitigation credits)							**2,113.600**	**1,167.200**
Released Credits							**1,796.560**	**992.120**
Unrealized Credits							**0.000**	**0.000**
Owning Program	**Req. Id**	**TIP #**	**Project Name**	**USACE Permit #**	**DWR Permit #**	**DCM Permit #**		
Statewide Stream & Wetland ILF Program	REQ-002943		Charlotte Douglas Airport Third Parallel Runway	2006-32521-360	2000-1195		11.403	
Statewide Stream & Wetland ILF Program	REQ-002943		Charlotte Douglas Airport Third Parallel Runway	2006-32521-360	2000-1195		0.960	
Statewide Stream & Wetland ILF Program	REQ-002943		Charlotte Douglas Airport Third Parallel Runway	2006-32521-360	2000-1195		31.287	
Statewide Stream & Wetland ILF Program	REQ-002943		Charlotte Douglas Airport Third Parallel Runway	2006-32521-360	2000-1195		85.040	
Statewide Stream & Wetland ILF Program	REQ-002943		Charlotte Douglas Airport Third Parallel Runway	2006-32521-360	2000-1195		34.400	
Statewide Stream & Wetland ILF Program	REQ-002943		Charlotte Douglas Airport Third Parallel Runway	2006-32521-360	2000-1195		2.880	
Statewide Stream & Wetland ILF Program	REQ-003121		Lenoir Wal-Mart	2006-30760	2006-1179		394.000	
Statewide Stream & Wetland ILF Program	REQ-003578		Northlake Centre Parkway	2003-31287	2003-1080		0.001	
Statewide Stream & Wetland ILF Program	REQ-003714		Reflection Pointe	2004-30050	2004-0776		0.006	
Statewide Stream & Wetland ILF Program	REQ-004008		Villages of Denver	2005-32056	2005-0993		4.393	
Statewide Stream & Wetland ILF Program	REQ-004085	U-2211A	DOT Widening of SR 1001	1998-30188	1998-1266		78.420	
Statewide Stream & Wetland ILF Program	REQ-004085	U-2211A	DOT Widening of SR 1001	1998-30188	1998-1266		11.200	
Statewide Stream & Wetland ILF Program	REQ-004085	U-2211A	DOT Widening of SR 1001	1998-30188	1998-1266		0.960	
Statewide Stream & Wetland ILF Program	REQ-004087	R-2248AC R-2248AD R-2248BA	DOT - Charlotte Outer Loop	1999-30776	1999-0337		117.660	
Statewide Stream & Wetland ILF Program	REQ-004087	R-2248AC R-2248AD R-2248BA	DOT - Charlotte Outer Loop	1999-30776	1999-0337		120.880	
Statewide Stream & Wetland ILF Program	REQ-004386		Berewick Residential Community	2003-30598	2003-0249		0.003	
Statewide Stream & Wetland ILF Program	REQ-004431	R-2248BB R-2248C R-2248D	DOT - North Charlotte Outer Loop	2001-31321	2001-1231		207.942	
Statewide Stream & Wetland ILF Program	REQ-004431	R-2248BB R-2248C R-2248D	DOT - North Charlotte Outer Loop	2001-31321	2001-1231		452.868	
Statewide Stream & Wetland ILF Program	REQ-004431	R-2248BB R-2248C R-2248D	DOT - North Charlotte Outer Loop	2001-31321	2001-1231		28.497	
Statewide Stream & Wetland ILF Program	REQ-004431	R-2248BB R-2248C R-2248D	DOT - North Charlotte Outer Loop	2001-31321	2001-1231		2.400	
Statewide Stream & Wetland ILF Program	REQ-002681	R-2206A	DOT - NC 16 Widening	2000-31430	2000-1232			5.000

Mitigation Project Name	**Middle South Muddy Creek**	**USACE Action ID**	**2011-02233**
DMS ID	**93875**	**DWR Permit**	**2012-0383**
River Basin	**Catawba**	**Date Project Instituted**	**10/1/2010**
Cataloging Unit	**03050101**	**Date Prepared**	**4/20/2020**
County	**McDowell**	**Stream/Wet. Service Area**	**Catawba 03050101**

Debits

							Stream Restoration Credits	**Stream Restoration Equivalent Credits**
Beginning Balance (mitigation credits)							**2,113.600**	**1,167.200**
Released Credits							**1,796.560**	**992.120**
Unrealized Credits							**0.000**	**0.000**
Owning Program	**Req. Id**	**TIP #**	**Project Name**	**USACE Permit #**	**DWR Permit #**	**DCM Permit #**		
Statewide Stream & Wetland ILF Program	REQ-004087	R-2248AC R-2248AD R-2248BA	DOT - Charlotte Outer Loop	1999-30776	1999-0337			350.160
Statewide Stream & Wetland ILF Program	REQ-004087	R-2248AC R-2248AD R-2248BA	DOT - Charlotte Outer Loop	1999-30776	1999-0337			116.720
Statewide Stream & Wetland ILF Program	REQ-004087	R-2248AC R-2248AD R-2248BA	DOT - Charlotte Outer Loop	1999-30776	1999-0337			10.568
Statewide Stream & Wetland ILF Program	REQ-004431	R-2248BB R-2248C R-2248D	DOT - North Charlotte Outer Loop	2001-31321	2001-1231			125.845
Statewide Stream & Wetland ILF Program	REQ-004431	R-2248BB R-2248C R-2248D	DOT - North Charlotte Outer Loop	2001-31321	2001-1231			267.107
Total Credits Debited							**1,585.263**	**875.400**
Remaining Available balance (Released credits)							**211.297**	**116.720**
Remaining Credits (Unreleased credits)							**317.040**	**175.080**

This Page Intentionally Left Blank

Prepared by:

37 Haywood Street, Suite 100
Asheville, North Carolina 28801

This Page Intentionally Left Blank

EQUINOX
balance through proper planning

January 28, 2021

Matthew Reid
Western Project Manager
NCDENR – Division of Mitigation Services
5 Ravenscroft Dr., Suite 102

Re: DMS Draft Monitoring Year 5 Report
Review for the Middle South Muddy Stream Restoration Site
Catawba River Basin – CU# 03050101
McDowell County, North Carolina
NCEEP Project # 93875
Contract No. 6783

Mr. Reid,

On January 19, 2021, Equinox received comments on the Draft Monitoring Year 5 report for the Middle South Muddy Stream Restoration Site from DMS. Below are our responses to the DMS comments: Equinox responses in Red:

1.4. Project Performance

- Please add the following sentences to the end of paragraph 1 of this section: MY5 will be the final monitoring report submitted for Middle South Muddy Stream Restoration Project. The project has successfully met the project performance standards outlined in the approved Mitigation Plan, and it will be presented for regulatory closeout in 2021. Sentence added.

1.4.1. Vegetation

- Please add that the site was treated for invasives in July 2020 and will continue to be treated through project closeout. Sentence added.
- The section indicates invasive exotic vegetation totaling 0.03 ac (n=6), but Table 6 and the CCPV show 0.01 (n=3). Please update. Checked feature calculations and updated text.

Table 2

- Update table to include the invasive treatments that occurred in July 2020. Updated Table 2.

Perennial and Intermittent Gauge Graphs

- Please shorten the date axis to only include the 2020 data. This will make it easier for the reader to review the MY5 data. Updated graphics to depict MY5 data only.

EQUINOX
balance through proper planning

Digital Deliverable File Review:

- Please provide the monitoring photos as JPEGS. Uploaded to the support files
- Please include the workbook used to create the longitudinal profile figures. Longitudinal profile data and graphics checked for continuity and included in the support files as a separate workbook.
- The hydrology worksheet does not appear to contain the data that was used to produce the perennial and intermittent gauge figures. Please include these data with final deliverables. Iva Branch gage data and graphics checked for continuity and included in the Support Files as separate workbooks.

Regards,

Danvey Walsh
Environmental Scientist
Equinox Environmental

Contents

This Page Intentionally Left Blank

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 (SMUs) 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 whit 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 composed 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 As-built Baseline Monitoring Report, stream lengths in the Haney Tract were 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 As-built 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 ratios 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 5 (MY5) data was collected from May to November 2020. 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. MY5 will be the final monitoring report submitted for Middle South Muddy Stream Restoration Project. The project has successfully met the project performance standards outlined in the approved Mitigation Plan, and it will be presented for regulatory closeout in 2021.

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 well established throughout the project. Small areas of invasive exotic vegetation were noted totaling 0.01 acre (n = 3). These areas are confined to the lower portion of the site including Iva Branch. Areas of invasive species were treated in July 2020 and will continue to be treated through project closeout.

Monitoring of the permanent vegetation plots (n = 5; VP) was completed in October 2020. Summary tables and photographs associated with MY5 vegetation monitoring are located in Appendix C. MY5 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 364 to 607 planted stems per acre with an annual mean of 453 planted stems per acre across all plots. A total of 8 species were documented within the plots. When volunteer stems are included, the mean annual total stems per acre rose to 1,125 and ranged between 364 and 2,185 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. Sprouse Branch has remained stable throughout the project. Changes is pool depths and spacing were noted but have remained transient in nature. A persistent problem area was noted on South Muddy Creek since MY3 and is associated with the structure at STA 108+83. The exposure of the backer log and filter fabric which resulted in piping through the structure. The structure has remained stable into MY5, but increased stress on the right bank has resulted in scouring of the bankfull bench approximately 25 feet downstream (Table 5). Material from the failed structure on Iva Branch (Station 303+67) has cleared from the riffle at STA 303+75 and has migrated to Station 304+62 (Appendix D: Iva Branch Longitudinal Profile). Problem areas on Iva Branch noted in the MY3 and MY4 reports remain but have not worsened into MY5.

Geomorphic data for MY5 was collected in November 2020. Summary tables and cross-section data plots related to stream morphology are located in Appendix D. Overall, little change was noted in the cross-section data between MY4 and MY5. Some shifting of the thalweg were noted in cross-sections 2 and 3, while, only minimal changes in channel dimension were observed in the remaining cross-sections (Appendix D, Table 11a/b and cross-sectional overlays). Pebble count data for MY5 was collected in November 2020. Summary tables and graphics related to pebble counts are located in Appendix D. A trend of coarsening bed materials has been observed throughout the project and continues into MY5.

Generally, South Muddy Creek longitudinal profile data (Appendix B, Table 11b) indicated relatively little change in riffle and pool dimensions between MY4 and MY5. The debris jam and subsequent pool at STA 103+01 has remained stable into MY5 and the pool at XS 6 appears to be reforming. Profile dimensions for Sprouse Branch changed very little between MY4 and MY5. The overall profile of Iva remained unchanged from MY4 to MY5. Iva Branch had some surface water present in the channel upstream of the culvert beginning at STA 302+03. Bankfull and water surface slopes were calculated based upon the limited observations available on the upper section of Iva Branch.

1.4.3. Stream Hydrology

Since project completion in December 2015, five bankfull events have been documented on South Muddy Creek and Sprouse Branch and four bankfull events have been documented on Iva Branch. Based on precipitation data, the suspected dates are February 2nd, 2016 (MY1), October 23rd, 2017 (MY2), February 11th, 2018 (MY3), October 18th, 2018 (MY3), May 9th, 2019 (MY4), and February 6, 2020 (MY5). Checks of the crest gauges in April of 2020 did not indicate a bankfull event despite new wrack lines and sediment deposits within the South Muddy Creek reach. Both crest gauges on Sprouse Branch and South Muddy Creek had been colonized by ants during the summer months. Checks of those gauges during the November monitoring were unreliable due to the activity of the ants, which had used the cork as material for building a nest within the crest gauges. No other indication of a bankfull event were noted during the November site visit.

Two continuous stage recorders were installed during MY0 on Iva Branch to document surface flow. One water level logger was installed in the perennial section and another was installed on the intermittent section to document 30 consecutive days of flow. The water level logger in the perennial section recorded continuous surface water flow from January 1, 2020 until March 30, 2020; a period of 89 days. The water level logger in the intermittent section did not record evidence of continuous surface flow.

During the MY5 monitoring year the intermittent section only saw approximately seven days of surface flow, none of which were consecutive (Appendix E).

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 SPIN in Spindale, NC. Two crest gauges are installed on the site, one located on South Muddy Creek and another on Sprouse Branch. Crest gauges are monitored semi-annually.

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

Appendix A
General Tables and Figures

This Page Intentionally Left Blank

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 in 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.

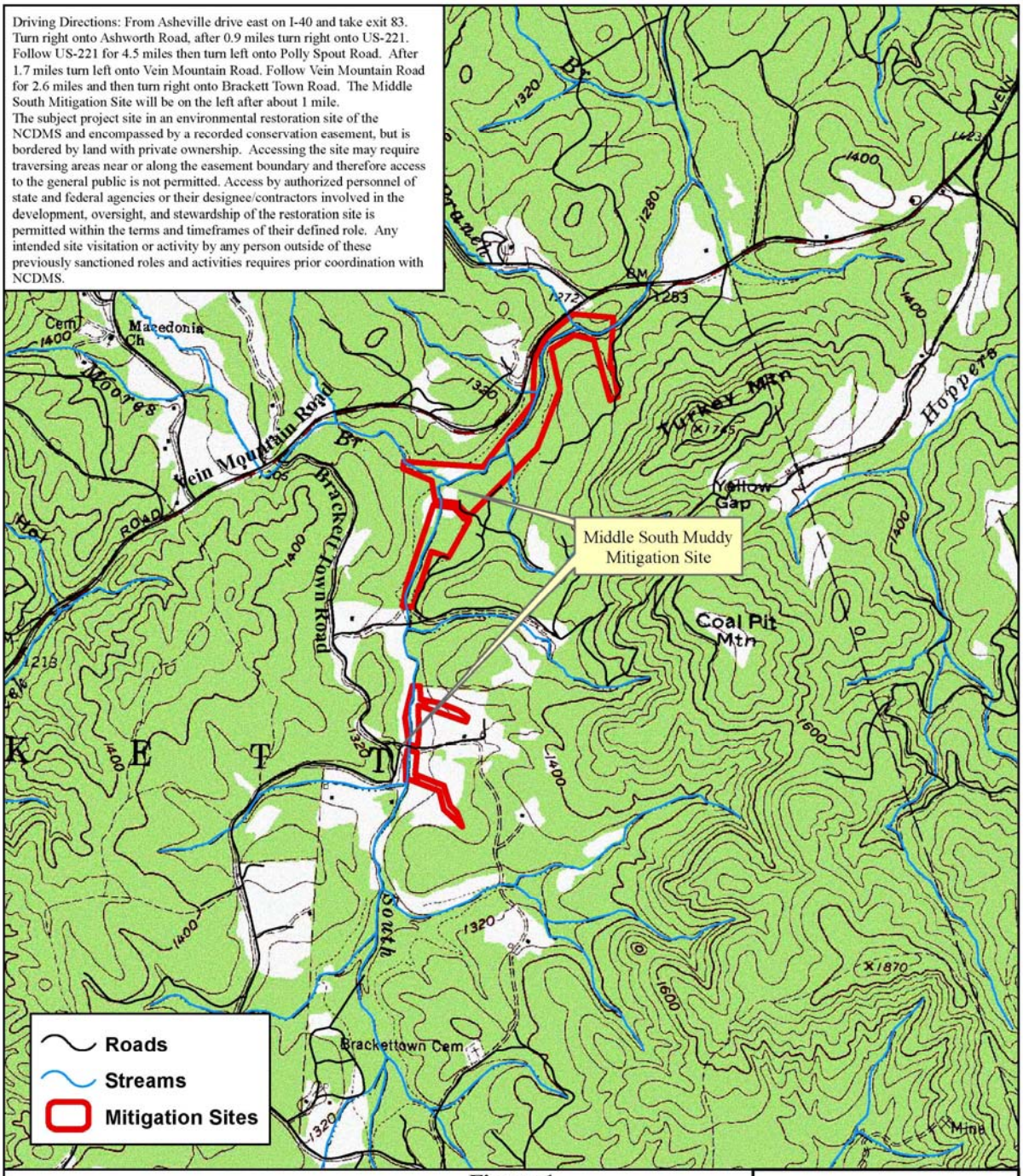
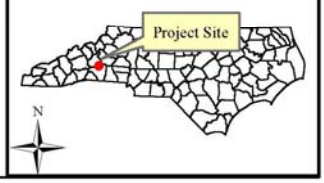


