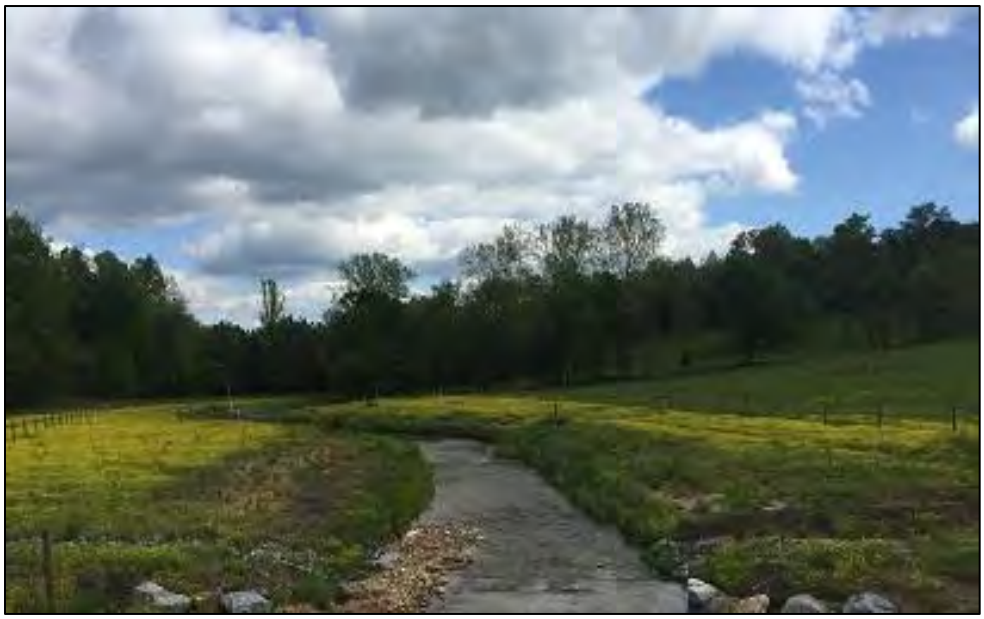
Middle South Muddy

As-Built Baseline Monitoring Report

FINAL

Middle South Muddy Stream Restoration Site
NCDMS Contract No. 6783
NCDMS Project No. 93875
McDowell County, North Carolina
Data Collected: May 18th, 2015 - May 4th, 2016
Date Submitted: July 11, 2016



Submitted to:

NCDEQ-Division of Mitigation Services
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Executive Summary

The Middle South Muddy Stream Restoration Site (Site) 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 81.9249° W. The Site is comprised of two tracts, the Middle South Muddy Creek Tract which encompasses approximately 5.87 acres of predominately agricultural and forested land, and the 41.05 acre Haney Tract that is predominately forested. The Middle South Muddy Creek Tract consists of three streams, Iva Branch, Sprouse Branch, and South Muddy Creek. The Haney Tract consists of approximately 9,796 linear feet of stream. The tract is comprised of South Muddy Creek and approximately thirteen tributaries, including Jackson Branch and Moores Branch.

The Site generated a total of 4,073 stream mitigation units through the use of Priority I and II Restoration, Enhancement I and II, and Preservation. The goal of the project was to address the stressors identified in the Targeted Local Watershed Plan (TLWP) such as improving water quality, aquatic and terrestrial habitat, flood flow attenuation, and precluding land disturbing activities. The goals were addressed by restoring stable channel morphology and sediment transport capacity, improving stream bed form and habitat, improving channel and stream bank stabilization, constructing a floodplain bench that is accessible at the proposed bankfull discharge, providing riparian buffer restoration and cattle exclusion fencing, and constructing a barricade on the existing dirt road network located on the Haney Preservation Tract.

Historic land use at the Site consisted primarily of pastureland for cattle, hay production, and some forested land. Grazing livestock have historically had access to most on-site stream reaches and adjacent terraces. Additional land use practices included maintenance and removal of riparian vegetation, relocating, dredging and straightening of on-site streams have contributed to unstable channel characteristics and degraded water quality. The Haney Preservation Tract has been the location of continuous mining for the last 50 years. Mining operations may have been commercial at one time, but recently consisted of a club of individual prospectors mining for gold lag deposits in the floodplain.

The Site was delineated into five components totaling 11,997 linear feet. The Site was then delineated into eight separate reaches South Muddy Creek (931 feet), Lower South Muddy Creek (177 feet), Upper and Lower Iva Branch (471 feet), Upper Sprouse Branch (24 feet), Middle and Lower Sprouse Branch (598 feet), and the Haney Tract (9,796 feet). South Muddy Creek received Priority II Restoration and Enhancement I, Upper and Lower Iva Branch received Priority I Restoration, Upper Sprouse Branch received Enhancement II, Middle and Lower Sprouse Branch received Priority II Restoration, and the Haney Tract is Preservation. The installation of brush, rock, and wood structures were utilized throughout the restored reaches to provide bed and bank stability as well as aquatic habitat. South Muddy Creek saw only minor adjustments to the profile which re-established proper riffle-pool sequence. Upper Sprouse Branch enhancement efforts included the installation of grade control structures in the upper portion of the reach and livestock exclusion fencing to reduce erosion and instability. Middle and Lower Sprouse Branch dimension adjustments included an increase in width/depth ratio to reduce stress on channel banks, and the excavation of a floodplain bench to provide for the conveyance of flood flows. The valley of Upper Iva Branch was filled to raise the channel and vertically stabilize the stream. The pattern, profile, and dimension of Lower Iva Branch was adjusted to provide proper pool spacing, riffle-pool sequence, and reductions of stress along stream banks. A bankfull bench was also constructed to provide proper conveyance of greater-than-bankfull flows.

A baseline stream and topographic survey was performed between May 18th, 2015 and May 4th, 2016 to document baseline conditions at the Site. The stream pattern, profile, and dimension very closely reflected those values outlined in the design.

A vegetation survey of the Site was conducted on March 23, 2016. Results from this initial survey indicate that the planted stem density ranged from 405 to 526 with the mean density of 486 through all plots in MY0. A total of seven species were documented across all plots with species diversity in plots ranging from four to five.

Annual monitoring will begin during late 2016 and will include stream and vegetation monitoring components as established in this document. Annual monitoring will occur for five years.

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1.0 PROJECT GOALS, BACKGROUND, AND ATTRIBUTE

1.1. Location and Setting

The Middle South Muddy Stream Restoration Site (Site) 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 81.9249° W. The Site is comprised of two tracts, the Middle South Muddy Creek tract which encompasses approximately 5.87 acres of predominately agricultural and forested land, and the 41.05 acre Haney Preservation Tract which is predominately forested. The Middle South Muddy Creek Tract consists of three streams, Iva Branch, Sprouse Branch, and South Muddy Creek. The Haney Tract consists of approximately 9,796 linear feet of stream. The tract is comprised of South Muddy Creek and approximately thirteen tributaries, including Jackson Branch and Moores Branch. The Site 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 the Site 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.

1.2. Project Goals and Objectives

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

- Provide approximately 4,073 stream mitigation units (SMU's) through Priority I and II restoration of approximately 1,989 linear feet of stream, enhancement of approximately 196 linear feet of

stream, and preservation of approximately 9,796 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 existing dirt road network on Haney Tract to prevent future vehicular trespassing.

1.3. Project Structure, Restoration Type and Approach

1.3.1. Project Structure

Construction of the Site produced a total of 4,073 stream mitigation units, as outline in Table 1 and depicted in Figure 2. The Site is comprised of eight reaches totaling 11,981 length feet of Restoration or Restoration Equivalent; South Muddy Creek (916 feet), Lower South Muddy Creek (172 feet), Upper Sprouse Branch (24 feet), Middle and Lower Sprouse Branch (611 feet), Upper and Lower Iva Branch (462 feet), and Haney Tract (9,796 feet).

1.3.2. Restoration Type and Approach

South Muddy Creek

South Muddy Creek is divided into two sub-reaches, South Muddy Creek and Lower South Muddy Creek. South Muddy Creek was constructed as a Priority II restoration of a type C4 stream with moderate sinuosity and an average slope of 0.3%. Lower South Muddy Creek was constructed as an Enhancement I of a type C4 stream with moderate sinuosity and an average slope of 0.3%. This channel configuration provides a stable and natural form in the Type VIII(b) alluvial valley in which the existing stream is found. Restoration of the channel facilitated proper riffle-pool sequence and reduced bank stress.

Sprouse Branch

Sprouse Branch is divided into three sub-reaches, Upper Sprouse Branch, Middle Sprouse Branch, and Lower Sprouse Branch. Upper Sprouse Branch was constructed through Enhancement II restoration. Enhancement efforts include the installation of grade control at the top of the reach to prevent headcut migration, supplemental planting to stabilize bare banks, and cattle exclusion fencing to reduce erosion and instability within the reach. Middle and Lower Sprouse Branch was constructed through Priority II restoration of a type B5 and type B5c stream, with moderate sinuosity and an average channel slope of 2.9% and 1.7% respectively. These channel configurations provide the most stable and natural form for these slightly entrenched channels flowing through moderately sloped colluvial valleys. The moderately high gradient of Middle Sprouse Branch warrants installation of rock grade-control structures to stabilize the vertical profile. As Sprouse Branch intersects the valley of South Muddy Creek, gradient decreases, resulting in a transition to a B5c stream type. In order to accommodate the steep valley gradient a terraced profile was constructed. Dimension adjustments included an increase in width/depth ratio to reduce stress on channel banks and the excavation of a floodplain bench to provide for the conveyance of flood flows.

Iva Branch
Iva Branch is divided into two sub-reaches, Upper Iva Branch and Lower Iva Branch, both of which were constructed as Priority I restoration of type B5 stream with moderate sinuosity and an average slope of 5.6% and 3.2% respectively. The existing incised valley of Upper Iva Branch was filled to raise the channel to reconnect it with the floodplain. The constructed channel was vertically stabilized through the installation of rock structures. Lower Iva Branch was adjusted to provide proper pool spacing, riffle-pool sequence, and reductions of stress along the stream banks. A bankfull bench was constructed to provide proper conveyance of greater-than bankfull flows. Log and rock structures were installed to control the vertical alignment and provide aquatic habitat.

Haney Tract
The Haney Tract was put under a permanent conservation easement to preserve approximately 5,836 linear feet of stream channel and approximately 35 acres of riparian buffer (Mitigation Plan, 2012). Due to historic commercial and recreational mining operations within the floodplain of South Muddy Creek, the riparian buffer has been degraded over time. Establishment of the conservation easement will protect stream and adjacent floodplain from future destructive mining activities. The network of dirt roads was also barricaded in strategic locations to prevent future vehicular access. The Haney Tract surveyed conservation easement plat reveals additional stream linear feet within the protected easement. Streams include South Muddy Creek, Moores Branch, Jackson Branch and eleven unamend tributaries. The total stream length within the conservation easement is 9,796 LF (Figure 2. Asset Map). The project preservation assets have been updated to reflect this additional stream length.

1.4. Project History, Contacts and Attribute Data

The project was first identified as a Design-Bid-Build mitigation project for the North Carolina Department of Mitigation Services by Equinox Environmental. Project planning began in 2011 with the final mitigation plan completed in March of 2012 and the final design and construction plans completed in September of 2014. Construction and planting of the Site was completed in March of 2016. Project activities, reporting dates, project contacts, and background information are outlined in Tables 2-4 (Appendix A)

2.0 SUCCESS CRITERIA

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 is also to be expected. If some trend is evident, it should be very modest or indicate migration to another stable form.

2.1.1. 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.

2.1.2. Pattern and Profile

Measurements and calculated values should indicate stability with little deviation from as-built conditions and established morphological ranges from the restored stream type. Annual measurements should

indicate stable bed-form features with little change from the as-built survey. The pools should maintain their depth with flatter water surface slopes, while the riffles should remain shallower and steeper.

2.1.3. 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.

2.1.4. 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.

2.2. Surface Water Hydrology

Monitoring of stream surface water stages should indicate recurrence of bankfull flow 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.

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 rate is not being met or the development of detrimental conditions (i.e., invasive species, diseased vegetation), appropriate corrective actions will be developed and implemented

3.0 MONITORING PLAN

3.1. Stream Channel Stability and Geomorphology

A total of 10 cross-sections, including seven riffles and three pools, were installed upon completion of construction and will be monitored during Monitoring Years 1-5. The total number of cross-sections include four on South Muddy Creek, three on Sprouse Branch, and three on Iva branch. Additionally, a total of 2,166 linear feet— approximately 1,088 feet on South Muddy Creek and Lower South Muddy Creek, approximately 611 feet on Middle and Lower Sprouse Branch, and approximately 462 feet on Upper and Lower Iva Branch—of longitudinal profile data will be collected during Monitoring Years 1-5. Data collected from annual monitoring will be compared with the as-built conditions to document the current state of the channel and any trends in the stream profile occurring throughout the monitoring period.

3.2. Stream Hydrology

A total of two crest gauges—one on South Muddy Creek and one on Sprouse Branch—were installed on site. Crest gauges will be monitored semi-annually to document highest stage for the monitoring interval and verify occurrences of bankfull events. Observations of wrack and depositional features in the floodplain will be documented with photos when encountered during field visits.

3.3. Vegetation

Five vegetation monitoring plots, approximately 0.025 acres individually, were established based on guidance given in the *CVS-EEP Protocol for Recording Vegetation Version 4.2* (Lee et al. 2008). Data was collected using the Level I protocol during initial baseline monitoring to document baseline conditions immediately after construction and planting. Subsequent annual vegetation monitoring will use the Level II protocol. Annual monitoring will determine planted vegetative success and the overall trajectory of woody plant restoration and regeneration at the Site. Vegetation monitoring plot corners were marked with t-posts and PVC conduit.

3.4. Permanent Photo Stations

Permanent photo stations were established at each cross-section to digitally document annual conditions of the left and right banks. Each vegetation monitoring plot includes a photo station taken diagonally from the origin towards the opposite plot corner. Additionally, 31 permanent photo stations were established throughout the project area to provide representative digital documentation of stream features and vegetation conditions. Permanent photo stations were marked with labeled PVC pipe and red flagging tape.

3.5. Maintenance and Contingency

NCDMS and Equinox will monitor the Site on a regular basis and shall conduct a physical inspection of the Site a minimum of once per year throughout the post-construction monitoring period until performance standards are met. These site inspections may identify site components and features that require routine maintenance. Routine maintenance should be expected most often in the first two years following site construction and may include the following:

- *Stream* - Routine channel maintenance and repair activities may include chinking of in-stream structures to prevent piping, securing of loose coir matting, and supplemental installations of live stakes and other target vegetation along the channel. Areas where stormwater and floodplain flows intercept the channel may also require maintenance to prevent bank failures and head-cutting.
- *Vegetation* - Vegetation shall be maintained to ensure the health and vigor of the targeted plant community. Routine vegetation maintenance and repair activities may include supplemental planting, pruning, mulching, and fertilizing. Exotic invasive plant species shall be controlled by mechanical and/or chemical methods. Any vegetation control requiring herbicide application will be performed in accordance with NC Department of Agriculture (NCDA) rules and regulations.
- *Site Boundary* - Site boundaries shall be identified in the field to ensure clear distinction between the mitigation site and adjacent properties. Boundaries may be identified by fence, marker, bollard, post, tree-blazing, or other means as allowed by site conditions and/or conservation easement. Boundary markers disturbed, damaged, or destroyed will be repaired and/or replaced on an as needed basis.
- *Ford Crossings* - Ford crossings within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.
- *Road Crossings* - Road crossings within the site may be maintained only as allowed by Conservation Easement or existing easement, deed restrictions, rights of way, or corridor agreements.

- *Stormwater Management Device* - Storm water management devices will be monitored and maintained per the protocols and procedures defined by the NC Division of Water Quality Storm Water Best Management Practices Manual.

4.0 BASELINE CONDITIONS

A baseline stream and topographic survey was completed on May 18th 2015 to document baseline conditions at the Middle South Muddy Stream Restoration Site (Site). Additionally, permanent cross-sections were installed and data collected on February 25, 2016 and May 4, 2016. A vegetation survey was conducted March 23rd, 2016 to document planted vegetation after construction for future comparison.

Reach summary tables, cross-section summary tables, and cross-section plots related to stream morphology can be found in Appendix B. Generally the pattern, profile, and dimension were very similar to those values outlined in the design. The Lower Iva Branch as-built slope (0.032 ft/ft) was slightly higher than the design slope of 0.026 ft/ft; however the slope falls within the applicable slope ranges for B5 stream types (0.02-0.039 ft/ft).

Vegetation data, summary tables, and plot photos are located in Appendix C. Results from this initial survey indicate that the planted stem density ranged from 405 to 526 with the mean density of 486 across all plots in MY0. A total of seven species were documented across all plots with species diversity in plots ranging from four to five. At the time of vegetation data collection, herbaceous vegetation had begun to establish, however some bare areas were noted, which can be expected during the first year of monitoring after construction. Additionally, good recruitment of woody vegetation is expected within on the lower end of South Muddy Creek and Iva Branch due to the presence of mature trees within the easement.

5.0 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.

North Carolina Department of Environment and Natural Resources, Division of Water Quality. Stormwater Best Management Practices Manual. 2007.

Lee, Michael 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)

Turner Surveying. 2015. As-Built Survey of Middle South Muddy Stream Restoration Project. Prepared for N.C. Ecosystem Enhancement Program.

Wolf Creek Engineering. 2012. Final Mitigation Plan Middle South Muddy Creek Restoration. Prepared for North Carolina Department of Environment and Natural Resources, Ecosystem Enhancement Program. Final Mitigation Plan, Middle South Muddy Restoration, McDowell County. EEP Project No: 93875

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Appendix A
General Tables and Figures

