MY3 FINAL MONITORING REPORT
Hornpipe Branch Tributaries Mitigation Project
Lenoir County
Neuse River Basin
CU 03020202

DMS Project # 100076
DMS Contract # 7605
Contracted RFP # 16-007401
USACE Action ID Number: SAW-2018-01762
DWR Project # 2018-1155

Calendar Year of Data Collection: 2023

Prepared for:
North Carolina Department of Environmental Quality
Division of Mitigation Services
1652 Mail Service Center
Raleigh, NC 27699-1652

WATER & LAND SOLUTIONS
7721 SIX FORKS ROAD, SUITE 130, RALEIGH, NC 27615
(919) 614 - 5111 | waterlandsolutions.com

December 15th, 2023

NC Department of Environmental Quality

Division of Mitigation Services

Attn: Emily Dunnigan

217 West Jones Street, Suite 3000-A

Raleigh, NC 27603

RE: WLS Responses to NCDEQ DMS Review Comments for Task 9 Draft Monitoring Report Year 3 for Hornpipe Branch Tributaries Mitigation Project, NCDEQ DMS Full-Delivery Project ID #100076, Contract #7605, Neuse River Basin, Cataloging Unit 03020202, Lenoir County, NC

Dear Ms. Dunnigan:

Water & Land Solutions, LLC (WLS) is pleased to present the Final Monitoring Year 3 Report for the Hornpipe Mitigation Project to the North Carolina Department of Environmental Quality (NCDEQ) Division of Mitigation Services (DMS). Per the DMS review comments, WLS has updated the Final Monitoring Year 3 Report and associated deliverables accordingly. We are providing the electronic deliverables via cloud link. The electronic deliverables are organized under the following folder structure as required under the digital submission requirements:

1. Report PDF
2. Support Files
    - 1_ Tables
    - 2_CCPV
    - 3_Veg
    - 4_Geomorph
    - 5_Hydro
    - 6_Photos

We are providing our written responses to DMS' review comments on the Monitoring Year 3 Report below. Each of the DMS review comments is copied below in bold text, followed by the appropriate response from WLS in regular text:

General:

1. **Pg. 10, Section 4.1.2: Based on the November site visit, beaver activity impacts were present along MS2 and additional action is needed to restore channel flow. Please provide the linear feet of stream channel impacted by the beaver impoundment and update the CCPV with the stream section impacted (include the shapefile in the digital deliverables).** WLS Response: Verbiage on the beaver impacts, including linear footage of stream channel impacted, has been updated within the report. The CCPV has been updated with the impacted area, and the relevant shapefile has been included in the electronic deliverables.

2. **Pg. 12, Section 4.2.5: Please indicate that the proposed planted trees will only be species included in the approved mitigation plan.** WLS Response: WLS has added this verbiage to the report for clarification.
3. **Section 4: Please add a section discussing benthic data/results.** WLS Response: A paragraph discussing the benthic data results has been added as "Section 4.5 Macrobenthic Sampling" on page 12.
4. **Appendix C, Evidence of Headwater Channel Formation Photos: It's great that UT1 and UT2 appear to have 8/9 channel forming indicators, but only photos were provided for 2 of the indicators. Please update with additional photos and/or provide photographs for each indicator in future reports.** WLS Response: WLS will take photos of additional channel forming indicators and provide them in the MY4 report.
5. **Appendix D, Monthly Rainfall Summary Data: Based on the data for October 2023 rainfall was not normal; please update the table/graph. Please update with rainfall through November if possible.** WLS Response: WLS updated the October 2023 rainfall overall designation and added the rainfall total for November 2023 in the table and graph.
6. **Appendix D, Flow Gauge Data, FG-1 Graph: There is an error in the legend; please update.** WLS Response: The legend has been fixed on the FG-1 graph and updated in the report.
7. **Appendix D, Flow Gauge Data FG-2 & FG-3 Graphs: The arrows indicating max days of consecutive flow do not match the correct dates; please update.** WLS Response: The arrows on FG-2 & FG-3 graphs have been adjusted to match the correct consecutive flow days.
8. **Appendix F: Add photos for MY3 sampling.** WLS Response: The benthic sampling location photos have been updated with MY3 photos.

Boundary Inspection:

1. **Minor scalloping encroachments were noted along active farmed fields and the potential for future encroachment was high in many locations. Please add horse tape and/or signs along active farm fields to help the farmer determine the CE location. Please include the encroachments in the narrative, on the CCPV, in the Visual vegetation assessment table, and provide shapefiles in the digital submittal.** WLS Response: Horsetape will be added early in MY4 along active farmed fields to deter further scalloping encroachments from mowing. WLS has added the identified encroachment areas in the narrative, Visual Vegetation Assessment table, Appendix A, and on the CCPV. The shapefiles have been added to the electronic deliverables.
2. **Multiple boundary posts had been hit with farm equipment resulting in damage. Please replace any damaged posts and refresh signs.** WLS Response: WLS will replace damaged boundary posts and refresh easement marker signs early in MY4 (2024).

Electronic comments:

1. **Please submit a file depicting the location of the 2.41 ac. Invasive area indicated on the CCPV.** WLS Response: The shapefiles for the invasive area included on the CCPV have been added to the electronic deliverables in the Shapefiles subfolder.

Please contact me if you have any questions or comments.

Sincerely,

Water & Land Solutions, LLC

Alyssa Davis
Water & Land Solutions, LLC
7721 Six Forks Road, Suite 130
Raleigh, NC 27615
Office Phone: (412) 526-2762
Email: alyssa@waterlandsolutions.com

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LIST OF APPENDICES

1 Project Summary

1.1 Project Location and Description

The Hornpipe Branch Tributaries Mitigation Project ("Project") is a North Carolina Department of Environmental Quality (NCDEQ), Division of Mitigation Services (DMS) full-delivery stream mitigation project contracted with Water & Land Solutions, LLC (WLS) in response to RFP 16-007401. The Project will provide stream mitigation credits in the Neuse River Basin (Cataloging Unit 03020202). The Project is in Lenoir County, North Carolina, in the Community of Deep Run at coordinates 35.134242° North and -77.655045° West. The project site is in the Targeted Local Watershed 003020202050010 (Warm Water Thermal Regime).

The Project involved the restoration of five stream reaches (MS1, MS2, MS3, UT1, and UT2) and their riparian buffers. Proposed stream lengths total 1,239 linear feet of headwater streams and 3,912 linear feet of single-thread streams. The mitigation plan provides a detailed project summary and Table 1 provides a summary of project assets. Figure 1 illustrates the project mitigation components and Figure 2 illustrates the reference site location in proximity to the project.

Monitoring Year 3 (MY3) activities occurred in April and September 2023. This report presents the data for MY3. The Project meets the MY3 success criteria for stream hydrology, stream horizontal and vertical stability, streambed condition and stability, stream flow, and vegetation. Based on these results, the Project is on a trajectory to meet interim and final success criteria in Monitoring Year 4 (MY4). For more information on the chronology of the project history, activity, and contact information, refer to Appendix E.

1.2 Project Quantities and Credits

The Project mitigation components include Stream Restoration activities as summarized in Table 1 below.

Table 1. Hornpipe Branch Tributaries (ID-100076) Project Mitigation Quantities and Credits

Project Segment	Original Mitigation Plan Ft/Ac	As-Built Ft/Ac	Original Mitigation Category	Original Restoration Level	Original Mitigation Ratio (X:1)	Credits	Comments
Stream							
MS1	1,440	1,468	Warm	R	1.00000	1,440.000	Full Channel Restoration, Planted Buffer, Permanent Conservation Easement
MS2	943	940	Warm	R	1.00000	943.000	Full Channel Restoration, Planted Buffer, Permanent Conservation Easement
MS3	1,529	1,521	Warm	R	1.00000	1,529.000	Full Channel Restoration, Planted Buffer, Permanent Conservation Easement
UT1	677	677	Warm	R	1.00000	677.000	Headw ater Channel Restoration, Planted Buffer, Permanent Conservation Easement
UT2	562	562	Warm	R	1.00000	562.000	Headw ater Channel Restoration, Planted Buffer, Permanent Conservation Easement
					Total:	**5,151.000**	
Wetland							
					Total:	**0.000**	

Project Credits							
	Stream			Riparian	Non-Rip	Coastal	
Restoration Level	Warm	Cool	Cold	Wetland	Wetland	Marsh	
Restoration	5,151.000	0.000	0.000	0.000	0.000	0.000	
Re-establishment				0.000	0.000	0.000	
Rehabilitation				0.000	0.000	0.000	
Enhancement				0.000	0.000	0.000	
Enhancement I	0.000	0.000	0.000				
Enhancement II	0.000	0.000	0.000				
Creation				0.000	0.000	0.000	
Preservation	0.000	0.000	0.000	0.000	0.000		
Totals	**5,151.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	

Total Stream Credit	**5,151.000**
Total Wetland Credit	**0.000**

Wetland Mitigation Category		Restoration Level	
CM	Coastal Marsh	HQP	High Quality Preservation
R	Riparian	P	Preservation
NR	Non-Riparian	E	Wetland Enhancement - Veg and Hydro
		EII	Stream Enhancement II
		EI	Stream Enhancement I
		C	Wetland Creation
		RH	Wetland Rehabilitation - Veg and Hydro
		REE	Wetland Re-establishment Veg and Hydro
		R	Restoration

1.3 Current Condition Plan View

The following pages present the Current Condition Plan View (CCPV).

WATER & LAND™ SOLUTIONS	NC Mitigation Services ENVIRONMENTAL QUALITY	**Hornpipe Branch Tributaries Mitigation Project Lenoir County, North Carolina**	USACE Action ID Number: SAW-2018-01762 Data Collection Date: October 2023 MY3	USACE Current Conditions Plan View Monitoring Year 3 NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 1a

Conservation Easement
Top of Bank
Pre-existing Channel
Stream Restoration
Channel (No Credit)
Encroachment Area (0.02 ac)
Rain Gauge
Crest Gauge
Wetland Gauge
Flow Gauge
VPA-1 Low Stem Density (0.10 ac)
Beaver Impacted Area
Constructed Log Riffle
Geolift - Toewood
Log Riffle
Log Structure
Rock Riffle
Root Wad
Photo Station (2)
Stationing
Woodline
Existing Wetland
Cross Sections
Fixed Vegetation Plot
Success Criteria Met
Success Criteria Not Met
Random 50m x 2m Vegetation Plot
Success Criteria Met
Water Quality Improvement Features
Culvert

Encroachment Area 2 (0.01 ac)
MS1
FG-1
10+00
11+00
12+00
13+00
1
XS-3
24+00
26+00
25+00
23+00
22+00
XS-2
16+00
15+00
14+00
PS-1
2
RG
21+00
17+00
XS-1
Encroachment Area 1 (0.01 ac)
27+00
XS-4
MS2
CG-2
20+00
19+00
18+00
28+00
29+00
WG-1
Beaver impacted area
160 LF of stream channel
30+00
6
VPA-1
31+00
3
PS-2
UT2
XS-5
FG-3
32+00
4
33+00
11+90
12+90
13+90
10+90
34+00
14+90
15+62
9+90

N
0 125 250 Feet

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

WATER & LAND™ SOLUTIONS

NC Mitigation Services ENVIRONMENTAL QUALITY

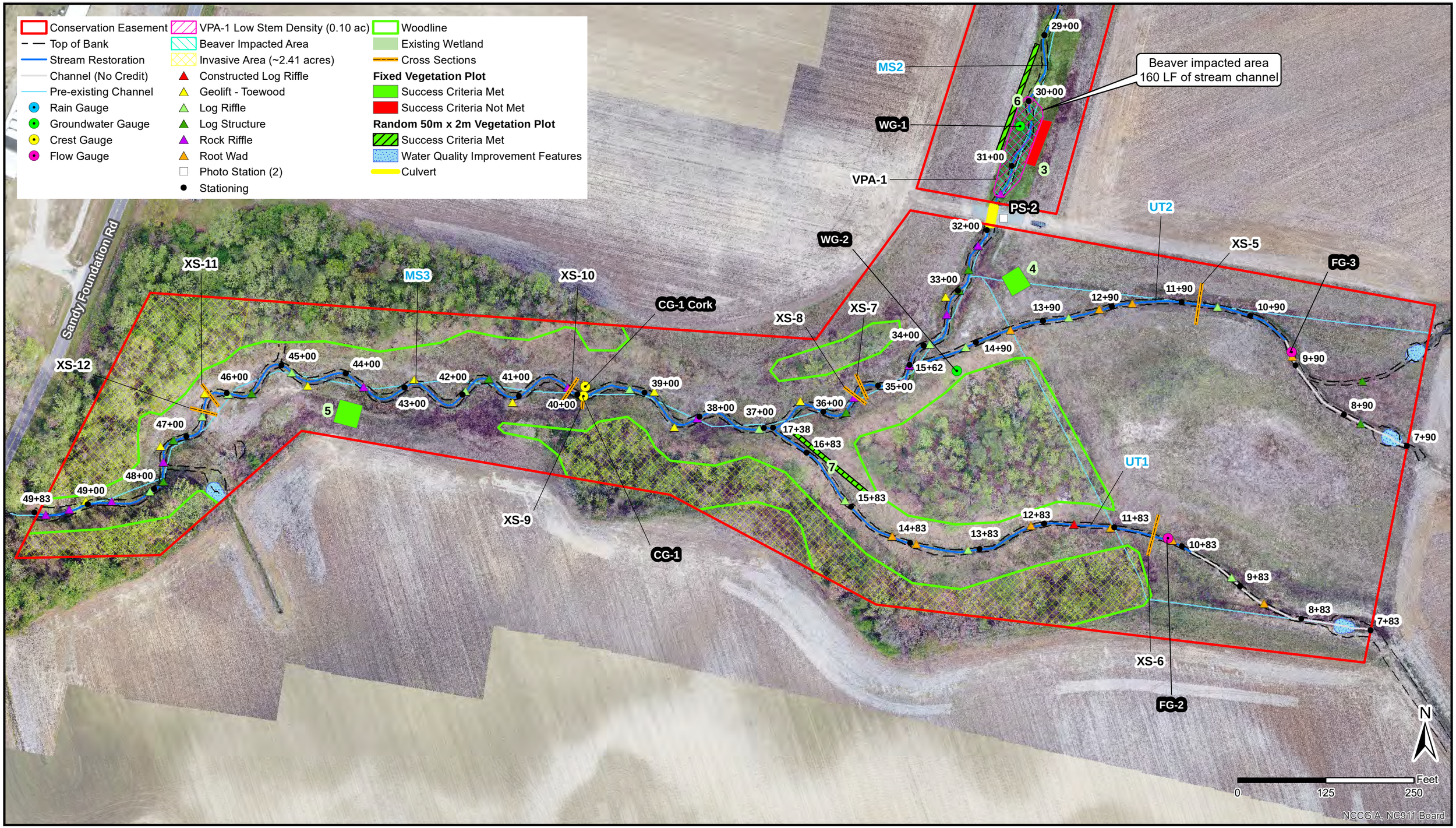
Hornpipe Branch Tributaries Mitigation Project
Lenoir County, North Carolina

USACE Action ID Number:
SAW-2018-01762
Data Collection Date: October 2023
MY3

USACE
Current Conditions Plan View
Monitoring Year 3

NAD 1983 2011 State Plane
North Carolina FIPS 3200 FT US

FIGURE
1b



WATER & LAND™ SOLUTIONS	Mitigation Services ENVIRONMENTAL QUALITY	**Hornpipe Branch Tributaries Mitigation Project Lenoir County, North Carolina**	USACE Action ID Number: SAW-2018-01762 Data Collection Date: October 2023 MY3	USACE Current Conditions Plan View Monitoring Year 3 NAD 1983 2011 State Plane North Carolina FIPS 3200 FT US	FIGURE 1c

2 Goals, Performance Criteria, and Functional Improvements

2.1 Project Goals and Objectives

The Project will meet the goals and objectives described in the Hornpipe Branch Tributaries Final Approved Mitigation Plan and will address general restoration goals and opportunities outlined in the 2010 (amended 2018) Neuse River Basin Watershed Restoration Priorities (RBRP). More specifically, the functional goals and objectives outlined in the RBRP will be met:

- Reducing sediment and nutrient inputs to the Southwest Creek Watershed.
- Restoring and protecting streams, wetlands, riparian buffers and aquatic habitat.
- Implementing agricultural BMPs and stream restoration in nutrient sensitive watersheds.

To accomplish these project-specific goals, the following objectives will be measured to document overall project success:

- Restore stream and floodplain interaction and geomorphically stable conditions by reconnecting historic flow paths and promoting more natural flood processes;
- Improve and protect water quality by reducing streambank erosion, nutrient and sediment inputs;
- Restore and protect riparian buffer functions and habitat connectivity in perpetuity by recording a permanent conservation easement; and
- Incorporate water quality improvement features to reduce nonpoint source inputs to receiving waters.

Table 2: Summary: Goals, Performance and Results

Goal	Objective/Treatment	Likely Functional Uplift	Performance Criteria	Measurement	Cumulative Monitoring Results
Improve Stream Base Flow Duration	Improve and/or remove existing stream crossings and restore a more natural flow regime and aquatic passage.	Create a more natural and higher functioning headwater flow regime and provide aquatic passage; re-establish appropriate wetland hydroperiods and provide hydrologic storage	Maintain seasonal flow on intermittent stream for a minimum of 30 consecutive days during normal annual rainfall	3 Flow gauges (MS1, UT1, UT2)	3/3 met requirements - 2023
Reconnect channels with floodplains and riparian wetlands to allow a natural flooding regime.	Design BHRs to not exceed 1.2 and increase ERs no less than 2.2 for Rosgen 'C' and 'E' stream types and 1.4 for 'B' stream types.	Provide temporary water storage and reduce erosive forces (shear stress) in channel during larger flow events.	Minimum of four bankfull events in separate years. Wetland hydrology data is supplementary and is not tied to project success criteria.	Minimum of four bankfull events in separate years. Wetland hydrology data is supplemanetary. Wetlands are not tied to project success criteria.	CG-1 : 10 recorded bankfull events, CG-2: 9 recorded bankfull events - 2023
Improve stabilty of stream channels	Construct stream channels that will maintain stable cross-sections, patterns, and profiles over time.	Reduction in sediment inputs from bank erosion, reduction of shear stress, and improved overall hydraulic function.	Bank height ratios remain below 1.2 over the monitoring period. Visual assessments showing progression towards stability.	12 Cross section surveys	all cross sections - BHR<1.2 - 2023
Establish Riparian Buffer Vegetation	Plant native species vegetation a minimum 50' wide from the top of the streambanks with a composition/density comparable to downstream reference condition.	Increase woody and herbaceous vegetation will provide channel stability and reduce streambank erosion, runoff rates and exotic species vegetation.	Within planted portions of the site, a minimum of 320 stems per acre must be present at year three; a minimum of 260 stems per acre must be present at year five with an average height of seven feet; and a minimum of 210 stems per acre and average ten foot tree heights must be present at year seven.	Tree data for 5 fixed veg plots and 2 random plots (species & height), visual assessment	6/7 veg plots met - 2023

2.2 Project Success Criteria

The success criteria for the Project will follow the approved performance standards and monitoring protocols from the final approved mitigation plan; which was developed in compliance with the USACE October 2016 Guidance, USACE Stream Mitigation Guidelines (April 2003 and October 2005), and 2008 Compensatory Mitigation Final Rule. Cross-section and vegetation plot data will be collected in Years 0, 1, 2, 3, 5, and 7. Stream hydrology data and visual monitoring will be reported annually. Specific success criteria components and evaluation methods are described below.

2.2.1 Single-Thread Streams

***Stream Hydrology*:** Four separate bankfull or over bank events must be documented within the seven-year monitoring period and the stream hydrology monitoring will continue until four bankfull events have been documented in separate years. Stream hydrology monitoring will be accomplished with pressure transducers installed in pools and correlating sensor depth to top of bank elevation. Recorded water depth above the top of bank elevation will document a bankfull event. The devices will record water depth hourly and will be inspected quarterly.

The stage recorders include an automatic pressure transducer (HOBO Water Level (13 ft) Logger) set in PVC piping in the channel. The elevation of the bed and top of bank at each stage recorder location will be recorded to be able to document presence of water in the channel and out of bank events. Visual observations (i.e. wrack or debris lines) and traditional cork crest gauges will also be used to document out of bank events.

Stream Profiles, Vertical Stability, and Floodplain Access: Stream profiles, as a measure of vertical stability and floodplain access will be evaluated by looking at Bank Height Ratios (BHR). In addition, observed bedforms should be consistent with those observed for channels of the design stream type(s). The BHR shall not exceed 1.2 along riffles within the restored Project stream reaches. This standard only applies to restored reaches of the channel where BHRs were corrected through design and construction. Vertical stability will be evaluated with visual assessment, cross sections and, if directed by the IRT, longitudinal profile.

Stream Horizontal Stability: Cross-sections will be used to evaluate horizontal stream stability on restored streams. There should be little change expected in as-built restoration cross-sections. If measurable changes do occur, they should be evaluated to determine if the changes represent a movement toward a more unstable condition (e.g., downcutting, erosion) or a movement towards increased stability (e.g., settling, vegetation establishment, deposition along the streambanks, decrease in width/depth ratio). Cross-sections shall be classified using the Rosgen Stream Classification method and all monitored cross-sections should fall within the quantitative parameters defined for channels of the design stream type.

Stream cross-section monitoring will be conducted using a Topcon Total Station. Three-dimensional coordinates associated with cross-section data will be collected in the field (NAD83 State Plane feet PIPS 3200). Morphological data will be collected at 12 cross-sections. Survey data will be imported into Microsoft Excel® and DMS Shiny App for data processing and analysis.

Reference photo transects will be taken at each permanent cross-section. Lateral photos should not indicate excessive erosion or continuing degradation of the streambanks. Photographs will be taken of both streambanks at each cross-section. A survey tape stretched between the permanent cross-section

monuments/pins will be centered in each of the streambank photographs. The water elevation will be shown in the lower edge of the frame, and as much of the streambank as possible will be included in each photo. Photographers will attempt to consistently maintain the same area in each photo over time.

Streambed Material Condition and Stability: Streambed material is expected to have minimal changes over time and any significant changes (e.g., aggradation, degradation, embeddedness) will be noted after streambank vegetation becomes established and a minimum of two bankfull flows or greater have been documented. If significant changes are observed within stable riffles and pools, additional sediment transport analyses may be required.

Jurisdictional Stream Flow: Monitoring of stream flow will be conducted to demonstrate that the restored stream systems classified as intermittent and/or ephemeral exhibit base flow for a minimum of 30 consecutive days throughout some portion of the year during a year with normal rainfall conditions. Stream flow monitoring will be accomplished with pressure transducers installed in pools and correlating sensor depth to the downstream top of riffle elevation (see appendix D for installation diagrams). If the pool water depth is at or above the top of riffle elevation, then the channel will be assumed to have surface flow. The devices will record water elevation twice per day and will be inspected quarterly to document surface hydrology and provide a basis for evaluating flow response to rainfall events.