Figure 1
Middle South Muddy Mitigation Site
Vicinity Map

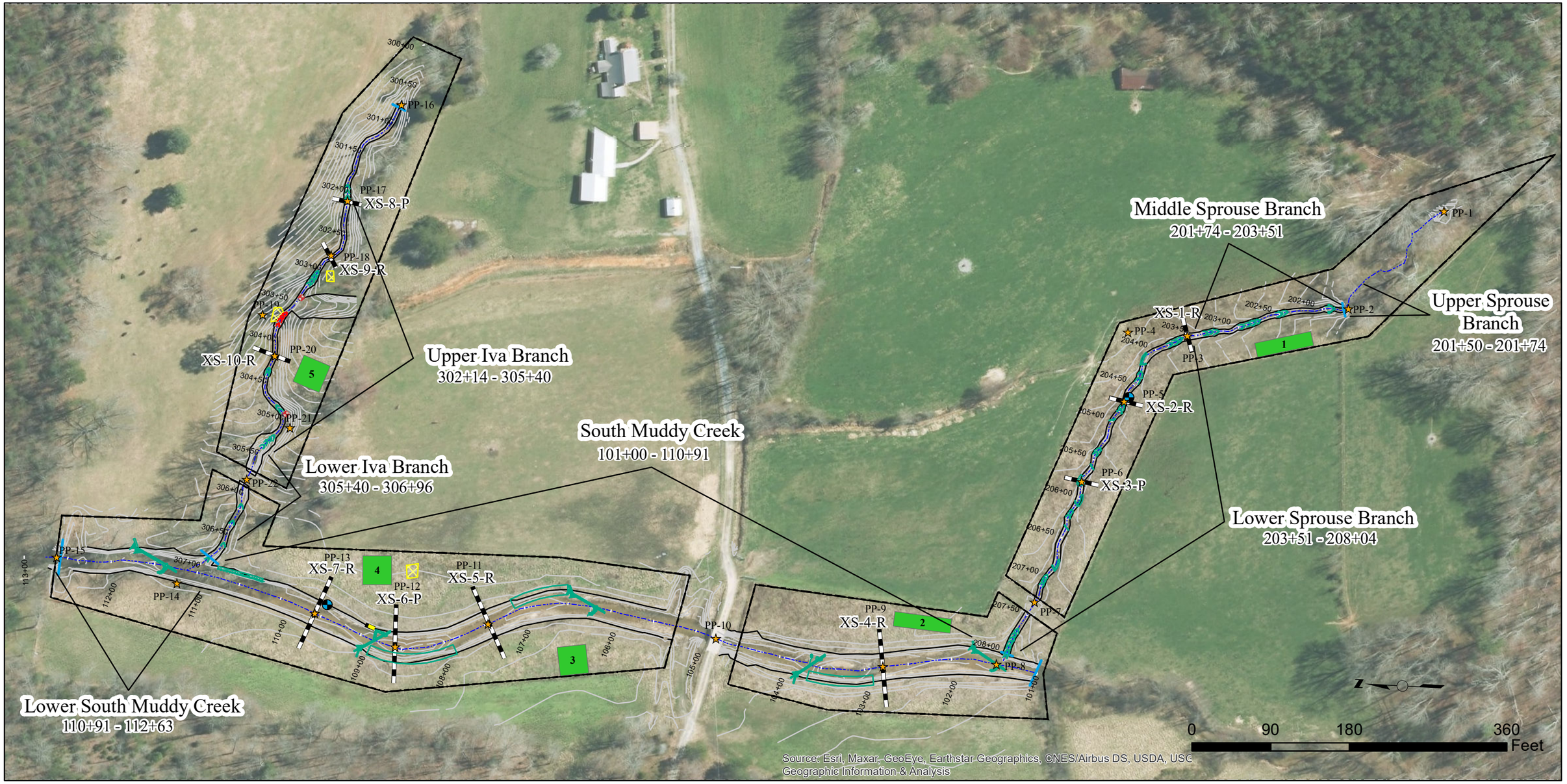
EQUINOX

0 0.25 0.5 1 Miles



This Page Intentionally Left Blank

Figure 2. Integrated Current Condition Plan View



Prepared for

Environmental Quality

Middle South Muddy
Stream Restoration Project
Monitoring Year 5
McDowell County, NC
NCDMS Contract No.: 00006783
December 2020
Sheet 1 of 2

- Easement
- Cross-Section
- Long Pro Start/End
- Photo Point Crest
- Gauge
- Continuous Stage Recorder
- Thalweg
- Top of Bank
- Contour (1 ft)

Vegetation Plots
- Vegetation Plot Criteria Met

Stream Problem Areas
- Bank Erosion

Invasive-Exotic Vegetation
- Dense
- Present
- Treated

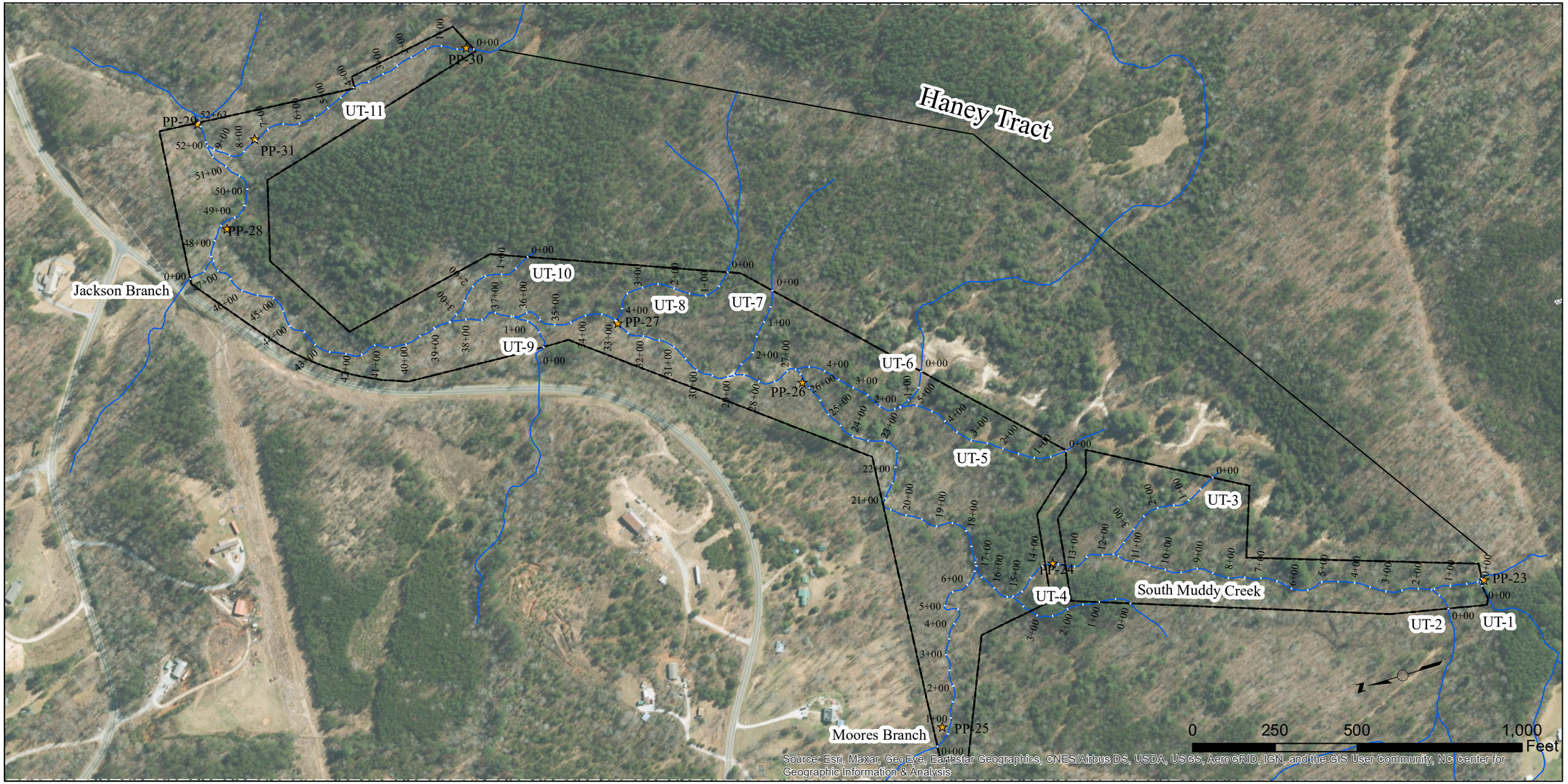
- Hook-Log Run
- Hook Run
- Boulder-Arch
- Boulder-Arch with Log
- Armored Riffle
- Structure
- Failed Structure
- Log Vane with Hook
- Log Sill
- Log Sill no Baffle
- Brush Toe

Notes:
1) Baseline Data Provided by Turner Land Surveying

Prepared by

EQUINOX

Figure 2. Integrated Current Condition Plan View



Prepared for

Environmental Quality

Middle South Muddy
Stream Restoration Project
Monitoring Year 5
McDowell County, NC
NCDMS Contract No.: 00006783
December 2020
Sheet 2 of 2

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

Invasive-Exotic Vegetation

- Dense
- Present
- Treated

- 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

EQUINOX

Table 1. Project Mitigation Components and Summation

Middle South Muddy Stream Restoration Site

Mitigation Credits

	Stream		Riparian Wetland		Non-riparian Wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
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 (linear feet)	Riparian Wetland (acres)		Non-riparian Wetland (acres)	Buffer (square feet)	Upland (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 Report	Nov - 2018	Nov - 2018
Year 3 Vegetation Monitoring	Sept - 2018	-
Year 3 Geomorphology Monitoring	Oct - 2018	-
Year 3 Monitoring Report	-	Nov - 2018
Year 4 Invasive vegetation treatment	-	Jul-2019
Year 4 Invasive vegetation secondary treatment	-	Oct-2019
Year 4 Monitoring	Oct - 2019	Dec- 2019
Year 5 Invasive vegetation treatment	-	July-2020
Year 5 Vegetation Monitoring	Oct - 2020	-
Year 5 Geomorphology Monitoring	Nov - 2020	
Year 5 Monitoring Report	-	Dec - 2020

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-MY5) 2016 - 2020	Equinox Environmental 37 Haywood St. Asheville, North Carolina 28801 Danvey Walsh (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

This Page Intentionally Left Blank

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. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars).			0	0	100%			
		2. Degradation - Evidence of downcutting.			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate.	9	9			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6).	9	9			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstream riffle).	9	9			100%			
	4. Thalweg Position	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.			0	0	100%	0	0	100%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	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.	9	10			90%			
	2. Grade Control	Grade control structures exhibiting maintenance of grade across the sill.	9	10			90%			
	2a. Piping	Structures lacking any substantial flow underneath sills or arms.	9	10			90%			
	3. Bank Protection	Bank erosion within the structures extent of influence does NOT exceed 15%.	9	10			90%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth Ratio ≥ 1.6. Rootwads/logs providing some cover at base-flow.	10	10			100%			

Table 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. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars).			0	0	100%			
		2. Degradation - Evidence of downcutting.			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate.	14	14			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6).	16	16			100%			
		2. Length 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 NOT 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 NOT exceed 15%.	18	18			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth Ratio ≥ 1.6. Rootwads/logs providing some cover at base-flow.	18	18			100%			

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. Aggradation - Bar formation/growth sufficient to significantly deflect flow laterally (not to include point bars).			0	0	100%			
		2. Degradation - Evidence of downcutting.			0	0	100%			
	2. Riffle Condition	1. Texture/Substrate - Riffle maintains coarser substrate.	5	5			100%			
	3. Meander Pool Condition	1. Depth Sufficient (Max Pool Depth : Mean Bankfull Depth ≥ 1.6).	5	5			100%			
		2. Length appropriate (>30% of centerline distance between tail of upstream riffle and head of downstream riffle).	5	5			100%			
	4. Thalweg Position	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.			1	11	99%	0	0	99%
	2. Undercut	Banks undercut/overhanging to the extent that mass wasting appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	0	100%	0	0	100%
	3. Mass Wasting	Bank slumping, calving, or collapse.			0	0	100%	0	0	100%
				Totals	1	11	99%	0	0	99%
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.	4	5			80%			
	3. Bank Protection	Bank erosion within the structures extent of influence does NOT exceed 15%.	5	5			100%			
	4. Habitat	Pool forming structures maintaining ~ Max Pool Depth : Mean Bankfull Depth Ratio ≥ 1.6. Rootwads/logs providing some cover at base-flow.	5	5			100%			

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 MY3, 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

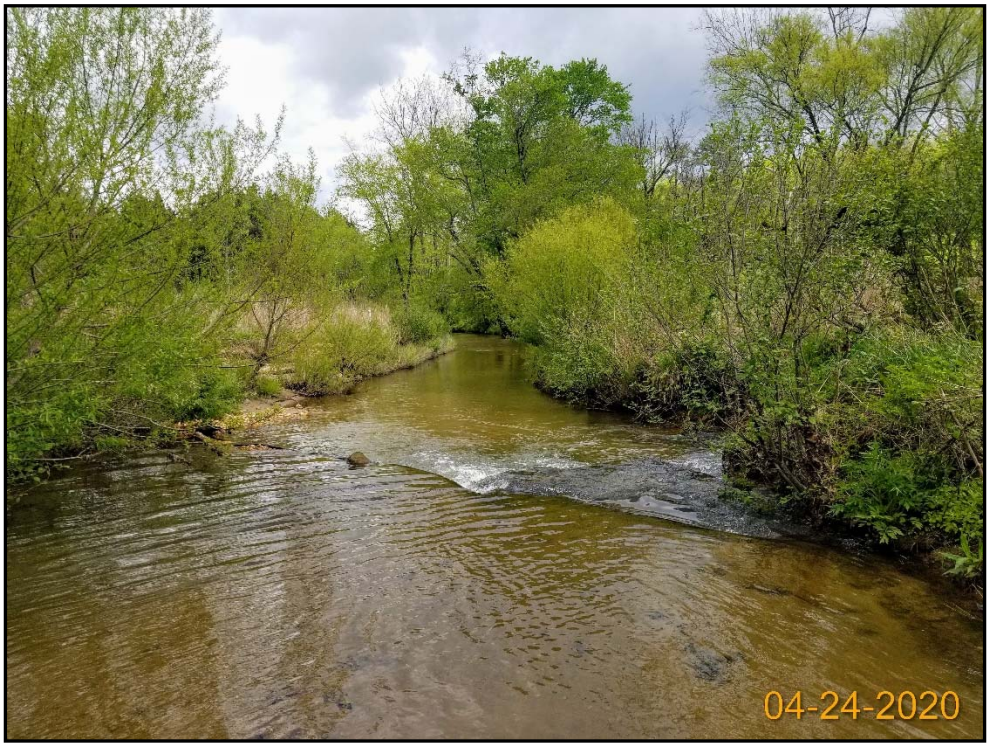
South Muddy Creek – Permanent Photo Station 8
Station 101+50 - Looking Upstream

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

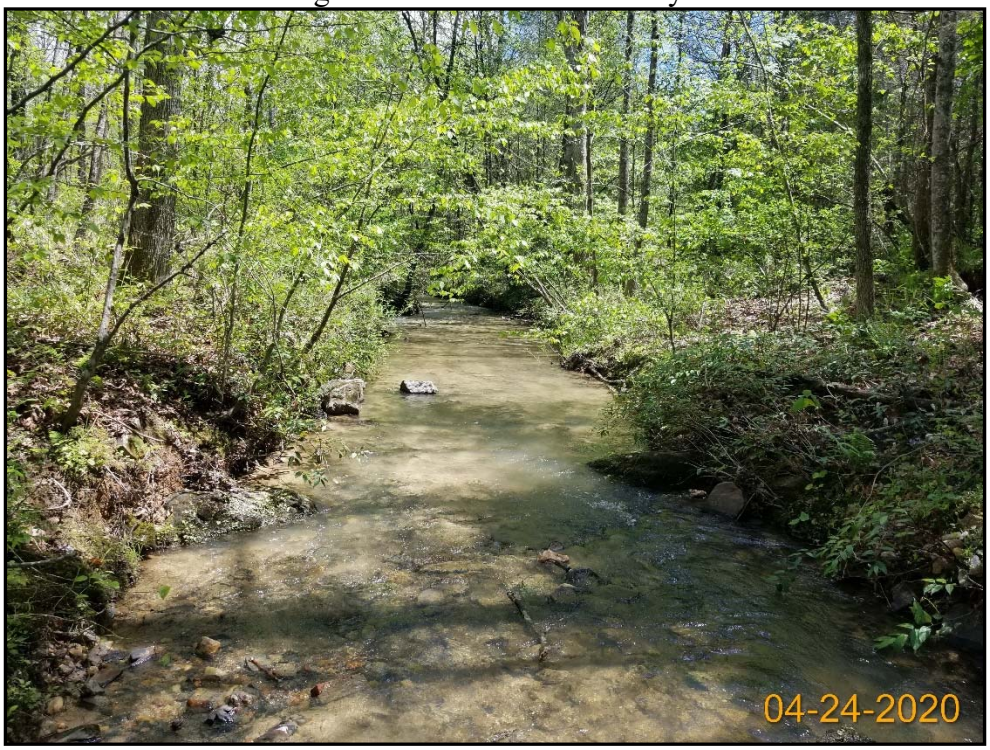
Upper Iva Branch – Permanent Photo Station 21
Station 305+10 - Looking Upstream