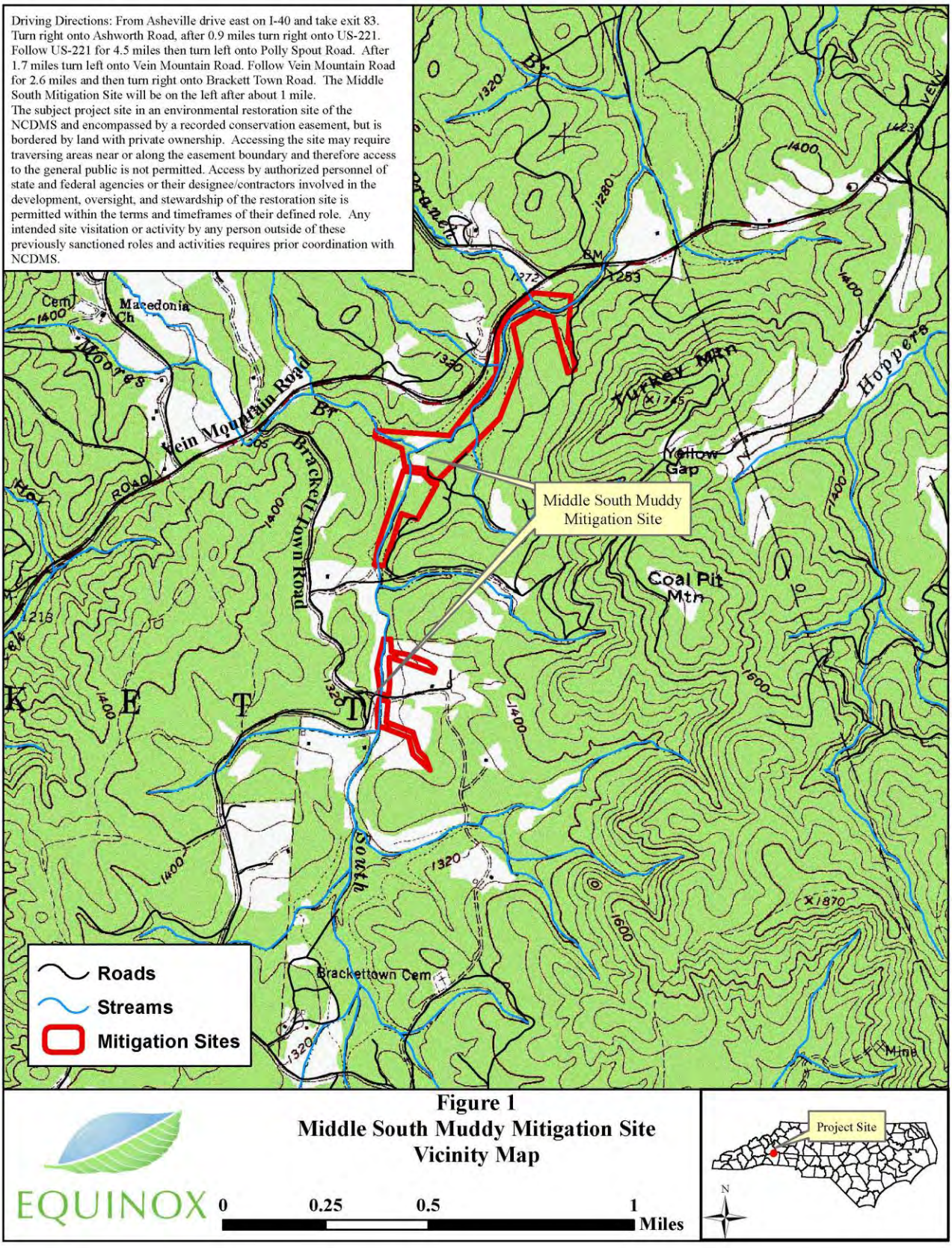
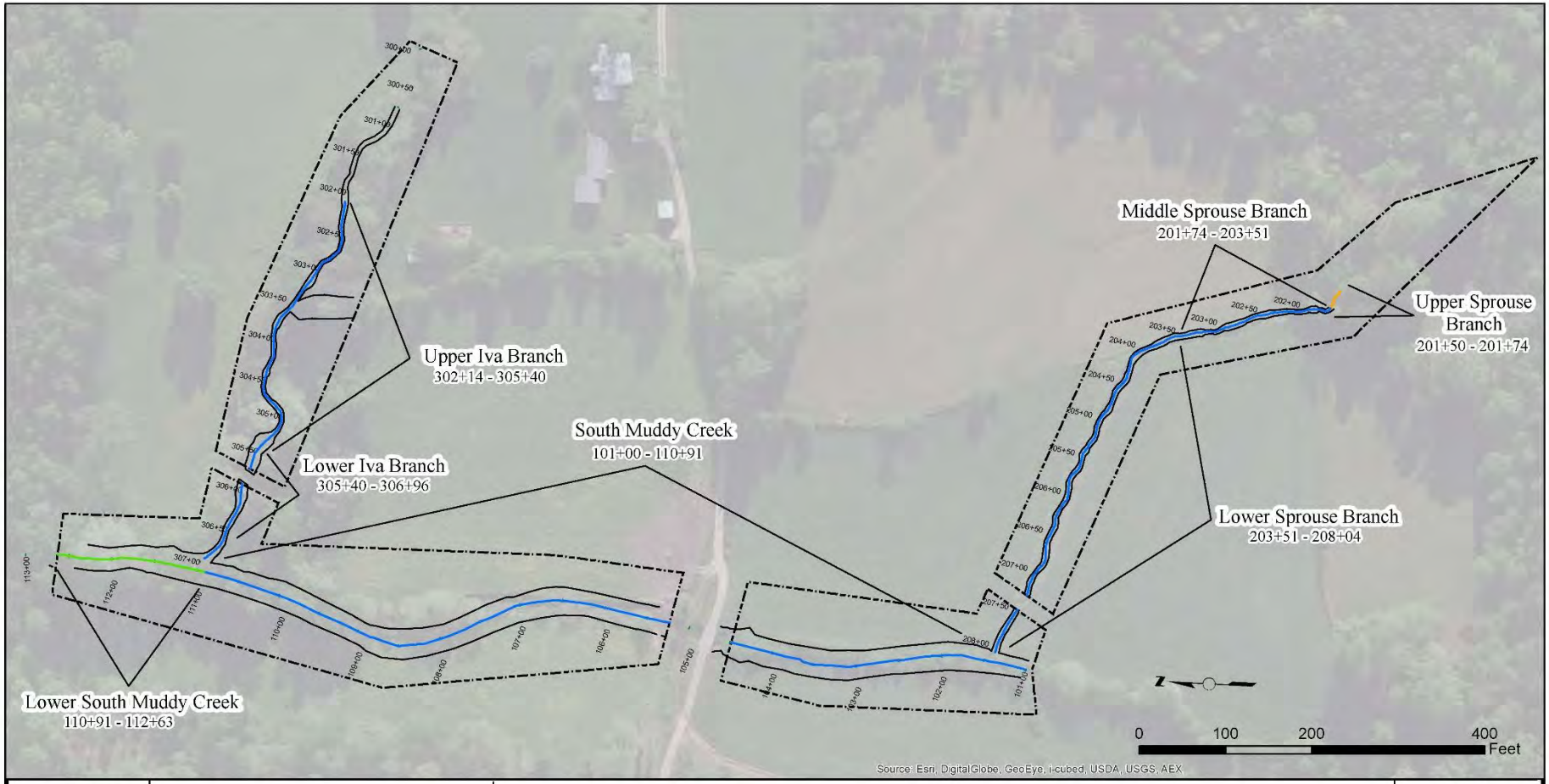


Figure 1
Middle South Muddy Mitigation Site
Vicinity Map



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DMS

Stream Asset Type

Easement

Enhancement I

Enhancement II

Restoration

Figure 2. Asset Map
Middle South Muddy Stream Restoration Site
Project No. 93875
McDowell County, North Carolina
Sheet 1 of 2

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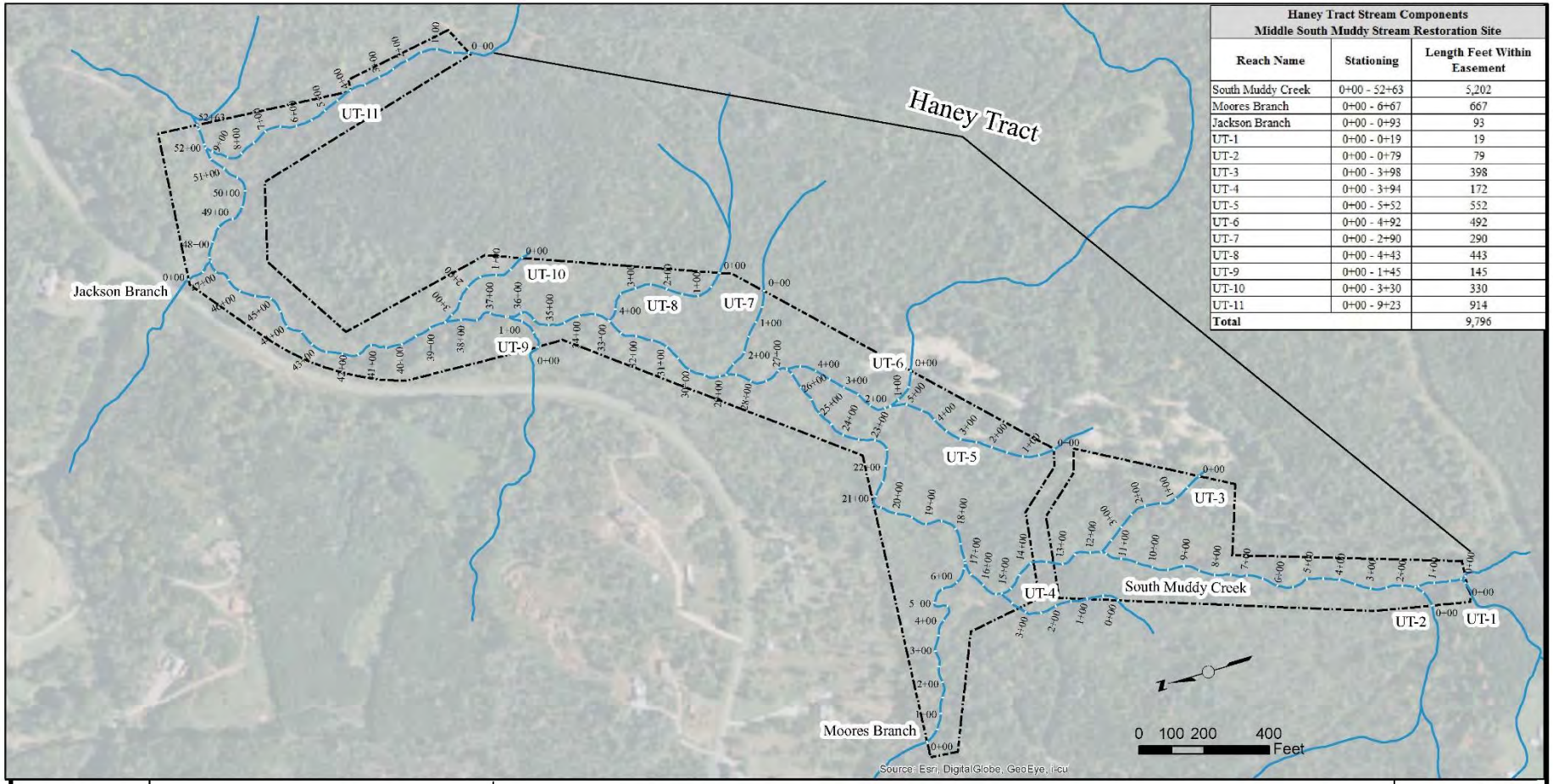

Haney Tract Stream Components
Middle South Muddy Stream Restoration Site

Reach Name	Stationing	Length Feet Within Easement
South Muddy Creek	0+00 - 52+63	5,202
Moores Branch	0+00 - 6+67	667
Jackson Branch	0+00 - 0+93	93
UT-1	0+00 - 0+19	19
UT-2	0+00 - 0+79	79
UT-3	0+00 - 3+98	398
UT-4	0+00 - 3+94	172
UT-5	0+00 - 5+52	552
UT-6	0+00 - 4+92	492
UT-7	0+00 - 2+90	290
UT-8	0+00 - 4+43	443
UT-9	0+00 - 1+45	145
UT-10	0+00 - 3+30	330
UT-11	0+00 - 9+23	914
Total		9,796

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Stream Asset Type
Easement
Preservation

Figure 2. Asset Map
Middle South Muddy Stream Restoration Site
Project No. 93875
McDowell County, North Carolina
Sheet 2 of 2

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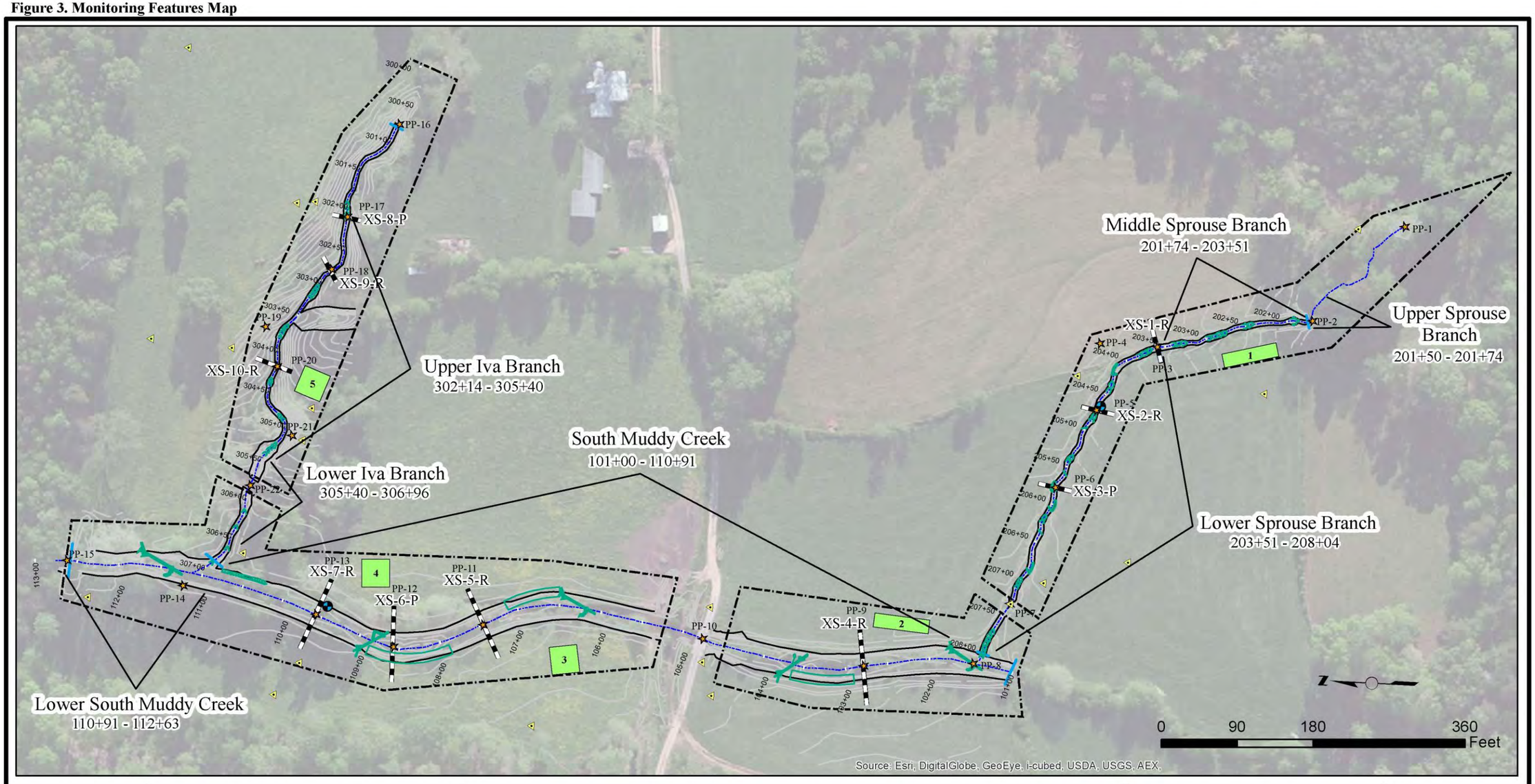
Figure 3. Monitoring Features Map



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Middle South Muddy
Stream Restoration Project
Monitoring Year 0
McDowell County, NC
NCDMS Contract No.: 00006783
NCDMS Project No.: 93875
May 2016
Sheet 1 of 2

Photo Point
Crest Gauge
Control Point
Structure
Cross-Section
Long Pro Start/End
Thalweg
Top of Bank
Contour (1 ft)
Vegetation Plots
Easement
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

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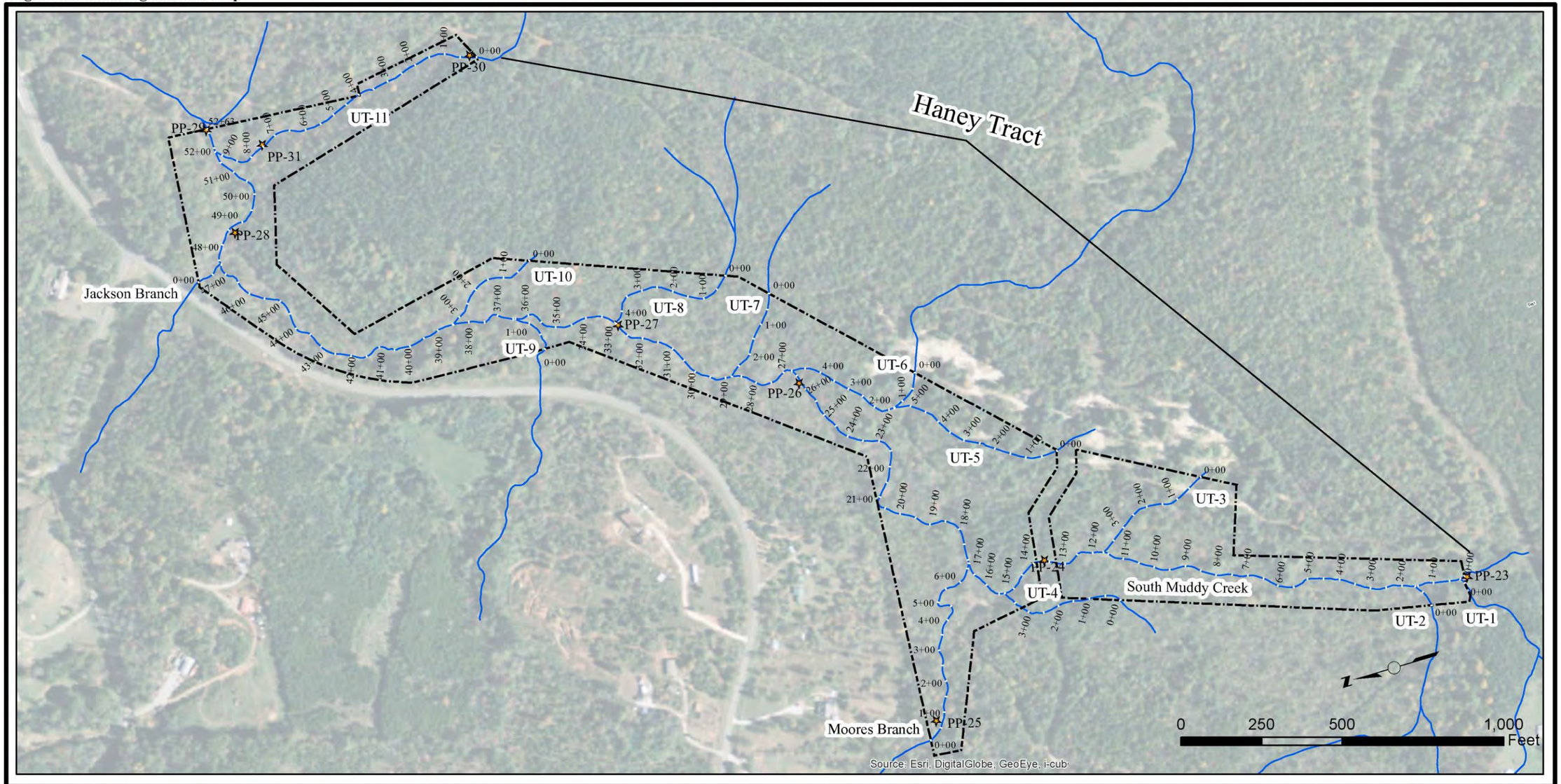
Figure 3. Monitoring Features Map



Prepared for

DMS

Middle South Muddy
Stream Restoration Project
Monitoring Year 0
McDowell County, NC
NCDMS Contract No.: 00006783
NCDMS Project No.: 93875
May 2016
Sheet 2 of 2

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

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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**	**1,959**							

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		9,796	9,796	RE	Preservation	5:1	1,959	-

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	9,796					
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		
Year 2 Monitoring		
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		

Table 3. Project Contacts	
Middle South Muddy Stream Restoration Site	
Prime Contractor	North Carolina Division of Mitigation Services 217 W Jones Street Suite 3000a Raleigh, North Carolina 27603 Matthew Reid (828) 231-7812
Designer	Wolf Creek Engineering 12 1/2 Wall Street Suite C Asheville, North Carolina 28801 S. Grant Ginn (828) 449-1930
Construction Contractor	River Works, Inc 6105 Chapel Hill Road Raleigh, North Carolina 27607 Jon Harrell (919) 710-3326
Seeding Contractor	River Works, Inc 6105 Chapel Hill Road Raleigh, North Carolina 27607 Jon Harrell (919) 710-3326
Planting Contractor	River Works, Inc 6105 Chapel Hill Road Raleigh, North Carolina 27607 Jon Harrell (919) 710-3326
As-built Surveys	Turner Land Surveying 3719 Benson Drive Raleigh, North Carolina 27609 David Turner (919) 827-0745
Seeding Mix Source	Green Resource 5204 Highreen Court Colfax, North Carolina 27235 (336) 855-6363
Live Stakes	Foggy Mountain Nursery 797 Helton Creek Road Lansing, North Carolina (336) 384-5323
Monitoring Performers (Y0)-2016	Equinox Environmental 37 Haywood St. Asheville, North Carolina 28801 Drew Alderman (828) 253-6856

Table 4. Project Baseline Information and Attributes			
Project Information			
Project Name	Middle South Muddy Creek		
County	McDowell		
Project Area (acres)	5.87		
Project Coordinates (latitude and longitude)	35.5635° N , 81.9249° W		
Project Watershed Summary Information			
Physiographic Province	Blue Ridge		
River Basin	Catawba River		
USGS Hydrologic Unit 8-digit: 3050101		USGS Hydrologic Unit 14-digit: 03050101040020	
DWR Sub-basin	03-08-30		
Project Drainage Area (acres)	2,893		
Project Drainage Area Percentage of Impervious Area	> 1%		
CGIA Land Use Classification	2.03.01.01		
Reach Summary Information			
Parameters	**South Muddy Creek**	**Iva Branch**	**Sprouse Branch**
Length of reach (linear feet)	1,108	471	622
Valley classification (Rosgen)	Valley Type VIIIb	Valley Type II	Valley Type II
Drainage area (acres)	3,002	27	29
NCDWQ stream identification score	44	31	34
NCDWQ Water Quality Classification	C	C	C
Morphological Description (stream type) (Rosgen)	G4	G5	G5
Evolutionary trend (Rosgen)	F4	G5	G5
Underlying mapped soils	Iotla, Hayesville Clay	Iotla, Hayesville Clay	Iotla, Hayesville Clay
Drainage class	Poorly drained	Poorly drained	Poorly drained
Soil Hydric status	Non-hydric	Non-hydric	Non-hydric
Slope	0.40%	4.60%	2.20%
FEMA classification	Limited Detail	N/A	N/A
Native vegetation community	Agricultural	Agricultural	Agricultural
Percent composition of exotic invasive vegetation	<1%	<1%	<1%
Wetland Summary Information			
Parameters	**Wetland 1**	**Wetland 2**	**Wetland 3**
Size of Wetland (acres)	-	-	-
Wetland Type (non-riparian, riparian riverine or riparian non-riverine)	-	-	-
Mapped Soil Series	-	-	-
Drainage class	-	-	-
Soil Hydric Status	-	-	-
Source of Hydrology	-	-	-
Hydrologic Impairment	-	-	-
Native vegetation community	-	-	-
Percent composition of exotic invasive vegetation	-	-	-

Regulatory Considerations			
Regulation	**Applicable?**	**Resolved?**	**Supporting Documentation**
Waters of the United States – Section 404	Yes	Yes	NW 27 (2011-02233)
Waters of the United States – Section 401	Yes	Yes	401 Certification (DWR# 12-0383)
Endangered Species Act	No	N/A	ERTR
Historic Preservation Act	No	N/A	ERTR
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (CAMA)	No	N/A	
FEMA Floodplain Compliance	Yes	Yes	Case #: 14-04-0367R
Essential Fisheries Habitat	No	N/A	

Appendix B
Morphological Summary Data and Plots

Table 5. 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	-	-	-	-	-	-	-	63.7	86.4	92.6	103	20.3	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 5 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 5 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^{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				0.04							
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 5 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 5 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^{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						0.046								
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.