2.2.2 Headwater Streams

Continuous Surface Flow: Continuous surface water flow within the valley or crenulation must be documented to occur every year for at least 30 consecutive days during the prescribed monitoring period. Additional monitoring maybe required if surface water flow cannot be documented due to abnormally dry conditions.

Channel Formation: During monitoring years 1 through 4, the preponderance of evidence must demonstrate a concentration of flow indicative of channel formation within the topographic low-point of the valley or crenulation as documented by the following indicators:

- Scour (indicating sediment transport by flowing water)
- Sediment deposition (accumulations of sediment and/or formation ripples)
- Sediment sorting (sediment sorting indicated by grain-size distribution with the primary path of flow)
- Multiple observed flow events (must be documented by gauge data and/or photographs)
- Destruction of terrestrial vegetation
- Presence of litter and debris
- Wracking (deposits of drift material indicating surface water flow)
- Vegetation matted down, bent, or absent (herbaceous or otherwise)
- Leaf litter disturbed or washed away

During monitoring years 5 through 7, the stream must successfully meet the requirements above and the preponderance of evidence must demonstrate the development of stream bed and banks as documented by the following indicators:

- Bed and banks (may include the formation of stream bed and banks, development of channel pattern such as meander bends and/or braiding at natural topographic breaks, woody debris, or plant root systems)

- Natural line impressed on the bank (visible high-water mark)
- Shelving (shelving of sediment depositions indicating transport)
- Water staining (staining of rooted vegetation)
- Change in plant community (transition to species adapted for flow or inundation for a long duration, including hydrophytes)
- Changes in character of soil (texture and/or chroma changes when compared to the soils abutting the primary path of flow).

2.2.3 Vegetation

Vegetation monitoring will occur in the fall each required monitoring year, prior to leaf drop. Plots will be monitored in years 1, 2, 3, 5, and 7. Vegetative success for the Project during the intermediate monitoring years will be based on the survival of at least 320, three-year-old planted trees per acre at the end of Year 3 of the monitoring period; and at least 260, five-year-old, planted trees per acre that must average seven feet in height at the end of Year 5 of the monitoring period. The final vegetative restoration success criteria will be achieving a density of no less than 210, seven-year-old planted stems per acre that must average ten feet in height in Year 7 of monitoring.

Vegetation success is being monitored at a total of five permanent vegetation plots and two random transects. Vegetation plot monitoring follows the CVS-EEP Level 2 Protocol for Recording Vegetation, version 4.2 (Lee et al. 2008) and includes analysis of species composition and density of planted species. Data are processed using the NCDMS Shiny App. For each fixed plot the origin was marked with a PVC pole and the other three corners were marked with rebar. For each random transect the ends of the transect and each tree was marked with flagging tape. Tree species and height will be recorded for each planted stem and photos of each plot are to be taken from the origin each monitoring year.

2.2.4 Visual Assessment

WLS will conduct visual assessments in support of mitigation performance monitoring. Visual assessments of all stream reaches will be conducted twice per monitoring year with at least five months in between each site visit for each of the seven years of monitoring. Photographs will be used to visually document system performance and any areas of concern related to streambank and bed stability, condition of in-stream structures, channel migration, active headcuts, live stake mortality, invasive plant species or animal browsing, easement boundary encroachments, and general streambed conditions. Permanent photo points will be at the cross-sections and culvert crossings.

3 Project Attributes

3.1 Design Approach

3.1.1 Stream

The Project stream design approach included a combination of stream restoration activities. Priority Level I, II and III restoration approaches were incorporated with the design of a single-thread meandering channel and headwater stream valley, with parameters based on reference site comparisons, published empirical relationships, NC Coastal Plain Regional Curves, and hydrologic and hydraulic analyses. All non-vegetated areas within the conservation easement were planted with native vegetation and any areas of invasive species were removed and/or treated.

- **MS1 –** Priority Level II/III Restoration

- **MS2 –** Priority Level I/II Restoration
- **MS3 –** Priority Level I Restoration
- **UT1 and UT2 –** Headwater Restoration

3.2 Project Attributes

See Table 3 below for Project Attributes.

Table 3. Project Attribute Table					
Project Name	Hornpipe Branch Tributaries Mitigation Project				
County	Lenoir				
Project Area (acres)	23.43				
Project Coordinates (latitude and longitude decimal degrees)	35.134242°, -77.655045°				
Project Watershed Summary Information					
Physiographic Province	Coastal Plain				
River Basin	Neuse River				
USGS Hydrologic Unit 8-	3020202				
DWR Sub-basin	3/4/2005				
Project Drainage Area (acres)	331				
Project Drainage Area Percentage of Impervious Area	2.00%				
Land Use Classification	2.01.03, 2.01.01, 3.02 (78% cultivated crops, 16% evergreen/mixed forest)				
Reach Summary Information					
Parameters	**Reach MS1**	**Reach MS2**	**Reach MS3**	**Reach UT1**	**Reach UT2**
Pre-project length (feet)	1,493	774	1,548	498	644
Post-project (feet)	1,468	940	1,521	677	562
Valley confinement (Confined, moderately confined, unconfined)	unconfined	unconfined	unconfined	unconfined	unconfined
Drainage area (acres)	183	222	331	46	32
Perennial, Intermittent, Ephemeral	Intermittent	Perennial	Perennial	Intermittent	Ephemeral
NCDWR Water Quality Classification	C, NSW	C, NSW	C, NSW	C, NSW	C, NSW
Dominant Stream Classification (existing)	N/A (channelized ditch)	N/A (channelized ditch)	F5	N/A (channelized ditch)	N/A (channelized ditch)
Dominant Stream Classification (proposed)	DA/E5	C5/E5	C5/E5	DA	DA
Dominant Evolutionary class (Simon) if applicable	IV	IV	III/IV	IV	IV
Regulatory Considerations					
Parameters	**Applicable?**	**Resolved?**	**Supporting Docs?**		
Water of the United States - Section 404	Yes	Yes	404 Permit		
Water of the United States - Section 401	Yes	Yes	401 Permit		
Endangered Species Act	Yes	Yes	Categorical Exclusion		
Historic Preservation Act	Yes	Yes	Categorical Exclusion		
Coastal Zone Management Act (CZMA or CAMA)	No	N/A	N/A		
Essential Fisheries Habitat	No	N/A	Categorical Exclusion		

4 Monitoring Year 3 Assessment and Results

4.1 Morphological Assessment

Morphological data for MY3 was collected in April 2023. Refer to Appendices A and C for summary data tables, morphological plots, and stream photographs.

4.1.1 Stream Horizontal Pattern & Longitudinal Profile

The MY3 stream channel pattern and longitudinal profiles closely match the design parameters. The MY3 plan form geometry or pattern fell within acceptable ranges of the design parameters for all restored reaches. Minor channel adjustments in riffle slopes, pool depths and pattern do not present a stability concern or indicate a need for remedial action and will be assessed visually during the annual assessments.

4.1.2 Stream Horizontal Dimension

The MY3 channel dimensions generally match the design parameters and are within acceptable and stable ranges of tolerance. Two of the 12 cross-sections are located in headwater restoration reaches and the remaining 10 cross-sections are located in Priority I/II single-thread restoration channels. All ten of the PI/PII cross-sections show little change in the bankfull area and all bank height ratios are less than 1.2. All cross-sections are stable. It is expected that over time some pools may accumulate fine sediment and organic matter, however, this is not an indicator of channel instability. Maximum riffle depths are also expected to fluctuate slightly throughout the monitoring period as the channels adjust.

One beaver dam was discovered during the summer quarterly site visit located above the culvert crossing on MS2. The dam was removed, and the USDA Beaver Management Assistance Program was contacted to trap the beaver. Trapping occurred during September and October of 2023, removing two beavers from the project site. During the November site visit and boundary walk with DMS, beaver activity was still present. This activity is affecting stream flow from approximately station 30+00 to the culvert located at 31+60 on MS2. WLS will remove the remnants of the dam in MY4 to restore stream flow through the affected area and work with the USDA if additional trapping is necessary. A small area of replanting will occur in the wetland area affected by the beaver to re-establish vegetation. Beaver maintenance and replanting will be documented in the MY4 report.

4.2 Stream Hydrology

4.2.1 Stream Flow

All three pressure transducers (flow gauges), installed in March 2021 on reaches MS1, UT1, and UT2, documented that the streams exhibited surface flow for a minimum of 30 consecutive days throughout the monitoring year (Appendix D). One additional flow gauge, FG-4, is located on a reference reach located 0.5 miles north of the project. During MY3, FG-1's pressure sensor malfunctioned resulting in inaccurate data from April 12th, 2023, to July 12th, 2023, a total of 92 days. The gauge was replaced with a new unit on July 12th. Additionally, to determine if rainfall amounts are normal for the given year, precipitation data was obtained from an onsite rain gauge.

Flow Gauge Data

Flow Gauge Name	Flow Gauge Location	Longest Period of Consecutive Flow	Total Days of Cumulative Flow	Total Days of Cumulative No Flow	Longest Period of Consecutive No Flow
*FG-1	MS1	102 days* 1/1/2023 – 4/12/2023	133 days	25 days	16 days
FG-2	UT1	102 days 1/22/2023 – 4/4/2022	139 days	111 days	51 days
FG-3	UT2	112 days 1/22/2023 – 5/13/2023	155 days	94 days	47 days
FG-4	Reference Reach	39 days 1/26/2023 – 3/5/2023	99 days	151 days	89 days

*FG-1's lost data is not included in any calculations of Flow or No Flow. However, it is expected that flow continued through the lost portion of data based off baseflow being present at CG-2 further down on MS-1.

4.2.2 Bankfull Events

During MY3, bankfull events were recorded on both pressure transducer crest gauges. CG-1 on MS-R3 recorded 10 events with a maximum event of 2.327' above bankfull on August 31st, 2023. CG-2 was installed on MS-1 on December 12th, 2021. CG-2 recorded 9 events with a maximum event of 2.113' above bankfull on September 6th, 2023. Associated data and photographs are located in Appendix D.

4.2.3 Headwater Stream Channel Formation

During MY3, streams UT1 and UT2 exhibited evidence indicative of channel formation within the topographic low-point of the valley (see table and photographs in appendix C). UT1 and UT2 both exhibited eight of the nine channel forming indicators during MY3.

4.3 Wetlands

Wetland mitigation credits are not contracted or proposed for this project. Two groundwater wells were installed in March 2021 in an existing jurisdictional wetland on MS-2 (GW-1) and adjacent to UT2 (GW-2) to monitor groundwater levels in the project. No performance standards for wetland hydrology success were proposed in the Mitigation Plan and therefore wetland mitigation monitoring is not included in the project. GW-1 had a consecutive hydroperiod of 61.5% and GW-2 had a consecutive hydroperiod of 10.62% of the growing season during MY3. Groundwater well locations are shown on the CCPVs, and the data is included in Appendix D.

4.4 Vegetation

Monitoring of the five permanent vegetation plots and two random transects was completed during September 2023. Vegetation data and photos can be found in Appendix B. The MY3 average planted density is 445 stems per acre, which exceeds the interim measure of vegetative success of at least 320 planted stems per acre at the end of the third monitoring year. Six of the seven vegetation plots are meeting the interim measure requirements and overall, the project has 283 - 607 stems per acre. Volunteer black willow (*Salix nigra*) and winged sumac (*Rhus copallinum*) was noted during MY3, but more species are expected to establish in upcoming years. Plot 3 did not meet success criteria for planted stems, with 7 total stems. This area experienced increased wetness due to beaver activity and a portion of the plot is within the low stem density area to be replanted in the dormant season prior to MY4. Only tree

species included in the approved mitigation plan will be utilized in replanting. Remedial action and replanting will be documented and included in MY4 reporting.

Visual assessment of vegetation outside of the monitoring plots indicates that the herbaceous vegetation is becoming well established throughout the project. One Low Stem Density Area totaling 0.11 acres is located in the existing wetland area on MS2. This area was affected by beaver in MY3 and will be replanted with wet-tolerant containerized trees in the dormant season. Remedial action will be documented in the MY4 report.

Two areas of minor landowner encroachment were identified during the DMS boundary inspection site visit in MY3. One area is located along the southern easement border of MS1 near STA 13+00 and is approximately 0.01 acres. The second area is along the easement at the beginning of the project on MS1 near STA 10+00 and is approximately 0.01 acres. Both encroachments are a result of mowing vegetation along the easement boundary due to farming activities. During MY4, the easement will be more clearly marked, and the upper encroachment will be replanted with appropriate stems from the approved mitigation plan. The landowner will also be contacted and notified of the encroachments and conservation easement rules to prevent further easement issues. All future actions will be documented in the MY4 report.

A significant population of privet (Ligustrum sinense) was located along MS3 and the wooded areas of UT1 and UT2 prior to construction. Construction activities included removing existing privet within the easement. Mechanical and herbicide treatments of privet along MS3 (~2.41 acres) were conducted during MY3 (see CCPV). Larger privet was cut and resprouts will be treated as needed. Smaller privet was foliar sprayed with 3% herbicide. Treatments are documented in the table below.

Invasive Species Treatment Table

Monitoring Year	Invasive Targeted	Invasive Treatment	Date Treatment Conducted	Herbicide Used
1	Privet	Foliar	5/5/2021	Rodeo (3%), Garlon 3A (3%)
	Privet	Foliar	5/19/2021	Rodeo (3%), Garlon 3A (3%)
	Privet	Foliar	6/1/2021	Garlon 3A (3%)
2	Privet	Cut	2/3/2022	N/A
	Privet	Cut	2/8/2022	N/A
	Privet	Cut	2/16/2022	N/A
	Privet	Cut	3/3/2022	N/A
	Privet	Foliar and cut-stump	4/19/2022	Rodeo (3%) and Garlon 3A (3%)
	Privet	Foliar	5/3/2022	Rodeo (3%)
3	Privet	Foliar	7/5-6/2023	Garlon & Rodeo (3%)

These areas will be closely monitored, and re-sprouts will be treated as needed to prevent further establishment. Any future treatments will be documented and included in subsequent monitoring reports.

4.5 Macrobenthic Sampling

One macrobenthic sampling location was surveyed prior to restoration activities on MS3. No benthics were collected pre-construction due to lack of habitat. MS3 was re-surveyed in MY3 on April 12, 2023. MS3 scored “Poor” and had a biotic index value of 7.72. The biotic score is expected to improve by MY7 as the stream habitat continues to develop. Benthic data is located in Appendix F.

Appendix A:
Visual Assessment Data

Visual Stream Morphology Stability Assessment Table
Vegetation Condition Assessment Table
Cross-Section Photos
Stream Photo Points (Culvert Crossings) Photos
Encroachment Areas and Additional Photos

Visual Stream Stability Assessment						
Reach		MS1				
Assessed Stream Length		1,468				
Assessed Bank Length		2,936.00				
Major Channel Category		**Metric**	**Number Stable, Performing as Intended**	**Total Number in As-built**	**Amount of Unstable Footage**	**% Stable, Performing as Intended**
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
				Totals	0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	12	12		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	4	4		100%

Visual Stream Stability Assessment						
Reach		MS2				
Assessed Stream Length		940				
Assessed Bank Length		1,880.00				
Major Channel Category		**Metric**	**Number Stable, Performing as Intended**	**Total Number in As-built**	**Amount of Unstable Footage**	**% Stable, Performing as Intended**
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
				Totals	0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	14	14		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	11	11		100%

Visual Stream Stability Assessment						
Reach		MS3				
Assessed Stream Length		1,521				
Assessed Bank Length		3,042.00				
Major Channel Category		**Metric**	**Number Stable, Performing as Intended**	**Total Number in As-built**	**Amount of Unstable Footage**	**% Stable, Performing as Intended**
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
				Totals	0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	17	17		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	16	16		100%

Visual Stream Stability Assessment						
Reach		UT1				
Assessed Stream Length		677				
Assessed Bank Length		1,354.00				
Major Channel Category		**Metric**	**Number Stable, Performing as Intended**	**Total Number in As-built**	**Amount of Unstable Footage**	**% Stable, Performing as Intended**
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
				Totals	0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	8	8		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	4	4		100%

Visual Stream Stability Assessment						
Reach		UT2				
Assessed Stream Length		562				
Assessed Bank Length		1,124.00				
Major Channel Category		**Metric**	**Number Stable, Performing as Intended**	**Total Number in As-built**	**Amount of Unstable Footage**	**% Stable, Performing as Intended**
Bank	**Surface Scour/Bare Bank**	Bank lacking vegetative cover resulting simply from poor growth and/or surface scour			0	100%
	Toe Erosion	Bank toe eroding to the extent that bank failure appears likely. Does NOT include undercuts that are modest, appear sustainable and are providing habitat.			0	100%
	Bank Failure	Fluvial and geotechnical - rotational, slumping, calving, or collapse			0	100%
				Totals	0	100%
Structure	**Grade Control**	Grade control structures exhibiting maintenance of grade across the sill.	8	8		100%
	Bank Protection	Bank erosion within the structures extent of influence does not exceed 15%. (See guidance for this table in DMS monitoring guidance document)	5	5		100%

Visual Vegetation Assessment				
Planted Acreage	**17.7**			
Vegetation Category	**Definitions**	**Mapping Threshold**	**Combined Acreage**	**% of Planted Acreage**
Bare Areas	Very limited cover of both woody and herbaceous material.	0.10 acres	0.00	0.0%
Low Stem Density Areas	Woody stem densities clearly below target levels based on current MY stem count criteria.	0.10acres	0.11	0.6%
	Total		0.11	0.6%
Areas of Poor Growth Rates	Planted areas where average height is not meeting current MY Performance Standard.	0.10 acres	0.00	0.0%
	Cumulative Total		0.11	0.6%
Easement Acreage	**23.43**			
Vegetation Category	**Definitions**	**Mapping Threshold**	**Combined Acreage**	**% of Easement Acreage**
Invasive Areas of Concern	Invasives may occur outside of planted areas and within the easement and will therefore be calculated against the total easement acreage. Include species with the potential to directly outcompete native, young, woody stems in the short-term or community structure for existing communities. Species included in summation above should be identified in report summary.	0.10 acres	2.41	10.3%
Easement Encroachment Areas	Encroachment may be point, line, or polygon. Encroachment to be mapped consists of any violation of restrictions specified in the conservation easement. Common encroachments are mowing, cattle access, vehicular access. Encroachment has no threshold value as will need to be addressed regardless of impact area.	none	0.02	

MS1, XS1, Upstream (MY-00)

MS1, XS1, Upstream (MY-03)

MS1, XS1, Downstream (MY-00)

MS1, XS1, Downstream (MY-03)

MS1, XS1, Left Bank (MY-00)

MS1, XS1, Left Bank (MY-03)

MS1, XS1, Right Bank (MY-00)

MS1, XS1, Right Bank (MY-03)

MS1, XS2, Upstream (MY-00)

MS1, XS2, Upstream (MY-03)

MS1, XS2, Downstream (MY-00)

MS1, XS2, Downstream (MY-03)

MS1, XS2, Left Bank (MY-00)

MS1, XS2, Left Bank (MY-03)

MS1, XS2, Right Bank (MY-00)

MS1, XS2, Right Bank (MY-03)

MS2, XS3, Upstream (MY-00)

MS2, XS3, Upstream (MY-03)

MS2, XS3, Downstream (MY-00)

MS2, XS3, Downstream (MY-03)

MS2, XS3, Left Bank (MY-00)

MS2, XS3, Left Bank (MY-03)

MS2, XS3, Right Bank (MY-00)

MS2, XS3, Right Bank (MY-03)

MS2, XS4, Upstream (MY-00)

MS2, XS4, Upstream (MY-03)

MS2, XS4, Downstream (MY-00)

MS2, XS4, Downstream (MY-03)

MS2, XS4, Left Bank (MY-00)

MS2, XS4, Left Bank (MY-03)

MS2, XS4, Right Bank (MY-00)

MS2, XS4, Right Bank (MY-03)

UT2, XS5, Upstream (MY-00)

UT2, XS5, Upstream (MY-03)

UT2, XS5, Downstream (MY-00)

UT2, XS5, Downstream (MY-03)

UT2, XS5, Left Bank (MY-00)

UT2, XS5, Left Bank (MY-03)

UT2, XS5, Right Bank (MY-00)

UT2, XS5, Right Bank (MY-03)

UT1, XS6, Upstream (MY-00)

UT1, XS6, Upstream (MY-03)

UT1, XS6, Downstream (MY-00)

UT1, XS6, Downstream (MY-03)

UT1, XS6, Left Bank (MY-00)

UT1, XS6, Left Bank (MY-03)

UT1, XS6, Right Bank (MY-00)

UT1, XS6, Right Bank (MY-03)

MS3, XS7, Upstream (MY-00)

MS3, XS7, Upstream (MY-03)

MS3, XS7, Downstream (MY-00)

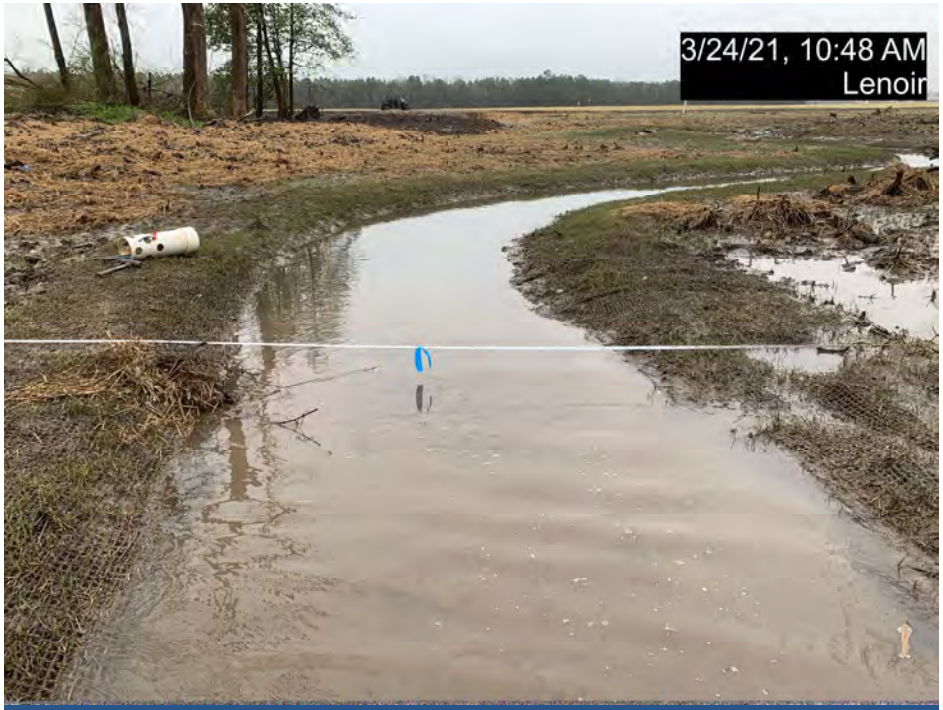
MS3, XS7, Downstream (MY-03)