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 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)

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

Appendix C
Vegetation Plot Data

This Page Intentionally Left Blank

Table 7. Vegetation Plot Criteria Attainment Middle South Muddy Stream Restoration Site		
Vegetation Plot ID	Vegetation Survival Threshold Met?	Tract Mean
93875-01-0001	Yes	100%
93875-01-0002	Yes	
93875-01-0003	Yes	
93875-01-0004	Yes	
93875-01-0005	Yes	

Table 8. CVS Vegetation Plot Metadata Middle South Muddy Stream Restoration Site	
Report Prepared By	Owen Carson
Date Prepared	10/30/2020 12:12
database name	Equinox_2020_A_MiddleSouthMuddy_MY5.mdb
database location	Z:\ES\NRI&M\EEP Monitoring\Middle South Muddy\MY5_2020\Data\Veg
computer name	FIELD-PC
file size	60858368
DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT----------	
Metadata	Description of database file, the report worksheets, and a summary of project(s) and project data.
Proj, planted	Each project is listed with its PLANTED stems per acre, for each year. This excludes live stakes.
Proj, total stems	Each project is listed with its TOTAL stems per acre, for each year. This includes live stakes, all planted stems, and all natural/volunteer stems.
Plots	List of plots surveyed with location and summary data (live stems, dead stems, missing, etc.).
Vigor	Frequency distribution of vigor classes for stems for all plots.
Vigor by Spp	Frequency distribution of vigor classes listed by species.
Damage	List of most frequent damage classes with number of occurrences and percent of total stems impacted by each.
Damage by Spp	Damage values tallied by type for each species.
Damage by Plot	Damage values tallied by type for each plot.
Planted Stems by Plot and Spp	A matrix of the count of PLANTED living stems of each species for each plot; dead and missing stems are excluded.
ALL Stems by Plot and spp	A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded.
PROJECT SUMMARY----------	
Project Code	93875
project Name	Middle South Muddy Creek
Description	
River Basin	Catawba
length(ft)	
stream-to-edge width (ft)	
area (sq m)	
Required Plots (calculated)	
Sampled Plots	5

Table 9. Total Planted Stem Counts (Stems by Plot)
Middle South Muddy Stream Restoration Project

			Current Plot Data (MY5 2020)															Annual Means														
			93875-01-0001			93875-01-0002			93875-01-0003			93875-01-0004			93875-01-0005			MY5 (2020)			MY4 (2019)			MY3 (2018)			MY2 (2017)			MY1 (2016)			MY0 (2016)		
Scientific Name	Common Name	Species Type	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Acer rubrum	red maple	Tree																								2								
Acer rubrum var. rubrum	red maple	Tree	2	2	2	1	1	1				1	1	1	7	7	7	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Betula nigra	river birch	Tree	2	2	2	3	3	3	1	1	1	2	2	2				8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	5	5	5
Carpinus caroliniana	American hornbeam	Tree													2	2	2	2	2	2	2	2	2	2	2	2	4	4	4	4	4	4	5	5	5
Celtis occidentalis	common hackberry	Tree							2	2	2							2	2	2	2	2	2												
Cercis canadensis	eastern redbud	Tree				1	1	1										1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cornus amomum	silky dogwood	Shrub						2												2			1												
Fraxinus pennsylvanica	green ash	Tree	1	1	1	3	3	3	4	4	4	2	2	2				10	10	10	10	10	10	11	11	11	11	11	11	11	11	11	11	11	11
Juniperus virginiana	eastern redcedar	Tree																					2												
Platanus occidentalis	American sycamore	Tree	4	4	4	7	7	14	1	1	7	6	6	45	2	2	17	20	20	87	20	20	40	20	20	47	20	20	39	20	20	20	20	20	20
Rhus aromatica	fragrant sumac	Shrub																								11								
Rhus copallinum	flameleaf sumac	shrub																													11			
Rhus glabra	smooth sumac	shrub												4			10			14			16						12					
Ulmus americana	American elm	Tree													2	2	2	2	2	2	2	2	2	4	4	4	4	4	4	6	6	6	7	7	7
		Stem count	9	9	9	15	15	24	8	8	14	11	11	54	13	13	38	56	56	139	56	56	95	57	57	97	58	58	89	60	60	71	60	60	60
		size (ares)	1			1			1			1			1			5			5			5			5			5			5		
		size (ACRES)	0.02			0.02			0.02			0.02			0.02			0.12			0.12			0.12			0.12			0.12			0.12		
		Species count	4	4	4	5	5	6	4	4	4	4	4	5	4	4	5	8	8	10	8	8	11	7	7	9	7	7	8	7	7	8	7	7	7
		Stems per ACRE	364.2	364.2	364.2	607	607	971.2	323.7	323.7	566.6	445.2	445.2	2185	526.1	526.1	1538	453.2	453.2	1125	453.2	453.2	768.9	461.3	461.3	785.1	469.4	469.4	720.3	485.6	485.6	574.7	485.6	485.6	485.6

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%

This Page Intentionally Left Blank

Middle South Muddy - Vegetation Monitoring Plot 1

Middle South Muddy - Vegetation Monitoring Plot 2

Middle South Muddy - Vegetation Monitoring Plot 3

Middle South Muddy - Vegetation Monitoring Plot 4

Middle South Muddy - Vegetation Monitoring Plot 5

This Page Intentionally Left Blank

Appendix D
Stream Geomorphology Data

This Page Intentionally Left Blank

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					
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)	-	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																								
Riffle Length (ft)				-	-	-	-	-	-	17.7	-	-	64.0	-	-	-	-	-	54.4	109.6	85.4	229.5	68.9	5
Riffle 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	3.3	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 / di^p / di^{sp} (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						4.7							
Impervious Cover Estimate (%)					-						-						-							
Rosgen Classification					-						C4						C4			C4				
Bankfull Velocity (fps)		-			-						3.9						-							
Bankfull Discharge (cfs)		-			-						143.0						-							
Valley Length (ft)					-						550						1,136							
Channel Thalweg Length (ft)					-						600						1,161			1,163				
Sinuosity					-						1.10						1.03			1.03				
Water Surface Slope (ft/ft)					-						-						0.003			0.003				
Bankfull Slope (ft/ft)					-						-						0.003			0.002				
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 - Middle Sprouse Branch (177 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)	-	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																								
Riffle Length (ft)				-	-	-	-	-	-	20.0	-	-	40.0	-	-	-	-	-	15.2	20.0	16.1	28.8	7.6	3
Riffle 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	-	-	-	-	-	2.3	-	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^{sp} (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				B5			
Bankfull Velocity (fps)		-				-						6.1					-							
Bankfull Discharge (cfs)		-				-						210.0					-							
Valley Length (ft)						-						380					187							
Channel Thalweg Length (ft)						-						400					177				177			
Sinuosity						-						1.1					1.06				1.01			
Water Surface Slope (ft/ft)						-						-					0.031				0.029			
Bankfull Slope (ft/ft)						-						-					0.031				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					
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)	-	5.3	-	-	-	-	-	-	-	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																								
Riffle Length (ft)				-	-	-	-	-	-	20.0	-	-	40.0	-	-	-	-	-	6.0	16.2	14.2	32.2	9.3	9
Riffle 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^m (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					
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)	-	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^{sp} (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			B5				
Bankfull Velocity (fps)		-			-						6.1						-							
Bankfull Discharge (cfs)		-			-						210.0						-							
Valley Length (ft)					-						380						424							
Channel Thalweg Length (ft)					-						400						326			326				
Sinuosity					-						1.10						1.09			1.10				
Water Surface Slope (ft/ft)					-						-						0.058			0.056				
Bankfull Slope (ft/ft)					-						-						0.058			0.056				
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 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^p / di^m (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				0.046							
Impervious Cover Estimate (%)							-						-				-							
Rosgen Classification							-						B4				B5				B5			
Bankfull Velocity (fps)		-					-						6.1				-							
Bankfull Discharge (cfs)		-					-						210.0				-							
Valley Length (ft)							-						380.0				151							
Channel Thalweg Length (ft)							-						400.0				156				156			
Sinuosity							-						1.10				1.02				1.03			
Water Surface Slope (ft/ft)							-						-				0.026				0.032			
Bankfull Slope (ft/ft)							-						-				0.026				0.035			
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.

This Page Intentionally Left Blank

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

	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					
Dimension	**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	1,278.1	1,278.2	1,275.8	1,275.8	1,275.8	1,276.0	1,275.9	1,275.8	1,273.7	1,273.7	1,273.7	1,273.8	1,273.7	1,273.8	1,269.4	1,269.4	1,269.4	1,269.5	1,269.4	1,269.5	1,267.9	1,267.9	1,267.9	1,268.1	1,268.0	1,268.1
Low Bank Height Elevation (datum) Used	-	-	-	1,278.1	1,278.4	1,278.3	-	-	-	1,275.9	1,276.0	1,276.1	-	-	-	1,273.7	1,273.6	1,273.4	-	-	-	1,269.4	1,269.5	1,269.4	-	-	-	1,268.4	1,268.6	1,268.7
Bankfull Width (ft)	5.4	6.1	6.3	5.5	5.5	5.5	5.1	5.3	5.4	6.3	6.0	4.4	6.1	6.8	6.8	8.0	7.2	8.3	31.6	32.6	31.8	30.2	29.0	28.0	30.7	30.6	31.8	29.6	29.0	28.4
Floodprone Width (ft)	14.0	14.0	14.0	14.0	14.0	14.0	23.0	23.0	23.0	23.0	23.0	23.0	32.0	32.0	32.0	32.0	32.0	32.0	65.0	65.0	65.0	65.0	65.0	65.0	101.0	101.0	101.0	101.0	101.0	101.0
Bankfull Mean Depth (ft)	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.4	1.0	0.9	0.9	0.7	0.8	0.7	1.6	1.7	1.7	1.7	1.7	1.8	1.9	1.9	1.9	2.0	2.0	2.1
Bankfull Max Depth (ft)	0.6	0.5	0.4	0.5	0.6	0.6	0.6	0.5	0.5	0.7	0.5	0.7	1.5	1.6	1.7	1.3	1.6	1.6	2.3	2.6	2.6	2.8	2.8	2.9	2.8	2.8	3.0	3.3	3.4	3.1
Bankfull Cross Sectional Area (ft^2)	1.8	1.5	1.5	1.8	1.8	1.8	1.7	1.3	1.2	1.7	1.7	1.7	5.9	6.3	6.3	5.9	5.9	5.9	50.5	54.1	52.8	50.5	50.5	50.5	59.0	57.9	61.3	59.0	59.0	59.0
Bankfull Width/Depth Ratio	16.7	25.4	25.8	17.4	17.0	16.7	15.1	21.5	23.7	23.3	21.2	11.4	6.3	7.5	7.3	10.9	8.7	11.9	19.8	19.7	19.1	18.0	16.7	15.5	15.9	16.2	16.4	14.9	14.3	13.6
Bankfull Entrenchment Ratio	2.6	2.3	2.2	2.5	2.5	2.5	4.5	4.3	4.3	3.7	3.9	5.3	5.3	4.7	4.7	4.0	4.5	3.8	2.1	2.0	2.0	2.2	2.2	2.3	3.3	3.3	3.2	3.4	3.5	3.6
Bankfull Bank Height Ratio*	1.0	0.9	0.9	0.9	1.5	1.2	1.0	1.0	0.9	0.9	1.2	1.5	1.0	1.1	1.0	0.9	0.9	0.7	1.0	0.9	1.0	1.0	1.0	0.9	1.0	1.0	1.1	1.1	1.2	1.2
Low Top of Bank Height Depth (ft)	-	-	-	0.4	0.9	0.8	-	-	-	0.6	0.6	1.1	-	-	-	1.2	1.5	1.2	-	-	-	2.7	2.2	2.7	-	-	-	3.6	3.5	3.8
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	N/A	N/A	N/A	N/A	N/A	N/A	14.0	27.0	27.0	44.0	36	N/A	18.0	15.0	16.0	2.4	18
	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**					
Dimension	**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	1,268.2	1,268.2	1,267.3	1,267.3	1,267.3	1,267.5	1,267.6	1,267.6	1,286.1	1,286.1	1,286.1	1,286.2	1,286.1	1,286.2	1,285.3	1,285.3	1,285.3	1,285.2	1,285.3	1,285.2	1,277.1	1,277.1	1,277.1	1,277.2	1,277.1	1,277.1
Low Bank Height Elevation (datum) Used	-	-	-	1,268.5	1,268.4	1,268.6	-	-	-	1,267.4	1,267.3	1,267.4	-	-	-	1,286.0	1,285.9	1,285.9	-	-	-	1,285.2	1,285.2	1,285.2	-	-	-	1,277.2	1,277.2	1,277.2
Bankfull Width (ft)	35.3	35.9	36.7	31.7	31.7	30.3	31.0	31.2	34.0	36.2	36.2	33.7	5.5	5.8	5.6	7.2	6.9	6.5	4.6	4.2	4.1	6.0	5.2	5.6	5.3	5.6	5.8	4.2	4.5	6.1
Floodprone Width (ft)	166.0	166.0	166.0	166.0	166.0	166.0	88.0	88.0	88.0	88.0	88.0	88.0	17.0	17.0	17.0	17.0	17.0	17.0	14.0	14.0	14.0	14.0	14.0	14.0	17.0	17.0	17.0	17.0	17.0	17.0
Bankfull Mean Depth (ft)	2.4	2.4	2.4	2.7	2.7	2.8	2.1	2.2	2.0	1.8	1.8	1.9	1.0	1.0	1.0	0.8	0.8	0.9	0.4	0.4	0.5	0.3	0.4	0.3	0.4	0.3	0.4	0.5	0.5	0.3
Bankfull Max Depth (ft)	4.0	3.9	3.9	4.3	3.7	3.6	2.9	3.0	3.1	3.5	3.5	3.4	1.8	1.7	1.7	1.6	1.6	1.5	0.7	0.6	0.8	0.7	0.6	0.6	0.6	0.6	0.6	0.8	0.7	0.7
Bankfull Cross Sectional Area (ft^2)	85.7	86.3	89.2	85.7	85.7	85.7	64.9	67.7	67.9	64.9	64.9	64.9	5.7	5.6	5.6	5.7	5.7	5.7	1.9	1.8	2.1	1.9	1.9	1.9	2.1	1.9	2.5	2.1	2.1	2.1
Bankfull Width/Depth Ratio	14.5	14.9	15.1	11.7	11.8	10.7	14.8	14.4	17.0	20.2	20.2	17.5	5.4	6.1	5.5	9.0	8.4	7.4	11.0	9.8	8.0	18.7	14.8	16.4	13.3	16.7	13.3	8.4	9.8	17.9
Bankfull Entrenchment Ratio	4.7	4.6	4.5	5.2	5.2	5.5	2.8	2.8	2.6	2.4	2.4	2.6	3.1	2.9	3.1	2.4	2.5	2.6	3.0	3.3	3.5	2.3	2.7	2.5	3.2	3.0	3.0	4.0	3.8	2.8
Bankfull Bank Height Ratio*	1.0	1.0	1.0	1.1	1.1	1.1	1.0	0.9	0.9	0.9	0.9	0.9	1.0	0.9	1.0	0.8	0.9	0.8	1.0	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	0.9	0.9
Low Top of Bank Height Depth (ft)	-	-	-	4.7	3.9	4.0	-	-	-	3.2	3.2	3.2	-	-	-	1.3	1.3	1.3	-	-	-	0.7	0.6	0.6	-	-	-	0.8	0.6	0.6
d50 (mm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.91	1.3	18.0	6.2	22.0	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	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					
Dimension & Substrate - Riffle	**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)	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	29.0	31.4	29.0	36.2	4.1	3	28.0	30.0	28.4	33.7	3.2	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	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	1.7	1.9	1.8	2.0	0.2	3	1.8	1.9	1.9	2.1	0.1	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	2.8	3.2	3.4	3.5	0.4	3	2.9	3.1	3.1	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	50.5	58.1	59.0	64.9	7.3	3	50.5	58.1	59.0	64.9	7.3	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	14.3	17.1	16.7	20.2	3.0	3	13.6	15.5	15.5	17.5	1.9	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	2.2	2.7	2.4	3.5	0.7	3	2.3	2.8	2.6	3.6	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	0.9	1.1	1.1	1.2	0.1	3	0.9	1.0	0.9	1.2	0.2	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	44.4	114.6	113.4	203.3	55.8	6	13.3	57.7	43.9	121.7	38.0	6
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	0.002	0.004	0.003	0.007	0.002	6	0.0	0.0	0.0	0.0	0.0	6
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	21.8	42.6	37.4	67.6	17.1	5	14.3	55.3	46.8	103.3	31.7	9
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	3.9	5.4	5.4	7.5	1.3	5	1.1	1.9	1.6	3.5	0.9	10
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	69.1	212.7	256.5	268.6	96.1	4	26.5	116.4	80.3	263.8	86.5	8
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						C4						C4						C4					
Channel Thalweg Length (ft)	1,163						1,158						1,174						1,151						1,141						1,141					
Sinuosity (ft)	1.03						1.03						1.05						1.03						1.02						1.019					
Water Surface Slope (Channel) (ft/ft)	0.003						0.0033						0.0033						0.0027						0.0033						0.0035					
Bankfull Slope (ft/ft)	0.002						0.0029						0.0037						0.0031						0.0034						0.0032					
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%		64%	6%	20%	10%	0%		30%	4%	44%	21%	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					
Dimension & Substrate - Riffle	**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)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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	16.3	29.6	32.5	37.0	9.5	3	8.4	29.0	28.3	51.0	19.0	4
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	0.007	0.013	0.012	0.019	0.005	3	0.0	0.0	0.0	0.0	0.0	4
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	8.44	11.04	10.99	13.72	2.22	4	4.1	9.2	7.6	20.3	5.2	8
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	1.22	1.55	1.57	1.80	0.22	4	0.6	0.9	0.8	1.5	0.3	8
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	42.23	48.86	47.81	56.53	7.21	3	8.4	24.8	18.5	56.7	18.8	8
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						B5						B5					
Channel Thalweg Length (ft)	177						159						160						158						156						158					
Sinuosity (ft)	1.01						1.02						1.03						1.02						1.01						1.01					
Water Surface Slope (Channel) (ft/ft)	0.029						0.028						0.029						0.030						0.02						0.02					
Bankfull Slope (ft/ft)	0.029						0.025						0.026						0.023						0.021						0.024					
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%		49%	0%	18%	13%	21%		56%	0%	35%	6%	2%	