Table 6. 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						1,275.8						1,273.7						1,269.4						1,267.9					
Bankfull Width (ft)	5.4						5.1						6.1						31.6						30.7					
Floodprone Width (ft)	14.0						23.0						32.0						65.0						101.0					
Bankfull Mean Depth (ft)	0.3						0.3						1.0						1.6						1.9					
Bankfull Max Depth (ft)	0.6						0.6						1.5						2.3						2.8					
Bankfull Cross Sectional Area (ft^2)	1.8						1.7						5.9						50.5						59.0					
Bankfull Width/Depth Ratio	16.7						15.1						6.3						19.8						15.9					
Bankfull Entrenchment Ratio	2.6						4.5						5.3						2.1						3.3					
Bankfull Bank Height Ratio	1.0						1.0						1.0						1.0						1.0					
d50 (mm)	N/A						N/A						N/A						N/A						N/A					
	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						1,267.3						1,286.1						1,285.3						1,277.1					
Bankfull Width (ft)	35.3						31.0						5.5						4.6						5.3					
Floodprone Width (ft)	166.0						88.0						17.0						14.0						17.0					
Bankfull Mean Depth (ft)	2.4						2.1						1.0						0.4						0.4					
Bankfull Max Depth (ft)	4.0						2.9						1.8						0.7						0.6					
Bankfull Cross Sectional Area (ft^2)	85.7						64.9						5.7						1.9						2.1					
Bankfull Width/Depth Ratio	14.5						14.8						5.4						11.0						13.3					
Bankfull Entrenchment Ratio	4.7						2.8						3.1						3.0						3.2					
Bankfull Bank Height Ratio	1.0						1.0						1.0						1.0						1.0					
d50 (mm)	N/A						N/A						N/A						N/A						N/A					

N/A - Item does not apply.

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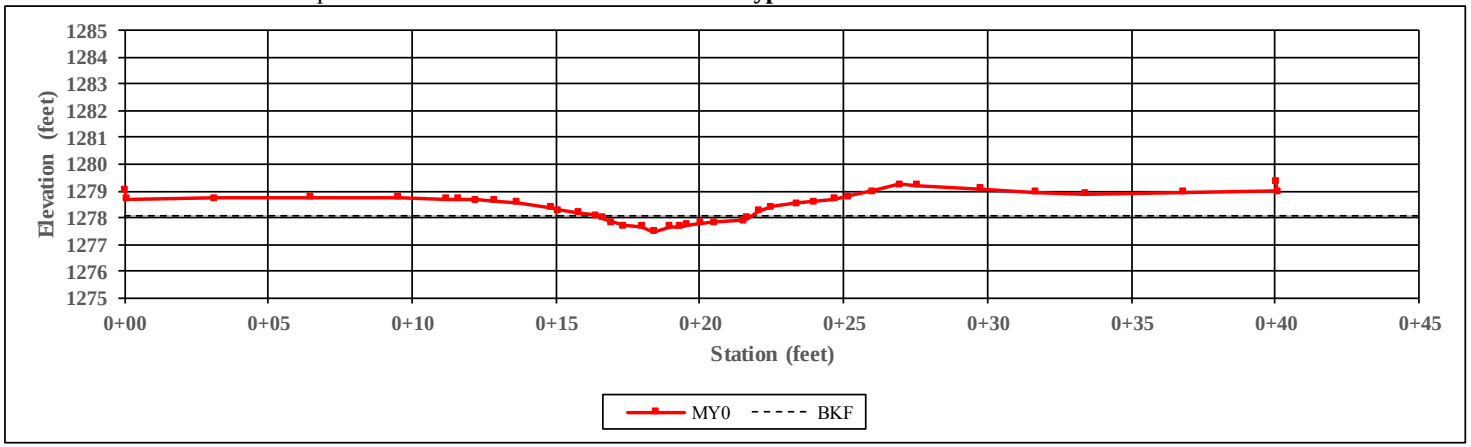
Project Name: Middle South Muddy **XS Number:** 1 **Station:** 203+60

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



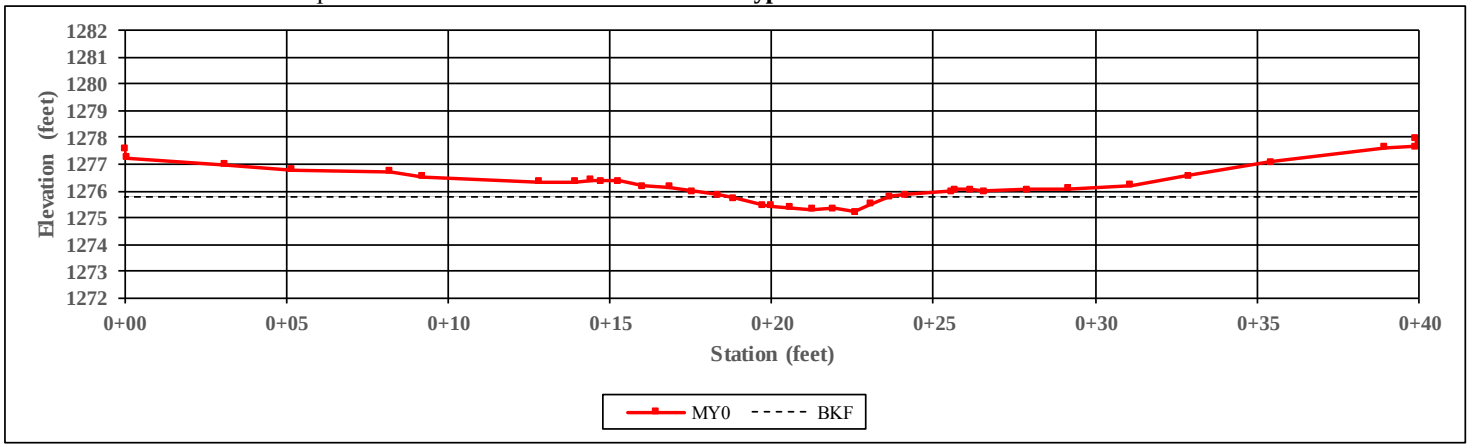
CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	5.4	-	-	-	-	-	-	-
Floodprone Width (ft)	14.0	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	0.3	-	-	-	-	-	-	-
Bankfull Max Depth (ft)	0.6	-	-	-	-	-	-	-
Bankfull Cross-Sectional Area (ft^2)	1.8	-	-	-	-	-	-	-
Width/Depth Ratio	16.7	-	-	-	-	-	-	-
Entrenchment Ratio	2.6	-	-	-	-	-	-	-
Bank Height Ratio	1.0	-	-	-	-	-	-	-

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



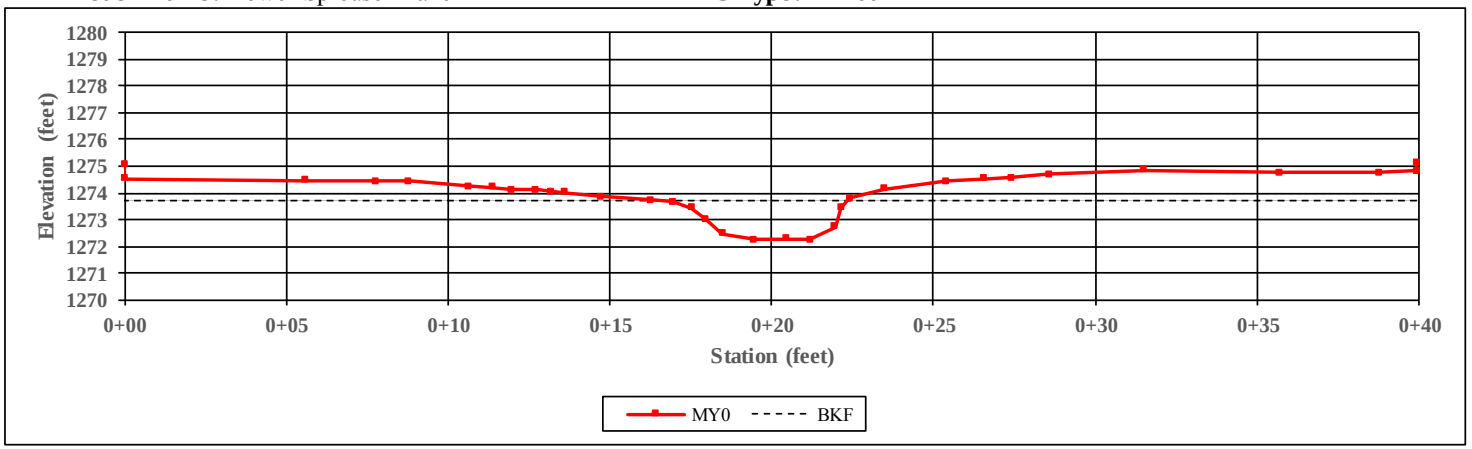
CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	5.1	-	-	-	-	-	-	-
Floodprone Width (ft)	23.0	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	0.3	-	-	-	-	-	-	-
Bankfull Max Depth (ft)	0.6	-	-	-	-	-	-	-
Bankfull Cross-Sectional Area (ft^2)	1.7	-	-	-	-	-	-	-
Width/Depth Ratio	15.1	-	-	-	-	-	-	-
Entrenchment Ratio	4.5	-	-	-	-	-	-	-
Bank Height Ratio	1.0	-	-	-	-	-	-	-

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

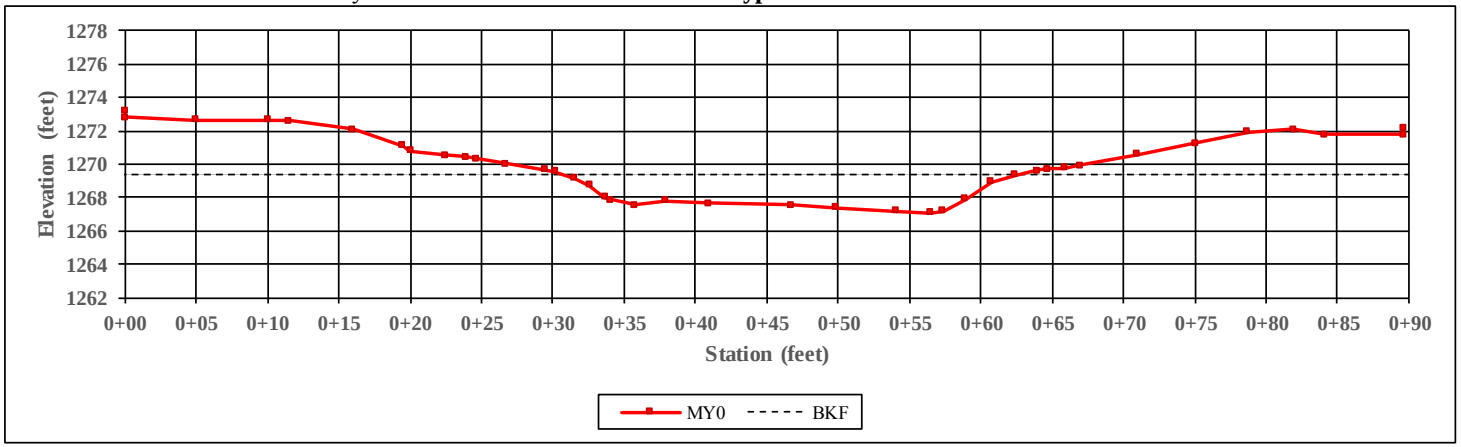


CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	6.1	-	-	-	-	-	-	-
Floodprone Width (ft)	32.0	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	1.0	-	-	-	-	-	-	-
Bankfull Max Depth (ft)	1.5	-	-	-	-	-	-	-
Bankfull Cross-Sectional Area (ft^2)	5.9	-	-	-	-	-	-	-
Width/Depth Ratio	6.3	-	-	-	-	-	-	-
Entrenchment Ratio	5.3	-	-	-	-	-	-	-
Bank Height Ratio	1.0	-	-	-	-	-	-	-

Left Descending Bank

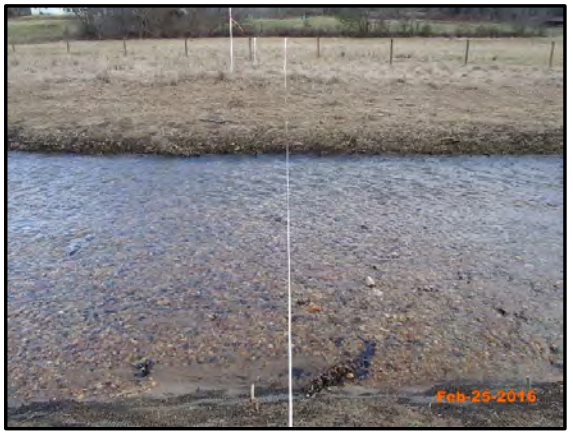
Right Descending Bank

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



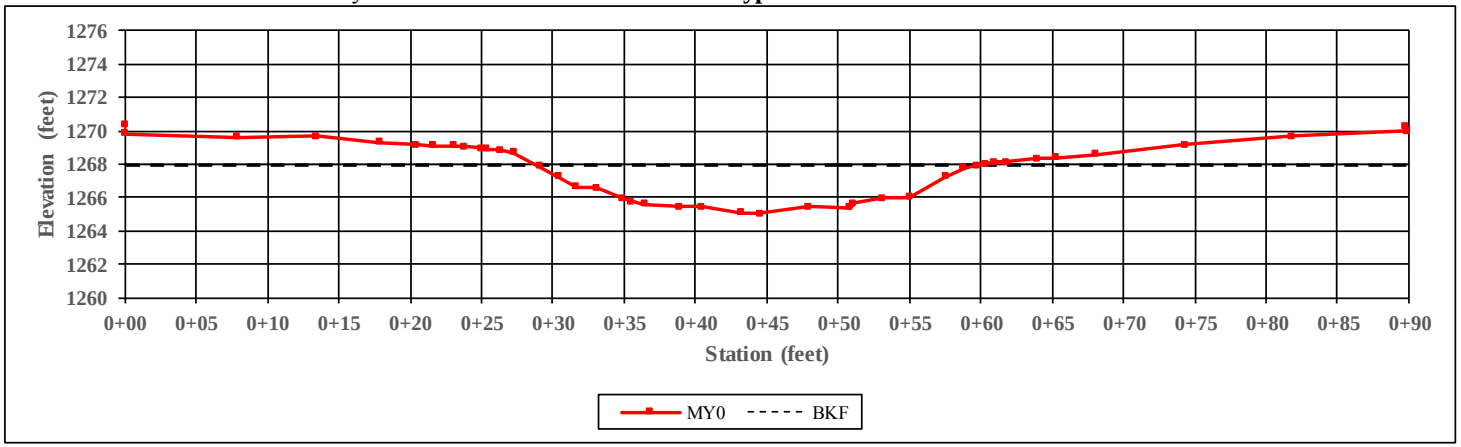
CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	31.6	-	-	-	-	-	-	-
Floodprone Width (ft)	65.0	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	1.6	-	-	-	-	-	-	-
Bankfull Max Depth (ft)	2.3	-	-	-	-	-	-	-
Bankfull Cross-Sectional Area (ft^2)	50.5	-	-	-	-	-	-	-
Width/Depth Ratio	19.8	-	-	-	-	-	-	-
Entrenchment Ratio	2.1	-	-	-	-	-	-	-
Bank Height Ratio	1.0	-	-	-	-	-	-	-

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



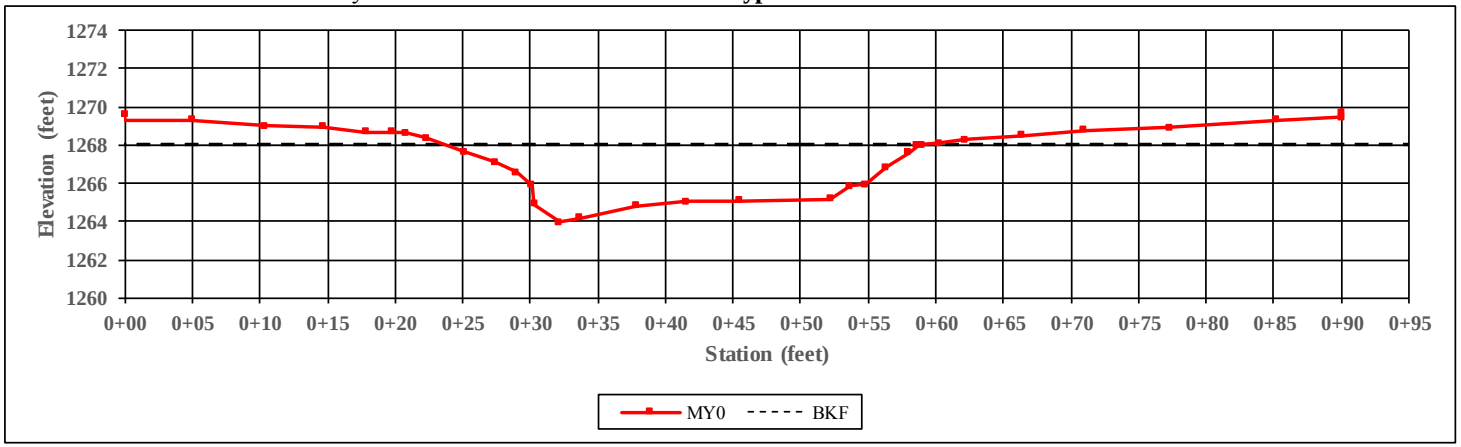
CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	30.7	-	-	-	-	-	-	-
Floodprone Width (ft)	101.0	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	1.9	-	-	-	-	-	-	-
Bankfull Max Depth (ft)	2.8	-	-	-	-	-	-	-
Bankfull Cross-Sectional Area (ft^2)	59.0	-	-	-	-	-	-	-
Width/Depth Ratio	15.9	-	-	-	-	-	-	-
Entrenchment Ratio	3.3	-	-	-	-	-	-	-
Bank Height Ratio	1.0	-	-	-	-	-	-	-