MS3, XS7, Left Bank (MY-00)

MS3, XS7, Left Bank (MY-03)

MS3, XS7, Right Bank (MY-00)

MS3, XS7, Right Bank (MY-03)



MS3, XS8, Upstream (MY-00)

MS3, XS8, Upstream (MY-03)

MS3, XS8, Downstream (MY-00)

MS3, XS8, Downstream (MY-03)

MS3, XS8, Left Bank (MY-00)

MS3, XS8, Left Bank (MY-03)

MS3, XS8, Right Bank (MY-00)

MS3, XS8, Right Bank (MY-03)

MS3, XS9, Upstream (MY-00)

MS3, XS9, Upstream (MY-03)

MS3, XS9, Downstream (MY-00)

MS3, XS9, Downstream (MY-03)

MS3, XS9, Left Bank (MY-00)

MS3, XS9, Left Bank (MY-03)

MS3, XS9, Right Bank (MY-00)

MS3, XS9, Right Bank (MY-03)

MS3, XS10, Upstream (MY-00)

MS3, XS10, Upstream (MY-03)

MS3, XS10, Downstream (MY-00)

MS3, XS10, Downstream (MY-03)

MS3, XS10, Left Bank (MY-00)

MS3, XS10, Left Bank (MY-03)

MS3, XS10, Right Bank (MY-00)

MS3, XS10, Right Bank (MY-03)

MS3, XS11, Upstream (MY-00)

MS3, XS11, Upstream (MY-03)

MS3, XS11, Downstream (MY-00)

MS3, XS11, Downstream (MY-03)

MS3, XS11, Left Bank (MY-00)

MS3, XS11, Left Bank (MY-03)

MS3, XS11, Right Bank (MY-00)

MS3, XS11, Right Bank (MY-03)

MS3, XS12, Upstream (MY-00)

MS3, XS12, Upstream (MY-03)

MS3, XS12, Downstream (MY-00)

MS3, XS12, Downstream (MY-03)

MS3, XS12, Left Bank (MY-00)

MS3, XS12, Left Bank (MY-03)

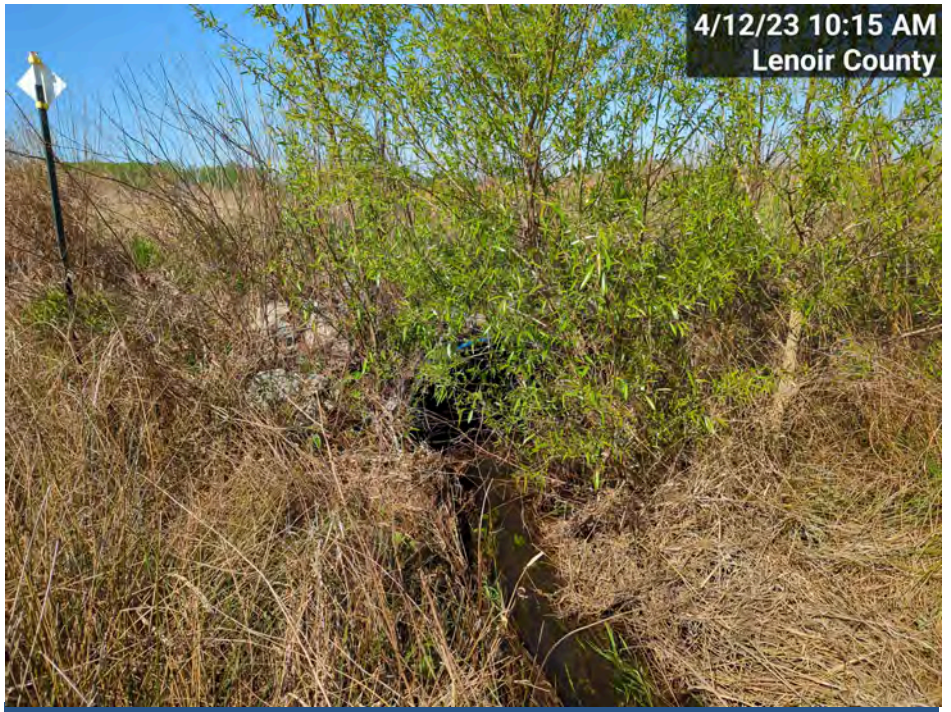
MS3, XS12, Right Bank (MY-00)

MS3, XS12, Right Bank (MY-03)

PS-1 – MS1, Culvert Crossing, Upstream (MY-00)

PS-1 – MS1, Culvert Crossing, Upstream (MY-03)

PS-1 – MS1, Culvert Crossing, Downstream (MY-00)



PS-1 – MS1, Culvert Crossing, Downstream (MY-03)

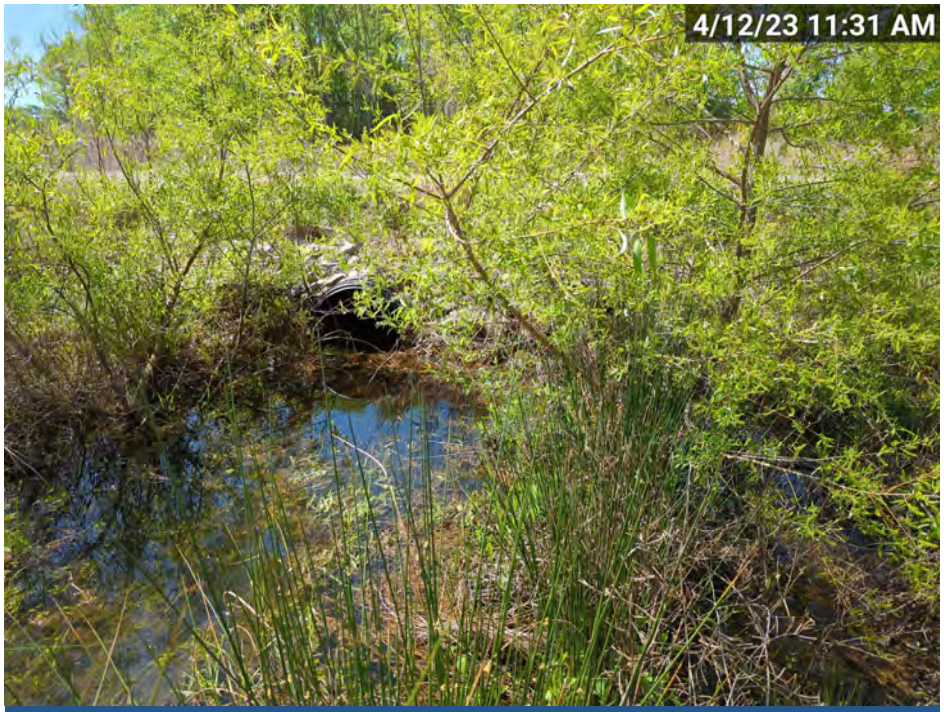
PS-1 – MS1, Culvert Crossing, Upstream Left (MY-03)

PS-1 – MS1, Culvert Crossing, Downstream Left(MY-03)

PS-2 – MS2, Culvert Crossing, Upstream (MY-00)

PS-2 – MS2, Culvert Crossing, Upstream (MY-03)

PS-2 – MS2, Culvert Crossing, Downstream (MY-00)



PS-2 – MS2, Culvert Crossing, Downstream (MY-03)

PS-2– MS2, Culvert Crossing, Upstream Left (MY-03)

PS-2– MS2, Culvert Crossing, Downstream Left(MY-03)

Encroachment Area 1, MS1, near STA 13+00 (MY-03)

Encroachment Area 2, MS1, near STA 10+00 (MY-03)

Appendix B:
Vegetation Plot Data

Vegetation Performance Standards Summary Table
Vegetation Plot Counts and Densities Table
Red-line Planting List
Vegetation Plot Photos

Vegetation Performance Standards Summary Table

	Veg Plot 1 F				Veg Plot 2 F				Veg Plot 3 F			
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3	486	4	5	0	486	5	5	0	283	4	3	0
Monitoring Year 2	445	3	5	0	486	3	5	0	405	3	4	0
Monitoring Year 1	364	2	5	0	405	2	5	0	445	2	4	0
Monitoring Year 0	526	1	5	0	607	1	7	0	769	1	7	0

	Veg Plot 4 F				Veg Plot 5 F				Veg Plot Group 1 R			
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives
Monitoring Year 7												
Monitoring Year 5												
Monitoring Year 3	607	3	7	0	324	5	6	0	445	5	7	0
Monitoring Year 2	526	2	7	0	486	3	8	0	364	3	4	0
Monitoring Year 1	607	2	6	0	445	2	7	0	567	2	5	0
Monitoring Year 0	648	1	7	0	607	2	10	0	607	2	8	0

	Veg Plot Group 2 R			
	Stems/Ac.	Av. Ht. (ft)	# Species	% Invasives
Monitoring Year 7				
Monitoring Year 5				
Monitoring Year 3	486	3	5	0
Monitoring Year 2	445	4	6	0
Monitoring Year 1	324	2	6	0
Monitoring Year 0	729	2	9	0

*Each monitoring year represents a different plot for the random vegetation plot "groups". Random plots are denoted with an R, and fixed plots with an F.

Vegetation Plot Counts and Densities Table	
Planted Acreage	17.7
Date of Initial Plant	2021-03-31
Date(s) of Supplemental Plant(s)	NA
Date(s) Mowing	2023-09-06
Date of Current Survey	2023-09-06
Plot size (ACRES)	0.0247

	Scientific Name	Common Name	Tree/Shrub	Indicator Status	Veg Plot 1 F		Veg Plot 2 F		Veg Plot 3 F		Veg Plot 4 F		Veg Plot 5 F		Veg Plot 6 R	Veg Plot 7 R
					Planted	Total	Planted	Total	Planted	Total	Planted	Total	Planted	Total	Total	Total
Species Included in Approved Mitigation Plan	Betula nigra	river birch	Tree	FACW	1	1	1	1	2	2			1	1	1	
	Carpinus caroliniana	American hornbeam	Tree	FAC			1	1								
	Fraxinus pennsylvanica	green ash	Tree	FACW			3	3					1	1	3	
	Liriodendron tulipifera	tuliptree	Tree	FACU			4	4								5
	Nyssa biflora	swamp tupelo	Tree	OBL							2	2				
	Persea borbonia	redbay	Tree	FACW											2	
	Persea palustris	swamp bay	Shrub	FACW							2	2				
	Platanus occidentalis	American sycamore	Tree	FACW	2	3					2	2	2	2	1	3
	Quercus alba	white oak	Tree	FACU	1	1					2	2	1	1	2	1
	Quercus bicolor	swamp white oak	Tree	FACW	1	1					2	2				
	Quercus michauxii	swamp chestnut oak	Tree	FACW					1	1	4	4	1	1	1	2
	Quercus phellos	willow oak	Tree	FACW	6	6	3	3	4	4	1	1	2	2	1	1
Sum	Performance Standard				11	12	12	12	7	7	15	15	8	8	11	12
Post Mitigation Plan Species	*Rhus copallinum*	*winged sumac*	*Tree*	*UPL*						*1*						
	Salix nigra	*black willow*	*Tree*	*OBL*						*2*						
Sum	Proposed Standard				11	12	12	12	7	7	15	15	8	8	11	12
Mitigation Plan Performance Standard	Current Year Stem Count					12		12		7		15		8	11	12
	Stems/Acre					486		486		283		607		324	445	486
	Species Count					5		5		3		7		6	7	5
	Dominant Species Composition (%)					50		33		40		27		25	27	42
	Average Plot Height (ft.)					4		5		4		3		5	5	3
	% Invasives					0		0		0		0		0	0	0
Post Mitigation Plan Performance Standard	Current Year Stem Count					12		12		7		15		8	11	12
	Stems/Acre					486		486		283		607		324	445	486
	Species Count					5		5		3		7		6	7	5
	Dominant Species Composition (%)					50		33		40		27		25	27	42
	Average Plot Height (ft.)					4		5		4		3		5	5	3
	% Invasives					0		0		0		0		0	0	0

1). Bolded species are proposed for the current monitoring year, italicized species are not approved, and a regular font indicates that the species has been approved.
2). The "Species Included in Approved Mitigation Plan" section contains only those species that were included in the original approved mitigation plan. The "Post Mitigation Plan Species" section includes species that are being proposed through a mitigation plan addendum for the current monitoring year (bolded) , species that have been approved in prior monitoring years through a mitigation plan addendum (regular font), and species that are not approved (italicized).
3). The "Mitigation Plan Performance Standard" section is derived only from stems included in the original mitigation plan, whereas the "Post Mitigation Plan Performance Standard" includes data from mitigation plan approved, post mitigation plan approved, and proposed stems.

Hornpipe Mitigation Project Red-line Planting List				
Species	**Common Name**	**Stems**	**% Planted**	**Mitigation Plan %**
Fraxinus pennsylvanica	Green Ash	700	5.56%	3%
Betula nigra	River birch	1800	14.29%	10%
Quercus michauxii	Swamp chestnut oak	700	5.56%	8%
Quercus bicolor	Swamp white oak	700	5.56%	8%
Platanus occidentalis	American sycamore	1700	13.49%	10%
Quercus nigra	Water Oak	1500	11.90%	8%
Liriodendron tulipifera	Tulip Poplar	1400	11.11%	10%
Quercus phellos	Willow Oak	1700	13.49%	8%
Nyssa biflora	Swamp black gum	700	5.56%	8%
Quercus alba	White Oak	600	4.76%	6%
~~***Clethra alnifolia***~~	~~Sweet pepperbush~~	~~0~~	~~0.00%~~	3%
Carpinus caroliniana	Ironwood	700	5.56%	3%
Persea palustris	Red bay	200	1.59%	3%
Ilex verticillata	Winterberry	200	1.59%	0%
~~***Eubotrys racemosus***~~	~~Swamp doghobble~~	~~0~~	~~0.00%~~	3%
~~***Magnolia virginiana***~~	~~Sweetbay magnolia~~	~~0~~	~~0.00%~~	3%
~~***Cyrilla racimiflora***~~	~~Titi~~	~~0~~	~~0.00%~~	3%
~~***Itea virginica***~~	~~Sweetspire~~	~~0~~	~~0.00%~~	3%
Total		**12,600**	**100%**	

* changes from mitigation plan in red

Riparian Buffer Live Stake Plantings – Streambanks (Proposed 2'- 3' Spacing @ Meander Bends and 6'- 8' Spacing @ Riffle Sections)			
Scientific Name	**Common Name**	**% Planting by Species**	**Wetland Tolerance**
Cephalanthus occidentalis	Buttonbush	20%	OBL
Salix sericea	Silky willow	30%	OBL
Salix nigra	Black willow	30%	OBL
Sambucus canadensis	Elderberry	20%	FACW-
Note: Final species selection may change due to refinement or availability at the time of planting. Species substitutions will be coordinated between WLS and planting contractor prior to the procurement of plant stock and documented in the as-built report.			

Fixed Veg Plot 1 (MY-00)

Fixed Veg Plot 1 (MY-03)

Fixed Veg Plot 2 (MY-00)

Fixed Veg Plot 2 (MY-03)

Fixed Veg Plot 3 (MY-00)

Fixed Veg Plot 3 (MY-03)

Fixed Veg Plot 4 (MY-00)

Fixed Veg Plot 4 (MY-03)

Fixed Veg Plot 5 (MY-00)

Fixed Veg Plot 5 (MY-03)

Random Veg Plot 6, Facing North (MY-03)

Random Veg Plot 6, Facing South (MY-03)

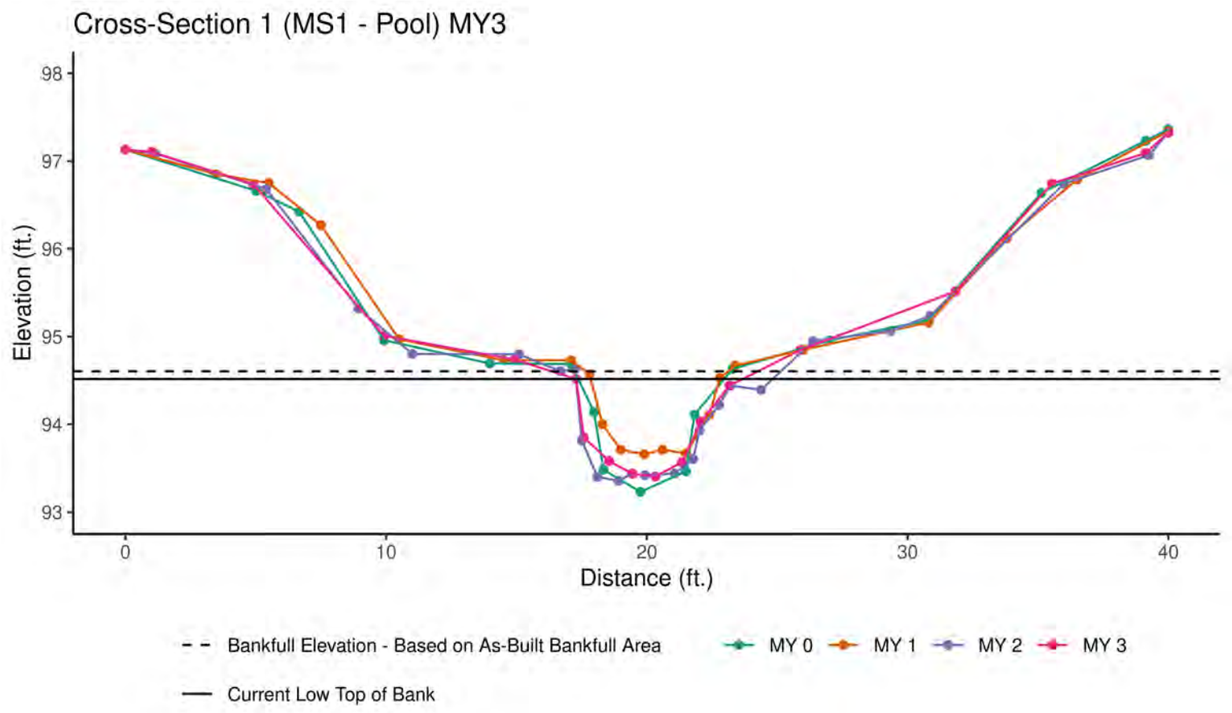
Random Veg Plot 7, Facing East (MY-03)

Random Veg Plot 7, Facing West (MY-03)

Appendix C:

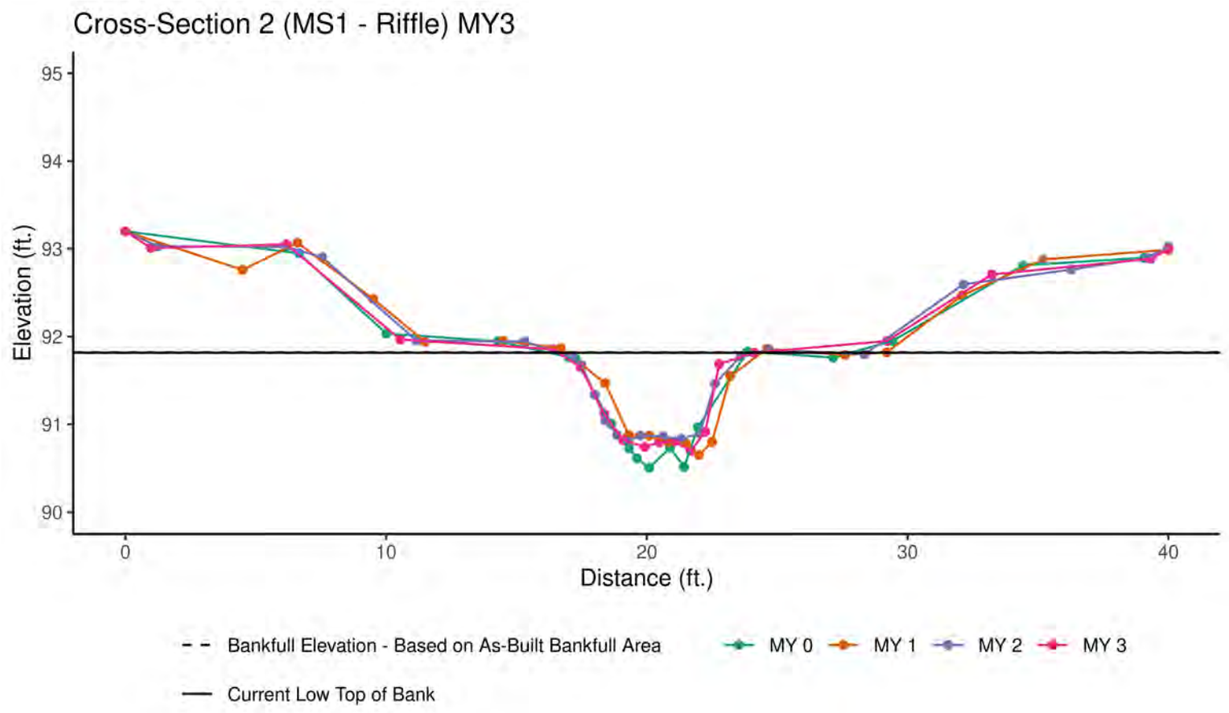
Stream Geomorphology Data

Cross-Sections with Annual Overlays
Baseline Stream Data Summary Tables
Cross-Section Morphology Data
Headwater Stream Channel Formation Table
Evidence of Headwater Channel Formation Photos