- 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					
Dimension & Substrate - Riffle	**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	5.5	5.7	5.7	6.0	0.3	2	4.4	4.9	4.9	5.5	0.8	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	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	0.3	0.3	0.3	0.3	0.0	2	0.3	0.4	0.4	0.4	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	0.5	0.5	0.5	0.6	0.0	2	0.6	0.7	0.7	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	1.7	1.7	1.7	1.8	0.1	2	1.7	1.8	1.8	1.8	0.1	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	17.0	19.1	19.1	21.2	3.0	2	11.4	14.0	14.0	16.7	3.7	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	2.5	3.2	3.2	3.9	0.9	2	2.5	3.9	3.9	5.3	1.9	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	1.2	1.4	1.4	1.5	0.3	2	1.2	1.3	1.3	1.5	0.2	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	8.8	19.9	14.8	37.0	11.4	6	12.2	28.7	30.4	41.7	14.4	4
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	0.005	0.010	0.010	0.017	0.005	6	0.0	0.0	0.0	0.0	0.0	4
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	3.1	12.1	10.7	35.9	7.3	11	3.3	12.2	6.3	36.7	9.9	14
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	1.2	1.6	1.6	2.0	0.3	11	0.3	0.9	0.9	1.3	0.3	13
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	19.4	29.8	29.2	42.2	8.4	10	5.2	29.4	17.2	96.6	27.7	12
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						B5						B5					
Channel Thalweg Length (ft)	453						465						463						466						469						469					
Sinuosity (ft)	1.07						1.04						1.04						1.04						1.05						1.05					
Water Surface Slope (Channel) (ft/ft)	0.017						0.014						0.017						0.018						0.020						0.02					
Bankfull Slope (ft/ft)	0.017						0.016						0.020						0.020						0.021						0.021					
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%		30%	13%	27%	13%	17%		31%	5%	46%	12%	7%	

- 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					
Dimension & Substrate - Riffle	**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)	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	3.7	5.2	5.2	6.7	2.2	2	5.6	5.8	5.8	6.1	0.3	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	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	0.3	0.3	0.3	0.3	0.0	2	0.3	0.3	0.3	0.3	0.0	2
Bankfull Max Depth (ft)	0.6	0.6	0.6	0.7	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	0.5	0.6	0.6	0.6	0.1	2	0.6	0.6	0.6	0.7	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	1.2	1.7	1.7	2.1	0.6	2	1.9	2.0	2.0	2.1	0.1	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	11.2	16.4	16.4	21.5	7.3	2	16.4	17.2	17.2	17.9	1.1	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	2.1	3.4	3.4	4.6	1.8	2	2.5	2.6	2.6	2.8	0.2	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	0.9	1.0	1.0	1.1	0.1	2	0.9	0.9	0.9	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	13.0	30.5	27.2	49.3	15.2	5	31.4	50.2	43.4	86.4	22.4	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	0.007	0.015	0.014	0.024	0.006	5	0.0	0.0	0.0	0.0	0.0	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	7.6	15.7	19.1	20.5	7.1	3	2.1	4.5	4.7	7.1	1.7	11
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	0.2	0.9	0.3	3.7	1.5	5	-	-	-	-	-	-
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	45.0	60.9	60.9	76.8	22.5	2	-	-	-	-	-	-
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						B5						B5					
Channel Thalweg Length (ft)	326						330						328						332						325						325					
Sinuosity (ft)	1.10						1.11						1.11						1.12						1.09						1.09					
Water Surface Slope (Channel) (ft/ft)	0.056						-						-						0.0532						-						0.048					
Bankfull Slope (ft/ft)	0.056						0.0598						0.0595						0.0670						0.047						0.036					
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%		66%	0%	20%	0%	14%		79%	0%	16%	1%	5%	

- Information Unavailable
N/A - Information does not apply.

* Calculations based upon dry channel indicators
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)

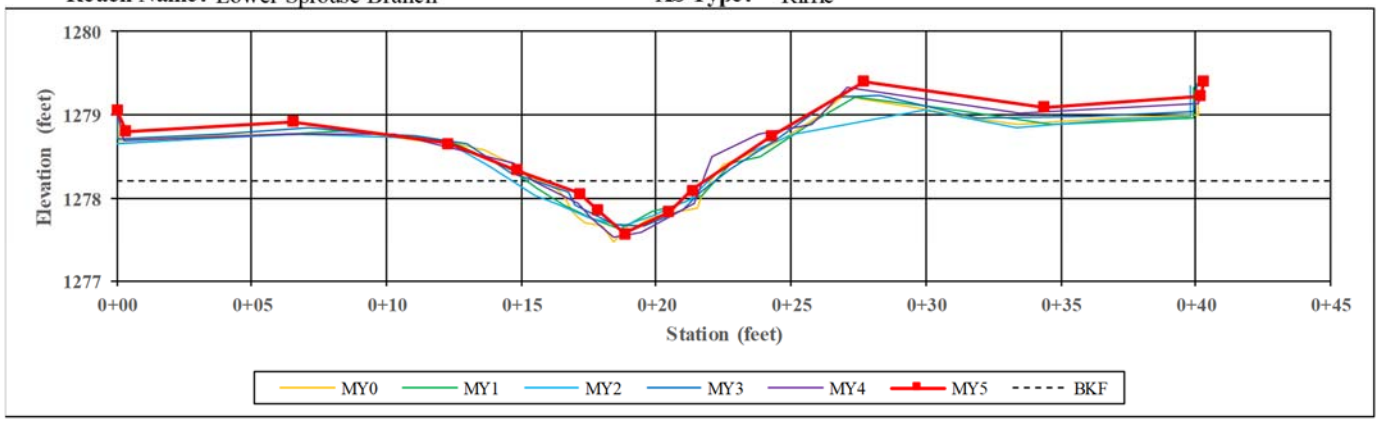
Parameter	Baseline						MY - 1						MY - 2						MY - 3						MY - 4						MY - 5					
Dimension & Substrate - Riffle	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**	**Min**	**Mean**	**Med**	**Max**	**SD**	**n**
Bankfull Width (ft)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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	6.7	27.3	19.2	64.1	25.2	2	9.4	17.6	16.5	27.9	8.3	4
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	0.005	0.016	0.011	0.035	0.013	2	0.0	0.0	0.0	0.0	0.0	4
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	3.8	12.4	12.5	20.7	8.2	4	8.5	15.5	13.1	31.0	9.1	5
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	0.3	0.8	0.7	1.5	0.5	4	0.6	1.1	1.1	1.8	0.5	8
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	24.8	49.2	42.6	80.1	28.2	3	4.5	20.1	17.7	46.9	15.6	7
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						B5						B5					
Channel Thalweg Length (ft)	156						154						159						158						153						153					
Sinuosity (ft)	1.03						1.03						1.07						1.06						1.03						1.03					
Water Surface Slope (Channel) (ft/ft)	0.032						-						-						0.0503						0.03						0.03					
Bankfull Slope (ft/ft)	0.035						0.026						0.033						0.034						0.042						0.043					
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%		56%	6%	33%	5%	0%		44%	0%	49%	7%	0%	

- Information Unavailable

N/A - Information does not apply.

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

Project Name: Middle South Muddy **XS Number:** 1 **Station:** 203+60
Reach Name: Lower Sprouse Branch **XS Type:** Riffle



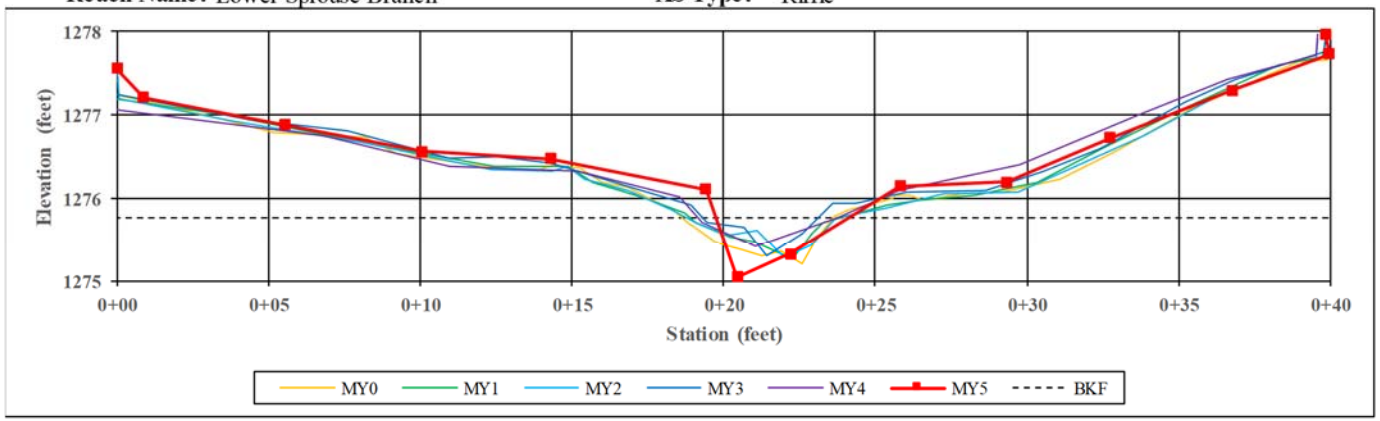
CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	5.4	6.1	6.3	5.0	5.5	5.5	-	-
Floodprone Width (ft)	14.0	14.0	14.0	14.0	14.0	14.0	-	-
Bankfull Mean Depth (ft)	0.3	0.2	0.2	0.3	0.3	0.3	-	-
Bankfull Max Depth (ft)	0.6	0.5	0.4	0.4	0.6	0.6	-	-
Bankfull Cross-Sectional Area (ft^2)	1.8	1.5	1.5	1.4	1.8	1.8	-	-
Width/Depth Ratio	16.7	25.4	25.8	17.4	17.0	16.7	-	-
Entrenchment Ratio	2.6	2.3	2.2	2.8	2.5	2.5	-	-
Bank Height Ratio	1.0	0.9	0.9	1.5	1.5	1.2	-	-
Low Top of Bank Depth (ft)	0.6	0.4	0.9	0.4	0.9	0.8	-	-

Left Descending Bank

Right Descending Bank

Project Name: Middle South Muddy **XS Number:** 2 **Station:** 204+72

Reach Name: Lower Sprouse Branch **XS Type:** Riffle

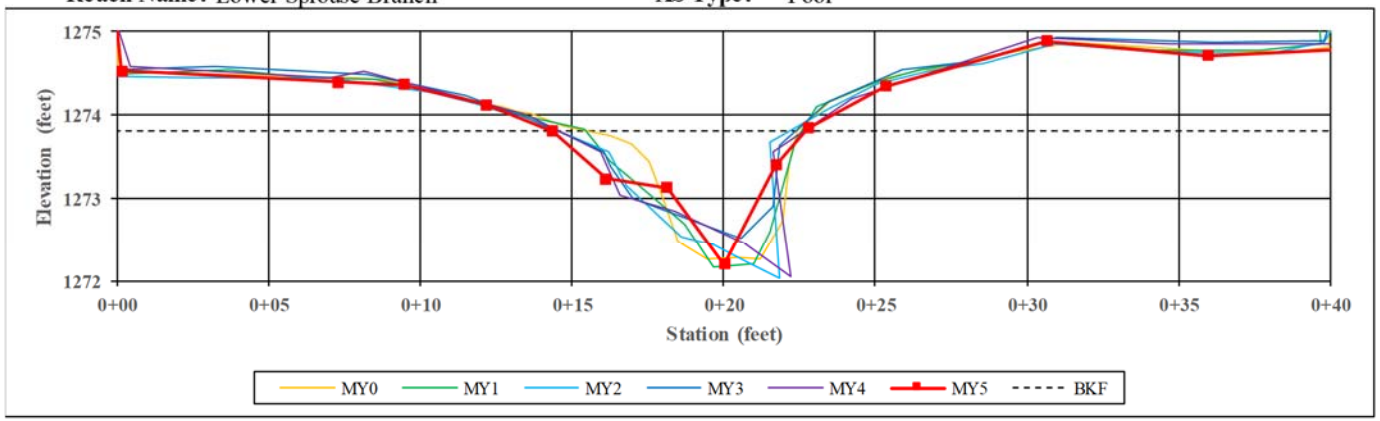


CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	5.1	5.3	5.4	4.0	6.0	4.4	-	-
Floodprone Width (ft)	23.0	23.0	23.0	23.0	23.0	23.0	-	-
Bankfull Mean Depth (ft)	0.3	0.2	0.2	0.2	0.3	0.4	-	-
Bankfull Max Depth (ft)	0.6	0.5	0.5	0.5	0.5	0.7	-	-
Bankfull Cross-Sectional Area (ft^2)	1.7	1.3	1.2	0.9	1.7	1.7	-	-
Width/Depth Ratio	15.1	21.5	23.7	18.3	21.2	11.4	-	-
Entrenchment Ratio	4.5	4.3	4.3	5.8	3.9	5.3	-	-
Bank Height Ratio	1.0	1.0	0.9	1.2	1.2	1.5	-	-
Low Top of Bank Depth (ft)	0.6	0.5	0.5	0.4	0.6	1.1	-	-

Left Descending Bank

Right Descending Bank

Project Name: Middle South Muddy **XS Number:** 3 **Station:** 205+79
Reach Name: Lower Sprouse Branch **XS Type:** Pool

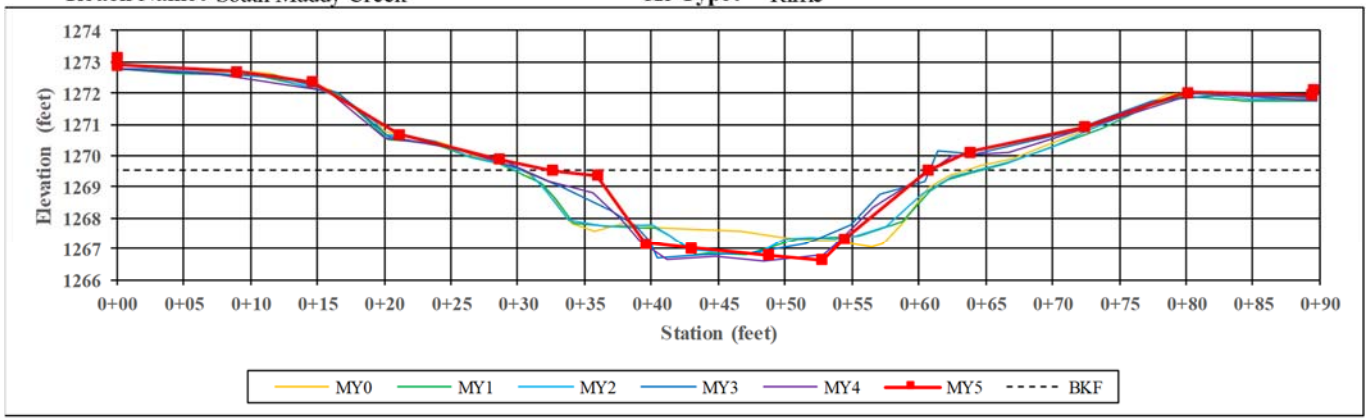


CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	6.1	6.8	6.8	7.3	7.2	8.3	-	-
Floodprone Width (ft)	32.0	32.0	32.0	32.0	32.0	32.0	-	-
Bankfull Mean Depth (ft)	1.0	0.9	0.9	0.7	0.8	0.7	-	-
Bankfull Max Depth (ft)	1.5	1.6	1.7	1.2	1.6	1.6	-	-
Bankfull Cross-Sectional Area (ft^2)	5.9	6.3	6.3	5.3	5.9	5.9	-	-
Width/Depth Ratio	6.3	7.5	7.3	10.1	8.7	11.9	-	-
Entrenchment Ratio	5.3	4.7	4.7	4.4	4.5	3.8	-	-
Bank Height Ratio	1.0	1.1	1.0	1.0	0.9	0.7	-	-
Low Top of Bank Depth (ft)	1.5	1.6	1.8	1.2	1.5	1.2	-	-