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



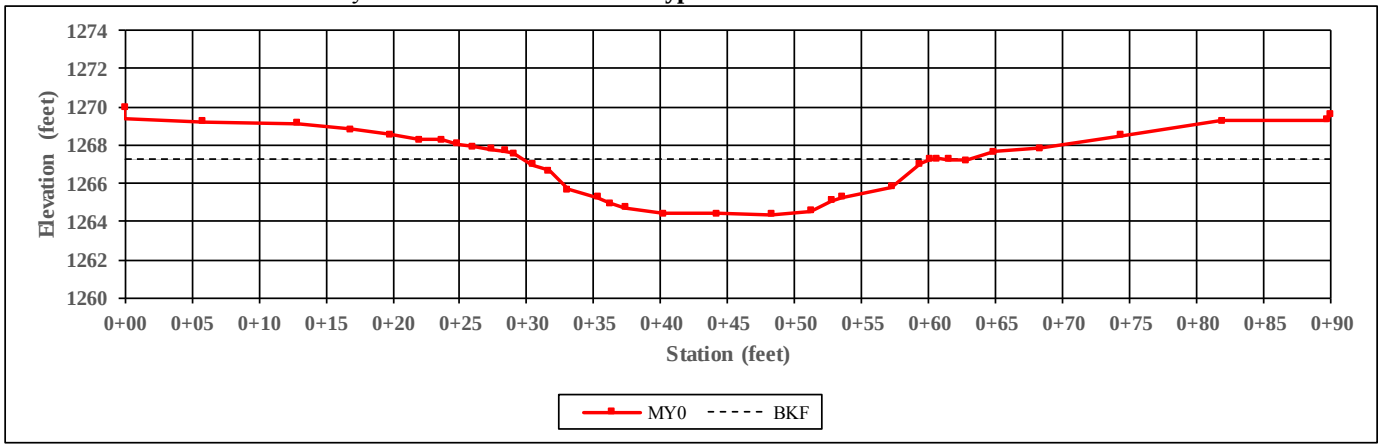
CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	35.3	-	-	-	-	-	-	-
Floodprone Width (ft)	166.0	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	2.4	-	-	-	-	-	-	-
Bankfull Max Depth (ft)	4.0	-	-	-	-	-	-	-
Bankfull Cross-Sectional Area (ft^2)	85.7	-	-	-	-	-	-	-
Width/Depth Ratio	14.5	-	-	-	-	-	-	-
Entrenchment Ratio	4.7	-	-	-	-	-	-	-
Bank Height Ratio	1.0	-	-	-	-	-	-	-

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



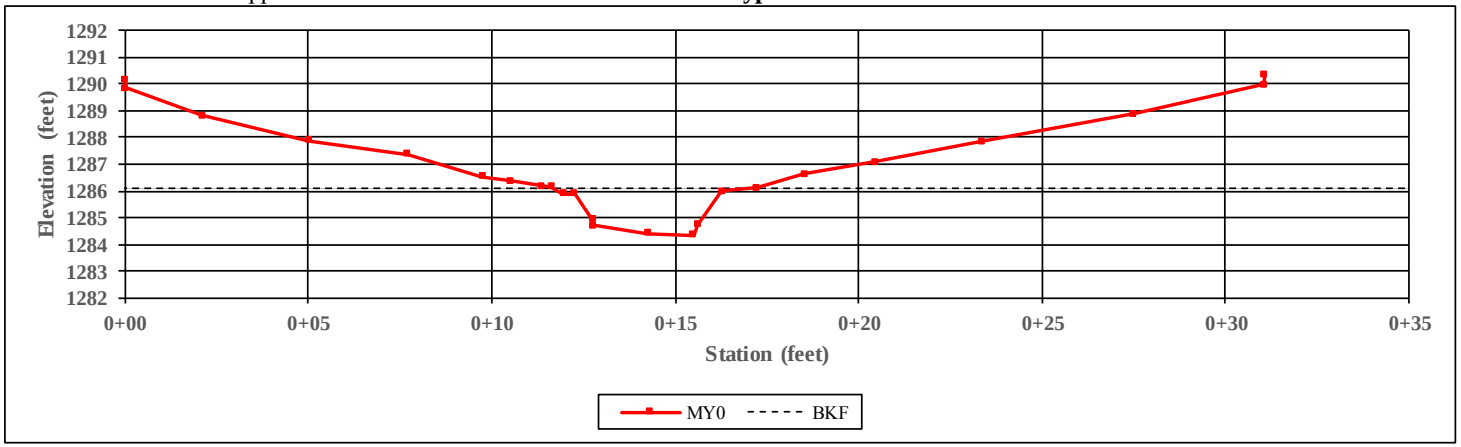
CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	31.0	-	-	-	-	-	-	-
Floodprone Width (ft)	88.0	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	2.1	-	-	-	-	-	-	-
Bankfull Max Depth (ft)	2.9	-	-	-	-	-	-	-
Bankfull Cross-Sectional Area (ft^2)	64.9	-	-	-	-	-	-	-
Width/Depth Ratio	14.8	-	-	-	-	-	-	-
Entrenchment Ratio	2.8	-	-	-	-	-	-	-
Bank Height Ratio	1.0	-	-	-	-	-	-	-

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



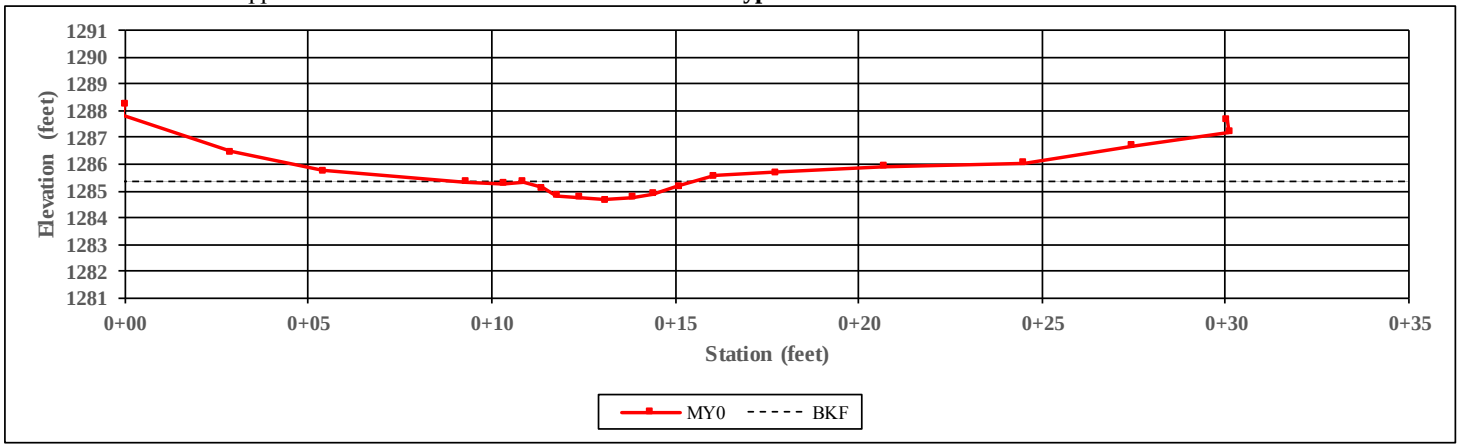
CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	5.5	-	-	-	-	-	-	-
Floodprone Width (ft)	17.0	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	1.0	-	-	-	-	-	-	-
Bankfull Max Depth (ft)	1.8	-	-	-	-	-	-	-
Bankfull Cross-Sectional Area (ft^2)	5.7	-	-	-	-	-	-	-
Width/Depth Ratio	5.4	-	-	-	-	-	-	-
Entrenchment Ratio	3.1	-	-	-	-	-	-	-
Bank Height Ratio	1.0	-	-	-	-	-	-	-

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



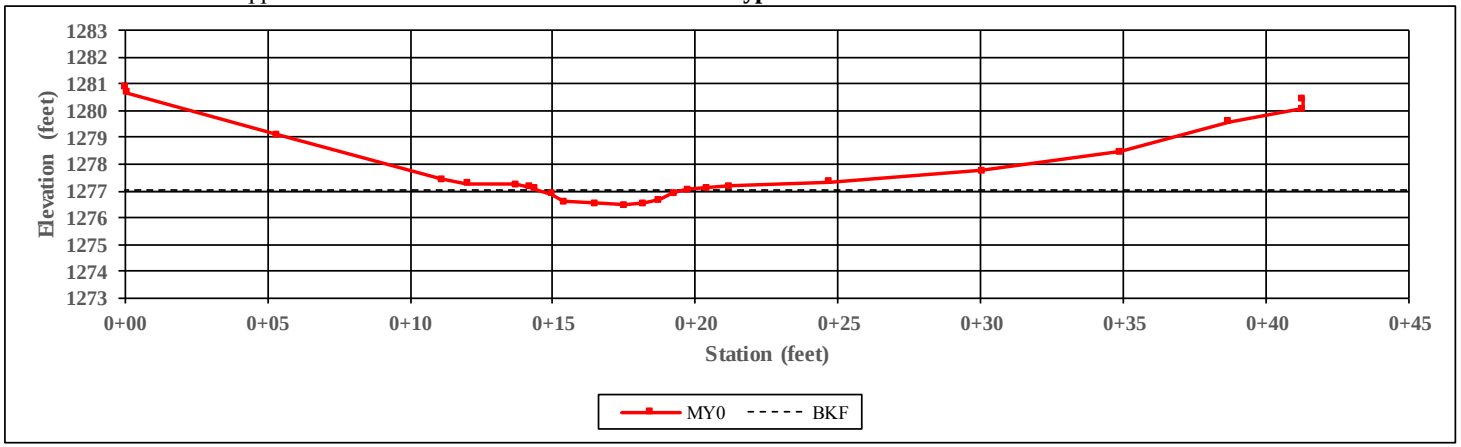
CHANNEL DIMENSIONS SUMMARY	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankful Width (ft)	4.6	-	-	-	-	-	-	-
Floodprone Width (ft)	14.0	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	0.4	-	-	-	-	-	-	-
Bankfull Max Depth (ft)	0.7	-	-	-	-	-	-	-
Bankfull Cross-Sectional Area (ft^2)	1.9	-	-	-	-	-	-	-
Width/Depth Ratio	11.0	-	-	-	-	-	-	-
Entrenchment Ratio	3.0	-	-	-	-	-	-	-
Bank Height Ratio	1.0	-	-	-	-	-	-	-

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	-	-	-	-	-	-	-
Floodprone Width (ft)	17.0	-	-	-	-	-	-	-
Bankfull Mean Depth (ft)	0.4	-	-	-	-	-	-	-
Bankfull Max Depth (ft)	0.6	-	-	-	-	-	-	-
Bankfull Cross-Sectional Area (ft^2)	2.1	-	-	-	-	-	-	-
Width/Depth Ratio	13.3	-	-	-	-	-	-	-
Entrenchment Ratio	3.2	-	-	-	-	-	-	-
Bank Height Ratio	1.0	-	-	-	-	-	-	-

Left Descending Bank

Right Descending Bank

Appendix C
Vegetation Data

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Table 7. Current Plot Data (MY0 2016) Middle South Muddy Stream Restoration Site																					
			Current Plot Data (MY0 2016)																Annual Means		
		Species	Plot 1			Plot 2			Plot 3			Plot 4			Plot 5			MY0 (2016)		
Scientific Name	Common Name	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
Acer rubrum var. rubrum	Red maple	Tree	2	2	2	1	1	1				1	1	1	7	7	7	11	11	11
Betula nigra	River birch	Tree	3	3	3				2	2	2							5	5	5
Carpinus caroliniana	American hornbeam	Tree				1	1	1				2	2	2	2	2	2	5	5	5
Cercis canadensis	Eastern redbud	Tree				1	1	1										1	1	1
Fraxinus pennsylvanica	Green ash	Tree	2	2	2	3	3	3	4	4	4	2	2	2				11	11	11
Platanus occidentalis	American sycamore	Tree	4	4	4	7	7	7	1	1	1	6	6	6	2	2	2	20	20	20
Ulmus americana	American elm	Tree	2	2	2				3	3	3				2	2	2	7	7	7
Stem count			13	13	13	13	13	13	10	10	10	11	11	11	13	13	13	60	60	60
size (ares)			1			1			1			1			1			5		
size (ACRES)			0.02			0.02			0.02			0.02			0.02			0.12		
Species count			5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	7	7	7
Stems per ACRE			526	526	526	526	526	526	405	405	405	445	445	445	526	526	526	486	486	486

P=Planted, T=Planted & Volunteer

Color for Density

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

Table 8. Vegetation Plot Criteria Attainment Middle South Muddy Stream Restoration Site		
Vegetation Plot ID	Vegetation Survival Threshold Met?	Tract Mean
1	Yes	100%
2	Yes	
3	Yes	
4	Yes	
5	Yes	

Vegetation Monitoring Plot 1

Vegetation Monitoring Plot 2

Vegetation Monitoring Plot 3

Vegetation Monitoring Plot 4

Vegetation Monitoring Plot 5

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Appendix D
Permanent Photo Stations

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 300+50 - Looking Downstream at Cross-Section 8

Upper Iva Branch – Permanent Photo Station 18
Station 300+50 - 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 300+50 - 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 Upstream South Muddy Creek

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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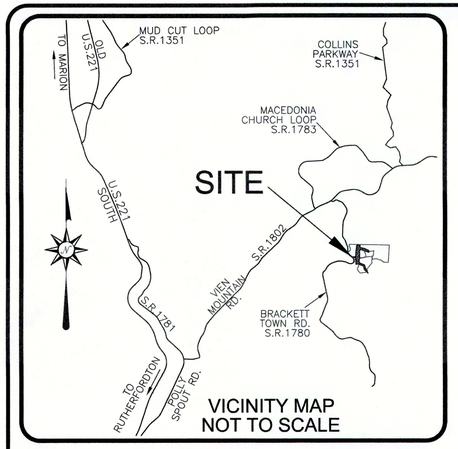
Appendix E
Record Set

AS-BUILT SURVEY OF

MIDDLE SOUTH MUDDY STREAM RESTORATION PROJECT

McDOWELL COUNTY, NC

NCEEP PROJECT# 93875



VICINITY MAP
NOT TO SCALE

I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 16th DAY OF OCTOBER, 2015.

David S. Turner

DAVID S. TURNER, P.L.S. #L-4551

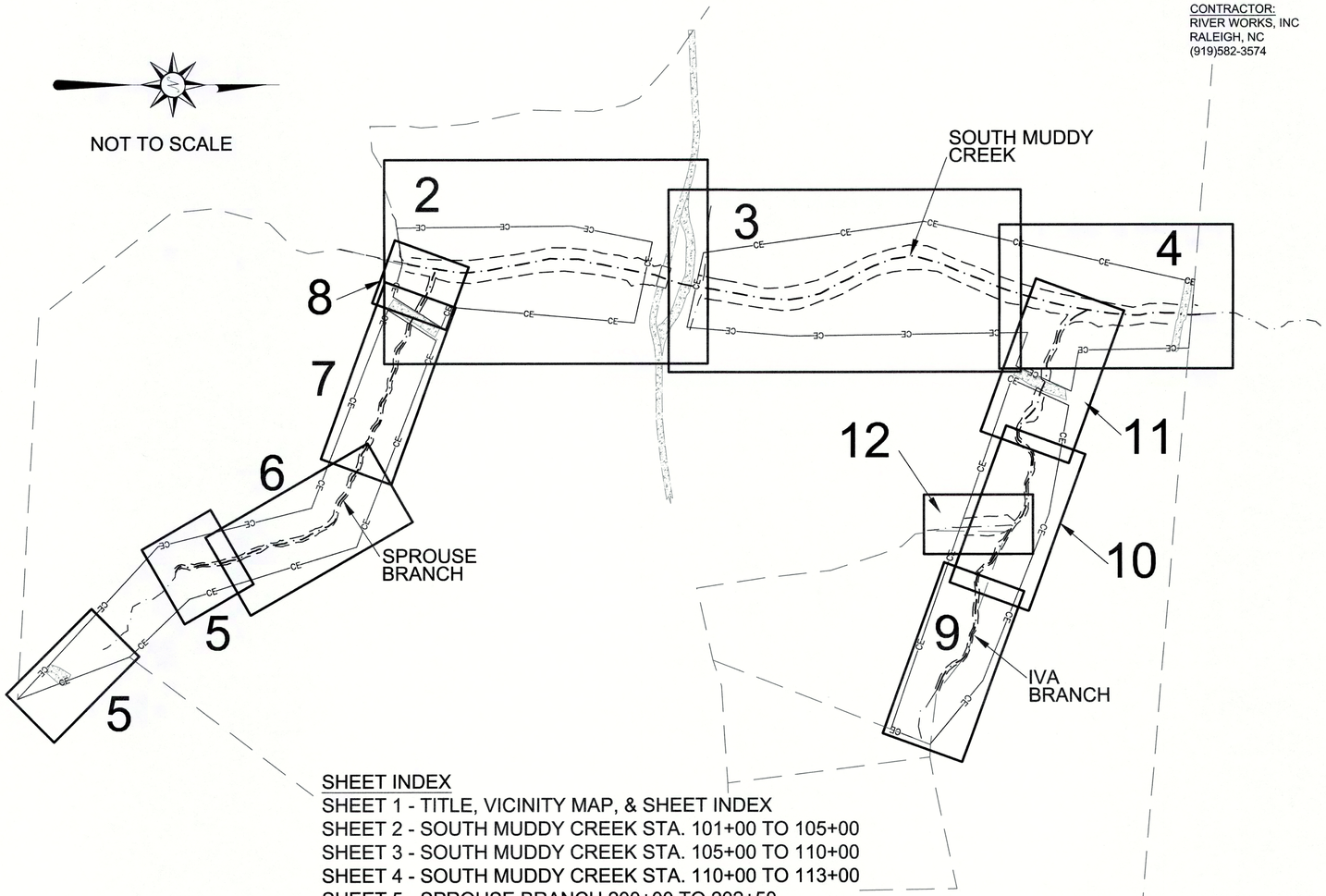
NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER 10-16-15

AS–BUILT SURVEY CONTROL POINTS:

PT#	Northing(Y)	Easting(X)	Elev(Z)	Description
1	672158.10	1130953.56	1282.72	gps ex–cpt
2	673478.96	1130950.27	1297.86	gps ex–cpt
3	673452.70	1131296.97	1333.32	gps ex–cpt
4	672057.12	1131154.83	1292.76	ex–cpt
7	672800.62	1130666.80	1274.05	ex–cpt
8	673147.99	1130799.81	1274.65	ex–cpt
13	673382.71	1130944.29	1285.23	ex–cpt
19	672407.91	1130716.16	1273.52	gps ex–cpt
20	672308.95	1130745.51	1274.55	TLS#20 NAIL
21	673004.77	1130515.40	1271.32	TLS#21 NAIL
22	673312.03	1130536.44	1270.22	TLS#22 NAIL
23	673356.48	1130701.97	1269.09	TLS#23 NAIL
24	673314.66	1131119.75	1300.75	TLS#24 NAIL
25	673537.90	1130640.33	1268.22	TLS#25 NAIL
26	673293.08	1130839.46	1278.23	TLS#26 NAIL
27	672794.03	1130562.20	1271.40	TLS#27 NAIL

GENERAL NOTES:
1. ALL DISTANCES ARE HORIZONTAL UNLESS OTHERWISE NOTED.
2. HORIZONTAL DATUM IS NAD83(2011) & VERTICAL DATUM IS NAVD88.
3. CONTROL IS BASED ON EXISTING CONTROL DATA PROVIDED BY THE DESIGNER AND RECOVERED DURING THE CONSTRUCTION & AS-BUILT SURVEYS. ADDITIONAL CONTROL WAS ESTABLISHED USING TOTAL STATION METHODS AND CONFIRMED DURING AS-BUILT SURVEY. AS-BUILT CONTROL POINTS ARE LISTED ON SHEET 1.
4. THIS MAP IS NOT FOR RECORDATION, SALES, OR CONVEYANCES AND DOES NOT COMPLY WITH G.S. 47-30 MAPPING REQUIREMENTS.
5. THE PURPOSE OF THIS SURVEY IS TO SHOW THE POST CONSTRUCTION CONDITIONS OF THE STREAM AND GRADING RELATED TO THE MIDDLE SOUTH MUDDY CREEK STREAM RESTORATION PROJECT AND MAY NOT SHOW ALL UTILITIES, STRUCTURES, & BOUNDARIES.
6. INFORMATION SHOWN OUTSIDE THE LIMITS OF AS-BUILT SURVEY WAS PROVIDED BY THE DESIGNER AND WAS NOT VERIFIED BY TURNER LAND SURVEYING, PLLC.
7. NO PROPERTY RESEARCH WAS PERFORMED. FOR CONSERVATION EASEMENT SEE PLAT RECORDED IN McDOWELL COUNTY REGISTER OF DEEDS OFFICE PLAT BOOK 21, PAGE 34.