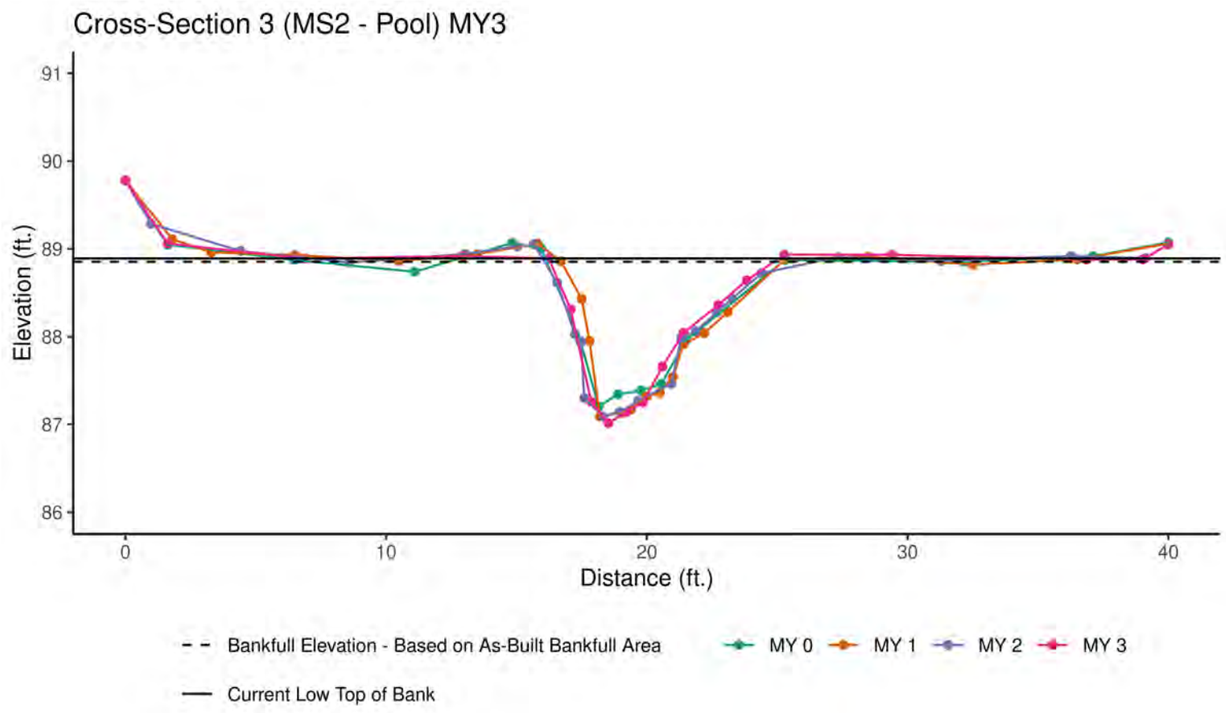
Distance	Elevation	Features
0	97.13	TLP
1.00728596	97.105	
4.90926003	96.737	
9.91295314	95.01	
14.9291972	94.738	
17.2897136	94.517	TLB, BKF
17.5836225	93.851	
18.5518013	93.581	
19.4525751	93.437	
20.3273745	93.405	THW
21.3410772	93.568	
22.0669786	94.027	
23.1675527	94.441	
25.8805483	94.846	TRB
31.8400614	95.516	
35.5332749	96.743	
39.1198754	97.091	
40	97.323	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	94.63	94.85	94.57	94.61				
Bank Height Ratio - Based on As-Built Bankfull Area	1.00	0.85	0.89	0.93				
Thalweg Elevation	93.23	93.66	93.42	93.41				
LTOB Elevation	94.63	94.67	94.44	94.52				
LTOB Max Depth	1.401	1.01	1.023	1.112				
LTOB Cross Sectional Area	5.20	4.13	4.43	4.64				



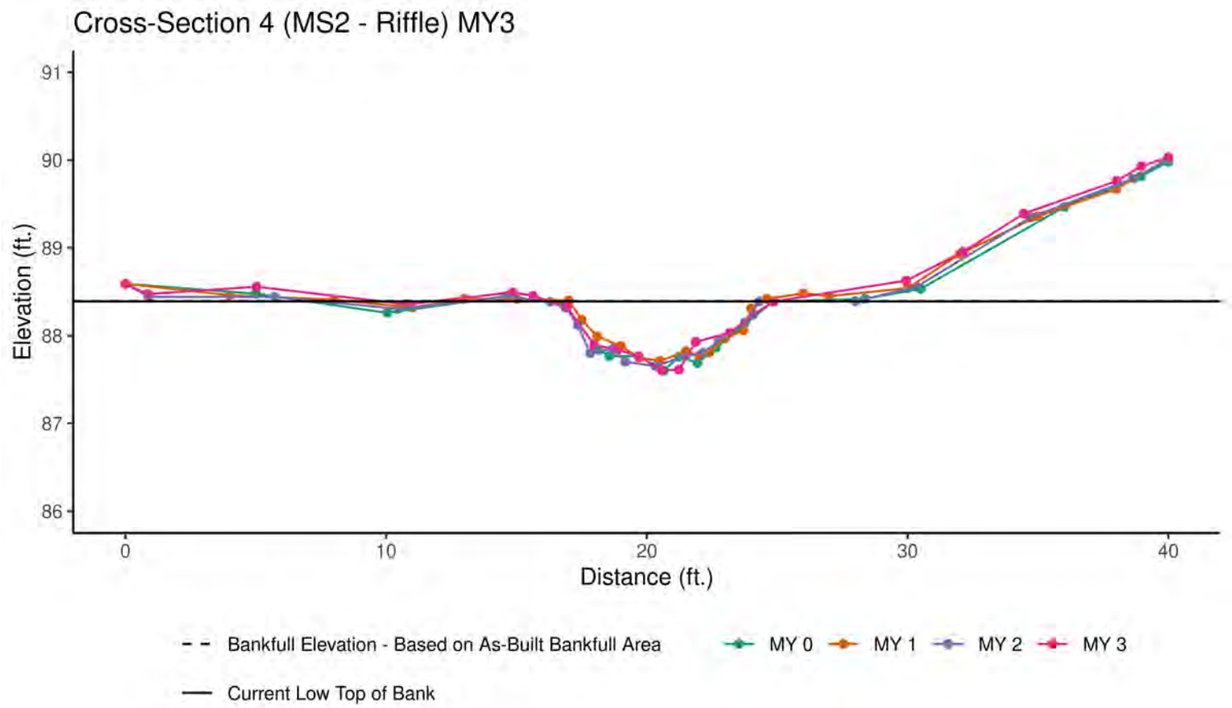
Distance	Elevation	Features
0	93.2	TLP
0.98051619	93.01	
6.181033	93.051	
10.5441383	91.967	
16.3665084	91.856	TLB, BKF
17.4654913	91.653	
18.3685489	91.118	
19.0930792	90.819	
19.9154704	90.743	
20.4759145	90.796	
21.0557184	90.806	
21.6796194	90.697	THW
22.2391962	90.915	
22.774637	91.686	
24.1097805	91.816	TRB
29.2110723	91.95	
33.2310439	92.708	
39.3260754	92.887	
40	92.996	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	91.75	91.82	91.85	91.82				
Bank Height Ratio - Based on As-Built Bankfull Area	1.00	1.03	1.00	1.00				
Thalweg Elevation	90.51	90.65	90.80	90.70				
LTOB Elevation	91.75	91.86	91.85	91.82				
LTOB Max Depth	1.245	1.21	1.048	1.119				
LTOB Cross Sectional Area	4.72	5.03	4.74	4.69				



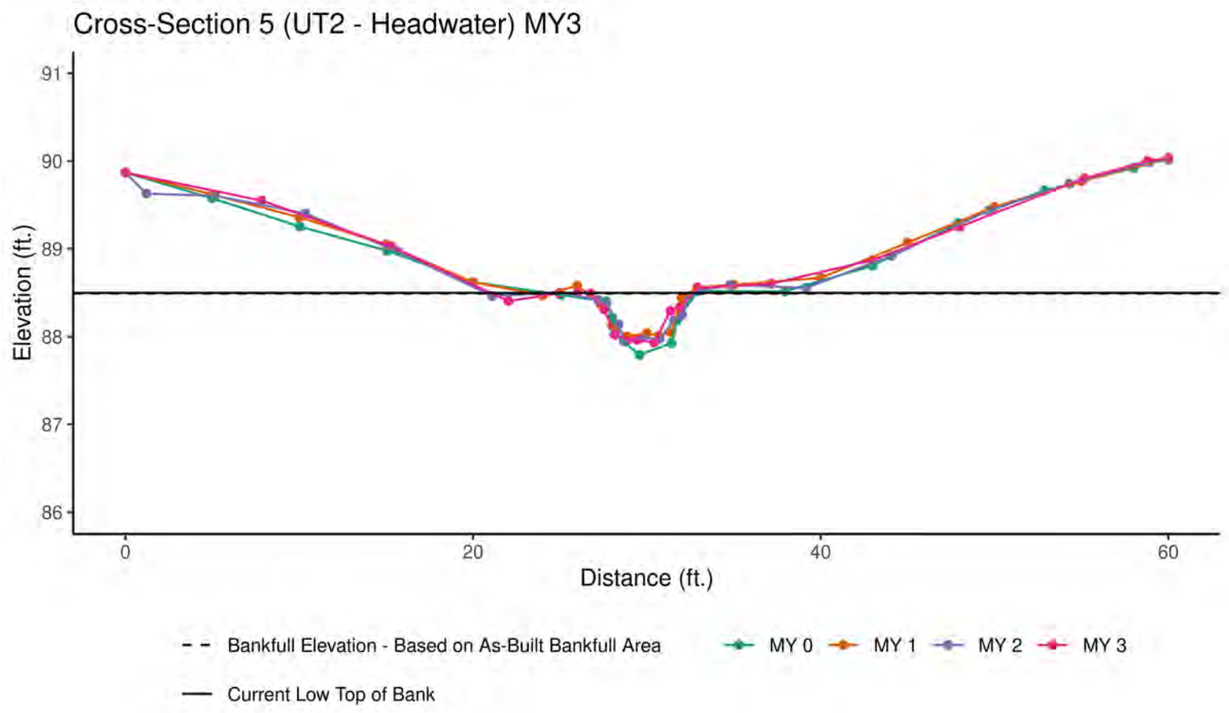
Distance	Elevation	Features
0	89.78	TLP
1.62339921	89.061	
6.87894185	88.889	
12.9483731	88.918	
16.2344765	88.89	TLB, BKF
17.0778401	88.31	
17.8668707	87.257	
18.522995	87.013	THW
19.1855537	87.134	
19.8475082	87.251	
20.5966906	87.657	
21.4056065	88.042	
22.7385251	88.36	
23.8318918	88.641	
25.2712279	88.933	TRB
29.4037762	88.932	
36.8604291	88.878	
39.0147926	88.879	
40	89.049	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	88.87	88.84	88.79	88.85				
Bank Height Ratio - Based on As-Built Bankfull Area	1.00	1.02	0.96	1.02				
Thalweg Elevation	87.34	87.09	87.09	87.01				
LTOB Elevation	88.87	88.88	88.72	88.89				
LTOB Max Depth	1.529	1.79	1.632	1.877				
LTOB Cross Sectional Area	7.68	8.01	7.12	8.01				



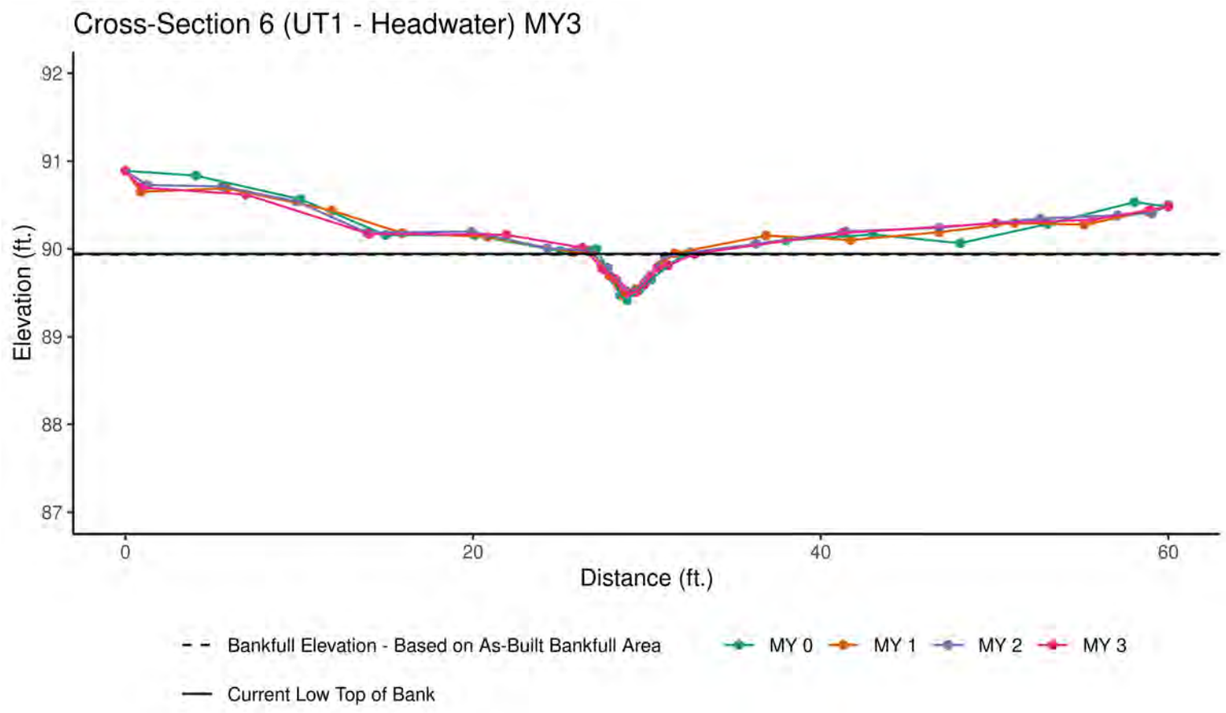
Distance	Elevation	Features
0	88.59	TLP
0.84607151	88.473	
5.02918731	88.556	
10.7864734	88.357	
14.8611713	88.493	
15.6316802	88.452	TLB
16.9335805	88.329	
17.9809322	87.894	
18.8769609	87.84	
19.6759572	87.764	
20.5700892	87.606	THW
21.2313463	87.611	
21.8776974	87.929	
23.185129	88.033	
24.0641209	88.237	
24.870131	88.39	TRB, BKF
29.9414951	88.626	
32.1355269	88.955	
34.4579146	89.39	
38.021443	89.763	
38.9610532	89.93	
40	90.032	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	88.35	88.43	88.37	88.39				
Bank Height Ratio - Based on As-Built Bankfull Area	1.00	0.97	0.93	1.00				
Thalweg Elevation	87.60	87.71	87.65	87.61				
LTOB Elevation	88.35	88.40	88.32	88.39				
LTOB Max Depth	0.755	0.69	0.665	0.784				
LTOB Cross Sectional Area	3.64	3.45	3.27	3.62				



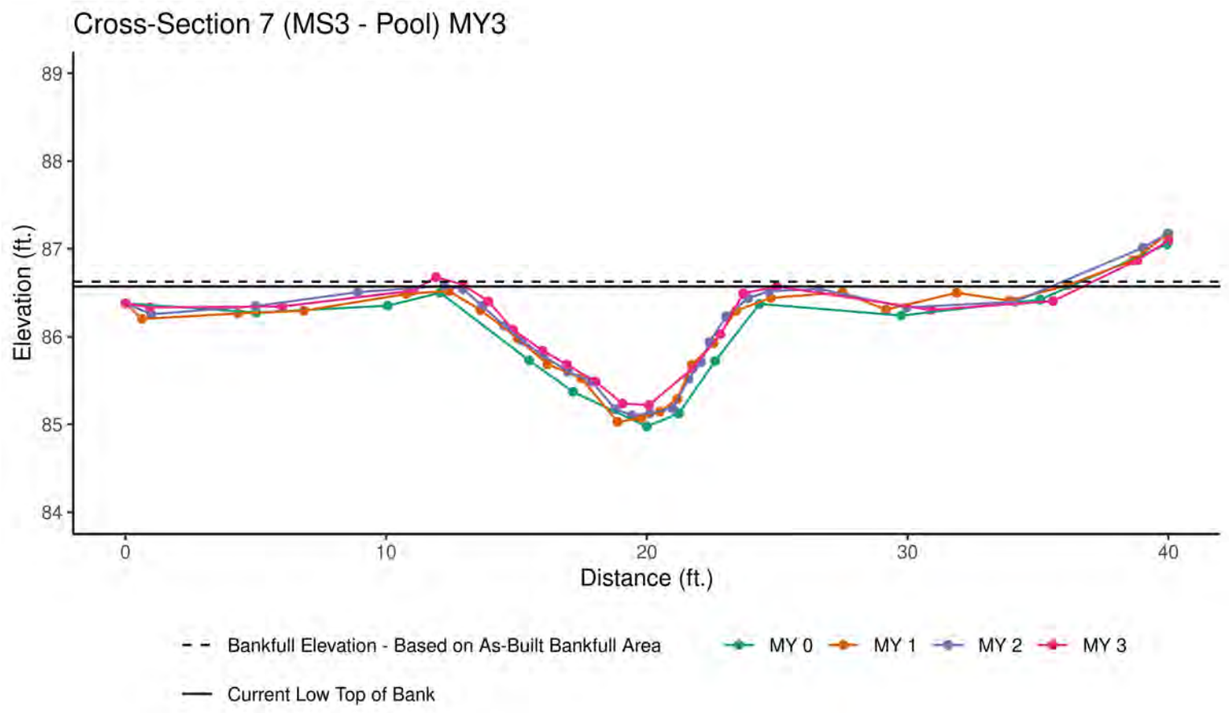
Distance	Elevation	Features
0	89.87	TLP
7.81805379	89.551	
15.2950021	89.028	
22.0371678	88.405	
24.9591252	88.495	
25.9972816	88.498	TLB
26.7608072	88.493	
27.5391162	88.312	
28.1630618	88.021	
28.905923	87.964	
29.4455502	87.962	
30.4099913	87.933	THW
31.3542236	88.291	
31.8944213	88.334	
32.9525901	88.553	TRB, BKF
37.1452518	88.603	
42.987824	88.872	
47.99112	89.251	
55.1691417	89.804	
58.8027736	90.002	
60	90.037	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	88.40	88.50	88.49	88.49				
Bank Height Ratio - Based on As-Built Bankfull Area	1.00	1.12	0.93	1.01				
Thalweg Elevation	87.79	88.00	87.95	87.93				
LTOB Elevation	88.40	88.56	88.45	88.50				
LTOB Max Depth	0.609	0.56	0.504	0.565				
LTOB Cross Sectional Area	1.96	2.35	1.73	2.01				



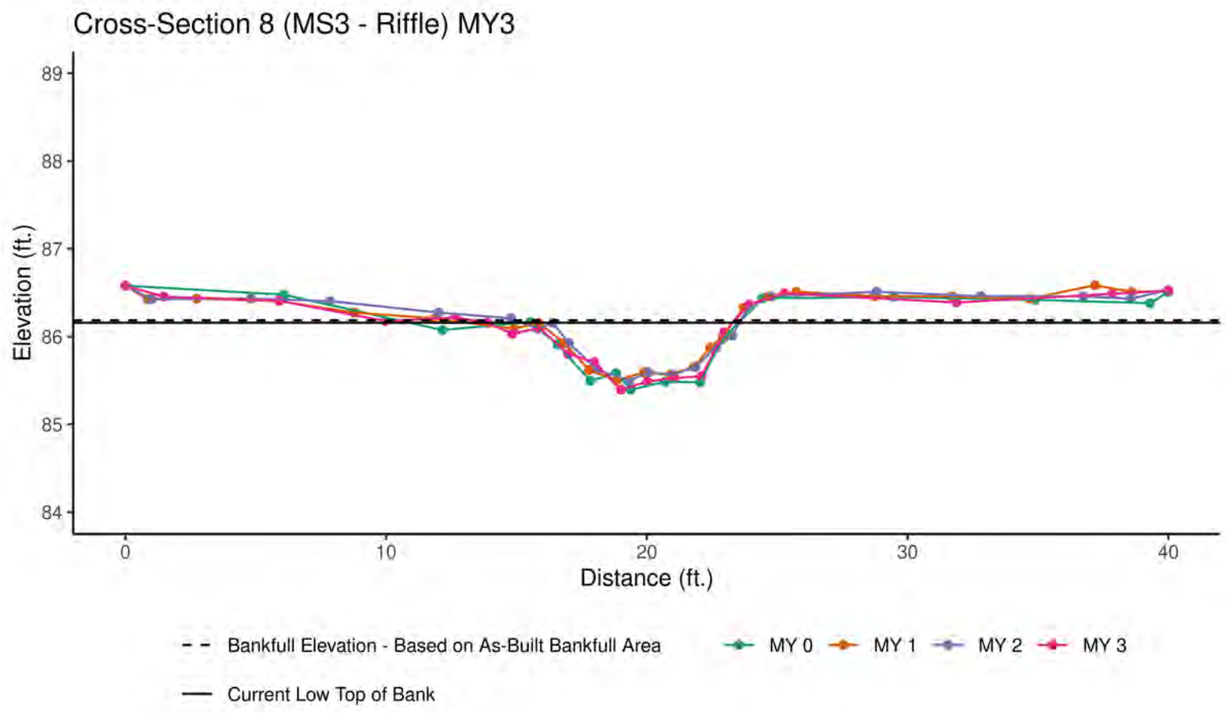
Distance	Elevation	Features
0	90.89	TLP
0.92939765	90.698	
6.9220744	90.62	
14.0287494	90.171	
21.9114886	90.16	
26.2989664	90.014	TLB
27.457377	89.772	
28.1704331	89.656	
28.5272962	89.553	
28.9693655	89.491	THW
29.3739754	89.507	
29.827946	89.591	
30.2170252	89.69	
30.6046758	89.783	
31.223154	89.811	
32.7555523	89.944	TRB, BKF
41.2023808	90.18	
50.0552364	90.292	
55.6131059	90.331	
58.9671744	90.443	
60	90.483	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	89.93	89.96	89.98	89.93				
Bank Height Ratio - Based on As-Built Bankfull Area	1.00	0.98	0.95	1.02				
Thalweg Elevation	89.42	89.47	89.52	89.49				
LTOB Elevation	89.93	89.95	89.96	89.94				
LTOB Max Depth	0.511	0.477	0.437	0.453				
LTOB Cross Sectional Area	1.23	1.19	1.10	1.29				