Left Descending Bank

Right Descending Bank

Project Name: Middle South Muddy **XS Number:** 4 **Station:** 102+79
Reach Name: South Muddy Creek **XS Type:** Riffle

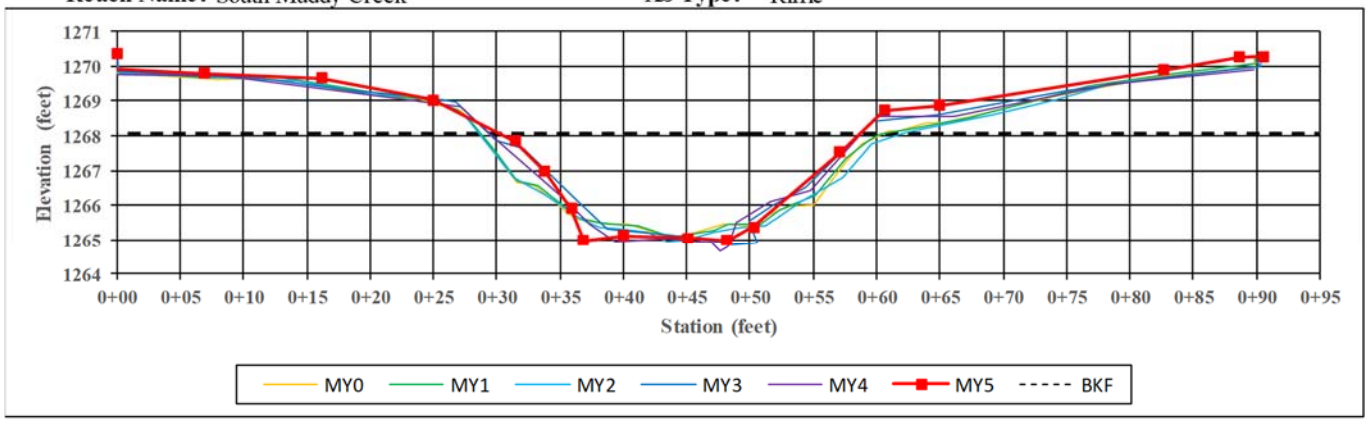


CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	31.6	32.6	31.8	29.5	29.0	28.0	-	-
Floodprone Width (ft)	65.0	65.0	65.0	65.0	65.0	65.0	-	-
Bankfull Mean Depth (ft)	1.6	1.7	1.7	1.6	1.7	1.8	-	-
Bankfull Max Depth (ft)	2.3	2.6	2.6	2.7	2.8	2.9	-	-
Bankfull Cross-Sectional Area (ft^2)	50.5	54.1	52.8	46.9	50.5	50.5	-	-
Width/Depth Ratio	19.8	19.7	19.1	18.6	16.7	15.5	-	-
Entrenchment Ratio	2.1	2.0	2.0	2.2	2.2	2.3	-	-
Bank Height Ratio	1.0	0.9	1.0	1.0	1.0	0.9	-	-
Low Top of Bank Depth (ft)	2.1	2.4	2.5	2.7	2.2	2.7	-	-

Left Descending Bank

Right Descending Bank

Project Name: Middle South Muddy **XS Number:** 5 **Station:** 107+45
Reach Name: South Muddy Creek **XS Type:** Riffle

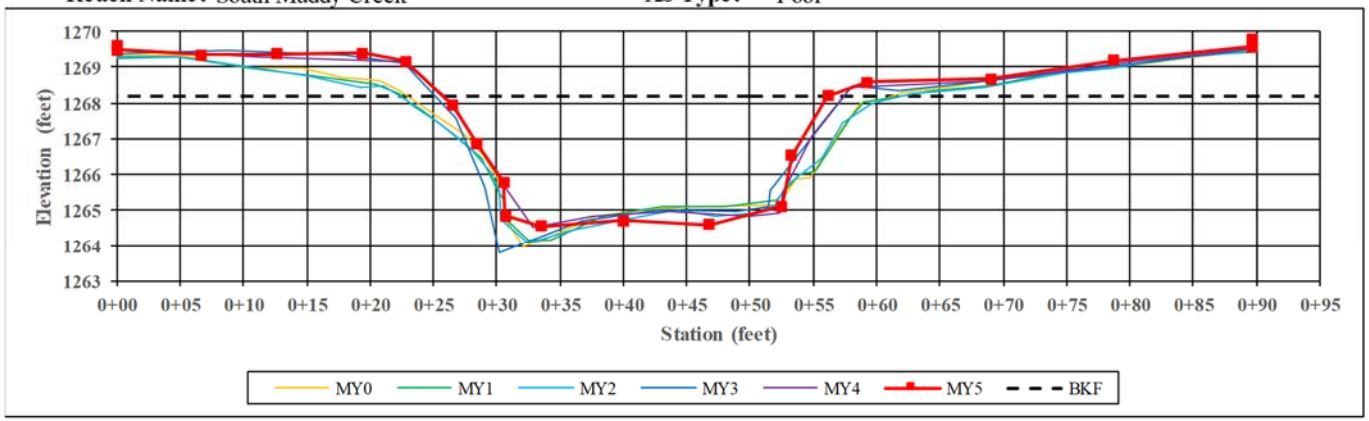


CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	30.7	30.6	31.8	28.4	29.0	28.4	-	-
Floodprone Width (ft)	101.0	101.0	101.0	101.0	101.0	101.0	-	-
Bankfull Mean Depth (ft)	1.9	1.9	1.9	1.9	2.0	2.1	-	-
Bankfull Max Depth (ft)	2.8	2.8	3.0	3.1	3.4	3.1	-	-
Bankfull Cross-Sectional Area (ft²)	59.0	57.9	61.3	52.9	59.0	59.0	-	-
Width/Depth Ratio	15.9	16.2	16.4	15.3	14.3	13.6	-	-
Entrenchment Ratio	3.3	3.3	3.2	3.6	3.5	3.6	-	-
Bank Height Ratio	1.0	1.0	1.1	1.1	1.2	1.2	-	-
Low Top of Bank Depth (ft)	3.3	3.0	3.2	3.6	3.5	3.8	-	-

Left Descending Bank

Right Descending Bank

Project Name: Middle South Muddy **XS Number:** 6 **Station:** 108+57
Reach Name: South Muddy Creek **XS Type:** Pool

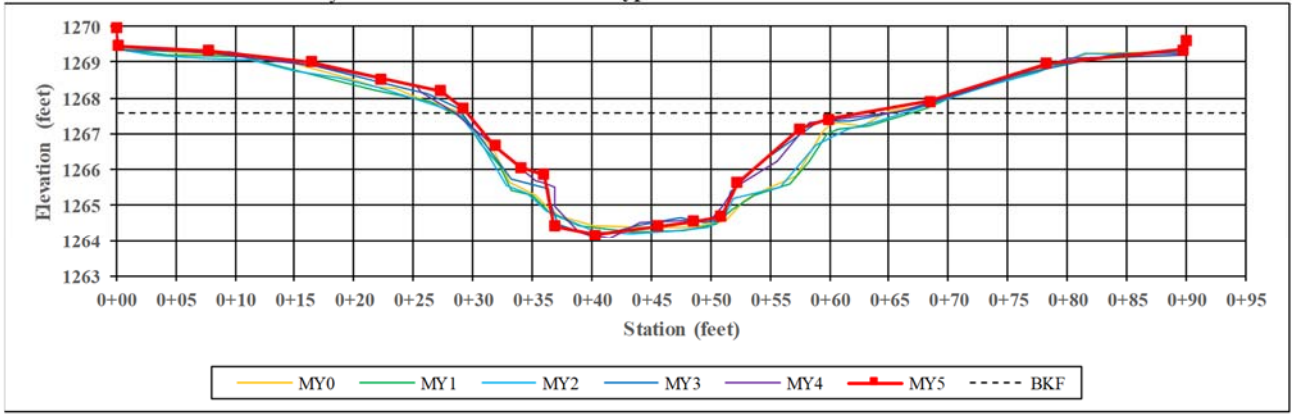


CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	35.3	35.9	36.7	31.4	31.7	30.3	-	-
Floodprone Width (ft)	166.0	166.0	166.0	166.0	166.0	166.0	-	-
Bankfull Mean Depth (ft)	2.4	2.4	2.4	2.7	2.7	2.8	-	-
Bankfull Max Depth (ft)	4.0	3.9	3.9	4.2	3.7	3.6	-	-
Bankfull Cross-Sectional Area (ft^2)	85.7	86.3	89.2	84.0	85.7	85.7	-	-
Width/Depth Ratio	14.5	14.9	15.1	11.7	11.8	10.7	-	-
Entrenchment Ratio	4.7	4.6	4.5	5.3	5.2	5.5	-	-
Bank Height Ratio	1.0	1.0	1.0	1.0	1.1	1.1	-	-
Low Top of Bank Depth (ft)	4.7	3.8	3.9	4.7	3.9	4.0	-	-

Left Descending Bank

Right Descending Bank

Project Name: Middle South Muddy **XS Number:** 7 **Station:** 109+57
Reach Name: South Muddy Creek **XS Type:** Riffle

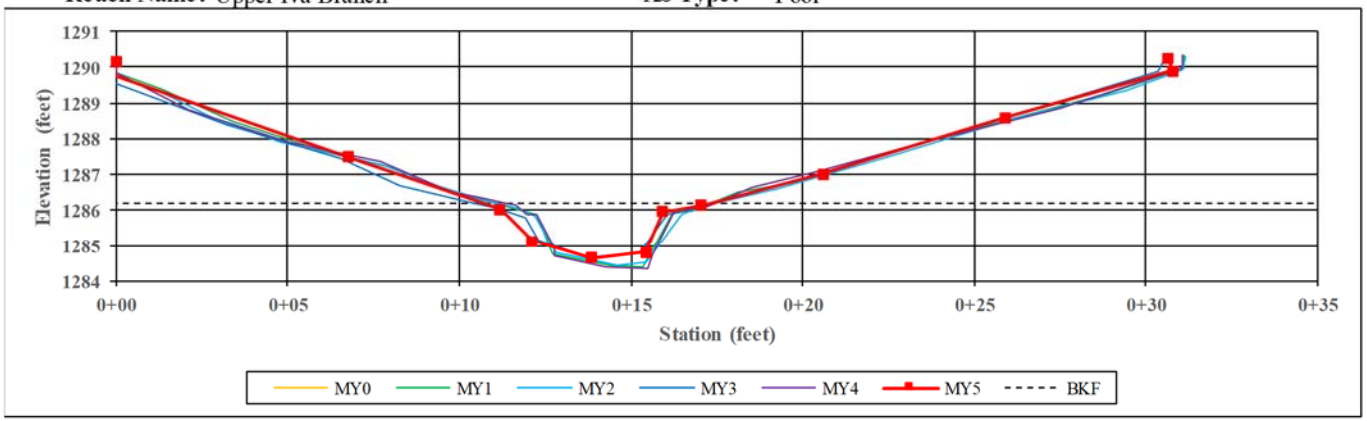


CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	31.0	31.2	34.0	29.1	36.2	33.7	-	-
Floodprone Width (ft)	88.0	88.0	88.0	88.0	88.0	88.0	-	-
Bankfull Mean Depth (ft)	2.1	2.2	2.0	2.0	1.8	1.9	-	-
Bankfull Max Depth (ft)	2.9	3.0	3.1	3.2	3.5	3.4	-	-
Bankfull Cross-Sectional Area (ft^2)	64.9	67.7	67.9	57.9	64.9	64.9	-	-
Width/Depth Ratio	14.8	14.4	17.0	14.6	20.2	17.5	-	-
Entrenchment Ratio	2.8	2.8	2.6	3.0	2.4	2.6	-	-
Bank Height Ratio	1.0	0.9	0.9	0.9	0.9	0.9	-	-
Low Top of Bank Depth (ft)	2.8	2.9	2.9	3.3	3.2	3.2	-	-

Left Descending Bank

Right Descending Bank

Project Name: Middle South Muddy **XS Number:** 8 **Station:** 302+13
Reach Name: Upper Iva Branch **XS Type:** Pool

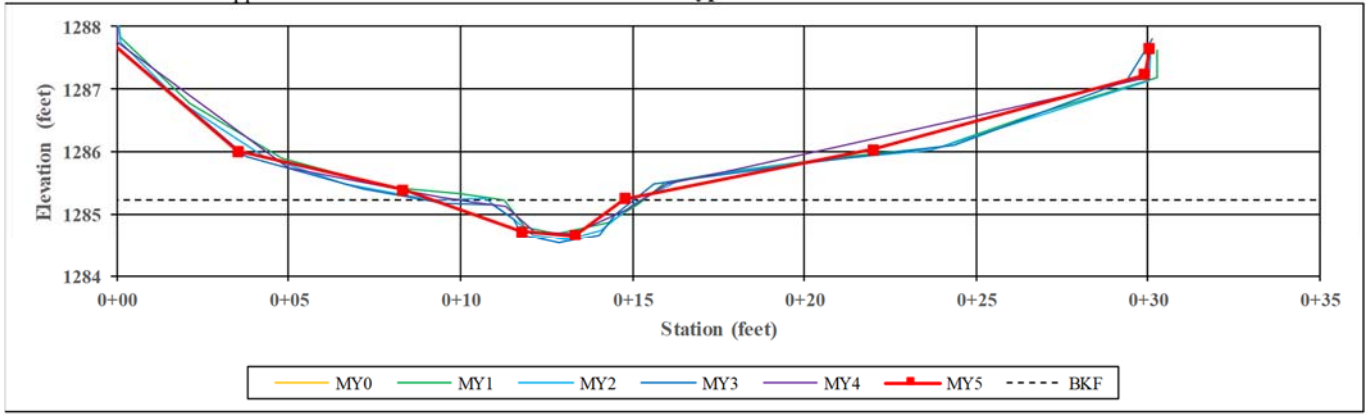


CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	5.5	5.8	5.6	6.4	6.9	6.5	-	-
Floodprone Width (ft)	17.0	17.0	17.0	17.0	17.0	17.0	-	-
Bankfull Mean Depth (ft)	1.0	1.0	1.0	0.8	0.8	0.9	-	-
Bankfull Max Depth (ft)	1.8	1.7	1.7	1.5	1.6	1.5	-	-
Bankfull Cross-Sectional Area (ft^2)	5.7	5.6	5.6	5.0	5.7	5.7	-	-
Width/Depth Ratio	5.4	6.1	5.5	8.1	8.4	7.4	-	-
Entrenchment Ratio	3.1	2.9	3.1	2.7	2.5	2.6	-	-
Bank Height Ratio	1.0	0.9	1.0	1.0	0.9	0.8	-	-
Low Top of Bank Depth (ft)	3.1	1.6	1.6	1.3	1.3	1.3	-	-


Left Descending Bank


Right Descending Bank

Project Name: Middle South Muddy **XS Number:** 9 **Station:** 302+82
Reach Name: Upper Iva Branch **XS Type:** Riffle