NOT TO SCALE



SHEET INDEX

REFERENCES:

OWNER:
NORTH CAROLINA DIVISION OF MITIGATION SERVICES (Formerly ECOSYSTEM ENHANCEMENT PROGRAM)
217 WEST JONES ST., SUITE 3000A
RALEIGH, NC 27603
(919)707-8976
EEP PROJ. MANAGER: PAUL WIESNER

DESIGNER:
WOLF CREEK ENGINEERING
12 1/2 WALL ST., SUITE C
ASHEVILLE, NC 28801
(828)449-1930

CONTRACTOR:
RIVER WORKS, INC
RALEIGH, NC
(919)582-3574

REVISIONS, DATE AND INITIAL:
1. ADDED GATES INSTALLED AFTER AS-BUILT SURVEY-SHEET 8 & SHEET 11, 10/15/15, EGT

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TITLE, VICINITY MAP, & SHEET INDEX
MIDDLE SOUTH MUDDY STREAM RESTORATION PROJECT
NCEEP PROJECT # 93875
McDOWELL COUNTY
NORTH CAROLINA
NEBO

DATE: 05/18/2015
SURVEYED BY: DST/JAP
DRAWN BY: ROB/DST
REVIEWED BY: DST/EGT
PROJECT: TLS-15-007
FILE: MSM CREEK_93875_AB_TLS_F.dwg
SCALE: AS SHOWN

SHEET 1 of 13

I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 16th DAY OF OCTOBER, 2015.

David S. Turner

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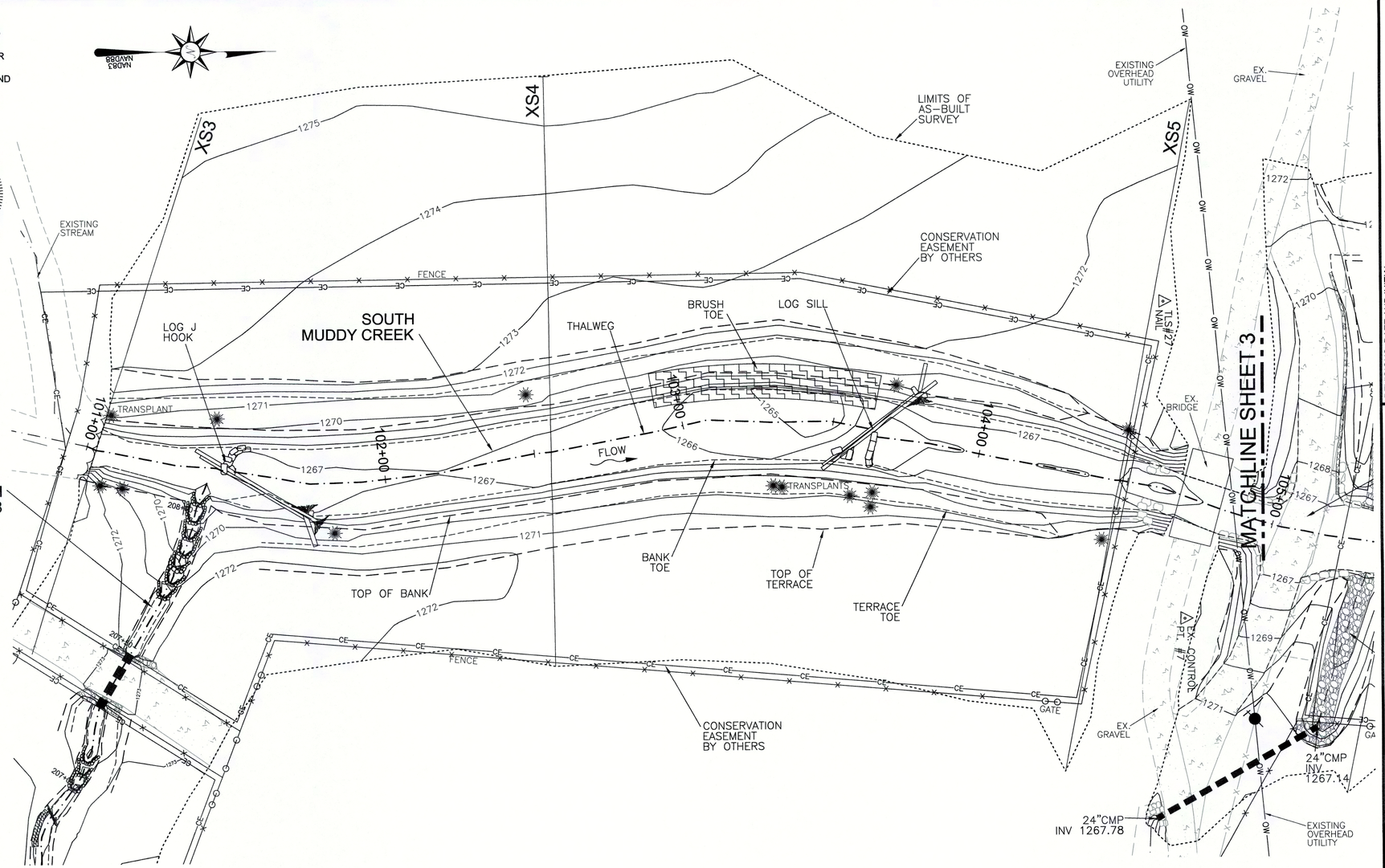
NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER

AS-BUILT SURVEY BY:
TURNER LAND SURVEYING, PLLC
SURVEYED JULY 2015

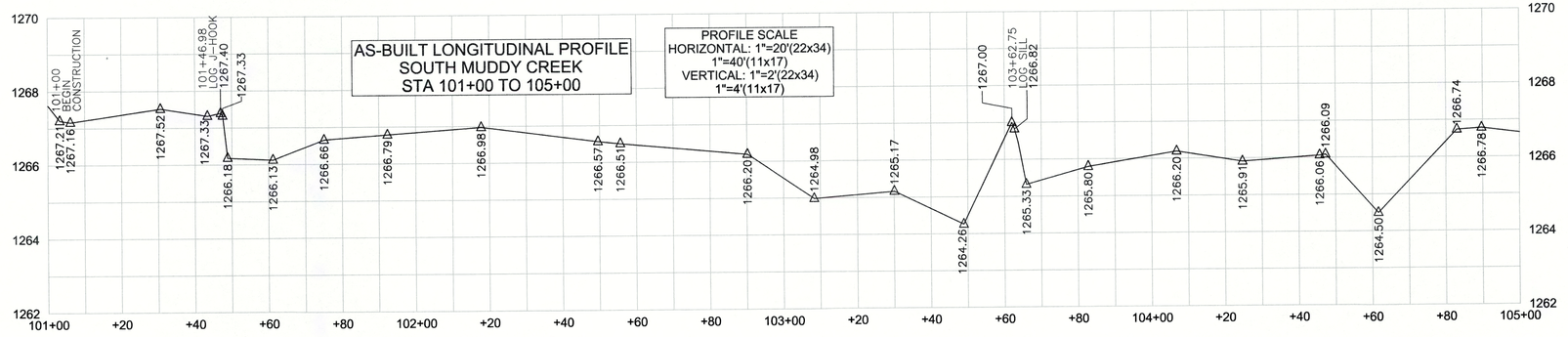
20' 0' 20' 40'

SCALE: 1"=20' (22x34)
1"=40' (11x17)
CONTOUR INTERVAL = 1'

NOTES:
1. SEE SHEET 1 FOR NOTES.
2. SEE SHEET 13 FOR CROSS SECTIONS.



LEGEND:
- THALWEG
- TOP OF BANK/TERRACE
- BANK/TERRACE TOE
- CONSERVATION EASEMENT
- FENCE
- LIMITS OF AS-BUILT SURVEY
- EXISTING FENCE
- EX. PROPERTY LINE (NOT SURVEYED)
- LOG J HOOK
- CONTROL POINT
- BRUSH TOE
- TRANSPLANT



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SOUTH MUDDY CREEK STA. 101+00 TO 105+00
MIDDLE SOUTH MUDDY STREAM RESTORATION PROJECT
NCEEP PROJECT # 93875
McDOWELL COUNTY NORTH CAROLINA

NEBO

DATE:	05/18/2015
SURVEYED BY:	DST/JAP
DRAWN BY:	ROB/DST
REVIEWED BY:	DST/EGT
PROJECT:	TLS-15-007
FILE:	MSM CREEK_93875 _AB_TLS_F.dwg
SCALE:	AS SHOWN

SHEET 2 of 13

I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 16th DAY OF OCTOBER, 2015.

DAVID S. TURNER, P.L.S. #L-4551

NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER

AS-BUILT SURVEY BY:
TURNER LAND SURVEYING, PLLC
SURVEYED JULY 2015

20' 0' 20' 40'

SCALE: 1"=20' (22x34)
1"=40' (11x17)
CONTOUR INTERVAL = 1'

NAD83 NAVD88

LEGEND:
- THALWEG
- TOP OF BANK/TERRACE
- BANK/TERRACE TOE
- CONSERVATION EASEMENT
- FENCE
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- EXISTING FENCE
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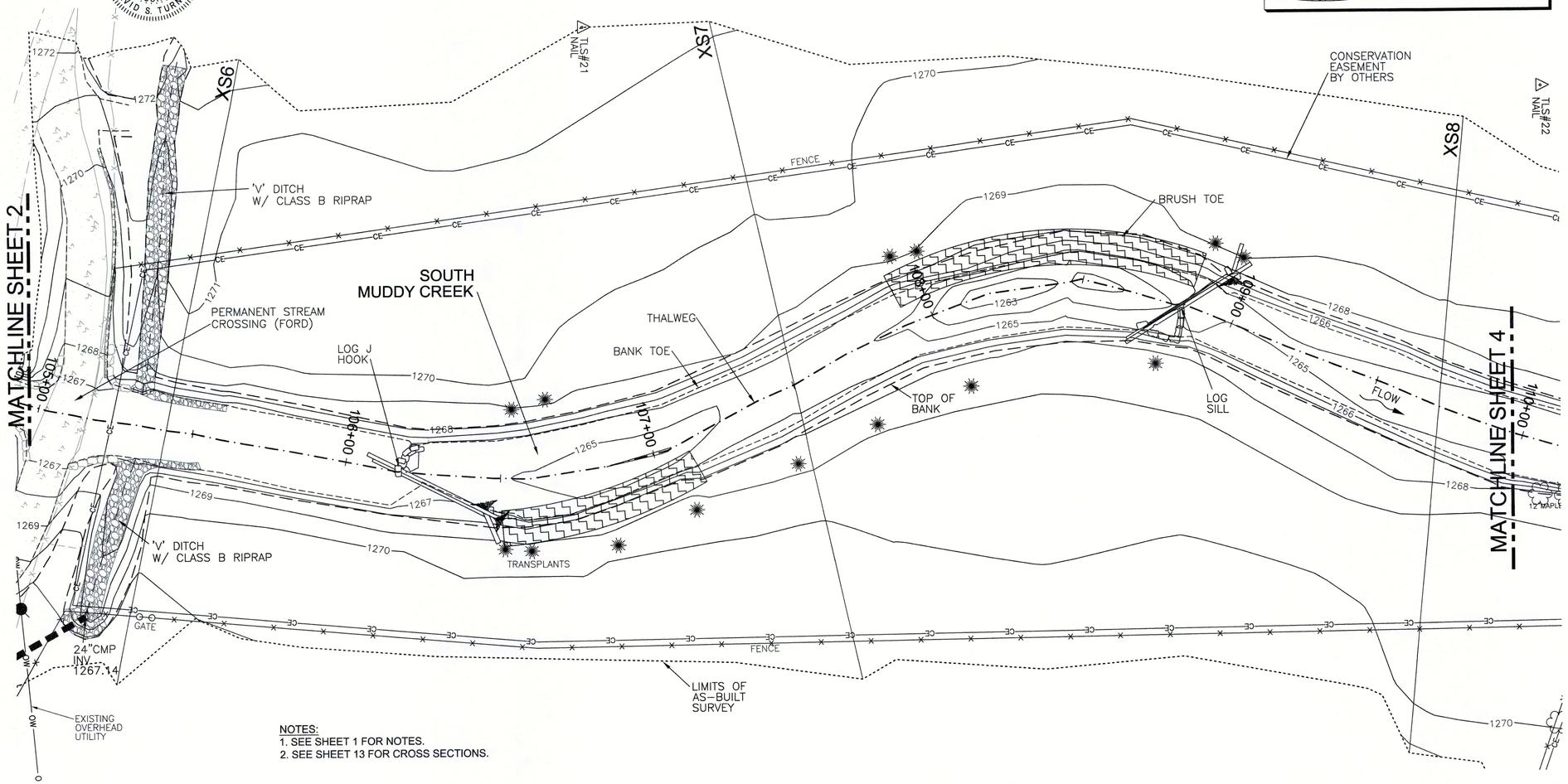
- LOG J HOOK
- CONTROL POINT
- BRUSH TOE
- TRANSPLANT



NOTES:
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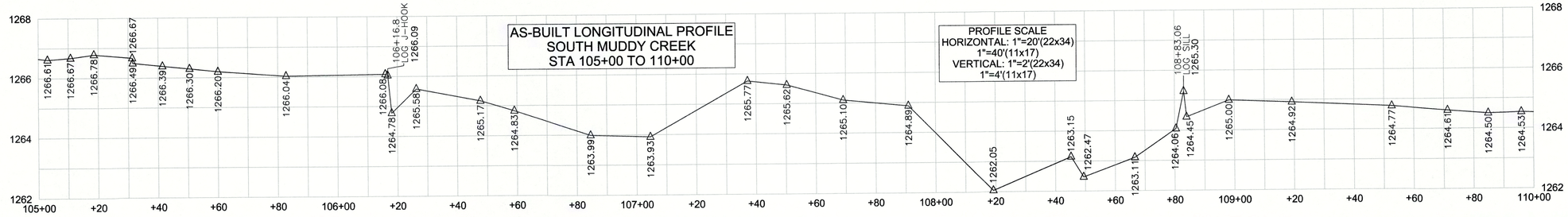

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SOUTH MUDDY CREEK STA. 105+00 TO 110+00
MIDDLE SOUTH MUDDY STREAM RESTORATION PROJECT

NCEEP PROJECT # 93875
McDOWELL COUNTY
NORTH CAROLINA
NEBO

DATE:	05/18/2015
SURVEYED BY:	DST/JAP
DRAWN BY:	ROB/DST
REVIEWED BY:	DST/EGT
PROJECT:	TLS-15-007
FILE:	MSM CREEK_93875_AB_TLS_F.dwg
SCALE:	AS SHOWN

SHEET 3 of 13

I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 16th DAY OF OCTOBER, 2015.

David S Turner

DAVID S. TURNER, P.L.S. #L-4551

NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER 10-16-15

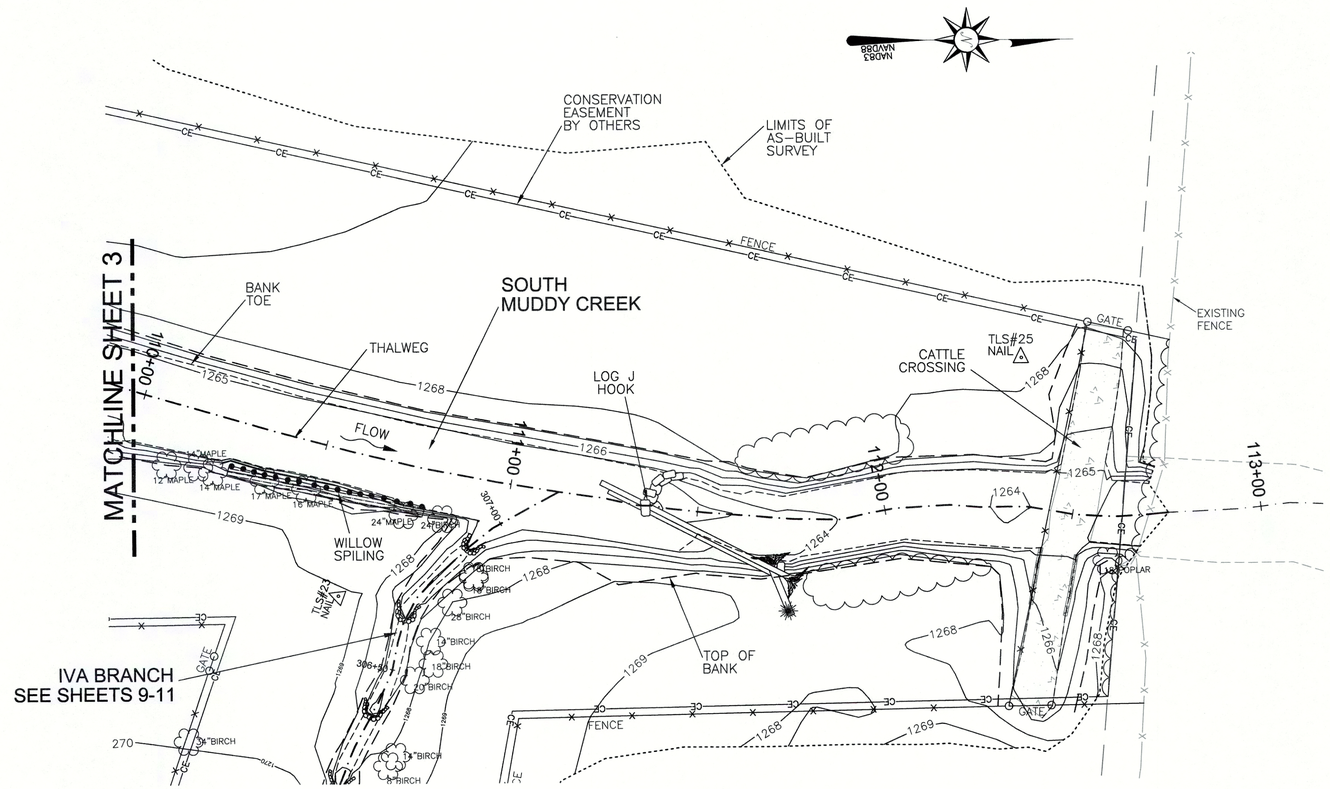
AS-BUILT SURVEY BY:
TURNER LAND SURVEYING, PLLC
SURVEYED JULY 2015

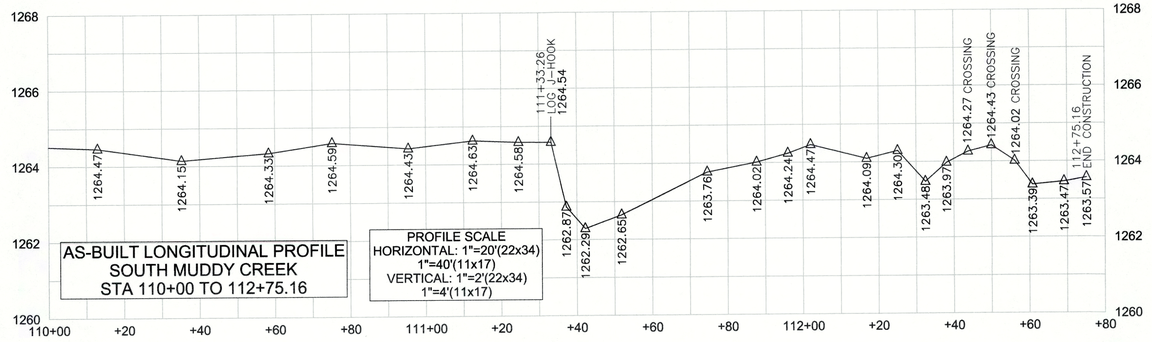
20' 0' 20' 40'

SCALE: 1"=20' (22x34)
1"=40' (11x17)
CONTOUR INTERVAL = 1'

LEGEND:
- THALWEG
- TOP OF BANK/TERRACE
- BANK/TERRACE TOE
- CE — CONSERVATION EASEMENT
- FENCE
- LIMITS OF AS-BUILT SURVEY
- EXISTING FENCE
- EX. PROPERTY LINE (NOT SURVEYED)
- LOG J HOOK
- CONTROL POINT
- BRUSH TOE
- TRANSPLANT

NOTES:
1. SEE SHEET 1 FOR NOTES.
2. SEE SHEET 13 FOR CROSS SECTIONS.