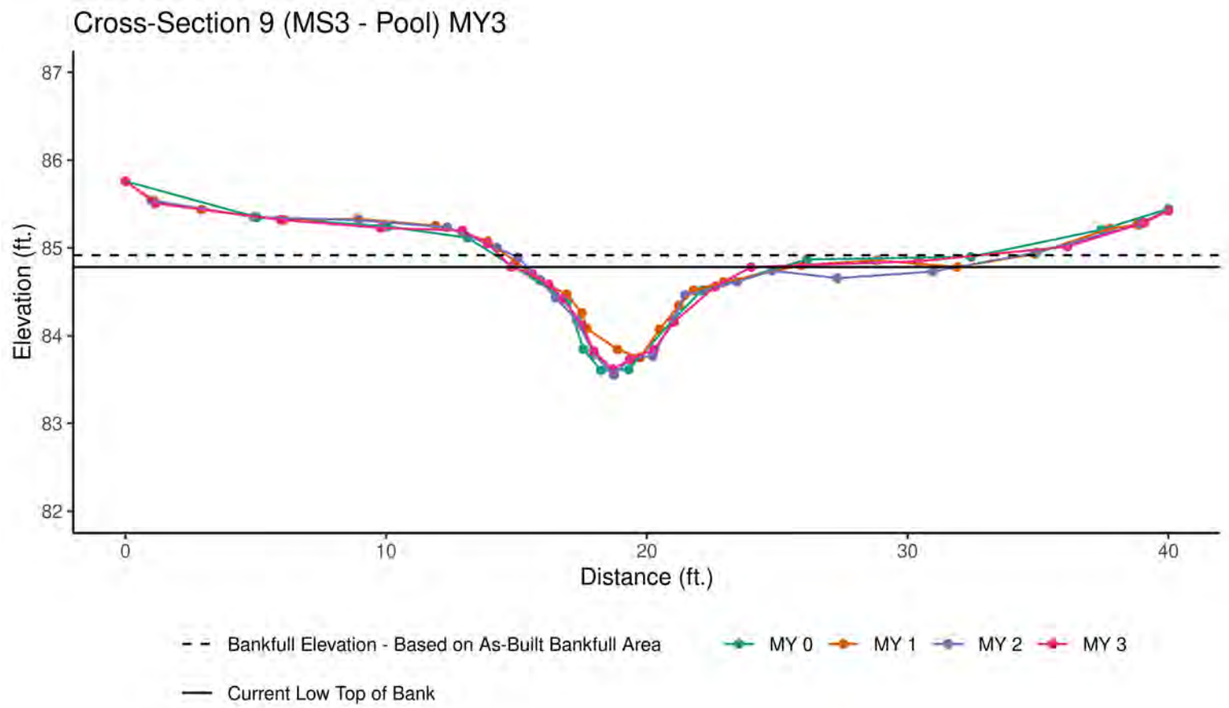
Distance	Elevation	Features
0	86.38	TLP
0.92833022	86.333	
6.0177087	86.343	
11.0428129	86.524	
11.9106112	86.677	
12.9380472	86.593	TLB
13.9283882	86.401	
14.8642499	86.079	
16.0011807	85.839	
16.9301562	85.682	
18.0290735	85.489	
19.0623543	85.237	
20.0778195	85.22	THW
21.7521973	85.637	
22.818733	86.027	
23.7017493	86.493	
24.9784511	86.571	TRB, BKF
30.8893229	86.305	
35.573642	86.405	
38.8167175	86.872	
40	87.095	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	86.37	86.51	86.56	86.63				
Bank Height Ratio - Based on As-Built Bankfull Area	1.00	0.95	0.97	0.96				
Thalweg Elevation	84.98	85.03	85.10	85.22				
LTOB Elevation	86.37	86.44	86.52	86.57				
LTOB Max Depth	1.398	1.413	1.414	1.351				
LTOB Cross Sectional Area	9.20	8.37	8.75	8.55				



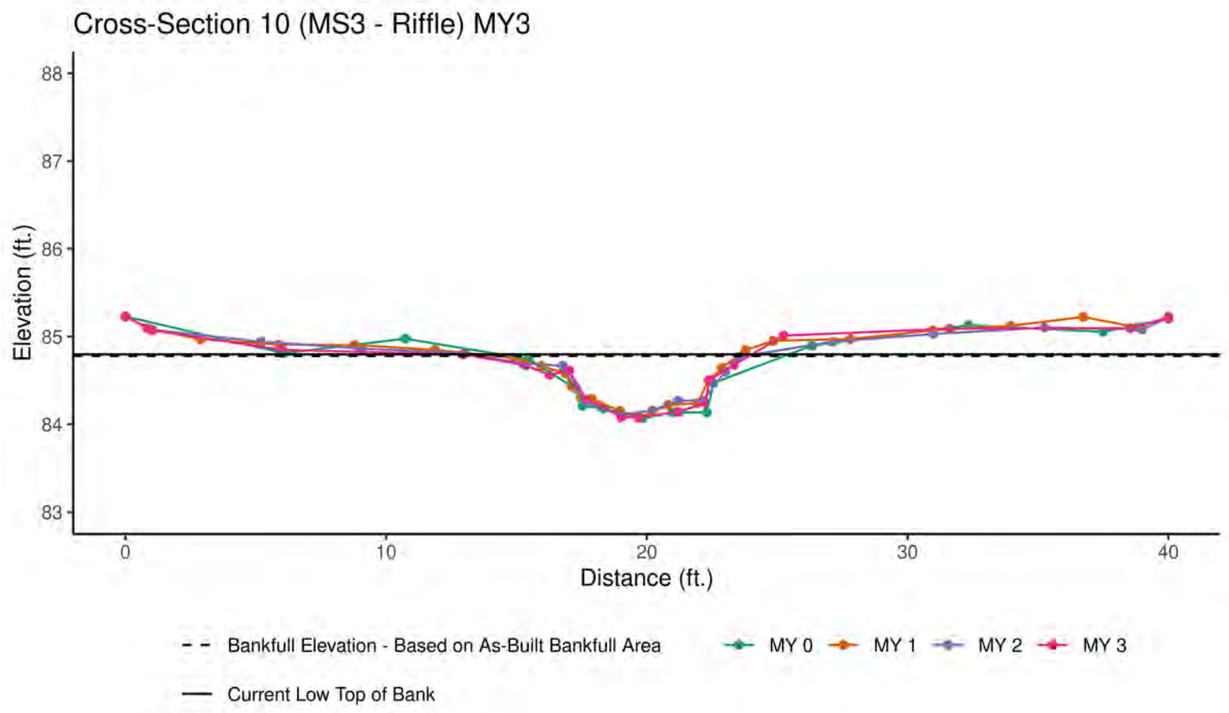
Distance	Elevation	Features
0	86.58	TLP
1.47032309	86.455	
5.88345655	86.41	
9.97414483	86.177	
12.6651745	86.218	
13.8921092	86.158	TLB, BKF
14.8371604	86.031	
15.8902816	86.099	
16.9808778	85.801	
17.9811079	85.709	
19.00604	85.394	THW
20.0148663	85.487	
21.0448253	85.528	
22.0892997	85.548	
22.9671623	86.048	
23.9179663	86.365	TRB
25.2711498	86.493	
31.8705723	86.389	
37.8441143	86.487	
40	86.524	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	86.17	86.27	86.28	86.19				
Bank Height Ratio - Based on As-Built Bankfull Area	1.00	0.85	0.84	0.96				
Thalweg Elevation	85.40	85.50	85.50	85.39				
LTOB Elevation	86.17	86.16	86.16	86.16				
LTOB Max Depth	0.773	0.655	0.655	0.764				
LTOB Cross Sectional Area	4.04	3.20	3.14	3.78				



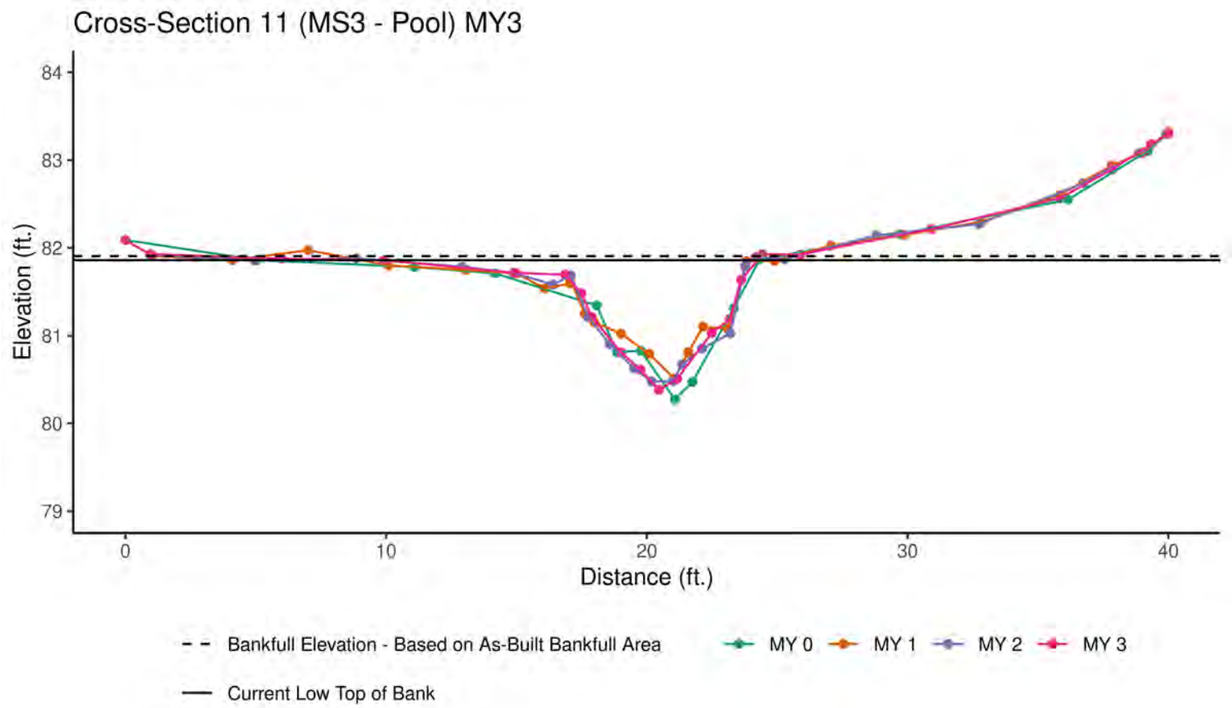
Distance	Elevation	Features
0	85.76	TLP
1.15420146	85.507	
5.95411538	85.319	
9.78471998	85.228	
12.9241549	85.198	TLB
13.8879122	85.052	
14.800438	84.782	
15.6023072	84.704	
16.2399621	84.583	
16.7890186	84.421	
17.5418159	84.111	
17.9597624	83.824	
18.6873888	83.615	THW
19.3603562	83.73	
20.2768396	83.842	
21.0407525	84.156	
22.6298513	84.559	
23.9962305	84.781	TRB, BKF
30.4144137	84.847	
36.1343495	85.014	
39.0721075	85.287	
40	85.422	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	84.87	84.93	84.90	84.92				
Bank Height Ratio - Based on As-Built Bankfull Area	1.00	0.94	0.88	0.90				
Thalweg Elevation	83.60	83.75	83.55	83.62				
LTOB Elevation	84.87	84.86	84.74	84.78				
LTOB Max Depth	1.265	1.107	1.188	1.166				
LTOB Cross Sectional Area	6.09	5.12	4.63	4.85				



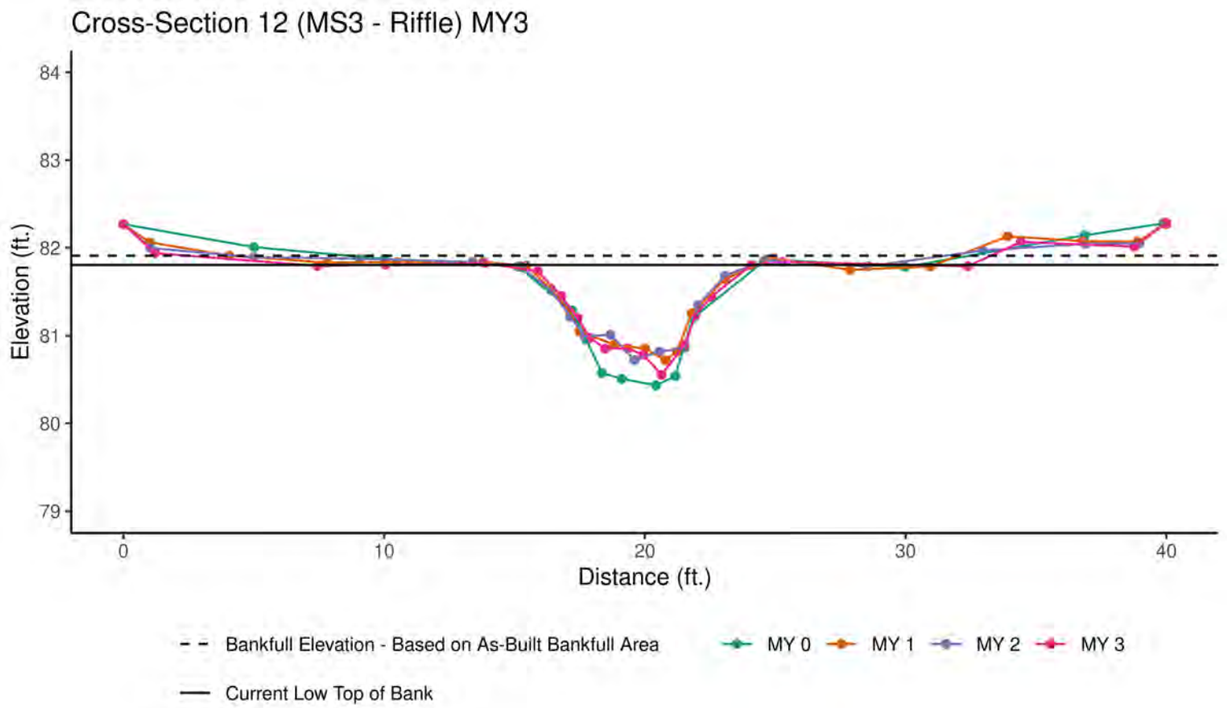
Distance	Elevation	Features
0	85.23	TLP
1.0306333	85.072	
6.01486243	84.848	
12.9393243	84.797	TLB, BKF
15.3394968	84.675	
16.2605625	84.563	
17.0232319	84.614	
17.658921	84.281	
18.1978978	84.211	
19.015964	84.082	
19.6579731	84.079	THW
21.2215403	84.142	
22.2412394	84.245	
22.400657	84.506	
23.3444156	84.677	
25.2362009	85.011	TRB
31.6093342	85.09	
38.5305588	85.097	
40	85.21	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	84.74	84.83	84.81	84.78				
Bank Height Ratio - Based on As-Built Bankfull Area	1.00	0.91	0.94	1.03				
Thalweg Elevation	84.07	84.07	84.11	84.08				
LTOB Elevation	84.74	84.76	84.77	84.80				
LTOB Max Depth	0.674	0.686	0.655	0.718				
LTOB Cross Sectional Area	3.77	3.18	3.36	3.97				



Distance	Elevation	Features
0	82.09	TLP
0.9358424	81.929	
5.99973541	81.876	
9.91627879	81.86	TLB, BKF
14.9487883	81.715	
16.8729901	81.694	
17.491771	81.482	
17.8880047	81.212	
19.0187546	80.807	
19.7547407	80.611	
20.4639801	80.383	
21.1594633	80.506	
22.4863203	81.029	THW
23.1842871	81.191	
23.6178707	81.633	
24.4330612	81.926	
25.8749222	81.924	TRB
30.9095059	82.214	
35.8328861	82.565	
37.8444575	82.895	
39.3393859	83.181	
40	83.301	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	81.71	81.83	81.77	81.91				
Bank Height Ratio - Based on As-Built Bankfull Area	1.00	0.91	0.94	0.95				
Thalweg Elevation	80.27	80.51	80.48	81.03				
LTOB Elevation	81.71	81.71	81.69	81.86				
LTOB Max Depth	1.437	1.196	1.211	0.831				
LTOB Cross Sectional Area	5.88	4.84	5.37	5.23				



Distance	Elevation	Features
0	82.27	TLP
1.21421003	81.94	
7.44568257	81.794	
10.0505348	81.809	
13.8631413	81.827	TLB, BKF
15.8893878	81.733	
16.795879	81.452	
17.4230318	81.198	
17.8943135	80.975	
18.484224	80.85	
19.3454406	80.853	
19.9441639	80.781	
20.638293	80.552	THW
21.5189306	80.896	
21.941375	81.234	
22.5480563	81.443	
24.0905149	81.805	TRB
25.297086	81.841	
32.3840046	81.79	
34.418225	82.068	
38.7582966	82.014	
40	82.283	TRP

	MY0	MY1	MY2	MY3	MY4	MY5	MY6	MY7
Bankfull Elevation - Based on As-Built Bankfull Area	81.79	81.93	81.95	81.91				
Bank Height Ratio - Based on As-Built Bankfull Area	1.00	0.92	0.87	0.92				
Thalweg Elevation	80.43	80.72	80.72	80.55				
LTOB Elevation	81.79	81.84	81.79	81.81				
LTOB Max Depth	1.354	1.121	1.064	1.253				
LTOB Cross Sectional Area	6.47	5.46	5.04	5.44				

Table7a: Baseline Stream Data Summary Hornpipe, MS1											Hornpipe, MS2										Hornpipe, MS3									
Parameter	Pre-Existing Condition (3/14/2018)					Design		MY0 (3/24/2021)			Pre-Existing Condition (3/14/2018)					Design		MY0 (3/24/2021)			Pre-Existing Condition (3/14/2018)					Design		MY0 (3/24/2021)		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)		4.2			1		6.9		6.4	1		4.5			1		7.5		7.9	1		8.4			1		8.4	8.0	9.5	3
Floodprone Width (ft)		9.0			1	15.0	30.0		34.5	1		8.7			1	29.0	47.0		33.9	1		8.8			1	19.0	30.0	40.0	40.0	3
Bankfull Mean Depth (ft)		0.9			1		0.5		0.7	1		1.0			1		0.6		0.5	1		0.7			1		0.6	0.4	0.7	3
Bankfull Max Depth (ft)		1.2			1		0.7		1.2	1		1.3			1		0.8		0.8	1		0.8			1		0.9	0.7	1.3	3
Bankfull Cross Sectional Area (ft^2)		3.8			1		3.7		4.7	1		4.4			1		4.3		3.6	1		5.5			1		5.4	3.8	6.5	3
Width/Depth Ratio		4.7			1		13.0		8.8	1		4.5			1		13.0		17.1	1		12.7			1		13.0	13.0	24.0	3
Entrenchment Ratio		2.1			1	2.2	4.3		5.4	1		2.0			1	3.9	6.3		4.3	1		1.1			1	2.3	3.6	4.2	5.0	3
Bank Height Ratio		2.6			1	1.0	1.1		1.0	1		2.2			1	1.0	1.1		1.0	1		4.8			1	1.0	1.1	1.0	1.0	3
Max part size (mm) mobilized at Bankfull	14.0					10.0		12.0			13.0					8.0		6.0			10.0					9.0		8.0		
Rosgen Classification	Channelized					DA/E5		E5			Channelized					E5/C5		C5			F5					E5/C5		C5		
Bankfull Discharge (cfs)	4.0					4.0		4.0			4.5					4.5		4.5			6.6					6.6		6.6		
Sinuosity (ft)	1.01					1.02		1.02			1.01					1.11		1.10			1.02					1.18		1.16		
Water Surface Slope (Channel) (ft/ft)	0.005					0.0049		0.0044			0.0041					0.0037		0.0033			0.004					0.0044		0.0042		
Other																														

Table7a: Baseline Stream Data Summary Hornpipe, UT1 (HW)											Hornpipe, UT2 (HW)									
Parameter	Pre-Existing Condition (3/14/2018)					Design		MY0 (3/24/2021)			Pre-Existing Condition (3/14/2018)					Design		MY0 (3/24/2021)		
Riffle Only	Min	Mean	Med	Max	n	Min	Max	Min	Max	n	Min	Mean	Med	Max	n	Min	Max	Min	Max	n
Bankfull Width (ft)		4.3			1		4.4		4.7	1		2.7			1		4.4		4.8	1
Floodprone Width (ft)		6.9			1	15.0	30.0		44.5	1		4.4			1	15.0	30.0		30.5	1
Bankfull Mean Depth (ft)		0.4			1		0.3		0.3	1		0.4			1		0.3		0.4	1
Bankfull Max Depth (ft)		1.0			1		0.3		0.5	1		0.6			1		0.3		0.6	1
Bankfull Cross Sectional Area (ft^2)		1.6			1		1.2		1.2	1		1.1			1		1.2		2.0	1
Width/Depth Ratio		11.5			1		16.0		18.2	1		6.8			1		16.0		11.9	1
Entrenchment Ratio		1.6			1	3.4	6.8		9.4	1		1.6			1	3.4	6.8		6.3	1
Bank Height Ratio		3.3			1	1.0	1.1		1.0	1		4.7			1	1.0	1.1		1.0	1
Max part size (mm) mobilized at Bankfull	9.0					6.0		6.0			9.0					7.0		10.0		
Rosgen Classification	Channelized					DA		DA			Channelized					DA		DA		
Bankfull Discharge (cfs)	1.4					1.4		1.4			1.2					1.2		1.2		
Sinuosity (ft)	1.06					1.09		1.09			1.06					1.07		1.05		
Water Surface Slope (Channel) (ft/ft)	0.0065					0.0062		0.0063			0.0067					0.0065		0.0062		
Other																				

Monitoring Data - Cross-Section Morphology Monitoring Summary

Hornpipe Branch Tributaries/DMS:100076 Segment/Reach: MS1, MS2, MS3, UT1, UT2 (Data Collected 7/11/2022)

	Cross-Section 1 (Pool - MS1)							Cross-Section 2 (Riffle - MS1)							Cross-Section 3 (Pool - MS2)							Cross-Section 4 (Riffle - MS2)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	94.63	94.85	94.57	94.61				91.75	91.82	91.85	91.82				88.87	88.84	88.79	88.85				88.35	88.43	88.37	88.39			
Bank Height Ratio_Based on AB Bankfull[1] Area	N/A	N/A	N/A	N/A				1.00	1.03	1.00	1.00				N/A	N/A	N/A	N/A				1.00	0.97	0.93	1.00			
Thalweg Elevation	93.23	93.66	93.42	93.41				90.51	90.65	90.80	90.70				87.34	87.09	87.09	87.01				87.60	87.71	87.65	87.61			
LTOB[2] Elevation	94.63	94.67	94.44	94.52				91.75	91.86	91.85	91.82				88.87	88.88	88.72	88.89				88.35	88.40	88.32	88.39			
LTOB[2] Max Depth (ft)	1.40	1.01	1.02	1.11				1.25	1.21	1.05	1.12				1.53	1.79	1.63	1.88				0.75	0.69	0.67	0.78			
LTOB2 Cross-Sectional Area (ft2)	5.20	4.13	4.43	4.64				4.72	5.03	4.74	4.69				7.68	8.01	7.12	8.01				3.64	3.45	3.27	3.62			