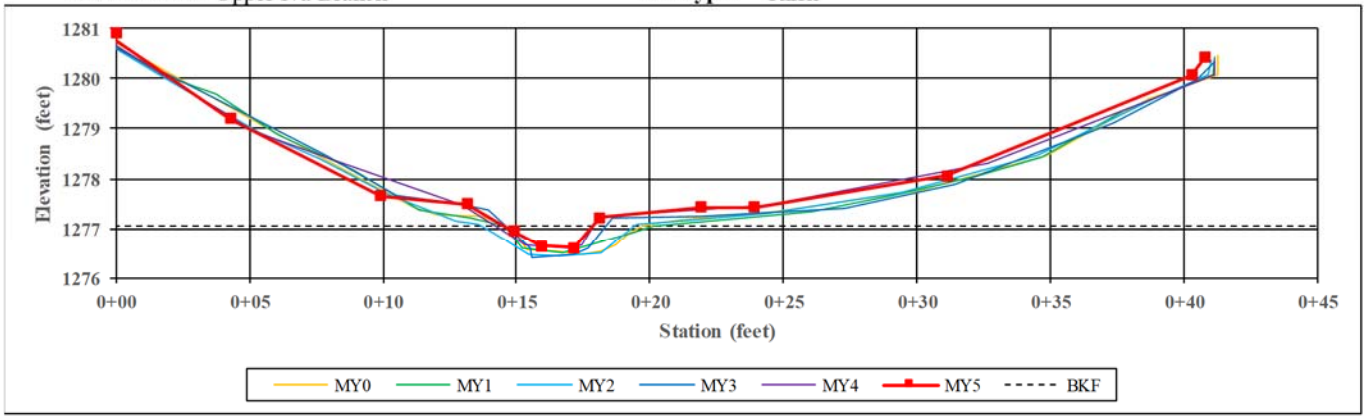


CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	4.6	4.2	4.1	7.3	5.2	5.6	-	-
Floodprone Width (ft)	14.0	14.0	14.0	14.0	14.0	14.0	-	-
Bankfull Mean Depth (ft)	0.4	0.4	0.5	0.4	0.4	0.3	-	-
Bankfull Max Depth (ft)	0.7	0.6	0.8	0.8	0.6	0.6	-	-
Bankfull Cross-Sectional Area (ft^2)	1.9	1.8	2.1	2.7	1.9	1.9	-	-
Width/Depth Ratio	11.0	9.8	8.0	20.2	14.8	16.4	-	-
Entrenchment Ratio	3.0	3.3	3.5	1.9	2.7	2.5	-	-
Bank Height Ratio	1.0	1.0	0.9	0.9	0.9	1.0	-	-
Low Top of Bank Depth (ft)	3.0	0.6	0.6	0.7	0.6	0.6	-	-

Left Descending Bank

Right Descending Bank

Project Name: Middle South Muddy **XS Number:** 10 **Station:** 304+20
Reach Name: Upper Iva Branch **XS Type:** Riffle

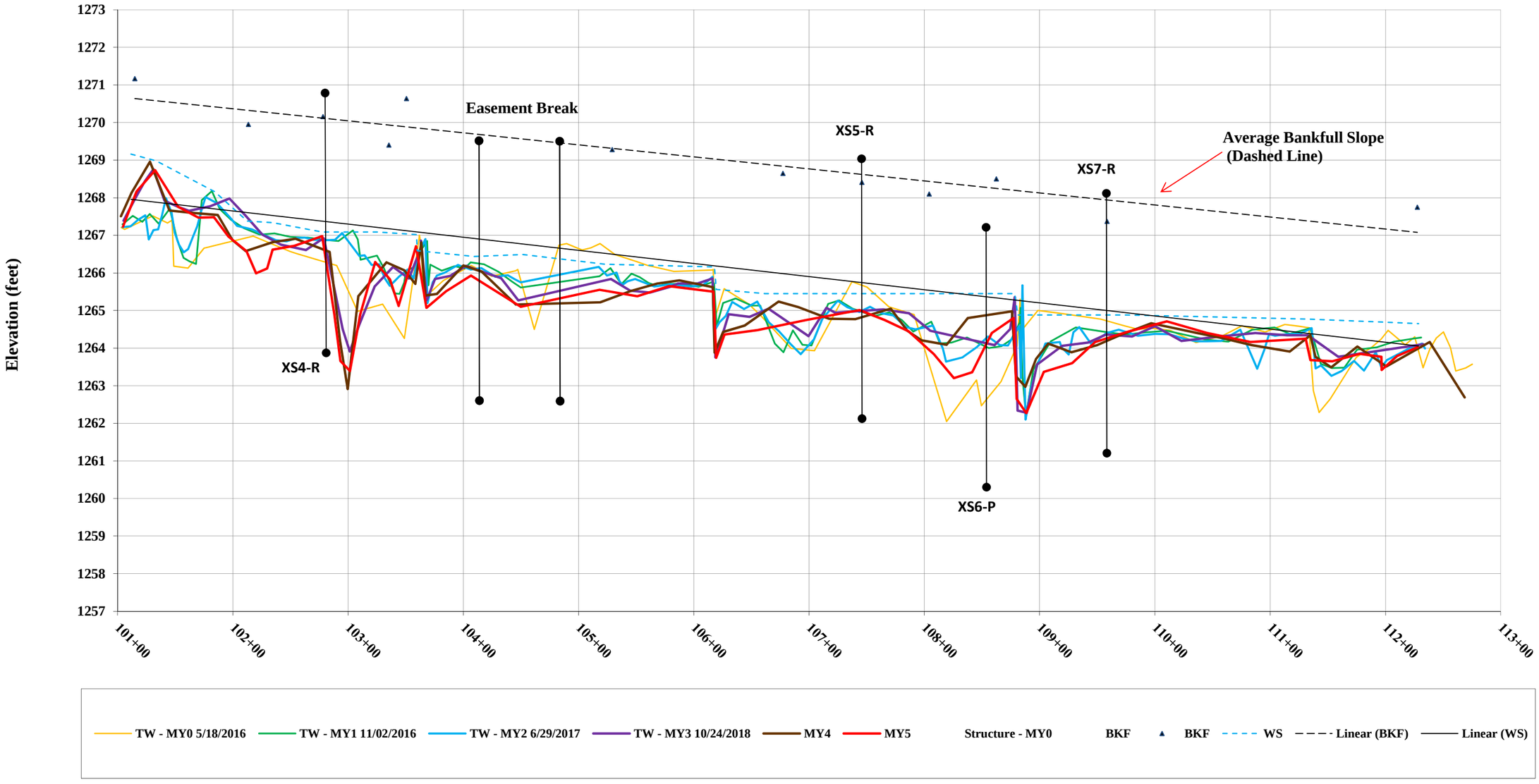


CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	5.3	5.6	5.8	3.8	4.5	6.1	-	-
Floodprone Width (ft)	17.0	17.0	17.0	17.0	17.0	17.0	-	-
Bankfull Mean Depth (ft)	0.4	0.3	0.4	0.4	0.5	0.3	-	-
Bankfull Max Depth (ft)	0.6	0.6	0.6	0.7	0.7	0.7	-	-
Bankfull Cross-Sectional Area (ft^2)	2.1	1.9	2.5	1.7	2.1	2.1	-	-
Width/Depth Ratio	13.3	16.7	13.3	8.7	9.8	17.9	-	-
Entrenchment Ratio	3.2	3.0	3.0	4.4	3.8	2.8	-	-
Bank Height Ratio	1.0	1.0	1.0	1.0	0.9	0.9	-	-
Low Top of Bank Depth (ft)	0.6	0.6	0.7	0.8	0.6	0.6	-	-

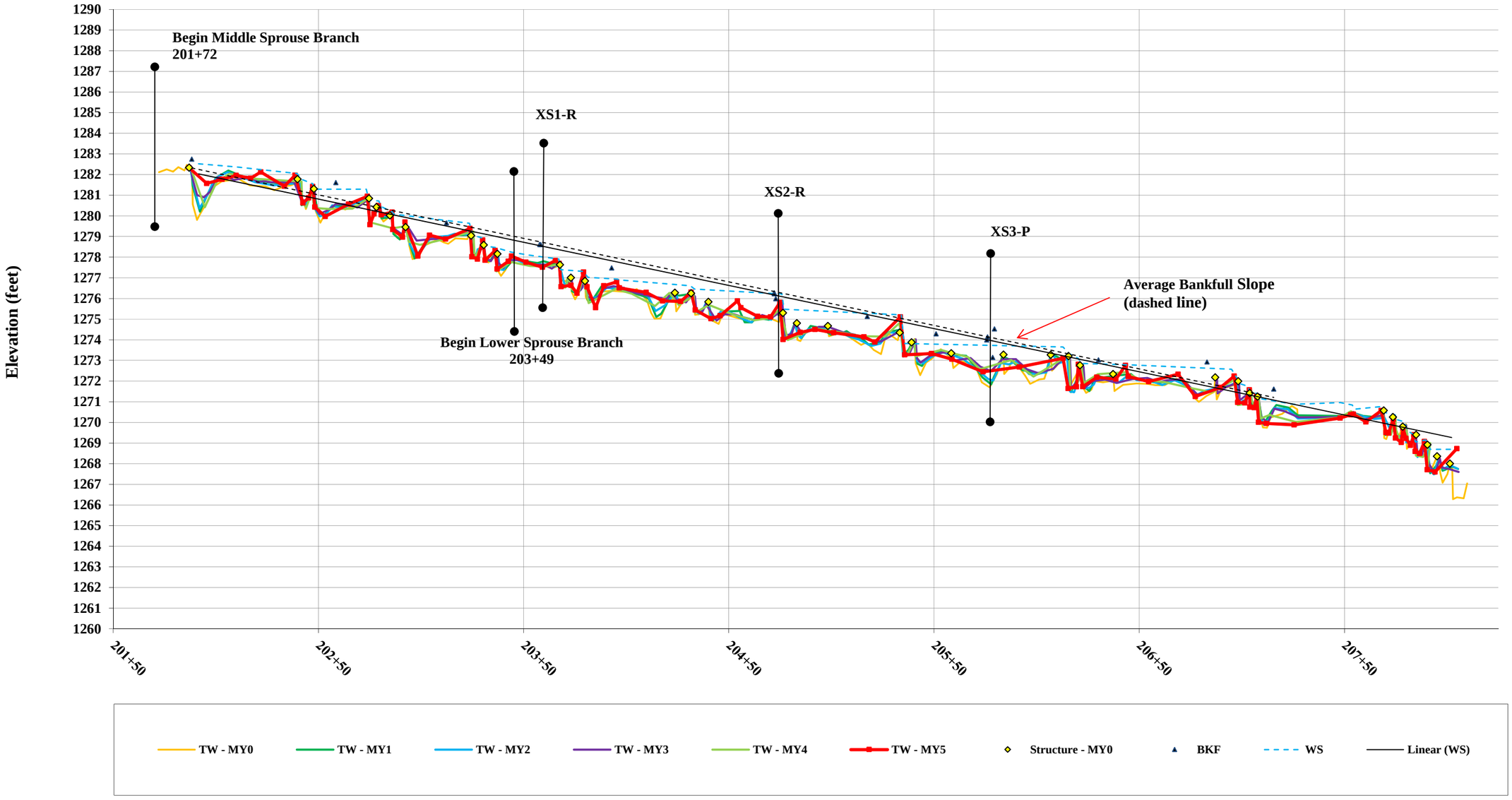
Left Descending Bank

Right Descending Bank

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



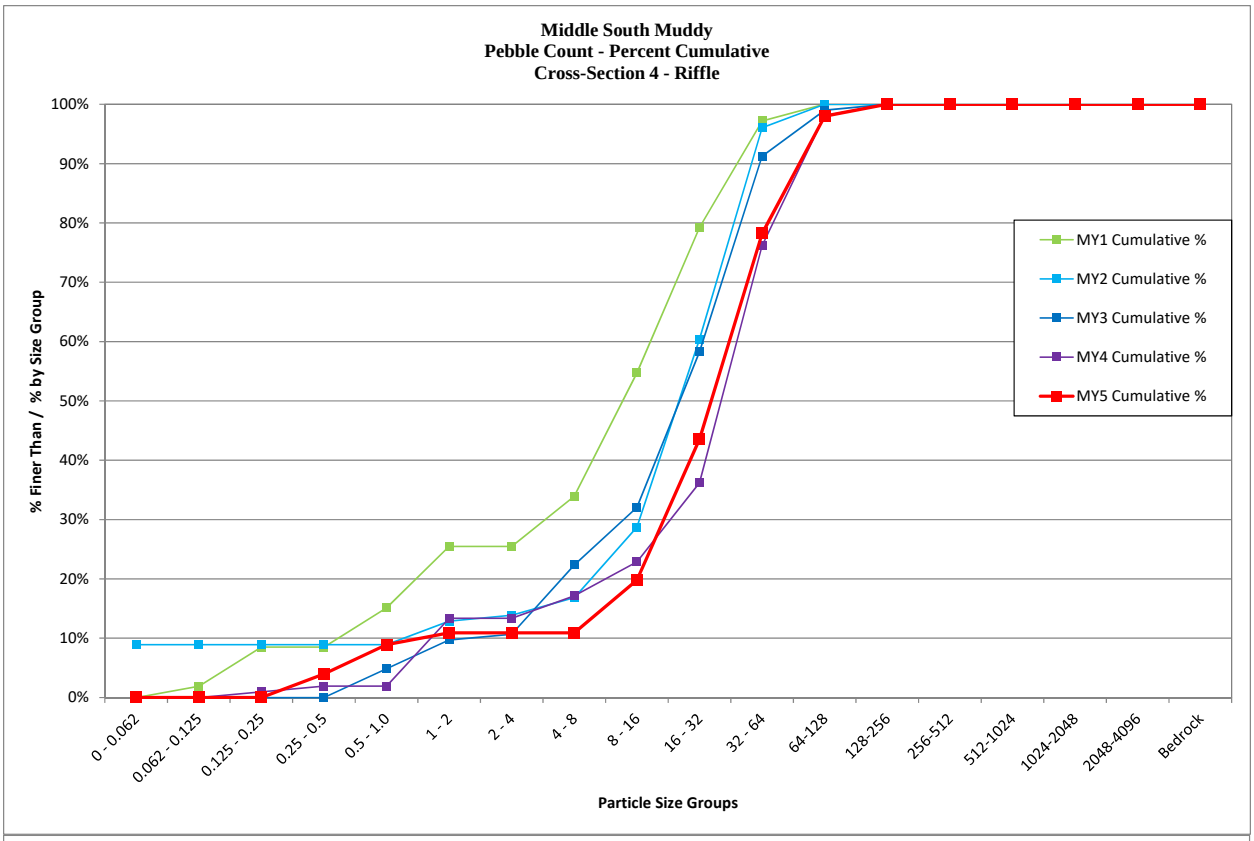
Middle South Muddy
Sprouse Branch
Longitudinal Profile
Staioning 201+72.34 to 208+91.81

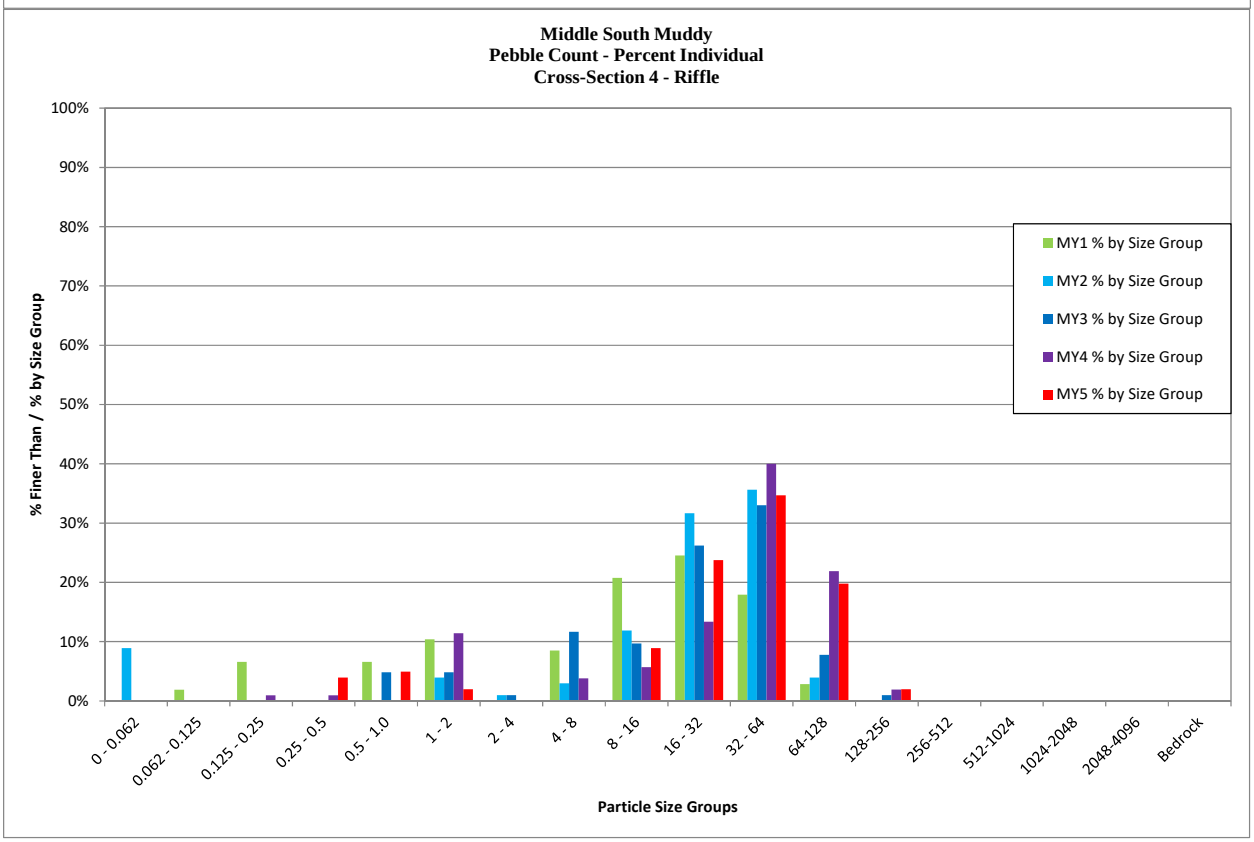


Middle South Muddy
Iva Branch
Longitudinal Profile
Staioning 300+79.55 to 307+17.78