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SOUTH MUDDY CREEK STA. 110+00 TO 113+00

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NCEEP PROJECT # 93875

McDOWELL COUNTY NORTH CAROLINA

NEBO

DATE: 05/18/2015
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REVIEWED BY: DST/EGT
PROJECT: TLS-15-007
FILE: MSM CREEK_93875_AB_TLS_F.dwg
SCALE: AS SHOWN

SHEET 4 of 13

I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 16th DAY OF OCTOBER, 2015.

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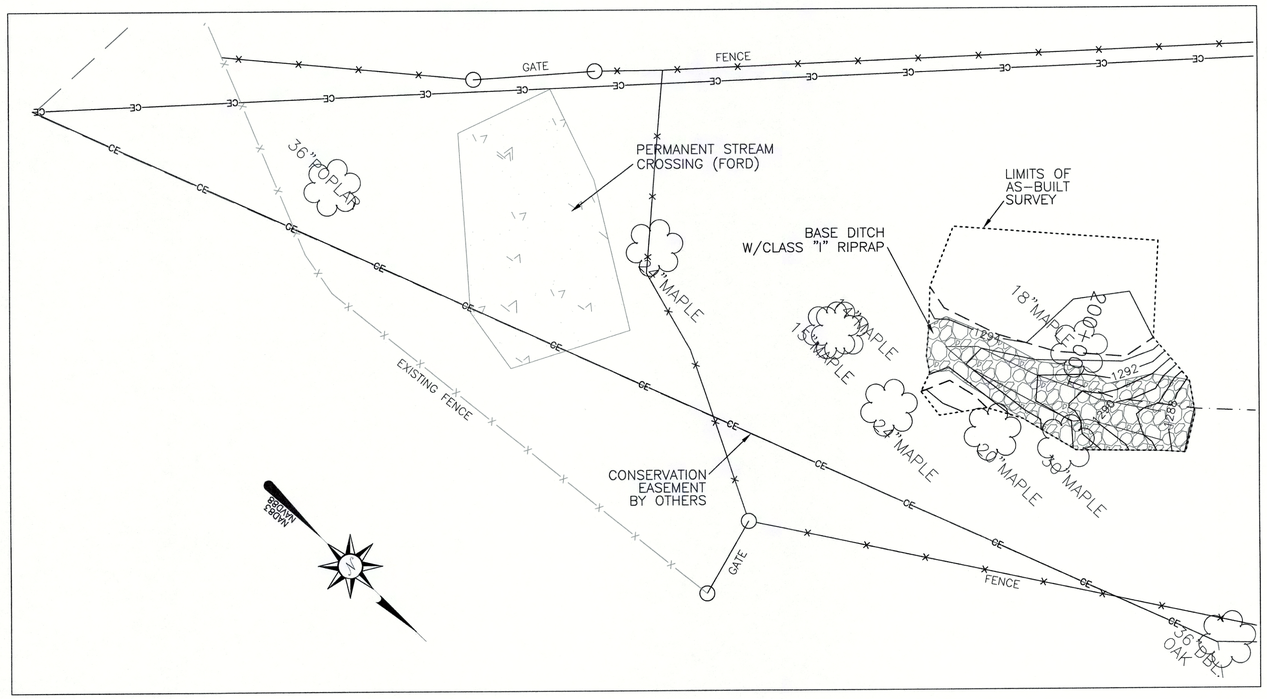
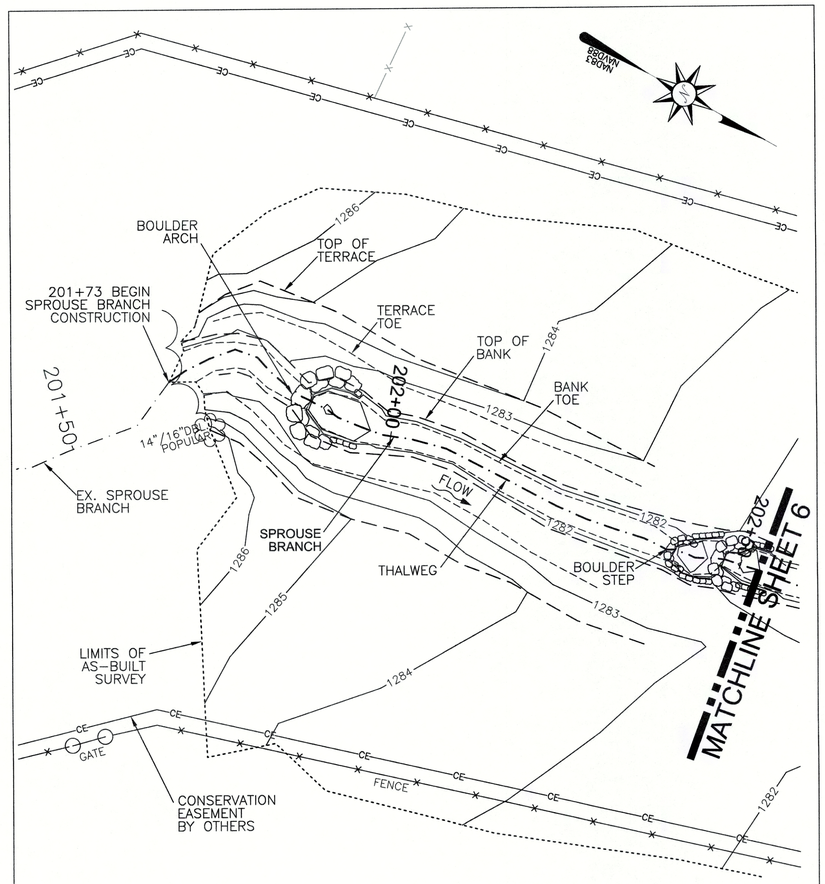




LEGEND:
- THALWEG
- TOP OF BANK/TERRACE
- BANK/TERRACE TOE
- CE — CONSERVATION EASEMENT
- FENCE
- LIMITS OF AS-BUILT SURVEY
- EXISTING FENCE
- EX. PROPERTY LINE (NOT SURVEYED)
- TRANSPLANT
- CONTROL POINT
- BOULDER ARCH
- BOULDER STEP
- LOG SILL
- BRUSH TOE
- RIPRAP

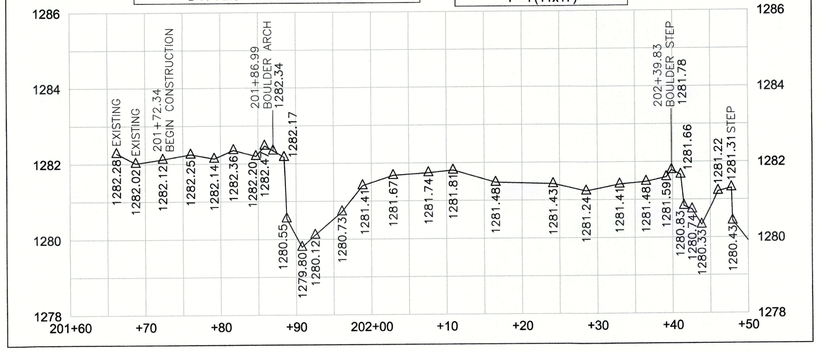
AS-BUILT SURVEY BY:
TURNER LAND SURVEYING, PLLC
SURVEYED MAY & JULY 2015

10' 0' 10' 20'

SCALE: 1"=10' (22x34)
1"=20' (11x17)
CONTOUR INTERVAL = 1'

AS-BUILT LONGITUDINAL PROFILE
SPROUSE BRANCH
STA 201+60 TO 202+50

PROFILE SCALE
HORIZONTAL: 1"=10'(22x34)
1"=20'(11x17)
VERTICAL: 1"=2'(22x34)
1"=4'(11x17)



NOTES:
1. SEE SHEET 1 FOR NOTES.

REVISIONS, DATE AND INITIAL:
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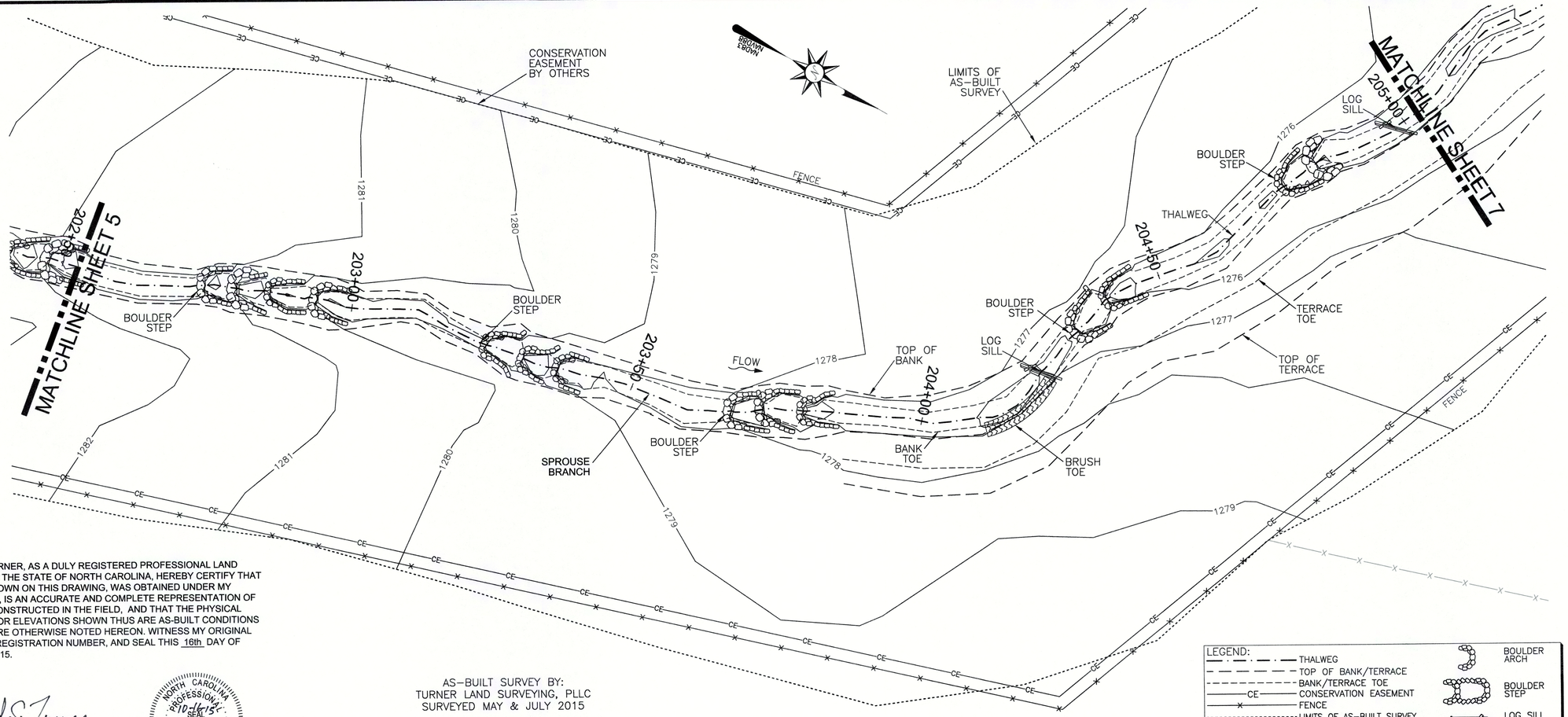
MIDDLE SOUTH MUDDY STREAM RESTORATION PROJECT
NCEEP PROJECT # 93875
McDOWELL COUNTY NORTH CAROLINA
NEBO

DATE:	05/18/2015
SURVEYED BY:	DST/JAP
DRAWN BY:	ROB/DST
REVIEWED BY:	DST/EGT
PROJECT:	TLS-15-007
FILE:	MSM CREEK_93875_AB_TLS_F.dwg
SCALE:	AS SHOWN

SHEET 5 of 13



I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 16th DAY OF OCTOBER, 2015.

David S. Turner

DAVID S. TURNER, P.L.S. #L-4551

NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER

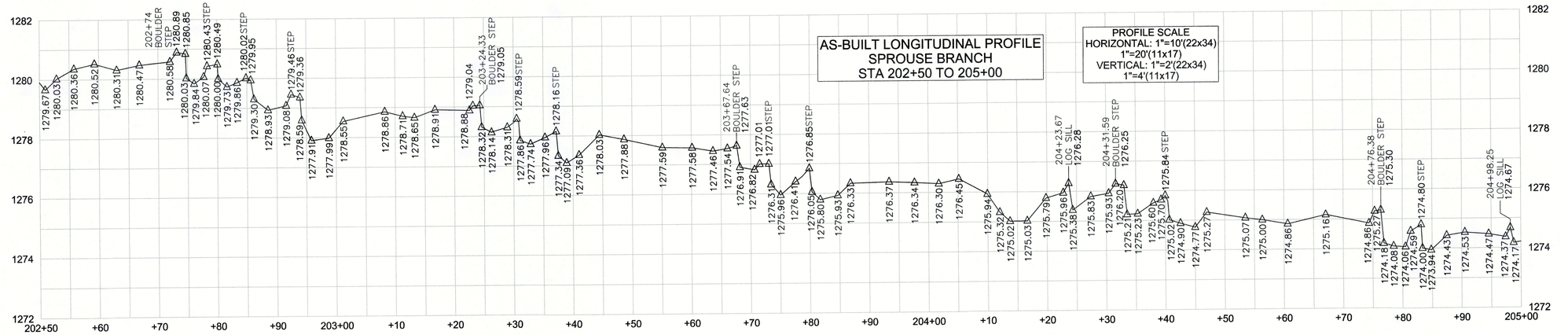
AS-BUILT SURVEY BY:
TURNER LAND SURVEYING, PLLC
SURVEYED MAY & JULY 2015

10' 0' 10' 20'

SCALE: 1"=10' (22x34)
1"=20' (11x17)
CONTOUR INTERVAL = 1'

NOTES:
1. SEE SHEET 1 FOR NOTES.

LEGEND:
- THALWEG
- TOP OF BANK/TERRACE
- BANK/TERRACE TOE
- CE — CONSERVATION EASEMENT
- FENCE
- LIMITS OF AS-BUILT SURVEY
- EXISTING FENCE
- EX. PROPERTY LINE (NOT SURVEYED)
- TRANSPLANT
- CONTROL POINT
- BOULDER ARCH
- BOULDER STEP
- LOG SILL
- BRUSH TOE
- RIPRAP



REVISIONS, DATE AND INITIAL:
1. ADDED GATES INSTALLED AFTER AS-BUILT SURVEY-SHEET 8 & SHEET 11. 10/15/15. EGT

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MIDDLE SOUTH MUDDY STREAM RESTORATION PROJECT
NCEEP PROJECT # 93875
McDOWELL COUNTY
NORTH CAROLINA

NEBO

DATE: 05/18/2015
SURVEYED BY: DST/JAP
DRAWN BY: ROB/DST
REVIEWED BY: DST/EGT
PROJECT: TLS-15-007
FILE: MSM CREEK_93875_AB_TLS_F.dwg
SCALE: AS SHOWN

SHEET 6 of 13

I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 16th DAY OF OCTOBER, 2015.

David S. Turner

DAVID S. TURNER, P.L.S. #L-4551

NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER 10-16-15

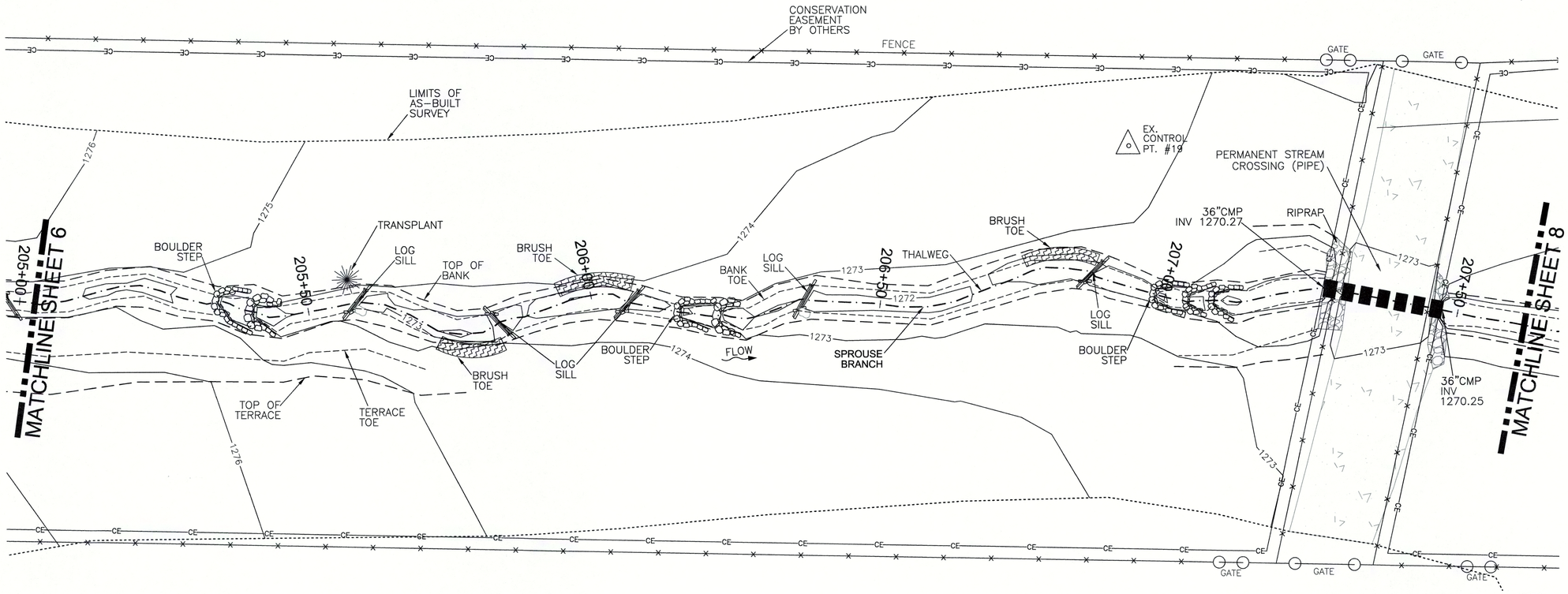
NOTES:
1. SEE SHEET 1 FOR NOTES.