	Cross-Section 5 (Headwater - UT2)							Cross-Section 6 (Headwater UT1)							Cross-Section 7 (Pool - MS3)							Cross-Section 8 (Riffle - MS3)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	88.40	88.50	88.49	88.49				89.93	89.96	98.98	89.93				86.37	86.51	86.56	86.63				86.17	86.27	86.28	86.19			
Bank Height Ratio_Based on AB Bankfull[1] Area	1.00	1.12	0.93	1.01				1.00	0.98	0.95	1.02				N/A	N/A	N/A	N/A				1.00	0.85	0.84	0.96			
Thalweg Elevation	87.79	88.00	87.95	87.93				89.42	89.47	98.52	89.49				84.98	85.03	85.10	85.22				85.40	85.50	85.50	85.39			
LTOB[2] Elevation	88.40	88.56	88.45	88.50				89.93	89.95	89.96	89.94				86.37	86.44	86.52	86.57				86.17	86.16	86.16	86.16			
LTOB[2] Max Depth (ft)	0.61	0.56	0.50	0.56				0.51	0.48	0.44	0.45				1.40	1.41	1.41	1.35				0.77	0.66	0.66	0.76			
LTOB2 Cross-Sectional Area (ft2)	1.96	2.35	1.73	2.01				1.23	1.19	1.10	1.29				9.20	8.37	8.75	8.55				4.04	3.20	3.14	3.78			

	Cross-Section 9 (Pool - MS3)							Cross-Section 10 (Riffle - MS3)							Cross-Section 11 (Pool - MS3)							Cross-Section 12 (Riffle - MS3)						
	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+	MY0	MY1	MY2	MY3	MY5	MY7	MY+
Bankfull Elevation (ft) - Based on AB-Bankfull[1] Area	84.87	84.93	84.90	84.92				84.74	84.83	84.84	84.78				81.71	81.83	81.77	81.91				81.79	81.93	81.95	81.91			
Bank Height Ratio_Based on AB Bankfull[1] Area	N/A	N/A	N/A	N/A				1.00	0.91	0.94	1.03				N/A	N/A	N/A	N/A				1.00	0.92	0.87	0.92			
Thalweg Elevation	83.60	83.75	83.55	83.62				84.07	84.07	84.11	84.08				80.27	80.51	80.48	81.03				80.43	80.72	80.72	80.55			
LTOB[2] Elevation	84.87	84.86	84.74	84.78				84.74	84.76	84.77	84.80				81.71	81.71	81.69	81.86				81.79	81.84	81.79	81.81			
LTOB[2] Max Depth (ft)	1.27	1.11	1.19	1.17				0.67	0.69	0.66	0.72				1.44	1.20	1.21	0.83				1.35	1.12	1.06	1.25			
LTOB2 Cross-Sectional Area (ft2)	6.09	5.12	4.63	4.85				3.77	3.18	3.36	3.97				5.88	4.84	5.37	5.23				6.47	5.46	5.04	5.44			

The above morphology parameters reflect the 2018 guidance that arose from the mitigation technical workgroup consisting of DMS, the IRT and industry mitigation providers/practitioners. The outcome resulted in the focus on three primary morphological parameters of interest for the purposes of tracking channel change moving forward. They are the bank height ratio using a constant As-built bankfull area and the cross sectional area and max depth based on each years low top of bank. These are calculated as follows:

1 **- Bank Height Ratio (BHR)** takes the As-built bankful area as the basis for adjusting each subsequent years bankfull elevation. For example if the As-built bankfull area was 10 ft2, then the MY1 bankfull elevation would be adjusted until the calculated bankfull area within the MY1 cross section survey = 10 ft2. The BHR would then be calculated with the difference between the low top of bank (LTOB) elevation for MY1 and the thalweg elevation for MY1 in the numerator with the difference between the MY1 bankfull elevation and the MY1 thalweg elevation in the denominator. This same process is then carried out in each successive year.

2 - **LTOB Area and Max depth -** These are based on the LTOB elevation for each years survey (The same elevation used for the LTOB in the BHR calculation). Area below the LTOB elevation will be used and tracked for each year as above. The difference between the LTOB elevation and the thalweg elevation (same as in the BHR calculation) will be recroded and tracked above as LTOB max depth.

Note: The smaller the channel the closer the survey measurements are to their limit of reliable detection, therefore inter-annual variation in morphological measurement (as a percentage) is by default magnified as channel size decereases. Some of the variability above is the result of this factor and some is due to the large amount of depositional sediments observed.

Headwater Stream Channel Formation Table Hornpipe Branch Tributaries Mitigaiton Project				
Channel Forming Indicators - UT1	**MY1**	**MY2**	**MY3**	**MY4**
Scour (indicating sediment transport by flowing water)	Yes	Yes	Yes	
Sediment deposition (accumulations of sediment and/or formation of ripples)	No	No	No	
Sediment sorting (sediment sorting indicated by grain-size distribution within primary flow path)	No	No	Yes	
Multiple observed flow events (must be documented by gauge data and/or photographs)	Yes	Yes	Yes	
Destruction of terrestrial vegetation	No	No	Yes	
Presence of litter and debris	No	No	Yes	
Wracking (deposits of drift material indicating surface water flow)	Yes	Yes	Yes	
Vegetation matted down, bent, or absent (herbaceous or otherwise)	No	Yes	Yes	
Leaf litter disturbed or washed away	No	Yes	Yes	
Channel Forming Indicators - UT2	**MY1**	**MY2**	**MY3**	**MY4**
Scour (indicating sediment transport by flowing water)	Yes	Yes	Yes	
Sediment deposition (accumulations of sediment and/or formation of ripples)	No	No	No	
Sediment sorting (sediment sorting indicated by grain-size distribution within primary flow path)	No	No	Yes	
Multiple observed flow events (must be documented by gauge data and/or photographs)	Yes	Yes	Yes	
Destruction of terrestrial vegetation	No	No	Yes	
Presence of litter and debris	No	No	Yes	
Wracking (deposits of drift material indicating surface water flow)	Yes	No	Yes	
Vegetation matted down, bent, or absent (herbaceous or otherwise)	No	No	Yes	
Leaf litter disturbed or washed away	No	No	Yes	

UT1, flow documentation – dye test, 4/12/2023 (MY-03)

UT2, flow documentation – dye test, 4/12/2023 (MY-03)

UT1, flow documentation – dye test, 4/12/2023 (MY-03)

UT2, flow documentation – dye test, 4/12/2023 (MY-03)

MS1 Aerial, 4/12/2023 (MY-03)

MS2 Aerial, 4/12/2023 (MY-03)

MS3 Aerial, 4/12/2023 (MY-03)

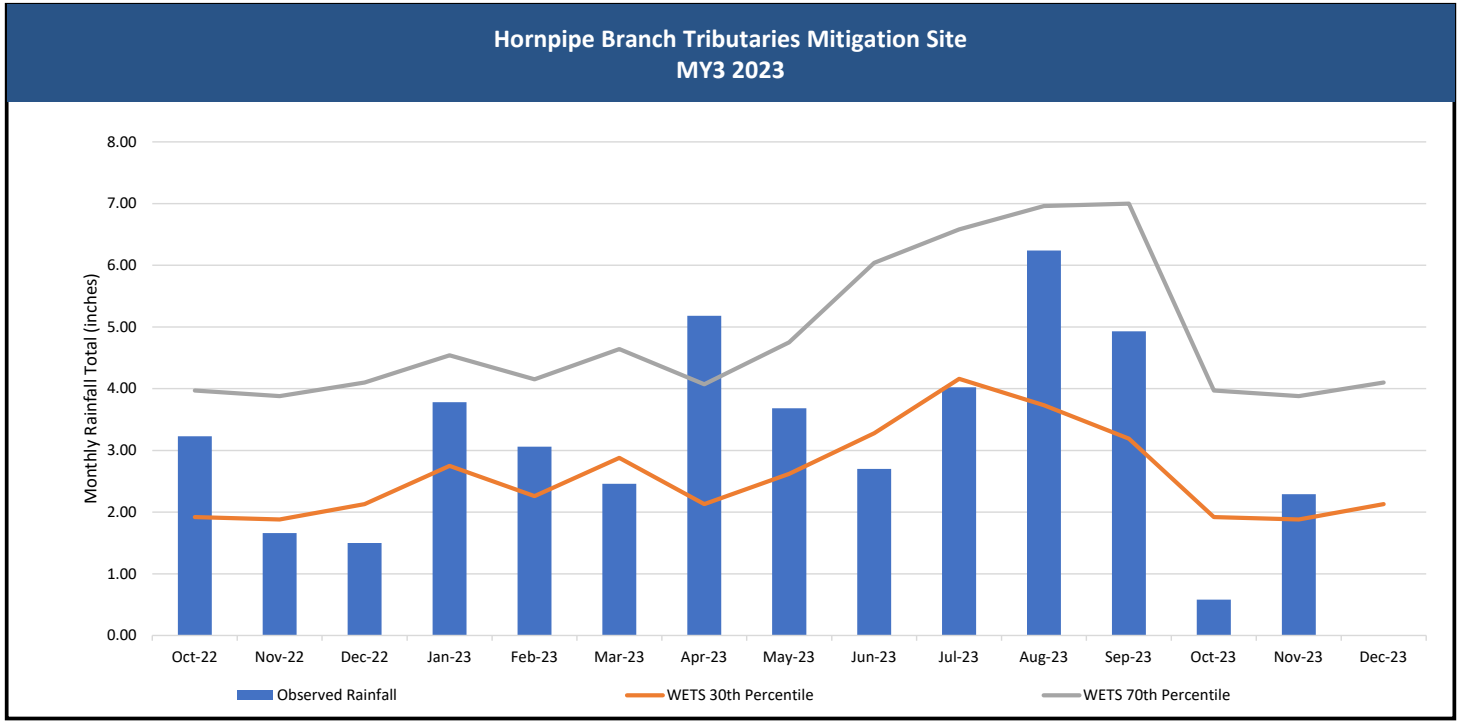
MS3, bankfull documentation - wrack lines (MY-03)

Appendix D:
Hydrologic Data

Verification of Bankfull Events
Monthly Rainfall Summary Data
Water Level Hydrographs
Flow Gauge and Crest Gauge Installation Diagrams
Wetland Hydrology Criteria Attainment Table and Graphs

Hornpipe Branch Tributaries Mitigation Project: Overbank Events (MY3) Crest Gauge CG-1 (MS3)					
	Date of Collection	Date of Occurrence	Method	Notes	Measurement Above Bankfull (feet)
MY1	4/7/2021	3/27/2021 - 3/28/2021	Pressure Transducer	Bankfull due to rainfall event	0.411
	4/7/2021	4/1/2021	Pressure Transducer	Bankfull due to rainfall event	0.488
	8/5/2021	unknown	Cork Gauge	Evidence of bankfull on traditional cork gauge	0.85
	10/19/2021	unknown	Cork Gauge	Evidence of bankfull on traditional cork gauge	0.45
MY2	4/5/2022	1/3/2022	Pressure Transducer	Bankfull due to rainfall event	1.058
	4/5/2022	1/10/2022	Pressure Transducer	Bankfull due to rainfall event	0.131
	4/5/2022	1/16/2022	Pressure Transducer	Bankfull due to rainfall event	1.48
	7/11/2022	4/6/2022	Pressure Transducer	Bankfull due to rainfall event	0.599
	7/11/2022	6/4/2022	Pressure Transducer	Bankfull due to rainfall event	1.165
	7/11/2022	7/9/2022	Pressure Transducer	Bankfull due to rainfall event	0.458
	9/29/2022	7/13/2022	Pressure Transducer	Bankfull due to rainfall event	0.309
	9/29/2022	7/31/2022	Pressure Transducer	Bankfull due to rainfall event	0.529
	9/29/2022	8/21/2022	Pressure Transducer	Bankfull due to rainfall event	0.623
MY3	4/12/2023	1/22/2023 - 1/23/2023	Pressure Transducer	Bankfull due to rainfall event	0.222
	4/12/2023	1/25/2023 - 1/26/2023	Pressure Transducer	Bankfull due to rainfall event	0.623
	4/12/2023	2/2/2023 - 2/6/2023	Pressure Transducer	Bankfull due to rainfall event	0.729
	4/12/2023	2/12/2023 - 2/13/2023	Pressure Transducer	Bankfull due to rainfall event	0.637
	4/12/2023	4/8/2023 - 4/9/2023	Pressure Transducer	Bankfull due to rainfall event	1.362
	4/12/2023	Unknown	Photos	Wrack Lines	NA
	7/7/2023	4/28/2023	Pressure Transducer	Bankfull due to rainfall event	0.169
	7/7/2023	4/30/2023 - 5/1/2023	Pressure Transducer	Bankfull due to rainfall event	0.281
	9/6/2023	8/30/2023 - 9/2/2023	Pressure Transducer	Bankfull due to rainfall event	2.327
	9/6/2023	9/6/2023	Pressure Transducer	Bankfull due to rainfall event	0.425
MY3 total of 10 Bankfull events with a high of 2.327					

Hornpipe Branch Tributaries Mitigation Project: Overbank Events (MY3) Crest Gauge CG-2 (MS1)					
	Date of Collection	**Date of Occurrence**	**Method**	**Notes**	**Measurement Above Bankfull (feet)**
MY1	Not Installed in MY1				
MY2	4/5/2022	1/3/2022	Pressure Transducer	Bankfull due to rainfall event	1.28
	4/5/2022	1/10/2022	Pressure Transducer	Bankfull due to rainfall event	0.236
	4/5/2022	1/16/2022	Pressure Transducer	Bankfull due to rainfall event	1.654
	4/5/2022	Unknown	Visual	Observance of wrack lines, alluvial deposit in floodplain of MS1	NA
	4/5/2022	4/5/2022	Pressure Transducer	Bankfull due to rainfall event	0.911
	7/11/2022	6/4/2022	Pressure Transducer	Bankfull due to rainfall event	1.676
	7/11/2022	7/8/2022	Pressure Transducer	Bankfull due to rainfall event	0.344
	9/29/2022	7/14/2022	Pressure Transducer	Bankfull due to rainfall event	0.289
	9/29/2022	7/31/2022	Pressure Transducer	Bankfull due to rainfall event	0.465
	9/29/2022	8/21/2022	Pressure Transducer	Bankfull due to rainfall event	0.791
MY3	4/12/2023	1/22/2023	Pressure Transducer	Bankfull due to rainfall event	0.353
	4/12/2023	1/25/2023 - 1/26/2023	Pressure Transducer	Bankfull due to rainfall event	0.762
	4/12/2023	1/30/2023	Pressure Transducer	Bankfull due to rainfall event	0.048
	4/12/2023	2/2/2023 - 2/6/2023	Pressure Transducer	Bankfull due to rainfall event	0.867
	4/12/2023	2/12/2023 - 2/14/2023	Pressure Transducer	Bankfull due to rainfall event	0.782
	4/12/2023	3/27/2023	Pressure Transducer	Bankfull due to rainfall event	0.236
	4/12/2023	4/8/2023 - 4/10/2023	Pressure Transducer	Bankfull due to rainfall event	1.535
	7/7/2023	4/30/2023	Pressure Transducer	Bankfull due to rainfall event	0.169
	9/6/2023	8/30/2023 - 8/31/2023	Pressure Transducer	Bankfull due to rainfall event	2.113
MY3 total of 9 Bankfull events with a high of 2.113					

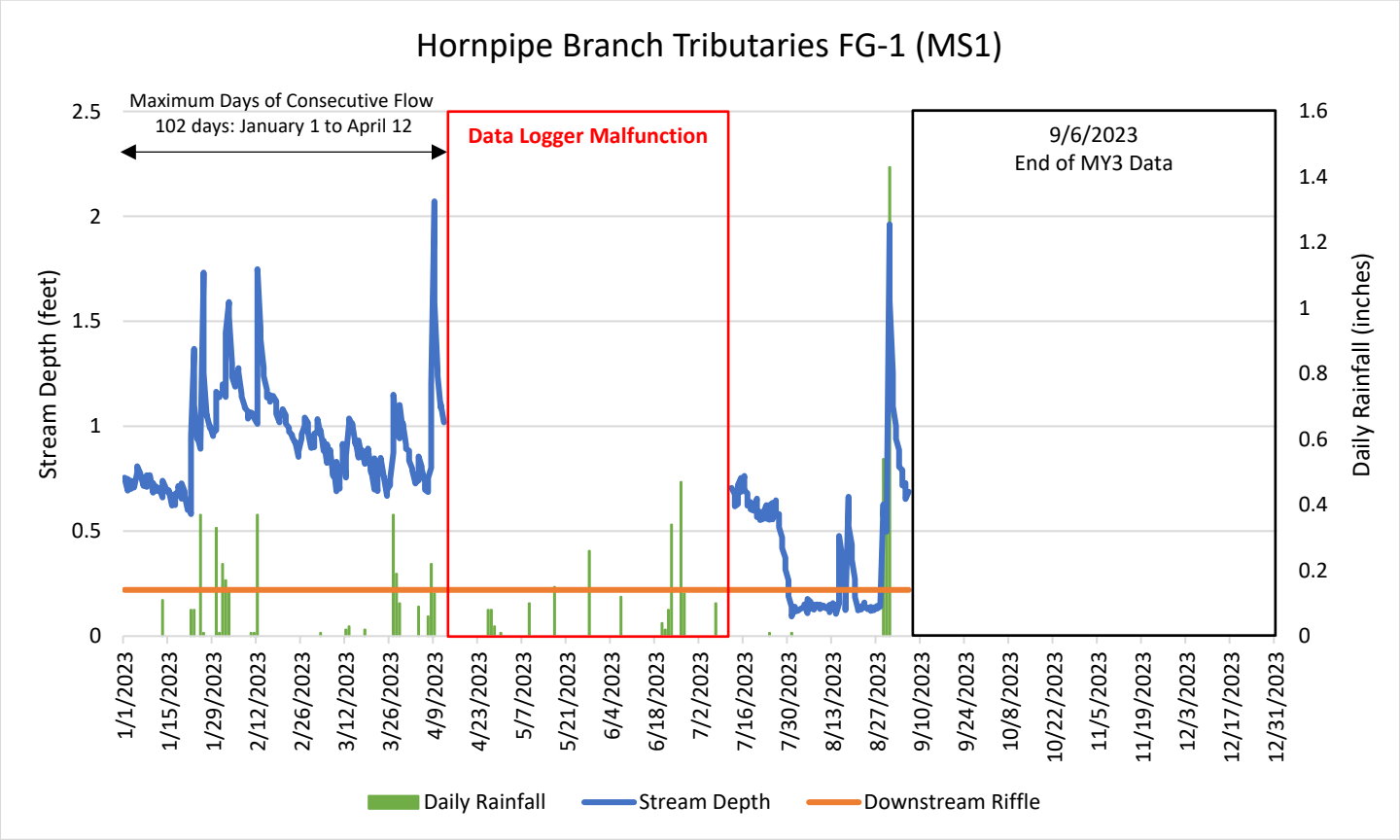


Hornpipe Branch Tributaries Mitigation Project Monthly Rainfall Summary															
	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23
Observed Rainfall	3.23	1.66	1.50	3.78	3.06	2.46	5.18	3.68	2.70	4.02	6.24	4.93	0.58	2.29	**
WETS 30th Percentile	1.92	1.88	2.13	2.75	2.26	2.88	2.13	2.62	3.28	4.16	3.73	3.19	1.92	1.88	2.13
WETS 70th Percentile	3.97	3.88	4.10	4.54	4.15	4.64	4.07	4.75	6.04	6.58	6.96	7.00	3.97	3.88	4.10
Low/Normal/High	N	L	L	N	N	L	H	N	L	L	N	N	L	N	**

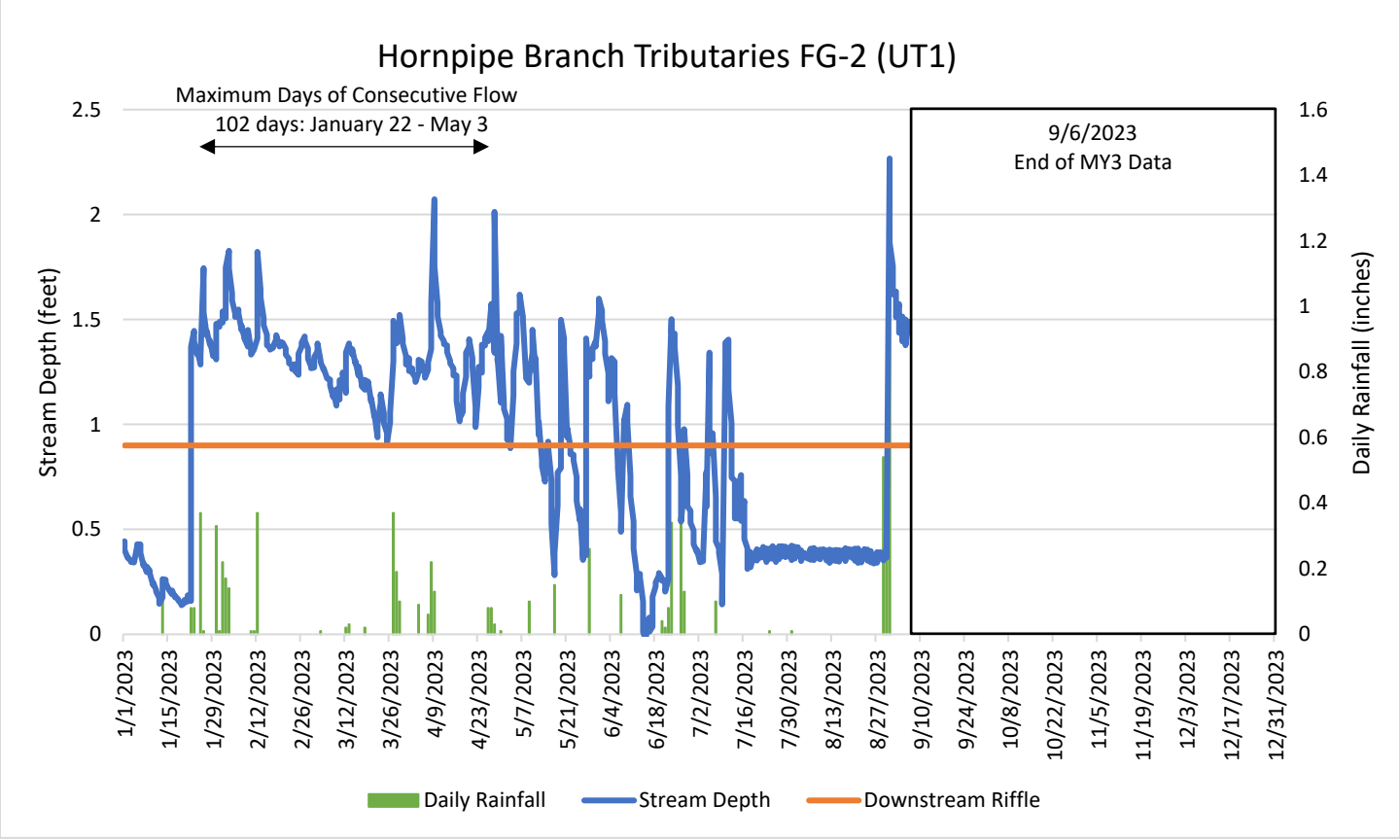
*30th and 70th Percentile data collected from data from WETS Station: KINSTON AG RESEARCH, NC