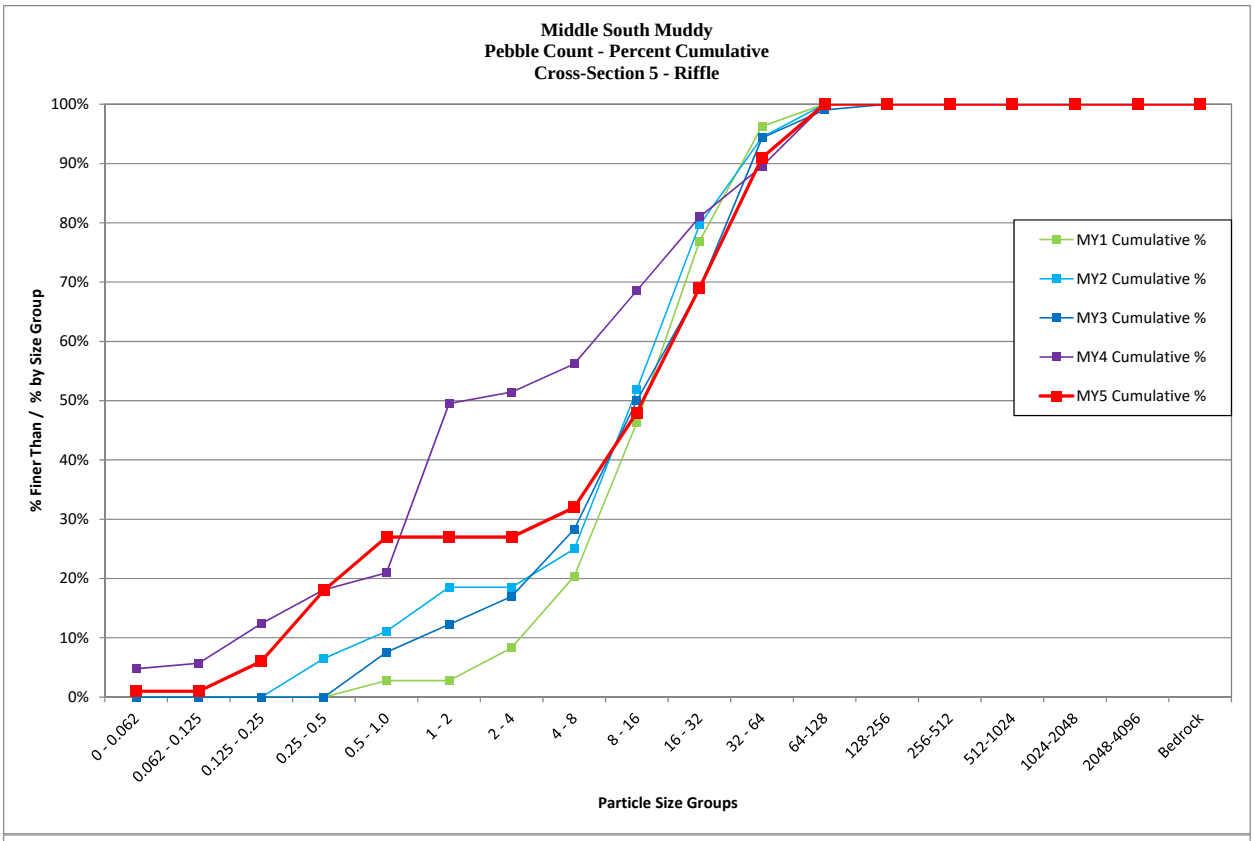
This Page Intentionally Left Blank

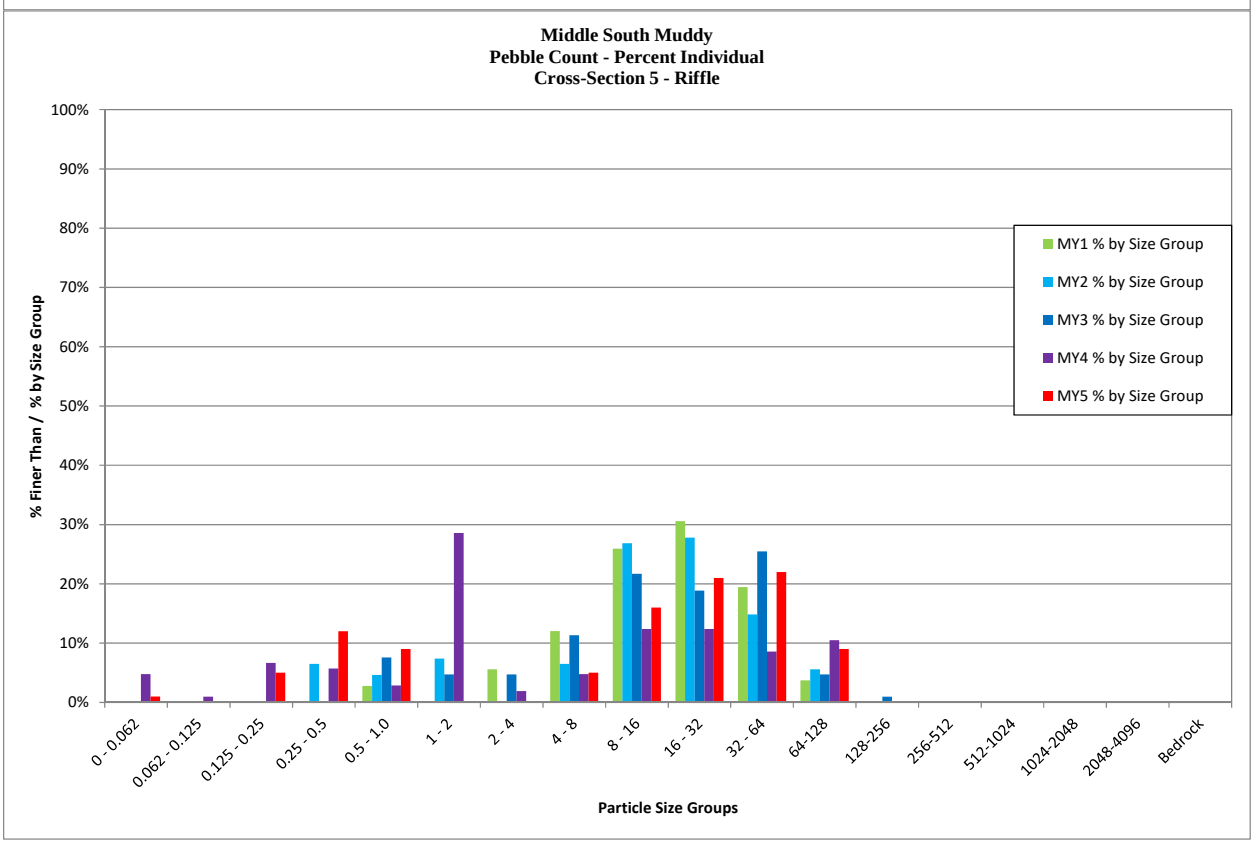
Middle South Muddy			
Cross Section 4 - Riffle			
Monitoring Year - 2020; MY5			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
0 - 0.062	0	0.0%	0%
0.062 - 0.125	0	0.0%	0%
0.125 - 0.25	0	0.0%	0%
0.25 - 0.5	4	4.0%	4%
0.5 - 1.0	5	5.0%	9%
1 - 2	2	2.0%	11%
2 - 4	0	0.0%	11%
4 - 8	0	0.0%	11%
8 - 16	9	8.9%	20%
16 - 32	24	23.8%	44%
32 - 64	35	34.7%	78%
64-128	20	19.8%	98%
128-256	2	2.0%	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	**101**	**100%**	**100%**
		Summary Data	
		D50	**36**
		D84	**74**
		D95	**110**


Middle South Muddy
Pebble Count - Percent Cumulative
Cross-Section 4 - Riffle
% Finer Than / % by Size Group
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
MY1 Cumulative %
MY2 Cumulative %
MY3 Cumulative %
MY4 Cumulative %
MY5 Cumulative %
0 - 0.062
0.062 - 0.125
0.125 - 0.25
0.25 - 0.5
0.5 - 1.0
1 - 2
2 - 4
4 - 8
8 - 16
16 - 32
32 - 64
64-128
128-256
256-512
512-1024
1024-2048
2048-4096
Bedrock
Particle Size Groups

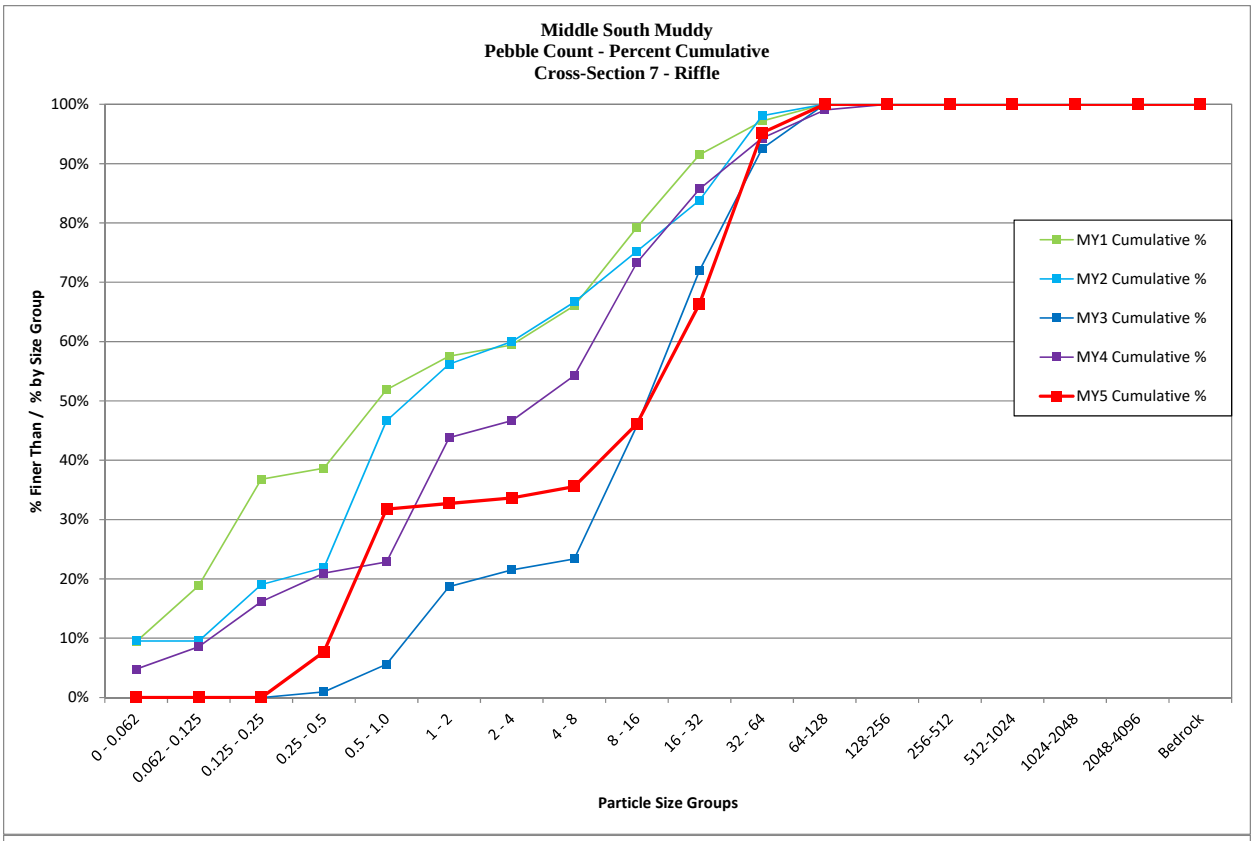

Middle South Muddy
Pebble Count - Percent Individual
Cross-Section 4 - Riffle
% Finer Than / % by Size Group
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
MY1 % by Size Group
MY2 % by Size Group
MY3 % by Size Group
MY4 % by Size Group
MY5 % by Size Group
0 - 0.062
0.062 - 0.125
0.125 - 0.25
0.25 - 0.5
0.5 - 1.0
1 - 2
2 - 4
4 - 8
8 - 16
16 - 32
32 - 64
64-128
128-256
256-512
512-1024
1024-2048
2048-4096
Bedrock
Particle Size Groups

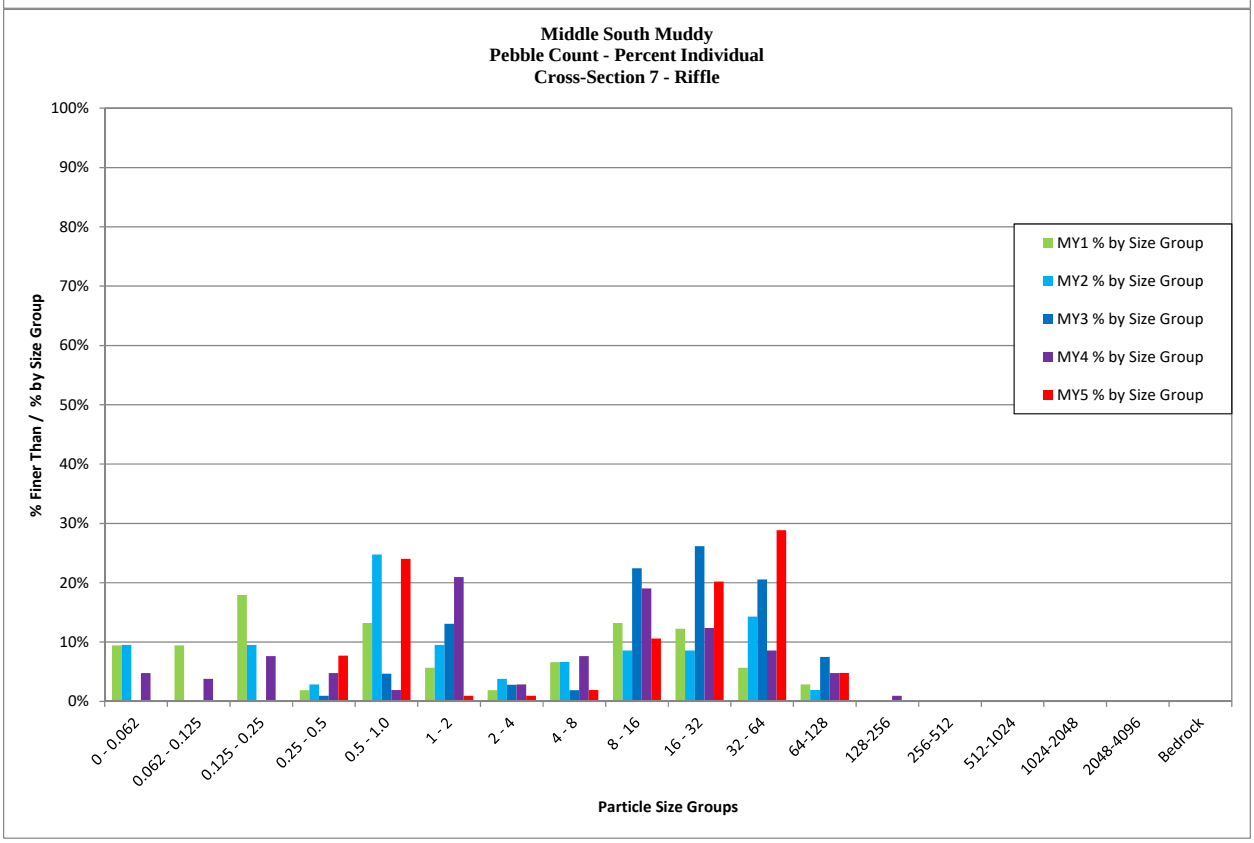
Middle South Muddy			
Cross Section 5 - Riffle			
Monitoring Year - 2020; MY5			
Bed Surface Material Particle Size Class (mm)	**Number**	**% Individual**	**% Cumulative**
0 - 0.062	1	1.0%	1%
0.062 - 0.125	0	0.0%	1%
0.125 - 0.25	5	5.0%	6%
0.25 - 0.5	12	12.0%	18%
0.5 - 1.0	9	9.0%	27%
1 - 2	0	0.0%	27%
2 - 4	0	0.0%	27%
4 - 8	5	5.0%	32%
8 - 16	16	16.0%	48%
16 - 32	21	21.0%	69%
32 - 64	22	22.0%	91%
64-128	9	9.0%	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	**100**	**100%**	**100%**
		Summary Data	
		D50	**18**
		D84	**49**
		D95	**84**