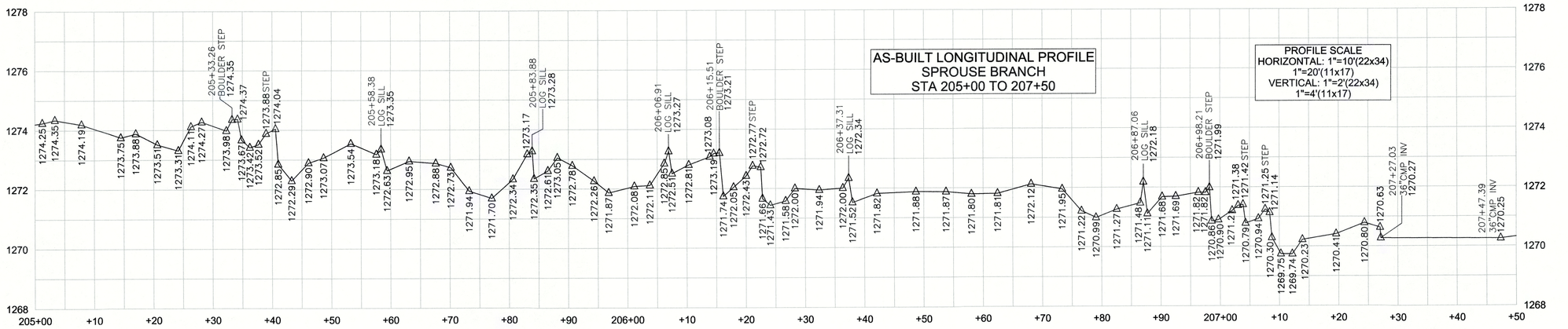
LEGEND:
- THALWEG
- TOP OF BANK/TERRACE
- BANK/TERRACE TOE
- CE — CONSERVATION EASEMENT
- FENCE
- LIMITS OF AS-BUILT SURVEY
- EXISTING FENCE
- EX. PROPERTY LINE (NOT SURVEYED)
- TRANSPLANT
- CONTROL POINT
- BOULDER ARCH
- BOULDER STEP
- LOG SILL
- BRUSH TOE
- RIPRAP

AS-BUILT SURVEY BY:
TURNER LAND SURVEYING, PLLC
SURVEYED MAY & JULY 2015

10' 0' 10' 20'

SCALE: 1"=10' (22x34)
1"=20' (11x17)
CONTOUR INTERVAL = 1'





REVISIONS, DATE AND INITIAL:
1. ADDED GATES INSTALLED AFTER AS-BUILT SURVEY-SHEET 8 & SHEET 11, 10/19/15, EGT

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MIDDLE SOUTH MUDDY STREAM RESTORATION PROJECT
NCEEP PROJECT # 93875
McDOWELL COUNTY
NORTH CAROLINA

NEBO

DATE:	05/18/2015
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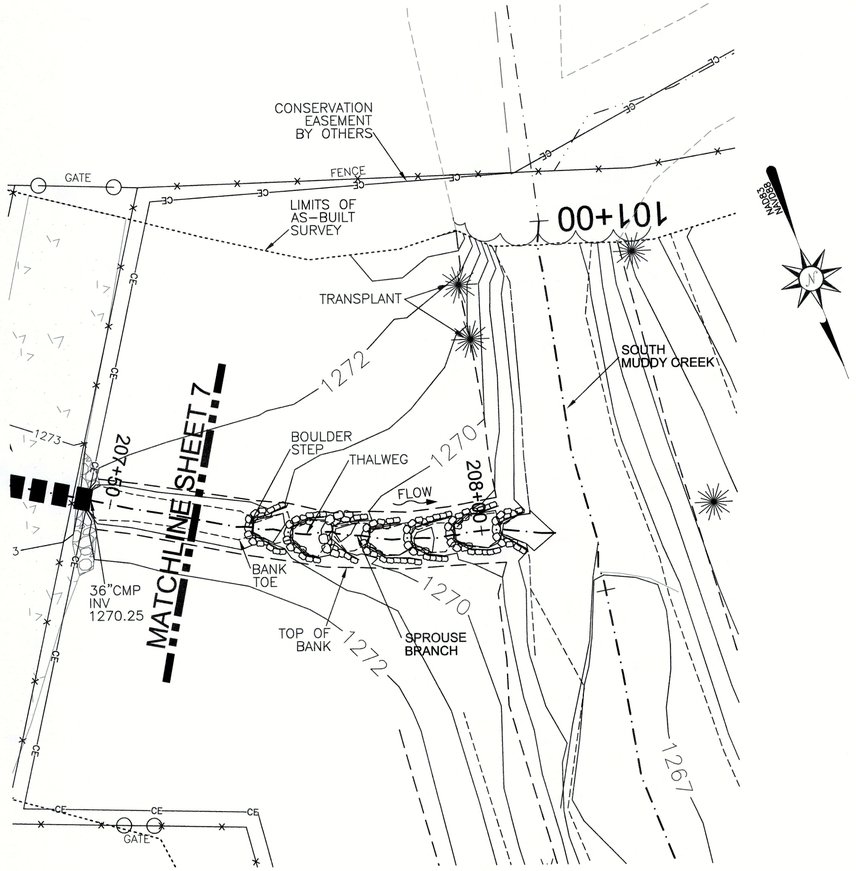
DRAWN BY:	ROB/DST
REVIEWED BY:	DST/EGT
PROJECT:	TLS-15-007
FILE:	MSM CREEK_93875 _AB_TLS_F.dwg
SCALE:	AS SHOWN

SHEET 7 of 13

I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 16th DAY OF OCTOBER, 2015.

DAVID S. TURNER, P.L.S. #L-4551

NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER



LEGEND:
- THALWEG
- TOP OF BANK/TERRACE
- BANK/TERRACE TOE
- CE — CONSERVATION EASEMENT
- FENCE
- LIMITS OF AS-BUILT SURVEY
- EXISTING FENCE
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- TRANSPLANT
- CONTROL POINT
- BOULDER ARCH
- BOULDER STEP
- LOG SILL
- BRUSH TOE
- RIPRAP

AS-BUILT SURVEY BY:
TURNER LAND SURVEYING, PLLC
SURVEYED MAY & JULY 2015

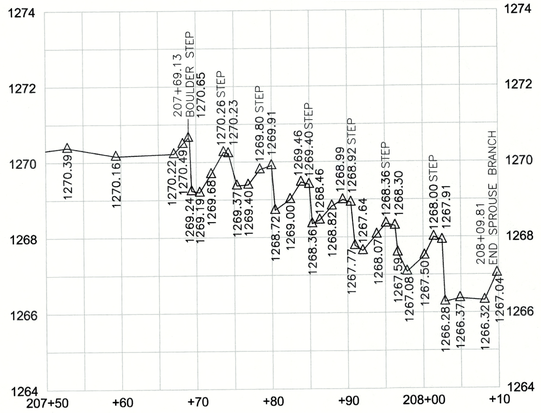
10' 0' 10' 20'

SCALE: 1"=10' (22x34)
1"=20' (11x17)
CONTOUR INTERVAL = 1'

NOTES:
1. SEE SHEET 1 FOR NOTES.

AS-BUILT LONGITUDINAL PROFILE
SPROUSE BRANCH
STA 207+50 TO 208+10

PROFILE SCALE
HORIZONTAL: 1"=10'(22x34)
1"=20'(11x17)
VERTICAL: 1"=2'(22x34)
1"=4'(11x17)



REVISIONS, DATE AND INITIAL:
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SPROUSE BRANCH STA. 207+50 TO 208+10
MIDDLE SOUTH MUDDY STREAM
RESTORATION PROJECT
NCEEP PROJECT # 93875
McDOWELL COUNTY
NORTH CAROLINA
NEBO

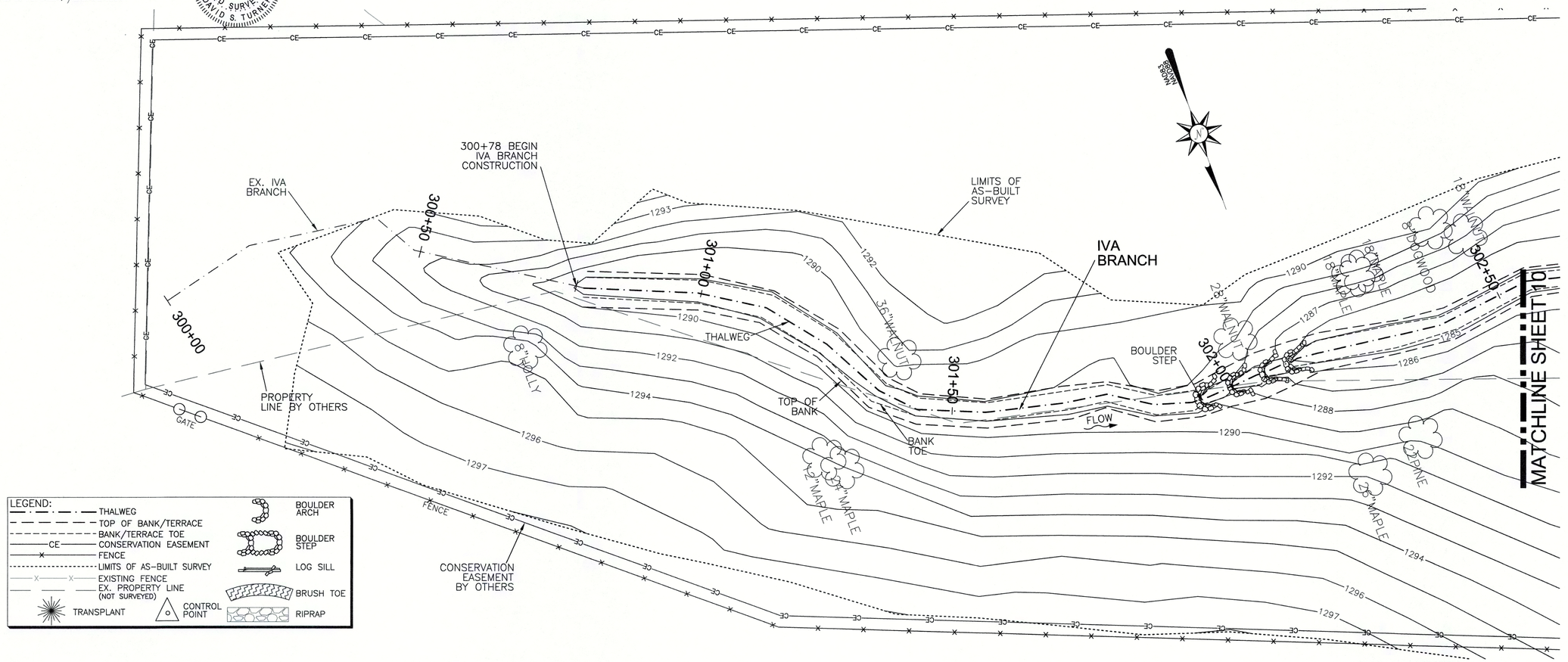
DATE: 05/18/2015
SURVEYED BY: DST/JAP
DRAWN BY: ROB/DST
REVIEWED BY: DST/EGT
PROJECT: TLS-15-007
FILE: MSM CREEK_93875_AB_TLS_F.dwg
SCALE: AS SHOWN

SHEET 8 of 13

I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 16th DAY OF OCTOBER, 2015.

DAVID S. TURNER, P.L.S. #L-4551

NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER



LEGEND:
- THALWEG
- TOP OF BANK/TERRACE
- BANK/TERRACE TOE
- CE — CONSERVATION EASEMENT
- FENCE
- LIMITS OF AS-BUILT SURVEY
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- TRANSPLANT
- CONTROL POINT
- BOULDER ARCH
- BOULDER STEP
- LOG SILL
- BRUSH TOE
- RIPRAP

AS-BUILT SURVEY BY:
TURNER LAND SURVEYING, PLLC
SURVEYED MAY & JULY 2015

10' 0' 10' 20'

SCALE: 1"=10' (22x34)
1"=20' (11x17)
CONTOUR INTERVAL = 1'

NOTES:
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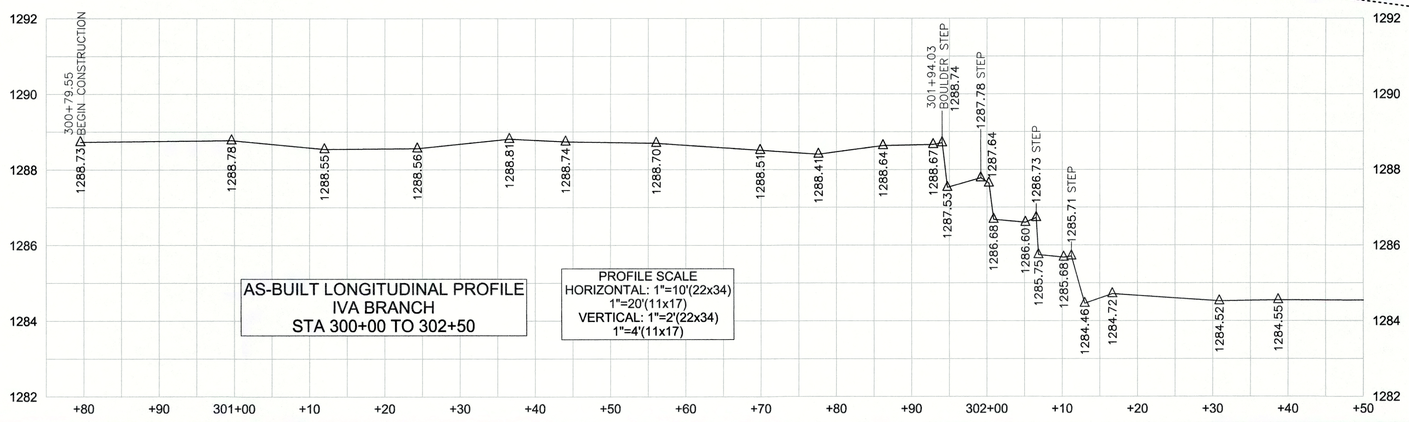

AS-BUILT LONGITUDINAL PROFILE
IVA BRANCH
STA 300+00 TO 302+50

PROFILE SCALE
HORIZONTAL: 1"=10'(22x34)
1"=20'(11x17)
VERTICAL: 1"=2'(22x34)
1"=4'(11x17)

REVISIONS, DATE AND INITIAL:
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IVA BRANCH STA. 300+00 TO 302+50

MIDDLE SOUTH MUDDY STREAM RESTORATION PROJECT

NCEEP PROJECT # 93875

McDOWELL COUNTY NORTH CAROLINA

NEBO

DATE:	05/18/2015
SURVEYED BY:	DST/JAP
DRAWN BY:	ROB/DST
REVIEWED BY:	DST/EGT
PROJECT:	TLS-15-007
FILE:	MSM CREEK_93875 _AB_TLS_F.dwg
SCALE:	AS SHOWN

SHEET 9 of 13

I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 16th DAY OF OCTOBER, 2015.

DAVID S. TURNER, P.L.S. #L-4551

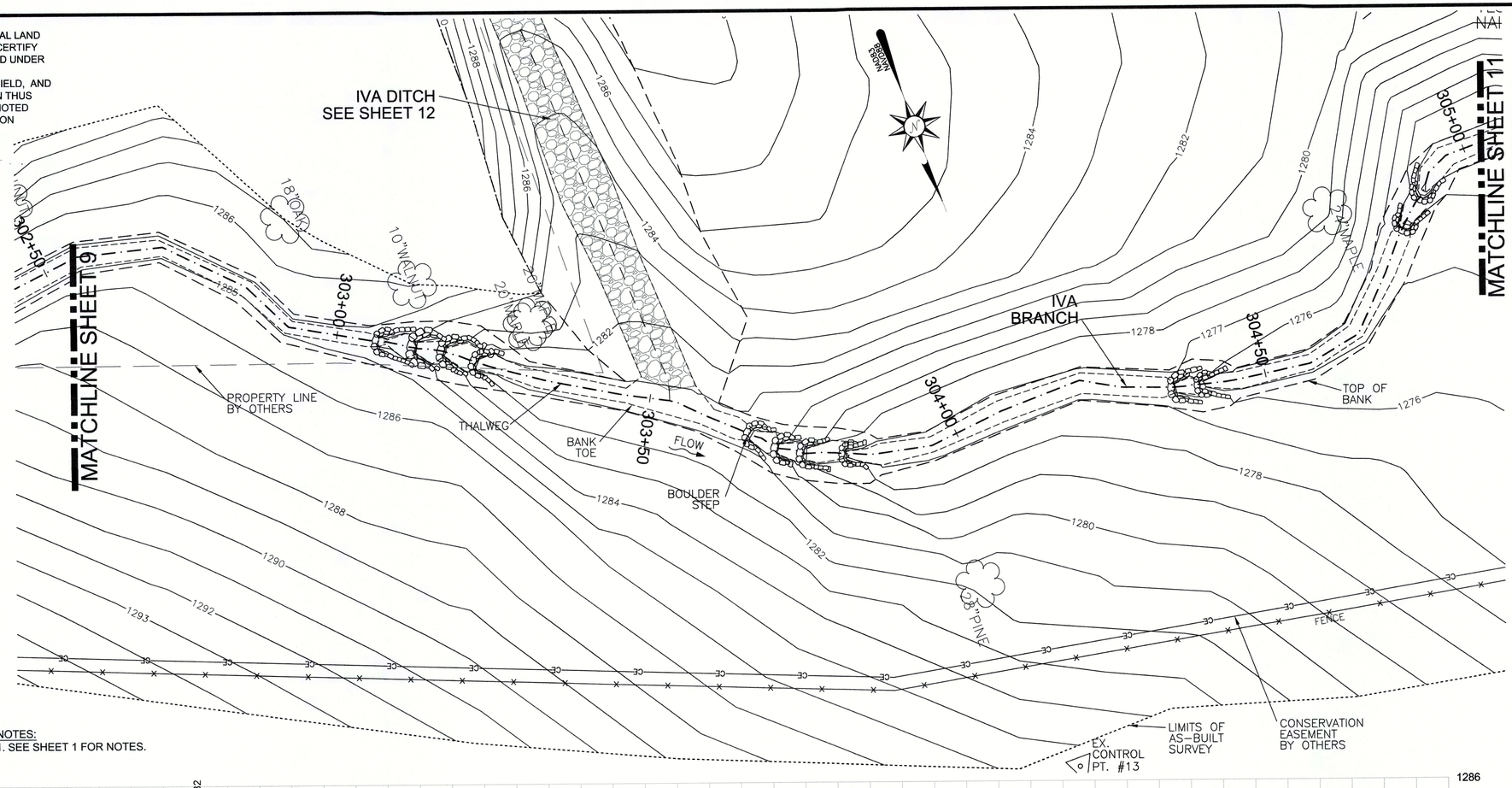
NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER 270-14-75

AS-BUILT SURVEY BY:
TURNER LAND SURVEYING, PLLC
SURVEYED MAY & JULY 2015

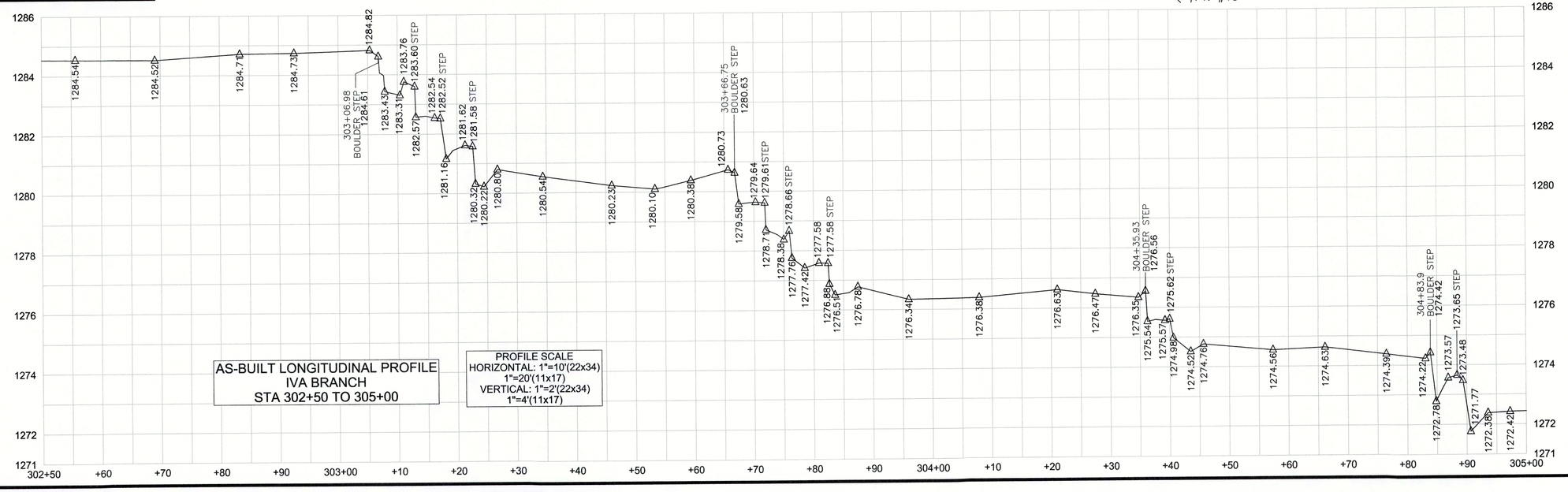
10' 0' 10' 20'

SCALE: 1"=10' (22x34)
1"=20' (11x17)
CONTOUR INTERVAL = 1'

LEGEND:
- THALWEG
- TOP OF BANK/TERRACE
- BANK/TERRACE TOE
- CE — CONSERVATION EASEMENT
- FENCE
- LIMITS OF AS-BUILT SURVEY
- EXISTING FENCE
- EX. PROPERTY LINE (NOT SURVEYED)
- TRANSPLANT
- BOULDER ARCH
- CONTROL POINT
- BOULDER STEP
- LOG SILL
- BRUSH TOE
- RIPRAP



NOTES:
1. SEE SHEET 1 FOR NOTES.



AS-BUILT LONGITUDINAL PROFILE
IVA BRANCH
STA 302+50 TO 305+00

PROFILE SCALE
HORIZONTAL: 1"=10'(22x34)
1"=20'(11x17)
VERTICAL: 1"=2'(22x34)
1"=4'(11x17)

REVISIONS, DATE AND INITIAL:
1. ADDED GATES INSTALLED AFTER AS-BUILT SURVEY-SHEET 9 & SHEET 11, 10/15/15, EGT

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MIDDLE SOUTH MUDDY STREAM RESTORATION PROJECT
NCEEP PROJECT # 93875
McDOWELL COUNTY NORTH CAROLINA
NEBO

DATE: 05/18/2015
SURVEYED BY: DST/JAP
DRAWN BY: ROB/DST
REVIEWED BY: DST/EGT
PROJECT: TLS-15-007
FILE: MSM CREEK_93875_AB_TLS_F.dwg
SCALE: AS SHOWN

SHEET 10 of 13

I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 16th DAY OF OCTOBER, 2015.