**Incomplete Month

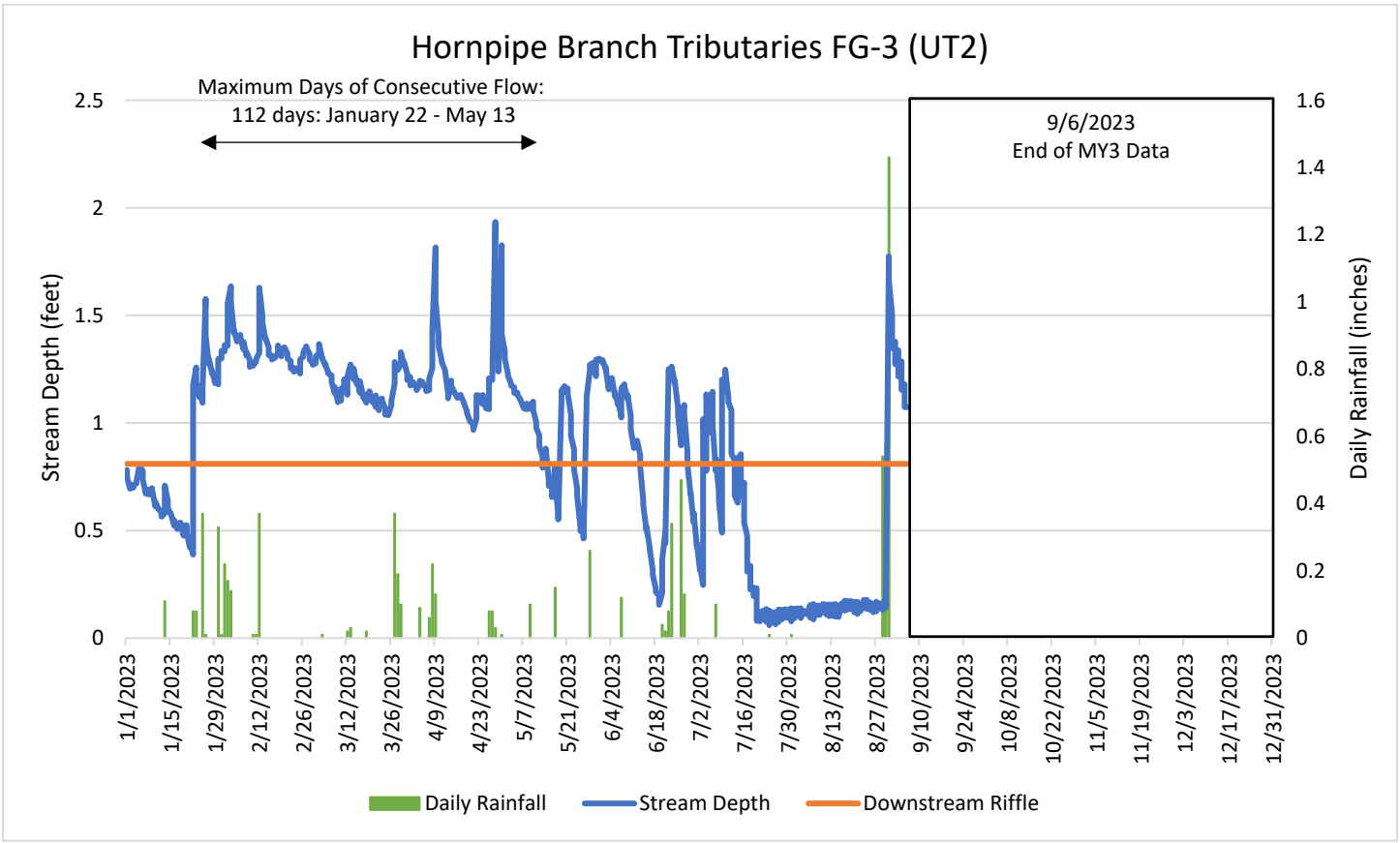
Flow Gauge Data – Hornpipe Branch Tributaries MY3



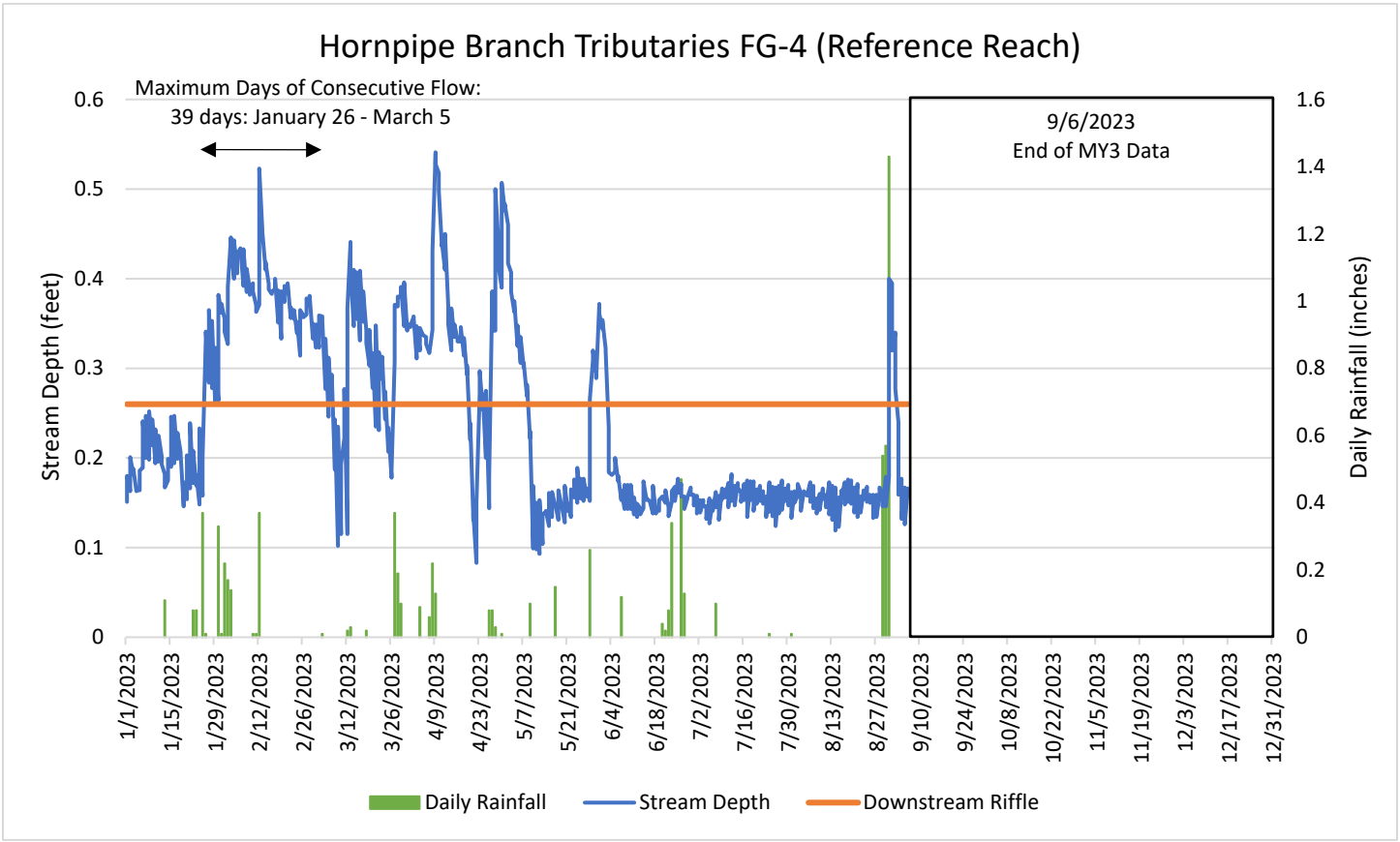
*247 days of cumulative flow in MY3, 25 days of cumulative no flow in MY3



*117 days of cumulative flow in MY3, 155 days of cumulative no flow in MY3

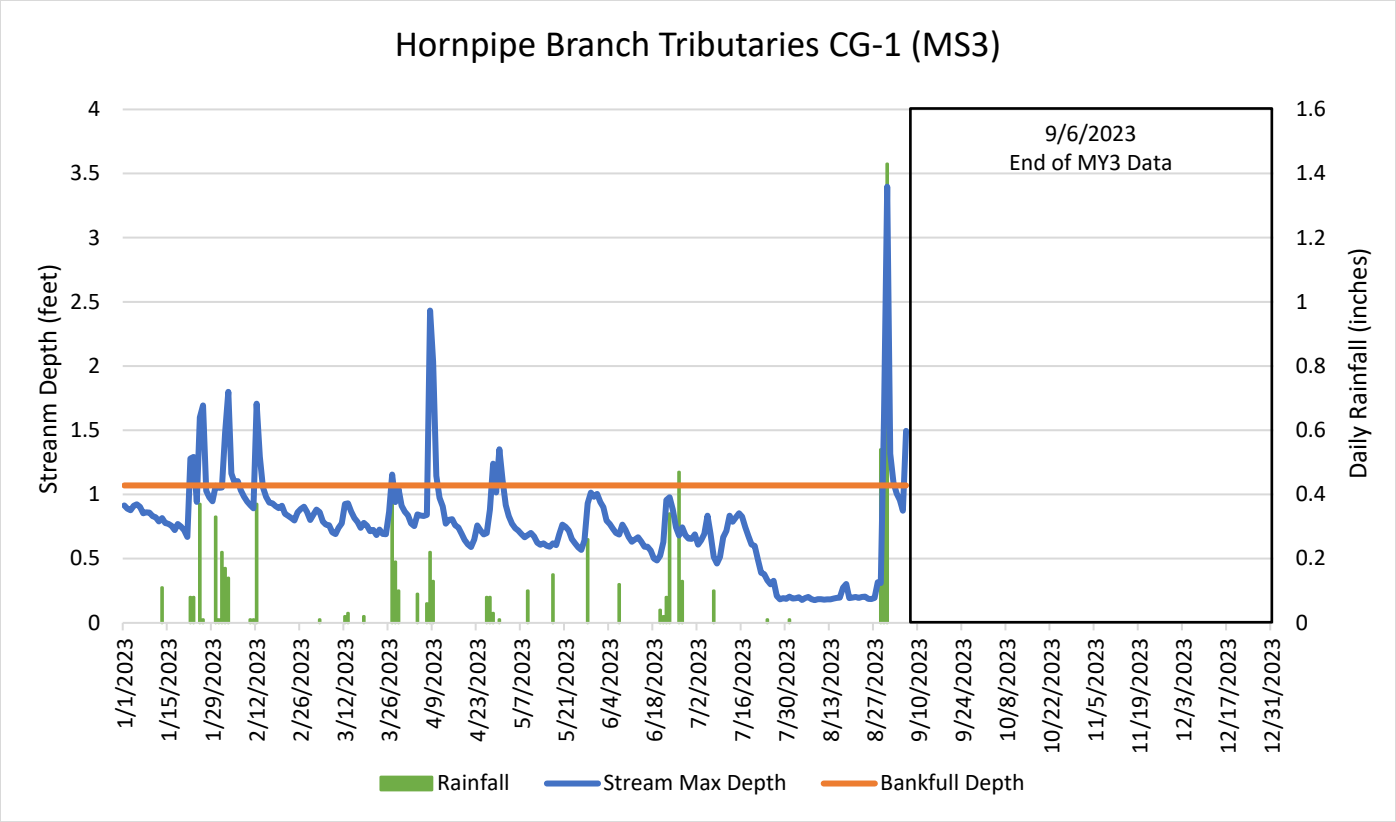


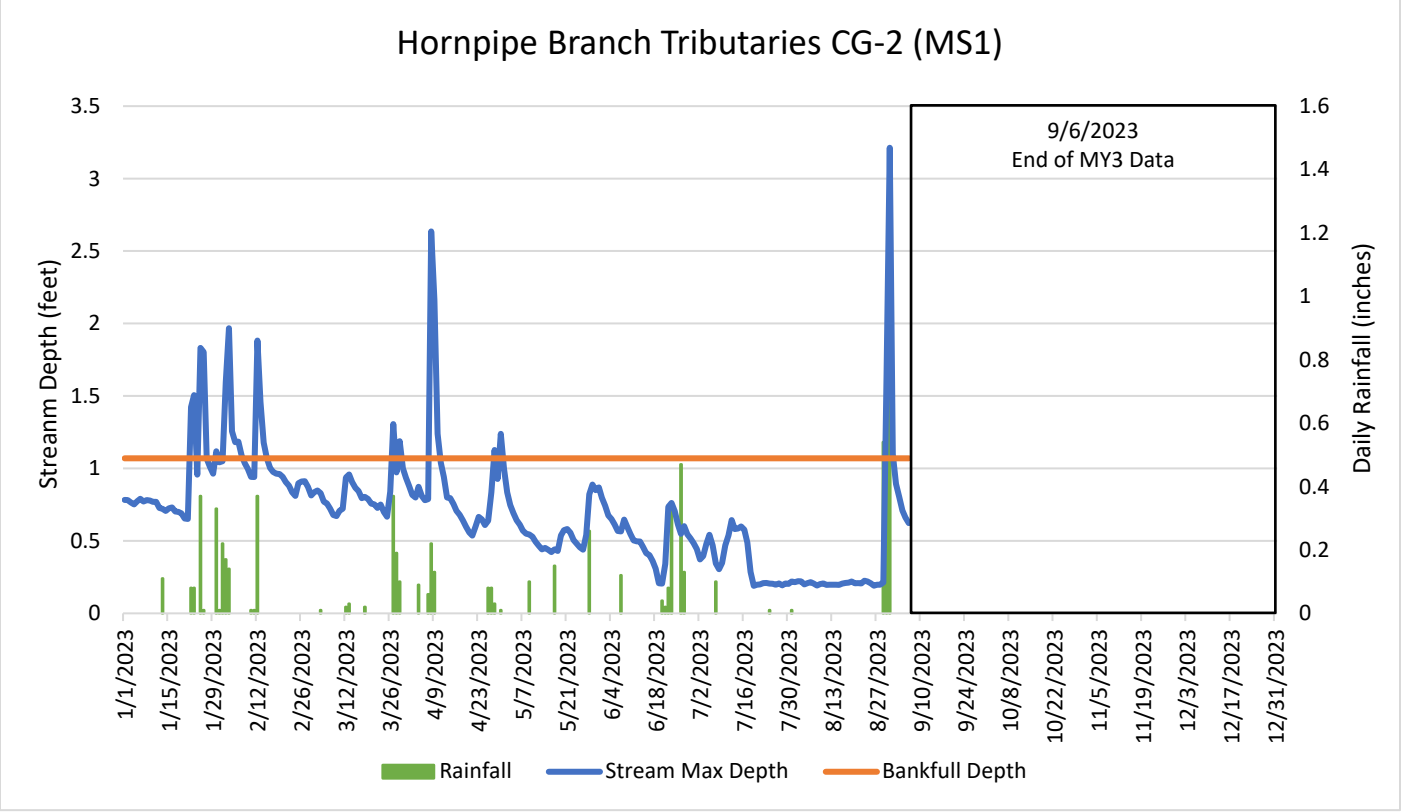
*154 days of cumulative flow in MY3, 118 days of cumulative no flow in MY3

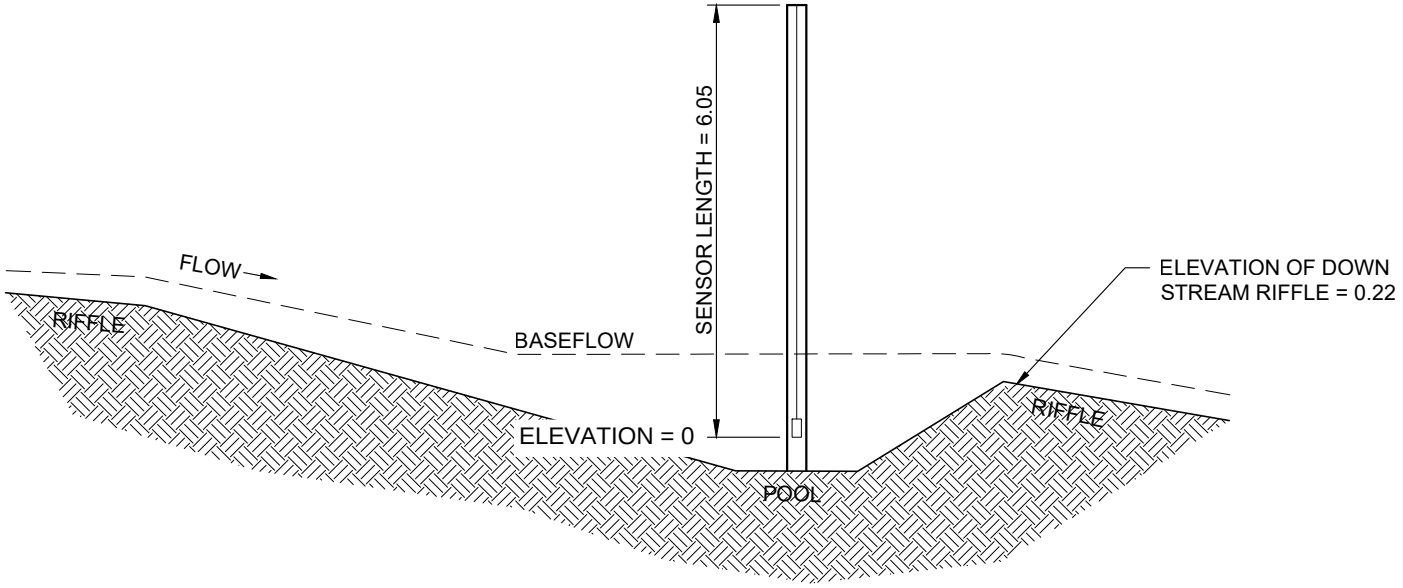


*99 days of cumulative flow in MY3, 151 days of cumulative no flow in MY3

Crest Gauge Data – Hornpipe Branch Tributaries MY3



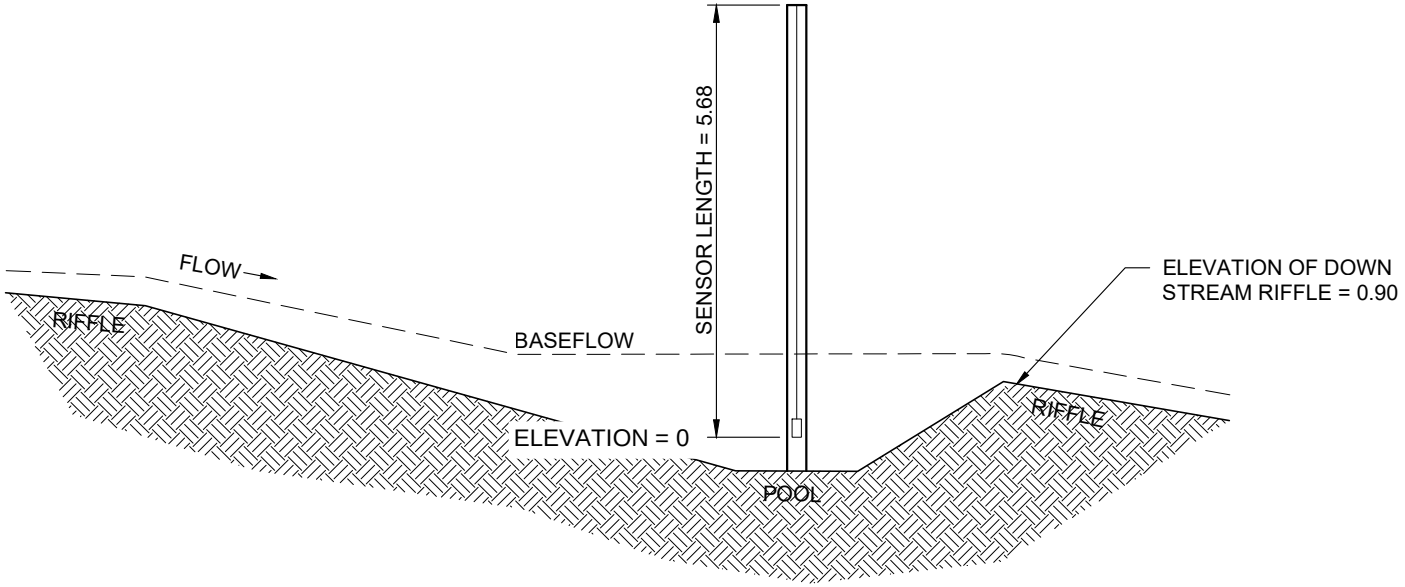




FLOW GAUGE #1 - MS1

Flow Depth = 0.22 feet

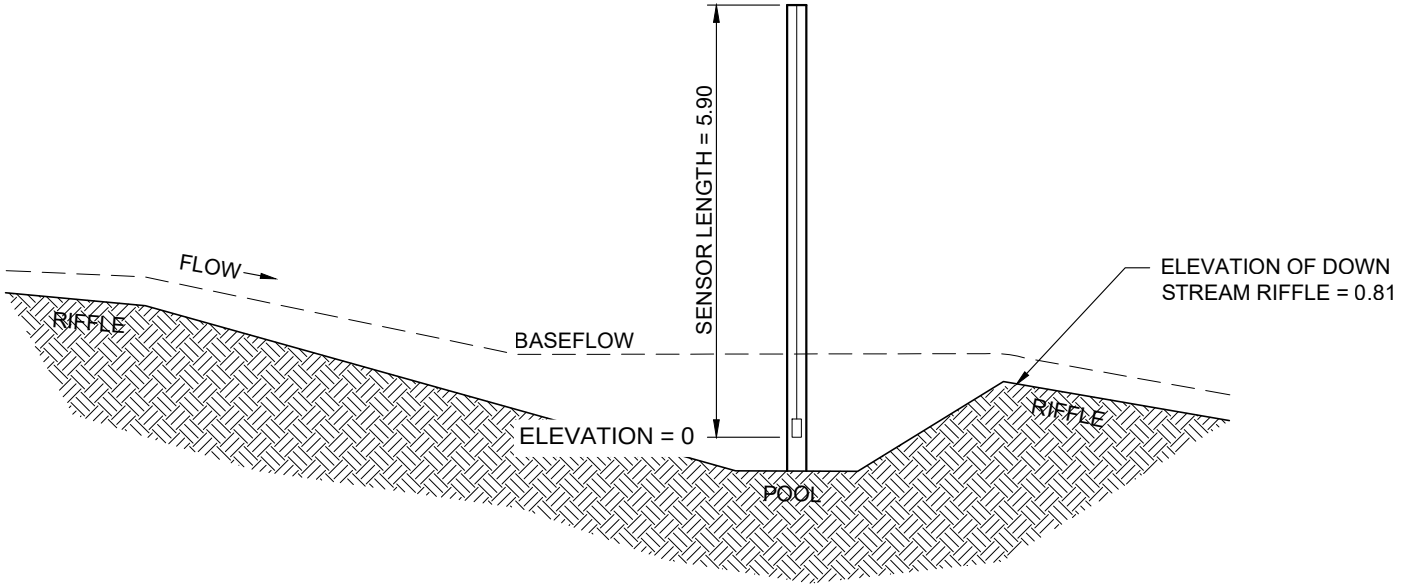
*All elevations relative to sensor depth