Middle South Muddy
Pebble Count - Percent Cumulative
Cross-Section 5 - Riffle
% Finer Than / % by Size Group
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
MY1 Cumulative %
MY2 Cumulative %
MY3 Cumulative %
MY4 Cumulative %
MY5 Cumulative %
0 - 0.062
0.062 - 0.125
0.125 - 0.25
0.25 - 0.5
0.5 - 1.0
1 - 2
2 - 4
4 - 8
8 - 16
16 - 32
32 - 64
64-128
128-256
256-512
512-1024
1024-2048
2048-4096
Bedrock
Particle Size Groups


Middle South Muddy
Pebble Count - Percent Individual
Cross-Section 5 - Riffle
% Finer Than / % by Size Group
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
MY1 % by Size Group
MY2 % by Size Group
MY3 % by Size Group
MY4 % by Size Group
MY5 % by Size Group
0 - 0.062
0.062 - 0.125
0.125 - 0.25
0.25 - 0.5
0.5 - 1.0
1 - 2
2 - 4
4 - 8
8 - 16
16 - 32
32 - 64
64-128
128-256
256-512
512-1024
1024-2048
2048-4096
Bedrock
Particle Size Groups

Middle South Muddy			
Cross Section 7 - Riffle			
Monitoring Year - 2020; MY5			
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	8	7.7%	8%
0.5 - 1.0	25	24.0%	32%
1 - 2	1	1.0%	33%
2 - 4	1	1.0%	34%
4 - 8	2	1.9%	36%
8 - 16	11	10.6%	46%
16 - 32	21	20.2%	66%
32 - 64	30	28.8%	95%
64-128	5	4.8%	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	**104**	**100%**	**100%**
		Summary Data	
		D50	**22**
		D84	**43**
		D95	**63**


Middle South Muddy
Pebble Count - Percent Cumulative
Cross-Section 7 - Riffle
% Finer Than / % by Size Group
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
MY1 Cumulative %
MY2 Cumulative %
MY3 Cumulative %
MY4 Cumulative %
MY5 Cumulative %
0 - 0.062
0.062 - 0.125
0.125 - 0.25
0.25 - 0.5
0.5 - 1.0
1 - 2
2 - 4
4 - 8
8 - 16
16 - 32
32 - 64
64-128
128-256
256-512
512-1024
1024-2048
2048-4096
Bedrock
Particle Size Groups


Middle South Muddy
Pebble Count - Percent Individual
Cross-Section 7 - Riffle
% Finer Than / % by Size Group
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
MY1 % by Size Group
MY2 % by Size Group
MY3 % by Size Group
MY4 % by Size Group
MY5 % by Size Group
0 - 0.062
0.062 - 0.125
0.125 - 0.25
0.25 - 0.5
0.5 - 1.0
1 - 2
2 - 4
4 - 8
8 - 16
16 - 32
32 - 64
64-128
128-256
256-512
512-1024
1024-2048
2048-4096
Bedrock
Particle Size Groups

Appendix E
Hydrologic Data

This Page Intentionally Left Blank

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	Unknown[3]	Wrack Lines	Unknown	-
11/1/2018	Unknown[4]	Wrack Lines	Unknown	-
5/9/2019	Unknown[5]	Wrack Lines	Unknown	-
4/27/2020	Unknown[6]	Wrack Lines	Unknown	1 & 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	Unknown[3]	Crest Gauge	0.1	-
11/1/2018	Unknown[4]	Crest Gauge	0.4	-
5/9/2019	Unknown[5]	Crest Gauge	0.33	-
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	Unknown[3]	Wrack Lines	Unknown	-
11/1/2018	Unknown[4]	Wrack Lines	Unknown	-

[1]Potential Date is 2/2/2016 [3]Potential Date is 2/11/2018 [5]Potential Date is 2/18/2019

[2]Potential Date is 10/23/2017 [4]Potential Date is 10/18/2018 [6]Potential Date is 2/6/2020

Photo Verification of Bankfull Events

Photo #1 - South Muddy Creek Wrack Lines

Photo #2 – South Muddy Creek, sediment deposits.

Figure 1. Daily Precipitation Totals for the Middle South Muddy Stream Restoration Site Project

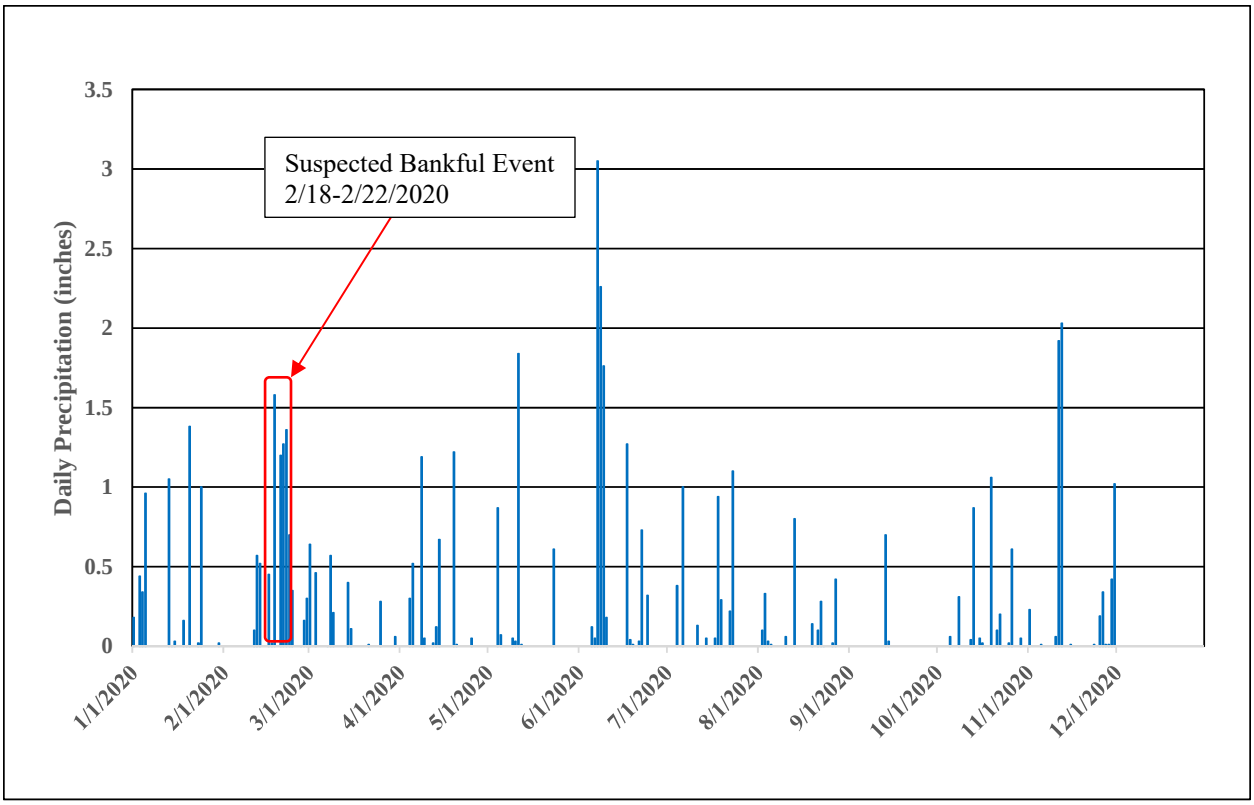
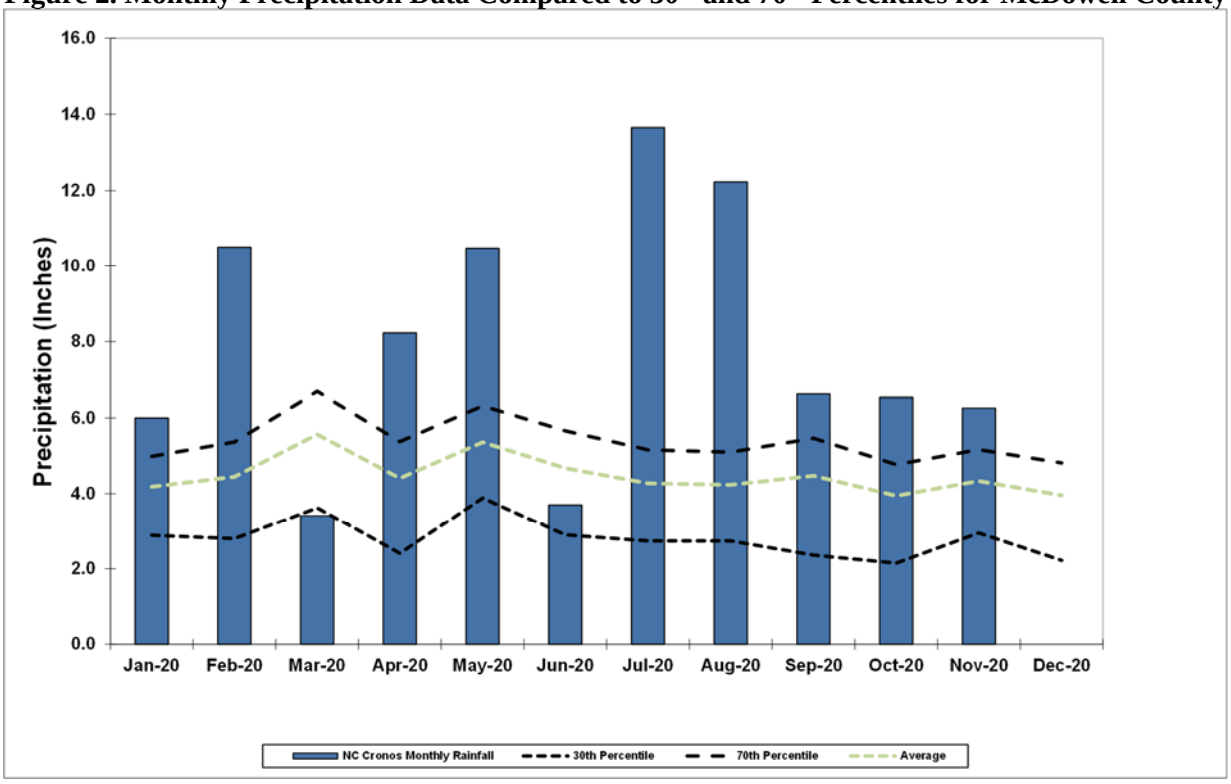
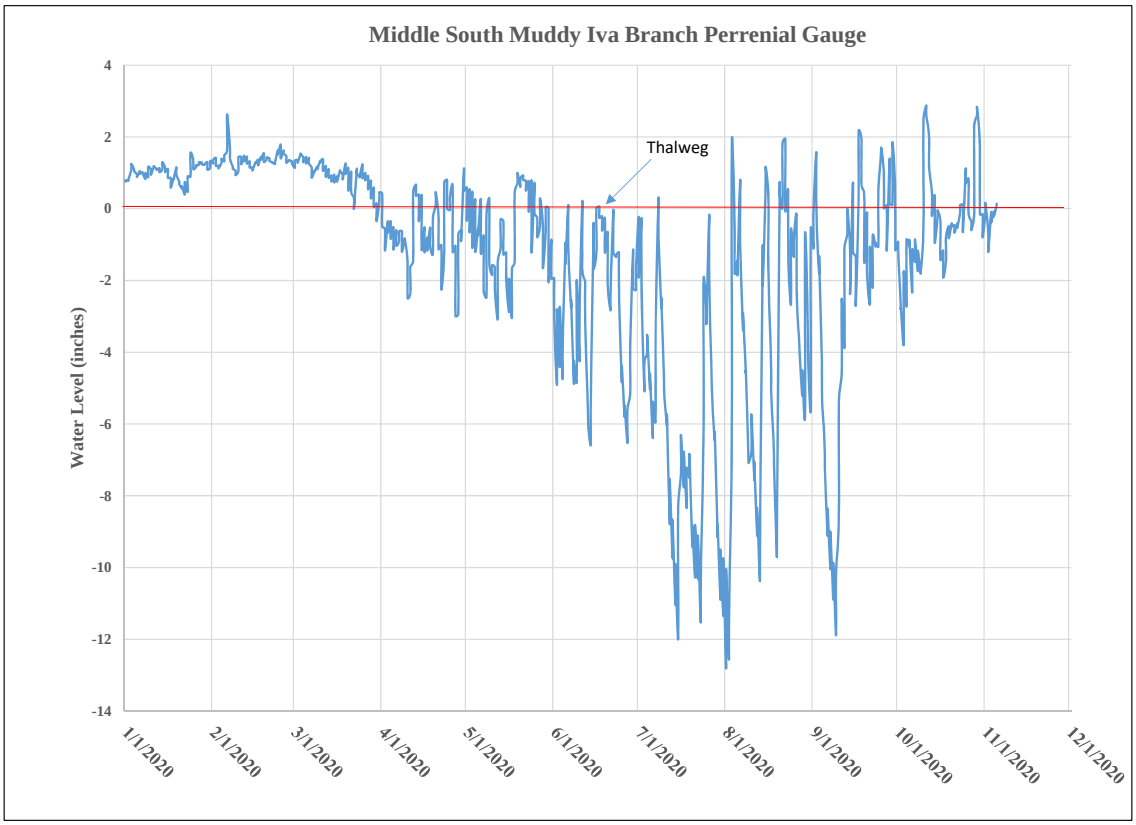
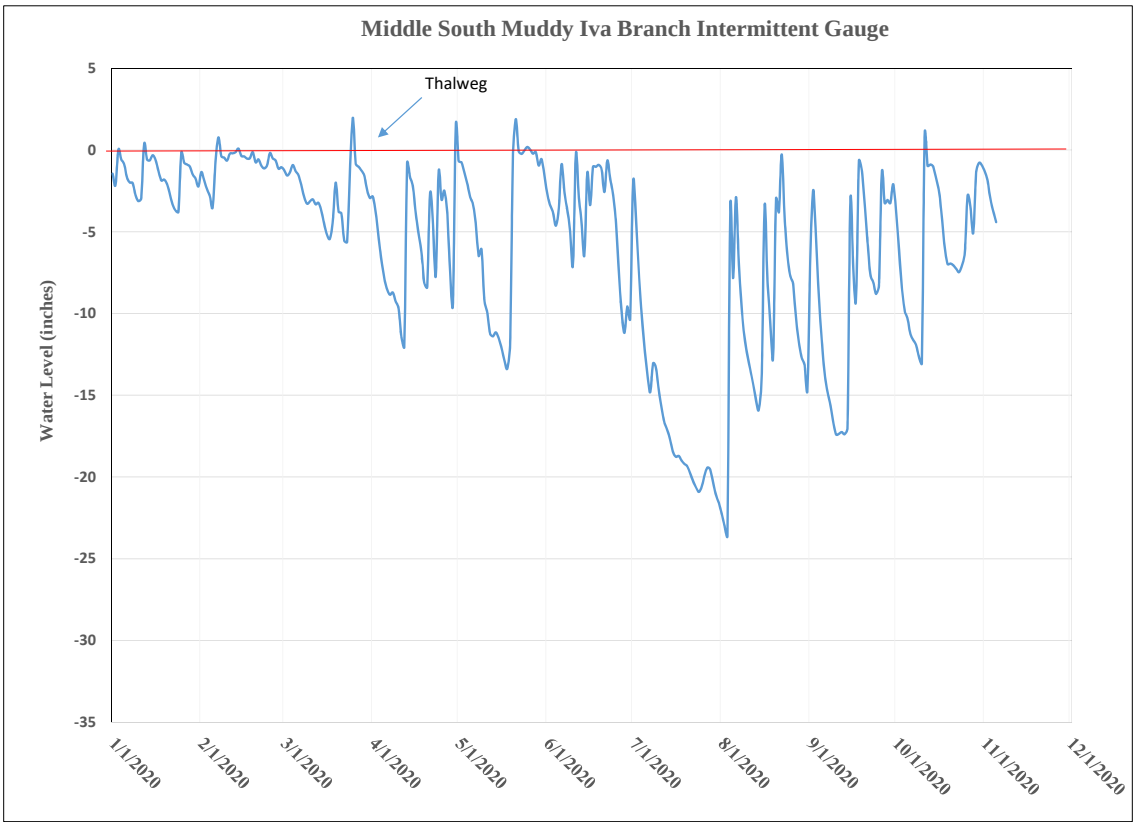


Figure 2. Monthly Precipitation Data Compared to 30th and 70th Percentiles for McDowell County




Middle South Muddy Iva Branch Perrenial Gauge
Water Level (inches)
Thalweg
4
2
0
-2
-4
-6
-8
-10
-12
-14
1/1/2020
2/1/2020
3/1/2020
4/1/2020
5/1/2020
6/1/2020
7/1/2020
8/1/2020
9/1/2020
10/1/2020
11/1/2020
12/1/2020


Middle South Muddy Iva Branch Intermittent Gauge
Water Level (inches)
Thalweg
5
0
-5
-10
-15
-20
-25
-30
-35
1/1/2020
2/1/2020
3/1/2020
4/1/2020
5/1/2020
6/1/2020
7/1/2020
8/1/2020
9/1/2020
10/1/2020
11/1/2020
12/1/2020