David S. Turner

DAVID S. TURNER, P.L.S. #L-4551

NORTH CAROLINA PROFESSIONAL 10-16-15 SEAL L-4551 LAND SURVEYOR DAVID S. TURNER

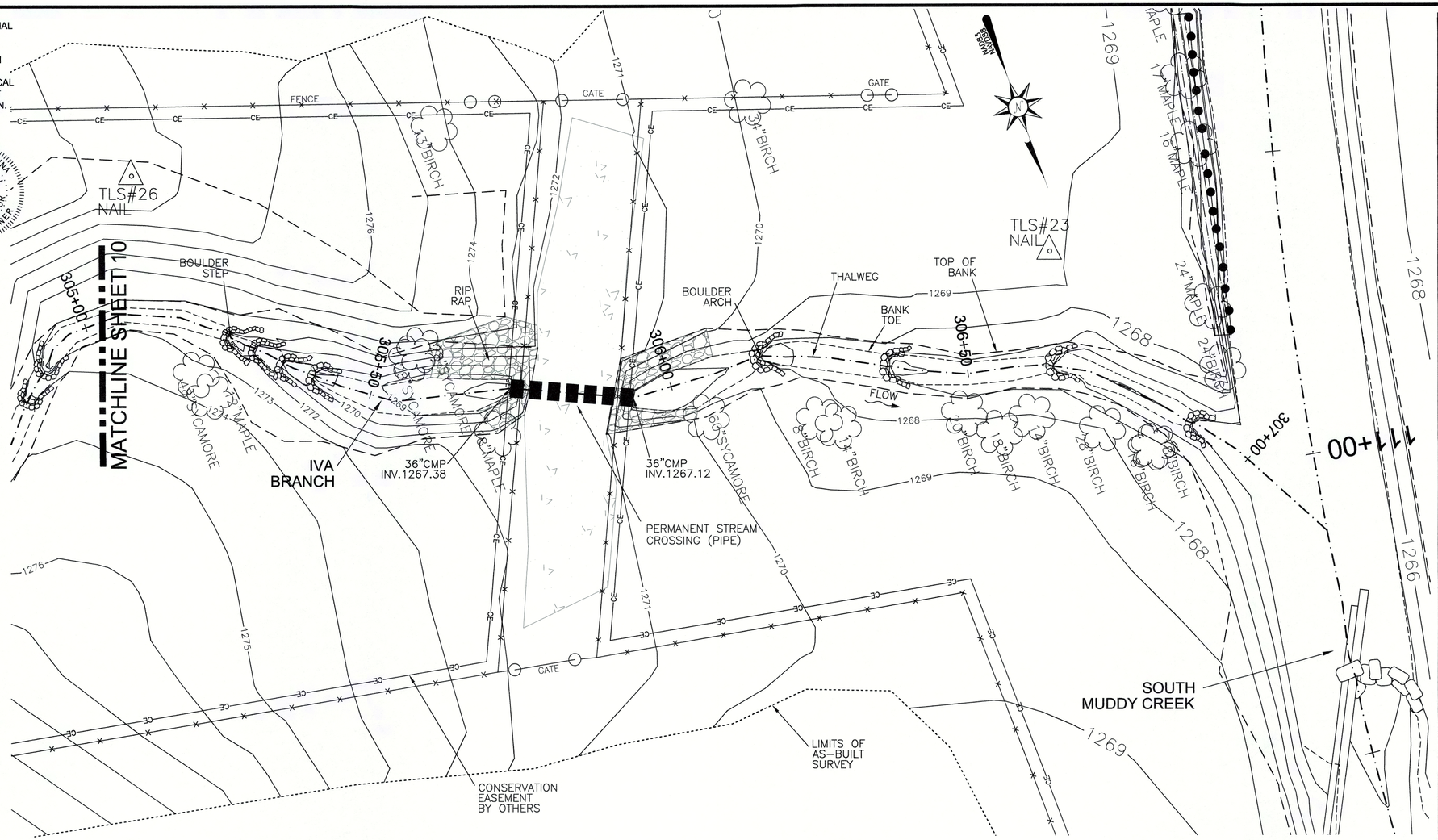
LEGEND:
- THALWEG
- TOP OF BANK/TERRACE
- BANK/TERRACE TOE
- CE — CONSERVATION EASEMENT
- FENCE
- LIMITS OF AS-BUILT SURVEY
- EXISTING FENCE
- EX. PROPERTY LINE (NOT SURVEYED)
- TRANSPLANT
- BOULDER ARCH
- CONTROL POINT
- BOULDER STEP
- LOG SILL
- BRUSH TOE
- RIPRAP

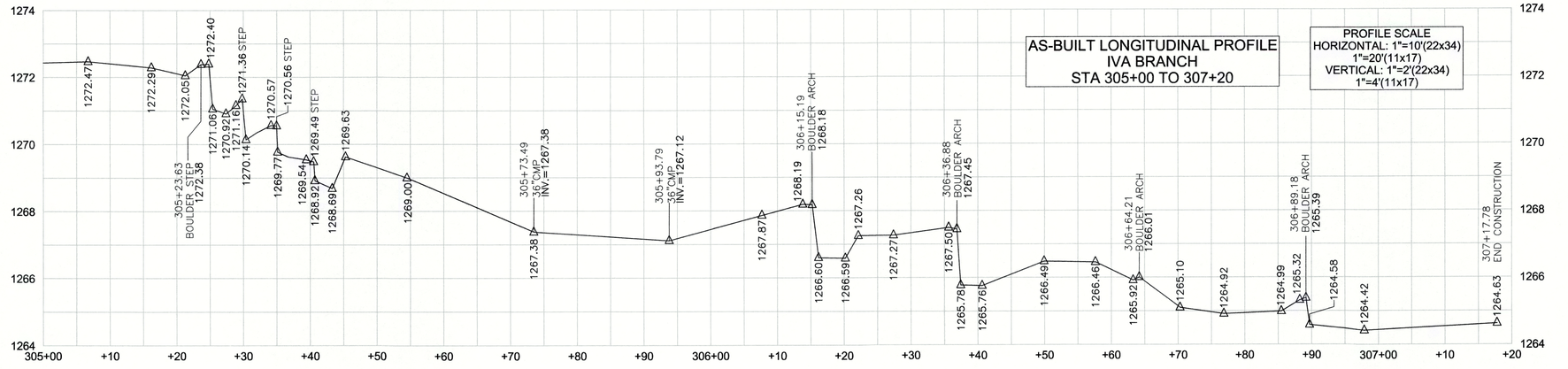
AS-BUILT SURVEY BY:
TURNER LAND SURVEYING, PLLC
SURVEYED MAY & JULY 2015

10' 0' 10' 20'

SCALE: 1"=10' (22x34)
1"=20' (11x17)
CONTOUR INTERVAL = 1'

NOTES:
1. SEE SHEET 1 FOR NOTES.





REVISIONS, DATE AND INITIAL:
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MIDDLE SOUTH MUDDY STREAM RESTORATION PROJECT
NCEEP PROJECT # 93875
McDOWELL COUNTY
NORTH CAROLINA
NEBO

DATE:	05/18/2015
SURVEYED BY:	DST/JAP
DRAWN BY:	ROB/DST
REVIEWED BY:	DST/EGT
PROJECT:	TLS-15-007
FILE:	MSM CREEK_93875 _AB_TLS_F.dwg
SCALE:	AS SHOWN

SHEET 11 of 13

I, DAVID S. TURNER, AS A DULY REGISTERED PROFESSIONAL LAND SURVEYOR IN THE STATE OF NORTH CAROLINA, HEREBY CERTIFY THAT THE DATA SHOWN ON THIS DRAWING, WAS OBTAINED UNDER MY SUPERVISION, IS AN ACCURATE AND COMPLETE REPRESENTATION OF WHAT WAS CONSTRUCTED IN THE FIELD, AND THAT THE PHYSICAL DIMENSIONS OR ELEVATIONS SHOWN THUS ARE AS-BUILT CONDITIONS EXCEPT WHERE OTHERWISE NOTED HEREON. WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER, AND SEAL THIS 16th DAY OF OCTOBER, 2015.

DAVID S. TURNER, P.L.S. #L-4551

NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER 10-16-15

LEGEND:
- THALWEG
- TOP OF BANK/TERRACE
- BANK/TERRACE TOE
- CE — CONSERVATION EASEMENT
- FENCE
- LIMITS OF AS-BUILT SURVEY
- EXISTING FENCE
- EX. PROPERTY LINE (NOT SURVEYED)
- RIPRAP
- CONTROL POINT

AS-BUILT SURVEY BY:
TURNER LAND SURVEYING, PLLC
SURVEYED MAY & JULY 2015

10' 0' 10' 20'

SCALE: 1"=10' (22x34)
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CONTOUR INTERVAL = 1'

NOTES:
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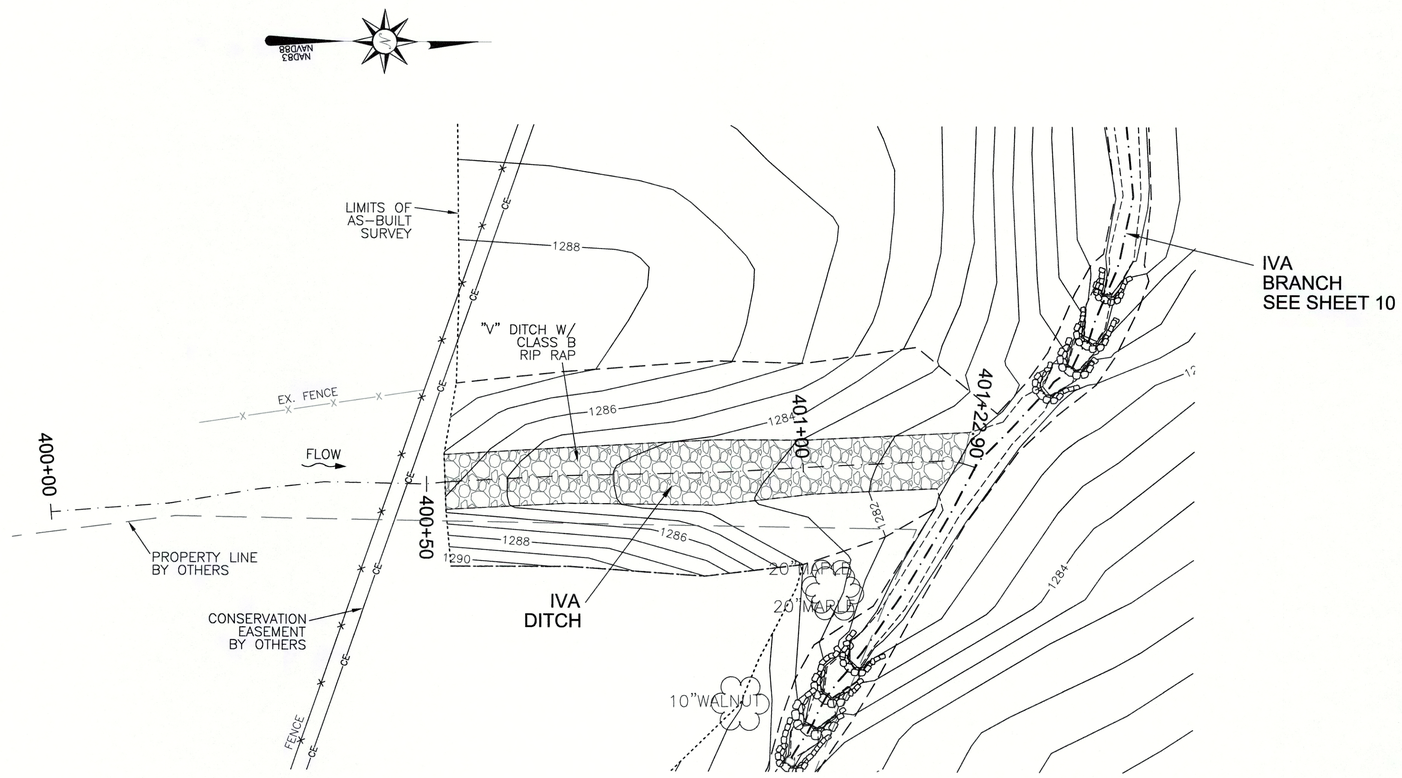

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SCALE: AS SHOWN

SHEET 12 of 13

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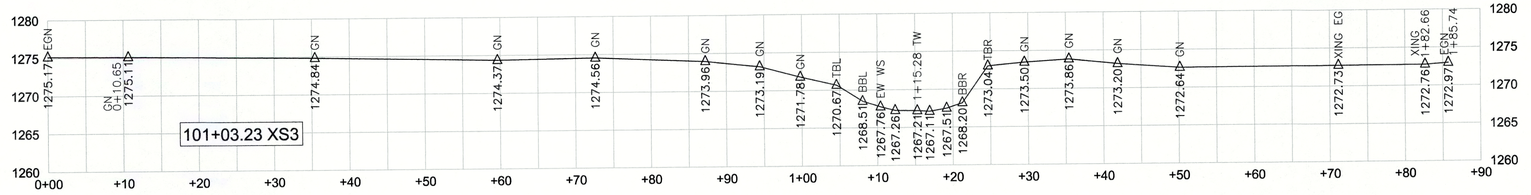
DAVID S. TURNER, P.L.S. #L-4551

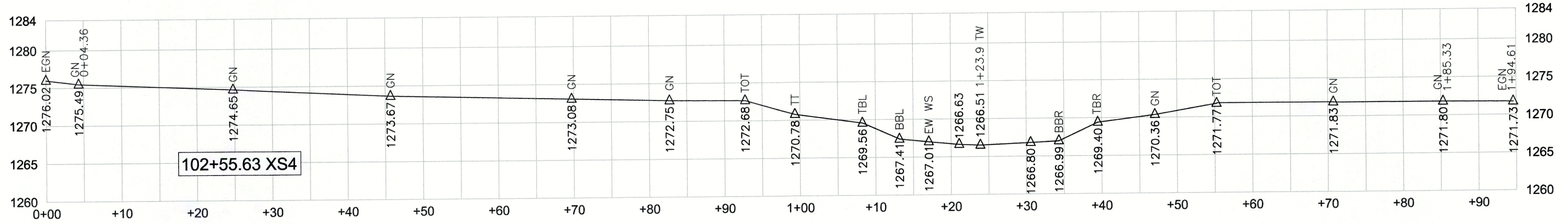
NORTH CAROLINA PROFESSIONAL SEAL L-4551 LAND SURVEYOR DAVID S. TURNER

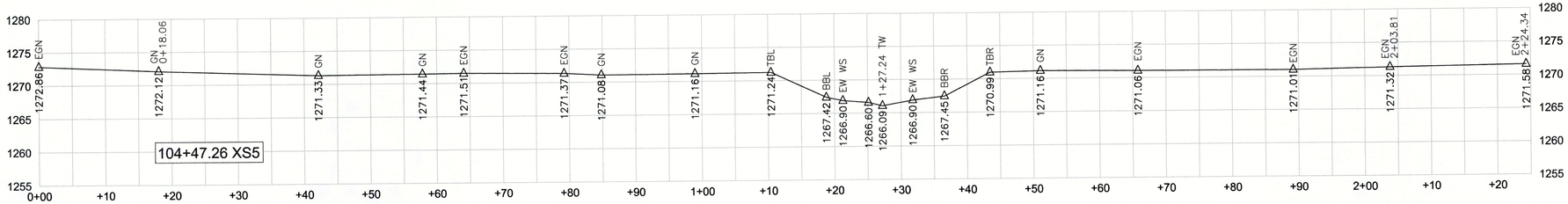
CROSS SECTION SCALE
HORIZONTAL: 1"=10'(22x34)
1"=20'(11x17)
VERTICAL: 1"=10'(22x34)
1"=20'(11x17)

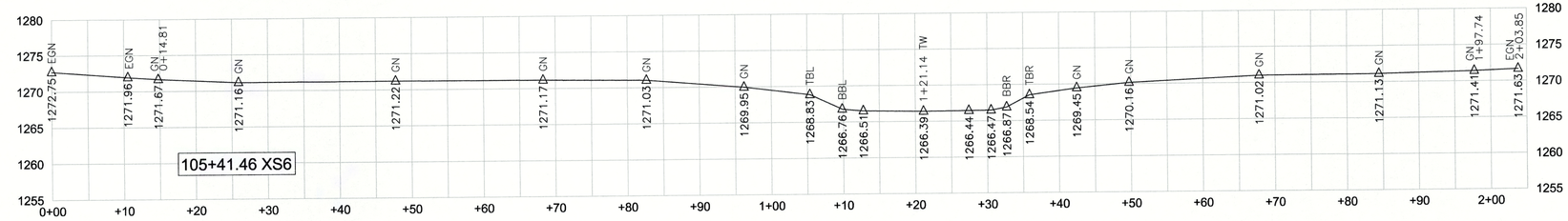
TBL–LEFT TOP OF BANK
TBR–RIGHT TOP OF BANK
BBL–LEFT BANK TOE
BBR–RIGHT BANK TOE
TW–THALWEG
GN–GROUND
EGN–EXISTING GROUND
EW–EDGE OF WATER
WS–WATER SURFACE
XING–CROSSING
TOT–TOP OF TERRACE
TT–TERRACE TOE

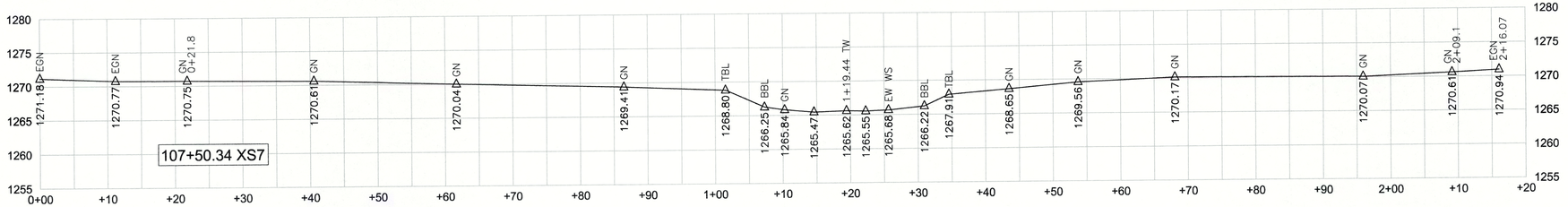
NOTES:
1. SEE SHEET 1 FOR NOTES.

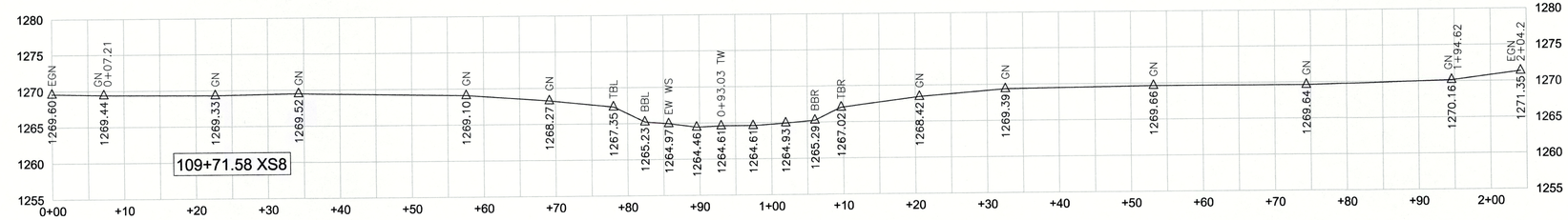












REVISIONS, DATE AND INITIAL:
1. ADDED GATES INSTALLED AFTER AS-BUILT SURVEY-SHEET 8 & SHEET 11. 10/15/15. EGT

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CROSS SECTIONS XS3-XS8
MIDDLE SOUTH MUDDY STREAM RESTORATION PROJECT
NCEEP PROJECT # 93875
McDOWELL COUNTY
NORTH CAROLINA
NEBO

DATE:	05/18/2015
SURVEYED BY:	DST/JAP
DRAWN BY:	ROB/DST
REVIEWED BY:	DST/EGT
PROJECT:	TLS-15-007
FILE:	MSM CREEK_93875_AB_TLS_F.dwg
SCALE:	AS SHOWN
SHEET	13 of 13