FLOW GAUGE #2 - UT1

Flow Depth = 0.90 feet

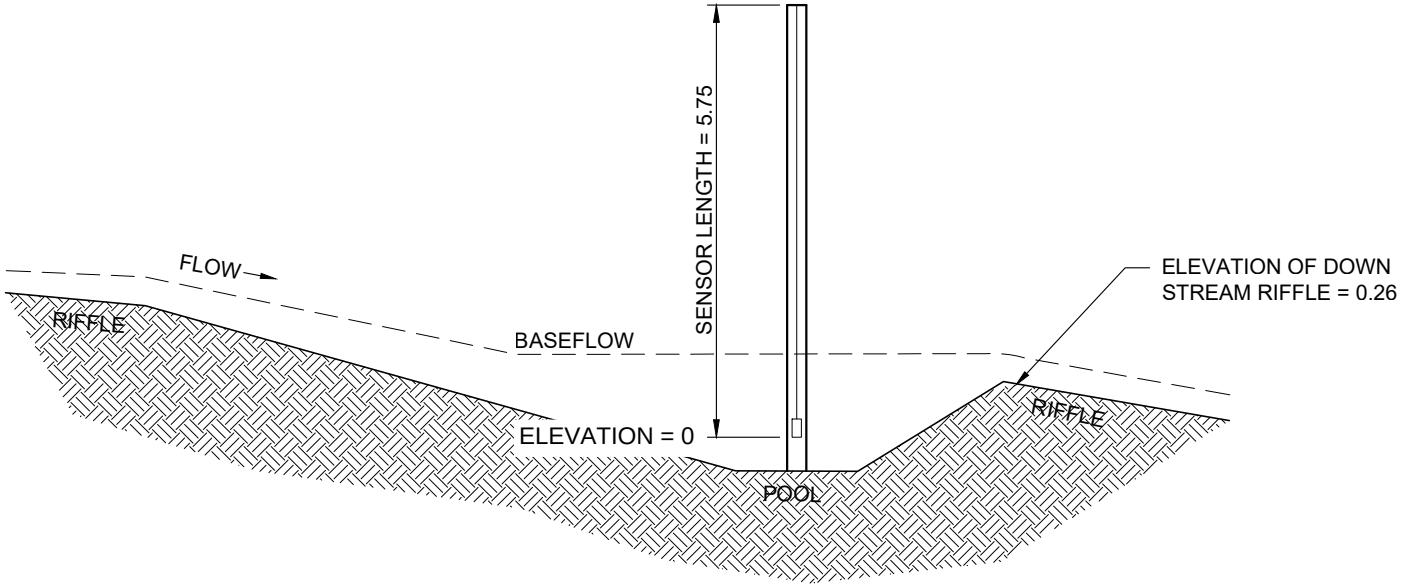
*All elevations relative to sensor depth



FLOW GAUGE #3 - UT2

Flow Depth = 0.81 feet

*All elevations relative to sensor depth

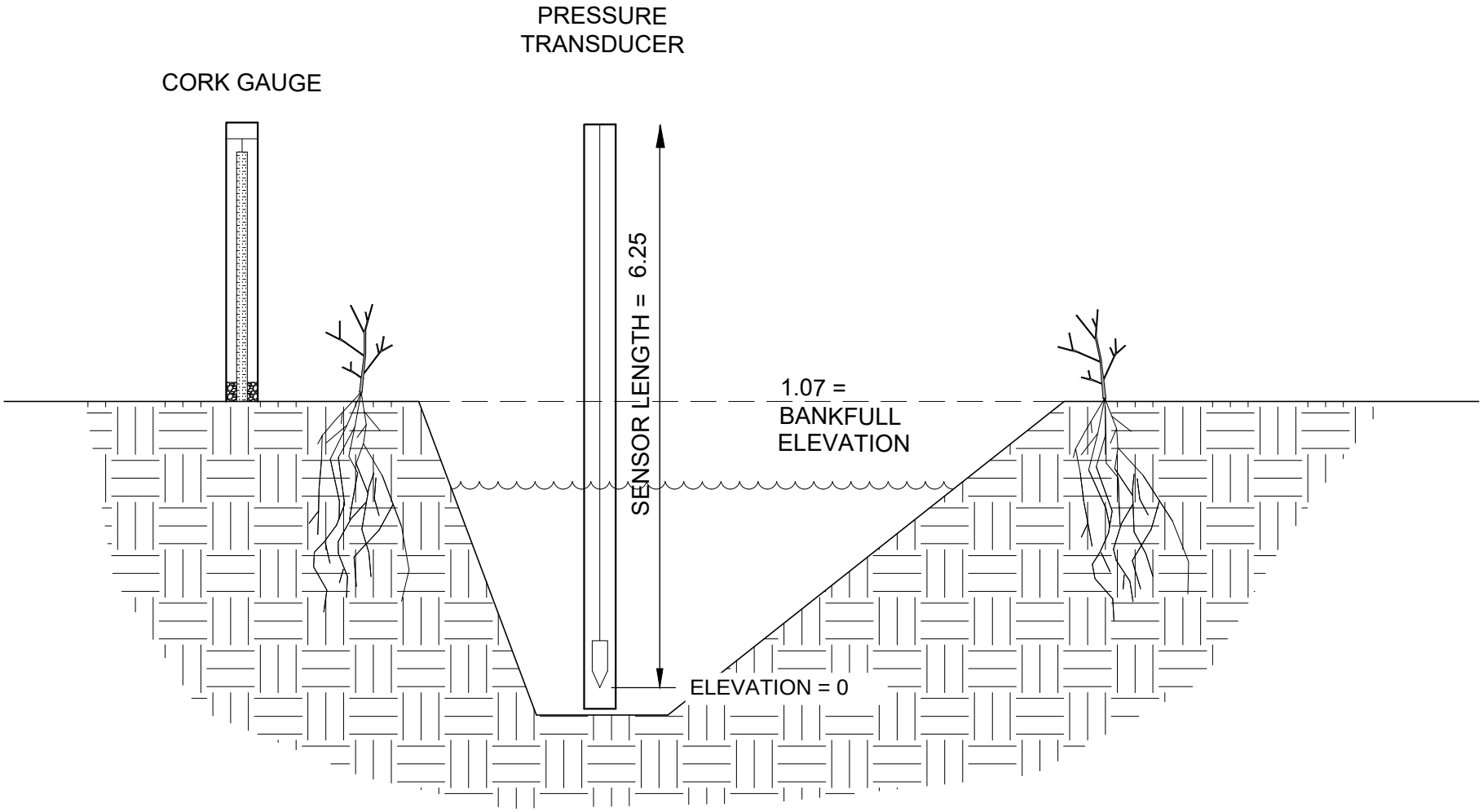


FLOW GAUGE #4 - Reference Reach

Flow Depth = 0.26 feet

*All elevations relative to sensor depth

CROSS SECTIONAL VIEW OF STREAM

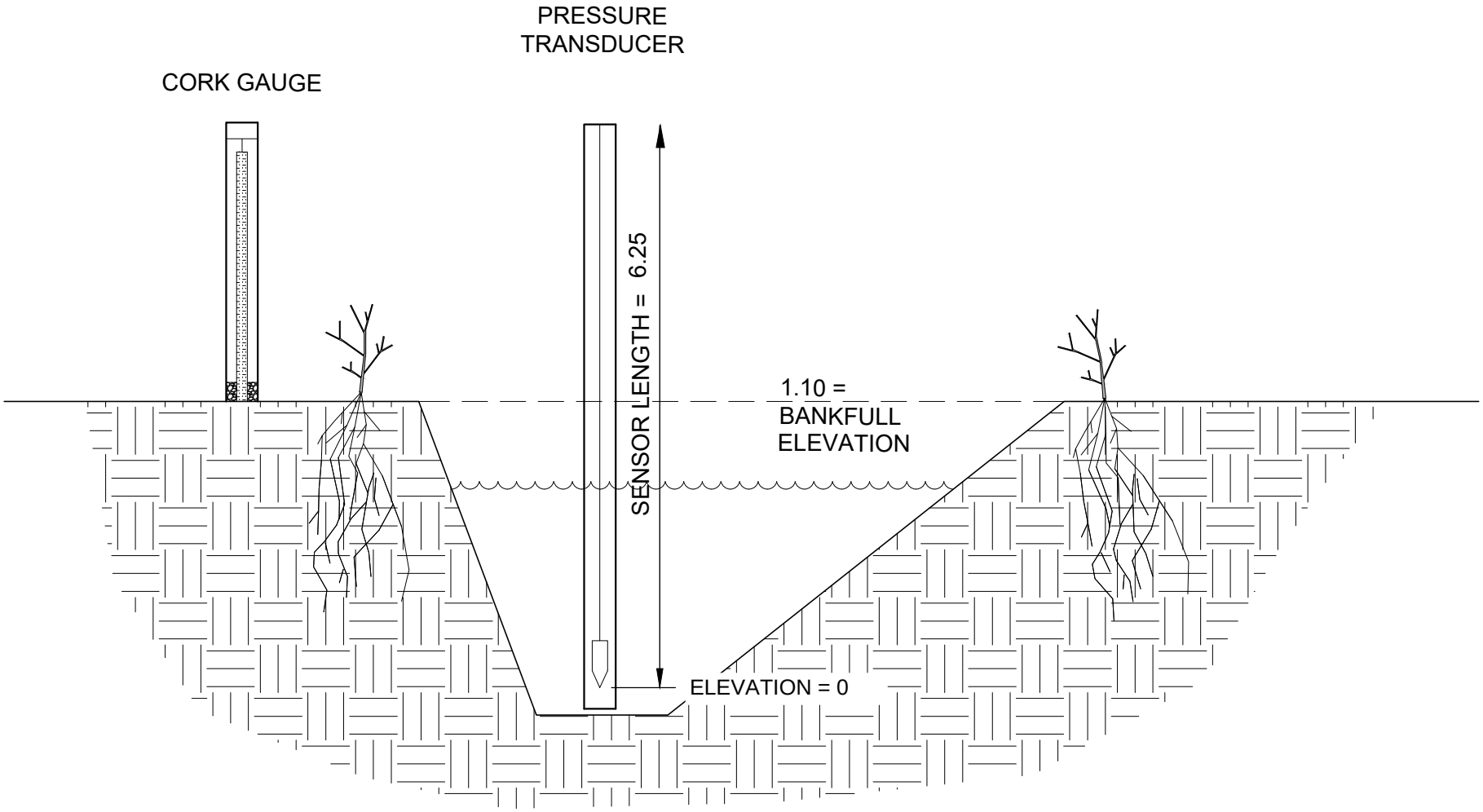


Crest Gauge CG-1 (MS-3)

Bankfull Event Depth = 1.07 feet

*All elevations relative to sensor depth

CROSS SECTIONAL VIEW OF STREAM



Crest Gauge CG-2 (MS-1)

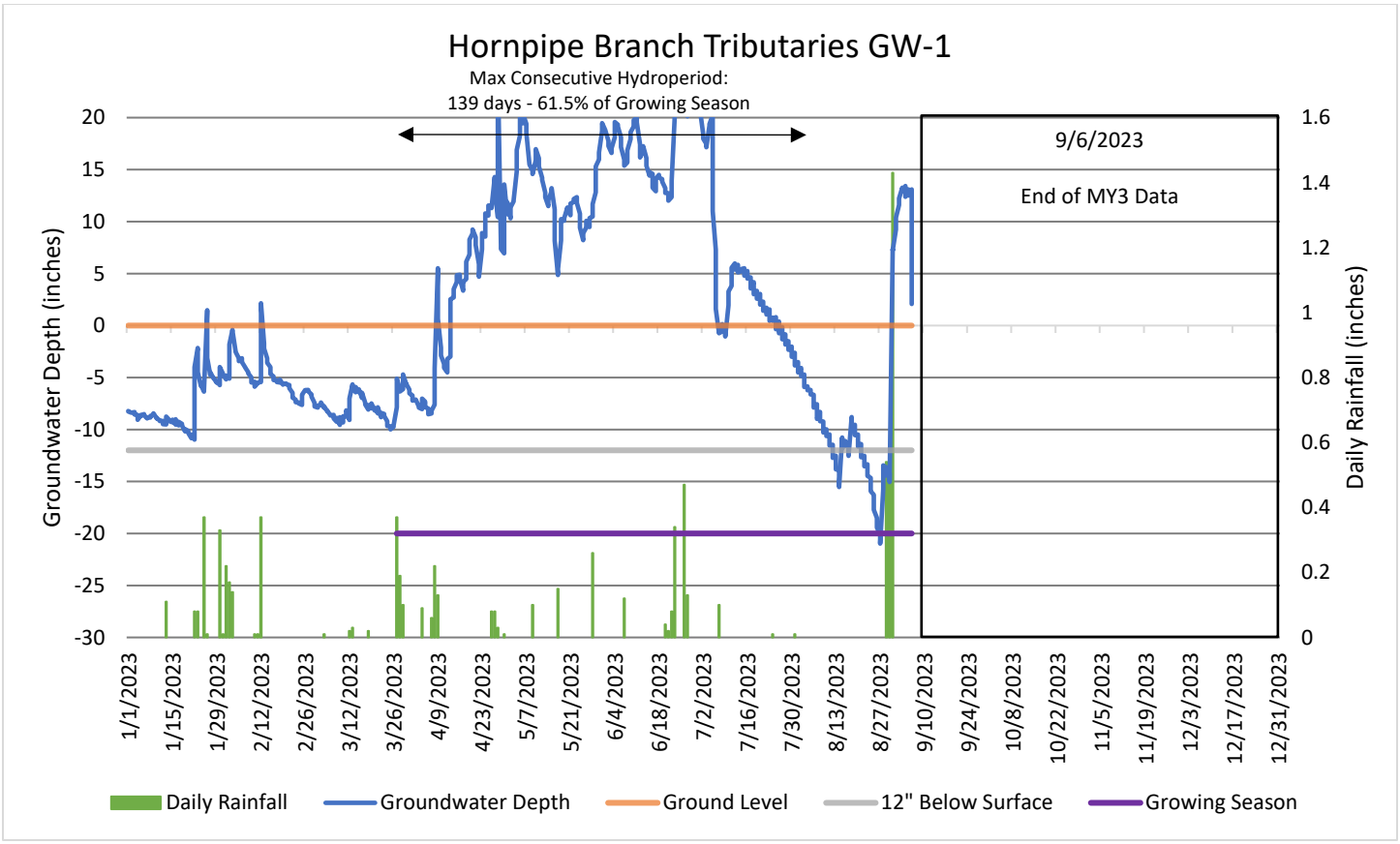
Bankfull Event Depth = 1.10 feet

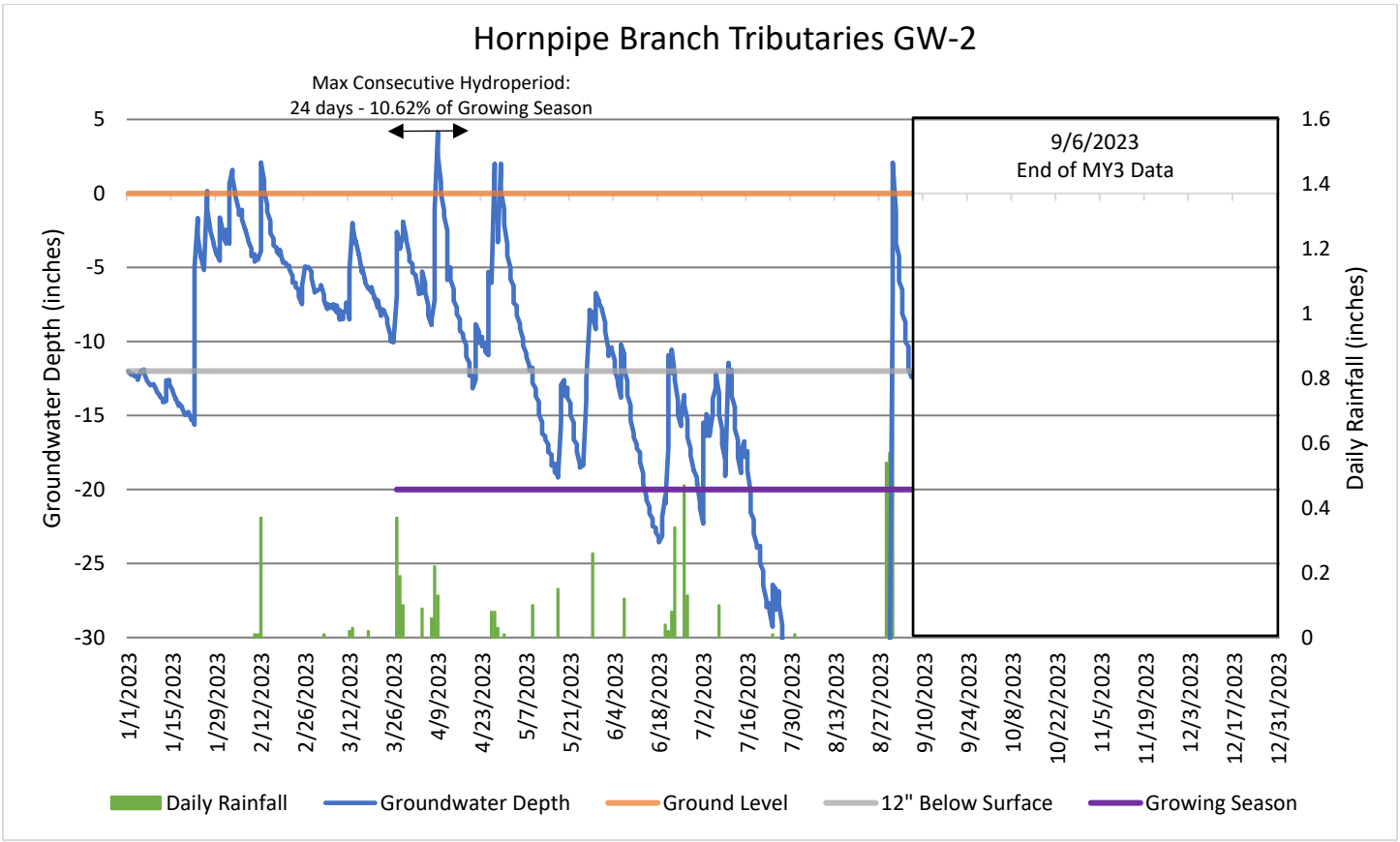
*All elevations relative to sensor depth

Hornpipe Branch Tributaries Wetland Hydrology Criteria Attainment Table									
	Performance Standard: N/A* WETS Station: Kinston Ag Research, Inc Growing Season: 3/27 to 11/7 (225 days) Max. Consecutive Hydroperiod (%)								
Monitoring Gauge	MY 1 2021	MY2 2022	MY 3 2023	MY 4 2024	MY 5 2025	MY 6 2026	MY 7 2027	MY 7+ 2028	Average
GW-1	12.00%	27.56%	61.50%						33.69%
GW-2	11.56%	8.44%	10.62%						10.21%

*No wetland mitigation credits were contracted or proposed for Hornpipe Branch Tributaries therefore no performance standards for wetland hydrology success are proposed.

Groundwater Gauge Data – Hornpipe Branch Tributaries MY3





Appendix E:

Project Timeline and Contact Info

Project Timeline and Contacts		
Activity or Deliverable	**Data Collection Complete**	**Task Completion or Deliverable Submission**
Project Instituted	NA	6/14/2018
Mitigation Plan Approved	NA	7/6/2020
Construction (Grading) Completed	NA	3/26/2021
Planting Completed	NA	4/3/2021
As-built Survey Completed	NA	5/14/2021
MY-0 Baseline Report	4/29/2021	6/18/2021
MY1 Monitoring Reports	10/19/2021	11/29/2021
MY2 Monitoring Reports	9/30/2022	11/30/2022
Beaver Removal from Site (2 total)	N/A	10/20/2023
MY3 Monitoring Reports	9/6/2023	12/15/2023

Hornpipe Branch Tributaries	
Provider	7721 Six Forks Road, Suite 130
Water & Land Solutions, LLC	Raleigh, NC 27615
Mitigation Provider POC: Leah Farr	(919) 971 - 4575
Designer	7721 Six Forks Road, Suite 130
Water & Land Solutions, LLC	Raleigh, NC 27615
Primary project design POC: Kayne Van Stell	(919) 818-8481
Construction Contractor	453 Silk Hope Liberty Road
Wright Contracting, LLC	Siler City, NC 27344
Primary contractor POC: Ben Johnson	(336) 402-8312

Appendix F:
MY3 Benthic Data

Macrobenthic Sampling Data

MS3 - Hornpipe Branch Tributaries Mitigation Site			
Monitoring Year	MY0	MY3	
Biotic Index Score	NA*	7.72	
Water Quality Level	NA*	Poor	

**No benthics were collected during sampling*

MY3 - View Upstream

MY3 - View Downstream

Biotic Index Data and Scores	
MY3 2023	
Taxa / Biotic Index Value	**MS3**
TRICHOPTERA	
Family Hydropsychidae	
Cheumatopsyche spp (6.6)	A
ODONATA	
Family Coenagrionidae	
Enallagma spp (8.5)	C
COLEOPTERA	
Family Haliplidae	
Peltodytes spp (8.4)	R
Family Hydrophilidae	
Tropisternus spp (9.3)	R
DIPTERA; CHIRONOMIDAE	
no genus specified (7.2)	C
HEMIPTERA	
Family Belostomatidae	
Belostoma spp (9.5)	R
Family Corixidae	
Sigara spp (8.7)	A
CRUSTACEA	
Family Cambaridae	
Orconectes spp (2.7)	R
GASTROPODA	
Family Physidae	
Physa spp (8.7)	R
HIRUDINEA	
Family Glossiphoniidae	R
Total Taxa Richness	**10**
EPT Taxa Richness	**1**
EPT Abundance	**11**
Biotic Index	**7.72**
Key **R = Rare, C = Common, A = Abundant**	

*no benthics were found at pre-construction sampling (MY0)